REPORT
OF A

# CONSENSUS CONFERENCE ON APPROPRIATE LOWER LIMB ORTHOTICS FOR DEVELOPING COUNTRIES

HANOI, VIETNAM
3-8 APRIL 2006

EDITED BY
NERROLYN RAMSTRAND
AND
NORMAN A JACOBS

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## ACKNOWLEDGEMENTS

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The Society undertook the arrangements for the conference.

The Vietnamese College of Orthopaedic Technology (VIETCOT) provided the local organization in Hanoi which the organisers gratefully acknowledge.

The Organizing Committee thank all the presenters and participants for their active contributions throughout the conference.

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# PART 1

## Organisation and outcomes

## Background

## Nerrolyn Ramstrand and Norman A Jacobs

The Consensus Conference on Appropriate Lower Limb Orthotics for Developing Countries follows on from the Consensus Conferences on Appropriate Prosthetics for Developing Countries held in Phnom Penh, Cambodia in 1995 and Appropriate Orthopedic Technology for Low-Income Countries held in Moshi, Tanzania in 2000.

The purpose of this conference was to pick up from some of the topics identified in the two previous conferences on orthotics in the developing world and in particular, orthotics related to the lower limb. The conference covered the lower limb orthotic management of poliomyelitis, clubfoot, trauma, stroke/traumatic brain injury and feet lacking protective sensation.

Once again this conference was organized by the International Society for Prosthetics and Orthotics (ISPO) in collaboration with the Leahy War Victims Fund of the United States Agency for International Development (LWVF-USAID) and the World Health Organization (WHO). The local organizers were VIETCOT/GTZ.

The meeting was attended by representatives of all the major agencies involved in the provision of lower limb orthotics services in the developing world and ISPO, LWVF-USAID and WHO are grateful for the input that they made in presenting background papers and the contributions they made in the ensuing discussions.

This publication reports on the work of the conference and contains the background papers and the discussions on them, detailed reports of the syndicate discussions on selected topics, the resulting plenary discussions, and the final conclusions and recommendations.

ISPO appreciates the efforts of all the people involved in this meeting and hopes that this report of this conference goes some way to help improve the lower limb orthotics services in developing countries.

## Opening ceremony

## Mr Harold Shangali, President ISPO

Mr Chairman
Representative of the Leahy War Victim Fund, USAID: Mr Rob Horvath
Representative of the World Health Organisation: Mr Chapal Khasnabis
Representative of MOLISA: Dr Dam Huu Dac
Representative of the Ministry of Health: Mr Tran Trong Hai
Representative of the German Agency for Technical Cooperation: Mr Guenter Rietmacher
Chairman of the Conference Organising Committee: Dr Bakht Sarwar
The US Ambassador to Vietnam: Mr Michael Marine
Distinguished Participants and Guests

On behalf of the International Society of Prosthetics and Orthotics, and myself, I wish to extend a word of thanks to all of you and, in particular, the guest of honour Dr Dac for accepting to host this conference in Hanoi, Vietnam. My sincere thanks should go to the representatives of the Leahy War Victim Fund of USAID for supporting this conference and other related activities associated with the work of ISPO in helping to ensure that the quality of life for people with disability is achieved. WHO has also been a major collaborator in all the Society's areas of education, training, service delivery and research and therefore we continue to register our appreciation.

As with the ISPO consensus conference on lower limb prosthetic technology in Phnom Penh, Cambodia, 1995 and the conference on orthopaedic technology in Moshi, Tanzania, 2000, we have great expectations of extending discussions on lower limb orthotics with experts from different countries and work with different organizations in developing countries. Once again, ISPO in consultation with LWVF-USAID, WHO and other organizations/ institutions has appreciated the need to gather expert views of experiences of the different technological approaches as well as the experiences and opinions of the users.

The continuing growth of the understanding for both appropriate technology and education in this field of rehabilitation medicine has, to a certain extent, resulted in raising consumer awareness in terms of their role in determining their treatment course. There have been a number of WHO conferences of different groups of people with disabilities in Helsinki, Finland, 2003;, Johannesburg, South Africa, 2003 and Geneva, Switzerland, 2005 amongst others, addressing the equalisation of opportunities and their role in determining what is best for their own quality of life. This is a vivid challenge on the need to revisit the approach of our entire practice in the field of rehabilitation medicine and thereby open ourselves to an inclusion principle in order to optimize the services rendered to people with physical disabilities.

It is therefore my sincere hope that, we will reach to a consensus in most of the controversial issues in orthotics technology but if not then an understanding of these issues will stimulate and provoke positive challenges.

I look forward for a successful conference

Thank you very much.

## Dr Dam Huu Dac, Vice Minister of Ministry of Labor, Invalids and Social Affairs (MOLISA), Vietnam

His Excellency ISPO President, His Excellency United State Ambassador, Ladies and Gentlemen

First of all, I would like to thank the President and the Organizing Committee for inviting me and giving me the honour to address at the Opening Ceremony of this important conference. On behalf of the Ministry of Labor, Invalids and Social Affairs (MOLISA), I would like to warmly welcome all participants to the consensus conference on appropriate lower limb orthotics for developing countries held in Hanoi, the capital of our country.

Along with human history, disability have appeared and existed due to different reasons. Thanks to the rapid development of modern technology, the number of disabled persons may be reduced gradually but can not disappear totally and no one can say for sure that they will never get disabled for their whole life. This is due to on-going consequences of epidemics, diseases, contaminated environment, war, traffic accidents, and work-related accidents. In this regards, developing countries are facing great challenges and difficulties. Disability often comes along with poverty. Therefore, to help disabled people and their families get out of poverty and integrate into the society; in addition to economic assistance policies, it is necessary to provide them health support, orthopaedics and rehabilitation, particularly early detection and timely surgery. Together with the support of Government, communities and families, disabled people can feel themselves no different to other citizens and despite their disability, they are as valuable as other people and must be respected the same as other citizens.

Participants, in Vietnam, a war-torn country suffering from consequences of frequent natural disasters, the number of disabled people is 5.3 million people, covering 6.63% of the total population. Among which, the mobility disabled persons occupy the largest percentage (29.41%). For the past many years, in addition to its economic development policies, the Government has given guidelines and completed the legal system to ensure social welfare policies for everyone and particularly the social protection policies for disadvantaged group, including disabled people. With great efforts by the Government, community and support from the international organizations, hundreds of thousands of Vietnamese disabled people are rehabilitated and provided with orthopaedic devices to integrate into the society. With 20 orthopaedic and rehabilitation centres nationwide, the need for prostheses and orthoses for disabled people has been gradually matched. Remarkably, since the establishment of VIETCOT, international technology and expertise have contributed to train our rehabilitation and orthotic technologists, provide better quality rehabilitation services and orthopedic devices for disabled people. We recognize all the active and valuable support from international organizations, NGOs whose many representatives are present here today.

On behalf of MOLISA, I would like to express our sincere thanks for the kind support of international organizations and participants for Vietnamese disabled people. At the same time, I do believe that on the basis of the fine existing cooperation and for the common goal to facilitate the equal social inclusion of disabled people into the society, disabled people in Vietnam in particular and in the world in general will continue to get efficient assistance from the international prosthetics and orthotics organizations that you participants represent here. We are now advising the Government for the National Action programme on early detection, early surgery and timely rehabilitation as well as provision of good quality orthopaedic devices for disabled people to help them integrate fully and equally into the socio-economic activities of the country. We expect to share experience, expertise with all participants here and hope to get your support.

On the occasion that ISPO, in collaboration with sponsoring agencies organize this important conference, once again, I take this opportunity to wish you all good health, happiness and success.

Thank you!

## Mr Michael Marine, US Ambassador to Vietnam

Vice Minister Dr Dam Huu Dac, members of the International Society of Prosthetics and Orthotics, Distinguished Guests, Ladies and Gentlemen.

Good morning and thank you for inviting me to speak at the opening of the International Society of Prosthetics and Orthotics Conference. This conference brings together a diverse group of delegates from around the world. Over the next few days you will have a unique opportunity to share best practices with Vietnamese experts, to discuss quality assurance in orthotic development and delivery and most importantly, to develop a concrete set of guidelines for good orthotic treatment in the developing world.

Looking around the room, I see a tremendous amount of skill and dedication and I would like to commend the people here in this room; the Vietnamese participants who have worked tirelessly for years to improve the lives of those with disabilities and the extensive network of practitioners throughout the world who dedicate their time and energy to improving prosthetic and orthotic supply and delivery to the disabled.

This is an issue which is of great importance to the United States. My government recently announced a new contribution of $3.1 million to assist Vietnamese living with disabilities, bringing the total United States assistance to Vietnam's disabled to over $32 million. It is also an important issue to me personally, as my father was disabled at age 20 after losing an arm in a car accident.

I would like to use this opportunity to call on the Government of Vietnam to continue to work on and accelerate its provision of quality care to the disabled, particularly in the production and delivery of prosthetics and orthotic devices. I realize this is a costly intervention, but one which is absolutely essential for the well being of many of Vietnam's disabled. In the future, I hope Vietnam can become a model of regional excellence with a rehabilitation system its neighbors admire and copy. Now, while donor support is still strong, is the time for the Government of Vietnam to build this system and I urge Ministry of Health to dedicate appropriate resources and personnel to this very important cause.

I realize you have a very full five days ahead of you, so in conclusion, I would like to wish you all a successful and productive conference and good luck in all of your future work.

## Mr Rob Horvath, LWVF-USAID

Vice Minister Dac, Ambassador Marine, conference organizers, and participants

Thank you for this opportunity to speak briefly.

Let me begin by sharing Lloyd Feinberg's regrets that he was not able to make this important meeting. As most of you know, Lloyd is the manager of the War Victims Fund at USAID and his responsibilities necessitated him remaining in Washington this week. He sends his regards to the organizers and participants of this consensus conference as well as his full support for this meeting and his hopes that this conference will help to strengthen the delivery of orthotic services throughout the world.

It was in 1995, 11 years ago, that USAID, ISPO, and WHO partnered to support and sponsor the first consensus conference on prosthetic and orthotic technology in the developing world. I see many faces in the audience today that were at that consensus meeting. This is a testament both to your and our commitment to the field and, more depressingly, to our age. Probably most striking to me, however, is the fact that in 1995, the audience consisted almost entirely of expatriates. Look around you today. This is one important reason why we are here. Yes, ultimately our objectives are to provide the best services that we can to our clients, but our objectives must also include ensuring that those services are delivered by qualified and confident local staff.

Since 1998, USAID's War Victims Fund has invested over $120 million US dollars in orthopaedic services in the developing world. We can count many successes from that investment. The United States investment has provided for the production and delivery of over a hundred thousand mobility devices and aids, the development and strengthening of over a hundred rehabilitation facilities, and the training and capacity building of hundreds of staff. In addition to this direct service support, USAID, primarily through its partnership with ISPO, has led the charge to ensure that people have access to technically appropriate, well fitting, and useful devices. However, our ultimate success does not lie in the raw number of people served.

Over the last ten years we have seen significant changes in the quality, quantity, and methods in which rehabilitation services are delivered. We are here this week to ostensibly discuss the technical aspects of orthotics services. I have no doubt that the outcomes of the week here in Vietnam will do much to move the field of orthotics in a very positive direction. Previous consensus conferences have shown this to be true.

However, I would like to remind you of our ultimate charge. That is to ensure that all people, including those with disabilities can participate as fully as possible in their families, communities, and societies. This is their inherent right and USAID is committed to this objective both in policy and in practice. Former US President Franklin Delano Roosevelt once said, *"We know that equality of individual ability has never existed and never will, but we do insist that equality of opportunity must still be sought."* I would like to take this opportunity to applaud the level of commitment and the tremendous work that the Vietnamese government has done to help people with disabilities overcome the physical, social, and economic barriers that exist in their society.

I wish you all a productive and successful week and, on behalf of USAID, thank you all for your commitment to ensuring that people with disabilities obtain, and maintain, equitable participation in the world.

## Mr Chapal Khasnabis, WHO

Your Excellency, Honorable Minister of MOLISA, US Ambassador to Vietnam, Harold, Rob, my colleagues and friends, Ladies and Gentleman

Greetings from our Director and coordinator.

It is a great honour for WHO to be associated with ISPO and USAID to organize this important event. Though WHO works for the whole world, priority is always given to the people of developing countries, especially those who are poor.

Studies have shown strong links between poverty, illiteracy, poor health care, with disability and exclusion. As a group, persons with disabilities are among the most marginalized. Poverty increases disability, at the same time, disability enhances poverty. People living in poverty are more likely to acquire disability.

People with disabilities and their family members usually have less opportunity and are deprived of basic human rights - rights to access food, education, shelter, healthcare and rehabilitation services etc. In any community, often the poorest of the poor are people with disabilities and their family members. Among all, orthotics users are usually the poorest. Many causes which create the demand for orthoses are due to poverty such as polio, leprosy etc. Fortunately, those numbers are going down drastically but the people who are already affected especially children need orthotics and rehabilitation services for long time.

The number of disabled persons is growing also, as a result of factors such as poverty, population growth, ageing and medical advances that preserve and prolong life. Obviously, need of orthotics services are also growing.

With appropriate orthotics and rehabilitation services, one can more successfully come out of poverty, access equal rights and opportunities, and meet their basic needs. Lower limb orthotics is often the first step for a child to go to school, play or adults to make an income. Orthotics is an important tool for many users to be included in the society and overcome poverty.

Considering the need and importance, WHO requests for partnership to invest in orthotics sector to develop appropriate orthotics technology, manpower and service delivery system with good follow up in developing countries.

WHO counts on your knowledge, expertise and goodwill to make millions of children and adults to have a better quality of life with equal rights and dignity. It is we who can convert these millions of people from passive receivers to active contributors, from isolation to inclusion - a world for all. Let us join hands to achieve it.

Thank you.

## Mr Guenter Rietmacher, GTZ Country Director

Vietnam, a country of 80 million inhabitants, faces an enormous problem in rehabilitating its disabled population; a problem of developing countries that was exacerbated by the wars the country has endured in recent decades.

Estimates based on World Health Organization (WHO) data and calculation methods suggest that 0.5% of the population, or 400 000 Vietnamese, are in need of rehabilitative health care. Official statements of Hanoi government offices double this estimate. These offices report that 0.8%-1% of the population, about 800 000 Vietnamese, are physically handicapped.

Whatever the actual figure, it is increasing due to an alarming rise in traffic accidents in major cities that too often result in amputation or physical disability. According to official figures poliomyelitis as an infectious disease has been eradicated in Vietnam, but post polio care for thousands of patients is still a task to be tackled. Children with congenital clubfeet deformities and cerebral palsy are in need of the orthopedic services. This group of patients is the focal area in rehabilitation to avoid or reduce severe deformities.

In light of the tremendous need for qualified orthotics and prosthetics specialists in Vietnam, the Federal Republic of Germany and the Socialist Republic of Vietnam have initiated co-operation through government-sponsored programmes of “Technical Collaboration” (GTZ). A bilateral agreement between the governments has led to the establishment and management of an orthotics and prosthetics training centre in Hanoi which has started its programme in October 1997. The Vietnamese Training Centre for Orthopedic Technologists (VIETCOT) has trained up to date 120 orthopedic technologists based on standards of ISPO and WHO, who can provide service for 360,000 people with physical disabilities around the country. Germany has contributed around 10 Mio Euro since the start of the project. Thanks to the good work of the Vietnamese crew and its German advisor Mr. Wilfried Raab. VIETCOT has now an excellent international reputation with participants from other Asian and even African countries.

Focused on the increasing demand in orthotic rehabilitation services, VIETCOT is offering skills upgrading seminars for professionals in order to improve the quality of these services in the country.

The German Agency for Technical Cooperation is therefore very happy and thankful, that ISPO is organising the Consensus Conference on Appropriate Lower Limb Orthotics for Developing Countries in Vietnam, Hanoi. We hope that the outcome after six days hard work will be of great use for the rehabilitation of people with physical disability in developing countries. In case you find the time please visit the VIETCOT training centre and get inspired by the good work they are doing.

On behalf of the German Government and GTZ, I would like to wish you a pleasant stay in Hanoi, a good working atmosphere and a successful week.

## Introduction to the conference

## Bakht Sarwar, Conference Chairman

Dear colleagues and friends
Today I have the honour and the pleasure to welcome you all for a consensus conference on appropriate lower limb orthotics for developing countries. We have a very full, hard working and demanding week ahead of us.

ISPO has held six such conferences in the past sixteen years. Each has been very successful at arriving at specific suggestions for improved practices. Previously the emphasis has been placed on a diligent literature review. Best practices were determined based on the weight of that literature and discussions that ensued.

A detailed review of the literature on orthotic design and use in developing countries was done by Robert Singer spanning a time from the early 1970s to the year 2000 based on a series of 103 articles obtained from a RECAL. It was presented in International consensus conference on Appropriate Technology in developing countries held from 18-22 September 2000 in Moshi Tanzania. A copy has been distributed to you. In the preparation of this conference we have not done such a review aside from that which each of the presenters may have done in the preparation of their manuscripts. Based on the conclusions reached in the previous consensus conferences we are here to discuss the issues surrounding appropriate lower limb orthotics for the developing countries about which little literature exists. The present workshop is mainly addressing the ground realities and practices presently done in the developing countries.

Considering that most of the participants who attended the consensus conference in Moshi in 2000 have had more than 5 years further experience, and also the fact that many new experts from developing countries have now joined the group, it may in fact be correct to assume that this group has a greater collective experience in this field than any other group which has ever met.

You are not here to listen, you are here to contribute and actively participate in discussions. As is usual in ISPO consensus conferences the format will be number of sessions each with a series of papers as back ground information on topics for discussions which have been identified by the steering committee. Following each such session we will divide in to small groups for syndicate discussions. Specific questions and issues arising from the presentations will be identified. Each will be brought before at least two of the syndicate groups. Reports will be brought back to plenary sessions for further discussions hopefully arriving at consensus on the different topics. At the end of this conference the steering committee will meet again to collect these conclusions and ultimately write a report of the conference.

I would like to thank all of you for coming. I would of course also like to thank USAID and WHO for making the conference possible, ISPO for realizing it, and VIETCOT for all the practical arrangements in and around this event.

I wish you all a very interesting, fruitful and successful week.

Thank you.

## Conclusions and recommendations

The conference agreed upon the following conclusions and recommendations listed under their respective sub-headings.

**Needs assessment**

1. Need of orthotics has not been met and orthotics should be given greater attention.
2. The greatest area of need is the lower limbs.
3. Epidemiological data collection related to orthotics needs is required for policy and service development.
4. Standardised tools and methodology need to be developed and implemented for data collection.

**Outcome assessment**

1. Reliable patient record keeping is essential for all phases of orthotic management including prescription, checkout and follow-up.
2. Regular follow-up/evaluation of outcomes of orthotic management should be performed. This should include functional outcomes.
3. User involvement including satisfaction surveys must be an integral part of outcome assessment.
4. User satisfaction surveys should be performed and include measures of the impact of orthotic management to enhance the quality of life.

**Education**

1. There remains an overwhelming unmet need for trained persons to work in the orthotics sector in developing countries.
2. The meeting endorses the ISPO standards of education and the WHO/ISPO guidelines for education and training.
3. There is a need for upgraded knowledge and understanding of medical and rehabilitation personnel in issues relevant to orthotic management.
4. Need for upgraded knowledge and understanding of relevant pathologies for orthotics personnel.
5. The conference endorses the use of quality management and outcome systems in P&O educational institutions.
6. P&O schools should promote the role of orthotics in rehabilitation, the rehabilitation team and continuing education.
7. ISPO should establish a working group to investigate issues related to the provision of orthopaedic footwear in developing countries.

**Technology**

1. Need for research, development, production and evaluation of appropriate* orthotic components
2. ISPO should explore and implement methods to share and transfer appropriate technology.
3. ISPO should promote and encourage the coordination of availability and accessibility to appropriate orthotic technology.

**Rehabilitation team**

1. Establish better links between orthotic service and user groups
2. The user/family must be an equal member of the rehabilitation team
3. There is a great need for exchange of information between different rehabilitation personnel.
4. It is recognised that the full clinical team is not always available. However it is recommended that the minimal clinical team should include the user/family and the orthotist.

**Community based rehabilitation**

1. Establish a network between the orthotic service and CBR, PHC and/or other community based programmes - an example of a positive relationship between CBR and orthotic services is the implementation of the Ponseti club foot management programme in Uganda, amongst other places.
2. A close working relationship between CBR programmes and the orthotics service providers should facilitate early detection, early intervention and follow-up to promote optimum functional capacity and prevent further impairment.

**Quality management**

1. Schools should promote the knowledge and need of quality orthotic services as a part of their education curriculum.
2. Orthotic service providers need to develop and implement quality management procedures.
3. The conference endorses the use of quality management and outcome systems in orthotic service delivery.

**Cost calculation**

1. The conference recommends promotion, feedback, evaluation and development of the ISPO/USAID cost calculation tool.
2. It is recommended that the individual P&O schools use the ISPO/USAID cost calculation tool in their curriculum.
3. Recommend the establishment of a forum through which users of the ISPO/USAID cost calculation tool can communicate.

**General**

1. Orthotic management should address the most common conditions encountered in the field. These include; cerebral palsy, clubfoot, polio, stroke/traumatic brain injury and the insensate foot.
2. Orthotic treatment should be based upon individual assessment of the patients functional deficit
3. General orthotics treatment protocols may be impractical due to the variability of individual patients' presentation.

# Syndicate reports

## Syndicates A

**Discussion questions**

1. Needs assessment –
    a. What is the current orthotic scenario in developing countries?
    b. What data needs to be collected?
    c. What is required to be done?

    *(Syndicates A1, A2, A3)*

2. Based upon the conference programme, what areas would you like to see consensus reached? Identify three areas in which you would hope consensus can be reached.

    *(Syndicates A1, A2, A3)*

3. What is necessary to deliver appropriate orthotic services in developing countries?

    *(Syndicates A4, A5)*

4. Based upon the conference programme, what areas would you like to see consensus reached? Identify three areas in which you would hope consensus can be reached.

    *(Syndicates A4, A5)*

# Syndicate A reports

## Group A1 report

Chairman: Mel Stills
Rapporteur: Carson Harte
Participants:

| | | |
|---|---|---|
| Alaa | Endley | Robijn |
| Bowers | Museru | Steenbeek |
| Ghosh | Nguyen Hong Ha | Tran Van Chuong |
| Hascinovic | Penny | Urseau |
| Khasnabis | Pierron | Zelaya |
| Krishnan | | |

**1. Needs assessment**

**a. What is the current scenario in developing countries***?*

Based on the presentations made in the sessions prior to the syndicate, the impression given is that there are not enough trained personnel in developing countries. The energy required to train more people is restricted because there is not enough awareness and appreciation of the impact LLO can make. This applies to both resource holders and to potential clients. This factor is limiting the uptake of orthotics services

The quality of available devices, whether the quality is low because of material, components or technique, helps reinforce the undervaluing of LLO services. Clients are not valuing low quality services. Resource holders may be witnessing services that are of suspect quality and negatively judging the efficacy of orthotics services based on misinformation.

There are three main components of a good orthotics service: service delivery infrastructure, technology/materials and trained manpower.

To understand the orthotics needs in a country, we need to understand the profile of disabling diseases. These patterns are changing as polio declines and changes its demography (the majority of patients are now middle aged or older) CP is on the increase as better health care means more borderline children survive birth trauma.

Demand for orthotics treatment does not come easily from the clients since the output is not easily understood by them. Prosthetics is much more explainable and simpler to implement. This applies to the public and more importantly to doctors, therapist and health care workers.

It is important when planning to be aware of the state of general health and medical care in the country. It is not sensible to develop a high level service when the rest of the services are at a low level.

It is important that salary structure and schemes of service are clearly understood and negotiated before training people otherwise valuable people can be lost. The attitude of policy makers must be understood or perhaps influenced and changed. Government leaders are not likely to understand the effectiveness (in both cost and social terms) of the implementation of good services.

Some members called for the publication of more guidelines, research papers and public relations literature that could be used to educate officials. This should include some evidence based practice research. However, the caveat was issued that research should be of good quality and should only be applied to orthotics practice of sound quality. It is unconscionable that good research should be used to make decisions based on the impact of poor practice.

Post-conflict intervention tends to concentrate on prosthetics services. Orthotics tends to be an afterthought. The actual situation is that orthotics services demand a higher degree of training and engagement.

The question was raised, should we lower orthotics quality so we can fit more patients. The group concluded that we should not compromise on good sound technique but should be able to apply it to all levels of technology and material according to the country and individuals capacity to pay.

Example: one may drive an old cheap car, but one should not be a bad driver.

The key to good quality is well trained staff who can adapt to materials and conditions. We should apply best practice. Get basic principles right and apply them to different materials and technologies. Lowering training standards is a very dangerous route. If devices are not well fitted it will undermine the value of the service in the eyes of stake holders. The panel thought well of the work of Huckstep in Africa. He used low technology materials and achieved good results.

It was agreed that training is not to be compromised. The level of technology and material to be used will be decided by the stakeholders.

It is important that the other members of the clinical team understand the advantages of a good Orthotic service. If the surgeons and PTs see the value, they will be good allies. We should strategise with them.

It was felt that training schools should be careful how they are set up. High tech, expensive workshops can discourage graduates from entering private practice, because the cost appears prohibitive. It is important we teach with local machines etc where possible.

**b. What data needs to be collected?**

Collect data on the political willingness to have an orthotics service. Estimate the support of the rehabilitation professionals.

Situation analysis: What is going on already in the country?

Who collects disability data? Seek epidemiology department help. Develop outcome data. Follow-up study.

Data on its own is wasted. Collected data should be used to influence and engage the other rehab professions. Alliances should be fostered.

Data is seldom collected within a national framework. We should encourage this sort of behaviour. The data should be used to develop a national strategy. NB: Data should be well presented and in the right format. Disease data is very well understood, the rehabilitation data is often fragmented, poorly thought through and poorly presented.

**c. What needs to be done?**

*General comments*
We need to better understand the status of orthotics training. Despite the fact that orthotics practice is often more demanding than prosthetics, we often find that training material is not that well developed. Donors have focused too much on prosthetics as the glamorous subject we need to reset the bias. Best students need to be engaged in orthotics by challenging their intellect. .

We need to understand the numbers of orthotists needed in the country/region and plan accordingly.

Bear in mind and encourage students on graduation to embrace the private sector as well. Donors and institutions should be encouraged to support or subsidise the private sector. Clients are the poorest of the poor and hence financial sustainability is hard to achieve without help. This help should not just be towards the major centres.

We should figure out the main causes of disability in the country and plan to reduce that.

*Clinic team*
Work closely with orthopaedic surgeons and other rehab people in data collection, needs assessment and planning. Some delegates feel the clinic team aspiration is lost as orthopaedic surgeons move away from their traditional role and exclusively towards surgery. Most practitioners do not see the model of the cosy clinic team working, rather the reality is that the Orthotist, therapist, surgeon work separately, but in a trusting relationship with one another, knowing intuitively when to seek each others help.

**2. Based upon the conference programme what areas would you like to see consensus reached? Identify three areas where you would like to see consensus achieved at this conference.**

i. Data.
A simple definition of “disability” relating to mobility impairment that could be applied in data collection exercises.

ii. Technology.
Simple definition of appropriate LLO technology that defines design, material, technique, accessibility and affordability of devices

iii. Outcomes.
Identify a series of outcome measures that embrace clinical treatment outcomes, mobility outcomes, social inclusion outcomes and impact on quality of life. That can be used as a basis for evidence based practice.

## Group 2A report

Chairman: John Fisk
Rapporteur: Heinz Trebbin
Participants:

| | | |
|---|---|---|
| Andrew | Kim Bo Song | Nguyen Lan Anh |
| Camacho | Kumar | Poetsma |
| Dunleavy | Link | Rodriguez |
| Folcalvez | Mey | Schlierf |
| Gillani | Nagels | Zhao Huisan |
| Horvarth | | |

**1. Needs assessment**

**a. What is the current orthotic scenario in developing countries?**

Each participant represented a location so unique and different that a consensus was impossible to arrive at. The following list of items is to be considered:

- Distribution of services, city vs. rural
- Available facilities in a given region
- Available practitioners + rehabilitation team
- Education of teams members
- Recognition of orthotist/prosthetist profession
- Regulation of services
- Referral system, case identification
- Quality of prescription by medical doctors
- Follow-up of services:
    - Practice effectiveness
    - Patient care
    - Best practice

Observation: Orthotics is more difficult to deal with than prosthetics

**b. What data needs to be collected?**

- Causes of disability
- Type of disability including severity
- Needed and available services

**c. What is required to be done?**

A simplified system for functional evaluation of disability:

- Outcome studies based on functional evaluation and social inclusion
- Create more evidence on clinical outcomes as a measure of service effectiveness

**2. Based upon the conference programme, what areas would you like to see consensus reached?**

- Consensus statements based on realistic and practical recommendations

- Educational recommendations:
    - Orthotics prescription who and what
    - Members of the team starting with the patient and family
    - Mentoring
    - Continuing education
    - Multidisciplinary educational experience
    - Exchange of experiences between countries and schools

- The orthotics management of:
    - The insensate foot (diabetes and leprosy)

- Clubfoot and other congenital deformities
- Post-trauma (fracture bracing)
- Realistic expectations of orthotics management

- What should be the minimum conditions and resources available before starting an orthotic program?

- Mechanisms for case identification, CBR is not working

## Group 3A report

Chairman: J Steen Jensen
Rapporteur: Gordon Ruder
Participants:

| | | |
|---|---|---|
| Bhanti | Kim San | Schiappacasse |
| Canicave | Lastring | Shangali |
| Do Trong Anh | Long Hua | Tardif |
| Eberle | Möller | Thomas |
| Gul | Naik | Verhoeff |
| Jones | Pokora | Visser |

**1. Needs assessment**

**a. What is the current orthotic scenario in developing countries?**

- Regardless of the materials/components used, the function and the fit are paramount.
- Not so much "high-tech" or "low-tech", but *right-tech*
- Metal (steel, aluminium), and leather, is often the most appropriate.
- Plastic is often not resilient enough to withstand climate and/or work conditions. Locally available plastics can be used, if appropriate and experienced in working with the material.
- ICRC based component where available.

**b. What data needs to be collected?**

- Disability information, using a standardised, sensitive, and globally excepted "tool"
- Assess the region: availability of materials, resources, care givers, rural/urban
- Before surveys are sent out, retrospective studies from existing hospital data bases should be completed.

**c. What is required to be done?**

- Disability information needs to be collected from the urban and rural sources and then centralised within a country.
- Each disabled person has a "handicap card" where their information is stored. (as in India)
- Surveys should be run through existing infra structures CBR, health care systems
- Governments need to be made to hear our concerns. User groups may be able to help.
- Minimum educational requirement is a formal orthotics technologist education of 1year (schooling) and 6 months (clinical placement). Must involve clinical team work is also.

**2. Based upon the conference programme, what areas would you like to see consensus reached? Identify three areas in which you would hope consensus can be reached.**

i. Standardization and control of treatment guidelines. Recognising the patient as a part of the team. Pool resources from various global regions, and make available through the ISPO web page. Follow-up and outcomes is mandatory.

ii. Standardization and qualification of training. Consistent terminology.

iii. Encourage clinicians to be able to design the best device for the individual patient. Not to "over brace", or only repeat designs that you are comfortable with.

## Group A4 report

Chairman: Sepp Heim
Rapporteur: Dan Blocka
Participants:

| | | |
|---|---|---|
| Dang Xuan Khang | Kelly | Raab |
| Eboh | Koll | Sarwar |
| Francis | Le Ha Van | Sibila |
| Haq | Mtalo | Tazawa |
| Heagarty | Nepali | Watts |
| Henlein | Pham Thi Hoa | |

**3. What is necessary to deliver appropriate orthotic services in developing countries?**
a. A functional rehabilitation team:

- The ideal situation is the full rehabilitation team.
- Realistically this could encompass a less comprehensive group, but they would then have to encompass a wider scope of competencies across the professions.
- The minimum team would be an orthotist with medical backing and the ability to seek out other health professionals if necessary.
- The implementation of a complete patient assessment, orthotic prescription and the development of a treatment plan must be assured.

b. “Follow-up” procedures must be implemented in the treatment plan of an individual receiving orthotic services.

c. The capacity for early detection and intervention should be an element incorporated in a service involved in the provision of orthoses.

**4. Based upon the conference programme, what areas would you like to see consensus reached? Identify three areas in which you would hope consensus can be reached**
i. To find realistic solutions to orthotic services in developing countries:

a. Consensus on the required level of training for these services.
b. Consensus on the appropriate materials and components required.
c. Consensus on a method that would facilitate a practical way to share and transfer technology.
d. Consensus on the appropriate treatment plan for various clinical issues confronted in the field.

ii. What is the prevalence of disability as it relates to the provision of orthoses?

a. Consensus on the definition of what disability is.
b. Develop a cooperation and standardized method for determining what the prevalence of disability is.

iii. Consensus on a strategy to facilitate the process of measuring outcomes to affect the quality and effectiveness of the provision of orthoses. This would be in terms of proper data collection, the development of measurement tools and the analysis of data.

a. Consensus about finding a standardized template to collect the necessary statistics.
b. Consensus on how to evaluate the outcome of a treatment.

iv. Others

a. Consensus on a how to prioritize orthotic treatment for various scenarios where there are limited resources.
b. Consensus on developing a cooperative strategy for the NGO involvement when orthotic services are required.

## Group A5 report

Chairman: Nerrolyn Ramstrand
Rapporteur: Aaron Leung
Participants:

| | | |
|---|---|---|
| Borgne | Le Hai Ahn | Pham Thuy |
| DeMuth | Mannion | Rechsteiner |
| Fang Xin | McMonagle | Savino |
| Frank | Muller | Sovann |
| Hjelmström | Nguyen Hai Thanh | Williams |
| Kouma | | |

**3. What is necessary to deliver appropriate orthotic services in developing countries?**

a. Education:
- systematic training & education of the profession
- continuing education of the profession
- collaboration among schools to have instructors exchange programme
- simple means of sharing of information

b. Recognition of the profession:
- incentive and social status
- to attract people with good quality to work in the field

c. Manpower
- the qualified persons to provide the service

d. Patient education
- for patient compliance & proper use of the orthosis

e. Appropriate service;
- to fulfill patients' needs

f. Cost effectiveness:
- for effective service delivery

g. Appropriate materials:
- to fulfil local needs
- with support from local industry

h. Environment:
- understanding of the existing system or service provision

i. Outcome evaluation:
- to ensure the need and quality of the service

j. Multi-disciplinary approach:
- patient centered
- availability of relevant service, e.g. surgery, therapeutics

k. Follow-up of patients:
- accessibility (e.g. location of service centre)

l. Epidemiological data:
- needs assessment

m. Governmental support:
- how to convince the government

- health and social policy

n. An active advocacy group

- collaboration among organisations including NGOs and government

**4. Based upon the conference programme, what areas would you like to see consensus reached? Identify three areas in which you would hope consensus can be reached**

i. Data collection for needs and outcomes
ii. Practice guidelines. Prioritize the types of orthotic service provision
iii. Appropriateness - custom made vs prefabricated
iv. Cost recovery - means of addressing this issue

## Plenary discussion – Syndicates A

### Discussion

Following presentation by groups who were assigned the task of discussion Questions 1 and 2, the following discussion points were made:

Initial discussion focused upon the perception of prosthetics and orthotics services by governmental authorities and by members of society. It was recognised that orthotics is often an undervalued service in developing countries and delegates were interested in discussing means by which this situation could be rectified. It was recognised that the services provided must be appropriate for the patient and the region and that anything less than this would result in government authorities and members of society not valuing the service. In addition, it was stated that consensus papers must make a strong impact.

There was much discussion about the usefulness of Community Based Rehabilitation (CBR) as a referral source for patients requiring orthoses and as a means of following up patients. Some delegates expressed the opinion that CBR is not beneficial to potential and existing patients with orthoses. This opinion was opposed by other delegates who believed that some beneficial programmes do exist in developing countries. Much of the success of these programmes was attributed to motivated and highly active individuals. It was also stated that the beneficial effects of CBR are not immediate and that it may take a generation before any obvious benefit is observed.

The issue of education of physicians and allied health professionals on the availability and benefits of orthotics services was raised. In recognising the need for improving education of medical and other health professions, delegates identified the schools for prosthetics and orthotics as having a key responsibility in providing this information.

In discussing the needs and necessary requirements for orthotics services in developing countries, it was noted that focus on the patient was an area that received little attention in syndicate groups. This was recognised as an element of orthotic management that requires attention. The group was reminded that the patients should be included as a member of the clinical team. Qualitative research with orthoses users was encouraged.

While patient advocacy groups were noted as important and as having the potential to influence policy makers, the group was cautious about placing too much emphasis on these groups to steer policy makers as often such groups promote their own issues without consideration of the limited funding available.

The issue of patient follow-up was raised. Delegates were interested in discussing the most appropriate means of following-up of patients who live in remote communities. This was recognised as a major problem and concern. It was believed that improved communication between clinics would facilitate this problem along with good quality outreach and CBR programmes.

## Syndicates B

**Discussion questions**

1. What are the elements associated with providing appropriate orthotic technology/service?

   *(Syndicates B1, B3)*

2. What are the barriers to offering good practice in developing countries?

   *(Syndicates B1, B2)*

3. How do we ensure that the scope of pathologies is covered and the associated orthotic services are available and provided?

   *(Syndicates B2, B3)*

4. Is the current education of members of the clinical team sufficient? What steps should be taken to facilitate a team approach?

   *(Syndicates B4, B5)*

5. What are the elements of a treatment plan that are necessary for good practice strategies for orthotics services? How does the team share responsibility for these elements?

   *(Syndicates B4, B5)*

## Group B1 report

Chairman: Dan Blocka
Rapporteur: Longini Mtalo
Participants:

| | | |
|---|---|---|
| Khasnabis | Möller | Frank |
| Pierron | Do Trong Anh | Muller |
| Camacho | Jones | Sovann |
| Kumar | Francis | Fisk |
| Poetsma | Sibila | Thomas |
| Eberle | | |

**1. What are the elements associated with providing appropriate orthotic technology/service?**

Elements involved in the provision of orthotic technology:

- ISPO appropriate technology definition was used as a framework for the discussion.
- From a technology point of view – it should be affordable and available and adhere to the principles of proper fit and alignment.
- The materials and components implemented should be optimal for what is available and of high quality. They should also take into account the climatic conditions that exist in the region.
- There must be proper education and training in the implementation of orthotic technology.
- There must be a way to provide resources needed to improve the availability of other ranges of orthotic technology.
- The orthotic technology should meet the objectives of the treatment plan developed.
- Research related activities should be initiated to investigate how the technology performs.

Elements involved in the provision of orthotic service:

- The service provision must have equal access, be within a reasonable reach and be sustainable in the country.
- Those involved in providing the service must be properly educated.
- Physical facilities must be appropriate in terms of accessibility, appearance, cleanliness, and have the appropriate patient areas for assessment and treatment. This also includes a safe working environment for the professional staff.
- The service should provide a caring and respectful attitude.
- The service should have outreach capabilities to provide service in the regions where it is absent.
- Elements of quality management should be implemented:
    - proper job descriptions
    - to deal with gender equality issues
    - to ensure proper procedures are performed
- Research related activities should be initiated to investigate how the service performs.

**2. What are the barriers to offering good practice in developing countries?**

- Geographical barriers - both distance and geographical
- The volumes of patients and demands on the service exceed capacity.
- A lack of qualified professionals to provide a proper service.
- Poor coordination among the orthotic service providers and at times a rivalry exists between these groups.
- The involved government does not recognize the need for such services and therefore does not provide the support the service in terms of a proper payment scheme (for salaries and/or the payment of orthoses), implementing proper regulations and recognizing competent professionals.
- NGOs involved do not implement a sustainable plan for the service.
- There is a lack of data for individuals requiring orthoses.

- There is a lack of proper statistics with regard to the service.
- Taboos/traditional beliefs create barriers to one receiving proper orthotic services.
- Corruption in the system!

## Group B2 – report

Chairman: Bakht Sarwar
Rapporteur: Olle Hjelmström
Participants:

| | | |
|---|---|---|
| Nepali | Rodriguez | Tazawa |
| Krishnan | Gul | Ruder |
| Robijn | Naik | Nguyen Hai Thanh |
| Penny | Visser | Trinh Quang Dung |
| Dunleavy | Haq | Savino |
| Link | | |

**2. What are the barriers to offering good practice in developing countries?**

a. Manpower:
- Lack or non-existence of qualified orthotist (Cat-I and Cat-II) and technicians (Cat-III)
- Interdisciplinary services/upgrading education
- Awareness among the stakeholders(both public and professionals

b. Infrastructure:
- No service structure
- Lack or non-existence of orthotic centres both in public and private sector
- Treatment protocol, no standard way of how to do/solve problem
- Interaction of knowledge
- No referral system
- Follow-up

c. Materials and components:
- Non-availability of materials and components
- Lack of information and know-how
- Finances

d. General:
- Low priority
- Evidence of effectiveness
- Communications
- Untrained workers
- No quality control
- Expectations of from user/other treatment consultant
- Prioritize cases/selection of case
- Lack of incentives, demand is higher then the capability
- Commitment
- Geographic distribution
- Lack of education materials especially in local languages
- Corruption

**3. How do we ensure that the scope of pathologies is covered and the associated orthotic services are available and provided?**

- Availability of appropriate orthotic services
- Awareness/knowledge about the existence of orthotic services amongst all the stakeholders
- Scope of pathologies can only be covered with the involvement of the full rehabilitation team
- Involvement of ordinary schools and community to give information on problem that can exist in the area
- Information in the clinics that treat the area of problem
- Continuing education for the professions working with cases

- Short workshops
- Client involvement
- Workshop to educate caregivers
- Acknowledge of the services
- Data collection of the pathologies in the area
- Protocols how treatment can solve specific problems

## Group B3 report

Chairman: Sharon DeMuth
Rapporteur: Christine McMonagle
Participants:

| | | |
|---|---|---|
| Tran Van Chuong | Schlierf | Borgne |
| Mendley | Kim San | Kouma |
| Steenbeek | Pokora | Pham Thuy |
| Harte | Henlein | Williams |
| Folcalvez | Pham Thi Hoa | Heagarty |
| Mey | | |

**1. What are the elements associated with providing appropriate orthotic technology/ service?**

Appropriate technology definition:

- *"A system providing proper fit and alignment based on sound biomechanical principles which suits the needs of the individual and can be sustained by the country at the most economical and affordable price."*
- We discussed if definition only considers the device rather than process
- machinery, skills, materials
- depends on context

The 3 As

- Affordability
- Availability
- Accessibility

Training

- Appropriate training for all rehabilitation staff
- Personnel
- ISPO Category-ll accreditation - is this necessary?
- Academic training
- Practical training
- More schools offering training in single discipline would be useful - need for more orthotists , however, 3 years training has greater recognition
- Need for regulation of training in-country, recognized by country
- Need for supervision by Category-l orthotists

Clinic team

- Clear definition of roles and expectations
- Patient and family, orthotist, physiotherapist - minimum
- When is doctor involved? -surgical, complex cases, specific pathologies
- Important that more clinic team members do not increase cost
- Referral systems and follow-up
- Effective systems of communication

Additional elements

- Infrastructure
- Finance
- Quality
- System for patient advocacy
- Patient motivation
- Standards of time/cost/personnel calculation to make an orthosis - need to be placed in local context
- Specialized footwear

Scope of pathologies

- Need to ask what pathologies can system deal with effectively
- Record keeping / data collection - share among service providers
- Training
- Personnel - skills
- Prioritization based on intervention effectiveness
  Definition of point at which orthotist becomes involved

Orthotic services

- Focus on functional deficit rather than pathology
- Treatment protocols
- Early identification and referral
- Proper referral system that involves all levels of heath system
- Role of CBR
- Understand limits of professional role
- Outreach with appropriate personnel (different functions, discussion on appropriateness)

Role of government

- Numbers of personnel – trained and skilled
- Government involvement
- Finance
- Facilities
- Infrastructure
- Trained staff
- Other providers

## Group B4 report

| | | | |
|---|---|---|---|
| Chairman: | Theo Verhoeff | | |
| Rapporteur: | Robert Bowers | | |
| Participants: | | | |
| | Museru | Lastring | Kelly |
| | Raab | Shangali | Le Hai Ahn |
| | Gillani | Schiappacasse | Rechsteiner |
| | Nagels | Dang Xuan Khang | Mannion |
| | Bhanti | Koll | Zelaya |

**4. Is the current education of members of the clinical team sufficient? What steps should be taken to facilitate a team approach?**

Sufficiency of training:

| | |
|---|---|
| Orthopaedic Surgeon | no |
| Rehabilitation Doctor | no |
| Orthotist/prosthetist (if role is to be expanded) | no |
| Physiotherapist | no |

Steps to be taken to facilitate a team approach:

- Training
  - ISPO and WHO recommendations to include prosthetics and orthotics in respective curricula (medicine, PT etc.)
  - Rotate rehabilitation medicine /orthopaedic staff in training through orthotics
  - Make this a condition of new orthotic services
  - Emphasise team approach in (distance) learning material?
- Communication
  - Regular meeting - discuss cases
  - Organise workshops on issues of concern
  - Address weaknesses
- Co-location of participating services
  - Orthotics located beside surgery, PT etc.

**5. What are the elements of a treatment plan that are necessary for good practice for orthotics services? How does the team share responsibility for these elements?**

- Respect patients desires/aspirations
- Consider availability, accessibility, affordability
- Increase awareness of availability of services
- Set treatment protocol:
  - Referral, assessment, individual functional goals, prescription, measurement/casting, manufacture, fitting, training, delivery/check-out, assessment of outcome, follow-up
  - Use appropriate tools to measure outcomes at beginning, middle and end

Motivate staff to work towards shared goals

Share of responsibility by the team:

- Referral — Doctor? PT?
- Assessment — Doctor, orthotist, PT?
- Goal-setting — Team
- Prescription — Cat-I P/O or Doctor
- Measurement/casting — Orthotist

- Manufacture Technician
- Fitting Orthotist
- Training PT/Orthotist
- Delivery/checkout Orthotist? Doctor? Team?
- Assessment of outcome Orthotist? Doctor? Team?
- Follow-up Orthotist? Doctor? Team?

## Group B5 report

| | | | |
|---|---|---|---|
| Chairman: | Heinz Trebbin | | |
| Rapporteur: | Ritu Ghosh | | |
| Participants: | | | |
| | Hascinovic | Zhao Huisan | Le Ha Van |
| | Nguyen Hong Ha | Canicave | Fang Xin |
| | Urseau | Long Hua | Alaa |
| | Andrew | Tardif | Leung |
| | Kim Bo Song | Eboh | Watts |
| | Nguyen Lan Anh | | |

**4. Is the current education of members of the clinical team sufficient?**

- Composition of clinical team is not clear. In reality, rehabilitation team does not exist in most part of the world. Many clinical/rehabilitation professionals even do not exist in developing countries. There are only few branches of rehabilitation professionals are available in developing countries and that too only in capital or major cities.

- Members of the group had vast experience of working in different situations and context. They had to take different approaches considering the ground reality for example, in some instances orthotist only had to make prescription, assessment, measurement, casting, assembling and fitting whereas, in some countries orthotist and therapist worked together. Group agreed that suggestions need to be practical and simple, considering the absence of ideal situation.

- Minimum clinical team could be combination of therapist and orthotist and if there is possibility, then it is always better to involve medical doctors for prescription and intervention plan.

- It was also mentioned that present education system and service delivery system also does not encourage the team approach. Rehabilitation professionals are not trained to exchange professional discussion and to participate in clinical team. The reality is that there is lack of knowledge among the orthotist about medical aspect and proper evaluation system and prescription criteria. On the other hand, the medical and other paramedical professionals also have very little knowledge about orthotics and its allied issues.

**What steps should be taken to facilitate a team approach?**

The following points were discussed:

- ISPO should facilitate to conduct orientation programme for medical and paramedical professional regarding orthotics.
- Prosthetics and orthotics schools could promote and involve in training/orientation of medical personnel, physiotherapist/occupational therapist and other health personnel in orthotics management.
- Medical doctors, therapist and orthotist need to have broader knowledge of each others areas of work and strengthen functional referral system within.
- Publish books, scientific articles, evidenced based practices, produce promotional videos on different aspects of orthotics technology and service delivery system. It was also suggested that more documents and literatures need to be available on internet.
- Add a chapter or two about orthotics management in the course curriculum of medical and paramedical personnel and add some therapeutic and medical conditions including management in orthotics course curriculum.
- Joint seminar/workshops involving medical doctors, orthotist, therapist and other health personnel

- Team members need to be treated equally - respect for each other
- ISPO could consider influencing world bodies of PT/OT to develop different levels of manpower as in prosthetics and orthotics

**5. What are the elements of a treatment plan that are necessary for good practice strategies for orthotics services?**

- Good diagnosis, prescription, good checkout and define functional outcome, linkage with health and CBR personnel

**How does the team share the responsibility for these elements?**

- It has been mostly covered in discussion on question 4

## Plenary discussion – Syndicate B

***Editors note: No reporting of the discus****sion is available* ***for this session***

## Syndicates C

**Discussion questions**

1. How do you measure user satisfaction after delivering a new orthosis?
   *(Syndicates C1, C3)*

2. What information should be collected to determine the effectiveness of a lower limb orthosis?
   *(Syndicates C2, C4)*

3. Is there a difference in quality management protocols between the industrial world and the developing world and if so what are they?
   *(Syndicates C1, C5)*

4. Do orthotic services for the care of children with cerebral palsy in the developing world need to be improved. How?
   *(Syndicates C2, C4)*

5. Do orthotic services for the care of patients with post-polio paralysis in the developing world need to be improved. How?
   *(Syndicates C3, C5)*

## Group C1 report

Chairman: Longini Mtalo
Rapporteur: Anthony Francis
Participants:

| | | |
|---|---|---|
| Fisk | Long Hua | Pierron |
| Frank | McMonagle | Tardif |
| Harte | Nguyen Lan Anh | Tazawa |
| Henlein | Pham Thi Hoa | Tran Van Chuong |
| Leung | Pham Thuy | Urseau |

**1. How do you measure user satisfaction after delivering a new orthosis?**

- Fit, function, comfort, acceptability, durability, pain, cosmesis, alignment

- Identification of client expectations:
  - Do they coincide with clinician expectations?
  - Are expectations realistic?
  - Do we need to raise our clients' expectations?
  - Have expectations been met?

- Focus on 'User' satisfaction v technical/clinical satisfaction

- Outcome measures - subjective or objective?
  - Functional assessment useful tool but it may not equate to user satisfaction
  - Patient satisfaction survey:
    - Does user know what a 'good' orthosis is? What are they comparing to?
    - Are they trying to impress surveyor?
    - 3rd party/independent assessor required
    - Does the user feel free to be critical and to really express opinion?
    - Satisfaction measure should include the 'whole service' not just the orthosis
  - Questionnaire designed to identify areas of concern and improvement
  - Follow up / review process: is the client using the orthosis in 'real life'

- How does one measure user satisfaction during the course of a lifetime of orthotic use?

**3. Is there a difference in quality management protocols between the industrial world and the developing world and if so what are they?**

- No difference in philosophy!

- Service providers <u>should</u> be using <u>a</u> quality assessment system in both industrialised and developing contexts:
  - Country specific standards/products?
  - Linked to socioeconomic level of country: does staff salary effect motivation to comply to system?
  - Is the system being implemented
  - NGO/donor target aims? Quantity vs quality. Does the service provider have resources and control of quality

## Group C2 report

| | | | |
|---|---|---|---|
| Chairman: | Munazza Gillani | | |
| Rapporteur: | Christian Schlierf | | |
| Participants: | | | |
| | Borgne | Kim Song Bo | Ruder |
| | Bowers | Le Ha Van | Thomas |
| | Dang Xuan Khang | Mey | Zelaya |
| | DeMuth | Naik | Zhao Huisan |
| | Gul | Robijn | |

**2. What information should be collected to determine the effectiveness of a lower limb orthosis?**

Pre-, post-, follow-up data assessment:

a. Standardized and systematic data collection.
b. Use existing and simplified questionnaire formats (PT, prosthetics and orthotics, quality of life measures (SF36)
c. Identification of goals in order to process data in the right direction

Functional assessment:

a. Motion
b. Pain
c. Gait

Socioeconomic condition of the patient:

a. Rehabilitation achieved?
b. Employment?
c. Cost effectiveness.

Social aspects:

a. Social integration
b. Quality of life
c. Psychological assessment

Comparison between pre- and post-condition:

a. Temporal statistics regarding mobility.
b. How much the appliance is used? (acceptance of the appliance)
c. Are predicted goals (treatment plan) and patient expectations met?

Evaluation done by independent observer (in follow-up) example from CSPO, ISO - 9001:2000.

**4. Do orthotic services for the care of children with cerebral palsy in the developing world need to be improved. How?**

a. Parents/guardian education.
b. Awareness-raising regarding orthotic intervention for the clinical team.
c. Inter-disciplinary workshops and case studies. (ISPO supported)
d. Specialised education for management of CP for the P&O and the clinical team ( e.g. 2 years specific CP training programme, Gujarat, India)
e. Forming self-help groups:
   - parents to parents
   - patient to patient
   - peer group, etc.
f. Mentoring and exchange programmes.
g. ISPO database of CP case studies showing the statistics of qualitative and quantitative outcomes.
h. Facilitate access to existing data bases and local experts, e.g. American Academy of Cerebral Palsy Developmental Medicine (AACPDM.org )

## Group C3 report

Chairman: Vinod Krishnan
Rapporteur: Aaron Williams
Participants:

| | | |
|---|---|---|
| Blocka | Folcalvez | Nagels |
| Camacho | Hjelmström | Pokora |
| Canicave | Kelly | Watts |
| Dunleavy | Koll | Visser |
| Eboh | Kouma | |

**1. How does one measure user satisfaction after delivering a new orthosis?**

Discussion centred around three topics:

- Factors that affect user satisfaction
- Types of information to collect
- Methodology and tools

Satisfaction is dynamic:

- Initial fitting
- Adaptation
- Acceptance (or rejection)

<u>a. Factors that affect user satisfaction</u>

Functional and aesthetic concerns:

- It works well, but looks bad
- It looks good, but works bad
- Dependant on patient age/social status/employment/etc.
- Cultural norms

Meeting of expectations:

- Patients ill-informed or misinformed
- Failure to discuss/set realistic goals
- Patient is shown how to maximize functionality of the orthosis
- Cost of device is agreed

Experience:

- A new patient has less experience:
  - may expect more
  - may expect less
  - has no point of reference
- Older patients have previous experience:
  - may be set in their ways
  - more demanding

Environmental and social factors:

- Employment
- Cultural acceptance
- Family

<u>b. Types of information to collect</u>

These fall into two categories:

- Patient's activity
- Patient's opinion

Patient's activity:

- Gives a measure of effectiveness of device
- Incidence of falls

- Function restored
- Onset of fatigue
- Lack of complications (pain, skin breakdown, etc)
- Return for repair/replacement
- Keeping appointments

Patient's opinion:
- Not just patient, but carer, family, peers, children
- Comfort/ease of use
- Ease to don and doff
- Does it help?
- Could it be better?
- Compliance (voluntary or enforced)
- Does it assist in participation?
- Aesthetics
- Patient mediated referrals

c. Methodology and tools
It was felt that someone other than the orthotist/prosthetist should collect the feedback..
Patients should be reassured of treatment despite negative feedback.
Methodology and tool were considered under 4 headings:
- Questionnaires/forms
- Written correspondence
- Home visits
- Follow-up
- Simple chat

Questionnaires/forms:
- Literacy is an obstacle
  - Visual modes, need to be culturally appropriate.
- Interviewer bias/repeatability
- Environmental/social factors

Written correspondence:
- Direct written communication with the patient.
- Letters or questions to patient
- Letters from patient

Home visits:
- Either the orthotist/prosthetist/CBR/other
- Real situation of use
- Identify problems/successes

Follow-up:
- Patient returns to the centre for formal review of device and patient (with clinic team).
- Patient satisfaction can be gauged during this time

Simple chat:
- Perhaps the easiest to execute and quickest to see results (but how to document?)
- Ask about complaints
- Suggestions to improve
- Daily life - issues

**5. Do orthotic services for the care of patients with post-polio paralysis in the developing world need to be improved. How?**

New cases of polio are decreasing, but "new" users are still coming forward.
They are lifetime users with changing demands

Requires:

- 3 (or 4) As
- Creative designs of good quality
- Long term support

The 3 (4) As:

- Accessible
  - More centres in rural settings / CBR
  - Referral systems and integration of other professions
  - WHO / ISPO to champion these
- Appropriate
  - Individual designs / devices
  - Simplicity of designs
  - Materials currently are adequate, but variety and “hi tech” are limited
- Affordable
  - Materials used must be within local budgets
  - Cost recovery is only possible where patients have enough money
- Accountable
  - Follow-up
  - Preserve function long term
  - Patient advocacy

Creative designs of good quality:

- Standard designs may suit most patients, but some will require thinking “outside the box”
- Education
- Ensure schools teach problem solving
- Continuing education
- Peer communication/review/case study
- Supervision by appropriate person (Category-I)
- Encourage innovation / R&D

Long term support:

- NGOs should seek:
  - to fit into existing systems
  - Involvement of government
- Commitment from government
  - Infrastructure
  - Manpower
  - Finances

## Group C4 report

Chairman: Wilfried Raab
Rapporteur: Peter Poetsma
Participants:

| | | |
|---|---|---|
| Alaa | Kim San | Muller |
| Bhanti | Link | Schiappacasse |
| Haq | Museru | Steenbeek |
| Hasanovic | Möller | Sibila |
| Heagarty | Nguyen Hai Thanh | |

**2. What information should be collected to determine the effectiveness of a lower limb orthosis?**

a. User:

- Instrument to measure outcomes
- "Participation Scale" is a tool to measure disabled against a peer group. It includes social and economic elements and device acceptance, life improvement issues of daily living.

b. Professional:

- Instrument to measure outcomes.
- Follow-up: hours of use, distance, comfort, pain, problems, donning, doffing (same as prosthetics)
- expectation vs reality

**4. Do orthotic services for the care of children with cerebral palsy in the developing world need to be improved. How?**

- Team building (team approach is compulsory) Pediatricians and maternity services included
- Educate all team members.
- Prioritize resources
- CBR identification and follow-up. (grassroots)
- Sensitizing the community, increase awareness and fight stigma.
- Advocacy.
- Low cost solutions?

## Group C5 report

Chairman: Norgrove Penny
Rapporteur: Steve Mannion
Participants:

| | | |
|---|---|---|
| Andrew | Kumar | Rodriguez |
| Eberle | Lastring | Sovann |
| Fang Xin | Endley | Trebbin |
| Ghosh | Nepali | Verhoeff |
| Khasnabis | Rechsteiner | |

**3. Is there a difference in quality management protocols between the industrial world and the developing world and if so what are they?**

- Quality management (QM) reflects quality of service and product
- Establishment of QM protocols in developed world is regulated; in developing world arrangements are less rigidly defined.
- Often QM protocols not in place in developing world.
- QM protocols not required by statute in developing world.
- Barriers to QM time, money
- Overwhelming need/demand and lack of services leads to compromise in product quality
- Developing status not *excuse* for not having QM protocols
- Good QM leads to improvements in efficiency, cost effectiveness
- Influence of NGO/donor in implementing QM protocols
- Quality control of product output; fee per item vs quality output (check out protocol). In developed world quality check by insurance companies. Conflict between quantity and quality, therefore assessment system needs to embrace quality standards and ideally involve impartial, external assessment.
- Underlying importance of professional ethics and standards

**4. Do orthotic services for the care of patients with post-polio paralysis in the developing world need to be improved. How?**

- Always room for improvement, in both developed and developing world.
- Training and education, orthotist/prosthetist and patients. Transfer of technology, training workshops. Collaboration
- Change in focus; traditionally need has been for children, now childhood polio is decreasing, different need of adult / elderly population?
- Involvement of family, client support groups.
- Strengthening follow-up arrangements, CBR based? Rehabilitation services made available at local level.
- Funding for new technologies and materials - sustainability?
- Model (research) projects to assess “appropriateness” of new technologies?
- Involves multidisciplinary team, not merely focussed on provision of orthosis, identification, referral, orthotic, PT, follow-up.
- Awareness material, availability of services, maintenance of orthoses, all material in local languages. General health factors: diet, exercise.
- Availability of surgical services: to “fit” orthoses, or to be able to discard orthosis.

## Plenary discussion – Syndicates C

**Discussion**

1. **How do you measure user satisfaction after delivering a new orthosis?**
    - Any satisfaction system for children can not be the same as that developed for adults.
    - Two levels of follow-up. Direct patient follow-up and then the follow-up as part of quality management systems on processes etc. Suggestion that it is impractical to perform follow-up on all patients.
    - We must remember that we first need to define what it is we wish to achieve.

2. **What information should be collected to determine the effectiveness of a lower limb orthosis?**
   A number of scales that already exist can be utilised.
    - Can we establish a small sub-committee to investigate this tool, e.g. participation scales (available via WHO, ILF and ICRC)?
    - One problem with the participation scale is that, if there are no base line details, it is very difficult to know how to handle the results. It is necessary to have a control group.

3. **Is there a difference in quality management protocols between the industrial world and the developing world and if so what are they?**
   Staff salary can not be linked in any way to quality measures:
    - There is a minimum that you can accept in order to request quality service from your workers
    - If rehabilitation is not given a priority then salaries will be quite low and service quality compromised.
    - It goes beyond salary. There is also available of materials.
    - There could be worker reward (salary increase) if they prove good outcomes.
    - I think the salary debate is an excuse for people. Quality is something that in an organised society is achievable.
    - In many countries the client doesn't dare to say to the supplier that they are not happy with the service.
    - We must take care to ensure we understand what a quality management system is. The essence of QM systems is that there is process of constant review, self criticism and external criticism. We need to have general principles for continuous improvement.

4. **Do orthotic services for the care of children with cerebral palsy in the developing world need to be improved. How?**
    - Your group was in support for a specialised training programme
        - In India we have special programme on CP for special educators. These peoples are not prosthetists/orthotists
    - Do schools have enough information to train their educators?
        - There is a lack of information to provide to people in schools.
    - Reminder that the Global health website has a book on CP management.
    - I am not sure that there is enough information and training available to prosthetists/orthotists in industrial countries
        - We should not forget that we only have a limited amount of time in the school.
    - It would be difficult to put training information together for CP because there is not enough evidence available to confirm the benefits of orthotic management.

- One suggestion is to put together a case study package to show benefits, pre- and post-treatment. This is not scientific.

- Project Projimo (Hesparian Foundation) has put out a lot of very good resources on management of CP.

**5. Do orthotic services for the care of patients with post-polio paralysis in the developing world need to be improved. How?**

- Is there any attention or guideline that exists for the prescription of crutches? Often it is just the physiotherapist or orthotist that prescribes these. Could others do the job
  - Others could do it with just a little education.
  - There is a huge need for research into appropriate crutch design and manufacture in the developing world.

## Syndicates D

**Discussion questions**

1. What kind of infrastructure is needed in order to have a successful Ponseti programme?

   *(Syndicates D1, D4)*

2. What are the lessons that have been learned from the Ponseti example to promote orthotics technology in developing countries?

   *(Syndicates D2, D3)*

3. What information, with regard to orthotic management, does a physician/surgeon need to know in order to write a useful orthotic prescription?

   *(Syndicates D1, D5)*

4. What information, with regard medical knowledge, does an orthotist need to know in order to provide the most appropriate device?

   *(Syndicates D2, D4)*

5. What should be the role of orthotic services in trauma management in developing countries?

   *(Syndicates D3, D5)*

**Group D1 report**

| | | | |
|---|---|---|---|
| Chairman: | Robert Bowers | | |
| Rapporteur: | Maciej Pokora | | |
| Participants: | | | |
| | Fisk | Naik | Williams |
| | Henlein | Canicave | Ghosh |
| | Pham Thi Hoa | Kelly | Endley |
| | Tazawa | Link | Rodriguez |
| | Gul | Poetsma | Nguyen Hong Ha |

**1. What kind of infrastructure is needed in order to have a successful Ponseti programme?**

- Identified dedicated clinic / time for service.
- Accommodation (rehabilitation hostel)/travel funding.
- Registration of all patients under central coordinating body.
- Training of nurses/midwives etc. Education of parents, including using street plays (India), posters in public places.
- Assessment and follow-up, immediate and long-term, to avoid losing patients (effect of poor compliance on outcomes). Use CBR team if working well, or else identify who will see the patients regularly (i.e. utilize existing services, e.g. missionary, family planning, vaccination service, etc.).
- Government involvement (do not rely on NGO it may withdraw).
- Personnel resources needed (depends on local context):
  - Orthotist, physiotherapist, CBR worker or other person with appropriate training/skill for plaster cast application
  - Surgical doctor or accepted local medical practitioner for surgery; orthotist for (pre-fabricated) abduction orthosis: could be locally made or bought (e.g. from ICRC?).

**3. What information, with regard to orthotic management, does a physician/ surgeon need to know in order to write a useful orthotic prescription?**

Doctors in developing countries need to have a wider education than in developed countries. They need to self-direct their learning in the area of orthotics. Doctors act as the highest authority in the team.

Information needed:

- Biomechanical principles.
- Correct orthotic terminology (ISO).
- Prescription criteria for various orthotic types.
- Knowledge of the role of orthoses in the management of the problem.
- Expectations of the patient/parent/guardian, and their capability and motivation to use an orthosis.
- Limitations of locally available service:
  - Orthotic expertise, resources, materials, equipment, financial constraints.
- Cost of the orthosis.
- Awareness of cultural issues in communicating information effectively: e.g. unwillingness to admit incomprehension, limited ability to prioritise, etc.
- Must have a realistic understanding of general effects of orthotic service and rehabilitation advised, e.g. website: global-help.org

**Group D2 report**

| | | | |
|---|---|---|---|
| Chairman: | Chapal Khasnabis | | |
| Rapporteur: | Aaron Leung | | |
| Participants: | | | |
| | Francis | Kim Song Bo | Muller |
| | Leung | Robijn | Raab |
| | Pham Thuy | Dunleavy | Andrew |
| | Tran Van Chuong | Koll | Nepali |
| | Dang Xuan Khang | Visser | Sovann |
| | Frank | | |

**2. What are the lessons that have been learned from the Ponseti example to promote orthotics technology in developing countries?**

- Based on sound anatomical and biomechanical principles
- A complete team involvement to achieve the final outcome ; orthopaedic doctor, PT, CBR personnel
- Need a whole package : funding, support from inside and outside
- Accessibility (should also facilitate accommodation of family members)
- Affordability
- Team: PT/orthotist to do casting, doctor, orthotist
- Mechanism for early identification and referral
- Early identification is also a crucial point for alternative approach
- Follow-up system
- Application of evidence based technique
- Simple and practical approach

How to introduce the approach to others not familiar with the approach:

- Vietnam experience: seminar at school, CD for information/review, participants were impressed and tried
- Implemented in an intensive approach to make it popular
- Good linkage between the community and and service unit
- Ministry of Health involved
- Documentation of the progress
- Consensus/agreement among all levels even before start
- Follow/up to see long term outcome
- Promotion /awareness of the protocol for different parties
- Take the experience as a reference but the approach may not be applied in general
- The results of the Ponseti approach are more easy to show. This attracts the interest of the medical doctors
- Disability needs long-term intervention. It requires a long time for success

**4. What information, with regard medical knowledge, does an orthotist need to know in order to provide the most appropriate device?**

A medical doctor may not have sufficient knowledge to prescribe the appropriate device

An orthotist needs to know:

- Prognosis of the disease/pathology/conditions
- Precautions and contraindications
- Knowledge and skills of assessment, evaluation, and prescription criteria
- Function of various orthotic designs
- Clear understanding of the impairment and future biomechanical consequence
- Knowledge to decide when to refer the patient for medical/other consultation
- Knowledge and awareness of available surgical and therapeutic management which will help to facilitate orthotic intervention

- Orthopaedic/musculoskeletal biomechanics related to common types of pathological conditions encountered? Category-I/Category-II?
- Communication and dissemination of orthotic aspects of pathological conditions with doctors/surgeons
- Conduct workshop/seminar/course and invite doctors/therapist/other members of the interdisciplinary tem to share knowledge and experience
- Ideally orthotics team at least has to involve a doctor and a PT
- Enhance knowledge on Functional anatomy and
- Basic pathophysiology, and its impact
- Self-learning skills

## Group D3 report

Chairman: Carolina Schiappacasse
Rapporteur: Michael Rechsteiner
Participants:

| | | |
|---|---|---|
| Long Hua | Ruder | Museru |
| Pierron | Zelaya | Kumar |
| Urseau | Eboh | Trebbin |
| DeMuth | Kouma | Sibila |
| Le Ha Van | Alaa | Nguyen Hai Thanh |

**2. What are the lessons that have been learned from the Ponseti example to promote orthotics technology in developing countries?**

- Look into simple devices (forgotten technologies) as made in earlier years
- The presentations showed that the clinical team works
- Good political example to show (justify) the effectiveness of orthosis to sensitize donors
- Due to early detection, complicated treatment and complicated orthoses can be avoided
- Educate medical and paramedical staff in early detection of clubfoot or other conditions
- Weakness of the Ponseti technique (not an ideal example to be applied everywhere :
  - not applicable where there is no doctor (tenotomy)
  - need of strong follow-up
  - distance and costs
  - Strong communication between the clinical team and the parents needs to emphasized
- Other professionals of the clinical team, as well as the parents, needs to be sensitized about orthotic management
- Lesson learned: to be more open to alternative techniques and new ideas
- Effective dissemination on methods like this should be emphasized (alerts us to the need of the diligence to stay abreast emerging techniques / practices

**5. What should be the role of orthotic services in trauma management in developing countries?**

- Role should be the same as in industrialized countries, but at more affordable prices. Orthotist should be involved immediately to facilitate trauma management pre- and post-surgery and to follow-up,
- To have in place emergency response protocols (tsunami, earthquake.)
- To stock and/or manufacture prefabricated devices or components (Mobility India) when appropriate.
- Education of the medical team members about indications and availability of devices and components as well as dissemination of information
- To be part of the team as a complementary role in trauma management
- Where there is orthopaedic surgery/emergency services, orthotic services should be available/accessible
- Promote creation of orthotic services where not available
- Training schools should include a specific curriculum dealing with orthotic management of trauma and disseminate the information to the rehabilitation team members, medics and paramedics

## Group D4 report

| | | | |
|---|---|---|---|
| Chairman: | Carson Harte | | |
| Rapporteur: | Christian Schlierf | | |
| Participants: | | | |
| | McMonagle | Folcalvez | Eberle |
| | Shangali | Bhanti | Lastring |
| | Zhao Huisan | Kim San | Penny |
| | Mey | Möller | Le Hai Ahn |
| | Blocka | Steenbeek | |

**1. What kind of infrastructure is needed in order to have a successful Ponseti programme?**

This question has been answered in the presentation of the last couple of days (ref Penny). We took the opportunity to think through some of the detailed issues.

Engagement with the government

Do Government/health ministries see clubfoot as a major problem?
- Yes. One of the largest birth defect issues.

Are governments engaged with the issue?
- When they are offered evidence and see it working in other countries they are very interested.
- Do governments need to be involved?
  - Yes. It may have a positive or negative impact on costing
  - Yes. They have access to infrastructure into which Ponseti can be built
- Alternatives to country wide plan:
  - Pilot project.
  - Dissemination and training centre
  - Regional hospital.

How are local surgeons involved?
- Not necessary, a physician will suffice.
- Local medical legislation will not allow non-doctors to perform even minor surgery.
- Tenotomy is not complex. Almost zero risk, but requires a competent and compliant doctor.

How are orthotists involved?
- They are not really required.
- Abduction orthosis is best fitted by a trained person possible, but not necessarily an orthotist.
- Orthoses sets can be mass produced and custom fitted.

Minimal requirements for functional service:
- Casting: PT/orthotist/nurse
- Orthosis: PO/shoemaker/factory
- Operation: Doctor

Ideal scenario:
- Training of medical/ technical team involved
  - Orthotist/prosthetist should be aware of full procedure
  - Conduct trainings/hands on workshops at regional/provincial hospital level
  - Develop education and awareness program through public health system
  - Institutionalization of method at the various schools (PT,OT nurse, doctor, orthotist/prosthetist)

- Awareness of population and medical/technical team
    - Identification
    - Technology
    - Treatment

Through governmental campaigns:

- Programme should be adapted to the opportunities of the country
- Strong argument towards the government
- Prevent disability. Clubfoot can be cured. This is quite different from most long-term orthotic treatments. It is a medical cure.
- CBR programmes
- ISPO could popularize the Ponseti method
- Functional referral system
- Availability of local health hospitals
- Supply of materials

**5. What information, with regard medical knowledge, does an orthotist need to know in order to provide the most appropriate device?**

- Level of knowledge depends on availability of team members
- Adhere to the existing standards of prosthetics and orthotics education; the level pathology/anatomy/biomechanics is appropriate and the standards are reasonable.
- The limits on decision making on the orthotist/prosthetist side is still unclear.
- Orthotists work in three possible scenarios:
    - In a clinic team, either close-knit or more informal. Will have good medical backup and the patient will have been given a full medical exam. Orthotist will make final detailed decisions re- prescription, but broad treatment objectives will be set by team.
    - In isolation, with broad referrals from a “first point of contact” medical infrastructure. S/he will have to take more responsibility and also will have to be very aware of when to seek support and help.
    - In isolation with no team. The orthotist is the first point of contact and will need to make a broad prescription and detailed prescription. Should have a solid knowledge of pathology, anatomy and medical conditions that could impact the rehabilitation or could be adversely affected by the orthosis.

- Making prescriptions. Indications/assessments
    - medical diagnostics are within the remit of doctors
    - if no doctor. is available, then orthotist/prosthetist should give recommendations and at a limit refer to the nearest available doctor
    - worst scenario, no doctor. available the orthotist/prosthetist wiill prescribe on own responsibility

- Range of assessment required in a 1 man team:
    - medical
    - physiogical
    - psychological
    - social

- Individual orthotist/prosthetists should know at what level they refer responsibilities

- If the orthotist/prosthetist works in “isolated’ circumstances there may be ethical and legal limitations.

Question for the conference:
How can we increase the confidence in orthotists/prosthetists so they are more willing to take on prescription? The surgeons and medics happily admit they are not the experts.

## Group D5 report

| | | | |
|---|---|---|---|
| Chairman: | Elisabeth Thomas | | |
| Rapporteur: | Theo Verhoeff | | |
| Participants: | | | |
| | Tardif | Camacho | Fang Xin |
| | Watts | Hjelmström | Mannion |
| | Borgne | Nagels | Krishnan |
| | Gillani | Haq | Hasanovic |
| | Mtalo | | |

**3. What information, with regard to orthotic management, does a physician/surgeon need to know in order to write a useful orthotic prescription?**

- The approach of physician / surgeon / other team members should be patient- (user-) centred
  - patient's expectations; living/working conditions, activities required, family's financial status, etc.
- The physician/surgeon should establish the diagnosis and the prescription.
  - condition of the limb etc
  - respect law requirements
  - MD's diagnosis/prescription mandatory in new orthotic services?
- Prescription can be general
- Prescription must address the functional deficit.
- Knowledge of types of available orthoses and respective functional outcomes which can be expected, requiring basic knowledge of:
  - biomechanical concepts
  - material characteristics
  - types of orthoses available in the region
  - price range of orthoses
  - respective functional outcomes of types of orthoses indications, contraindications
  - A common terminology or nomenclature
  - A concise information document for physician / surgeon may be helpful.
- Team approach: orthotist/prosthetist, PT, MD
  - participation of MD in check-out system enhances user satisfaction

**5. What should be the role of orthotic services in trauma management in developing countries?**

- What is trauma? WHO: RTA. Injuries
- Role of orthotic service in acute trauma management is generally very limited.
  - Post-traumatic fracture bracing etc. is usually done by MD in hospital
  - Sport trauma injuries: not considered a priority
  - Post–traumatic emergency treatment; pragmatic approach. Means are flexible (local appliance versus high tech appliance).
  - Availability of pre-fabricated orthoses in hospital.
- Use of orthoses in cases of non-union of lower limb is usually not very effective for union. Relief?
- Role of orthotic service for spinal cord injured patients to be considered.
- Prioritising. With limited resources, prioritising of funds/services to patients is an unavoidable process, also in the West.
- Public health approach: populations versus individuals. Reality on the ground: ethical dilemma. Pragmatic approach.

## Plenary discussion – Syndicates D

### Discussion

A member of the audience suggested that we can't rely too much on NGOs as they may pull out. NGOs were considered important however in initiating projects, setting them up and showing leadership.

The question of what can we learn from Ponsetti experiences was discussed. It was recommended that NGOs start these initiatives but that they should be sustained by Government.

In Vietnam, NGOs are involved in the roll out process. Any new concept however will need to be approved from higher up. A question was raised if WHO has a position on this and can they help convince the Ministries of Health. The group was of the opinion that NGOS alone will not be able to push thru the system.

The experience from Malawi is that it is extremely important to set up appropriate training. The technique is simple but radical and people MUST be trained. A country club foot committee was recommended to facilitate this..

In Cambodia there are 800 cases of club foot per year. It was suggested that it is easy to convince the government to provide assistance in this issue as the numbers are the same as for landmine accidents but the intervention comes at a fraction of the cost.

Two problems were highlighted; initiative and sustainability. Governments are not good at initiating new things. Sustainability with government is very difficult as well. Norgrove Penny indicated that a team approach essential.. No surgery is possible without it. Sometimes thee tenotomy is incomplete. There have also been cases of extreme bleeding and infections. He also suggested that orthotists can be the champions for this method.

In relation to the question of orthotic services in trauma management it was indicated that the orthotist should be active in setting up emergency splinting in cases of SI or fracture.

Spinal trauma was recognised as a very big problem. Participants considered what can orthotically at early stage in these cases. A trauma meeting was mentioned and ISPO involvement considered important.

Bakht Sarawar questioned the roll of Orthotist in non-union fractures. While a cast or orthosis was considered useful in humeral fractures and is cases of congenital pseudartrosis, the best treatment was considered surgical.

Gordon Ruder questioned the emergency response teams in place in many countries. Is there emergency response and are prefabricated orthosis available for emergency situations. Steve Mannion suggested that this was a good idea. PIPOS has experience in this and indicated that coordination of local services is vital

## Syndicates E

**Discussion questions**

1. What is needed to raise the level of care of patients with neuropathic (insensate) feet?

   *(Syndicate E1)*

2. What steps should be taken in order to provide appropriate orthotic services to patients with neuropathic (insensate) feet?

   *(Syndicate E1)*

3. Describe your experiences in using the ISPO/USAID protocol on cost calculation.

   *(Syndicate E4)*

4. What needs to be done to promote and improve orthotics technology in developing countries?

   *(Syndicate E4)*

5. Discuss the need for new componentry and materials for use in orthotics in the developing world.

   *(Syndicate E4)*

6. What is required to improve the level of the orthotic management of stroke patients in developing countries?

   *(Syndicate E2)*

7. What steps should be taken to meet the need for orthopaedic footwear in developing countries?

   *(Syndicate E3)*

## Group E1 report

Chairman: John Fisk
Rapporteur: Nancy Kelly
Participants:

| | | |
|---|---|---|
| Penny | Nguyen Hong Ha | Khasnabis |
| Schlierf | Hasanovic | Eboh |
| Eberle | Watts | Mannion |
| Folcalvez | Sibila | Robijn |
| Museru | Kouma | Steenbeek |
| Raab | | |

**1. What is needed to raise the level of care of patients with neuropathic (insensate) feet?**

Awareness

- Increased awareness on part of general population – use existing structures of MoH for this, with emphasis on early detection and causes (especially of diabetes)
- Role for care providers in increasing awareness of role of orthotics in management of neuropathic feet – through assessments,
- orthotists; medical society, CMEs, primary schools,
- ISPO Task Force to work with various networks?
- patient education - need common sense approach, specific instructions
- Various levels of education needed – general public, patients, families, providers, orthotists

Leprosy programmes tend to be well organized on national basis

Diabetes is growing problem, many NGOs have clinics to serve this patient population, surveillance is important in management of this disease

Strategies:

- Use end-user groups that focus on diabetes and leprosy for advocacy and information
- Leprosy should be incorporated into clinical medicine

**2. What steps should be taken in order to provide appropriate orthotic services to patients with neuropathic (insensate) feet?**

- Referral system to physician important but not all know how to care for wounds
- Sub-specialization – results in MDs not feeling comfortable outside of what they know/do daily
- Information on wound care:
  - Healing of ulcers – knowledge exists, handled by surgeons, teamwork, need diagnosis by MD, casting by orthotist/prosthetist, local care
  - Need to collect information that already exists with focus on insensate feet with distinction between diabetes, leprosy
  - (book – Essential Actions in Leprosy, Jean Watson)
  - Agreement: Education for Category-I and II needs to be improved in this area
  - Foot impressions – pressure surface evaluations as part of orthotic evaluation

Technology:

- Weight relieving orthosis (total contact) not being used in developing countries (can this be shared with prosthetics/orthotics schools?)
- Podiatrists – is losing turf to them an issue?
- Shoemaking: not part of school system, need to raise profession of shoemakers and expand their knowledge, more are needed, they do not have much status

    - Resolve: higher status, recognition, certificate/diploma level for shoemakers
    - Can some element of shoe maker be incorporated into PO training – but it may not have high priority
- Aircast walking boot might be appropriate technology
- Local products
    - shoes in the market: more cosmetic, work as well

## Group E2 report

| | | | |
|---|---|---|---|
| Chairman: | Robert Bowers | | |
| Rapporteur: | Gordon Ruder | | |
| Participants: | | | |
| | Sovann | Le Hai Ahn | Zelaya |
| | Frank | Verhoeff | Dang Xuan Khang |
| | Schiappacasse | Rodriguez | Koll |
| | Alaa | Bhanti | Dunleavy |
| | Francis | DeMuth | Andrew |

**6. What is required to improve the level of the orthotic management of stroke patients in developing countries?**

There has to be recognition of existing systems/structures, once you have identify the decision makers at the national (Ministry of Health, Social Services) and hospital level, then you target them first.

Identification/recognition that by neglecting stroke patients, the overall cost is far greater.

Education:

- of orthotists in their schools that includes user behaviour/cognitive, pathology, biomechanics, gait, other members contributions, etc
- further specialization once in the field at a multidisciplinary format (PT, Drs, nurses, etc).
- of patient/user and their family/care givers/CBR workers at discharge and follow-up.

Public, medical team, family members/care givers awareness of orthotic management of stroke.

ISPO to provide visual case studies illustrating the benefits of proper rehabilitation vs incomplete/compromised rehabilitation. To be used in schools, providers, and users. In the format of pamphlets, digital multimedia sources.

Refer to the ISPO stroke consensus report

In particular:

- Appropriate technology with low cost intervention that results in the best orthosis for the user. Focus on prioritizing treatments to assist users when you will have the greatest effects, minimize treatments for those that are functional ambulators that have a reasonable quality of life (pain, safe, endurance). Simple solutions (elastic straps, prefabricated orthoses) will only work for simple problems (weakness vs significant spasticity; swing phase vs stance phase).

- Applied biomechanics and gait, and clinical experience are required.

- To identify when orthotic intervention should start, most feel that the earlier, the better. (once the patient's vital health concerns have stabilized, out of Intensive care) preventative components of acute care that is cost effective (prefabricated orthoses, pressure sore and contracture management)

- Nothing will work unless the team, hospitals, public buy into the concept.

## Group E3 report

Chairman: Olle Hjelmström
Rapporteur: Dan Blocka
Participants:

| | | |
|---|---|---|
| Hjelmström | Tran Phi Tuoc | Nguyen Hai Thanh |
| Canicave | Nguyen Lan Anh | Nepali |
| Pierron | Gul | Pham Thi Hoa |
| Möller | Williams | Pokora |
| Kim Song Bo | Le Ha Van | Kim San |

**7. What steps should be taken to meet the need for orthopaedic footwear in developing countries?**

Planning/Implementation of the service

- proper planning in setting up the service
- interaction/coordination between those providing service
- proper recognition of the service - government, professionals, payment?
- match with cultural and geographical aspects of the region
- quality assurance to ensure there is a check-out of the service
- financial resources to initiate the service
- make users aware of the service
- possibly find other strategies outside of just custom orthopedic shoes and use existing designs of footwear that can be modified
- educate those in the remote area to support a more central service or make sure there is some sort of outreach service

Develop human resources

- Coordinate education from the qualified OSM to those with fabrication specialties (scheme of qualified personnel)
- attract at least one professional that is trained or can be trained to the level of a orthopaedic shoemaker
- attract those with existing & appropriate skills to this area, such as leather workers or similar
- train at appropriate levels and numbers to have proper manpower to provide service
- ensure expertise to treat clinical conditions/pathologies that are present

To source technical capabilities and raw materials

- is the technology available?
- are the materials available?
- if not, then source materials required to provide the service
- match the service with cultural and geographical aspects
- if possible, combine with existing orthotics and prosthetics services

## Group E4 report

Chairman: Sepp Heim
Rapporteur: Jo Nagels
Participants:

| | | |
|---|---|---|
| Kumar | Tran Van Chuong | Stills |
| Long Hua | Pham Thuy | Mey |
| Harte | Naik | Krishnan |
| Urseau | Borgne | Sarwar |
| Poetsma | Thomas | Trebbin |
| Tardif | McMonagle | |

**3. Describe your experiences in using the ISPO/USAID protocol on cost calculation.**

Comments on independent experience not ISPO/USAID related

VietCOT:
- cost calculation integrated into clinical work of 3 year education course
- Swiss NGO, VietCOT for 200 child devices cost calculations after delivery
- calculations sent and considered by up to 9 centres (government and private], via GTZ consultant, with positive feedback Might be basis for future refund.

PIPOS:
- 2 credit hours in cost calculation
- Full-time purpose reflect in increased human resource expenses

UDB:
- comprehensive internally developed cost calculation is used

India (Impact):
- comprehensive internal cost calculation tool is used

HI:
- centres have own tools hard to change
- implementation in new centres
- language barriers with existing cost calculation tools

Motivation:
- VietCOT/GTZ model followed
- who should implement the tool: the accountant
- problems: no connections between the salary and labour time, how easy to calculate labour time?

| Strengths | Weaknesses |
|---|---|
| - Same tool used everywhere, common data<br>- assessment tool<br>- tool where financial responsibilities can be discussion with governments, allowing financial projections<br>- various admin and services on a percentage base, including individual projections, depreciations<br>- know-how of cost of device will lead to better management<br>- <u>all</u> relevant costs are included<br>- specific department costs | - not user friendly coding<br>- not user friendly manual<br>- no timely updated versions<br>- add-ons not displayed<br>- overhead costs not shared<br>- hard-copy manuals<br>- extra financial and manpower input<br>- no follow-up |

| Opportunities | Threats |
|---|---|
| - based on previous success, next wider version<br>- link patient data base, store management<br>- profits can be adjusted/calculated<br>- centre cost calculation<br>- include in schools will allow progress and integration of the tool, all the way to government institutions | - incomplete data my reflect incorrect price<br>- implementation of too big data base<br>- disciplined coding<br>- recommendations: |

Recommendations:

- overall it is a positive tool
- timely distribution of latest version
- registered web download updates
- introduction short training
- offer a training possibilities to centres
- more user friendly manual
- part of the curriculum in all schools
- follow-up to improve the system
- ISPO web page as a forum

## Group E5 report

| | | | |
|---|---|---|---|
| Chairman: | Eiji Tazawa | | |
| Rapporteur: | Aaron Leung | | |
| Participants: | | | |
| | Fang Xin | Zhao Huisan | Rechsteiner |
| | Henlein | Camacho | Lastring |
| | Muller | Mtalo | Visser |
| | Ghosh | Endley | Haq |
| | Link | Gillani | |

**4. What needs to be done to promote and improve orthotics technology in developing countries?**

- There are different situations from place to place. There is a need to identify the government's initiative and activity of the NGOs. There are comments that in some developing countries orthotic/prosthetic services service are only lead by private sector.

- Promotion and improvement need to be worked with the government structure. Existing local strength/situation must be identified, so that additional appropriate external support can be applied.

- Initiation can be from NGOs with government. Communication among Ministries is essential. Affordability, Availability, Accessibility of the required service have to be demonstrated to the government and need to be applied fast.

- Multi-activities, e.g. training course to support/subsidise patient service

- How to enhance the status of rehabilitation?
  - Team approach
  - Link with CBR, e.g. Red Cross branches and other NGOs
  - Outreach programmes

- Focus on clinical part and let the manufacturing part to be taken up by other industries?
  - To have input from professionals of manufacturing industry for product development
  - Local supply of materials and components with reasonable price
  - Quality of local products

**5. Discuss the need for new componentry and materials for use in orthotics in the developing world.**

- New approach and method to be designed
- Different technological options should be considered
- Patient specific
- Good knowledge about the process, e.g. health and safety (PVC generates toxic material under high temperature)
- Needs also come with improvement of economy of certain class of people

## Plenary discussion – Syndicates E

### Discussion

It was observed that  many countries already have shoemakers and it was suggested that they might be upgraded by including some orthotics in their training.

Germany has a seven step check list for the care of the diabetic foot. Is there a need to develop an international check list?

There was some concern about getting shoemakers to make orthopaedic shoes.  In France the education for orthopaedic shoemakers is 4 years. Cutting corners will only create problems.

## PART 2

### Conference papers

The following papers are edited submissions made to the conference organisers by each of the invited presenters. It should be noted that the papers reflect the authors' individual opinions and are not necessarily endorsed by the conference organisers. Papers, however, formed the basis for group and plenary discussion and subsequently, the foundation upon which the conference conclusions were reached.

## USAID/LWVF role in development of orthotics service

## in post-conflict countries

**Mel Stills**

**Senior Technical Advisor, Leahy War Victims Fund, USA**

The Leahy War Victims Fund (LWVF) is named after the United States Senator Patrick J. Leahy of Vermont, who aided in establishing this special fund. The fund is administered by the United States Agency for International Development (USAID). Senator Leahy recognized that today the casualties of war are primarily innocent civilians whose injuries may have been caused years after conflict ceased because of the accidental detonation of landmines or unexploded ordnances (UXOs) that today still cover past battlefields. The Fund was established in 1989 after a trip Senator Leahy and his wife, Marcelle, took to Central America where they observed the lasting suffering of conflict in that region.

The Funds purpose is to help rebuild lives shattered by war, and in doing so rebuild families and whole communities. USAID uses the LWVF where humanitarian needs are greatest, in the spirit of the American people. While the needs of those injured during times of conflict and those injured as a result of coming in contact with landmines and UXO's is clearly understood, it has also been recognized that routine medical services have been severely disrupted and childhood immunization program, pre and post natal care, general lack of health care has greatly increased the incidence of disability. In addition to the war injured the incidents of polio, cerebral palsy, leprosy, inadequate care for road traffic, and industrial accidents have all greatly increased and overwhelmed many countries' ability to provide any medical/rehabilitation services.

USAID has three special funds, funded as part of USAID's annual budget. These funds are administered through USAID but are not USAID projects. They are the:

- Displaced Children and Orphan Fund
- Victims of Torture Fund
- Leahy War Victims Fund

These three funds are working in 40 countries with over 70 different projects that improve the social, economic, and development status of those in need.

The Displaced Children and Orphan Fund address the needs of children who are most at-risk and vulnerable, or those who live without the care and protection of a family.

The Victims of Torture fund assists in the treatment and rehabilitation of individuals who suffer the physical and psychological effects of torture.

The Leahy War Victims Fund assists civilian victims of conflict and other people living with disabilities, primarily those suffering from mobility related injuries, disease and birth defects. The Fund recognizes that in some countries former soldiers are classified as civilians because they may not have been working on the side of the victor and have no other services available to them. The LWVF is currently active in 21 different countries through support to non-governmental organizations (NGOs) directly providing services to those with primarily mobility disabilities.

The primary goals of the LWVF are to:

1. Expand access to affordable, appropriate prosthetic, orthotic, wheelchair and rehabilitation services
2. Provide barrier free accessibility to home, school, work and recreation
3. Focus on cost effectiveness and quality of service
4. Work with representatives of the disability community to strengthen country policies on disability
5. Include people with disability in developing and implementing the project

LWVF project activities include the delivery of appropriate:

1. Orthotics
2. Prosthetics
3. Wheelchairs
4. Physical and Occupational Therapy
5. Medical/Surgical/Rehabilitative Medicine Services
6. Training and Education of delivers of services and consumers of services
7. Accessibility to schools-workplace-home-recreation
8. Inclusion of Persons With Disability in all activities of daily living
9. Aid in establishment and organization of Persons with Disability Groups

LWVF projects that are specific to Orthotics can be found in Afghanistan, Angola, Cambodia, Central America, Democratic Republic of the Congo, Ethiopia, Senegal, Sierra Leone, Sri Lanka, and Vietnam. Rarely are any projects limited to strictly prosthetic or orthotics. It is clearly recognized that there are individuals who have multiple needs that might include both prosthetics and orthotics. The physical needs of those affected by polio are as great as those who are a victim of a landmine and it is extremely difficult to overlook one's needs over another particularly when there are so many similarities in the materials, equipment and training needed to provide either prosthetics and/or orthotics.

Early in the development of LWVF projects the emphasis was primarily prosthetics but the needs of the orthotic population were quickly recognized. There was not a great deal of experience in working in these developing countries and innovative methods were tried to make expensive prosthetic components available. At first some of the NGOs really did not employ qualified providers of prosthetic services and there were attempts to use discarded prostheses and orthoses, later the possibility to recover components and use them over again was attempted. Now it is recognized that there is such a wide variety of prosthetic/orthotic components and the indications of each are very specific that just collecting used system does not guarantee that the component needs would be available and any repairs would be extremely limited based on availability. The need to standardize materials and components became necessary in prosthetics and orthotics.

The LWVF is not greatly concerned about which of the orthotic technologies are used as long as they are appropriate, affordable, and can provide consistency between patients being treated. Whatever technology, material, and/or component is going to be used it must be documented to have the capacity to meet the functional needs of the individual patient being treated. Because individual patient may have traveled great distances and may have had to wait a very long time to receive their first or possible replacement device that it is not fair or ethical to give them something that its functionality or durability is unknown because the device is only in the development stages. Field trials are important events but they very much need to be a controlled event with little possibility that the individual patient will be without a usable orthotic system in the case of system failure.

Because there is such a need to have properly trained prosthetists and orthotists working in each of these projects and there are so few available and on-the-job training activities were not uniformly successful between all projects, it became obvious that the support of prosthetics and orthotics training and providing individual scholarships for attendance to accredited prosthetics and orthotics training facilities was required. The LWVF, through a grant to the International Society for Prosthetics and Orthotics (ISPO), is addressing the issues of training and scholarships. Currently there are over 50 students from 23 countries enrolled in six ISPO accredited prosthetics and orthotics training programs located in Tanzania, El Salvador, Vietnam, Cambodia, Pakistan, and Togo.

The Fund also recognizes that the postgraduate phase of prosthetics and orthotics training is also critical for the development of competent professionals. As in any training program there is a limited amount of time available to provide the basic instruction to a student. Not every clinical situation can be adequately covered because of the huge variations in the complexity of clinical cases that may present themselves. In many of these countries years of neglect add to the complexity and in others rare and unusual birth defects are a common occurrence;

each polio, cerebral palsy, fracture, and stroke is unique and different. A structured phase of training after graduation is necessary to develop those professional skills necessary so that mentoring can become an on-going process in a country or region.

The Fund primarily focuses on mobility issues but recognizes that physical disability can also involve the upper limbs and the spine. It's unclear when it is the appropriate time to expand prosthetics and orthotics treatment services that include all the spinal and upper limb options available. Are there recognized indicators that a project is ready technically and professionally to expand services to include spinal cord injury, spinal instability, scoliosis, etc? It is hoped that the conference will address some of these questions

The LWVF is looking forward to receiving the results of this important meeting that will include all the presentations and deliberations that go into the development of a consensus on lower limb orthotics treatments for the developing world.

**Disability and prevalence data that determine the needs for orthotics services and prioritizing orthotics services**

**Chapal Khasnabis & Federico Montero**

**Disability and Rehabilitation Unit, WHO, Geneva, Switzerland**

## Introduction

The number of people with disabilities is increasing due to population growth, ageing, emergence of chronic diseases and medical advances that preserve and prolong life. The most common causes of impairment and disability include chronic diseases such as diabetes, cardiovascular disease and cancer, injuries such as those due to road traffic accidents, conflicts, falls, landmines, mental impairments, birth defects, malnutrition, HIV/AIDS and other communicable diseases. These trends are creating overwhelming demands for health and rehabilitation services. Among health related rehabilitation services, orthotics and prosthetics services play a very important role in promotion of function and enhancing quality of life.

Exact global data regarding the prevalence of people with disabilities is not available. Current disability statistics are not robust or globally comparable due to the lack of common protocol or consensus. In addition, mechanism for data collection are quite week in low-income countries. WHO estimates of the 10% prevalence of disability in the world dates back to an expert committee report from 1981. This report was based on a document submitted to the World Health Assembly in 1976 that included a summary of the results of available data on disabilities undertaken in some of the developed countries and on the basis of estimates of the prevalence of impairing conditions in a number of developing countries.

In the absence of more recent, reliable statistical data regarding the incidence of disability, the "10%" estimate continues to be used. Unfortunately, there is no objective data regarding the number of people who require rehabilitation services. There is also lack of evidence concerning the cost effectiveness of investments into rehabilitation services. In absence of this information, it is difficult to plan any kind of rehabilitation programme and difficult to convince policy makers about the need for and benefit of rehabilitation services. There is also no reliable data on the number of services and personnel available to assure quality service provision. This is especially the case in developing countries.

Considering this urgent need, in May 2005, the 58th World Health Assembly (WHA Resolution - WHA58.23) approved a resolution on "Disability, including prevention, management and rehabilitation". This resolution invites WHO to support Member States in collecting more reliable data and to promote studies of incidence and prevalence of disabilities as a basis for the formulation of strategies for prevention, treatment and rehabilitation. It was agreed that women are affected by double discrimination, first as a woman and then as a disabled person. The strong linkage between poverty and disability has already been established. A good health care system with comprehensive rehabilitation services can change this scenario.

So far, WHO has collected and analyzed disability data from censuses and nationally representative surveys from 107 countries and territories which represent a combined population of about 5 billion people. This information shows that the prevalence of disability in these countries and territories varies greatly, from 0.4% in Kuwait to 26.8% in Puerto Rico. According to the results provided by these censuses and surveys, out of 107 countries including 4 territories, only 25 countries have more than 10% of their population with disabilities, 15 has 6 to10% and the remaining 67 countries have less than 5%. Some even less than 1%.

Despite the organization of numerous national and international events and despite the availability of numerous relevant documents, disability does not seem to be a priority to policy makers at national and international levels. Even though disability has been demonstrated to have a direct linkage with poverty and development, major global developmental initiatives

such as Millennium Development Goals (MDG) continue to ignore disability. In any country, often the poorest of the poor are people with disabilities and their family members, who are often marginalised. Lack of understanding and focus on disability results in the unavailability of disability data which makes the policy makers further ignore even the basic needs of people with disabilities.

Fundamental rights are health, education and food. In developing countries, the majority of disabled people cannot access healthcare services or health related rehabilitation services. In many instances, the Ministry of Health does not consider rehabilitation as part of its area of work. Though in the Alma Ata declaration of "Health for all", it is stated that healthcare should be promotive, preventive, curative and rehabilitative. According to UN Standard Rules on the Equalization of Opportunities for Persons with Disabilities which was adopted by the UN General Assembly in 1993, rehabilitation and support services including assistive devices are the key preconditions for equal participation. Despite this fact, rehabilitation and support services receive the lowest priority, often being seen as expensive and needed by only a few.

Rehabilitation services are like a bridge between isolation and exclusion and are often the first step towards achieving fundamental rights. Health is a fundamental right, and rehabilitation is a powerful tool to provide personal empowerment. Due to lack of rehabilitation services, the majority of people with disabilities in low income countries remain as passive receivers rather than active contributors to the whole development process. An example of the relationship between poor prevalence data and countries with fewer resources can be easily observed in Table I.

| | Under 5% | 6-10% | Above 10% |
|---|---|---|---|
| | Algeria# | Aruba# | United Kingdom* |
| low income | | | |
| lower-middle income | | | |
| upper-middle income | | | |
| High income | | | |
| | Bangladesh# | Belize | Australia# |
| | Benin# | Bermuda | Brazil |
| | Cape Verde | Estonia | Canada# |
| | Colombia | Germany# | Guam* |
| | Uganda | Greece# | Norway |
| | Egypt# | Hungary | Puerto Rico* |
| | India# | Ireland | Sweden# |
| | Japan# | Lithuania | Turkey |
| | Sudan | Netherlands Antilles | Uruguay# |
| | Jordan | Poland | Virgin Islands, U.S.* |
| | Nigeria | St Vincent and the Grenadines | Israel# |
| | Sierra Leone | South Africa# | USA |
| | Philippines# | Nicaragua | Peru |

Table I. Disability prevalence data as reported in countries with low, lower-middle, upper-middle and high incomes.

**Prevalence of disability**

In reviewing Table I, it is interesting to notice that the 1st column (reporting an incidence of disability less than 5%), is mostly occupied by low income countries, with the exception of Japan, whereas, other columns are occupied by middle and high income countries. Disability prevalence even among neighbouring countries shows gross variation. Why are there such discrepancies? Those interested in determining the extent of disability in a population encounter (at least) two major problems. One is deciding upon an acceptable definition of

disability and the second is the choice of instrument. There is a strong need to develop a consensus on terminology (i.e. core concepts, basic definitions and operational components), which are commonly used in disability and rehabilitation and to develop a partnership to raise awareness about the need for and benefit of having reliable data related to disability and rehabilitation.

Some disability definitions which are being commonly used are as follows:

According to WHO, in its International Classification of Functioning, Disability and Health (ICF), disability can be defined as "the outcome or result of a complex relationship between an individual's health condition and personal factors, and of the external factors that represent the circumstances in which the individual lives". It is an umbrella term for impairments, activity limitation and participation restriction where impairments are problems in body function or structure such as significant deviation or loss. Activity limitation are difficulties an individual may have in executing activities and participation restriction are problems an individual may experience in involvement in life situations.

The UN Standard Rules expresses that the term "disability" summarizes a great number of different functional limitations occurring in any population in any country of the world. People may be disabled by physical, intellectual or sensory impairment, medical conditions or mental illness. Such impairments, conditions or illnesses may be permanent or transitory in nature"

Inter-American Convention on the Elimination of All Forms of Discrimination Against Persons With Disabilities of 1999, which has the following definition at Article 1: “The term disability means a physical, mental, or sensory impairment whether permanent or temporary that limits the capacity to perform one or more essential activities of daily life and which can be caused or aggravated by the economic and social environment.”

Disabled Peoples International (DPI): “Disability is the loss or limitation of opportunities to take part in normal life of the community on an equal level with others due to physical and social barriers.”

The definition of a disabled person in many countries such as India is “a person with restrictions or lack of abilities to perform an activity in the manner or within the range considered normal for a human being and was treated as having disability within the common domains which are mental, visual, hearing, speech and locomotor/mobility”.

In the draft UN Convention on disability, the possible definition of Disability is proposed as “Disability results from the interaction between persons with impairments, conditions or illnesses and the environmental and attitudinal barriers they face. Such impairments, conditions or illnesses may be permanent, temporary, intermittent or imputed, and include those that are physical, sensory, psychosocial, neurological, medical or intellectual”.

Frequently in low income countries, a limited definition of disability and limited resources to carry out the whole exercise result in low prevalence data. For example, the 1991 Nigerian population census reports a disability incidence of 0.5% of the total population, India 1.8% was reported in 2002, whereas, 19.3% was recorded in the 2000 census in the USA.

**Disability or impairment**

Considering the objectives of the Consensus conference, it is important to discuss if it could be more practical to use Impairment Prevalence Data rather than looking at disability data. Common causes of disability/impairments are often due to disabling diseases such as diabetes, cancer, cardiovascular disease, birth defects, accidents and injuries, wars and conflicts. It also varies grossly between developed and developing countries and also suggests an age dependency. A sample survey of Community Based Rehabilitation (CBR) projects and orthopaedic workshop of Kenya with a sample size of 6791 children and 3872 of adults is shown in Table II. This table demonstrates a typical impairment scenario in developing countries. From the available census and survey data, it is quite evident that in most of the countries, the people with physical impairments are the largest group.

| | child % | adult % |
|---|---|---|
| 1. Cerebral palsy | 24 | 5 |
| 2. Clubfeet | 15 | 3 |
| 3. Delayed milestones | 14 | 0.9 |
| 4. Stroke | 9 | 19 |
| 5. Hydrocephalus | 6 | 0.4 |
| 6. Hearing impairment | 6 | 9 |
| 7. Angulatory deformity | 5 | 2 |
| 8. Down syndrome | 5 | 2 |
| 9. Spina bifida | 4 | 0.5 |
| 10. Post fracture | 3 | 9 |
| 11. Visual impairment | 3 | 20 |
| 12. Cleft lip/palate | 3 | 0.7 |
| 13. Polio | 2 | 21 |
| 14. Amputees | 1 | 8 |

Table II. Impairment prevalence data in Kenya (Source: CBM Kenya)

Physical impairment or mobility impairment is defined as "a person's inability to execute distinctive activities associated with moving both himself and objects from place to place". Various musculoskeletal or neurological conditions may cause a person to be unable to use his/her legs or arms which may result in mobility restrictions which limit activity and do not allow full community participation. Some of the major causative factors are:

- Injury related impairments such as spinal cord injuries, amputations,
- Acute flaccid paralysis,
- Post polio residual paralysis,
- Cerebral palsy,
- Birth defects and stroke.

By comparing all the data at hand (Table III) it is still injury and disease related impairments that are the most common factors requiring orthotics and prosthetics services.

| Long-term sequelae | Both sexes | Male | Female | AFRO | AMRO | EMRO | EURO | SEARO | WPRO |
|---|---|---|---|---|---|---|---|---|---|
| Injured spinal cord | 19,359 | 12,656 | 6,704 | 1,566 | 3,525 | 2,148 | 2,356 | 5,284 | 4,480 |
| Intracranial injury | 18,715 | 10,833 | 7,882 | 1,691 | 2,434 | 2505 | 1916 | 5,772 | 4,397 |
| Amputated arm | 5,578 | 3,526 | 2051 | 986 | 662 | 640 | 549 | 1,836 | 903 |
| Amputated foot/leg | 15,141 | 8,035 | 7,106 | 3,048 | 1,191 | 1,764 | 1,238 | 6,215 | 1,686 |

Table III. Injury prevalence (in ,000) by gender, age and WHO sub-region 2002

**Acute flaccid paralysis and polio**

WHO surveillance covers all cases of acute flaccid paralysis (AFP) in most of the developing countries. Target group refers to any child under 15 years of age with acute, flaccid paralysis; or any person in whom a clinician suspects polio. AFP usually includes, Guillain-Barre Syndrome, polio, transverse myelitis, traumatic neuritis and others with similar conditions. Due to effective polio eradication programmes, the number of children with polio has decreased dramatically.

In 2001, the world came closer to eradicating polio with only 483 children infected but this number is increasing again. Children with polio are being reported in more countries than 2002. In 2005, 1,940 cases (compared with 1,255 in 2004) of which there were 895 cases (compared with 999 in 2004) in endemic countries and 1,045 cases (compared with 256 in 2004) in non-endemic countries.

| WHO region | AFP Cases | | Confirmed Polio | |
|---|---|---|---|---|
| | 2004 | 2005 | 2004 | 2005 |
| African | 9686 | 11706 | 934 | 845 |
| Central | 1296 | 1926 | 67 | 3 |
| East | 1247 | 1998 | 1 | 23 |
| South | 957 | 1174 | 1 | 14 |
| West | 6186 | 6608 | 865 | 805 |
| American | 2191 | 2075 | 0 | 0 |
| Eastern Mediterranean | 6168 | 8836 | 186 | 726 |
| European | 1568 | 1540 | 0 | 0 |
| South East Asian | 16255 | 31441 | 136 | 419 |
| Western Pacific | 6512 | 5918 | 0 | 0 |
| Global | 42380 | 61516 | 1263 | 1990 |

Table IV - Comparison of AFP/polio 2004 and 2005 data

While analyzing the collected data of AFP (Table IV), it has been observed that in recent years, the numbers of children affected with AFP are 30 to 40 times higher than children getting polio. Many of these children also develop a residual paralysis which needs orthotic intervention. The exact data concerning how many people subsequently need orthoses, prostheses or wheelchairs, are not available. In absence of such data it becomes even more difficult to determine how many people can access orthoses services.

Assistive devices such as orthoses, prostheses and wheelchairs
The UN General Assembly adopted the Standard Rules on the Equalization of Opportunities for Persons with Disabilities in 1993. The rules represent a strong moral and political commitment from governments to take action to attain equalization of opportunities for persons with disabilities. Rule 4 on Support Services mentions that "States should ensure the development and supply of support services, including assistive devices for persons with disabilities, to assist them to increase their level of independence in their daily living and to exercise their rights". It further indicates that "States should support the development, production, distribution and servicing of assistive devices and equipment and the dissemination of knowledge about them".

In many countries, development, production and distribution of assistive devices such as orthoses, prostheses, wheelchairs and other mobility devices are not considered an integral part of the health care system.. Their provision typically falls to non-governmental organizations and other ministries. In countries where the provision of assistive devices is dependent on complete external funding, related programmes often collapse after the expiry of outside funding. There is also a scarcity of trained personnel to provide services at provincial and district levels. In many settings where access might be possible, costs are prohibitive. As a result, in many low and middle-income countries, only 5%-15% of people who require assistive devices have access to them.

The number of orthotics and prosthetics facilities in developing countries is very low. In many African countries, for example, the number of inhabitants per orthotics and prosthetics production unit may be about 2-10 million whereas, in western countries, this figure could be less than 200,000 – 400,000 people. The difference between developing and industrialized countries becomes even more striking when one considers that most orthotics and prosthetics facilities in Africa are small with limited staff, equipment and raw materials, i.e. with a considerably lower production than that of facilities in industrialized countries. In addition many provide only prosthetics services although the need for orthoses is greater.

In USA, it is estimated that 4.6 million people (1.6% of total population) use orthoses or prostheses to compensate for orthopaedic impairments and among those about 20% are

people with disabilities (0.3% of total population). Among O&P users, 4.3% of the population use prostheses whereas 41.7% use lower limb orthoses including knee orthoses.

From the report on "Living Conditions among People with Activity Limitations in Zimbabwe", it is shown that of the 1972 people with disabilities identified, 406 individuals with disabilities claimed that they used assistive devices including walking sticks or frames (119), crutches/callipers (51), wheelchairs (26) and prostheses (9). According to statistics from the National Rehabilitation Centre of Ghana in the year 2004, 261 lower limb orthoses against 11 prostheses were provided. This picture could be quite different where there is strong presence of prostheses providers irrespective of the need. It is to be noted that even in war affected countries such as Sierra Leone, Nicaragua, Afghanistan and Sudan, the need is more for orthoses than prostheses.

**Prioritizing orthotics services**

Even within the prosthetics and orthotics sector, orthotics is a low priority irrespective of the need. The possible reasons for this could be that the disability is less dramatic, often a poor person's problem, needs more skill to provide than other aids, is of a higher status, lacks interest/support from big multinationals, and that there is a weak users group with a very small voice. As polio is being eradicated, there is a risk that there will be even less attention given to orthotics. It should be recognised, however, that of the people who already have suffered from polio or may suffer from it, most will require orthoses. International NGOs tend to pay attention to providing prostheses rather than orthoses (another example of donor driven projects against a needs driven projects). WHO would like to draw the attention of the International Community towards orthotics provision within the orthotics and prosthetics services. The need for orthoses is clearly greater.

The need for appropriate orthotics technology is the need of the hour. In the prosthetics sector there are some successful examples of appropriate technology but in orthotics sector there remains very few. Handicap International introduced the PVC calliper and very recently, Mobility India introduced the Pre-Fabricated Knee Ankle Foot Orthoses (PFKAFO). In most of the developing countries however, lower limb orthoses have metal rods or bars with black leather boots. People, who have no other option, still go for these heavy metal callipers/orthoses. Technology and know-how exists and it is possible to replace these metal callipers with lightweight, user-friendly designs and materials. Partnership is very much needed to promote orthotics technology. In this way more people with disabilities will receive benefit at a substantially lower cost.

Beside technology, one also has to think seriously about the whole service delivery system. Many orthotics users, especially users of knee-ankle-foot orthoses, live in rural areas with limited resources. It is difficult for them to come to a city again and again for measurement, trials, training, delivery, repair and maintenance. Orthotics and prosthetics service providers need to become more innovative to find a solution and linking orthotics and prosthetics provision with CBR services is a step towards this goal. Focus also needs to be given to early identification and early intervention. The magnitude of disability and costs can be minimized drastically with early intervention and a good link between the orthotics and prosthetics workshop and CBR can make this possible.

WHO believes that access to orthoses, prostheses and wheelchairs can be promoted simultaneously to give benefit to a large number of people who have the potential to lead quality lifes and become active contributors in the mainstream development process. From a financial and technical point of view the step to expand a prosthetics facility to include orthotics is very minimal. The tools, machines, equipment and raw materials needed are much the same and so as the manpower. Therefore, while being aware of the great need for orthotics services, it would be essential to plan the establishment of any orthopaedics facility which can cope with both prosthetics and orthotics services.

Polio eradication programmes are well underway in most developing countries, but millions of adults and children who have contracted polio continue to live with its functional limitations. Their lives can be transformed by enhancing mobility and potential for social integration with

good quality orthotics service. People with polio, leprosy, Guilaain-Barrè syndrome, trauma or cerebral palsy will maintain the demand and as medical advances are preserving and prolonging life, people would need more orthoses in coming years.

**References**

United Nations Standard Rules on the Equalization of Opportunities for Persons with Disabilities.

WHO Disability and Rehabilitation Team (DAR) - http://www.who.int/disabilities/en/

Prosthetics and orthotics services in developing countries: a discussion document (1999) - http://www.who.int/disabilities/publications/technology/en/index.html

Data and statistics on disability in developing countries by EIDE, Arne H, LOEB, Mitch E Norwich and London, Disability Knowledge and Research (KaR) Programme 2005

Disability census questions, the perspective of developing countries by MBOGONI, Margaret Washington, Centers for Disease Control and Prevention 2002.

Disability policies, statistics, and strategies in Latin America and the Caribbean: a review by DUDZIK, Pamela, ELWAN, Ann, METTS, Robert New York, Inter-American Development Bank (IDB).

Margaret Mbogoni and Malin Synneborn, United Nations Statistics Division, General disability measures in developing countries – relationship to purposes for measurement, Ottawa, 9-10 January 2003.

Revising the United Nations census : recommendations on disability by Margaret MBOGONI and Angela ME - Washington, Centers for Disease Control and Prevention 2002.

United Nations Statistics Division,
http://unstats.un.org/unsd/demographic/sconcerns/disability/disab2.asp

PFKAFO an appropriate orthotics technology
http://www.disabilityanddevelopmentpartners.org/pfkafo.htm

Most Common Causes of Disability among U.S. Adults, 1999
http://www.cdc.gov/doc.do/id/0900f3ec8000f569

International Classification of Functioning, Disability and Health (ICF)
http://www.who.int/classifications/icf/en/

WHO and ISPO joint position paper on CBR and P&O Services 2004

Global Polio Eradication Initiative - http://www.polioeradication.org/

Post-Polio Health International (PHI), www.post-polio.org.

# Needs in developing countries for orthotics services: El Salvador country survey

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*(Editors' Note: Manuscript not submitted. This paper is based on the PowerPoint presentation made at the conference)*

## Introduction

- This paper is based on a survey to identify the amount of people with disability in El Salvador during the period January 2000 – July 2001.
- El Salvador has a population of 6.2 million inhabitants.
- Its population density is 295 people per $km^2$.
- The population growth rate is 2.0% per year.

## Objective of the survey

- Contribute to improve the quality of life of people with disability, by using the obtained data on all levels of a comprehensive rehabilitation process.
- Prepare and implement a low cost sample survey that can be repeated in other developing countries

## Specific objectives

- Determine through a survey the number of people with disability and their specific needs
- Identify the needs in the field of prostheses and orthoses
- Establish a reliable database for people with disability
- Analyze the acquired data and formulate conclusions and recommendations

## Social and political implications

- To obtain data that allows to analyze the politics, norms and actions that are taken within the field of disability
- Propose measures in all areas of politics and the society that contribute to the complete integration of people with disability into the society
- Sensitization of the involved communities to the problems of disabled people within their community

## Participating parties

- WHO/PAHO

- 22 selected communities and local health structures and health workers
- National council for the integral attention for disabled people (CONAIPD)
- Ministry of Health
- Local NGOs
- National Rehabilitation Institute (ISRI)
- University Don Bosco (UDB)
- Project UDB-GTZ

**Criteria of the survey**

- Phase 1: Identify all disabilities + the situation with regard to education, work and rehabilitation
- Phase 2: Identify the special needs in prosthetics and orthotics
- Establishing of a data base to validate the results of the survey for disabled people

**Parameters for the geographic selection**

- Rural areas
- Urban areas
- Economic development
- Post-conflict area

**Initial preparations for the first phase**

- Design of the survey
- Identification of the sample size
- Bibliographic investigation
- Preparation of a municipal archive

**Implementation of the survey**

- Inter-sectorial and inter-institutional coordination
- Validation of the instrument
- Elaboration of the database in Fox Pro
- Elaboration of a training manual
- Training of the interviewers (150 people)
- Pre-selection of the survey zone
- Elaboration of a chronogram for the fieldwork

**Fieldwork and implementation**

- Data collection
- Data registration
- Processing and analyzing of data
- Elaboration of the report
- Socialization of the results

**Questionnaire**

2 page questionnaire with 28 questions:

- Personal data
- Socioeconomic conditions
- Labour conditions
- Disability situation

**Surveyed areas**


**Database**

- The database used was Visual Fox Pro

**Fieldwork**

- In the 22 municipalities of the survey, a total of 12,009 households were visited, registering a number of 43,987 persons of both sexes and of different age groups.
- In the urban area 5,356 (45.36%) households were visited in the 22 head municipalities and in the rural area 6,453 (54.64%) households were visited.

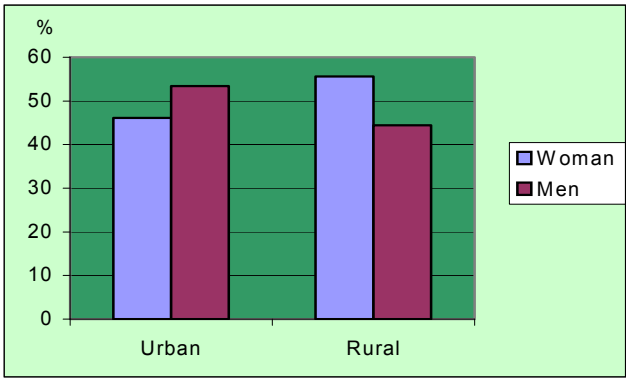
**Results of the first phase**

- During the recollection period, from the 1st of June to the 15th of August, 2000, 2,889 persons with some type of disability were interviewed, that is 6.56 % of the total registered population of 43,987.

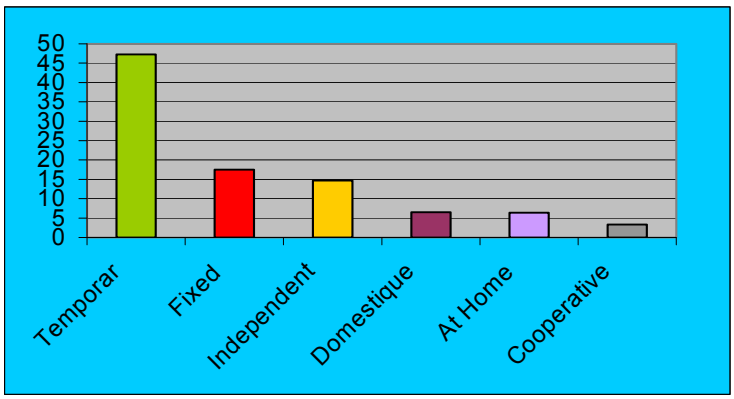
**Distribution by gender**

- 1,441 (49.89%) females
- 1,448 (50.12%) males

**Gender and living area**



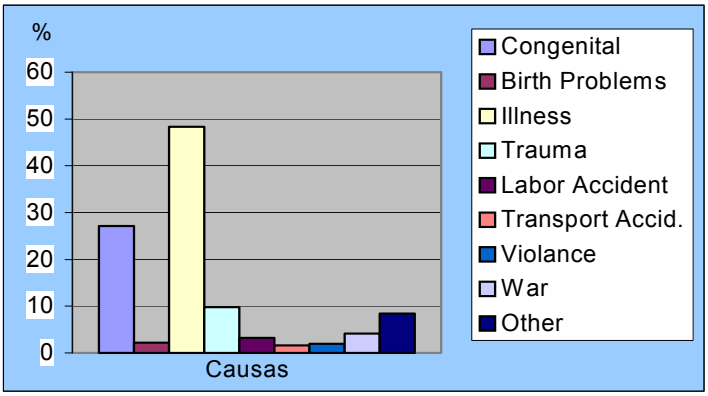
**25.7% have employment**



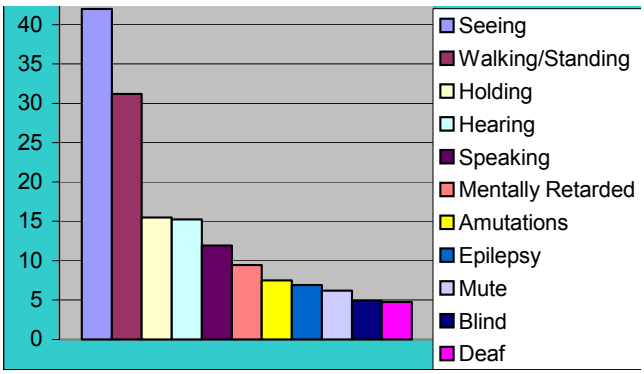

**Educational level**

- 46% Illiterate

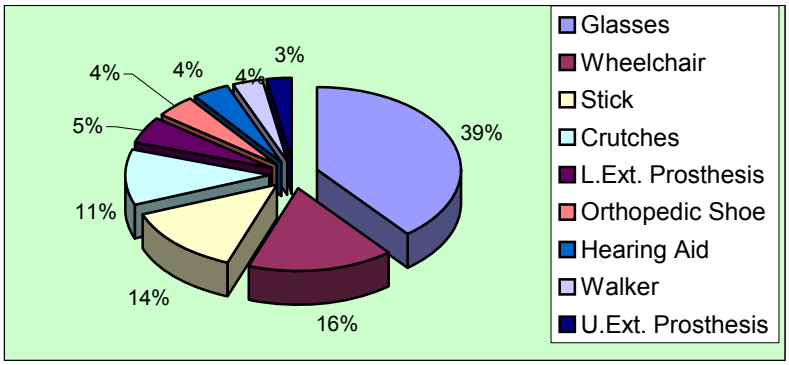
**Causes of disability**




**Type of Disability in %**



**Type of technical support used by people with disability**



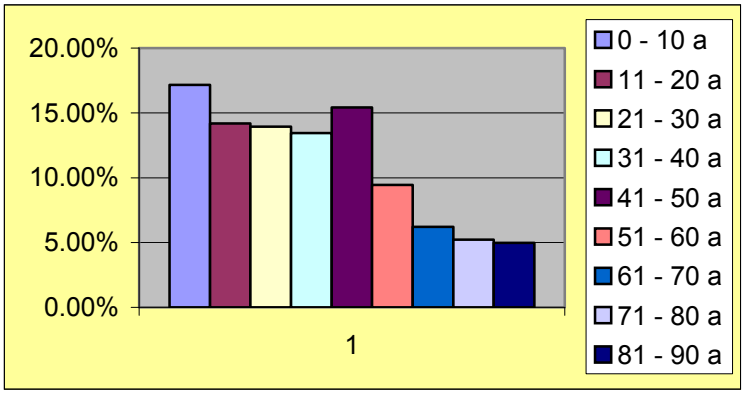

**Survey for people with disability: objectives of the second phase**

- Realize a clinical evaluation for the people with disability that have been detected in the first phase with some kind of mobility or locomotive problem
- Elaborate the prosthetics and orthotics needs for the identified group and the costs for these orthopedic needs and give a follow-up.

**Results of the second phase**

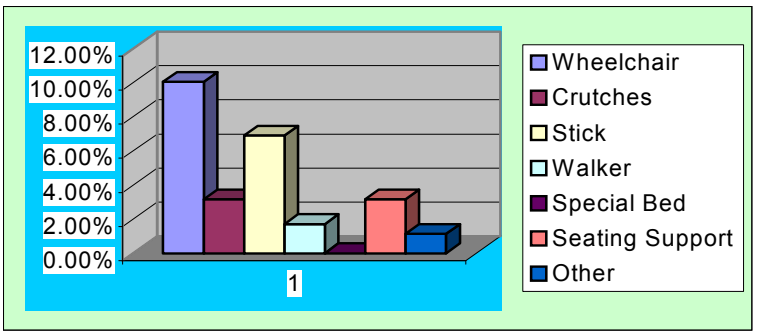
- 1165 of the 2889 identified people with disability (PwD) had some kind of locomotion of mobility problem of the lower or upper limb, which corresponds to 40.32% of the total number.
- Of these 1165 people with locomotion disabilities 402 where evaluated by specialists in order to determine their need for orthoses, prostheses or other orthopedic aids.
- Of the 402 PwD, 153 were female and239 were male
  - Of these, 128 (31.8%) needed some kind of lower limb orthoses: 71 (55%) were male and 57 (45%) were female

**Relation of disability/age**



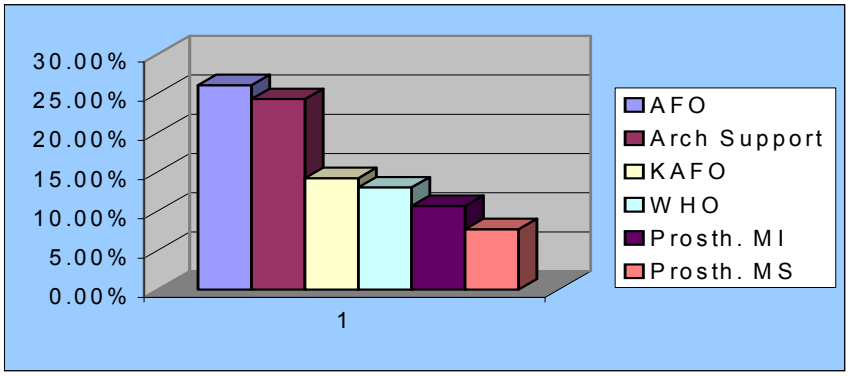
**Orthopedic support need**

105 (26%) of the 402 evaluated with mobility disability




**Prosthetic and orthotic prescription**

- 169 (41%) of the 402 evaluated with mobility disability required prostheses or orthoses




**Prescribed orthoses**

- Hand orthoses 20
- KAFOs 24
- AFOs 42
- Arch supports 41
- Spinal orthoses 4

**Some conclusions**

- All results have to be carefully analyzed with all involved parties in order to take actions on a political and service level
- There is a need for further decentralization of services up to the community level (CBR)
- The reference system has to be improved on a national level
- Opportunities for PwD are lacking in all sectors
- There is a stronger need for orthoses compared to prostheses

**Causes of disability: acquired**

Of the112 (87.5%) people with acquired disability who required an orthosis:

- Cerebral palsy 30 23.43%
- Poliomyelitis 60 46.87%
- Arthritis 12 9.37%
- Vascular cerebral accident 10 7.8%

**Causes of disability: congenital**

Of the 16 (12.5%) people with a congenital disability who required an orthosis:

| | | |
|---|---|---|
| • Scoliosis | 4 | 3% |
| • Talipes equinovarus | 8 | 6% |
| • Myelomengelities | 4 | 3% |

**Next steps**

- Complete population survey of the community of Santiago de Maria (pop. 100 000) within an existing CBR programme
- Detailed determination of pathologies and orthotics and prosthetics needs in this community.

**Prioritising orthotics services: the WHO viewpoint**

**Chapal Khasnabis**

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See author's previous paper – page 7

**Prioritising orthotics services: the medical surgical viewpoint**

**Lawrence Museru**

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## Introduction

Tanzania, with a population of approximately 34 million people has an area of almost one million square kilometres. Administratively it is divided into 21 Administrative Regions. Each region has a regional hospital which is manned by specialists, medical officers, nursing officers and other paramedics.

## Orthotics demand

Out of the 34 million people it is estimated that 400,000 people have various disabilities. There are two major orthopaedic workshops,the Tanzanian Training College for Orthopaedic Technology, (TATCOT), Kilimanjaro Christian Medical Centre (KCMC), Moshi and the Muhimbili Orthopaedic Institute (MOI), Dar es Salaam (Figure 1)

Figure 1: MOI workshop in Dar es Salaam

Both of these have adequate human resources, infrastructure and equipment to perform fabrication of all appliances (Figure 2).

Figure 2: Orthotic and prosthetic devices manufactured at MOI in Dar es Salaam.

There are seven other centres distributed in seven regions. Most of these have qualified orthopaedic technologists but the infrastructure is poor and supplies inadequate. This is because they have to compete with other hospital activities for funding while most of the materials are expensive as they usually imported. Therefore most of these workshops end up performing minor procedures usually the repair of orthotics.Tables I, II and III show the various statistics for MOI performance for the years 2000-2005.

| Year | Female | Male | Total |
|---|---|---|---|
| **2000** | 79 | 101 | 180 |
| **2001** | 46 | 84 | 130 |
| **2002** | 67 | 93 | 160 |
| **2003** | 46 | 57 | 103 |
| **2004** | 60 | 76 | 136 |
| **2005** | 55 | 95 | 150 |
| **Total** | **299** | **506** | **859** |

Table I: Clubfoot cases managed at MOI in Dar es Salaam.

| Year | Female | Male | Total |
|---|---|---|---|
| **2000** | 6 | 9 | 15 |
| **2001** | 5 | 5 | 10 |
| **2002** | 4 | 6 | 10 |
| **2003** | 8 | 9 | 17 |
| **2004** | 14 | 12 | 26 |
| **2005** | 20 | 23 | 43 |
| **Total** | **57** | **64** | **121** |

*Table II: Post-traumatic cases managed at MOI in Dar es Salaam*

| Year | Female | Male | Total |
|---|---|---|---|
| **2000** | 8 | 11 | 19 |
| **2001** | 7 | 11 | 18 |
| **2002** | 6 | 6 | 12 |
| **2003** | 5 | 5 | 10 |
| **2004** | 4 | 7 | 11 |
| **2005** | 6 | 10 | 16 |
| **Total** | **36** | **50** | **86** |

Table III: Polio cases managed at MOI in Dar es Salaam

When the MOI orthopaedic workshop is considered, it is obvious that although it is functioning optimally there are many patients who do not receive the service.

The reasons for failure of obtaining orthotic services include:

- *Accessibility:* In Tanzania almost all the orthopaedic workshops are in towns. This is despite the fact that almost 70% of the population in Tanzania is rural. The large size of the country and poor communication makes it difficult for those in need to access the service. In addition there is still a persistent belief that no assistance should be given to a disabled child. Some NGOs such as the Salvation Army and Comprehensive Community Based Rehabilitation in Tanzania (CCBRT) have attempted to overcome this problem by carrying out outreach programmes.

- *Cost:* Most of the appliances are expensive, ranging from USD10 for splints to USD 500 for polio orthoses. These prices are not affordable for the majority of patients. There are no successful programmes for facilitating patients to pay for the costs. Programmes through the government are not sustainable.

- *Poor knowledge:* The fact that disabled people can be treated and rehabilitated is not very well known. Parents or relatives are usually ignorant or follow traditional beliefs and tend to hide their disabled children.

The general population in many developing countries still has a negative attitude toward disabled children. Medical and other health workers' knowledge of rehabilitation is poor. This means doctors either do not prescribe orthoses or may prescribe an inappropriate device. In a study in Tanzania, It was found that many families with disabled children did not know what to do for their disabled children.

**What can be done?**

Much is required to be done in order to achieve the desirable effects associated with helping the disabled:

- Sensitise the general population that disabled people can be medically and technically helped.

- Policy makers should be educated so that deliberate efforts can be made to promote assistance to disabled people.

- The cost factor should be addressed. Most of the appliances are high because most of the components and materials are imported.

- The teaching curricula for health workers, especially doctors, should include the importance of and methods associated with rehabilitation.

- Accessibility should be improved by establishing more orthotics centres.

- Reinforce the training of prosthetists and orthotists.

## Prioritising orthotics services: the orthotist's viewpoint

**Juan Carlos Camacho Gómez**

**SMOPAC , México**

### Backgound

As you know today the world looks smaller in many ways. Large companies are opening new markets everyday and everywhere, selling their products all over the world and making substantial investments. Travel from country to country an be made in a short period of time with the current transportation systems. News travels instantly around the planet through television, internet, radio, newspaper and other communication systems. Industry, science and technology reach new levels each day.

However, in this dynamic world there are people suffering. Their existence sometimes ignored and at other times forgotten. People in poor condition are surviving while being forced to fight against the illness, hunger, unemployment, ignorance, war, loneliness and many more obstacles. Religions, customs, cultures and governments sometimes look as though they are opposed to the advancement of developing countries rather than our allies to improve the prospects of the population..

Children with disabilities seem to be concentrated in the poorer regions of this planet. Our obligation is to facilitate a better environment in which children can grow and to improve their quality of life. We can not simply be spectators.

Let the Mexican situation be used as an example. It is true that it is far from its final goal but at the same time it is also far from the beginning.

In the 1950s young men with different backgrounds started to manufacture orthoses and prostheses under the coordination of medical doctors. These men were originally trained as carpenters, shoemakers and metal workers. In 1974 a group of them founded the first Mexican association of prosthetist and orthotists which was eventually to become Sociedad Mexicana de Ortesistas y Protesistas (SMOPAC) (www.smopac.org.mx)

SMOPAC provides a programme of training in prosthetics and orthotics which started in 1974, in collaboration with internationally known teachers, universities, hospitals, associations, companies and institutons. There are three seminars each year and in February 2007 there will be a combined meeting with ISPO (USA) in Cancun, México.

By the 1970s the social security offered a service to people who had suffered a work related accident and required an orthosis or prosthesis through private orthotics and prosthetics workshops.

A government school, now called the National Rehabilitation Institute, directed attention to rehabilitation by providing training in prosthetics and orthotics, rehabilitation and other areas.

Poliomyelitis was a serious blow to the world and México was no exception. Philanthropic businessmen opened rehabilitation centres, like who provided orthotics, prosthetics, rehabilitation and jobs to hundreds of people in México City.

In the 1970s a government department called the DIF (Integral Development of the Family) was formed where families with few economic resources could attend. This department addressed many different issues but especially rehabilitation. There are two different administrations within DIF. One is from the state government and the other is from the municipal government. As a result a DIF facility can be found in almost every city and small town in the country.

In the 1990s a foundation formed of the most important companies in communication known as the TELETON. In May of 1999, CRIT (Integrated Rehabilitation Centre "Teleton") open its

first centre in Mexico close to Mexico city and now there are 6 more, a further one being opened each year. They are sited in Mexico State, Oaxaca, Aguascalientes, Coahuila, Guanajuato and Hidalgo. At the present time CRIT have provided service to more than 2 million people in areas such as:

- Physical therapy
- Multiple stimulation
- Multisensitive stimulation
- Language therapy
- Occupational therapy
- Psychology and school for parents.

CRIT works under the philosophy of 'Love and science at the service of life'.

**Solutions to the orthotics service**

To facilitate good planning it is necessary to consider all the information available about disability in each country. In Mexico this is carried out by the INEGI (National Institute of Geography, Information and Statistics).
It provided the following current information:

- Mexico has the 11th largest population; it currently has 103.1 million inhabitants.
- 7% of the Mexican population suffers from some kind of disability.
- More than 2.2 million people require some orthotic or prosthetic service. Of this number 19.4% have congenital issues, 31.6% disease, 17.7% result of trauma, 22.7% are elderly, 1.9% suffers from other problems and 6.7 did not specify their problem.

More specific information about this topic can be found through INEGI (www.inegi.gob.mx)

How is the orthotics service prioritised with regard to demand?
There are 1500 or more persons with prosthetic and orthotics shops in Mexico. Of these people approximately 150 are educated at the school and the remainder are empirically trained. Most of these people perform a reasonable job but people can be found who take advantage of the situation. Doctors provide orthotics to their patients buying them from a supplier or have someone to make them who has not been appropriately trained. However, an orthotics and prosthetics workshop can be found in almost all the cities. It is true though that many people have to travel long distances in order to receive care and if the treatment requires long term physical therapy they cannot afford it most of the time.

What is the place of lower limb orthotics in the service?
Even when there is no education in orthotics and prosthetics formally directed toward the orthopaedic doctors, they come to learn about new materials and systems trough the SMOPAC continuous education programme and through working with other members of the multidisciplinary team.

It is clear that orthoses have a special place in the treatment of lower limbs and they are found in common use. It is considered that polypropylene and polyethylene give almost all the possibilities of treatment for most of the pathologies such as:

- Fractures
- Congenital deformities
- Asymmetry in lower limbs
- Post-poliomyelitis
- Clubfoot
- Sickness

**What are the priorities in lower limb orthotics?**

The problems in providing orthotics to the people from developing countries must be resolved in the medium and short term as follows:

*Medium term solution:*

1. Establish education programmes in each country.
   In Mexico there are 12 prosthetist/orthotists who are proudly ISPO Category II certified from the University of Don Bosco, El Salvador by means of its distance learning education programme. Five more students are currently attending the course while 12 further students are about to start in the new session of the distance learning programme. One hundred and forty more clinicians have improved their knowledge through SMOPAC's continuous education programme. Unfortunately the remainder have not taken any educational initiatives. For this reason the Certification Programme must be supported by ISPO, WHO, USAID and all the NGOs (non-governmental organizations).

2. Regulate those who provide orthotics and prosthetics services.

Regulation in each country must be made by the orthotists and prosthetists themselves; however, they do not have large enough numbers to influence governments if they do not have the support of the groups mentioned above. In Mexico, the formation of the Orthotics and Prosthetics College is about to be completed. How can the orthotics service be improved if anyone can open a workshop without knowledge and just for business?

*Short time solution:*

If a short time solution is required to meet the demand for orthoses in developing countries everyone must work together to do the following:

3. Individuals can work with groups of 10 prosthetist/orthotists in a foreign country for one week per year; as a compromise to group all being ISPO recognised Category-I and Category-II personnel some locally recognised can be included in the group. These individuals should be supported and sponsored by ISPO, WHO and other organisations and institutions.

4. Work could be carried out using a mobile workshop such as Cube-Lab. Cube-Lab is a portable and mobile laboratory It has a stainless steel frame with the follow measurements: Height 80cm; Length 70.5cm; Depth 79.5 cm; Weight 150 kg. The Cube contains tools and equipment necessary for orthotic manufactureure such as a sewing machine, a make-up work-place, a drill, a press and a tube support. In addition, it can be transformed into a table for taking measurements. The Cube-Lab contains hand tools such as hammers and screwdrivers and includes a portable oven for thermoplastics. The oven works with a heat gun and has a lamination capacity of 70 x 55 cm. The Cube-Lab also includes a vacuum and a compressor.

5. When pre-fabricated orthoss should possibly be fitted. A prototype could be made that I call the KAFOX. This device can be fitted on right or left side and can be made in small, medium and large sizes. The KAFOX can be fitted to most leg circumferences and is made in aluminium and stainless steel.

**Conclusions**

With the right information and the equipment a plan for a short time solution can be made while the longer term solutions are being developed.

Advantage has to be taken of the best of the team available.

We have a challenge to face and should recognise that its solution is in our hands.

## The value of the user's participation in the clinic team

**Elizabeth Thomas**

**Mobility India, Bangalore, India**

Rehabilitation is a team work where besides the professionals, the user or family member is an equal member. In the changing scenario, often a person with a disability is considered as an expert of his or her chronic conditions and the environment she or he lives in. Issues related to life style falls in the domain of users rather than of professionals. User's active participation in the clinic team can assist the service providers to offer more appropriate choices which would be beneficial to all. Professionals, usually with their knowledge, could suggest what could be the possible best solution for a person with disabilities but cannot prescribe. Rehabilitation is not as straightforward an issue like giving medicine to cure a fever or an illness. It needs to be a combined decision to choose the best orthosis or rehabilitation intervention. The individual's socio-economic condition, environment and life style all, matter very much in the selection of an orthotic device. It is often the users, especially the experienced users who know better what will be best for them.

In the fifties and early sixties, India did not have trained orthotics personnel. Rehabilitation centres and orthotic workshops were rare. By listening to the interactions and discussions between the surgeon and the shoe maker or calliper maker and through personal use of the calliper, I learnt a few lessons. Getting orthoses made at different places, meeting different doctors and orthotists, the knowledge of the user increases. Many users are often more experienced than professionals. In the present world of Information Technology, one will learn more quickly. Often new suggestions are not well accepted either by the service providers or users. It takes time to develop a relationship and mutual confidence. Respecting each other makes the process faster. Rehabilitation is often more a long term, complex affair. The relationship between user and service provider is very crucial.

The user's role in motivating other people with disabilities is also a very important aspect and the user's participation in the clinic team assists other disabled persons to accept their disability better, and at the same time to gain confidence over the whole environment. This is more important for people who suddenly acquire a disability. As a long time user of orthotic devices, the user himself/ herself can be the counsellor/adviser to fellow users, i.e. be a 'peer counsellor'. An experienced user in the clinic team also can be of tremendous help; such a person would have had various types of experiences, especially in solving many problems with his or her own inventions or tricks which often could help the new ones to adapt more easily in the new situation.

The user also could be a good motivator for others. It took a long time for me to switch from the traditional calliper to the plastic orthosis (KAFO); when I show my orthosis and share my experiences of this switching over and the benefits of the present orthosis, people with disabilities definitely pay greater attention to my words than to professionals saying the same. Experience counts a lot! Many also go for a switchover from the traditional conventional calliper to the plastic moulded orthoses.

To mention few, I had to adapt a way of getting into the seat of a car as the appliance would not bend enough at the knee joint! I had to figure out how to use the Indian type of commode, in a squatting position! I had to gauge how long I could wear a new appliance before it started to hurt my affected limb, and before chaffing began! I had to discover which surfaces would be easier to learn to start walking with the new appliance! How do I negotiate steps/stairs, gradients were all a kind of dilemma to me! I am fairly confident that experienced users like me can advise new users on these matters! These may appear simple tasks to the non-disabled professionals, but let me emphasize, that to the new orthosis user, these are insurmountable problems. A user can demonstrate some physical exercises which may help the affected limb as well as the normal limb. An experienced user often knows all these and can assist the clinic team to make a better choice for himself or herself and also other disabled people.

We could explain to fellow new users what precautions would be required to prevent chafing, itching, or formation of calluses. We may be able to demonstrate to the disabled, ways of doing various chores while wearing the braces. In my opinion, an experienced user, if included in the clinic team, can advise and counsel the new user on the advantages of using the device, especially to young users, more effectively, than another counsellor, as 'seeing is believing '.The former can point out to the latter what might be the result if these devices are not used. This will be of reassurance to parents of children with disabilities and who have to wear orthoses. Parents need to be advised about the importance of parental emotional support to the user.

Asserting our rights is another way the user can help fellow users. Fellow users need to know their rights and what one should expect from others; to illustrate this point: airlines do allow a disabled passenger to carry an extra orthosis as free hand baggage, but how many times I have faced opposition from the ground staff! They have told me that the appliance would not fit in the overhead bin and I have to assert that I have measured the dimensions of the bag in which I carry my extra brace and that it will fit without any problem. Once, when a member of staff still opposed me I told her the cost of the appliance, exaggerating a little and that the airline would be responsible if it breaks while sending it as a 'checked in' baggage. Needless to say, I got my way when she heard of the cost of the brace!

Sometimes a user is embarrassed to remove a full length calliper while travelling long distance, say in a train, without others noticing or even staring at the whole 'operation'! An experienced user would have devised some method to do it without drawing the attention of fellow passengers. A user can advise on the right kind of clothing to be worn which would help easy donning and doffing.

A satisfied user also is the ambassador of the Clinic Team - if he or she gets quality service, he or she definitely would influence others to have similar experiences and lead a dignified life. Users also can play an active role in promoting the service, the clinic team and the organization. History shows many changes especially related to disability rights and laws; these took place due to the active lobbying by the users and their parents and organizations involved in disability and rehabilitation work. As a satisfied user, it gives me tremendous motivation and encouragement to promote this sector knowing full well, the impact of having a good team and quality orthotics services which can change the life style of millions of people who are still waiting to access rehabilitation services.

A healthy relationship between my orthotist, other team members and myself made me realise the importance of supporting the organization from where people like me get help and benefits. This fact motivated me to be a volunteer for the organization where the orthotist was working, achieving excellent results. I felt I owe my 'alma mater' something for making me what I am today.- from a puss in ugly boots to a Cinderella with a glass slipper, not quite so, but with 'Tewa brand' sandal! What does this all lead to? My belief is that if the user is happy and satisfied with the rehabilitation management or in my case orthotics service, then the person can be an ambassador for the rehabilitation team of doctors, therapists and orthotists.

It would be better to value our participation in the whole process - we are the users, you exist because we exist or vice versa - we need each other. My plea to all of you rehabilitation professionals is that a partnership approach is needed between the user and the rehabilitation professional. I am sure you are familiar with the slogan 'Nothing about us without us'. Thank you very much for giving me this opportunity; let us work together for the benefit of humanity and establishing a Rights Based Society, where disabled people will be able to access rehabilitation services to become equal citizens of society.

**Plenary Discussion "Needs in developing countries for orthotic services"**

**Chair: Bakht Sarwar**

**Rapporteur: Nerrolyn Ramstrand**

**Discussion**

Mel Stills presented an overview of the role of USAID and the Leahy War Victims Fund. A question was raised regarding support for postgraduate education by these organisations. Stills commented that USAID and the Leahy War Victims Fund recognise the importance of postgraduate education but that no specific projects were being supported at this time.

Much discussion followed the presentation by Chapal Khasnabis on disability prevalence and epidemiological factors that determine the needs for orthotics services. Discussion focussed largely on the lack of a standardised definition and measurement tool for quantifying disability. Khasnabis stated that WHO is interested in supporting the collection of epidemiological data related to disability but that this can not be done well until a clear definition of the term disability and an appropriate measurement tool is identified. It has been stated by WHO that 0.5% of the world's population requires an assistive device. A question was raised regarding the source of this data. Khasnabis indicated that the figure was based upon a compilation of studies from both developing and indusrial countries and that additional information and data is necessary to confirm this number. In response to a statement highlighting the need for a measure of functional levels within the disabled population, the group was invited to review the WHO/ICF website which presents a list of seven qualifiers related to functional level that can be used with any condition.

Reference was made to a study indicating that 26.8% of the population in Puerto Rico was disabled. It was highlighted that the study in question included the use of eyeglasses to correct vision as an indicator of disability. As a result the usefulness of this study was questioned.

WHO will hold a meeting on the 27$^{th}$ and 28$^{th}$ of July 2006 in order to address this issue. In 2009 the WHO intend to produce a report on disability and rehabilitation. The need for quality epidemiological data before this time was emphasised.

Heinz Trebbin presented an overview of a country survey of disability performed in El Salvador. Participants were interested in the training that survey administrators received. Trebbin indicated that survey administrators received a 50 page training manual that was designed, among other things, to facilitate understanding of disability by the administrators.

Several presentations highlighted that development in the field of orthotics has received little attention and that the field of prosthetics has received relatively more attention. It was recognised that when distributing funding for orthotic developments groups must consider which specific areas of orthotics require the most attention. For example, areas such as orthotic management in polio and cerebral palsy should be prioritised.

In response to Lawrence Museru's presentation regarding the prioritisation of orthotics services from a medical perspective the group agreed that there is a serious lack of education for medical doctors and therapists regarding the potential benefits of orthotic management. It was recognised that this is an issue for both the developing and the industrial world.

# Current orthotic practice in Africa

**Longini B. Mtalo**

**TATCOT, Moshi, Tanzania**

## Introduction

Up until the late 1960s the orthotics services in Tanzania were provided by technicians who had very little background in the profession. These were bench workers who had attended informal in-service training or short-term courses organized by various partner organizations in Africa. Indeed the achievement made in these training programmes is to be admired as they produced technicians who could fabricate simple callipers for poliomyelitis victims who needed immediate rehabilitative measures.

The need to develop and extend the current formal training programmes within the continent is of paramount importance so that appropriate technology can be practiced. Within the continent there exist training programmes, which are offering various courses in the field of orthotics. More collaboration needs to be developed so as to share the experiences and technology transfer between such institutions within the continent. It is surprising to note that, these existing training institutions do not have links with each other but could have some links with institutions outside the African continent; as such links should be encouraged so as to share the common issues which surround most African countries in the area of provision of rehabilitation services to the disabled community.

By the year 2000 the trend started changing drastically within the continent thanks to various partner organizations such as ICRC and HI diverting from the concept of short-term to long term training programmes. This is a great break-through in the development of orthotics/prosthetics service provision within the continent and it is hoped that this move will continue to be supported by other partner organizations so that the sustainability of the rehabilitation services can be realized by having adequately trained orthotists/prosthetists within the continent who can deliver the appropriate technology required.

## Current orthotic practices in Africa

This paper focuses on four selected countries due to the fact that the Tanzanian Training College in Orthopaedic Technology (TATCOT) has visited each country as a means of following-up and obtaining feedback from its graduates regarding the impact and technology transfer in their respective countries. Thease countries are Zambia, Zimbabwe, Malawi and Tanzania. It is believed that this activity is important as a tool to judge and assist in the overall evaluation of the training programmes and ISPO and other partner organizations are requested to look into the possibility of supporting such activities on a broader perspective in the various countries involved in training prosthetics and orthotics professionals.

### *Zambia*

The population of Zambia is estimated to be 10 million spread throughout 9 provinces. There are estimated to be 120,000 peeople with physical disabilities.

Graduates from TATCOT are employed in 4 centres:

- Central Orthopaedic Workshop, University Teaching Hospital, Lusaka which is the Capital
- Central Orthopaedic Workshop, Kitwe City, Copper belt
- Dagema Childrens Home Rehabilitation Centre, Ndola City
- Rehabilitation Centre, St. Theresa Hospital, Luanshya City.

<u>Central Orthopaedic Workshop, University Teaching Hospital. Lusaka</u>

The University Teaching Hospital is the biggest consultant and referral orthopaedic workshop in the country. It is well equipped with all necessary machines, tools and basic equipment.

The government pays the salaries for the staff and meets the other costs of the appliances, including service of machines, equipment and tools. Locally available materials are purchased where possible.

The workshop has total of 8 staff members:

- 3 Category II Orthopaedic Technologists trained at TATCOT
- 1 Category III Bench Technician trained at TATCOT
- 4 Category IV personnel trained in-service

Other members of the rehabilitation team include:
Orthopaedic Surgeons: There are 5 orthopaedic surgeons in the country and they regularly receive visiting orthopaedic surgeons from abroad.
Physiotherapists: There are about 20 physiotherapists with a diploma level education and 8 with a BSc level practicing at the University Teaching Hospital. The physiotherapists work together with the other members of Rehabilitation Team for special cases. The Government is fully engaged in supporting people with physical disabilities in collaboration with non-governmental organizations as well as international agencies.

The orthopaedic unit at the University Teaching Hospital receives most of the orthopaedic materials and components from ICRC and a small amount from Otto Bock, Germany. Other materials are locally purchased such as plaster of Paris (POP), plaster bandages, rubber sheets, metal sheets, leather, steel bars and other small technical items.

Central Orthopaedic Workshop, Kitwe City
The government pays the salaries for the staff and meets the other costs of the appliances including servicing of the machines, equipment, tools and purchases locally available materials.

The workshop has a total of 4 staff members:

- 1 Category I Prosthetist /Orthotist trained in Germany
- 3 Category IV personnel trained in-service

Other members of rehabilitation team include:
Orthopaedic Surgeon: There is only one orthopaedic surgeon.
Physiotherapists: There are about 6 physiotherapists trained at the diploma level and 1 BSc level therapist at Kitwe Central Hospital. These therapists work together with the other members of the rehabilitation team for special cases. The Government is fully engaged in supporting people with physical disability in collaboration with non-governmental organizations and International agencies.

The central Orthopaedic Workshop at Kitwe receives most of the orthopaedic materials and components from Otto Bock, Germany. Other materials are locally purchased such as POP, plaster bandages, rubber sheets, metal sheets, leather, steel bars and other small technical items. A wide range of orthopaedic appliances are manufactured and fitted to the disabled community in the copper belt.

The central orthopaedic workshop is not so well equipped with machines, tools and equipment. The hospital has a capacity of 800 beds (40 orthopaedic beds).
An orthopaedic Meister (Germany) manages the workshop. The hospital is the biggest consultant and referral orthopaedic workshop in the copper belt province.

Saint Theresa Mission Hospital, Luanshya
The Mission pays the salaries for the staff and meets the other costs associated with providing the appliances, including servicing of the machines, equipment and tools. They purchase locally available materials where possible.

The workshop has a total of 2 staff members:

- 1 Category I Prosthetist/Orthotist trained at TATCOT, Tumaini University
- 1 Category III Bench Technician trained in-service

Other members of rehabilitation team jnclude:

Orthopaedic Surgeon: There is only one General Surgeon at the Centre.
Physiotherapists: There are 2 physiotherapists with diploma level qualification practicing at the centre. They work together with the other members of the rehabilitation team for special cases. The Roman Catholic Mission is full engaged in supporting children with physical disability in collaboration with the non-governmental organizations, as well as international agencies
The Centre has one Social Welfare Officer
The Centre does home visits to physical disabled children in order to encourage the daily living activities and ensure the proper utility of the walking appliances being provided by the centre.

The entire Saint Theresa Mission Hospital receives most of the orthopaedic materials and components from the ICRC. Other materials are locally purchased such as POP, plaster bandages, rubber sheets, metal sheets, leather, steel bars and other small technical items.

The Orthopaedic Rehabilitation Centre at Saint Theresa Mission Hospital is well equipped with machines, tools and equipments necessary to carry out day-to-day activities.

***Zimbabwe***
The population of Zimbabwe is estimated to be 14 million. There are estimated to be 140,000 people with physical disabilities.

The Orthopaedic Rehabilitation Services are centralized in Harare and Bulawayo provinces:
- Central Orthopaedic Workshop at Parirenyatwa National Hospital, Harare City
- Central Orthopaedic Workshop at United Bulawayo Hospital, Bulawayo City
- Satellite Programme Orthopaedic Workshop, Mutare city

Orthopaedic Workshop, Central Parienyatwa National Hospital
The Central Parirenyatwa National Hospital, Harare, where the orthopaedic rehabilitation services are provided, is one of the biggest in Southern sub-Saharan countries. The hospital has a capacity of more than 10,000 beds with two orthopaedic wards (male and female). The Orthopaedic Workshop at Parirenyatwa National Hospital is mainly supported by Government through the Ministry of Health. The government pays the salaries for the staff and meets the other cost of the appliances.

The Orthopaedic Workshop has a total of 14 staff members:
- 1 Category I Prosthetist/Orthotist trained in Germany.
- 8 Category II Orthopaedic Technologists trained at TATCOT
- 5 Category III bench Technicians in-service trained in Harare, Zimbabwe

Other members of the rehabilitation team include:
Orthopaedic Surgeons: There are 3 orthopaedic surgeons working in the country and 3 working privately.
Physiotherapists: There are an adequate number of physiotherapists trained to Diploma and Degree level working in the Hospital and in the country.

The Orthopaedic Workshop in Parirenyatwa National Hospital receives and purchases components and materials from SFD/ICRC, Geneva and some from Otto Bock, Germany. Other materials are bought within the country. These materials include Evafoam, polypropylene plastics, POP, plaster bandages, rubber sheets, metal sheets, leather, steel bars, and other small technical items**.**

The Central Orthopaedic Workshop at Parirenyatwa Hospital is well equipped and has enough human resourses with the skills and knowledge to deliver services to the disabled community. The workshop is well equipped with all necessary machines, tools, and basic equipment. The Orthopaedic workshop at Parirenyatwa Hospital is the largest consultant and referral in the country.

The Zimbabwe Government is fully engaged in supporting people with physical disability in collaboration with the non-government organizations as well as international agencies.

***Malawi***
Malawi has three provinces and its population is estimated to be 12 million. There are estimated to be 120,000 with physical disabilities.

The status of the orthopaedic services is as follows:
- Proposed Orthopaedic Workshop, Mzuzu
- Proposed Regional Orthopaedic Workshop, Lilongwe (the new capital city)
- Existing Central Orthopaedic Workshop, Queen Elizabeth Hospital, Blantyre

Central Orthopaedic Workshop, Queen Elizabeth Hospital, Blantyre
The main consultant orthopaedic services for the whole country are provided in Queen Elizabeth Hospital. The hospital has bed capacity of 1,000 with 30 orthopaedic beds. It is well equipped with all necessary required machines, tools, and basic equipment.

The Central Orthopaedic Workshop has a total of 15 staff members:
- 1 Category I Prosthetist/Orthotist trained in UK/USA
- 6 Category II Orthopaedic Technologists, trained at TATCOT
- 8 Category III Bench Technicians in-service trained at Blantyre
- 1 Volunteer Prosthetist/Orthotist from Norway working on a visiting exchange programme.

Other members of the rehabilitation team include:
Orthopaedic Surgeon: There are 3 orthopaedic surgeons in the country and there are regular visiting orthopaedic Surgeons from abroad.
Physiotherapists: There is only 1 physiotherapist and 1 occupational therapist working at the Central Queen Elizabeth Hospital

The Malawi Government is fully engaged and committed in supporting people with physical disability in collaboration with the non-governmental organizations, as well as internationals agencies. At present the Ministry of Health is negotiating with the Norwegian Government to build an orthopaedic workshop which will be the second largest in the country in the new capital city of Lilongwe.

There is also a plan to build an orthopaedic workshop in the city of Mzuzu with negotiations taking place between the Local Government and Rotary International. The technology which is practiced in this region is Jaipur prostheses at the Missionary Orthopaedic Workshop.

***Tanzania***
The population of Tanzania is estimated to be 30 millions. There is estimated to be 300,000 people with disabilities in the country. A pilot survey in various regions has been carried out to collect information of the scope of disabilities with intention to categorize them into physical and mental disabilities. It is hoped that the information provided in this survey will help identify the need for prosthetic/rthotic interventions within the Tanzania.

Many of the lower limb neuromuscular deformities which are seen in Tanzanian clinics present with paralysis from mild to complete paralysis. Some of the cases present with severe involvement of the trunk. The majority of these patients have paralysis of one or two limbs and the lower limbs are mostly affected than the upper limbs. The degree of severity of deformities depends mainly on whether the patient:
- Has an access to a clinical facility whereby conservative therapeutic management can be offered.
- Can afford to meet the costs of attending for orthotic treatment in one of the few existing technical orthopaedic facilities.
- Can afford to attend the rehabilitation centres, which are based in some of the few referral and regional hospitals.

The follow-up for children fitted with lower limb orthoses poses a challenge in the country due to a number of factors including financial constrains, location and geographical conditions, proper education of the family and the community, and physical and infrastructure barriers.

Most children report late for adjustments/new orthotic solutions to the orthopaedic workshops leading to ill-fitting orthoses, which may result in thesecondary development of other deformities such as contracture and spinal deformities.

There are eight orthopaedic workshops in Tanzania:

- KCMC Orthopaedic Centre, Moshi
- Muhimbili Orthopaedic Institute, Dar es Salaam
- Comprehensive Community Based Rehabilitation Centre, Dar es Salaam
- Dodoma Regional Orthopaedic Centre
- Bulongwa Orthopaedic Centre
- Bugando Orthopaedic Centre
- Moduli Rehabilitation Centre
- Ruvuma Orthopaedic Centre

KCMC Orthopaedic Workshop

The KCMC Orthopaedic Workshop is the biggest consultant and referral orthopaedic workshop in the country. It is well equipped with all necessary required machines, tools and basic equipment.

The Good Samaritan Foundation of Tanzania in collaboration with the Tanzania Government provides the salaries for the staff and meets the other recurrent expenditure including the service of the machines, equipment, tools, and purchase of locally as well as imported materials, components, and consumables. There exists a very close link with TATCOT regarding the clinical attachment of students during training

The KCMC Orthopaedic Centre has a total number of 10 staff members:

- 2 Category I Prosthetist/Ortyhotists trained at BUFA and Tumaini University
- 4 Category II Orthopaedic Technologists trained at TATCOT
- 4 Category III Orthopaedic Shoemakers in-service trained

Other members of the rehabilitation team include:

Orthopaedic Surgeons: There are 5 orthopaedic surgeons practicing at KCMC Hospital who are linked with the Orthopaedic Workshop and TATCOT. There are regular consultations and clinics which are related to provision of Orthopaedic Technical Services for the different pathological conditions requiring orthoses or prostheses.

Physiotherapists: There are an adequate number of physiotherapists with MSc level and Diploma level training practicing at KCMC Hospital who work with the other members of rehabilitation team in evaluating the cases that needs orthotics/prosthetics services

The KCMC Orthopaedic Centre purchases most of the orthopaedic materials and components from Otto Bock and receives materials and components from ICRC. Other materials are locally purchased such as POP, plaster bandages, rubber sheets, metal sheets, leather, steel bars and other small technical items.

Orthotic service delivery within the continent is still a big challenge particularly if the orthotics practitioner has little knowledge on the proper fit and alignment of lower limb orthoses. Some cases which are seen at TATCOT and KCMC have significant malalignment and improper fit which results in high pressure zones with subsequent soft tissue damage. Individuals who can not afford the cost of a new appliance and attend follow-up may be enrolled by.TATCOT as models in its training courses and be provided with orthoses through this mechanism.

Muhimbili Orthopaedic Institute

The Muhimbili Medical Centre, which caters for the eastern Tanzania has a bed capacity of 1423. The Muhimbili Orthopaedic Institute (MOI) is within the Centre and TATCOT has developed close links using it for field-work placements for students during their clinical attachments

The workshop has a total number of 11 staff members:

- 2 Category I Prosthetist/Orthotists trained at Tumaini University

- 4 Category II Orthopaedic Technologists trained at TATCOT
- 2 Category III Bench Technicians trained in-service
- 3 Category III Shoemakers trained in-service

Other members of the rehabilitation team include:
Orthopaedic Surgeons: There are 4 orthopaedic surgeons practicing at MOI who work closely with the orthopaedic workshop. There are regular consultations and clinics which are related to the provision of technical orthopaedic services to the different pathological conditions requiring orthoses or prostheses.
Physiotherapists: There is a physiotherapy department within Muhimbili Orthopaedic Institute which works closely with MOI Orthopaedic Workshop.

A thorough clinical assessment is carried out routinely for each patient requiring an orthotics fitting in order to determine the magnitude of the disability and related orthotics intervention required.

Comprehensive Community Based Rehabilitation (CCBR) Centre
The CCBR centre in Dar es Salaam has been a successful field-work station for TATCOT students during their clinical attachments.

The workshop has a total number of 7 staff members:
- 3 Category II Orthopaedic Technologists trained at TATCOT
- 2 Category II Bench Technicians I trained in-service Technicians
- 2 Category III Shoemakers trained in-service

Other members of the rehabilitation team include:
Orthopaedic Surgeons: There is 1 orthopaedic surgeon practicing at the CCBR Centre who works closely with the orthopaedic workshop. There are regular consultations and clinics which are related to provision of technical orthopaedic services to the different pathological conditions requiring orthoses or prostheses.
Physiotherapists: There is a physiotherapy department within the CCBR Centre which works closely with orthopaedic workshop.

Different orthosis ranging from AFOs to KAFOs are manufactured at this centre utilizing different types of materials.

The International Committee of the Red Cross has supported this centre, among others, with equipment and materials.

The other centres which have been mentioned in this report also similar services although to varying degrees of technology. These centres are managed by Category II Orthopaedic Technologists qualified from TATCOT.

**Summary**

According to a WHO estimate there are about 10% persons with disabilities in any low income country. Low-income countries are prone to such ailments due to their overall poverty which is reflected in malnutrition, childhood illnesses, poor hygiene, and insufficient medical provision. On top of that illiteracy and lack of awareness compound the problem in such developing countries. Poverty and ignorance play a major role in contributing towards the escalating number of people with physical disabilities. As compared to the magnitude of the problem, the number of orthotics professionals, NGOs, and government agencies involved in disability prevention and rehabilitation programmes is very small. In the absence of preventive and supportive system, people with disabilities (PWDs) are left helpless and simply considered as burdens by their families. This situation calls for concerted efforts from all the stakeholders in order to improve the conditions of people with physical disabilities within the African region in order to bring back improvement of life conditions of PWDs and integrate them in the society as productive people for their families, societies and the nation at large. The stigma associated with disability issues within the African context should be addressed

and education to the public be promoted so that disabled individuals can be reintegrated back into the society.

The Tanzania Training Centre for Orthopaedic Technologists (TATCOT) was founded in June, 1981 with the main objective of upgrading and elevating the number of professionals equipped with adequate knowledge and skills to serve persons with neuromusculoskeletal deficiencies. As years have gone by the school has increased the enrolment of students, not only from East Africa but also from other English speaking African countries. In the mid-1980s the school realized the need of incorporating its programme under Tumaini University by which the qualifying professionals have a better chance to be publically recognized, have a clear path for academic as well as professional development, and are well suited in the scheme of services in their respective countries

Since its inception the centre has trained over 300 graduates from different parts of the continent who are equipped with knowledge and skills in the management of different lower and upper limb disabilities. Within the African continent orthotics has continued to be a priority in serving individuals who have disabilities due to the following problems:

- Infectious diseases (e.g. post-poliomyelitis)
- Trauma (road traffic accidents, falls, industrial accidents)
- Congenital malformations (talipes equinonovarus))
- Peripheral vascular accidents (stroke)

The principle of maintaining as well as assuring quality, quantity and service delivery has to be adhered to. It is by realising this that the persons with physical disabilities will be rehabilitated with the aim of attaining an optimum body posture, re-alignment of the neuromusculoskeletal system and gait pattern. Governments and other stakeholders in the rehabilitation sector have to establish the field of prosthetics and orthotics as a priority so as to achieve the intended goals in the rehabilitation of individuals who need appropriate rehabilitative devices.

## Current orthotics practice in developing countries: Asia

**Vinod Krishnan**
**Motivation, Colombo, Sri Lanka**

### Introduction

In this paper an attempt has been made to provide a 'bigger picture view' of the orthotics service provision for some of the most common pathologies seen in developing countries of Asia. Statistical and other relevant information has largely contributed to these comments which has been extracted from publications by the UN, WHO, APCD, ESCAP and ISPO, to name a few. As much as possible, effort was made to gather information about all relevant countries.

Asia can be conveniently divided into South Asia, Central Asia, East Asia and West Asia, also popularly termed the Middle East. The information provided about pathologies excludes the scenario seen in South Asia (Indian sub-continent) and China. There are a total of 11 countries classified as low income and 15 classified as middle income countries as per the latest World Bank report. This definition is based on Gross National Income.

### Polio

The last case of polio officially registered in most countries has been in the early or late 1990s. Global polio eradication programmes coupled with national level programmes have almost seen the eradication of this virus. Though there are no concrete statistics available on existing polio clients, it can be safely argued that the orthotics needs for a majority of the patients has been met. The most common types of devices fabricated for those who suffer from the effects of polio are metallic or plastic AFOs and KAFOs. The efforts taken in countries like Cambodia, Vietnam and India to duplicate the production of thermoplastic ankle joints like the ones used in the West, has contributed to the increased use of such joints. Though hybrid KAFOs were thought of an option to convert a majority of the conventional metallic KAFO users to plastic ones, for unknown reasons they are not popular. The use of resin is also much less than might be expected in lower limb orthotics probably due to difficulties involved in the manufacturing process. The use of devices for correction of deformity in cases of polio is usually exaggerated. Most of the prescribed devices contribute to preventing further deterioration of the deformity rather than serving to correct it.

### Clubfoot

It has been estimated that in every one to two births in 1000 a child is born with clubfoot. It is one of the most common types of congenital deformity. The most common types of orthoses provided are shoes and splints. Clubfoot splints would probably have one of the highest success ratios in relation to correction of a deformity through application of an orthotic device. There has been recently an increase in the concept of providing pre-fabricated devices to manage clubfoot in middle income countries. The popularity is probably due to the adjustable features the splint provides plus being off-the-shelf.

Unfortunately, no clinical studies have been conducted so far to measure the success of such devices and the fit of such devices are questionable. Variations in design features of shoes or splints are quite commonly seen in lot of middle income countries; however, they are rarely supported by clinical evidence and necessary evaluation. The reoccurrence of deformities due to insufficient follow-up even in institutional based rehabilitation settings is quite common in most developing countries. Most neglected clubfoot cases often have some form of soft padding attached to their feet that serves as footwear. In places where professional services are available, modified shoes or AFOs are fabricated. The number of neglected clubfoot patients receiving surgery is very minimal.

### Stroke

On average, 10 in 1000 people affected by stroke become disabled. These numbers are higher reaching 20 to 1000 in Central Asian countries. A notable fact about this pathology is

the lack of knowledge the professionals possess with regards to orthotic management. The amount of research papers presented about stroke in almost 90% of the developing countries in Asia does not exceed 10. The most common orthosis prescribed is a rigid AFO, either conventional or plastic, provided with the aim of preventing foot drop and aiding mobility. Orthosis are also provided with the aim of preventing contractures and thereby reducing the time of therapy input. Since the gait of a person is dependant on very many factors, provision of an AFO alone does not achieve the desired results with respect to gait. More research to improve the gait through provision of orthoses is being carried out but mainly in the West. Client acceptance is also a troubling factor and in the majority of cases the rejection of the orthosis is quite high, especially if there are high energy costs. The acceptance of orthoses when patients are treated in a multidisciplinary environment is better. Though successful attempts have been made to raise awareness regarding orthotic treatment for stroke patients by conducting consensus conferences, due to lack of appropriate information dissemination systems, the outcomes of such conferences usually do not get filtered sufficiently in most underdeveloped countries.

### Arthritis

The prevalence of arthritis is less in Asia as compared to the Americas or Europe. It has been identified that with the growing life expectancy, arthritis is more likely to be the fourth largest cause of disability by 2020. The burden will be the greatest in developing economies especially in Asia where the life expectancy is increasing but access to surgical procedures such as arthroplasty and joint replacement are not readily available. Prevalence of osteoarthritis is more than rheumatoid arthritis. FOs, AFOs and KOs seem to be the most common choices for orthotic management. The orthoses are primarily indicated for reducing pain and correcting as well as preventing deformity. In cases of severe pain and disability, mobility aids are prescribed. Lack of comprehensive rehabilitation services in many countries has resulted in the failure of treatments to have an adequate impact. It is quite interesting to note that in many countries where there is not even one professional orthotics service provider, imported and locally made off-the-shelf products are readily available. These off-the-shelf products have contributed in the treatment of arthritic patients, where services are not available. However, studies have revealed that custom made (rigid orthoses) are more effective in relieving pain and correction of deformity when compared to pre- fabricated (flexible and semi-flexible) orthoses.

### Cerebral palsy

From the available statistics it has been estimated that 70% of children born with cerebral palsy in developing countries do not have access to rehabilitation. Some 60 – 65% of the cerebral palsy cases fall under the spastic category. The most commonly prescribed orthoses are KAFOs, AFOs, gaiters and post-operative splints. The orthoses are provided primarily for correction or further deterioration of deformity. Provision of orthoses for tone reduction is also witnessed but only in places where there are qualified practitioners. However, in a developing country where multidisciplinary services are uncommon and frequent follow-ups are a luxury the success rate of orthotic management is quite poor. Orthoses being prescribed without clear understanding of the pathology or the treatment outcome is not an uncommon event in cases of cerebral palsy. Due to the lack of appropriate componentry, children with complex levels of cerebral palsy are usually provided with standing frames, wheelchairs, supportive seating etc. Even then, in most places, such services are unavailable or very basic.

### Injuries

The majority of injuries in developing countries are caused as a result of road traffic accidents (RTA), war, burns, falls, poisonings and deliberate acts of violence. RTAs contribute approximately 25% of the entire percentage of injuries. Some 90% of the RTAs are seen in middle income and low income countries, mainly in South East Asia. Paraplegia and fractures are probably the two areas that are more relevant in the context of orthotics provision. Due to an absence of facilities and adequate training, most complicated fractures result in amputation. It is quite common to note that, even years post-surgery, bone union has not taken place and as a result many patients eventually turn out to be permanent orthoses users. The most common type of orthoses provided are resting splints. Use of low temperature thermoplastics and pre-fabricated splints are witnessed in middle income

countries. PTB weight reliving AFOs and ischial weight bearing KAFOs seem to be the choice where there is a possibility of providing partial weight bearing. Prescribing a KAFO for a paraplegic is quite uncommon even when a multidisciplinary facility is available. Prolonged rehabilitation, high energy cots, frequent follow-ups and eventually limitations with the orthosis itself makes the wheelchair a better choice.

**Management of foot**

It is estimated that improper foot care or management is the third highest reason for amputation in developing countries. Orthotic management of the foot is subsequently an area that is not provided sufficient attention. Training and lack of appropriate materials are some of the major reasons that have impeded the growth of this service. In some middle income countries there is evidence of provision of off-the-shelf insoles, arch supports and heel pads made of silicone or similar materials. This, however, is not sufficiently complemented by adequate professional input. In most developing countries the orthosis is fabricated by an orthopaedic shoe maker under the guidance of an orthotist, where possible. The growth of pedorthotics as a separate profession in the west does warrant prompt the question, ‘are we doing sufficient enough?’

## Current orthotics practice in developing countries: India

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### Introduction

Orthotic technology is not new to India, if the pages of history are examined it is found that man has always used supports for relief from pain as well as to compensate for disability due to injury, paralysis or other similar conditions.

If the history of Ayurveda (Indian system of medicine) is gone into it is seen that support appliances were commonly provided after surgery performed by the ancient surgeons, such as Sushratha.

With the advent of a regular medical system, orthoses became common, however, these were made by blacksmiths and carpenters under the guidance of doctors and osteopaths (local bone setters).

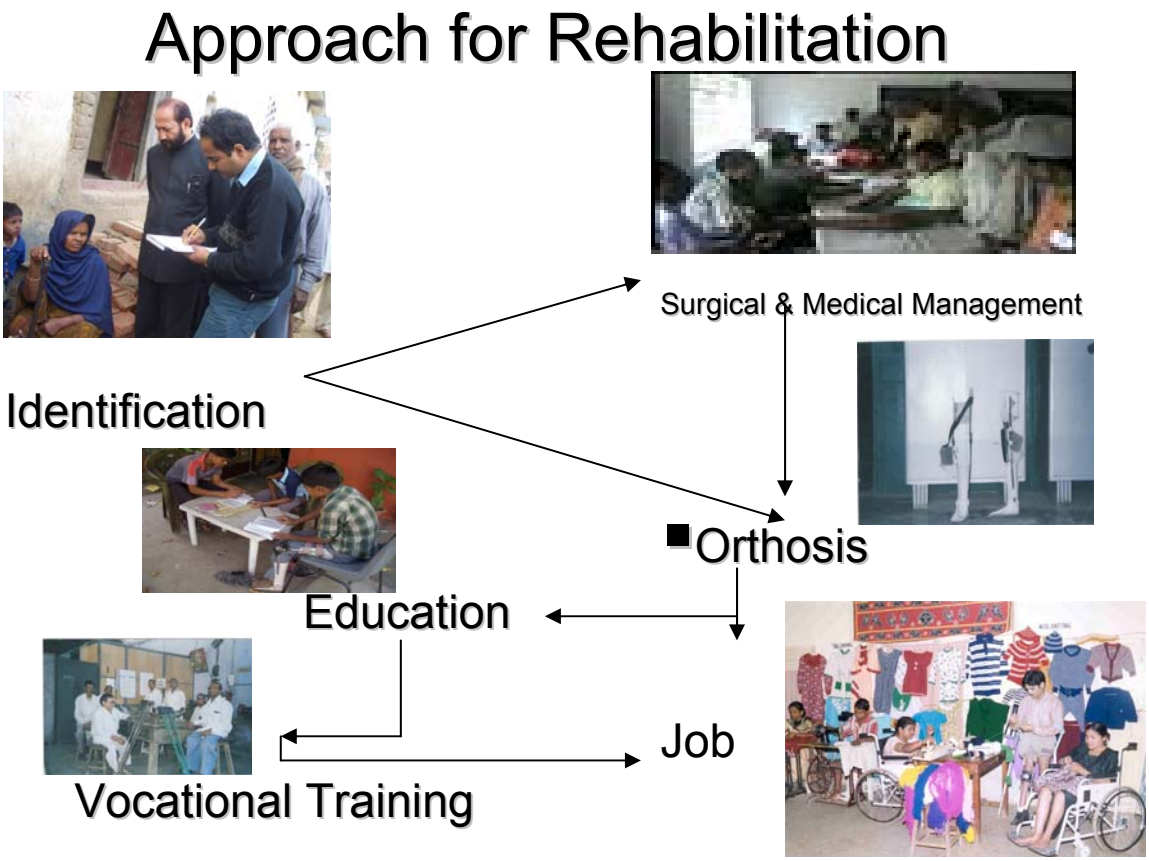
The first orthotics and prosthetics centre in South Asia was started in the year 1920 at Sialkot (now in Pakistan). The centre was developed to cater for the needs of armed personnel who became injured during the war. This centre was capable of providing artificial limbs and orthopaedic appliances however words such as orthosis, prosthesis and rehabilitation were not used. This centre was under the control of a surgeon. After the partition in 1947 the centre was shifted to Pune in India and became a pioneering institute, providing prosthetics and orthotics and other rehabilitation services across the country.

In the year 1950, British trained engineers and doctors became interested in development and standardisation of appliances. The concept of evaluation and design came to India during this period. Informal training was introduced by Dr. M.V Sant, who was the founder of All India Institute of Physical Medicine & Rehabilitation in Bombay

It was in 1955 that Government of India started rehabilitation programmes and a centre which provided training of “personnel” in Bombay (now Mumbai).

This was the first centre in India having comprehensive facilities in rehabilitation such as Medicine, Prosthetics and Orthotics, Physical Therapy, Occupational Therapy, Vocational Counselling and Job Placement.

Dr. Sant selected a team of dedicated engineers and technicians such as T.P. Mirajkar, Joseph T. Carvalho, M.G. Mokashi and S.T. Nagale; later S.A. Deshpande also joined this team and remains a well known teacher in the country.




The case conferences in the centre were very varied and included patients with disability due to amputation, stroke, poliomyelitis, congenital disorders, spinal disorders, cerebral palsy, fractures and trauma.

Although mixed types of cases were being seen, the numbers of cases requiring lower limb orthoses were highest due to paralysis as a result of poliomyelitis.

**Control of poliomyelitis**

It was in 1996-1997 that mass immunization programmes for control of poliomyelitis were taken by the government. Rotary and other organisations also joined the cause to eliminate poliomyelitis from the country by end of century.
Poliomyelitis overall has been controlled due to these programmes but as some cases are still reported, India has not yet been certified has polio free. It is, however, expected that by the end of 2006 this goal will be achieved.

**Provision of lower limb orthoses**

The government of India became sensitive to the provision of lower limb orthoses and in 1981 began to provide funds to non-governmental organisations under the ADIP scheme. The aim of funding was to ensure that the maximum number of persons can be provided with appliances, which would normally be beyond their reach due to high costs.

Camps for initial survey were being conducted in almost all the districts, however problems were observed due to the lack of infrastructure, such as workshops to cater to the high number of persons registered.

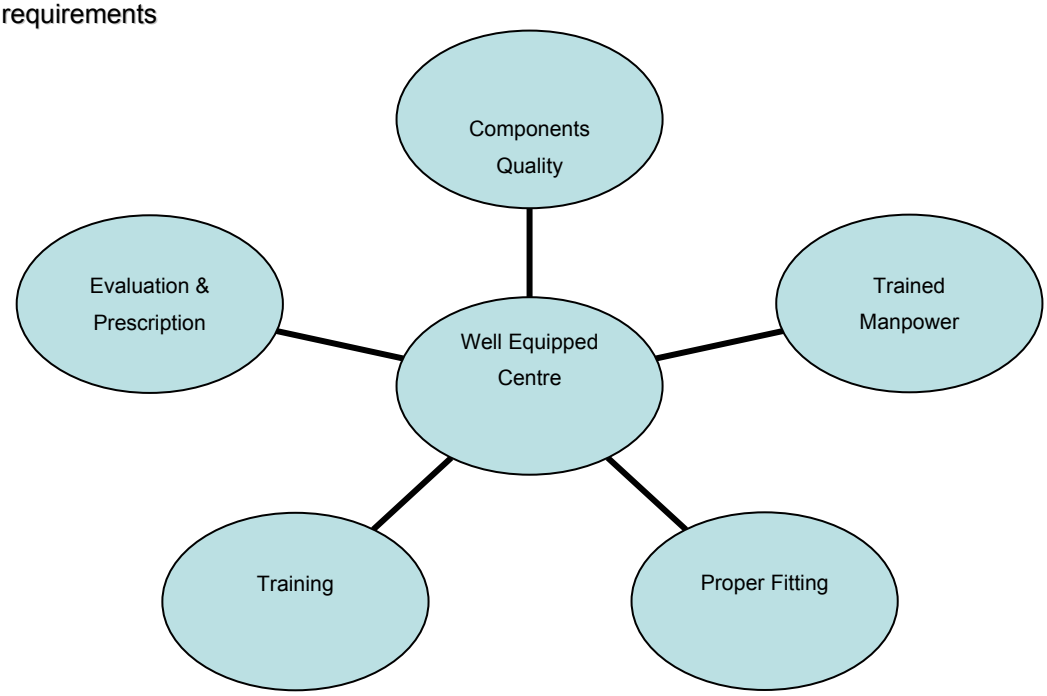
To overcome this situation the following steps were taken:

- National institutes were started with the purpose of training manpower to meet the service demand.
- The Artificial Limb Manufacturing Corporation of India (ALIMCO) was initiated to mass produce quality components at no profit no loss.
- The District Rehabilitation Project was developed.
- Small fitting centres were established.
- All the medical college in the country undertook special training for surgeons, so that corrective surgery could be provided.
- Rotary took up corrective surgery in camps.

**Present scenario**

With the available infrastructure hardly 2% of the disabled population has been covered and suitable action is required to improve the situation. In addition evaluation and prescription in camps has been affected due to the high numbers of cases coming into camps.

Orthotic requirements




For the proper prescription for orthoses:

- There must be a full evaluation of the patient.
- The purpose of bracing should be clearly indicated.
- Refer to the workshop for fitting.
- The check-up should be carried out at trial stage.

Well equipped prosthetics and orthotics centres in India:
At present India has 3 national level institutes, 6 CRCs, 107 DDRCs and approximately 50 NGOs capable of fabricating quality lower limb orthoses in the organised sector.
There are small prosthetics and orthotics facilities available in districts and smaller towns depending upon the medical and orthopaedic facilities available in the area. These centres manage more than 50% of the total provision of appliances.

With regards training of prosthetists and orthotists:
India at present has adopted a three tier system of education and training of prosthetics and orthotics professionals:

- Graduate Level for management and training
- Diploma level for supervision in workshop
- Certificate level for bench workers
- Short courses in collaboration with foreign universities have been established for upgrading technical knowledge.

All training is regulated by the Rehabilitation Council of India (which is a statutory body of Ministry of Social Justice and Empowerment).
Proposals are in the pipeline for training to a Masters level and also to adopt the WHO modules so that manpower is available to meet the total requirement in the country.

**Production of quality components**
Initially components were made according to measurements of the the patient. Joint and other components were forged by local blacksmiths and aligned afterwards depending on the profile of the measurement and prescription guidelines. The appliances produced were subsequently heavy and the fabrication was time consuming. At times due to cosmetic reasons, the devices were rejected.

The concept of a modular system came between 1965 and 1970 when local entrepreneurs started manufacturing kits and orthotists in peripheral areas recognised the benefits of saving time and money.

It was after the Pakistan war that our late Prime Minister, Mrs. Indira Gandhi, who had concern for rehabilitating the war victims accepted the idea of a mass component manufacturing company proposed by Dr. B. Shankaran who was an orthopaedic surgeon and Director of Health Services. Thus, in the public sector, a corporation, ALIMCO, was formed which is probably the world's largest component manufacturing company in the public sector (no profit no loss).

**Shoes**:
The other constraint was shoes. After measurement, every shoe was to be hand made which required time and money. Now regular footwear is generally used with modifications unless custom shoes are required due to special needs.

After fitting and evaluation, the client is provided training in the proper use and maintenance of the device. Patients are also required to come back for follow-up.

**Training**:
All patients are provided gait training after fitting and during this period a comprehensive check-up is done to find out if any modification is required. Once the orthotist and physical therapist are satisfied and the patient feels comfortable, the orthosis is finished and handed over to the beneficiaries. The patient is also educated on the care and maintenance of the orthosis, so that it should not wear out early. They are also given dates for follow-up visits.

**Components**:
Materials used: Iron, Aluminium, Plastics, Leather etc.

Advantages:

- Material is locally available in all the areas.
- Fabrication is easy as local artisans like blacksmiths and cobblers can easily be trained for basic jobs so that orthotist can take up final fitting with minimum production supervision.
- Acceptable due to low costs. It has provided jobs to rural technicians who at times are better than qualified professionals due to their extensive experience.

Disadvantages:

- Forged components are crude, heavy, and if not properly fitted can harm the patient.
- Time taken for manufacture is long and cumbersome.
- Plastic components: Light weight and cosmetically acceptable, are more prone to breakages in hot climates and sweating causes many other problems.

Forged components:
Material used: Iron, Aluminium, Plastics, Leather etc.

**Hi – tech**

Advantages:

- Cosmetically acceptable
- Lightweight
- More functional

Disadvantages:

- Very expensive. Can be purchased only by higher income groups.
- Highly skilled technicians required.
- Services available only in metropolitan cities.

Sports and recreation

- Events related to sports for the handicapped are a regular feature, this encourages integration into society.

**Current orthotics practice in developing countries: China**

**Zhao Huisan**
**China Rehabilitation Research Center, Beijing, China**

## History

Before presenting the current orthotics practice in China, I would like to briefly introduce the usage of orthosis in traditional Chinese medicine. In China, orthosis have been used for a long time. More than 500 years ago, a corset made of several wooden bars was recorded and illustrated in an old traditional Chinese medicine book (Figure 1).

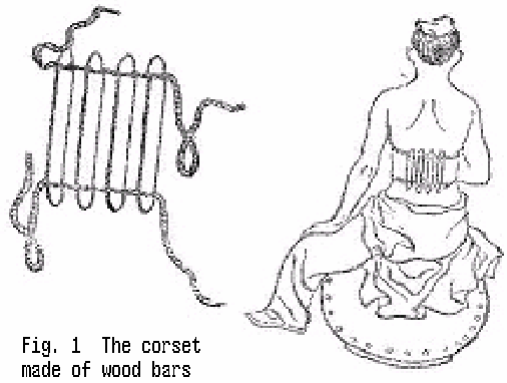


Fig. 1 The corset made of wood bars

We continuously use traditional Chinese medical devices such as a splint to treat bone fracture (Figure 2)

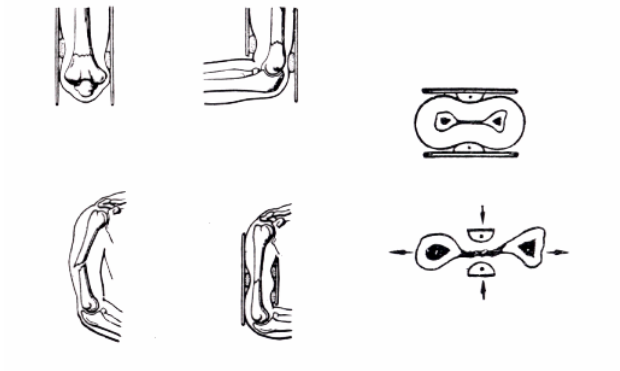


Fig. 2 Chinese traditional small splints for treatment bone fracture

Over 70 years ago, Professor Jimao Meng, who was the director of the department of orthopaedic surgery in Beijing Union Medicine College and was one of the founders of orthopaedic surgery in China, established the first artificial limb-brace workshop in his orthopaedic department. During the World War and the Civil War in China, many soldiers were disabled. After the wars, artificial limb workshops and hospitals were established to fit disabled veterans in almost every province in the Chinese mainland. After the Cultural Revolution (ca. 1966-1976), orthotics service has been improved with the development of the economy. But several limitations were also found in the orthotics service.

## Two limitations in the orthotics service

Twenty years ago, China started to implement the “Reform and Open Policy”. Two main limitations were found in the orthotics service. Firstly, the orthotics service covered only small areas and was centralized in large cities. In the 1980s there were only about 40 artificial limb factories and workshops providing orthoses in big cities. The total number of orthoses fitted was about 31,000 sets in 1994. Secondly, the orthotics service and surgical/medical services functioned separately.

### Attention and support from the Government and NGOs

In the last twenty years, the Chinese Government, with some Chinese NGOs and international institutions, have paid attention to orthotics services and provided support to develop orthopaedic surgery and comprehensive rehabilitation for physically disabled persons in China.

On December 28, 1990, a Bill of “Protection of Disabled Persons of the People's Republic of China” was decreed by the President of PRC. Article 17 [Appliances] of the Bill stipulates: “Government departments concerned are obliged to organize and support the research, manufacture, supply and maintenance of rehabilitation equipments, appliances for self-service, special utensils and other aids for disabled persons”.

The Management Regulation of Rehabilitation Service in Polyclinics, issued by the Health Ministry of China in 1996, stipulates that rehabilitation departments of large polyclinics are able to prescribe orthotic treatments, fit orthoses and train patients to use orthoses.

In 1994, the China Training Centre for Orthopaedic Technologists (CHICOT) was established by the Chinese and German Governments. Up to now 255 students have graduated from CHICOT, and nearly 2500 people have attended the training courses. The China Prosthetics and Orthotics Association (CPOA) was established in 1986 under the ordinance of the Civil Affairs Ministry of China. The number of group members is about 180 units and the number of personal members is now over 3000.

The Beijing Research Institute of Prosthetics and Orthotics (BRIPO) was founded by the Civil Affairs Ministry of China in 1979. In the past years, the emphasis was placed on foot orthoses manufactured using CAD-CAM technology.

The Technical Control Bureau of China issued the Standard of Terminology for Prosthetics and Orthotics in 1993. The Classification of Technical Devices for persons with disability and Standard terminology (GB/T 16432-2004/ ISO 9999-2002) were published in 2004. These standards promote communication and cooperation between orthopaedic surgeons, physicians, occupational therapists, physical therapists, and orthotic technologists.

With financial support from international NGOs, children with physical disabilities from low-income family are supplied with orthoses.

### Current orthotics practice in China

To meet the needs of comprehensive rehabilitation for people with physical disabilities and the development of orthopaedic surgery, more than 600 orthopaedic technical workshops have been established under the support of the departments concerned of the Chinese government. Although these workshops are different in regards to management systems and economic systems, most of them cooperate to a larger extent with medicine treatment and rehabilitation for physical disabilities than previously. This is a big change in orthotics service delivery for China. I would like to present some cases of orthotics services below:

### Orthotics practice in China Rehabilitation Research Centre (CRRC)

The CRRC was founded in 1988 under the leadership of the China Disabled Persons Federation (CDPF). The CRRC is now the biggest comprehensive rehabilitation centre in mainland China. There are 373 beds for inpatients of the CRRC. The rehabilitation medicine treatments are focused on patients with spinal cord injury, stroke, cerebral palsy, poliomyelitis sequelae and amputations. The methods of rehabilitation treatment include surgery, physical therapy, occupational therapy, speech therapy, psychological counselling, prosthetics and orthotics services, recreational therapy, traditional Chinese medicine and social work. The Department of Prosthetics and Orthotics in CRRC fitted various orthoses to 1099 patients last year (1995). Most of the orthoses are AFOs, which constitute 60.5% of the total orthoses fabricated (Figure 3). There is one orthotic technologist and four orthotic technicians in the department. Three of them graduated from CHICOT. Half of the materials and components

used in fabricating these devices were manufactured in China while the remainder were imported.

| Types of Orthoses | sets | % |
|---|---|---|
| Foot Orthoses | 270 | 23.2 |
| Ankle Foot Orthoses | 704 | 60.5 |
| Knee Ankle Foot Orthoses | 87 | 7.5 |
| TLSO | 31 | 2.7 |
| Corsets | 71 | 6.1 |
| Total | 1163 | 100 |

Figure 3: Types and number of orthoses fitted in CRRC in 2005

During the period of the 9th Five-Year Plan of the CDPF (1996-2000), the Rehabilitation Department of the CDPF, in cooperation with local hospitals and orthopaedic technique workshops, has supplied 344,193 sets of orthoses. 78,169 sets of them are financed partially by the CDPF.

Since 2000, the China Service for Development & Supply of Devices for the Disabled (CSDSDD) has started the “Cost-Effective Prosthetic Service Project of Chang Jiang New Milestone Programme”. The Chang Jiang New Milestone Programme has received a substantial financial contribution from Dr. Li Ka Shing of Hong Kong. We have established 180 cost-effective prosthesis fitting stations. Up to the end of 2004, we have fitted 60,261 trans-tibial prostheses and 9,000 trans-femoral prostheses for poverty-stricken amputees, and trained about 400 technicians. We are going to try to fit lower limb orthoses for low-income physical disabled people in the Assistive Products Service Net of CSDSDD.

From 2004 to 2006, the “Tomorrow Plan” of Orthopaedic Operation and Rehabilitation for 30,000 orphan children with physical disabilities is carried out by the adopting department of orphan children of the Civil Affairs Ministry of China. This project will benefit physically disabled children who need operations and orthoses. The total budget is about 300 million RMB.

Attention and support from international Non-Government Organizations, such as the New Hope Centre (NHC) of Pi Zhou, Jiangsu Province, is a rehabilitation resource centre for physically disabled children suffering from poliomyelitis. The NHC has been given donations from the Norway Missionary Alliance through the Amity Foundation. Various kinds of orthoses have been made in the Amity Brace Workshop. Services of the NHC are provided in both community-based rehabilitation and centre-based rehabilitation.

**The needs of and challenges to orthotics service delivery in China**

***The status of the people with physical disability in China***

The People’s Republic of China is a country of 9.6 million square kilometers and has a population of 1.3 billion people. More than 11.22 million people suffer from physical disabilities (including multiple disabilities). More than 10.33 million people are afflicted with motion function limitations and 0.89 million people are amputees. The physically disabled people are described as follows: Men:Women 6:4

Range of age: see Figure 4

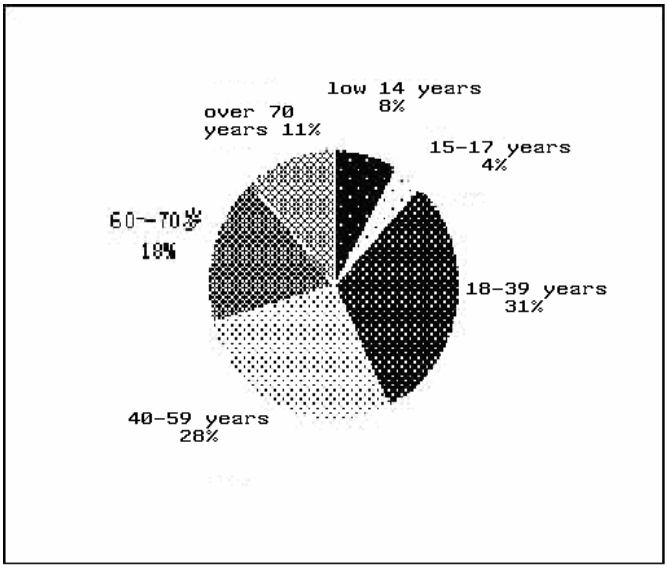



Figure 4: Range of age of the people with physical disability

Causes of physical disability: see Figure 5

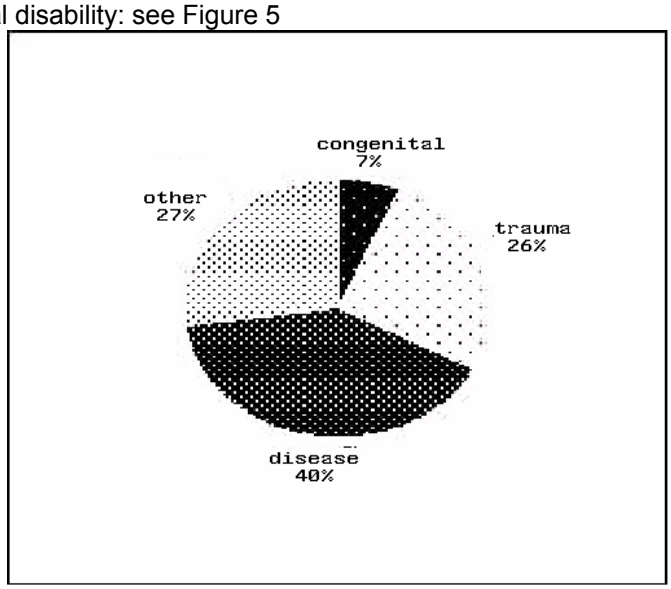



Figure 5: Causes of physical disability

Disabled parts of body: the number of persons with upper limb disabilities is 2.068 million (18.43%), with lower limb disabilities is 4.561 million (40.65%), with spinal disabilities is 1.283 million (11.43%), and with multi-disabilities is 2.752 million (24.53%).
Distribution as related to living areas: 1.54 million (13.7%) physically disabled persons live in cities while 9.68 million (86.3%) physically disabled persons live in the countryside.

### *The orthotics service in demand*

It is difficult to be clear about the detailed need for orthotics services in China nowadays. Here are results of two small surveys conducted on the need of orthotics services:

- In 1995, the project Caring for Disabled Persons of Hong Kong examined 875 persons with physical disabilities in Taiyuan, Sanxi Province, in which 209 cases had received surgery, and 253 persons were supplied with orthoses, which makes up 28.9% of all persons with physical disability. The percentage may be lower due to the limited equipment in the workshops.
- The investigation of the need of orthotics services for physically disabled persons was conducted in 6 districts of Shenzhen, Guangdong in 1999. Some 131 persons with physical disability were examined. The result of the investigation was:

i. Reasons for physical disability: see Figure 6

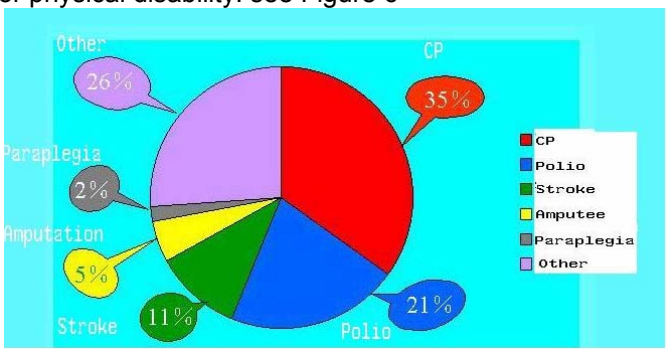



Figure 6: Reasons of physical disability

ii. The rehabilitation treatment ranges from operation of 18 persons (14%), rehabilitation training of 108 persons (79%) and fitting orthoses of 60 persons (46%).

28.9% out of the 11.22 million people with physical disability means that no less than 3.24 million persons need orthotics services. If one person needs one orthosis, and one technician fits 240 sets of orthoses per year, we will need 13,500 orthotics technicians. At the moment there are only about 600 technicians. How to train so much people as professionals who would like to work in the countryside for long time period? This is a huge challenge.

The People's Republic of China is a country of 9.6 million square km and 9.68 million people with physical disability live in the countryside. Most of them live in poverty. They are unable to pay for medical care, rehabilitation, orthotic devices and are even unable to pay for transportation or accommodation during the fitting procedure of an orthoses. To supply cost-effective orthotic device for every person with physical disability in such a big country will be very challenging.

Most of the people with physical disability have minimal or no insurance that covers orthopaedic operations and orthoses totally or partially. How to help every physically disabled person, who needs orthotics service to get an appropriate insurance, will also be a huge challenge.

While facing these huge challenges, there are still many opportunities open to us. The Chinese Government now pays more attention to the problems of China's countryside. The Ministry of Health is improving the medicine treatment for people with low income. The 11$^{th}$ Five-Year Plan for People with Disabilities (2006-2010) is approved by the Chinese Government. According to the plan, 10,000 orthoses will be fitted for needy people with physical disability through the assistive products service net of CSDSDD.

In my opinion, the development of orthotics services requires more attention and support from the Government and NGOs. It also needs more qualified and trained professionals, good cooperation between surgeons, physicians, therapists and orthotic technologists in the rehabilitation team. Orthotics services should be combined with comprehensive rehabilitation or with community-based rehabilitation for the people with physical disability. In order to help more people with physical disability equally participate in the society, we must cooperate and communicate with everybody in the orthotics service.

## Current orthotics practice in developing countries: Central and South America

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**Ortopedia Alemana, Buenos Aires, Argentina**

At present, the prosthetists and orthotists who live in developing countries resemble children staring at a toy shop's window. Thanks to modern communication media, distances are shorter, as if the world had become smaller. However, technological costs are increasing each day. That is why we constantly receive publications and discover through the internet, orthotics and prosthetics equipment which we frequently consider ideal for our patients, even although we are fully aware that they will never be able to afford them. This is often the case when we go over publications on orthotic innovations for patients with polio sequelae. This is well illustrated by the fact that at present, out of the 63 million people suffering from polio sequelae both in America and Europe, most of them live either in Central or South America. These are the continents where the smallest amount of money is allocated per capita to the population's health. We can see that the United States channels US$5,274 per capita for the health sector, whereas Argentina earmarks US$1,074 and Brazil US$611. It goes without saying that the services and assistance that the former have access to differ significantly from those offered to the latter. The situation in countries such as Haiti is even worse. This country allocates US$83 per capita and not only is it incapable of affording technological costs, but it is still fighting polio outbreaks (Source: American Immunization Program, January 2006) while in countries such as Argentina and Brazil the last cases were reported before 1980. This becomes evident in the different orthotic designs available in each of the above-mentioned countries.

In Argentina's case, it can be said that it is constantly struggling to have access to all kinds of technological innovations in all the fields. When costs are prohibitive they try to figure out how to replace whatever they cannot afford. As the saying in my country goes, 'the ingenious lead the engineers'. That is why we see all the designs used in developed countries become the inspiration to a new item manufactured with the resources available in the region. However, we should highlight that not all the population can afford this equipment.

Nowadays, Argentina has 35 million inhabitants, 800 thousand of which are physically disabled and therefore need orthotic and/or prosthetic equipment. Only 2% of them have access to high quality orthoses (imported from the United States and Europe), while 58% completely lack the possibility to be equipped, thus using precarious elements. In some cases, they do not use any orthosis at all as many times, they cannot even afford to travel to suitable care centres, where public health assistance might provide them with some elements even if they have limited use and quality**.** There is very recent legislation establishing that it is mandatory to guarantee rehabilitation. However, in the meantime, approximately 40% of the disabled population has private medical insurance, which is actually part of a company's compulsory benefits to their employees. These healthcare benefits include both the employee and his/her family, and only cover nationally manufactured materials. That is why only 2% of the disabled population has access to leading edge technology and if they do, they do so privately. Consequently, the orthotists and prosthetists most intense work focuses on 40% of the people who have a certain income or who have medical insurance allowing them to buy the equipment we can design within our budget constraints, as most equipment originally comes from developed countries.

We should not lose sight of the fact that in our region, where unemployment levels are sky-high, job opportunities for disabled people are extremely difficult and limited to a narrow sector, which is why many patients rely completely on the orthotist, if they want to have the chance to work. This grim situation is even worse because most traumatically injured patients are not offered any job seeking programmes. Therefore, their economic future is many times in the hands of hose who are in charge of their rehabilitation and equipment, depending on them for the development of their physical potential and the design of functional light equipment suitable for their injuries.

Another case in point is the equipment we manufacture at present for patients suffering from polio sequelae, especially those suffering from post-polio syndrome. The latter patients are the most difficult to equip as they show a strong psychological rejection and also because they require light orthosis so that the energy demand can be lower as they move. This is essential for their treatment since most of them suffer from severe *genu recurvatum* as a result of their PPS condition.

As a general rule, patients manifest a strong psychological rejection, which dramatically hinders their adaptation. Some of the inconveniences generally mentioned are:

- The necessity to articulate their ankle to continue driving (automatic gear vehicles is not frequent).
- They are reluctant to change their footwear.
- They do not adapt to ischial support.
- They cannot stand the contact with the thigh band, which results in the the loss of balance at some points when they are sitting down (when sitting on the toilet seat or on straight chairs)

Moreover, the first recommendation is that the orthoses should be extremely light so as to avoid increasing muscular fatigue**,** as was mentioned before.

Although worldwide there are orthosis which can perfectly fulfil all these needs nowadays, their cost is prohibitively expensive for most of the patients so that we try to make do with a combination of low-cost resources available in the region, thus replacing authentic designs:

- Carbon fibre for polypropylene
- Titanium for hard aluminium
- And we often use a very noble material close at hand to us: leather

A further pathology which has created the need to develop national products due to costs is spina bifida, the frequency of which is extremely high in Argentina compared to Europe and the United States. For every 100,000 births:

| | |
|---|---|
| USA: | 6 cases |
| Spain: | 7 cases |
| Argentina: | 100 cases |

In these cases, the strong need to use RGOs does not only arise from the suitable recommendation according to the level of disability, but from the need to use a mechanism which replaces other equipment or accessories, such as parapodiums. Additionally, difficulties and social and architectural barriers in the country seriously hinder the use of wheelchairs to move around, as the means are unsuitable for the handicapped, for example, the means of transport, access to buildings, sidewalks, corners, etc.

Regulations started to be established that buildings should be suitable for access by people with disabilities only a very short time ago. But for the time being, most buildings, public services, leisure areas, etc. put up impossible barriers to wheelchair users. A further common obstacle is the size of elevators, which very often prevent access by a wheelchair user. As a consequence, while some patients would be suggested using wheelchairs in other countries, we must make use of our creativity so that they can stand up or walk slowly for some time even if they do so with some limitations, for it would be virtually impossible to move about in a wheelchair.

Finally, the third pathology which demands a lot of effort in order to obtain high quality equipment is spinal cord injury of a traumatic origin as there is a high number of cases in the region as a result of work and road accidents. As mentioned before, there are no proper rehabilitation or job seeking programmes with the exception of some first-class rehabilitation clinics, but from which the majority of our population is excluded. Unfortunately, there are no reliable figures to claim that, both in South and Central America; these are also the most frequent pathologies facing orthotists. Yet, we have proven informally that in countries such as Chile, Uruguay, Colombia and Peru these same three injuries are the prevailing ones for the orthotists' work.

For these patients we generally manufacture bilateral KAFO orthosis combining polypropylene with hard-aluminium bars. Yet, whenever the patient can afford it we manufacture carbon fibre orthosis**.** Unfortunately, the ratio of carbon fibre to conventional equipment is 8:100. For adults the most frequent combination is steel and leather, while for children it is aluminium and polypropylene.

In South America, we are confident that the day will come when we can give our patients leading edge orthotic and prosthetic equipment, so that they do not have to add unnecessary hardship to the unavoidable despair caused by their disability and so that us, the orthotists and prosthetists can also 'enjoy the toys'.

**References:**

Disability Tables. International Center for Disability Information (ICDI) Tables Containing Data For The World.

World Health Organization (web information 2002)

Inter American Development Bank (Sustainable Development Department -Presentations on Disability Data - By Country). Published 20/03/2005

PAI (Programa Ampliado de Inmunización para America)

National Center for Health Statistics

Ministerio de Sanidad y Consumo de España (statistics 1997)

Wrong Diagnosis .com (information 2003)

Ministerio Salud Provincia Buenos Aires, Agentina. Published 2004

**Plenary Discussion "Current orthotics practice in developing countries"**

**Chair: Wilfries Raab**

**Rapporteur: Claude Tardif**

*Editors note; no report was submitted for this plenary discussion*

# Outcomes of previous ISPO consensus conferences: poliomyelitis, cerebral palsy and stroke

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## Introduction

I have thoroughly enjoyed the assignment to review these three previously published Consensus Conference Reports. It has given me a chance to reread documents that I had earlier set aside. I had the privilege of participating in two of these conferences and as Course Coordinator for the ISPO Board I have been involved with outcome activities of the third. These documents, Report of a Consensus Conference on the Lower Limb Orthotic Management of Cerebral Palsy (ISPO 1995), report of the Consensus Conference on Poliomyelitis (ISPO 2001), and Report of a Consensus Conference on the Orthotic Management of Stroke Patients (ISPO 2004) are landmark publications on each of their respective topics. In each case they are reports of the activities and conclusions of previous conferences such as that which brings us here this week. They are valuable reading for any professional working with patients having the referenced disabilities. Each course coordinator has brought together in an easy to read format the outcomes of very large projects. They reported on purposes and planning, goals and objectives, activities and discussions and conclusions and recommendations. As a challenge to the task before us I want to summarize some of the things they have written.

Much of what I will be saying is paraphrased from the three reports and credit needs to be given to the authors for the material presented here. I will try to give appropriate credit as I proceed, but may I extend my apologies ahead of time to those I have overlooked.

The approaches of ISPO for addressing issues such as those that are before us this week are well founded in international publications. In her introduction to the report on the Orthotic Management of Stroke Patients, Elizabeth Condie wrote, The National Health Service Health Technology Assessment Program states that “Consensus methods are used to develop clinical guidelines (good practice) which define key aspects of quality health care, particularly appropriate indications for interventions” (Health Technology Assessment 1998).

ISPO has organized six such conferences in the past sixteen years:

- 1990 Amputation Surgery, Glasgow, Scotland
- 1994 Lower Limb Orthotic Management of Cerebral Palsy, Durham, NC, USA
- 1995 Appropriate Prosthetic Technology for Developing Countries Phnom Penh, Cambodia
- 1997 Poliomyelitis, Hammamet, Tunisia
- 2000 Appropriate Orthopaedic Technology for Low-Income Countries, Moshi, Tanzania
- 2003 The Orthotic Management of Stroke Patients, Ellecom, The Netherlands

The objectives of all of the consensus conferences have been to scrutinize the past approximate 25 years publications, give reviews of this exercise, hear expert presentations, have syndicate discussions, plenary discussions and develop a consensus statement. The desire to disseminate the recommendations thus derived has given rise to short courses on many of these topics and they have been presented on 24 different occasions in almost as many countries. These activities reflect one of the fundamental goals of ISPO, to improve orthotic and prosthetic services throughout the developed and developing world (ISPO 2006).

In preparation for each clinically based conference the literature from the preceding decades is reviewed for ‘best practices’ evidence. These publications are rated according to their validity by a system reported by Sackett et al. (1996). More recently reviewers have been asked to rank the evidence contained is each paper according to a recognized system of critical appraisal by Greenhaugh in 1997 (Table I). The appraised papers were then to be

graded and grouped as falling into categories A, B, C or * as defined by Shekelle et al. (1999) (Table II).

This process demonstrated the inadequacy of the literature in the field of rehabilitation medicine in general and orthotics in particular as will be highlighted later. The consensus conferences on cerebral palsy, polio and stroke were selected for review here because they are germane to the use of lower limb orthotics in general. The conclusions derived from these conferences are appropriate for the world over with the knowledge that resources may differ.

*LEVEL OF EVIDENCE*

| *Rating of study design* | *Type of study* |
|---|---|
| *I* | *Systematic review and or meta-analysis (where statistical techniques are used to pool the results of included studies)* |
| *IIa* | *Randomized controlled trial (with definitive results that do not overlap the threshold clinically significant effect)* |
| *IIb* | *Randomized controlled trial (with non-definitive results, i.e. a point estimated that suggests a clinically effective effect with confidence intervals that overlap the threshold clinically significant effect)* |
| *III* | *Cohort studies (two or more groups are selected on the basis of differences in their exposure to a particular agent and followed up to see how many in each group developed a particular disease or other outcome)* |
| *IV* | *Case control studies (patients with a particular disease or condition are identified and matched with controls, like cohort studies case control studies are generally concerned with the etiology of a disease)* |
| *V* | *Cross-sectional survey (data are collected at a single time point but may refer retrospectively to health experiences in the past)* |
| *VI* | *Case reports* |
| *VII* | *Expert opinion* |

Table I

*GRADE OF RECOMMENDATION*

| | |
|---|---|
| *A* | *Directly based on Category I or IIa evidence, at least one meta analysis.* |
| *B* | *Directly based on Category IIb, III or IV evidence or extrapolated from Category I, II, III or IV.* |
| *C* | *Directly based on Category V or VI evidence or extrapolated from Category I, II, III or IV.* |
| * | *Good practice point, recommended best practice based upon clinical experience of the guideline development group.* |

Table II

**The lower limb orthotic management of cerebral palsy**

This conference was chaired by David Condie a bioengineer from Dundee, Scotland. Other organizers included Barry Meadows, engineer from Glasgow, Chris Drake, orthotist from London and David Scrutton, a physical therapist also from London. Held in Durham, North Carolina in 1994 it brought together 42 participants from 10 countries. The planners, after

considerable discussion, formulated a list of what they considered the "Aims and Objectives of Orthotic Treatment" for the defined group of patients.

- To prevent and/or correct deformity
- To provide a base of support
- To facilitate training in skills
- To improve the efficiency of gait

The Conference programme was then designed to examine systematically both the published evidence and the clinical experience of the use of orthoses to achieve each of these aims. In preparation for discussions 82 publications and 7 chapters were reviewed. Invited reviewers from all of the involved disciplines, physicians, surgeons, therapists, orthotists and bioengineers, 18 in total, were asked to prepare and present "review papers" dealing with a specific aspect of the subject. Together with the remaining experts they discussed these reviews and developed a general consensus on a number of specific issues. I will highlight the more fundamental ones as reported by the meeting chair David Condie;

1. Existing literature/research: The existing body of literature on the effects of orthotic intervention in cerebral palsy is, for the most part, seriously, scientifically and experimentally flawed with very few studies graded above Sackett's Level V.
2. To prevent/correct deformity: "Static" positioning, such as is applied in most existing orthotic designs, is probably less effective than the "dynamic" (e.g. by a therapist) application of force in preventing or correcting such deformities.
3. To provide a base of support and facilitate training of skills: Distal stabilization of joints (by the orthotist) does lead to improved proximal control and that good foot and leg position do provide valuable feedback. It was further concluded that "any motor learning effect remained to be scientifically demonstrated."
4. To improve the dynamic efficiency of gait: "Orthoses, by controlling the position on the joints they encompass, may alter the biomechanical demands upon more proximal joints" and that "this results in more normal external joint movements and hence may avoid over activity of some muscles."
5. Further research: "Further studies of orthotic intervention were required urgently", to offer guidance on more appropriate experimental designs and to support the idea of multi-center collaborations while drawing attention to the need to provide research training for clinical personnel to allow them to become involved in this type of activity.
6. Integration of orthotic treatment with overall management: Many aspects of orthotic management as a part of the overall management of cerebral palsy are well accepted and need only be mentioned. They are timing of initial treatment, assessment as a team activity, composition of the team, objectives of the assessment process and regular reviews with good documentation. These incorporate the roles of therapy, surgery, and the importance of the patient and family as active members of the team.
7. Timing of intervention: This can be divided into pre-standing, standing and walking. In the first instance, orthoses prevent deformities and assist with attaining trunk control. In the second instance they can facilitate balanced standing. In the third they facilitate desirable patterns of joint motion and resist undesirable patterns of motion.
8. Lastly those assembled recommended to ISPO that it facilitate the development of a coordinated data collecting process and the dissemination of the conclusions reached during the conference.

As a result of these conclusions and recommendations a short course on the Orthotic Management of Cerebral Palsy was developed and has been one of the most successful such courses thus far. It has been presented in six countries and is scheduled for a seventh this fall.

### Consensus conference on poliomyelitis

The Consensus Conference on Poliomyelitis was held in Hammamet, Tunisia November 16 – 22, 1997. The report of that conference was published in 2001 as edited by Heim, Jacobs, Jensen, Neff and Persson. There were 96 International and 12 Local participants making it the largest such conference held. Forty-three countries were represented.

The following consensus statements were arrived at for orthoses:

The basic principles which should be observed when developing lower limb orthotic prescription include;

- A thorough evaluation of the patient is necessary and should include the assessment of muscle strength, joint ranges of motion and limb length;
- The evaluation should include both the spine and the upper limbs since the status of these will influence the lower limb prescription.

The impairments which are present may be defined as:

- Joint instability is the inability to control the position of a joint. It is generally a consequence of muscle weakness but may also result from secondary damage to the ligaments of a joint.
- Deformity is a fixed position of a joint which precludes the normally present range of motion. It is generally secondary to instability.

The functional requirements of orthoses to treat these impairments may be defined as to:

- Correct, i.e. return an unstable joint to as close as possible its normal neutral alignment and thereafter either to; hold the joint in its corrected position; assist or resist the motion of the joint in a specified manner.
- Accommodate, i.e. hold a joint in a deformed alignment to prevent further deformity arising.
- Relieve, i.e. fully or partially unload a joint.
- Compensate for a limb or segment length discrepancy.

The orthotic solutions which will provide the specific functions may utilize a number of different materials and manufacturing methods. The selection of the “appropriate technology” will depend on a number of factors, including:

- The availability of materials.
- The training of available staff.
- The financial ability of the user.
- The age of the user.
- The social circumstances and environment of the user.
- The patient and family acceptance.

Whatever the materials or the technology employed it is essential that the resulting orthosis meets the functional requirements specified.

Consensus was reached for lower limb surgery in chronic poliomyelitis. They included:

- General principles.
- Aims of surgery on the lower limb.
- Surgery of the hip.
- Surgery of the knee.
- Surgery of the foot.
- Treatment of leg length inequality.

The recommendations arrived at are beyond the scope of this meeting. The reader is referred to the original report for a more in depth discussion.

Consensus reached concerning the relationship between orthotic treatment and surgery in the management of lower limb chronic poliomyelitis.

- Orthotic treatment is the preferred method of treatment in every instance unless: 1. Surgery is needed to facilitate orthotic treatment. 2. The patient prefers not to use orthoses (which includes noncompliance). 3. Surgery is indicated to reduce or eliminate the need for existing orthoses or footwear, and 4. Orthotic treatment considered ineffective or impossible.
- Another interrelationship exists between surgery and orthotic use. The amount and type of orthotic management may change as strength and compensatory mechanisms develop after a surgical procedure has been performed, i.e. brace for

stability and security early and lessen the support as security and strength develop later.

A consensus was reached concerning therapy and rehabilitation of the lower limb. The patient with poliomyelitis has to be approached by a multidisciplinary team according to resources available in each region. The ideal team will be formed by a rehabilitation doctor, physical therapist, occupational therapist, psychologist, orthotist, orthopaedic surgeon and social worker. It has to be a global approach, including social aspects. It can also be handled in a Community Based Rehabilitation (CBR) programme.

A consensus was reached concerning the orthotic and surgical treatment of the upper limb. This is beyond the scope of this presentation. The same is true for a consensus reached for the surgery and orthotic management of the spine.

The following consensus was reached concerning Post-Polio Syndrome**:**

- No consensus was reached on terminology, but it was generally agreed that the term post-polio syndrome should be used to describe the long term effects of poliomyelitis related to aging.
- Special attention should be paid to the patient's changing needs as they age with regard to assessment, orthotic provisions and environment. In certain cases, corrective surgery may be indicated.

The following consensus was reached concerning issues on International Cooperation**:**

1. The recipient government or executing organization must be involved in the identifying and planning of a project which should be formalised by a legal agreement.
2. Clear goals and objectives should be established which consider the long-term integration of services into governmental structures.
3. A clear plan of action should be adhered to by both parties which would include:
    - Timescale
    - Resources
    - Identifying a monitoring mechanism
    - Identifying area of action
4. Services to patients should be provided by qualified professionals in order to guarantee the medical and functional requirements.
5. Quality is of paramount importance and takes priority over quantity.
6. Data collection and exchange of information should be part of every project in order to establish a national register the help achieve the overall objectives.
7. Recipients of orthopaedic services should be encouraged to contribute to the costs of the services provided taking account of the social policy of the country being assisted.
8. A team approach is mandatory in the management of the polio patient.
9. It is preferable for professionals going to a low-income country to have a period of orientation and specific training prior to taking up their responsibilities.

The remainder of the report on the consensus conference on poliomyelitis records the syndicate conversations as they occurred during the seven day meeting.

**Consensus conference on the orthotic management of stroke patients**

The Consensus Conference on the Management of Stroke Patients was held in Ellecom, The Netherlands September 21 – 26, 2003. The consensus report was published a year later and was edited by Elizabeth Condie with assistance from James Campbell and Juan Martina.

A WHO Bulletin in 1976 stated, "A stroke is a clinical syndrome characterized by rapidly developing clinical symptoms and/or signs of focal, and at times global (applied to patients in deep coma and those with subarachnoid hemorrhage), loss of cerebral function, with symptoms lasting more than 24 hours or leading to death, with no apparent cause other than that of vascular origin."

This conference brought together 45 participants from 14 countries representing all of the disciplines which are involved in caring for individuals recovering from a stroke; physicians,

therapists, orthotists, engineers and other associated allied health personnel. Each participant was allocated a task of being a 'key reviewer', a 'state of the art presenter' or an 'expert discussant'.

The objectives for the conference were to:

- Trace, review and rank all the international literature relevant to the scope of the conference.
- Identify gaps in the literature where scientific evidence was weak or absent.
- Discuss key questions arising from this review.
- By means of expert group discussions, achieve consensus on 'best practice' in the absence of any scientific evidence.
- Document and report the recommendations of the conference.
- Encourage the dissemination and implementation of the recommendations internationally.

A literature search yielded approximately 2700 articles. Selected papers were ranked according to a validity scale and given a weight for scientific contribution. Seven 'state of the art' presenters provided an overview of current practices in specified topic areas. These were followed by eighteen 'key review papers', which were based on a structured review and appraisal of the available literature. By the process of syndicate and large group discussions, conclusions and recommendations of the conference were arrived at. They have been published in the 'Report'.

The following conclusions were agreed to by all participants:

1. Orthoses should be considered in the management of a patient with stroke.
2. "…there is no agreed "best practice" in terms of selection of patients for orthotic fitting, design of the orthosis, and timing of orthotic intervention."
3. Indications for the use of appropriate orthoses should be included in the education of all professional staff involved in the rehabilitation of a patient with stoke.
4. Qualified orthotists should be part of the stroke rehabilitation team.
5. Where unavailable an orthotist may be replaced by properly trained non-orthotist staff for temporary services.
6. The scientific literature on the orthotic management of stroke is generally poor.
7. Many of the conference recommendations lacked scientific evidence and therefore should only be considered as 'good practice points'.
8. Terminology was inconsistent.
9. Much of the literature was nonspecific about the type of orthosis being used and therefore was felt to be weak in the evaluation of its use.
10. The prescription writing responsibility should fall to the health care provider in a given setting best qualified to perform the function. It may be better referred to as a referral.
11. The design of all orthotic devices should be based upon sound biomechanical principles.
12. Regular monitoring is essential during recovery in order to modify orthotic management appropriately.
13. Complete records are necessary.

Many recommendations were made. They included specific prescription recommendations, timing for using orthoses, need for therapy, role of functional electrical stimulation, role of Botox, and other tone modifying pharmaceuticals.
Where 'good practices' were suggested but not supported in the scientific literature research activities were suggested. As with all of the clinically based consensus conferences it was suggested that short courses should be developed for the purpose of disseminating the conclusions and recommendations of the conference. There have been two such courses thus far, one held in The Netherlands and a second in Scotland. A third is scheduled for next month in Argentina.

**Common threads**

There are a number of common threads from all of the consensus conferences. They include:

- The team management of persons with disabilities is paramount.
- All appropriate team members are not always available.
- Terminology between and among health care providers working in these fields is imprecise.
- There is disagreement on who should write the orthotic prescription.
- The scientific literature on the orthotic management of all of these conditions is poor or nonexistent. Many areas for research have been suggested.
- Good record keeping is important
- Follow-up is important for insuring appropriate orthotic modification for a given patients needs.
- Orthotic recommendations should include a description of the desired mechanical force system, appropriate alignment and a description of materials and components.
- There is a strong need for improved outcome measures that will permit Validity, Reliability and Sensitivity.
- Measures of functional outcomes must be relevant to the patient, i.e. must deal with their 'quality of life' issues and be appropriate for their environment.
- ISPO should appoint a task office for the dissemination of information emanating from each consensus conferences.

**References**

ISPO. 1995. Report of a consensus conference on the lower limb orthotic management of cerebral palsy. Eds. Condie DN, Meadows CB. ISBN 87-89809-02-5. ISPO; Denmark.

ISPO. 2001. Consensus conference on poliomyelitis: consensus statements and syndicate reports. Eds. Heim S, Jacobs NA, Jensen JS, Neff G, Persson B. ISBN 87-89809-10-6. ISPO, Denmark.

ISPO. 2004. Report of a consensus conference on the orthotic management of stroke patients. Eds. Condie E, Campbell J, Martina J. ISBN 87-89809-14-9. ISPO: Denmark.

Health Technology Assessment. 1998. Consensus development methods and their use in clinical guideline development: Vol. 2, No 3.

ISPO. 2006. ISPO Objectives, www.ISPO.ws

Sackett DL, Rosenberg WM, Gray JA, Haynes RB, Richards WS. 1996. Evidence based medicine: What it is and what it isn't. BMJ 312:71-72.

Greenhaulgh 1997. How to read a paper. The basis of evidence based medicine. BMJ Publishing Group: England.

Shekelle PG, Woolf SH, Eccles M Grimshaw J. 1999. Clinical Guidelines – Developing Clinical Guidelines; BMJ 318:l:593-596.

**Outcomes of previous ISPO consensus conferences: Appropriate technology for developing countries: Cambodia, Tanzania**

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**TATCOT, Moshi, Tanzania,**

## Introduction

This paper is based on a review of two previous consensus conferences. One held in Phnom Penh, Cambodia in 1995 (ISPO 1996) and the second in Moshi, Tanzania in 2000 (ISPO 2001). It also provides a summary of developments in both prosthetics and orthotics that have resulted as an outcome of these conferences. The paper is organised in such a manner that will cover the following categories; executive summary; objectives; procedures used; areas of discussion; recommendations and consensus; recent developments and conclusions.

## Executive summary

In 1994 the International Society of Prosthetics and Orthotics (ISPO) organised a Consensus Conference on Lower Limb Management of Cerebral Palsy (ISPO 1995). Upon conclusion of the conference consensus was reached regarding the main goals of orthotic management for CP. These were stated as; to prevent and/or correct deformities, improve the dynamic efficiency of gait and to support and facilitate training in skills. The conference raised a number of discussion point whereby in 1995, ISPO in collaboration with the Leahy War Victims' Fund of United States Agency for International Development (LWVF-USAID) and the World Health Organisation (WHO) made the first attempt of bringing together experts from national and international government and non-government organisations, to describe and discuss the different prosthetics technologies practiced in developing countries (ISPO 1996).

The discussions in Phnom Penh, Cambodia led to further challenges but most notably a consensus was reached on the definition of *appropriate technology*. This definition was subsequently endorsed at the conference which was held in Moshi, Tanzania with further recommendations related to service provision, project protocol development, update of technology and appropriate orthotics technology (ISPO 2001).

## Objective of the conferences

The main objectives of the conferences were for the experts involved in the provision of prosthetics and orthotics services in developing countries to:

- **In the Cambodia conference:**
  - Describe, discuss and reach an agreement (consensus) on;
    - the key areas of appropriate technology and its application,
    - how to best utilize the resources which can be made available, and
    - how to measure the outcome and effectiveness of programmes.

- **In the Tanzania conference:**
  - Provide updates on Orthopaedic Technology as discussed at the Cambodian Conference and to;
    - further elaborate upon and consider appropriate orthotics technology,
    - further elaborate upon and consider appropriate prosthetics technology, and
    - discuss service Provision and project protocol development:

## Organisation structure of the conferences

Both conferences were organised in a similar structure with presentations of background papers, literature reviews of specific areas of interest and reports on experiences from different developing countries regarding technical orthopaedic services. This was followed by syndicate group discussions based upon formulated questions which led to plenary discussions and finally generation of agreement and consensus statements.

***Literature reviews***

The literature reviewed found that the major causes of amputations in developing countries are due to fighting, landmine explosion in war and post-war zones, traffic accidents as a result of over-loaded buses, trucks and assorted animal drawn carts, work place accidents especially in farming, leprosy, tumours and snake bites (Staats 1996). Amputation due to vascular disease and diabetes were not alarming causes of amputation. Rankin (1996) reports on the pervasive problem of road accidents throughout Africa. He states that there is a high prevalence of undiagnosed diabetes in some parts of Africa and that peripheral vascular disease becomes more common in countries where tobacco is grown and cigarettes are marketed. Loro and Franceschi (1999), Muyembe and Muhinga (1999) and Yakuba et al. (1996) reported that tumours were a major cause of lower limb amputation in Tanzania, Kenya and Nigeria.

It was also found that the main factors which influence the establishment of rehabilitation programmes and facilities are major earthquakes, war or landmines which cause a large number of deaths and injuries of civilians and soldiers. The establishment of these programmes has been rather varied due to the different levels and degrees of cultural, geographical and economic development of individual countries. It was also clear that these humanitarian projects focused more on amputee programmes whereas orthotics problems outnumber prosthetics problems by a 10 to 1 ratio (Staats 1995).

Cummings (1996) reviewed publications related to technical orthopaedic services in developing countries in which some factors used to determine the different components, materials and technology were applied. The other approach identified was through a description of prevailing factors affecting prosthetics and orthotics services. Cummings also indicated that Sankaran (1984) introduced general principles and outlined factors, of importance in the developing world sch as quality of amputation surgery, cost, training, production factors, and the need for devices to enable patients to squat, kneel and sit on the floor.

Cummings also indicated that Pooneakar (1992) highlighted a list of factors which influenced orthopaedic service delivery. These included economic factors, social factors, culture, climate, locally available forms of technology, time, distance, available resources, religion and appropriate technology. Lambert et al. (1997), Maat-Teerink (1999) and Pooneakar and Bupta (1999) reported that the number of persons with locomotor disabilities exceeds the numbers of amputees in some developing countries.

***Experts experience***

ICRC in Cambodia developed and improved the manufacture of polypropylene components which included prosthetic feet, knee units and alignment devices (PPCAS).

***Syndicate discussions***

In reference to the presentations of different experiences in developing countries, there were several major common issues where there was controversy or needs for further discussion. Among others, the most important areas for syndicate discussion were as follows:

- **Cambodia:**
  - Factors requiring consideration when setting up a prosthetics project
  - Barriers to establishing adequate prosthetic services
  - Requirements to be considered to ensure that prosthetics projects contributes to the development of a long-term sustainable national service
  - Indications for the choice and use of materials in different environments
  - Need for information regarding the interpretation and standardising of costs related to prosthetics supply
  - Issues related to quality control
  - Definition of acceptable socket fit and compromises which are appropriate
  - Components or features which limit the life of a prosthesis
  - Appropriateness of CAD/CAM systems

- Needs assessment criteria
- Evaluation and assessment criteria for ongoing or completed projects
- Role of CBR in a national prosthetics services
- Definition of appropriate technology

- **Tanzania:**
  - Prosthetics and orthotics services within the national health care system
  - Essential elements of developing a protocol for needs assessment, project planning, monitoring and final evaluation
  - Different groups and their roles in the provision of prosthetics and orthotics services
  - Elements required to make prosthetics and orthotics services self-sustaining
  - Protocol for cost calculation
  - Government role in the provision of prosthetics and orthotics services
  - Factors to be considered in introducing a prosthetics and orthotics technology and the role of NGOs
  - Government involvement on advising the various levels of training
  - Essential factors to improve prosthetics and orthotics services
  - Essential areas which require development in relation to prosthetics and orthotics technology
  - Update on the definition of appropriate technology

**Recommendations/consensus**
The discussions from both conferences resulted in reaching an agreement and consensus on different elements related to prosthetics and orthotics services in developing countries. In summary, consensus was reached in the following areas:

***Needs assessment and project planning***
The structure of needs assessment was classified to analyse the target group, i.e. number of people to be served); quantifying and classifying disabilities; situation analysis; data reliability check and anticipated expectations.

It was also agreed that partner analysis was required. This which would provide a clear understanding of who is responsible; what is available; identify available and potential skills for development; legal collaborating partners; and analysis of the existing infrastructure as it would serve the related needs, i.e. Physiotherapy, Occupational Therapy and other related social needs.

***Prosthetics and orthotics national health care structure***
The consensus reached was that:

- The role of governments in setting the framework for prosthetics and orthotics services was inevitable. It was recommended that, the government's role will be to ensure that, services are available; incorporate and avail policy at national level; regulate and provide funding for prosthetics and orthotics services.

- Prosthetics and orthotics services should be integrated in the national health care structure as part of Primary Health Care and preferably be part of the Ministry of Health.
  - Where there is more than one Ministry involved, then one should have the responsibility to oversee the delivery of prosthetics and orthotics services.

- In some circumstances, e.g. in post-war reconstruction, a national coordinating body could serve as an umbrella organisation to coordinate NGOs activities within the framework of government activity and interest.

- Various government partners and other groups who might be involved in the provision of prosthetics and orthotics services were identified as:
  - National government departments according to national preferences which might include, either Ministry of Health; Ministry of Social Welfare; Ministry of

Labour; Ministry of Education: Ministry of Industrial Development and Ministry of Defence.
- The relevant UN body relating to prosthetics and orthotics provision
- International Non-Governmental Organisations (INGO). International Donors
- NGO/Local Trusts/other local donors
- Disabled Persons Organisation (DPO)/People with Disability (PWD)
- Prosthetics/Orthotics professionals
- Medical and Paramedical professionals
- CBR Workers
- Insurance Agencies
- Private Players

- The various roles of ancillary groups are as follows:, i.e. NGOs; UN Agencies; Disabled Persons Organisations, Private Enterprise are as follows:

  - Government Departments
    - Make the services available
    - Regulatory role
    - Policy making at national level
    - Provision of financial support

  - UN Bodies
    - Provision of financial assistance
    - Advisory service
  - INGO/Donors
    - Financial assistance
    - Service provider
    - Partnership with national government
    - Encouragement of government to contribute to the sustainability of the programme
  - NGO/Local Trusts/other local donors
    - Provision of financial assistance
    - Provision of service and information
    - Sensitising government departments to the needs of disabled people
  - DPO/PWD
    - Advocacy/Pressure on Authority
    - Identification of people in need
    - Family education/integration into the society
    - Maintenance
    - Exchange of experience
  - Prosthetics/Orthotics professionals
    - Provision of service/maintenance
    - Introduction of the appropriate technology
    - Advice and influence
    - Provide training
  - CBR Workers
    - Link/Bridge between the service available and the person with disability
    - Identify and refer
    - Educate and make aware of the benefits/service available

  - Insurance Agencies
    - Provide finance
    - Advice
    - Make agreements with corporations
  - Private Players
    - Sponsorship

### *User groups*

The importance and various roles of users were identified as they are the central members of the clinic team. It was clear that the role of the consumer should:

- be improved by promoting their inputs in planning; execution of projects and service delivery
- provide peer support and communication to facilitate employment of disabled individuals in direct patient contact
- advocacy of user groups to be improved through direct involvement and cooperation of the prosthetics and orthotics professionals

### *Clinic team*

The clinic team was re-emphasised in that whenever possible a clinic team approach including the patient should be adopted and that social services should be included in evaluation and follow-up projects.

### *Education and training*

The conclusion was that ISPO in collaboration with WHO and ISPO National Member Societies should serve as advisors in:

- Promoting education and training in prosthetics and orthotics
- Recognition of various categories in orthopaedic technology
- Standards of training required in orthopaedic technology
- Develop specialised training courses to be provided for Prosthetist and Orthotists from industrialised countries to prepare them for the work in developing countries

### *CBR and training*

The role of CBR in a structured prosthetics services was outlined. A further outlined syllabus for training of community health/rehabilitation workers in the joint ISPO/WHO statement on the relationship between prosthetics and orthotics and CBR was endorsed with more:

- Emphasis on advisory roles at the community level of the CBR worker as opposed to a professional role of prescribing or providing function.
- Defining the role of the CBR worker in simple repairs of prosthetic and orthotic devices, with a clear list of appropriate repairs to be done and those which need to be referred to prosthetics and orthotics professionals
- Need of involving prosthetic and orthotic professionals in training CBR workers

### *Appropriate technology*

The definition of *Appropriate Technology* was endorsed in both conferences and defined as:

> *Appropriate Technology* is a system providing proper fit and alignment based on sound biomechanical principles which suits the needs of the individual and can be sustained by the country at the most economical and affordable price.

It was further agreed that, it was the responsibility of NGOs to consider the positive or negative impact of introducing a new technology in an existing system and service. In this case, however, it was recommended that:

- The technology should be evaluated through a pilot testing which would allow other local organisations to become familiar with it.
- Other organisations should be invited and encouraged to participate in decision making about the introduction of a new technology.
- Emphasis was made on the improved access to and transfer of information and publication of activities, through either OrthoLetter or Prosthetics and Orthotics International.

- Emphasis on the urgent need of research, development and evaluation activities in relation to appropriate orthopaedic technology
- Emphasis on the need to provide orthotic services with equal priority to the prosthetics services. Applied research and development in the subject areas of materials, component, techniques and machines/equipment.

***Sustainability***

The elements which would lead to sustainability of prosthetics and orthotics projects were identified as:

- A thorough needs analysis and planning of the project and the role of national partners should be identified and justified from the very initial stages of the project.
- The willingness of the government in contributing to the establishment and supporting its sustainability after the withdrawal of INGO/NGOs should be confirmed from the beginning.
- Recruitment, development and employment of skilled professionals at all levels is a pre-requisite for future sustainability of the project.
- Long-term financial sustainability systems which should include, pricing structure; purchase policy and income generation etc. should be in place.

***Quality assurance***

There was a general agreement on factors which should be considered in applying quality assurance, which were described graphically on a “fish bone” chart, i.e. reflects a path of implementing a quality assurance system through four main denominators; people and their relationship; manufacturing process; methods of implementing the system of the service provide.

***Project monitoring***

A protocol for project monitoring and evaluation was endorsed and it was recommended that, ISPO develops appropriate forms and tools to be used to be in line with guidelines developed by the Organisation of Economic Cooperation and Development (OECD).

***Cost calculation***

The model of cost calculation developed was endorsed. It was further recommended to develop tools which would be evaluated through pilot testing.

***CAD/CAM***

Although there was no consensus on the appropriateness of CAD/CAM, it was also noted that, since there were multiple technologies practiced in developing countries, it was not logical to exclude CAD/CAM and thereby discount its current use and future potential

***Materials/components***

There was a consensus on factors to be taken into account when selecting the materials to be used, i.e. costs; availability; adjustability; advantages and disadvantages in different environments; etc. It was also recommended to embark on the use of polypropylene as it is a multipurpose material; can be recycled; is cheaper as compared to the other materials; has good storage capacity; is long lasting and environmental friendly.

The discussion in respect to the different types and design of components used was very complex as they were seen to be the major contributors to a reduced prosthetic life span. The

consensus reached was that, there was a need to identify simple standardised mechanical testing and documentation of products prior to their introduction for use.

### *Safety at work*

Safety policy and implementation at working places was either not adopted or neglected. The recommendations were to ensure maximal safety of installation of machines and equipment and to safely to control work practices.

## Post-conference activities

### *Clinical field and technology testing/evaluation*

A number of evaluations and testing of prostheses have been carried out and published following these conferences. These include:

- Evaluation of polypropylene prostheses designed by International Committee of Red Cross for trans-tibial amputees at BaVi Orthopaedic Workshop, Hanoi, Vietnam (Jensen and Heim 2000).
- Clinical field testing of ATLAS prosthetic system for trans-tibial amputees at CSPO, Phnom Penh, Cambodia and Don Bosco University, El Salvador (Jensen and Raab 2002).
- Clinical field testing of ATLAS prosthetic system for trans-femoral amputees at CSPO, Phnom Penh, Cambodia and Don Bosco University, El Salvador (Jensen and Raab 2003).
- Clinical field follow-up of high density polyethylene (HDPE) Jaipur prosthetic technology of trans-tibial amputees in Honduras, Uganda and India (Jensen et al.2004).
- Quality benchmarks for trans-tibial prostheses in low income countries at CSPO Cambodia and VIETCOT, Vietnam) (Jensen et al. 2005).
- Sand Casting Technique for trans-tibia prostheses. (Jensen et al. 2005).

## Conclusion

These ISPO consensus conferences have made a large contribution to the development of appropriate technology in developing countries and the development of sustainable prosthetics and orthotics services. In addition they have encouraged an atmosphere of cooperation between the different agencies working in this field. However, there is still a need to develop standards of treatment and service for those people who require orthotic intervention and it is hoped that this consensus conferencew will go some way to help.

## References

Cummings D. 1996. Prosthetics in the developing world: a review of the literature. In: Report of an ISPO consensus conference on appropriate prosthetic technology for developing countries. Phnom Penh, Cambodia, 5-10 June 1995. Copenhagen: ISPO

ISPO. 1995. Report of a consensus conference on the lower limb management of cerebral palsy. Duke University, Durham, NC, 10-12 November 1994. Copenhagen: ISPO

ISPO. 1996. Report of an ISPO consensus conference on appropriate prosthetic technology for developing countries. Phnom Penh, Cambodia, 5-10 June 1995. Copenhagen: ISPO.

ISPO. 2001. Report of an ISPO consensus conference on appropriate orthopaedic technology fpr low-income countries. Moshi, Tanzania, 18-22 September, 2000. Copenhagen: ISPO.

Jensen JS, Craig J, Mtalo LB, Zelaya CM. 2004. Clinical field follow-up of high density polyethylene (HDPE) Jaipur prosthetic technology of trans-tibial amputees. Prosthet Orthot Int 28:230-243.

Jensen JS, Craig J, Poetsma PA, Thahn NH. 2005. Sand casting technique for trans-tibial prostheses. Prosthet Orthot Int 29:165-175

Jensen JS, Heim S, 2000. Evaluation of polypropylene prostheses designed by International Committee of Red Cross for trans-tibial amputees. Prosthet Orthot Int 24:47-54.

Jensen JS, Nilsen R, Zeffer J. 2005. Quality benchmarks for trans-tibial prostheses in low income countries. Prosthet Orthot Int 29:53-58.

Jensen JS, Raab W. 2002. Clinical field Testing of ATLAS prosthetic system for *trans-tibial* amputees. Prosthet Orthot Int, 26:85-92.

Jensen JS, Raab W. 2003. Clinical field testing of ATLAS prosthetic system for trans-femoral amputees. Prosthet Orthot Int 27:55-62.

Lambert M-L, Francois I, Salort C, et al. 1997. Household survey of locomotor disability caused by poliomyelitis and landmines in Afghanistan. Br Med J 29 November:1424-1425.

Loro A, Franceschi F. 1999. Prevalence and causal conditions for amputation surgery in the third world: ten years experience at Dodoma Regional Hospital, Tanzania. Prosthet Orthot Int 23:217-224.

Maat-Teerink T. 1999. A survey of rehabilitative services and people coping with disabilities in Uganda, East Africa. Int J Rehabil Res 22:311-316.

Muyembe VM, Muhinga MN. 1999. Major limb amputation at a provincial general hospital in Kenya. East Afr Med 76:163-176.

Pooneakar P. 1992. Prosthetics and orthotics in India. In: Report of a research planning conference – prosthetic and orthotic research for the twentyfirst century. Bethsheda, Maryland, 23-25 July 1992. National Institute for of Child Health and Human Development. pp233-239.

Pooneakar PD, Bupta PK. 1999. A look at health care and prosthetic/orthotic services in India. O&P Business World 2:1:24-30.

Rankin KC. 1996. Aputation surgery: the African perspective. In: Amputation: surgical practice and patient management. Eds Murdoch G, Wilson AB. London: Butterworth-Heinmann. pp 243-251.

Sankaran B. 1984. Prosthetics and orthotics in developing countries. Int Rehabil Med 6:85-101.

Staats TB. 1996. The rehabilitation of the amputee in the developing world: a review of the literature. In: Report of an ISPO consensus conference on appropriate prosthetic technology for developing countries. Phnom Penh, Cambodia, 5-10 June 1995. Copenhagen: ISPO

Yakubu A, Muhammak I, Mabogunje OA. 1996. Major limb amputation in adults, Zaria Nigeria. JR Coll Surg Edinb 41:102-104.

**Plenary Discussion "Outcomes of previous ISPO consensus conferences"**

**Chair: Rob Horvath**

**Rapporteur: Nerrolyn Ramstrand/Chapal Khasnabis**

## Discussion

***Poliomyelitis, cerebral palsy and stroke***

The consensus conference on cerebral palsy was on orthotic management and as a result wheelchair and sitting devices was not considered in the CP programme. It was mentioned that there will be a separate consensus conference on wheelchair and sitting devices, in Bangalore in November 2006. In response to a specific question, it was mentioned that the role of tone reduction orthotic devices, especially regarding their effectiveness was not scientifically proven to be successful yet. Further research needs to be done to define the role the tone reduction orthotic devices may have.

It was highlighted that there is a great need for training of CBR workers in prosthetics and orthotics and vice versa. The WHO and ISPO joint position paper on this issue was mentioned and it was also stated that WHO and ISPO would support implementation of the document. It has been mentioned that Disabled Peoples Organizations (DPOs) need to be considered as resource and allies.

A brief note on CBR Guidelines jointly being developed by WHO, ILO and UNESCO was presented and it was mentioned that this document would further reinforce the linkage between prosthetics and orthotics services and CBR. WHO in association with ISPO and USAID is also developing wheelchair guidelines which will be published at the forthcoming ISPO World Congress.

It was pointed out though the definition "Appropriate technology is a system providing fit and alignment based on sound biomechanical principles which suits the needs of the individual and can be sustained by the country at the most economical and affordable price". It was pointed out that outcome of research studies on various appropriate technologies which was presented by ISPO in last Hong Kong World Congress excluded cost factors or economical price and the points were well taken. It was clarified that purpose was more to see the quality of existing technologies rather than cost factors.

It was pointed out that the ISPO stroke course brought, for the first time, physiatrists and prosthetics and orthotics practitioners together - it helped both groups of professionals to become familiar with each others views and encouraged a collaborative approach. On the issue of pilot studies, it was suggested that pilot studies are always not enough - what works on a small scale always does not operate the same way in a big programme. More detailed long-term work is needed to find the impact and effectiveness of any programme and practitioners need to be more involved in the whole process.

It was pointed out that there are two tools on Cost Calculation being used - one developed by ISPO and the other by GTZ. It was an opinion that the GTZ tool used in Vietnam was effective. The ISPO tool is being used mostly by ICRC about there will be a presentation on Friday. It was also mentioned that there will be a syndicate session on the cost calculation tool. There was a suggestion that USAID supported projects should that use the tools developed by ISPO on cost calculation.

On the issue of sustainability, it was mentioned that government involvement is crucial for a long-term sustainable project. Concerns were raised regarding the continuation of projects after International NGOs phase out their input. Involvement of the government in the whole process from the beginning could be considered.

The need for and benefit of effective dissemination of the recommendations of the Consensus Conference Reports to the stakeholders and policymakers are very important. One way of doing this is that participants should be the ambassadors to promote the documents. Through WHO, one can send the documents to government. It was also suggested that National Member Societies (NMSs) of ISPO also can play an important role in the promotion of these documents. NMSs also can promote these documents in the neighbouring countries where NMSs do not exist. Stakeholders and key NGOs participating in the Consensus Conferences can also help in promotion of documents - it was mentioned that it would be better if all these documents are available online through ISPO, WHO and USAID websites. It was suggested that recommendations of such conferences need to be reached by the state authorities of various countries.

***Appropriate technology***

In discussions related to prosthetics and orthotics services, the term “appropriate technology” frequently created confusion. Often it is seen as “cheap technology in all senses”, but this is certainly not a proper description; even a low-cost device may be invaluable to the user.

**Good practice strategies for orthotics services: assessment of client, functional requirements and treatment plan: the doctor's viewpoint**

**Carolina Schiappacasse**

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## Introduction

The steps taken by the rehabilitation physician in clinical practice to systematize and improve management of a chronic patient are as follows:

- Case history and physical examination
- Evaluation and interpretation of the data collected
- Diagnosis and patient's functional level
- Prognosis and functional goals
- Prevention
- Meeting of rehabilitation team
- Planning of treatment
- Prescription of preventative or therapeutic orthotics
- Measurement of results obtained with orthotic devices

The objectives of orthotic treatment are to facilitate, maintain and/or restore the utmost functional capacity and independence of the client.

## Clinical evaluation

During the clinical examination the following aspects should be considered:

- Tone
- Trofism
- Articular balance
- Muscular balance
- Reflexes
- Sensitivity
- Static postural assessment
- Gait assessment
- Pain assessment
- Spasticity assessment
- Lymphedema assessment
- Skin assessment
- Cognitive assessment
- Neurogenic bladder and intestines
- Involuntory movements

The tools that are available for use are:

- Individual clinical protocols
- Diagnostic algorithms
- Treatment algorithms
- Guidelines of clinical practice for each pathology
- Adaptation for individual patients
- Scales and scores

The scales and scores will:

- Be helpful in decision-making on each specific diagnosis.
- Promote an appropriate use of technology
- Apply the best available scientific evidence
- Favour communication among professionals
- Reduce cost and improve the quality of care

There is no one scale that can meet every need, nor an ideal scale for every pathology.

The above techniques can be applied to:

- Describe functional status at a specific moment in time
- Plan treatment
- Predict prognosis
- Monitor functional changes
- Evaluate efficacy of treatment and prescription
- Plan discharge

**Complementary studies**

The following complementary techniques can be employed:

- X-rays
- CT scan
- MRI
- Ultrasound
- EMG electrodiagnosis
- Evoked potentials

**Examination of the musculoskeletal system**

The musculoskeletal system should be examined in order to find an adequate orthotic prescription:

- Static and dynamic inspection: Evaluation of posture, asymmetry, hypertrophy, muscular atrophy, retractions, articular alignment and rigidities
- Palpation: Evaluation of painful areas or protrusions to identify pressure points to avoid load-bearing on the orthotic device
- Articular balance: ROM, goniometric measurements for a correct individual orthotic alignment
- Articular stability: e.g. The Lachman Test
- Muscular balance: Degree of weakness, 0-5 Kendall Test.
- Sensitivity: Essential for adequate orthotic prescription to avoid pressure ulcers. e.g. tactile- pain-discriminative-propioceptive-somatic, 2 points test, hot/cold test

**Exploring functional needs for an adequate orthotic prescription**

The following functional requirements should be considered:

- Daily life activity skills at home and away from home
- Functional status before and after the onset of the current disease
- Community and recreational activities
- Socio-economical status
- Work history
- Environment assessment: accessibility, architectural barriers

**The rehabilitation team**

The multidisciplinary rehabilitation team could include:

- Physiatrist
- Orthopaedic surgeon
- Physiotherapist
- Occupational therapist
- Orthotist
- Psychologist

**Conclusion**

Many current orthotic developments are of great help in the daily life of a disabled person and are designed to facilitate the rehabilitation process, to provide greater independence and improve the patient's quality of life by contributing to a better interaction in society

**Good practice strategies for orthotics services: assessment of client, functional requirements and treatment plan: the orthotist's viewpoint**

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There are numerous factors that professionals in the area of health must respond to when assessing and formulating treatment plans for their patients. These include:

- very competitive practices
- a need for cost reduction while maintaining quality standards and providing products in a reasonable period of time
- availability of new technologies which may allow the orthotics professional apply new materials, components and designs.
- different requirements and procedures requested by third parties, insurance companies and users.
- increasing demand for documentation. In some cases this is even necessary for legal reasons
- increasing need to educate to the customer/user.The patients are the most important part of the rehabilitation team. They must be allowed to assist in the design of the orthosis. They need to know the different options available to them and the advantages and disvantages of various treatment plans. Patients want a choice and to be lead in the right direction.
- maximising the productivity, efficiency and quality of service offered is the responsibility of the orthotist. A clear, concise and complete prescription can be a means to achieve this and must written by the doctor himself / herself with details for manufacturing and use of a functional orthosis or support for a specific treatment of a pathology or condition.

The prescription should include:

- Patient's name, age, sex and diagnosis.
- Description of the orthosis, objectives of treatment and a short justification.
- Economic resources and origin of prescription.
- Identification of signing physician, including address and telephone number.

When an orthosis is prescribed and manufactured, the process should be dynamic where the objectives and orthotic treatment reflect the functional change that the patient needs and one should consider:

- the objective of the orthosis
- the range of movement to be affected.
- the muscular strength needed to achieve the intended objective.

The Indications should be to prevent misalignment and contracture or correct the deformities, provide a range of different movements, protect weak muscles, provide appropriate biomechanical alignment, provide a stable base for support when walking or standing and to help with function. It can also include one or more of the following goals:

- rest
- immobilization
- articulation protection
- control
- movement assistance
- correction
- compensation
- dynamic response

Conditions that often require some form of orthotic management include:

- Cerebral palsy
- Spina bifida
- Arthritis
- Injury of ligaments and tendons
- Bone injuries
- Diabetes mellitus
- Spinal injuries
- Cerebral vascular accident
- Craniocephalic trauma
- Peripheral nerve injuries
- Poliomyelitis

In order to maximize the likelihood of a successful outcome in relation to clinical management of the patient, it is necessary to perform a good examination, evaluation, and diagnosis. One must also establish the goals of the treatment and evaluate the results. Both qualitative and quantitative orthotic gait analysis should be performed (kinematic, kinetic, posture, muscle strength, joint movement). The clinical assessment is very important to device design.
To facilitate the collection of patient information, clinicians should have access to a variety of assessments forms. For a qualitative data collection clinicians can make use of new multimedia technology (digital camera or video camera). Such systems store information directly on to the computer and can be particularly beneficial for future reference.

Technical aids and technological support are essential for disabled people; it is the professionals duty to contribute with their development, so that they can lead a normal life, included and independent.

## Good practice strategies for orthotics services: biomechanical principles and control systems

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By employing good practice strategies, which includes understanding biomechanical principles, control systems, and gait analysis, an orthotist has the ability to build a better orthosis.

In order to realise this goal, a comprehensive understanding of normal gait is required. At a biomechanical level, this means knowing how we walk temporally (velocity, cadence, etc), kinematically (joint ROM), kinetically (joint torque and power, kinetic and potential energy), and electromyographically (identify co-contractions and whether muscles are eccentrically, concentrically or isometrically active).

This is not to say that every patient needs to be run through a three dimensional gait analysis in order to formulate a treatment plan. Before pathological gait can be understood and an orthosis designed which addresses its limitations can be created, knowledge of normal gait, at a biomechanical level, is required.

Observational gait analysis (OGA), so long as it is done correctly (systematic and comprehensive, in the cardinal planes),can be used to understand pathological gait, evaluate the effectiveness of an orthotic device, monitor progress over time, and share findings at another time/place. Video assisted OGA is no longer cost prohibitive or time consuming and allows a more detailed biomechanical analysis, justifies the efficacy of the orthosis, and can be used as educational tool. Furthermore, online real time video conferencing opens many possibilities that improve communication between medical and allied health personnel.

In lower limb orthotics, the biomechanical terms that need to be considered include:

1. Ground reaction force (GRF) and total body force (TBF): product of segmental mass and acceleration due to gravity and movement. TBF is the action, GRF is the reaction. In static or near static conditions, TBF and GRF are equal, opposite, and share the same line of action.
2. Centre of pressure: point of application of the GRF on the body.
3. Centre of mass: point of application of the TBF on the body.
4. Orthosis reaction forces: limb-orthosis interface pressure or force. Can be part of a 3-point pressure system, GRF control, hydraulic containment, and/or un-weighting.
5. Joint moment of force: torque demand placed on a joint due to external forces, or torque generated internally by a muscle contracting, a joint reaching end range, or an orthosis limiting joint movement.
6. Joint power: concentric/eccentric contraction of a muscle group to accelerate/ decelerate joint movement. Orthoses can also act as energy or shock absorbers, and have been thought to have the potential to return a portion of this absorbed energy.

Why understanding biomechanical principles, control systems, and gait are important:

1. Empowers the orthotist to understand a patient's means of compensating for their neuromotor and/or skeletal profile. Allows the clinician to form a practical treatment plan by implementing information gathered from static assessment and applying it to a dynamic situation, such as walking.
2. To build a better lowerlimb orthosis: by keeping it as simple as possible, so that it addresses the mobility needs of the patient, and hinders them as little as possible, by reducing bulk/weight. By maximising ease and comfort of standing and walking.
3. A better lower limb orthosis is one that improves the patient's quality of life, level of independence, and lifestyle. Functionally, this means a patient's gait has improved

stance stability, foot clearance and positioning for initial contact, adequate step length, energy conservation, and less pain.

Analysis and implementation process: needs to be systematic and comprehensive.

1. Interpretation of all assessment data (ROM, strengths, medical and orthotic history), the functional requirements, and the patient's expected outcome of the device.
2. Observational gait analysis without device and if possible with their current device. Video assisted if possible. Conduct functional or applied biomechanical tasks that recreate individual phases of gait (loading response, mid-stance, terminal stance, pre-swing). This simplifies the process of analyzing gait dynamically, and allows the patient to provide valuable feedback. These tasks also can be used to isolate suspected neuromotor deficits while weight bearing, reveal sources of pain, test dynamic balance, prove compensatory gait deviations, and/or predict how well a patient would be able to tolerate an orthotically supported alignment.
3. By applying the information gained from the assessment, OGA, and applied biomechanical tests, an optimal orthotic design can be derived. By comparing how the patient walks with the new device to how they walk with their previous device, or without orthosis, the quality of the fit and function can be evaluated. As the orthosis wears, or the patient's situation changes in follow-up, this technique continues to be useful.

Several orthotic case studies (OCS) will be presented to emphasize how an understanding of biomechanical principles, control systems and gait analysis result in:

- Improved quality of appropriate lower limb orthotic services,
- Improved competency, productivity and efficiency of existing orthotics personnel
- Improved communication between medical and allied health personnel

**Recommendations**

If the orthotist avoids biomechanical principles and gait analysis, a worn orthosis can be duplicated, and with experience and desire the design may even be improved; but there is a good chance that the orthosis will not help as much as it could. In many cases, the patient recognises that the orthosis they have is better than trying to get by without one, but they have no concept of how much better it could be. That is our responsibility. As orthotists we need to critically evaluate at a practical and applied biomechanical level the devices we dispense:

- Reinforce good practise strategies, standardise biomechanical and gait terminology to colleagues, employees, faculty and/or students.
- Encourage orthotic case study presentations that demonstrate biomechanical principles and OGA at a regional level.
- That ISPO provides a venue for OCS presentations at a global level.

We have the ability to positively effect another person's life, we should do our very best to achieve that outcome. Practical and applied biomechanics allow us to build a better orthosis.

**Bibliography**

Condie D. Orthotic function: its biomechanical basis. O&P World 3(4):18-19 and 21-22

Eastlack ME, Arvison J, Snydler-Mackler L (et al). 1991. Interrater reliability of videotaped observational gait- analysis assessments. Phys Ther 71:465-472

Kirtley C. 2000. Clinical gait analysis: theory and practice. Elservier Limited.

Redford JR. 2000. Orthotics and orthotic devices: general principles. Phys Med Rehabil 14:381-394

# Good practice strategies for orthotics services: criteria and standards for orthoses

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## Introduction

After the functional requirements for an orthotic device are specified related to the assessment of the patient, it is necessary to plan how the orthosis should be constructed in detail. For example, one has to consider the alignment of the joints to find a compromise between the anatomical and mechanical axis. One has to decide which material to use in order to give on the one hand enough stability and on the other hand satisfactory comfort. At the same time the material influences the safety of the orthosis. The stability of the leg is influenced by the joints construction, as well as the assembly of the orthosis and the union to the shoe.

## Joint alignment

In lower limb orthosis there are three large anatomical joints which must be aligned with orthotic joints: ankle, knee and hip. A first general truth for the alignment of the orthotic joints is that the joints on the medial and lateral side of the leg must be perfectly aligned to each other in all three dimensions.

### *Ankle*

In the frontal plane the anatomical axis of the ankle joint goes from the lower edge of the medial malleolus to the lower edge of the lateral malleolus. In the horizontal plane it reaches from the apex of the medial malleolus to a point ~1 cm anterior the apex of the lateral malleolus. This means we find an oblique axis in the frontal plane and an axis nearly orthogonal to the line of progression in the horizontal plane.

In consideration of the relative small range of motion it is possible to find a compromise axis for orthotic devices, which goes from:

- lower edge medial malleolus – horizontal to the lateral side
- apex medial malleolus – 90° to the line of progression to the lateral side.

### *Knee*

In spite of the complex sliding and rolling movement of the anatomical axis of the knee it is possible to find a compromise for a single axis orthotic joint. It should be placed:

- A/P - 60%/40% of sagittal width
- 14% - 17% of sagittal width above joint space
- 90° to the line of progression

### *Hip*

The orthotic hip joint should be fixed at the cross point between:

- upper edge of trochanter major
- line between tuber os ischii and spina iliaca anterior superior

A fourth important axis in lower limb orthotics is the summit of the rocker bottom, this should be in 90° to the line of progression. In general, all axes should be in line in horizontal and frontal plane. Which means all axes must be parallel to the floor and in 90° to the line of progression. If the incongruity between anatomical and mechanical axes becomes too big with this rule a compromise has to be found or, especially with locked knee joints, you should

follow the anatomy. But sometimes you have to do without -for example- an ankle joint if the foot is excessively rotated.

The easiest way to control the correct position of the orthotic knee joint is to look at the changes if the knee is flexed. In this position an incorrect alignment can be checked by looking at the pressure changing on the straps on the anterior side next to the knee.

| | Pressure below knee | Pressure above knee |
|---|---|---|
| Axis posterior | - | - |
| Axis anterior | + | + |
| Axis up | + | - |
| Axis down | - | + |

To check whether the orthotic axis is rotated to the anatomical axis the anterior straps of the lower leg shell and foot shell must be opened. Then the orthosis is flexed while the leg itself is maintained in an extended position. After this the leg itself is flexed too. If the leg falls right to the leg shell the rotation is correct. If the orthosis seems to have more valgus the axis of the orthosis is internally rotated, if the orthosis has more varus it is externally rotated.

In the same way, one can check to see whether the axis is oblique. In this case you perform the same test but this time you look at the rotation of the foot. If, for example, the orthotic foot shell is too far internally rotated in comparison to the foot, the medial knee joint is higher then the lateral.

**Materials**

In orthotic devices you find a large variety of very different materials. It ranges from more flexible materials for a comfortable adaptation to the body; to rather stiff materials to give stability. The traditional orthosis consists of leather and metal. More modern orthoses are made of thermoplastics or fibre composites. Combinations of these methods are possible as well.

The requirements to choose the appropriate material are, for example, durability, weight, availability, price, handling (by the technicians as well as the client) and hygiene.

According to these requirements each material has specific pros and cons.

***Leather/metal***

| + | – |
|---|---|
| sweat absorbing/breathable | gets brittle |
| comfortable/flexible | not washable |
| availability | unhygienic |
| workmanship | |
| price | Rust (steel) |

***Thermoplastics***

| + | – |
|---|---|
| postforming easy | thickness |
| washable/hygienic | not sweat absorbing/breathable |
| durable | forming requires special equipment like oven and vacuum pump (in comparison to leather/steel) |
| weight | |
| acceptable price | |
| time | |

***Fibre-reinforced composites***

| + | – |
|---|---|
| properties can be influenced | properties must be planned (expert knowledge required) |

| | |
|---|---|
| weight | postforming difficult |
| durable | sudden breakdown if overloaded (no “run flat” reserve) |
| strength/stiffness | price |
| thickness | special equipment required |
| | not sweat absorbing/breathable |
| | availability |

**Safety**

There are two aspects according to the safety of an orthosis. On the one hand there is the durability of the orthosis and on the other hand, the ability to stabilise the leg.

***Material safety***

The dimensioning of the weight bearing parts of the orthosis depends on the weight of the patient, his overall activity, the alignment of the leg (e.g. contractures, varus/valgus), the alignment of the orthosis (e.g. correct consideration of lever arms and moments) and the joint construction (provoking further moments).

Some of these items can be measured or calculated but unfortunately some of them can only be estimated. As a result the decision for the dimensioning of the device is most common based on experience (trial and error). There has been some attempt to provide guidelines, but to my knowledge they all failed because of the individualism of the clients according to the above-mentioned points.

***Patient safety***

To prevent a paralysed knee from flexing there are four possibilities.

- Ground reaction force AFO
- KAFO with posterior offset knee joint
- KAFO with locked knee joint in stance and swing
- KAFO with locked knee joint in stance and free joint in swing (automatic release)

All of these constructions have specific pros and cons

***Ground reaction force AFO***

| + | – |
|---|---|
| free knee movement in swing | secure only from midstance (ground reaction from forefoot required) |
| weight | patient must compensate knee flexing moment at heel strike (e.g. with hip extensors) |
| residual muscles must be used | not working going downhill (ground reaction too late) |
| | instable in rough areas |
| | if forefoot lever and dorsistop do not fit precisely there is danger of hyperextension in the knee |
| | height of shoe heel must be considered carefully |

***KAFO with posterior offset knee joint (free ankle joint)***

| + | – |
|---|---|
| secure earlier in mid-stance (weight bearing line must have passed orthotic joint but not anatomical joint) | patient must compensate knee flexing moment at heel strike (e.g. with hip extensors) |
| free knee movement in swing | discomfort because of incongruence during seating |
| free movement in ankle joint (foot can adapt to the ground) | during seating pressure from posterior shells near the knee might affect blood circulation |
| no hyperextension in the knee | |
| residual muscles must be used | |

***KAFO with locked knee joint in stance and swing***

| + | – |
|---|---|
| stable at every time and condition | no functional shortening during swing (hip must be lifted to swing thru) |
| | no training for residual muscles |
| | getting seated awkward |

***KAFO with locked knee joint in stance and free joint in swing (automatic release)***

| + | – |
|---|---|
| stable during stance | extension required to unload the lock at the end of stance<br>→ orthosis not in maximum extension<br>→ little movement during stance<br>→ difficult for patients used to a conventional lock |
| free during swing (functional shortening) | price |
| | only for flaccid paralyses |
| | only for rather straight legs |
| | not in combination with ischial weight bearing |
| | Knee must be complete extended before heel strike, otherwise the joint is not locked (UTX Swing, Free-Walk, Swing Phase Lock) |

**Union of orthosis to shoe**

In the above discussion of the advantages and disadvantages of a ground reaction force AFO, it was already mentioned that it does not work well if the heel height of the shoe does not correspond to the height the orthosis was originally made for.
If the shoe heel is too low the orthosis falls back and gives too much pressure to the tibial support. This might lead to knee hyperextension and makes it more difficult to roll over.
If the shoe heel is too high the orthosis falls to the front and does not give sufficient stability to the patient.
Therefore the patient must be taught about the effective heel size (difference in sole height at the heel and the forefoot) to use only correct shoes.

In the frontal plane it is important to look at the union of orthosis and shoe. Often, especially in sports shoes, the shoe has an integrated medial arch support. If the orthosis is placed in this shoe it falls to the lateral side and provokes a varus moment at the knee.
In conclusion it can be said that it takes as much effort to place the orthosis correctly in the shoe as it does to place the foot correctly in the orthosis.

**Further standards**

Finally I would like to draw your attention to some other small but important standards of orthotic treatment, which I have seen are often neglected.

1. The straps to secure the knee (if you have a posterior shell and you don't use a knee cap) should be placed as near as possible to the knee to be most effective.
2. If the trimlines of the posterior shell reach to far to the front a strap crossing the edges of the shell could not give stability to the knee. It needs either some padding or the trimlines have to be reduced.
3. The tibia has an edge, which everybody knows in prosthetics, that's why he or she try to give more load both sides of the tibial edge in trans-tibial-socket design. But in orthotics this edge is often neglected. Most of the time a simple strap is used which applies the full load to the tibial edge. This can easily be prevented by simply adding some padding which must be thicker both sides of the tibia.

## Conclusion

The effectiveness of an orthosis depends very much on the observation of constructive standards. On the one hand the correct fitting makes the patient feel comfortable in his device, but on the other hand basic constructive principles must be regarded otherwise the orthosis may do no harm to the patient but he still feels unstable within the device.

***Editors Note:***

*Readers should note that discussion following this presentation questioned the authors recommended positioning of the mechanical ankle joint of an orthosis. Roy Bowers (University of Strathclyde), support by numerous members of the audience indicated that the preferred placement of the mechanical ankle joints should be as follows:*
*Frontal plane; On an axis that passes from the lower edge of the medial malleolus to the lower edge of the lateral malleolus.*
*Horizontal plane: At the apex of the medial malleolus and on an axis that passes through the midline of both the medial and lateral malleoli*

# Good practice srategies for orthotics services: fitting procedures/assessment of quality of fit/checkout procedures

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## Introduction

The goal of this presentation is to give you information regarding the necessary steps to providing a comprehensive orthotic service to the user of an orthosis.

To start with, we have to emphasize how important communication between the interrelated medical and ancillary specialists is. This communication forms the basis of a successful rehabilitation service: the so-called “clinic team” has to have a comprehensive picture of the treatment plan. The basic clinic team consists of the physician or surgeon, acting as the head of the team, the physical and/or occupational therapist, and the prosthetist/orthotist.

This paper will focus on the aspects of

- Procedure/protocol
- Methodology
- Evaluation/standard of “quality fit”
- Check-out procedures

## Procedure/protocol

When the patient comes to the clinic for the first time, he/she has to provide his/her personal data, which will be entered into a patient data form and/or computer-supported patient evaluation system.

Next, the clinic team examines the patient in order to determine the medical factors related to the disability. At this point, a detailed consideration of the appropriate treatment procedures should be developed.

If the resulting prescription calls for medical care, the physician or the therapist will undertake appropriate action. If the prescription proposes a new orthosis - as part of a mutually acceptable appropriate treatment plan, developed at the clinic session - the prosthetist/ orthotist should follow this procedure.

## Methodology

- Examination of muscle strength and function. Overview of the situation of the - lower limb - trunk - upper limb.
- Determination of orthotic function and design (FO, AFO, KO, KAFO, HKAFO, HO)
- Selection of orthotic components.
- Measurement of affected limb
- Preparation of casting, positioning of the patient for casting
- Trace joints and other relevant body prominences
- Cast affected limb, prepare negative cast for filling and rectification
- Rectify cast according to the prescription criteria and function of the device
- Design the shape of the orthosis on the cast.
- Determine relevant mechanical axes for the construction of the orthosis.
- Manufacture the orthosis.

**Evaluation/standard of "quality fit"**

- Invite the patient for his/her first fitting appointment.
- Check the fitting of the orthosis while the patient is in a horizontal position on the bed.
- Check the fitting of the thigh shank and the inner shoe.
- Check the position of mechanical axes, the distance between orthosis and the skin, vertical level of the mechanical axis compared to the anatomical joint, parallelism
- Close the orthosis firmly with straps and let the patient stand up.
- Check the orthosis under weight bearing conditions: check the position of the hip, the knee and the ankle, and the length of the orthosis (if applicable, length of compensation)
- Make all relevant changes and fit a second time in the standing position.
- Let the patient walk and observe his/her gait and how the device functions.
- Note gait deviations and improve the design of the orthosis if necessary.
- Make an appointment for a second fitting.
- Make all relevant changes and prepare the orthosis for the second fitting (correct changes, trim all brims, polish side bars and stirrups, rivet side bars and stirrups, make joints parallel, assemble orthosis, add provisional closure [straps])
- During the final fitting, all the checks we carried out before we have to do again. The orthosis user should get instructions in how to use the orthosis and gait training through professional staff.
- Final finishing of the orthosis.
- Delivery and final check-out

The final check-out ensures that the patient is not in immediate need of any further orthotic, medical, or surgical attention.

**Check-out procedures**

The check-out procedures consist of two parts

1. Check-out and user education
2. Follow-up

***Check-out***

The day of check-out is the moment every member of the rehabilitation team has been looking forward too. It is the day when the disabled patient walks out of the door with a well-fitting orthosis. He or she is stable enough and well enough educated in all orthotic measures and details to take care of him/ herself.

During the rehabilitation process or in the process of getting used to the orthosis the patient has already learned most of what he or she has to know about their condition and the use and maintenance of themselves and their orthotic device. However, the day on which the patient walks home, is the day on which the rehab team has to make sure in a structured approach that the patient has the required knowledge, skill and satisfaction and that no questions remain.

The patient check-out is sub-divided into:

- Actual checks
    1. Final evaluation of fit and function
    2. Final orthotic safety check
    3. User satisfaction

- User education
    1. Hygiene of limb and orthosis
    2. How to don and doff the orthosis
    3. How to use the orthosis under various environmental circumstances
    4. Which additional technical aids are available?
    5. Fitness training
    6. Safety

***Actual checks***

1. Final evaluation of fit and function
The orthotist will check overall fit, orthotic alignment and the intended function of each of the orthotic components one last time before the patient walks out of the door.

2. Final orthotic safety check
The orthotist will check the intended function of each of the components using reliable and safe criteria. One of the most important checks is for joint safety and the reliability of locking mechanisms.

3. User satisfaction
The rehabilitation team will interview the patient one more time about his/her satisfaction with the device provided. A patient who is not "happy" or who is dissatisfied with the performance or even the appearance of the device will be psychologically ill-prepared to become a highly functional user.

User satisfaction is the key to rehabilitation. If the patient has demands that cannot reasonably be satisfied for functional or economical reasons, it is the responsibility of the whole team to be informed about complaints, to look for a remedy or to educate the patient about limitations of the "orthotic device".

***User education***

1. Hygiene of limb and orthosis
An orthosis is often worn just like a piece of underwear - but it cannot be put into the laundry. It is therefore potentially a highly un-physiological and un-hygienic container for a segment of the human body. Neglect of hygienic considerations could very well lead to fungal and/or bacterial infection and may cause serious problems. Orthoses must be cleaned on a regular basis. Orthoses made from leather or fabrics are not easy to keep clean. Orthoses made from modern plastic materials support a hygienic approach. The patients must learn what they can and cannot do how they have to take care of joints and locks when they get wet and what cleaning agents may be used on the specific materials of their orthosis.

2. How to don and doff the orthosis
With some orthoses it is easy to put them on and take them off. Some others are difficult because they may have posterior openings for functional reasons or even a mix of anterior/posterior openings. Patients need to learn how to put on their brace in an easy and functional way - otherwise it may not perform its therapeutic task or be unsafe. Patients will also have to learn how to use the closures (such as straps and buckles, Velcro, lacing *etc.*) in an appropriate way. They need to learn to close an orthosis in a safe way but also in a way which does not disturb blood circulation later in the day.

It is the orthotist's and the physical therapist's task to educate the patient on donning and doffing the orthosis.

3. How to use the orthosis under various environmental circumstances
To a high degree, orthotic fit and control depends on environmental conditions such as temperature, humidity, geographical conditions, walking surface quality, etc. A non-disabled person will rarely think about such matters compared to a patient wearing an orthosis. It is the rehabilitation team's task to inform themselves about the living and working conditions of the patient and then to educate the patients accordingly. This is also a matter of user safety and therefore must not be neglected.

4. Which technical aids are available?
Orthotic patients may want to use skin-friendly soaps and powders. They may want to use lotions to support the development of a tougher skin surface and they may need various kinds of donning aids and/or walking aids (crutches of various designs, walkers, wheel chairs etc.). It is the team's task to educate the patient about the available choices; the social worker should have a basic knowledge of the so-called rehabilitation aids and aids for daily living as far as applicable.

5. Fitness training
Orthotic patients need to keep themselves physically fit at all times. Depending on the deformity or the functional loss, there are specific exercises that should be made available. It is recommended that a patient talks with their physical therapist and receives individual exercises before going home for the long term.

6. Safety
Orthotic safety depends on the functional condition of the patient and the functional condition of the orthosis. Safety at all times depends on the continued upkeep of the condition of both, the patient and the device.

***Follow-up***

Patient follow-up is a task for the whole rehabilitation team.

**The physician** needs to see the long-term results or any problems occurring with the orthotic therapy or any other health indication, which may, in the mid- or long-term, cause any problems for the patient. In some cases a surgeon may want to consider a surgical review for enhancement of the situation, which may not have been possible to take care of during the primary intervention.

Paediatric patients outgrow orthoses, sometimes in incredibly short intervals of time. An outgrown orthosis, however, does not fit, it is not safe and it does not perform its therapeutic task. Paediatric patients, even more so than adults, need to be seen on a regular basis; they need to know their return schedules.

**The physical therapist** needs to know the physical condition, endurance and every-day performance and function of the orthotic device. After a period of learning, a patient may need a new set of exercises for further enhancement of performance.

**The orthotist** needs to know how well the patient has adapted to the orthosis and how effectively he or she manages to use it within the scope of the clinical and technical limitations. In some cases, the orthotist may want to do some necessary fit or alignment modifications to enhance the abilities of the user. Again - a paediatric patient needs to be seen on a regular basis, not only for considerations of growth and related fit, but also for safety and maintenance of the orthosis.

**Maintenance of the orthosis**

It is important to recognise that an orthosis is a technical device, prone to technical wear and tear.

An orthosis needs regular maintenance by a trained clinician who can, clean components not accessible to the patient, lubricate the device and perform a safety check. More often, especially when a patient hasn't seen the orthotist for a while, an orthosis may need modifications of fit, alignment corrections or repair (sometimes replacement) of components.

Obviously any component confronted with regular and repetitive loading or repetitive motion under weight bearing conditions (bearings, axes, joint stops, locking mechanisms, suspension aids) or confronted with difficult environmental conditions (dust, moisture, bodily fluids, aggressive perspiration etc.) needs regular reviewing and maintenance. It is therefore recommended that the patient is seen by the team approximately 6 weeks after the primary check-out for the first time, then 3 months later, then 6 months later and then regularly once a year on a continuing basis. The patient should also be educated to come in whenever he or she feels that something is "wrong" or "different" with the orthosis.

Regular maintenance is an important safety precaution. It must not be underestimated. In some countries, legal implications (such as warranties, guarantees and professional liability) are linked to patient education and to regular controls and maintenance of the device

**Plenary discussion “Good practice strategies for orthotics services**

**Chair: Harold Shangali**

**Rapporteur: John Fisk**

**The rapporteur reported no discussion of significance during this session.**

# Implementation of quality management protocol in orthotics services

**Prum Sovann and Olle Hjelmström**

**Cambodia Trust, Phnom Penh, Cambodia**

## Introduction

The Cambodia Trust specialises in providing artificial limbs and braces to people with disabilities, many of them having lost limbs through landmines and many suffering from the devastating effects of polio. It is one of only a handful of organizations in Cambodia with ISO 9001:2000 certification, one of the very few non-governmental organizations in the world to achieve this and possibility the first in a developing country.

The Cambodia Trust achieved certification in March 2002 and is one of only a handful of organizations in Cambodia with ISO 9001:2000 certification. What is unusual about the Cambodia Trust is that it is a non-governmental organization (NGO), one of the very few NGOs in the world with ISO 9001:2000 certification, and according to Walsh and Tang (2004) the first in a developing country to achieve certification to this standard.

## What is a quality management system?

A quality management system is a system that ensures consistency in the quality of services and products provided. It is a system that has defined processes that meet clients and professionals needs and it is a process for ensuring continual improvement.

A quality management system is, at its core; a set of written documents that tells everyone (clients, employees, donors) what you say is what you do. There must be no variation between what it says and what you actually do. Therefore, the system gives clients confidence in knowing that processes are smooth and consistent and furthermore guides professionals and all staff.

The Cambodia Trust uses a quality management system to provide rehabilitation services and to provide products to their clients. The quality management system is not a solitary, stand-alone system, it is not a stack of papers in a three-ringed folder; it is the very heart of the way in which The Cambodia Trust operates.

At the core of any quality management system has to be its clients or customers. Organisations depend on their clients and this means understanding current and future clients' needs, meeting client requirements and striving to exceed their expectations.

The Cambodia Trust uses a joint needs assessment process to ensure clients' needs are identified and in turn they receive equal treatment and services. The system is well organised, all new clients undergo a joint needs assessment. It is easy to use and it is understood by the professionals who use it. Professionals involved in the joint needs assessment are the prosthetist/orthotist, the physiotherapist and the community worker. All information is collected in a standardised way, information is well documented and clients are involved in all decision making.

## Why implement ISO 9001:2000 as a quality management system?

Some people are sceptical about the idea of applying ISO 9001:2000 to an NGO, but there is no reason why it should not be used. In fact, there are many extra benefits NGOs can enjoy from ISO 9001:2000 implementation compared to the other traditional profit-based organization which have increasingly begun to adopt the standard.

One of the major benefits it being able to say what you do. This is organized through clearly defined processes. All staff have precise job descriptions and this means no role ambiguity.

There are clear policies; quality manuals and procedures; clear work instructions, and all forms are document controlled which means any staff member can improve a process or a form but that there is a requirement for them do so using the  process.

A further benefit of ISO 9001:2000 is that it is principally a tool for continuous improvement of systems and procedures rather than for profit making. An NGO has internal and external customers just like a “for-profit” business. However, for an NGO one of the main stakeholders are the donors. Importantly, ISO 9001:2000 provides a mechanism for the NGO to be accountable to its two important customers: clients who use the services and donors. To ensure that continuous improvement is dynamic specific mechanisms are in place such as control of quality documents, accurate record keeping, customer satisfaction surveys, management reviews and internal and external audits. Continuous improvement can also result from recommendations from staff, from clients and visitors and from quality audits and external evaluations. Having a quality management system in place means the organization is proud of the way in which it operates and knows that the benefits far outweigh the processes and procedures.

Regarding orthotic services, The Cambodia Trust uses the quality procedure referred to as *Client/Patient Identification, Assessment, Treatment and Follow Up*. This procedure says what we do and guides staff to ensure that all clients are provided with services according to agreed policies and processes.

What are the advantages of a quality management system?

Some of the main advantages are to:

- Improve customer focus and process orientation within an organization
- Facilitate continuous improvement
- Create consistency throughout the organization
- Strengthen relationships – between donors
- Provide confidence to clients and donors
- Improve management decision making
- Reduce dependence on individuals
- Add value

What are the disadvantages of a quality management system?

- Some of the disadvantages are:
- Maybe seen as additional work;
- specifically paper work and the requirement to follow detailed instructions
- Difficulties in implementation if staff do not buy into the system
- Additional costs around audits

**Conclusion**

In summary some of the benefits to The Cambodia Trust of implementing a Quality Management System are:

- Further training for staff in business and language skills
- Building the capacity of local staff to manage the organization
- Empowering local staff to become engaged in organizational decision making
- Greater accountability to external customers: donors and clients
- Development of a customer focused approach and learning more about customer needs
- Improved services to clients, and
- Improvement in donor confidence and funding.

The implementation of ISO 9001:2000 at The Cambodia Trust has been an overwhelming success. It shows that ISO 9001:2000 can be equally effective for NGOs as for more traditional for-profit or governmental organizations. While NGOs face the same difficulties and challenges in achieving certification as other organizations, ISO 9001:2000 should be seen as a useful tool for overcoming some of the problems NGOs face the world over.

**References**

The Cambodia Trust Quality Procedures
Kantner R. (2000).The ISO 9000 answer book. 2nd Ed: John Wiley & Sons.

ISO Action Plan for developing countries 2005-2010; ISO Central Secretariat, ISBN 92-67-10398-9.

Walsh E, Tang K. 2004.NGO specialized in aid to landmine victims finds benefits in ISO 9001:2000. Management Systems 4(2).

## Information transfer and exchange and mentoring

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As an introduction to the topic of information transfer and exchange and mentoring, one should look immediately at the consensus conference aims and objectives which are as follows:

- To improve the quality of appropriate lower limb orthotics services in developing countries
- To improve the competency, productivity and efficiency of existing orthotics personnel
- To improve the competency of medical and allied health personnel

It is clear that if we can improve the way we transfer information between all of us as professionals at various levels and, at the same time, support this transfer by some sort of mentoring system, then we can indirectly assist in the improvement of the quality of services and the competency of those personnel involved in the delivery of lower limb orthoses in developing countries. This of course does not only apply to developing countries, but it extends globally to all areas.

The kind of information transfer and exchange addressed in this paper will be when students, teachers and professionals are not at the same location, and the tools utilized to facilitate this can be anything from a camera and a computer to a high-end delivery platform or system. These tools, for the most part, will utilize the internet as the vehicle for delivery but one should be aware that not all delivery must involve the internet. Due to the remoteness of some areas of the globe and the possible lack to internet access, there is still a need for the delivery to be via printed material, CDs, DVDs, etc.

For the purposes of this paper, information transfer and exchange can be categorized as being either at a "low end" or "high end".

At the "low end", there are very good text and audio chat systems available that can work well on lower speed internet connections (such as dial-up) and will allow multiple participants for the chat session. There are many services on the internet that allow such chats involving text and also audio. Again, most do not require a high speed internet connection and for the most part are free of any costs, except for the cost of the computer and microphone.

Also at the low end is the use of video and audio chat systems or similar that normally involve a higher speed internet connection and the use of a web-camera or similar and a microphone. This vehicle for information exchange can be very powerful as it facilitates face to face communication and will allow the participants to visually display or demonstrate techniques to each other. Using such systems one can also deliver lectures or seminars to a remote site by using a computer projector to project the lecturer on a bigger screen or monitor and utilzing speakers to deliver the audio content to an audience in a classroom or similar. Some of these video/audio chat systems now allow mulitple participants,which increase the effectiveness of this mode of information exchange. Again, it should be pointed out that most of these systems available are free of charge or entail minimal costs.

Included in the "low end" are other internet vehicles for information exchange such as list serves, blogs and websites. List serves such as OANP-L (accessed via oandp.com), allow individuals to email the list serve with questions or comments that are received by all those who have subscribed to the list serve. It then allows any subscriber to respond to the posted inquiry which will be made visible to all the subsribers on the list. Blogs are usually created by an indivdual or group with a specific interest and which can be accessed by anyone if they have the web address for the blog. The blog will normally be like a diary or listing of entries

that can give an continuing stream of information around a specific topic which can encompass various media to facilitate the information exchange. This information in many cases could be downloaded by the participant. In addition, websites in general, facilitate the delivery of content involving text, pictures, streaming video and may facilitate downloading of information for the participant.

At the “high end” of modes of information exchange and transfer we are normally discussing platforms of delivery requiring higher costs and ones that may involve the purchase of a licence in order to utilize the system. The methods of delivery normally require a higher speed internet connection and will often encompass an assortment of media types involving audio, video, powerpoint files, and allows the person making the presentation to bring in other file types such as photos, images, movies, charts and so on. Besides having such presentations stored and delivered on a demand basis, these systems also will deliver content to a high number of individuals at the same time in a live or sychronous fashion. Again, this will normally encompass higher costs to do this and involve a more complex level of technology to carry out the delivery. In terms of technology this would entail a dedicated computer that is a higher end server having the ability to carry out the tasks described. As mentioned previously, the current systems involving the delivery of a live or stored lecture or seminar, are often purchased by larger organizations or institutions that are involved in training as a major component of their activity. These modes of delivery can be very effective but for the most part are not currently utilized for Prosthetic and Orthotic educational purposes to any great degree.

Such “high end” systems also include course delivery systems such as Web CT. These platforms are utililized for the delivery of a course and involve all the components necessary to accomplish this, such as adminstrative and testing components. Some of the major prosthetics and orthotics schools in industrial countries are utilizing WebCT type systems to assist in the delivery of some of their course content.

At present, the various prosthetics and orthotics training institutions or schools are utilzing various tools to help facilitate, complement, and enhance the delivery of curriculum content. They involve the following:

- Download pages on the internet to view or download specific content involving PDF files, images and digital movies.
- Websites set up for information exchange and dialogue in a general way.
- Website development for a specific purpose such as the disemmination of clinical case studies involving prosthetic and orthotic applications.
- Full programme delivery of content on a customized platform encompassing most courses in a recognized curriculum.

Currently, the only full programme being delivered in Prosthetics and Orthotics is the Distance Learning Program run by the University of Don Bosco in El Salvador. This programme not only uses a custom platform which delivers it’s content over the internet but it also utilizes other media types for those who do not have access to the internet. These involve printed text, videos, CD, etc.. The goal of this programme is to provide a modular distance learning program for orsothetica and orthotics practitioners in Latin America who have at least 5 years of experience but no formal training. The programme consists of five specific modules covering all areas of prosthetics and orthotics at an ISPO Category-II level. The first intake of students went through the formal ISPO final examination process successfully in the Fall of 2004.

In summary, the real challenge will be to find ways to better use the tools presented to improve information transfer and exchange in prosthetic and orthotic applications. ISPO could be a significant player in attempting to make this happen and facilitate more development and collaboration in this area.

The other topic addressed in this presentation is mentoring. A mentor is an experienced or trusted advisor, an experienced person who trains and councels new employees, graduates, students and is someone who advises or trains a person who is typically younger. From a prosthetic and orthotic perspective there is a large need to provide aspects of mentoring to

the new graduates of the recognized prosthetics and orthotics schools. These new graduates have very little “frontline” clinical prosthetics and orthotics experience and need an experienced and trusted advisor to assist in the strengthing, and deepening of their skills and to assist in the broadening of their scope of prosthetics and orthotics practice. An effective mentor can also play a critical role in the development of a new graduate’s confidence and feeling of professional esteem. One of the worst things that can happen to the new graduates is that they lose their confidence as a practitioner early in their career and are in essence damaged to a great degree. Under such circumstances, the recovery of the lost confidence is often a difficult process.

In terms of mentoring it will be important to develop a strategy around recruitment of experienced prosthetics and orthotics practitioners that could fulfill the role of mentors and encourage those who could play a valuable role in this way. Often, such mentors may have to be accomodated in the current school structures and of course there may have to be financial support of such individuals.

In the end, we need find ways to facilitate better and effective information exchange and mentoring that are reasonable to implement. ISPO and it’s various partners in the prosthetic and orthotic field need to collaborate and strategize to make it the use of such techniques and strategies a reality and realize the potential outcomes they can bring.

# Outcome measure in lower limb orthotics

**J Steen Jensen**

**ISPO, Copenhagen, Denmark**

## Introduction

The lower limb orthotics problems in low-income countries are complicated by a number of inherent factors that differ from the conditions found in the industrialised world. These include:

- ambulating in rural areas including fields, hills and moors,
- dependence on technology that allows local manufacture from locally available materials,
- unstructured, often project-based development with no strength testing to international standards,
- devices developed and provided without clinical performance testing,
- devices manufactured and provided by artisans technicians with insufficient training and education, and
- financial constraints.

Appropriate orthopaedic technology was defined at previous ISPO consensus conferences (ISPO 1995 and 2000) and defined as:

- A system providing proper fit and alignment based on sound biomechanical principles which suits the needs of the individual and can be sustained by the country at the most economical and affordable price.

Recommendations from the conference on appropriate orthopaedic technology (ISPO 2000) include:

- It is the responsibility of NGOs to consider the positive and negative impact of the introduction of new technology on the existing system and services.
- New technology should be evaluated through pilot testing which would allow other local organisations to become familiar with it.

ISPO has picked up on these recommendations and established an evaluation programme to test prosthetic and orthotic components and devices.

## Aim

In lower limb orthotics the evaluation strategy is to achieve a systematic and independent assessment of lower limb orthotic designs applied in urban and rural areas of tropical low-income countries with respect to accomplishment of appropriate fit and function from a technical review. Devices should be comfortable, light and of assistive use for the person with disability (PWD). This evaluation preferably should be done prospectively.

ISPO is not and will not be involved in development, design and manufacturing of prosthetic or orthotic components and has no intention of singling out any particular product for superiority.

## The test site

The orthotic fabrication and fitting must be performed by a reputable facility with staff educated to an ISPO-recognised level. This demand can be met if the devices are provided by workshops attached to ISPO recognised Category-II schools as has been the case in ISPO's clinical field studies of prosthetic technologies. It is a possibility that major field operations by NGOs with a sufficient number of trained and educated orthotists to at least Category-II level with teaching skills and an interest in data collection and processing may also be utilised.

Before the start of a project the system/device developers must provide introductory training in its manufacture, fitting and use. The experiences from the past will make ISPO emphasise the requirements of adequate education and supervision of the staff who are directly involved in patient work in order to ascertain uniformity with respect to quality of fit and alignment according to the system's description and requirements.

### ISPO assessment team

An ISPO assessment team, will normally consist of a medical doctor, either an orthopaedic surgeon or a rehabilitation specialist, together with an Orthotist (Category-I) or failing that two Orthotists (Category-I). They should both have a certain academic experience with patient follow-up and some knowledge of developing world working conditions. The assessment team must be the same for all of the initial and follow-up investigations for one specific project,

### Patient selection

In testing new devices, e.g. new constructions, designs, or materials selection, it is important to choose among well-known users, whose walking impairment does not confine them to their home, but allow them to be subjected to a daily life with some physical demands. The group selected for testing can be sampled either from the entire cohort of users of a particular device (HKAFO, KAFO, AFO) independent of indication, or limited to specific pathologies (polio, CP).

Evaluating appropriateness can be done crudely by the assessment team, or can be expanded to collect records on fit and performance with the former device at the time of delivery of the new device under testing; and 6 Months later regarding function and compliance with the new device. This requires the presence of a Cattegory-I orthotist, who has been exposed to a learning process in use of the investigation forms.

The ISPO Office will be able to calculate the needed number of patients (nQuery software) to be included in a study, if the failure rate or non-compliance rate with the previous device and the annual production numbers of that specific device are known. ISPO would normally look for an effect size of 35-45% to maintain a statistical power of $\geq$ 90% in making statements about inappropriateness of one or the other of the devices.

### Outcome measures

Having established the fundamental requirements for the study the next problem is to define what to look for. There is no uniformly accepted method of following orthotic treatments. Systems applied to cohorts with severe mobility impairment, or quality of life measures for people with disabilities, have been looked at but not proved to be very useful.

For the prosthetics studies the Harold Wood Stanmore system was selected, because that is largely used in UK, and is a simple score system combining grade of disability and mobility. However, Davies and Datta (2003) found the mobility grade, which ranges from near normal walking to abandoned use or non-functioning prosthesis, quite useful with a geriatric population.

ISPO has developed and tested a system that was found adequate at a clinical follow-up of pre-fabricated knee-ankle-foot orthoses in Bangalore, India (Leung 2005, internal report).

The first part is a simple recording of demographics.

The second part of the interview relates to patient compliance. The comfort, pain and stability in standing and walking are explored, and the patient is asked to express opinions on the satisfaction with function, weight, and cosmesis.

An important factor in scrutinising longevity of devices is recording the physical challenge or strain when utilising the device. The walking ability is looked at in relation to terrain variations, the walking distance, the number of hours in daily use, and the socio-economic status, e.g. being in work, or sedentary. These records are all based on a face-to-face interview assisted by an interpreter, and the details are recorded both for the system under scrutiny and for the former device.

The interview is followed by the objective examination of the patient and the device interaction.

A muscle testing (grade 0-5) is performed for the muscle groups around the hip, the knee and the foot. Further joint movements are recorded, as well as deformity, joint laxity, or dislocation. Circumferences and leg lengths are measured.

The prescription is checked and the functional achievements recorded with regard to correction/prevention, accommodation/alignment, relief, and compensation.

Further, the orthosis is examined with regard to design features, interface contact, material, and components. Any breakdown the orthosis has sustained since its delivery, or that is observed at the examination is recorded and the actual life span of components calculated.

Eventually the fit and function of the orthosis is described with respect to the shells of the orthosis, the joint functions, the foot plate and the overall craftsmanship. Failures and their reasons are recorded.

The headline for the composition of the investigation form has been simplicity and versatility enabling the format to be used by others without needs for cumbersome instructions. The current format of the investigation form is attached as an appendix.

Ideally the former technology and its application for the individual patient should be examined and recorded. However, this can be impractical, either because the patients have given the old orthosis back to the workshop in exchange for the new, or because the old has been thrown away as defective or for other undisclosed reasons. In the prosthetic field studies information has been taken about performance and compliance with the former technology at face value and reported the results accordingly. It is believed that the detailed way the interview is conducted assures acceptable validity of the information collected. This pattern of examination gives the possibility of investigating two new technologies in randomised groups of 50 and at the same time comparing to the 100 orthoses of previous technology utilised, based on the patients case-stories.

Description of patient and patient function

a. The disease:
    - Cause of walking impairment
    - Prior treatment
    - Kind of orthosis
    - Kind of surgery

b. Socioeconomic factors:
    - Environment
    - Work

c. Patient compliance:
    - Pain
    - Comfort
    - Walking Distance
    - Walking Ability
    - Hours in Daily Use
    - Stability
    - Mobility Grade
    - Satisfaction.

Description of patient and orthosis interaction

d. Affected limb:
   - Muscle testing
   - Fixed deformity
   - Laxity
   - Dislocation
   - Range of motion in respect of hip, knee, and foot
   - Circumferences of thigh and calf
   - Length discrepancy

e. Prescription:
   - Correction or prevention
   - Accommodation or alignment
   - Relief
   - Compensation

f. Achievements:
   - Correction or prevention
   - Accommodation or alignment
   - Relief
   - Compensation

Description of orthosis construction, fit and function

g. Orthosis construction:
   - Type
   - Shells
   - Uprights
   - Joints
   - Shoe raise

h. Orthosis assessment:
   - Fit and walls of shells
   - Knee alignment
   - Foot plate
   - Craftsmanship

i. Assessment:
   - Appropriateness
   - Failure recording

**Ethics**

The ethical requirements are considered to be fulfilled if:

- the patient has given full informed consent,
- the patient has consented to the collection of information,
- the patient is aware that they may withdraw at any time without prejudice to care,
- the treatment is of non-invasive character, and
- there is no contact to natural orifices, circulation or central nervous system,.

**Orthosis provision**

The patients are called into the workshop for fitting with the new device. It is explained; that they have been selected to test out a new device, that they should use the new orthosis for the same purposes and to the same extent as the previous orthosis. Patients are informed that they are free to also use the previous orthosis during the testing period (if available), but the extent of use should be noted. They are asked to collaborate by participating in the

planned follow-up examination but informed that they can withdraw at any time without prejudice to continuous care.

The costs related to the patient transport and a daily allowance to cope with added living costs are carried by the project. The patient must accept at least two visits to the test site. The first visit for casting and fitting may require a night's stay at hotel. Further the patients must commit themselves to meet for control follow-up after 6 months. In case of repair becoming necessary during the course of the study the adjourned costs for transport, subsistence and repair must be carried by the project.

### The follow-up evaluation

The doctor interviews the user about socioeconomic factors, use and compliance with the device as well as assessing disability and handicap, the affected limb, its function, and compliance with prescription.

The orthotist assesses the technical issues such as the fit and alignment, co-assesses function and compliance with prescription.

Users who do not attend follow-up evaluation are sometimes considered as failures. However, if survival statistics are applied (Kaplan and Meier 1958), such dropouts will weigh towards the patient's known result as long as they meet up for follow-up, but otherwise affect the statistics in the same fashion as those patients who are dead during the observation period for whatever reason.

### Cost calculation

ISPO has developed a cost calculation method for orthopaedic service provision. The project is urged to participate in the continued testing of such a system.

### Reporting

ISPO will write a summary report for each tested orthotic model. This report will not be made available to the general public.

ISPO will develop a format for reporting on comparative studies between models of equal design or between models of different designs. The comparative report shall be made publicly available. ISPO has the final rights of publishing the results of either the single testing or comparative testing results in internationally available scientific journals, or in other publicly available reports. ISPO shall provide a copy of the draft manuscript to the supplier of those models described in the publication. The benefactor, Patrick J. Leahy War Victims Fund of USAID, will also be copied at the same time.

### References

Day HJB, Hughes J, Jacobs NA. 1995. ISPO Consensus Conference on Appropriate Prosthetic Technology for Developing Countries. Copenhagen : ISPO.

Hughes J. 2000. ISPO Consensus Conference on Appropriate Orthopaedic Technology for Low-income Countries. Copenhagen : ISPO.

Kaplan EL, Meier P. 1958. Non-parametric estimation from incomplete observations. J Amer Stat Ass, 53, 457-81.

## Annex 1 - LOWER LIMB ORTHOTICS EVALUATION FORM

### DESCRIPTION OF PATIENT AND DISEASE

Name : _____

ID-no. _____

| | Date | Year | Age | FU-time |
|---|---|---|---|---|
| FU-Date | | | 0 | |
| Year of Birth | | | | |
| Year of Onset | | | 0 | |
| *Delivery of Orthosis* | | | | 0 |

**Gender**
1. Female
2. Male

**Disease**
1. Polio
2. CP
3. TBC
4. Fracture
5. Other Infect.
6. Other Neurol
7. Others :

**Prior Treatment**
1. Orthotics
2. Surgery
3. Both

**Kind of Orthotics**
1. HKAFO
2. KAFO
3. AFO

**Region**
1. Hip
2. Thigh
3. Knee
4. Ankle
5. Foot

**Kind of Surgery**
1. Soft tissue release
2. Tenotomy
3. Tendon transfer
4. Osteotomy
5. Fusion
6. Epiphysiodesis
7. Shortening
8. Lengthening

**Socio-economic Status**
1. Child
2. Student
3. Skilled Worker
4. Unskilled Worker
8. Retired
9. Disability Pension

| |
|---|
| Skilled Work : white-collar job, office, store, house-wife etc. |
| Unskilled Work : farmer, industry, transport, fisherman etc. |

### PATIENT COMPLIANCE WITH ORTHOSIS

**Pain** (New / Old)
1. Low Back
2. Hip
3. Knee
4. Foot

**Cause of Pain** (New / Old)
1. By Disease
9. By Orthosis

**Comfort** (New / Old)
1. No Pain
2. Slight Pain
3. Uncomfortable (cause break-down)

**Walking Distance** (New / Old)
1. > 2km
2. 1-2km
3. 500-1000m
8. 100-500m
9. < 100m

**Walking Ability** (New / Old)
1. Fields/Moor
2. Hills/mountains
3. Unpaved Surface
4. Paved Surface
5. Outdoors
9. Indoors

**Use of Orthosis** (New / Old)
1. Intensively (>6hrs/day)
2. Moderately (≤5hrs/day)
3. Light (<1hr/day)
9. Abandonned

**Stability** (New / Old)
1. Stable
7. Knee Unstable
8. Foot Unstable
9. Orthosis Unstable

**Environment**
1. Urban
2. Dry Rural
3. Wet Rural
4. Sea-water

**Mobility Grade** (New / Old)
1. Normal or near normal gait
2. Independent indoors/outdoors
3. Indoors/outdoors, walking aids
7. Indoors only, walking aids
8. No Benefit of Orthosis
9. Abandoned Orthosis

**Satisfaction** (New / Old)
1. Very Satisfied
2. Satisfied
8. Unsatisfied
9. Very Unsatisfied

### PATIENT ASSESSMENT

| Muscle Testing | Active Movement | | |
|---|---|---|---|
| 0. No contraction | 2. Gravity eliminated | 4. Some resistance | 5. Normal |
| 1. Flick or trace | 3. Against gravity | 4+. Considerable resistance | |

**Muscle Testing**
Hip Flexors
Glut. Max.
Hip Abductors
Quadriceps
Hamstrings
Dorsiflexors
Plantarflexors
Unilateral
Bilateral

| | Hip A/P | Hip M/L | Knee A/P | Knee M/L | Foot A/P | Foot M/L |
|---|---|---|---|---|---|---|
| **Fixed Deformity** | | | | | | |
| **Laxity** | | | | | | |
| **Dislocation** | | | | | | |
| **Range of Movement** | | | | | | |

| Circumference Thigh (cm) | | Circumference Leg (cm) | | Leg Length (cm) | | Length Discrepancy (cm) |
|---|---|---|---|---|---|---|
| Right | Left | Right | Left | Right | Left | |
| | | | | | | |

| | Intended Function (Prescription), New | | | Achieved Function, New | | | Prescription, Old | | | Achieved Function, Old | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Hip* | *Knee* | *Foot/Ankle* | *Hip* | *Knee* | *Foot/Ankle* | *Hip* | *Knee* | *Foot/Ankle* | *Hip* | *Knee* | *Foot/Ankle* |
| **Correction or Prevention** | | | | | | | | | | | | |
| **Accommodation or Alignment** | | | | | | | | | | | | |
| **Relieve** | | | | | | | | | | | | |
| **Compensation** | | | | | | | | | | | | |

**ORTHOSIS CONSTRUCTION**

*Delivery Date, New* _____ *Delivery Date, Old* _____

**Orthosis**
New: 1. HKAFO 2. KAFO 3. AFO
Old:

**Thigh Shell**
New: 1. Rigid Thermoplastic 2. Semiflex. Thermoplastic 9. Leather
Old:

**Leg Shell**
New: 1. Rigid Thermoplastic 2. Semiflex. Thermoplastic 9. Leather
Old:

**Uprights**
New: 1. Aluminium 9. Steel
Old:

**Personnel**
1. Cat-I
2. Cat-II
3. Cat-III
4. Technician > 5y
5. Technician < 4y
9. Technician < 1y

**Knee Joint**
New: 1. Standard Side-bars 2. Posterior Off-set 3. Locked in Stance (Ground-reaction)
Old: 8. Locked (drop-lock) 9. No Knee-joint

**Ankle Joint**
New: 1. Oklahoma 2. Plastic Cord 3. Klenzak
Old: 8. Others 9. No Joint

**Assist or Stops**
New: 1. Dorsiflex Assist 2. Dorsiflex Stop
Old:

**Shoe Raise**
New: cm
Old:

**ORTHOSIS ASSESSMENT**

**Orthotic Fit, Thigh Shell**
New: 1. Appropriate 8. Excessive Contact Areas 9. Too Big
Old:

**Walls of Orthosis Thigh Shell**
New: 1. Good 2. Inclusion of Uprights 8. Pressure Points 9. Poor
Old:

**Knee Joint Alignment**
New: 1. Good 2. Acceptable 9. Poor
Old:

**Craftsmanship**
New: 1. Good 2. Acceptable 9. Poor
Old:

**Sides**
1. Right
2. Left
3. Bilat.

**Orthotic Fit, Leg Shell**
New: 1. Appropriate 8. Excessive Contact Areas 9. Too Big
Old:

**Walls of Orthosis Leg Shell**
New: 1. Good 2. Inclusion of Uprights 8. Pressure Points 9. Poor
Old:

**Foot Shell**
New: 1. Effectively Controlled 2. Acceptable 9. Poor
Old:

**Foot Plate Terminates**
New: 1. Full length 2. Distal to MT heads 3. Apex of MT heads 9. Prox. To MT heads
Old:

**Craftsmanship**
New: 1. Good 2. Acceptable 9. Poor
Old:

**Assessment**
New: 1. Appropriate 9. Not Appropriate
Old:

**Reason**
New: 1. Pathology 8. Craftsmanship 9. System
Old:

**FAILURE OF ORTHOSIS**

*Date of Failure* _____

**Shell**
New: 1. Thigh 2. Leg 9. Both
Old:

**Knee Joint**
New: 1. Malfunction 2. Rivets Loose 9. Broken
Old:

**Ankle Joint**
New: 1. Malfunction 2. Rivets Loose 9. Broken
Old:

**Foot Piece**
New: 1. Loose 9. Broken
Old:

**Interaction**
1. Repair
9. New Device

**Cause of Failure**
New: 1. Structural 9. Inappropriate Design
Old:

**Plenary Discussion "Good practice strategies for orthotics services"**

**Chair: Mel Stills**

**Rapporteur: Jo Nagels**

## Discussion

***Implementation of quality management protocols in orthotics services***

What was learned and the system for change was explained using the example of patient evaluation forms for prosthetics. These templates are open for change, which is discussed within the team. The new agreed template is then submitted to the director and implemented. The impact to the client/service was not explained in a measurable way; however, 10 patients per month are interviewed according to their ISO template.

Quality management issues of ISPO accreditation versus ISO was explained. It was clarified that ISPO accreditation does not require an ISO accreditation as education is not measured through this system. The ISO accreditation is a management system that provides a license to show product quality. The cost set-up easily outweighs the cost of "lost materials" and unnecessary expenses can be eradicated as they are identified by the system. The role of the ISO quality standards was discussed. It was explained that the focus of these standards are on client satisfaction and ongoing improvement. Changes or results can be measured from patient satisfaction until the evaluation of the supplier.

***Information transfer***

It was suggested that web tools are a good addition to modular course, especially in the developing world, where different technologies (not always accessible) are well explained. The Indian experience questions the feasibility since only 12-15% have access to the internet. This position was confirmed by representatives from Cambodia who indicated that it is difficult to get internet connections are that easily accessible and fast. Nevertheless, the low-end approach still remains a solid option, since hardcopies and software can form part of the package. There are centres such as training institutions that have installed broadband. Accessibility to these sites is typically on purchase of a password, this can be addressed by seeking collaboration with the local education institutions.

***Outcome measures in lower limb orthotics***

There was concern raised that the description of the orthotic design in this measurement tool is not appropriate. ISPO did look into other experiences and or scales but went forward with their own template. This tool, can also be used when follow up is implemented and can be considered as a basis for service provider protocols. Moreover, it was suggested that, in the future, local individuals might be able to ensure ongoing measurements of quality regarding function and fit. Every clinic should implement follow-up. It was recommended that ISPO might come forward with a simplified unified system.

# Orthopaedic aspects of the management of the residua of paralytic poliomyelitis

**Hugh G. Watts**

**Shriners Hospital for Crippled Children, Los Angeles, USA**

## Introduction

While the incidence of poliomyelitis in the world is markedly decreased, it has not been eliminated. In spite of the availability of prophylactic vaccination, 960 cases were reported to WHO in 2004 (as of 5 January 2005) and this does not include the cases in the Western Hemisphere. The incidence of new cases in the Western Hemisphere was said to be zero after 1994; however, recent outbreaks in the Dominican Republic and Haiti (WHO 2004) have proved this wrong. There is a suggestion that the reappearance in the Western world is due to mutation of the attenuated virus used during vaccination into the virulent form.
Social factors play an important role in the effort to eliminate the polio virus. Recent outbreaks of the disease in Northern Nigeria resulted from rumors that the immunization would cause sterility among the immunized boys. Children who then developed the disease as a result of non-immunization have spread the virus back into regions of West Africa where the disease had previously been declared polio free.

*Orthopedic implications of the changing epidemiology*
While the incidence of new cases has been remarkably reduced, the availability of immunization has no effect on those who already have had the disease. These children are now mostly late teenagers and adults.
The treatment of polio residua is now mostly an adult problem. This has a number of important orthopedic implications:

- Adults do not heal as quickly or as readily.
- Postoperative regimens need to be extended
- Rehabilitation facilities postoperatively will be in more demand.
- Polio results in complex patterns of paralysis that require adjusting to. Since children are remarkably adaptable the alteration in the mechanics, which follows some operations, is quickly accommodated by children. Not so in adults.
- Another important issue for polio victims who are now adults is: what will be the worldwide impact of “Post-Polio Syndrome”? Here, the term “Post-Polio Syndrome” refers to the recognition of new functional loss that may occur many decades after the disease first occurred in childhood. By some estimates 40% of polio victims will feel the scourge of Post-Polio Syndrome as they reach their 50s and 60s.
- During the period when the incidence of new cases dramatically declined, medical facilities have improved in many regions where polio was endemic. Before, the huge numbers of cases often required modifications in surgical technique to accommodate the vast number of patients. This led to the advent of “Polio Camps” in India and elsewhere, where large numbers of children were operated upon very commonly with percutaneous techniques, which were adequate, but not always optimal. As the medical facilities have become more prevalent, more standard techniques may be better selections.

## Implications for surgical techniques

When a person with the residua of paralytic poliomyelitis presents for treatment, the orthopaedist may have difficulty knowing where to begin. Turning to the literature for help is overwhelming. Campbell's Operative Orthopaedics (Canale 1987) alone has almost 40 pages related to the surgery of poliomyelitis and past editions (which are probably more useful to those still needing to treat patients with polio) had three times more. One can readily become enmeshed in a tangle of detail.
Although there are well-established patterns of polio, each person is different because of different combinations of paralyses. This poses a special challenge to treatment. One can

see a person with a totally flail leg who is able to walk orthosis-free or one with upper limbs so weak that he cannot support his body weight who somehow manages to use crutches to walk. Conversely, one often sees those with less impairment who have failed to reach their potential.

## Establishment of priorities

### *General*

When first seeing someone who has had poliomyelitis, it is all too easy to focus on a single deformity. One needs to establish an overall programme. In order to do so, priorities need to be established.

Thorough assessment is the cornerstone of priority setting regardless of the age of the patient. The person's gait (if he is walker) with and without his apparatus (i.e. crutches and orthoses), his sitting capabilities, passive and active range of motion and manual muscle testing of the limbs and trunk are basic. Limb length discrepancy and scoliosis should not be overlooked.

Good manual muscle testing skills need to be relearned. A muscle usually loses one full grade when transferred. Therefore to be functionally useful a grade of at least 4 is necessary prior to transfer. However, a grade 3 muscle, while unable to provider a useful function after transfer, may be effective in preventing deformity by better balancing forces about a foot or hand. The orthopaedist needs to be able to distinguish these differences and cannot expect to rely on the Physical Therapist for recording an adequate manual muscle test.

The most difficult assessment is the social/cultural one. Patient information is very frequently gathered through the filtering process of an interpreter and analyzed with limited understanding of local needs, uses and geography. As often as not, it is these social and cultural factors, which become paramount in the success or failure of treatment

In previous descriptions of the management of children with the residua of poliomyelitis, we have described a process of priority setting (Watts and Gillies 1992). Those priorities are summarized below together with the modifications we now consider given the changing epidemiology of the patients involved i.e. that the patient population is much older:

### *Will this person ever walk?*

Many patients who first present have never walked. For an orthopaedic surgeon, there can be few things as satisfying as converting a teenager, who has spent all of his life crawling, into an upright walker after relatively simple surgery and bracing. However, before embarking on multiple surgeries, the most important question to be asked is "Can this person ever be converted into a walker?" As obvious as this may seem, we have been consulted on many patients who had undergone multiple procedures to no avail because the basic ingredients for walking were not present.

A person with one normal lower limb can usually be made to walk (with or without orthoses and crutches) regardless of the severity of the affected limb. Some impairment in the good side can also lead one to be confident of the person's ability to become a walker. Even severe involvement of both lower limbs allows for walking provided the upper limbs and trunk are uninvolved, or only minimally involved.

A person whose both lower limbs are flail and who has inadequate upper limb strength and control is unlikely to become a walker, especially if the trunk muscles are at all impaired. A useful rapid guide of a person's ability to use his upper limbs to assist weak lower limbss is to ask the patient to place his hands on the examining table and to push down and lift his buttocks off the surface. Inability to do so is a bad omen.

Motivation of the patient and obesity become the critical factors in the marginal cases.

### *Priorities*

It is our belief that the priorities of management are, by and large, sequential:

1. To get the patient walking;
2. If the patient is a child, correct factors which will create deformity with growth
3. To correct factors which will obviate or reduce a lifetime dependency on an external orthoses
4. To correct upper limb problems;
5. To treat scoliosis

While the surgical techniques appropriate for use in children with polio differ in that a great deal can be done by percutaneous procedures, standard techniques should not be overlooked.

**The first priority: get the patient walking**

If the patient is a child, it is initially important to get the child walking in any fashion and not get bogged down by a vision of walking perfection. While the child may ultimately be able to walk without orthoses after appropriate releases, transfers and osteotomies, one does not need to do all such surgery at the beginning. Get the child up on his feet with the minimal contracture correction necessary by the simplest of releases and the simplest of orthoses. The contracture releases required at this stage are most often the hip flexors and abductors, the Fascia Lata distally and the heel cord. The extent and duration of the deformities will dictate the techniques chosen.
Children under 3 or 4 will often respond to stretching exercises alone. Those a few years older (i.e. 3 - 7 yrs) may do well with serial casting, while those older yet will probably require surgical releases.

1) Correction of hip flexion and abduction contractures
Hip flexion contractures may occur in isolation, but more commonly they are associated with contractures of the Tensor Fascia Lata and the Gluteus Medius tendon. Inability to extend the hips makes walking and standing difficult when unilateral, and nearly impossible when bilateral. The abduction contracture adds to this by tilting the pelvis laterally. This lateral pelvic tilt puts the high hip at risk of subluxation and may cause a secondary scoliosis.
When a knee flexion contracture is present, along with a hip flexion contracture, the Thomas test should be carried out with the knees over the edge of the bed. Otherwise, the knee flexion may well make the hip flexion seem greater than it is. An abduction contracture may only be revealed when the hips are fully extended.
At the time of surgery, many hip flexion and abduction contractures are relieved by radical release of the Illiotibial band and intra-muscular septum at the knee. If this does not result, then one can progress to an Ober release around the hip.
When doing an Ober release in older children and adults, the temptation to use subcutaneous tenotomies is best avoided. The proximal contracture of the abductors requires releasing far posteriorly or residual flexion deformity may be a problem if released percutaneously. A short transverse incision inferior to the Anterior Superior Iliac Spine is most easily used. The Lateral Cutaneous Nerve of the thigh is exposed and protected. The relatively avascular plane between the Tensor Fascia Lata and the Sartorius is identified. The fascia of the Sartorius (or its whole bulk if functionless) is released. The Tensor Fascia Lata is isolated and divided at its musculo-tendinous junction with cautery. Release is carried posteriorly to the Gluteus fascia and tendon if necessary, especially in older patients. Occasionally it is necessary to release the straight head of the Rectus Femoris, less frequently the Psoas and very rarely the joint capsule. After release, a residual contracture of 20° will usually correct by subsequent stretching exercises in children younger than 10 years.
Bilateral long-leg casts and a tie-bar between are applied with the affected leg in neutral adduction and rotation. Postoperatively the patient lies prone for two hours three times a day for six weeks. Stretching of the Femoral Nerve may occur, so should be looked for immediately postoperatively.

2) Correction of knee flexion contractures
Correction of knee flexion contractures may be accomplished by a number of different techniques that will depend on the age of the patient and the availability of medical facilities.

a) Serial casting: Knee flexion contractures can be improved by casting in younger children. Age, the degree of contracture, available facilities, and the distance the patient has to travel all modify the plan of treatment. The cast treatment can most expeditiously be carried out in the following manner: the cast is applied without sedation or anesthaesia; a short-leg cast is first applied; when it is firm, it is extended to a long-leg cast after first over-wrapping the upper end of the short leg cast with padding. Thus, only the upper end of the cast needs to be changed at each subsequent visit. One hand gently moulds the supracondylar area anteriorly (NOT over the Patella) while the other pulls the posterior aspect of the upper Tibia

anteriorly. The very proximal most part of the thigh should be closely moulded posteriorly. Minimal force is used. Force can produce pressure sores, micro-fractures and flattening of the femoral condyles and posterior subluxation of the Tibia. The above-knee section of the cast is easily changed at 2 or 3 week intervals. One can expect approximately 10° of correction per cast change.

b) Lateral release at the knee (Yount Procedure): All posterior structures can be released through a distal lateral incision. The lateral aspect of the Quadriceps fascia and intermuscular septum are excised for a distance of at least 2 cm. If the lateral Hamstring is functionless, it is divided. If it functions, then it is recessed, or when the patient has no hip extensor, transferred to the distal femur to work as a hip extender. At each stage of the surgical release the degree of knee extension is checked.
In children under 10 years, at about minus 20° of extension, the residual deformity at the end of the surgical release will be easily corrected by postoperative serial casting. However, where the knee is still flexed to more than 20° and especially in older children and adults, the medial hamstrings are approached through a separate medial incision. These muscles are divided if they are functionless, or if functional can be lengthened or recessed (as for the lateral hamstrings– see above). It is desirable to leave one hamstring so the knee can be actively flexed for squatting, but in very severe deformities (90° or more) they may have to be sacrificed.
If the knee still does not straighten out to more than minus 75°, then releasing the Gastrocnemius heads may need to be considered where there is a strong Soleus. Posterior capsulotomy of the knee should be avoided where possible but may be needed in an older child or adult with persisting deformity and posterior Tibial subluxation.

c) Surgical release followed by skeletal traction or Femoral shortening: If after soft tissues have been released, the contracture is greater than 60° or the neurovascular bundle is as tight as a piano wire, the Femur may be shortened and extended (see below) or postoperative skeletal traction may be used.
Skeletal traction can be highly effective, and is our preferred choice. However this technique does tie up hospital bed space often in just those situations where beds are already scarce.
If traction is used (especially in a patient who is small) a distal Femoral pin (directed proximally and posteriorly) may be needed to provide counter-traction in addition to the usual pin in the proximal Tibia.
The Tibial traction should be directed anteriorly as well as distally to minimize or correct the posterior subluxation of the Tibia. If there is a great deal of lateral Tibial rotation on the Femur secondary to a tight Fascia Lata and Biceps Femoris, the Tibial traction can also be adjusted to help correct this.
It is not necessary to correct the contracture fully by traction. Usually about 2-3 weeks of traction is ample. Once all but 40° have been achieved, the remainder can be gained by serial casting.
Alternatively, to postoperative use of traction, the Femur may be shortened during surgery by an amount adequate to relax the neurovascular structures when the limb is fully extended. Usually 2 or 3 cm suffices, and the Femur is fixed internally. Shortening is more satisfactorily carried out when the problem is bilateral and the child close to skeletal maturity.
When stretching out knee flexion contractures, hypertension must be watched for. If drugs cannot control the hypertension, the joints must be relaxed back into some flexion.
Following the releases, the child should be stood up and started on walking training using casts as temporary supports, while awaiting the fabrication of orthoses.

d) Distal Femoral extension osteotomy: If the patient is an adult, or a child near maturity, or the contracture is recurrent, a femoral extension osteotomy at the supracondylar level is preferred. The femur is approached laterally and a Yount release performed first. Where the persisting contracture is in excess of 40° it is safest to shorten the Femur. If the contracture is less than 20° an osteotomy can be performed leaving the posterior cortex and periosteum intact. By holding the leg in full extension in the cast, internal fixation is not required. The patient can be allowed to bear full weight by the first postoperative day and the cast need only be worn for six weeks.
When doing the osteotomy, it is important to avoid taking a slightly laterally based wedge thereby putting the knee into valgus. This is a very easy error to make.

If the patient has no potential for actively extending the knee, 10° to 15° of hyperextension should be the goal.
Large degrees of extension at the osteotomy will usually result in moderate loss of knee flexion. This can be a significant disability in cultures where sitting is done on the floor, or full flexion is needed for praying. In addition, excessive residual extension may result in a progressive hyperextension deformity, which is very difficult to treat.

3) Orthoses
Orthoses should be kept simple. Initially, if undecided whether to fit below the knee or above, error is better made on the side of more extensive orthoses. While a Floor Reaction Ankle-Foot Orthosis (i.e.. "Pre-Tibial AFO") in slight equinus might ultimately work to stabilize an absent quadriceps, a person who has never walked before may well become frustrated without the instant stability provided by a simple long leg brace (i.e. Knee-Ankle-Foot Orthosis or KAFO). Such a person may have a great deal of difficulty learning to stand, let alone walk. This lack of initial demonstrable success from your efforts may result in the patient disappearing back to where he had been crawling about, with him convinced of the uselessness of modern medicine.
For the same reason, the use of a walker may be the wisest initial choice. Later, progress can be made to axillary and then forearm crutches.
Naturally, the materials used in orthotics will depend on the facilities available. The lightness of plastic has to be balanced against durability and the relative ease of working steel and leather against weight. A patient who comes to a Western Hospital and is provided with a sophisticated orthosis still needs to return to his home country where repairs may be difficult. Usually a broken metal and leather orthosis is more readily repaired by local craftsmen than a fractured plastic orthosis.

Whatever the material, certain principles must be followed. A patient who is unable to maintain his knee in extension requires a KAFO with lockable knee hinges.* If the foot is flail, then ankle motion in the orthosis should be limited to approximately 15° of plantar and dorsiflexion. If dorsiflexion is paralyzed, a planter flexion stop at zero should be provided. Dorsiflexion spring assists seldom stand the abuse of even a few months of use by an active patient, and are unnecessarily expensive. Where the foot and ankle are in balance, a free ankle joint is satisfactory.
If the younger child cannot balance the trunk over the legs, a pelvic band and hip hinges may be added to the KAFO initially. When both hip extensors are paralyzed, a hip lock can be added. As the child improves, it is possible to abandon the pelvic band. Our experience has been that the need for long-run use of a pelvic band has been virtually zero. If the problems are below the knee, then a single metal-upright AFO is satisfactory, as long as the subtalar joint is balanced.
Where the subtalar joint of the foot is unbalanced, a moulded plastic AFO with anterior trim lines cut well forward provides much better control. If facilities for plastic moulded orthoses are not available, an orthosis with a lateral iron and the requisite T-strap is used.

**The second priority: in a growing child, prevent deformity**

Once a child is walking confidently (or if he presents initially as a walker), he should be assessed to focus on those problems that commonly result in deformity as the child grows.
1) Foot
a) Equinus: If the subtalar joint is unstable, equinus may be masked by heel eversion and mid-foot valgus. Examination of ankle motion should be done by first plantar flexing the ankle fully and then moving the hind-foot into inversion.
With the foot held in this position, the ankle is tested for any limitation in dorsilflexion.
In most children under the age of 10 years, equinus can be corrected by serial casts. For the reasons described above, the equinus must be corrected while holding the foot in inversion. If this is not done a false correction can occur through the subtalar and mid-tarsal joints.

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* In many cultures where living is done at ground level, rather than in chairs, knee joints are not needed for smaller children until they go to school where chair use has been adopted almost worldwide.

In older children, equinus is most expeditiously managed by lengthening the Tendoachilles. It is important to remember that some degree of equinus contracture may mechanically stabilize the knee by forcing the tibia back at initial contact and thus the knee into hyperextension, in the same manner as a Floor Reaction AFO ("Pre-Tibial AFO").
Where the Quadriceps is present at a strength of " 3 " or better, the Tendoachilles may be safely lengthened. However, if the child holds his knee in extension during stance by means of ankle equinus, lengthening the Tendoachilles may take away the child's ability to walk without an orthosis. The difficulty arises when the child locks the knee with a combination of ankle push-off muscles and hip extension of variable power. There is no easy answer to the difficulty of analyzing this problem except to weigh the strength of the existing muscles against the severity of equinus and if the decision is made to correct the equinus, one should proceed cautiously possibly starting with serial casts (even if a child is older than 10 years).
If the child is an orthosis wearer and there is an equinus contracture, the contracture can be corrected for comfortable orthosis wearing, remembering always that there is a surprising amount of functional improvement with time in almost any given child, so one should not burn a bridge which may be useful later on.
Equinus need not be overcorrected. The foot is better left in neutral plantar flexion to increase stride length.
Only rarely will a posterior ankle capsulotomy be needed, even after very long-standing severe contractures. If you find that there is residual equinus after surgically lengthening the Tendoachilles, it can be corrected by serial casting.

b) Drop-foot: A drop-foot may be corrected by an orthosis or by appropriate transfers. Tendon transfers can improve dorsiflexion if suitable muscles are available to prevent the knee from buckling. Tendon transfers, however, will not correct the commonly associated equinus, so the equinus contracture must be dealt with first. A transfer of the Tibialis Posterior is ideal but seldom present. The Peronei are the next choice followed by a Jones transfer of the EHL to the metatarsal neck if there is a cocked up great toe, or transfer of all of the Long Toe Extensors proximally. Tenodesis of the Anterior Tibialis tendon into the Tibia can be effective but May well stretch out, depending on the strength of the opposing plantar flexors.

c) Foot valgus: An everted heel and valgus at the mid-foot with active Peronei and lateral Long Toe Extensors is a deforming combination which is commonly seen. The Grice-Green Subtalar Arthrodesis is effective in stabilizing the heel. The Peronei should be transferred to the heel if the knee is likely to give way due to Quadriceps weakness and to the dorsum if the knee is not likely to buckle unless there is a Calcaneus deformity. In children who walk orthosis-free, the procedure can be done once the child is about 6. In those who are orthosis wearers, it may be postponed until the child is a little older, and it is obvious that either the deformity is progressing or the orthosis wearing is uncomfortable.
Stabilization and transfer should not be delayed too long, as stabilization of the heel and transfer of the Peronei may make a later Triple Arthrodesis unnecessary. In children below the age of 10 years, most foot deformities can be corrected by soft tissue release combined with Subtalar stabilization.
As the child approaches maturity, a Triple Arthrodesis may be needed. In doing a Triple Arthrodesis for a foot which corrects passively, one can simply cut away the cartilage surfaces of the joints which is easier than cutting wedges and results in much less foot shortening.
There is enormous variation between individual patients so that one may correct severe valgus deformity in a 20-year-old by soft tissue procedures alone and fail to do so in a 13 year old. Clearly, the amount of bony deformity on the lateral x-ray and the degree of correctability clinically are useful guides. If in doubt, it is best to proceed sequentially with a soft tissue release and later Triple Arthrodesis.

d) Equinovarus: In the younger child the deformity may be corrected by casts and stabilized by bracing or Tibialis Posterior transfer. If the deformity returns or correction fails, then a posteromedial release combined with a Subtalar fusion may be necessary, making sure that the resulting fusion is not in varus. The Tibialis Posterior should be transferred at the time of such surgery.

e) Calcaneus: If no muscles are available for transfer, then tenodesis of the Tendoachilles to the Fibula with the foot in 5°-10° of plantar flexion controls the heel. In the growing child, this may lead to a more normal development of the Os Calcis and distal Fibula 4. When done before the age of 11 years, equinus may develop but this can be managed by lengthening the tenodesis.

2) Knee

a) Back-knee deformity (recurvatum): Recurvatum in a growing child should be protected by an orthosis. It can be controlled by a KAFO, in the hope that the posterior structures of the knee will tighten with time. Because no knee lock is usually needed, the knee hinges may have to be set in a few degrees of hyperextension if the leg is flail. If there is sufficient quadriceps to maintain stability with the knee in a little flexion, correction may be hastened by fabricating the orthosis in 10° to 20° of flexion at the knee provided the child is a rigorous orthosis wearer. Soft tissue correction of recurvatum by Triple Tenodesis (Weston et al. 1988) requires a long postoperative course of bent knee bracing and then serial casting. Patient compliance is mandatory. We have not been impressed by the technique but have had only limited experience with it.
Where the recurvatum occurs solely in the Tibia, then a Tibial osteotomy will correct it.

3) Surgery for comfortable orthosis wearing

If the child proves that he is always going to be an orthosis wearer, then procedures should be aimed at comfort. It is wise to remember that in most children a spontaneous improvement in function occurs with time. Some children whom one thinks should not be able to walk free of an orthosis do so. Allow the child himself to prove that he will always be an orthosis wearer.
Procedures for orthosis comfort can be: i) Release of equinus; ii) Stabilization of the Subtalar joint so that the medial malleolus does not become abraded by the medial upright of the orthosis or the T-strap; iii) Derotation of an externally rotated Tibia; and iv) Tenodesis of the Tendoachilles to the Fibula in the presence of Calcaneus without another transfer available in order to prevent a painful heel.

4) The dangling leg

Where a child has a flail leg and normal upper limbs and trunk and a normal contralateral leg, he may learn to get about remarkably well by using crutches and dangling the affected limb. Leaving the situation as it is has the virtue of economy of medical effort but may not be in the child's best interest. Often such a child can be fitted with an appropriate KAFO and shoe lifts and then learns to walk without crutches. This has the advantage of freeing up his hands for more useful functions, as well as stimulating better growth in length of the flail limb. The bones will become more robust and may result in fewer fractures. The change from crutches and a dangling limb to an orthosis usually requires a period of crutch use and as well as the orthosis. This will appear to the child and the parents as a step backward. This difficult transition may require clever persuasion.

5) Leg length discrepancies

The degree of leg shortening which is acceptable to a child and the parents may depend upon the culture. In the Western world 2 cm is considered a reasonable upper limit, however a far greater leg length difference is usually tolerated elsewhere, especially if surgery is the alternative. It is not surprising to find children with 6 to 8 cm differences who are largely unconcerned and assume the associated limp to be inevitable and are not interested in treatment of the problem.
When evaluating which leg length discrepancies to treat, several factors need to be considered in addition to the shortness of the leg: i) A limb which will always require an orthosis should be left at least 1 cm short to allow for the thickness of the orthosis under the sole of the foot for easier swing through. This is particularly so if the child is to wear a KAFO and has weak lateral trunk muscles so that he is unable to hike his hip enough to allow for the braced leg to swing through, in which case, 2 cm or more shortening may be preferable. ii) An affected limb may be associated with a dysplastic hip. Leaving the leg short can provide added coverage. iii) Other surgery anticipated for in later years should be integrated in the planning. A Triple Arthrodesis may further shorten a foot, as may an Ankle Fusion. By contrast a bone graft for a Grice-Green Subtalar Arthrodesis, if taken from the proximal Tibia,

may give growth stimulation in the Tibia. During these later surgeries, one should consider techniques that increase length, (e.g. adding an Iliac graft between Tibia and Talus at the time of an Ankle Fusion.)
The choice of treatment for a leg length discrepancy is likely to be different in non-Western countries. Small shoe lifts are not usable where sandals or "bare feet" are the custom, and children would rather limp than bother with the encumbrance of a shoe. Conversely, very large cosmetically unattractive shoe lifts may be readily accepted in lieu of surgery. While an epiphyseodesis might be the obvious treatment for many leg length discrepancies in the view of the orthopaedic surgeon, parents may not see the logic of operating on a good limb however much simpler the procedure may be in comparison to lengthening the short leg.
Leg length discrepancies in polio do not necessarily increase in a predictable fashion. A 3 cm discrepancy at age 5 years may not increase. A limb left to dangle may increase in length once weight bearing has been started. For this reason, if lengthening is planned, it is best left until after skeletal maturity is achieved when the exact difference to be made up will be known.
In some cultures (such as Saudi Arabia and parts of India) children do not celebrate birthdays. Age becomes a guess. It is hard for Western physicians who are accustomed to having 3 and 4–year-olds know not only their age but also their exact birthdays to find 10 and 12-year-olds who aren't sure of their age by up to 3 years. The use of Skeletal Age estimates by X-Ray therefore becomes vital.
Leg lengthening capability is spreading worldwide. The parental preference of operating on the affected limb (as different from the normal limb in epiphyseodesis) and the enticing challenge to the surgeon has been proving overwhelming. Although the bones are very thin, they can be lengthened. If there is a choice between lengthening the femur or the tibia, our preference is to choose the tibia if possible since the lengthening apparatus can be removed earlier and replaced with a long leg cast or KAFO that decreases the likelihood of post-lengthening fracture.

6) Hip instability
Although a great deal has been written about regaining hip joint stability after polio, we have found the need for such surgery to be uncommon. As in the treatment of the unstable hip in myelodysplasia, a dislocated hip may not be a significant impairment to function, but multiple surgical attempts to regain muscle balance resulting in hip stiffness can be the cause of great disability. Hip stiffness is much more of a problem in cultures where floor sitting is an important activity of daily living; the very cultures where polio is still rampant.

**The third priority: decrease orthotics**

Once the person is walking with confidence, and anticipated deformities cared for, one may ask, "Can the child be made orthosis-free or can the hardware be decreased?"
This is a controversial issue. Surgeons are more likely to favour the idea of a child undergoing a simple operation to obviate the need for a lifetime of orthosis wearing. Those who are less sanguine about surgery (which may include the child, the parents or any of the other care givers) may preclude such a choice. In addition, where facilities are limited, the option may not be available. The economics in the local situation will determine which route is more cost-effective (i.e. a single operation versus a lifetime of orthosis fabrication and repairs).
The most important antigravity muscles are the Quadriceps, the Hip extensors, and the Gastrosoleus group. A person with absent Quadriceps can walk orthosis-free provided he has Hip extensors, or Ankle plantar flexors (or a block to ankle dorsiflexion secondary to an orthosis or surgical fusion), or a combination of both. These muscles will allow him to maintain the knee in extension so that it becomes mechanically stabilized by the ligaments of the knee that prevent hyperextension. A knee flexion contracture will make the knee unable to support the body in single leg stance by preventing the centre of gravity from coming anterior to the axis of the knee joint.
Consequently the first step is to correct a knee flexion contracture. Contractures cannot be corrected by tendon transfers or by orthotics. In a child under the age of 2 years, contractures can usually be stretched out gradually by Physical Therapy. Older children respond to serial casting, while teenagers will usually require surgery. Any contracture will be improved by casting, but age, degree of contracture, available facilities and the distance the patient has to travel all modify the plan of treatment (see above).

A knee flexion contracture may exist in isolation, but is usually accompanied by contractures about the hip joint. A hip flexion contracture will make it impossible for the child to extend his knee without excessive lumbar lordosis. A contracted Tensor Fascia Lata flexes the knee and twists the Tibia into external rotation and valgus.
If the knee can not be prevented from buckling in single leg stance (due to quadriceps weakness) operations can be chosen which will achieve this. This will depend on the muscles available. Most commonly, an attempt is made to improve push-off by stabilizing the hindfoot and transferring the Peronei and/or the Long Toe Flexors posteriorly into the Os Calcis. If the Tibialis Anterior is present, and the Peronei are to be transferred posteriorly to the Os Calcis, the Peroneus Longus must be left alone if possible or tenodesed to the distal stump of the Peroneus Brevis, otherwise a dorsal bunion can occur.
A strong Hamstring can be transferred anteriorly for knee extension. Transfers of the Hamstrings into the Patella have not proved popular in most societies where polio is still a problem due to the loss of the ability to flex the knee for floor sitting, squatting at a toilet and praying.
In the patient near skeletal maturity, knee extension stability may often be easily obtained by a supracondylar extension osteotomy. This is most effective in a patient who can walk orthosis-free while using a hand to push the thigh posteriorly to keep the knee in extension (i.e. “a Hand Thrust Gait”).
In the absence of ankle planter flexion muscles, a patient may gain sufficient knee stability to discard a KAFO by an Ankle Fusion in slight equinus. If you are unsure of the outcome of such surgery, the child can be tested by fabricating an AFO which fixes the ankle in equinus. The degree of equinus can be adjusted to find an optimal position. A short-leg cast can be used instead of an orthosis but the weight of the cast and the uneven sole may make this a less reliable test. In a child who is skeletally immature and felt to be too young for an Ankle Fusion, the same effect can be gained by a tenodesis of the Tendoachilles to the Fibula (Perry et al.1976). However, this will only be expected to work if the subtalar joint is surgically stabilized either by a Subtalar Arthrodesis in younger patients or a Triple Arthrodesis in older patients.

**The fourth priority: treat the upper limb**

Once a person is walking attention may be turned to the upper limb. While this consensus conference is focused on the lower limbs, a person with the residua of paralytic poliomyelitis cannot be so easily compartmentalized. Classically, the upper limb has been viewed as a mechanism to place the hand in space where it is needed to perform necessary functions. However, this thinking ignores the person’s use of the upper limbs to support the body weight with crutches so that a lower limb orthosis can be used.
Stabilizing a flail shoulder frequently provides a significant improvement in the function of the elbow and the hand. Presumably this is due to the provision of a fixed point against which the muscles activating more distal segments can work. For this reason we prefer to consider the shoulder first.

1) Shoulder

A flail shoulder is a common abnormality in polio. On theoretical grounds, the restoration of function by tendon transfer is clearly more desirable than by fusion and the work of Saha (1967) merits careful consideration. In practical terms however, the most frequent solution for a flail shoulder is fusion. With the Levator Scapuli, the Serratus Anterior and the medial Scapular muscles present, a shoulder fusion can be very beneficial. In order to gain significant arm elevation after a shoulder fusion a strong Serratus Anterior is the most important factor required in order to rotate the scapula.
Our experience has concurred with that of Makin (1977), in that the shoulder should be fused early (between the ages of 6-8) years. The proximal Humeral Physis should be protected since it provides 80% of the growth of the humerus. This is best done by a cruciate incision in the articular cartilage, then peeling the cartilage away from the underlying bone (like peeling the skin off an orange). Fixation is by threaded pins removed at 6-12 weeks. The chance of injury to the proximal Humeral Physis is minimal with this technique. In older patients the A-O technique of plate fixation has proved to be excellent.
The position of fusion has been the source of considerable debate. Earlier experience with the fusion of shoulders in children demonstrated a gradual loss of abduction over the years

after fusion prompting surgeons to recommend that the shoulder in children with polio be fused in 60°+ of abduction. This was a particular problem when fusion was done without internal fixation for fear of damaging the proximal Humeral Physis. With the advent of the use of internal fixation, this has not been a problem so the usually advocated postoperative position is preferred.
It is strongly advised to decide whether a Steindler flexorplasty will be necessary before the decision for shoulder fusion is made. Attempting a Steindler procedure with absence of shoulder external rotation after a shoulder fusion, make the Steindler operation markedly more difficult.

2) Elbow
The function of a normal hand is grossly limited if active elbow flexion is absent. Elbow flexion may be restored in a number of ways: by transferring the origin of the wrist flexors or extensors (or both) proximally (i.e. Steindler Flexorplasty); by transfer of the Pectoralis Major; or transfer of the Triceps forward to the Biceps; or by transfer of the Latisimus Dorsi on its neurovascular pedicle.
Care must be taken not to lose an important function with such transfers. Some elbow flexion contracture will result from any of these operations. Moving the Triceps forward to act as an elbow flexor may cause a loss of elbow stability in extension and thereby loss of the ability to use crutches. Inability to extend the elbow may eliminate the backward reach needed to get to the starting position for wheelchair propulsion. Lack of active elbow extension may result in an inability to stabilize paper on a desk with one hand in order to write with the other. Furthermore, after anterior transfer of the Triceps, elevation of the arm will be less functional if the forearm flops into flexion.

3) Forearm
A pronation contracture of the forearm may cause a functional loss not seen in the West; the person cannot feed himself if he is a member of a culture that eats food with their fingers rather than utensils. In a number of parts of the world, the main eating utensil is the hand, and the hand must be supinated to get food into the mouth. A pronation contracture is best treated by total release of the interosseous membrane (approached volarly) holding the corrected position in a cast for 6-8 weeks and maintaining the correction by physical therapy afterwards.
A supination contracture will allow the child to feed himself, but the absence of pronation means that usual hand work is impossible especially with the advent of the importance of keyboard use. Release of the contracture (approached dorsally) and re-routing of the Biceps Tendon to provide pronation (Zancolli Procedure) can improve function, but the balance between a working hand and a feeding hand must be assessed. The Zancolli procedure should only be used where there is an additional supinator other than the Biceps or else a pronation contracture can result.
In the older child, or an adult, it is sometimes necessary to carry out derotation osteotomies of the forearm to correct these deformities.

4) Hand
Lack of opposition may be dealt with by any of the classic techniques taking care to correct any abduction contracture of the thumb, which may coexist. In crutch walkers, the procedure should be delayed until the patient is able to cooperate, as there is a real concern that the transfer will stretch out. The patients need to understand that crutches cannot be used for at least 6 weeks and then the transfer needs to be protected for a further 3 months by a splint. Even afterwards, the transfer can stretch out with crutch use. Serious consideration should be given to maintaining opposition with an iliac strut graft between the first and second metacarpals rather than with tendon transfers. The same concern should be exercised in patients who are obligate wheelchair users where the thumb may be utilized to rotate the wheel and can stretch out a transfer. Again, the better choice is that of a bone bridge between the first and second metacarpals.
Metacarpal-Phalangeal and Inter-Phalangeal joint contractures may be stretched out with a combination of Physical Therapy and dynamic orthosis, but frequently, release of the MP joints needs to be carried out. Restoration of function in the supple hand is carried out along the principles firmly laid down in a number of hand surgery texts.

**The fifth priority: treat the scoliosis**

General

While this consensus conference is focused on the lower limbs, as in the problems of the upper limb, a person with the residua of paralytic poliomyelitis cannot be so easily compartmentalized. Inappropriate spinal position may make it impossible for a person with lower limb weakness to walk even with good orthoses.

Scoliosis in most people with paralytic polio residuals is focused in the lumbar region. Stabilizing the lumbar spine may decrease (or totally prevent) the patient's ability to walk, whether or not the Sacrum is included. A supple lumbar spine may be necessary not only for forward movement but also lateral "balance". This may be insignificant in a crutch-free and orthosis-free child, but it may be catastrophic in a marginal household walker. Children and parents not warned of this potential difficulty with walking will be justifiably upset if their child stops walking after a spine fusion.

Loss of lumbar lordosis following spine surgery can be a major problem if the hip extensors are weak since there will be no way for the child to lean back and get the mass of their trunk posterior to the hip joints. Every care must be taken to avoid this.

As a general rule, there is little role for orthotics in the treatment of children with scoliosis due to polio. Bracing a lumbar curve often makes walking impossible. Bracing a thoracic curve when the child has no muscles to withdraw from the pressures of an orthosis may lead to sores and further restrict respiration.

When a curve is noted, baseline Anteroposterior and Lateral x-ray should be taken with the patient sitting unsupported, either by his hands or an attendant (who thinks he is being helpful). Standing films can give important information concerning the role played by leg length discrepancy and pelvic tilt, but the variations in lower limb orthosis wear and the degree of spine stretching provided by using crutches to stand makes standing films more suspects. Sitting films will usually be more consistent.

One should look for asymmetric hip abduction contractures. Surgical release of these may be all that is needed to allow the spine to straighten.

Scoliotic spines in children resulting from polio tend to be much more flexible than those seen in Idiopathic Scoliosis. This is particularly evident in children under about 14 years. Thereafter, the curves tend to become rigid quickly. Consequently, an increasing curve seen on upright films (which would ordinarily signal the need for surgery) can often be ignored temporarily in younger children. The indication for surgery becomes not progression alone, but when stiffening becomes evident in a progressive curve. Thus, intermittent bending films can be useful. For an example, an 8-years-old child with a curve which has progressed to 40° but which bends down to 20° may be seen to progress to 60° or even 80° over the next 3 or 4 years, while the bending film still shows the curve reducing to 20°. Surgery at age 12 years will result in a curve no worse than if it had been done at age 8 years, yet the child will be taller and you will have avoided a spine fusion that might necessitate the use of extendable internal fixation with its concomitant complications.

Timing of scoliosis surgery in relation to lower limb surgery

If an older non-walking child is first seen with a severe scoliosis, it is our practice to fuse the spine first, before doing the lower limb releases required for standing. This is based on the observation that getting such an older child up and walking after lower limb releases may take many months, during which time the curve is worsening. Then when the spinal surgery is finally undertaken, the "learning-to-walk" process has to be started all over again after the spinal surgery.

**Summary**

The decisions in the surgical treatment of polio are more difficult than the procedures themselves. Although there are well-established patterns of the disease, each patient is different and one can “never say never”. Hurried decisions are frequently bad; if in doubt, proceed cautiously and in stages.

We have suggested a sequential philosophy of management, but obviously, with experience, various stages may be carried out at the same time.

**References**

WHO. 2004. World Health Organization Web site: http://www.who.int/en/ accessed January 7, 2005

Canale ST (ed). 1987., Campbell's operative orthopedics, 10th edition, Washington C.V. Mosby, pp 1282-1326.

Watts HG, Gillies H. 1992. A practical guide to the orthopedic management of children with the residua of paralytic poliomyelitis. Orthopedics Overseas Publication, Bobit Publishing, NY.

Weston CW, Dingeman RD, Gansewitz SH. 1988. The results of tendoachilles tenodesis to the fibula for paralytic pes calcaneus. J Bone Jt Surg 70A:320-328

Perry J, O'Brian JP, Hodgson AR. 1976. Triple tenodesis of the knee: a soft tissue operation for the correction of paralytic genu recurvatum. J Bone Jt Surg 58A:978.

Asirvatham R, Watts HG, Rooney R. 1991. Tendoachilles tenodesis to the fibula: a retrospective study. J Ped Ortho 11: 652 – 656.

Saha AK. 1967. Surgery of the paralysed and flail shoulder Acta Orthop Scand Suppl.97.

Makin M.1977, Early arthrodesis for flail shoulder in young children. J Bone Jt Surg 59A:317.

**Polio paralysis: discussion about an alternative orthotics solution for post-polio treatment**

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Classical orthotic design for 'polio-paralysis' treatment, is usually made of leather shafts or thermoplastic materials, often incorporates controlled ankle motion by parallel ankle joints, mechanical knee fixation and weight bearing support on the ischial tuberosity. This typical construction confronts the provider with a range of technical challenges but also could carry some disadvantages for the orthosis user due to heavy weight and limited dynamic motion.

This presentation describes the advantages and disadvantages of orthotic management using the classical techniques and offers some potential alternative solutions.

A number of orthotic solutions are discussed in terms of biomechanical and technical aspects while focusing on a potential alternative design which foregoes the classical parallel ankle joints. The design, initially manufactured using carbon lamination technique is described in detail to depict the concept.

The case of a 60 years old patient suffering from the late consequences of an early poliomyelitis, who was fitted with this specific type of orthosis is discussed. Until now he was wearing a conventional system of the HKAFO type. However, as he was a very active orthotics user the old device did not meet his requirements anymore.

The difficulties he felt were described first of all by limited motion due to the orthotic design with its rigid framework and high weight. Also the esthetic aspects were not satisfactory for him.

To answer the demands of the orthotic user in the best manner, different solutions in terms of design ideas and technical constructions were discussed. The preferred concept was the design of a carbon-matrix laminated thin frame, located on the dorsal aspect of the orthosis, forming a Y-shape along the knee area to place the joints, and finally to continue distal dorsally down to the sandal. The connection between the distal knee connection plate and the sandal incorporated a carbon plate that was individually manufactured and fixed with two 8mm screws each at both ends.

Attached to the thin carbon frame are two sleeves made of leather, that cling to the limb and are tightened by a single 50mm Velcro strap distally and a single, diagonally laid 25mm Nylon strap that concludes in a small quick-lock, for the proximal sleeve.

The locked knee-joints were of string-relief design and the unlocking mechanism was constructed based on the classical design for a bicycle brake. The relief string led through a tunnel inside the laminate terminating in an unbolting tool that is usually used for prosthetic designs.

Unfortunately, it was found that this carbon-fiber reinforced orthosis manufactured under normal workshop conditions could not reach the mechanical quality of the Malmö Technique or a solution that uses mild-steel material.

The carbon-plate connection along the Achilles tendon aspect needed permanent controlling and maintenance and also broke regularly. Even though the aesthetics and the excellent control of this light and high flexible orthosis design were greatly appreciated by the orthosis user, the distal carbon plate connection was not durable and carried a permanent risk to safety.

To solve this problem a similar design was manufactured, but instead of using an individual manufactured carbon plate, a flexible spring-steel plate was used to connect the sandal to the dorsal knee platform.

To use flexible spring-steel proved to be the ideal solution. There was no constrains discovered and the spring-steel never broke. This option offered a multi-axial dynamic orthosis without problems.

This design concept was followed up in a case study which applied the same design principles under limited circumstances in Kosovo, using thermoplastic materials while connecting the foot to the calf shell with a dorsally positioned flexible spring-steel blade.

The example given describes the orthotic treatment of a 32 year old patient in Kosovo who is suffering from the late consequences of an early poliomyelitis.

The orthotic shells were manufactured by classical ploypropylene thermoforming and a blocked knee joint with a Swiss lock.

Instead of using classic bi-lateral ankle joints, the sandal of the orthosis was connected to the distal, dorsal aspect of the calf shell by a spring-steel plate. The orthotic user easily adapted to the new orthosis and in this case immediately to the “new feeling”. The patient expressed early on that the dynamic properties of the device and the improved aesthetics were preferably to the regular orthotic device she has previously used. Ongoing case studies at the Kosovo Ortho-Prosthetic Center are underway with the aim to develop a simple system to manufacture definitive orthotics with the dorsal located flexible spring-steel connection.

To conclude, the presented orthotic design carries a great potential not only to facilitate the technical production procedure, but also to increase the mobility and cosmetic demands of an orthotic concept. This prototype still requires further research and field testing in order to develop it into a sustainable design which could be applied in a standardized manner.

## Post-polio syndrome: clinical aspects

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Post-polio syndrome deserves some definition. For purposes of this paper, post-polio paralysis (PPP) will refer to the impairments in individuals who are having weakness as the result of an acute poliomyelitis illness with anterior horn cell damage and consequent motor function loss. Post-polio syndrome (PPS) is a constellation of symptoms in an individual who has had a stable period of several years of disability after an acute poliomyelitis infection and motor weakness. Some argue that these late changes are the consequence of the normal aging on a diseased central nervous system and therefore should not be referred to as a new entity. To the patients who are experiencing a new loss of function after many years of stability these symptoms are very large concerns. To the health care professionals responsibility for caring for these individuals presents new and different challenges. Clearly as this paper will demonstrate PPS is not a new disease, but it is a syndrome of new symptoms.

Many have written extensively about PPS, but I wish to give due credit to one whose writing has helped me in the preparation of this paper. Frans Nollet, MD, PhD is in the Department of Rehabilitation at the Academic Medical Center University of Amsterdam. He has been active in ISPO and contributed to previous educational forums for this organization. I recommend the reader to his work (Nollet and Noppe in print).

One of the first descriptions of late-onset muscle weakness following poliomyelitis was made in 1875 by Raymond. The clinical syndrome which we know today was aptly described at a time when there was little knowledge about the causes of polio. PPS became generally recognized in the 1980s when large numbers of polio survivors of the epidemics in the 1940s and 50s voiced new complaints as they grew older (Halstead and Rossi 1985). After several decades of confusion the diagnostic criteria have been revised as follows (March of Dimes 2001):

1. A confirmed history of paralytic poliomyelitis characterized by an acute illness with fever and a usually asymmetrically distributed, flaccid paresis of a varying number of muscle groups; evidence of motor neuron loss on neurological examination with signs of residual weakness, atrophy, loss of tendon reflexes and intact sensation; signs of denervation or reinnervation on electromyography.
2. A period of partially to fairly complete neurological recovery after acute paralytic poliomyelitis followed by neurological and functional stability for at least 15 years.
3. New or increased muscle weakness or abnormal muscle fatigability (decreased endurance), with or without generalized fatigue, muscle atrophy, or muscle and joint pain.
4. Symptoms usually have a gradual, but sometimes a sudden onset and should persist for at least one year.
5. No other medical diagnosis to explain the symptoms.

Population-based studies have demonstrated that the prevalence of new symptoms in prior polio patients is high. In these studies the onset of new muscle weakness varied between 35 and 58% and new neuromuscular symptoms between 64 and 78% (Ivanyi et al. 1999; Ramlow et al. 1992; Windebank et al 1991). Risk indicators for the development of PPS are more severe initial polio paresis, better recovery from the acute polio, more severe residual impairments, the contraction of acute polio at older age, the number of years elapsed since acute polio, increasing age, and female gender (Ivanyi et al. 1999; Klingman et al. 1988; Ramlow et al. 1992; Trojan et al.1994; Windebank et al. 1991).

Paralytic poliomyelitis develops in 0.1 to 2% of polio virus infections when the virus invades the central nervous system and destroys the motor neurons in the spinal cord causing an acute, usually asymmetrically distributed, flaccid paresis. After the acute paralytic phase,

muscle function usually recovers partially to fairly completely due to extensive reinnervation of denervated muscle fibres through collateral sprouting of axons from motor neurons that survived the acute phase and regained their function. Motor units may increase five to eight times in size (Stalberg and Grimby 1995). Strength also improves because of muscle fibre hypertrophy and fibre areas may increase up to twice the normal size (Einarsson et al. 1990; Grimby et al. 1989). It is assumed that muscle fibre hypertrophy develops in response to the relatively high loads on paretic muscles in performing daily life activities (Grimby et al. 1989). After the recovery phase, the severity and extent of residual paresis, with large intra and inter individual variation, remains stable for decades.

What then is the cause of the new symptoms? The role of aging seems limited since most PPS patients develop new symptoms in their forties, an age range in which normally a physiological loss of motor neurons is not yet suppose to occur (Campbell et al. 1973). Other causes that have been considered include, a persistence of the polio infection, an immune-mediated response, and metabolic demands placed on the larger terminal axons. There remains uncertainty about the validity of the different hypotheses of the patho-physiological mechanism underlying PPS.

No diagnostic tests for PPS are available. Modern imaging techniques have confirmed that loss of muscle mass may be present with out a perceived loss in strength as determined by manual muscle testing. Thus it is important to note that manual strength testing may lead to an overestimation of the individual's capacities. Next to new onset weakness fatigue is one of the most common complaints. This may be due to exertion, but there is some evidence for a biochemical mechanism or abnormal neuromuscular transmitters.

Muscle strength has been shown to deteriorate in patients with PPS but only in studies with at least a four year follow up (Stolwijk-Swuste et al. 2005). No prognostic factors could be identified and the significance of co-morbidities and aging could not be determined.

Between the end of the 19$^{th}$ century and the middle of the 20$^{th}$ century, when large polio epidemics swept across the Western world, physicians were familiar with acute polio, the subsequent forms of recovery and the treatment of residual impairments. Because of the disappearance of acute polio, much of that experience has been lost. Instead the present challenge is to treat large numbers of former polio patients with new neuromuscular symptoms and functional deterioration many years after their acute polio infection.

The prognosis and time course for the progressive loss of function is frequently debated. It has been argued that co-morbid degenerative disorders in the musculoskeletal system are the main cause for functional loss (Howard 2005). In fact both a decline in strength and joint degeneration can occur in the same patient making a distinction of the tow impossible. A better knowledge of the patho-physiological mechanism of PPS is needed.

Pharmacological treatment of PPS has met with little success. Human growth hormone and insulin-like growth factor-1 which promote protein synthesis in muscle cells and axonal sprouting, amantadine, bromocriptine, and selegiline which are centrally acting dopaminergic agonists, high-dose prednisone for its strong anti-inflammatory effect and pyridostigmine which improves neuromuscular transmission, have all been evaluated in clinical trials without conclusive results. Studies may have been inconclusive due to the slow progression of the disease, poor outcome criteria and the heterogeneity of patients. Larger studies of longer duration are needed for a more effective evaluation of potential pharmacologic agents.

PPS is a collection of symptoms without a curative treatment. The only pharmacologic treatment is for symptom control as with analgesics. Management of PPS is aimed at developing an understanding in the patient that they are not getting polio again the notion of which is terrifying and that there are things they can do to adjust their lives to ameliorate the symptoms. Strategies aim at restoring the balance between the decreasing physical capacities and the persistent demands to conduct daily life activities.

The leading concept in treatment is that symptoms of PPS such as muscle pain, increased fatigue after physical activity and delayed recovery following physical activity signify that

muscles are overused in conducting ordinary daily life activities (Bennett and Knowlton 1958; Perry et al. 1988). Support for such a chronic overuse of muscles has been found in studies showing elevated activities of serum creatine kinase that were related to the distance walked during the previous day (Waring and McLaurin 1992),and in studies showing a type I fibre predominance in lower leg muscles supposedly due to fibre type transformation from chronic overload (Borg et al. 1988). Also, PPS subjects have been found to recover slower from fatiguing exercise than stable polio subjects (Agre et al. 1998).

Another factor that is said to contribute to the symptoms is a poor cardio respiratory condition (Dean and Ross 1993; Owen and Jones 1985). However, the cardio respiratory condition of polio subjects was not worse than that of healthy, comparably active subjects Nollet et al. 2001). In this study it appeared that the reduced sub-maximal performance capacity of the polio subjects was strongly correlated with the limited available muscle capacity and that movement economy was diminished compared with the control subjects. Lower concentrations of some oxidative enzymes in muscles of polio subjects have been reported while other oxidative enzymes were within normal ranges (Borg and Henriksson 1991). The clinical significance of these findings has been debated Nordgren et al. 1997).

PPS patients are best treated within a multidisciplinary, specialized rehabilitation setting (Gawne and Halstead 1995). Since individuals show considerable differences in polio residuals, treatment is individually adjusted and should be preceded by a thorough customised medical and functional evaluation. It should be emphasized that PPS is a diagnosis by exclusion and other possible causes to explain the symptoms should be ruled out first. The most commonly encountered neuromuscular problems that can effectively be managed and should not be confused with PPS include radiculopathies, and compression neuropathies, such as carpal tunnel syndrome, ulnar neuropathies at the wrist or elbow, and plexopathies. Compression of nerves may result from the long-term use of wheelchairs, crutches, braces, or poor posture. Orthopaedic disorders are quite common; especially pain from joint degeneration and joint instability, and it may be difficult to distinguish these symptoms from the muscular pain of over use in PPS. Patients with significant joint pain may limit their physical activity, which can lead to disuse weakness and atrophy. It is important to recognize orthopaedic problems as a possible cause for declining muscle function in patients with PPS because appropriate treatment of orthopaedic problems may slow down or arrest the decline in functioning.

To reduce overuse and rebalance capacities and demands, conservative management consists of three essential components: exercise, assistive devices, and life style changes. Exercise can optimise cardio respiratory fitness and may add to the patient's sense of well-being (Jones et al. 1989; Willen et al.2001). Exercise should be non-fatiguing and performed at sub-maximal levels to avoid overloading of the limited muscle capacity. Exercise can improve muscle strength especially in cases of disuse and in muscle groups which are only moderately affected. Intensive strengthening exercises are not generally recommended, although they may occasionally be indicated. Functional training may also be useful to improve the efficiency of ambulation. How must exercise is to right amount? Jackie Perry has been heard to say, “if the exercise induces muscle pain that lasts more than 20 minutes than the person is doing too much.”

Assistive devices comprise crutches, the use of a wheelchair, motorized scooters and home adaptations such as elevators, seating devices in the kitchen or shower. All of these devices should be individually indicated and aim to reduce the physical strain of performing highly demanding daily life activities.

Pacing of activities and taking rest intervals are of paramount importance to relieve symptoms. It has for instance been shown that upper extremity complaints often result from overuse of shoulder and arm muscles (Klein et al 2000). Usually PPS patients have successfully learned to deny their symptoms from childhood on to achieve a normal life (Maynard and Roller 1991). Patients were initially told to ‘use it or lose it’ now they are told to ‘conserve it to preserve it’. Therefore, PPS patients may have great difficulty with adapting their life style to their decreasing abilities and psychological support may be necessary.

Post-polio patients present unique challenges for orthotic management. They require orthoses for walking and standing if muscle weakness causes instability, falling, declining ambulatory ability or pain from overuse (Lord et al. 2002; Perry et al. 1988). Unstable joints due to altered biomechanics from weakness or deformity can also benefit from support. The patients present with two conflicting experiences. Either they have rejected their orthoses at an earlier time having developed compensatory habits or they are so accustomed to their old irons that consideration of a change in prescription is fraught with strong resistance. Patients will make their own 'cost-benefit' decision as to the usefulness of a new prescription. Bracing for prevention of possible negative outcomes rarely is met with acceptance, there must be the feeling that a new prescription optimizes their energy cost of locomotion. The energy cost of walking has been shown to be strongly inversely related to the severity of polio pareses Brehm et al. 2006). Devices may interfere with compensatory habits of walking in patients who are severely involved and therefore not be acceptable.

New devices may improve walking and standing, but might also have a negative effect. They might interfere with functional abilities such as transfers, stair climbing, sitting, or driving a car. Comfort is another consideration. These consequences should all be discussed with the patient before writing a prescription. Success will be met with patients having a high motivation who are falling due to stability problems and who can still adapt their gait pattern to use an orthosis.

In summary, the individual who formerly had post polio paralysis and is now experiencing a new decline with advancing age requires a work up to rule out other diseases. They then will benefit from an altered life style with rest, pacing, a judicious exercise program and perhaps new orthoses but most of all education and understanding.

**References**

Agre JC, Rodriquez AA, Franke TM. 1998. Subjective recovery time after exhausting muscular activity in postpolio and control subjects. Am J Phys Med Rehabil 77:140-144.

Bennett RL, Knowlton GC. 1958. Overwork weakness in partially denervated skeletal muscle. Clinical Orthopaedics 12:22-29.

Borg K, Borg J, Edstrom L, Grimby L. 1988. Effects of excessive use of remaining muscle fibers in prior polio and LV lesion. Muscle Nerve 11:1219-1230.

Borg K, Henriksson J.1991. Prior poliomyelitis-reduced capillary supply and metabolic enzyme content in hypertrophic slow-twitch (type I) muscle fibres. J Neurol Neurosurg Psychiatry 54:236-240.

Brehm MA, Nollet F, Harlaar J. 2006. Energy demands of walking in persons with postpoliomyelitis syndrome: relationship with muscle strength and reproducibility. Arch Phys Med Rehabil 87:136-140.

Campbell MJ, McComas AJ, Petito, F. 1973. Physiological changes in ageing muscles. J Neurol Neurosurg Psychiatry 36:174-182.

Dean E, Ross J. 1993. Movement energetics of individuals with a history of poliomyelitis. Arch Phys Med Rehabil 74:478-483.

Einarsson G, Grimby G, Stalberg E. 1990. Electromyographic and morphological functional compensation in late poliomyelitis. Muscle Nerve 13:165-171.

Gawne AC, Halstead LS. 1995. Post-polio syndrome: Pathophysiology and clinical management. Crit Rev Phys Rehabil Med 7:147-188.

Grimby G, Einarsson G, Hedberg M, Aniansson A. 1989. Muscle adaptive changes in post-polio subjects. Scand J Rehab Med 21:19-26.

Halstead LS, Rossi CD. 1985. New problems in old polio patients: results of a survey of 539 polio survivors. Orthopedics 8:845-850.

Howard RS. 2005. Poliomyelitis and the postpolio syndrome. BMJ 330:1314-1318.

Ivanyi B, Nollet F, Redekop WK, de Haan R, et al. 1999. Late onset polio sequelae: disabilities and handicaps in a population- based cohort of the 1956 poliomyelitis outbreak in The Netherlands. Arch Phys Med Rehabil 80:687-690.

Jones DR, Speier J, Canine K, Owen R, et al. 1989. Cardiorespiratory responses to aerobic training by patients with postpoliomyelitis sequelae. JAMA 261:3255-3258.

Klein MG, Whyte J, Keenan MA, Esquenazi A, et al. 2000. The relation between lower extremity strength and shoulder overuse symptoms: a model based on polio survivors. Arch Phys Med Rehabil 81:789-795.

Klingman J, Chui H, Corgiat M, Perry J. 1988. Functional recovery. A major risk factor for the development of postpoliomyelitis muscular atrophy. Arch Neurol 45:645-647.

Lord SR, Allen GM, Williams P, Gandevia SC. 2002. Risk of falling: predictors based on reduced strength in persons previously affected by polio. Arch Phys Med Rehabil 83:757-763.

March of Dimes Foundation. 2001. Post-poliosyndrome: identifying best practices in diagnosis and care. White Plains (NY), March of Dimes.

Maynard FM, Roller S. 1991. Recognizing typical coping styles of polio survivors can improve re-rehabilitation. Am J Phys Med Rehabil 70:70-72.

Nollet F, Beelen A, Sargeant AJ, de Visser M, et al. 2001. Submaximal exercise capacity and maximal power output in polio subjects. Arch Phys Med Rehabil 82:1678-1685.

Nollet F and Noppe CT. In print Orthoses for persons with post polio syndrome, Chapter 33, Atlas of Orthotics and Assistive Devices, Elsevier, Philadelphia.

Nordgren B, Falck B, Stalberg E, Ronquist G, et al. 1997. Postpolio muscular dysfunction: relationships between muscle energy metabolism, subjective symptoms, magnetic resonance imaging, electromyography, and muscle strength. Muscle Nerve 20:1341-1351.

Owen RR, Jones D. 1985. Polio residuals clinic: conditioning exercise program. Orthopedics 8:882-883, 1985.

Perry J, Barnes G, Gronley JK. 1988. The postpolio syndrome. An overuse phenomenon. Clin Orthop Relat Res145-162.

Perry J, Fontaine JD, Mulroy S. 1995. Findings in post-poliomyelitis syndrome. Weakness of muscles of the calf as a source of late pain and fatigue of muscles of the thigh after poliomyelitis. J Bone Joint Surg Am 77:1148-1153.

Ramlow J, Alexander M, LaPorte R, Kaufmann C, et al. 1992. Epidemiology of the post-polio syndrome. Am J Epidemiology 136:769-786.

Raymond. 1875. Note sur deux cas de paralysie essentielle de l'enfance. Gaz Med Paris 225-226.

Stalberg E, Grimby G. 1995. Dynamic electromyography and muscle biopsy changes in a 4-year follow-up: Study of patients with a history of polio. Muscle Nerve 18:699-707.

Stolwijk-Swuste JM, Beelen A, Lankhorst GJ, Nollet F. 2005. The course of functional status and muscle strength in patients with late-onset sequelae of poliomyelitis: a systematic review. Arch Phys Med Rehabil 86:1693-1701.

Trojan DA, Cashman NR, Shapiro S, Tansey CM, et al. 1994. Predictive factors for post-poliomyelitis syndrome. Arch Phys Med Rehabil 75:770-777.

Waring WP, McLaurin TM. 1992. Correlation of creatine kinase and gait measurement in the postpolio population: a corrected version. Arch Phys Med Rehabil 73:447-450.

Willen C, Sunnerhagen KS, Grimby G. 2001. Dynamic water exercise in individuals with late poliomyelitis. Arch Phys Med Rehabil 82:66-72.

Windebank AJ, Litchy WJ, Daube JR, Kurland LT, et al. 1991. Late effects of paralytic poliomyelitis in Olmsted County, Minnesota. Neurology 41:501-507.

# Cerebral palsy: clinical aspects

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## Introduction

Cerebral palsy is characterized by an aberrant control of movement which appears early in life secondary to damage upon the developing central nervous system. It is non-progressing, but with the passage of time often a changing motor impairment syndrome. The spastic variety is most common. Spasticity or muscle hypertonus is characterized clinically by an increased resistance to passive movement, brisk deep-tendon reflexes, reduced range of movement and clonus. Spasticity is also associated with some degree of weakness, abnormal posture and movement patterns, and a tendency to develop musculoskeletal deformities. Initially conceived of as an orthopaedic deficit with a neurological basis, cerebral palsy has become recognised as being responsible for multiple disabling conditions requiring the attention of many specialties and services (Sherzer 2001).

In addition to problems with movement and posture, most children with cerebral palsy have at least on additional disability associated with damage to the central nervous system. The most common of these associated deficits are cognitive impairments, sensory deficits, communication disorders, seizures, feeding problems, bladder dysfunction, drooling, behaviour, and emotional problems (Vles and deLouw 2000). In general the more the motor system is affected by spasticity the greater the likelihood that other systems will be involved. Sensory impairments include hearing loss, vision difficulties and poor proprioception. Seizures occur in 70% of individuals over their life time. Feeding problems affect growth and development more than any other factor and frequently leads to aspiration and chronic pulmonary fibrosis. Bladder dysfunction is present on a neurological basis in 60% of individuals and drooling is a problem with between 25% and 60% of children.

The incidence of cerebral palsy in countries which have been keeping statistics has stabilized at 2-2.5 per 1,000 live births. The advent of modern neonatal intensive care units has only served to keep alive many infants who are at high risk of involvement (Hagberg et al. 2001). They have increased the prevalence. Some 50% of neonates born at or below 1500 g will have central nervous system damage. Of interest is the fact that MRI studies indicated that related cerebral lesions (periventricular leukomalcia and parasagital damage) were as common in term as in preterm infants. What is certain is that perinatal infant trauma (neonatal asphyxia) as a cause occurs in the minority of affected children (Taylor 2001).

## The team approach

The team approach is a patient centred process of providing care for the child having cerebral palsy. A child having a few or having many of the associated impairments from cerebral palsy requires many different services. Few disabilities deserve the team approach more. Traditionally the team leader has been the orthopaedic surgeon since the motor function disabilities have been most apparent (Bleck 1987). There has been an ever increasing awareness for how all of the other associated impairments have an impact. The most common cause of increased spasticity is a nociceptive input. Pain or discomfort from constipation, gastric reflux, bladder infection, or an ill-fitting orthosis can frequently have an influence on tone more so than the underlying pathology. The total child must be considered. To function best as a team those caring for the disabled child require not leadership but true collaboration. The patient is the centre of the team with the family or care providers closely behind in importance. The priorities for the individual of improved function must drive the priorities of the team approach.

## Medical and surgical management

Perhaps the largest contribution in recent times to the care of children having cerebral palsy and for that matter adults as well, has been the development of interventions which can influence their spasticity. Dorsal rhizotomy, Botulinum Toxin-A (Botox), Baclofen and other GABA agonists are being used with ever increasing frequency.

Selective dorsal rhizotomy is a surgical procedure by which a chosen number of afferent nerve roots are cut to decrease the input from the muscle spindle and thus reduce tone. In a few centres with appropriate technologies and surgical experience and in selected this intervention has proven very effective.

Botulinum Toxin A (Botox), a neuromuscular blockade, is a toxin produced by *Clostridium botulinum* that affects the neuromuscular synapse by inhibiting the release of acetylcholine thus directly decreasing muscle tone. The use of Botox in the management of paediatric gait disorders is now widely accepted.

Gage (1991) has advised that, whenever possible, surgical intervention should be postponed until gait is mature. The disabling effects of spasticity can be mitigated with the use of Botox thus avoiding contractures and functional difficulties until an age is reached when the most appropriate surgical recommendations can be made. Botox can facilitate orthotic management when spasticity would interfere with joint control (Creedon et al. 1997). From functional and clinical post-treatment evaluations, it is clear that the earlier Botox treatment is started, the better the outcome is likely to be (Cosgrove et al. 1994). The general indication for Botox injections is 'the presence of a dynamic contracture, interfering with function, in the absence of a fixed myostatic contracture' (Boyd and Grahm 1997). Combining Botox injections with casting corrects muscle contracture to some extent. However, Botox injections should mainly be used to prevent contractures and a number of studies have demonstrated that injections of Botox, together with post injection physical therapy and orthotic management, improve function and may favourably influence the pathological process (Grahm.et al. 2000). Because repeated Botox injections can help to prevent the development of muscle contractures and bony deformities if started at an early age, such a treatment approach may lesson the complexity of future surgery and may help delay surgery until the optimal timing is achieved. Botox treatment can not be viewed in isolation, as it is only one aspect of an integrated approach to the multidisciplinary treatment of children with cerebral palsy.

The other medication which has had a major impact on the medical management of spasticity is Baclofen. Baclofen is a GABA B agonist and thus acts directly as an inhibitory substance at the spinal cord level to reduce the spastic reflex. When given orally it can be very helpful but often causes intolerable side effects before it reaches a therapeutic level in the central nervous system. Although it has been available for intrathecal administration for many years, it was approved for use in cerebral palsy in children in the mid 1990s. The technology has improved so that intrathecal pumps deliver therapeutic doses of Baclofen from reservoirs that require refills three times a year and will operate for as long as five years without needing a battery change. The use of a Baclofen intrathecal pump is not without complication. They may occur in as many as 10% of patients. Decreasing spasticity is often not sufficient by its self. Patients may have secondary deformities that require orthopaedic attention. The upper motor neuron syndrome also has negative effects that may be unmasked by Baclofen. Underlying weakness is one such difficulty, poor motor control is another. Before undertaking a program of intrathecal Baclofen therapy a patient requires a thorough team evaluation followed by appropriate goal setting. Just the reduction in tone as a goal is insufficient; outcomes should be based on functional criteria.

**Casting**

Casting enjoyed a strong popularity several years ago with some early evidence that it could influence tone. Follow-up studies have failed to give evidence that it could produce any lasting benefit (Crenshaw et al. 2000). There is, however, another role for casting. To understand it, consideration needs to be given to what is occurring with in the muscles and joints of an individual having spasticity. The characteristic of tone which all muscles possess is difficult to define. It is the combination of the background electrical or excitatory activity and the inherent

viscosity of the connective tissue. It is characterized as being increased, hypertonia, low, hypotonia or normal. Perhaps it can be thought of as the idling speed of the muscle. It is a non-velocity dependent resistance to passive joint movement. Tone can be observed during slow passive stretch of a muscle after maximal relaxation in counter distinction to spasticity which is a velocity dependent resistant to stretch. Hypertonia can be caused by changes in the biomechanical properties of the muscle without increased EMG activity. Increased stiffness can be caused by a change in the connective tissue (muscle shortening), but also by a change in stiffness within the muscle fibres themselves. Increased tone can contribute to an increase in cross-bridging of the muscle filaments.

The development of muscle shortening is a well known phenomenon in clinical practice. Nevertheless, this aspect of change in muscle function in upper motor neuron syndrome has received little attention in research. Muscle shortening takes place in the muscle belly. A form of physical therapy call Rolfing which is popular in some countries and casting have been applied to address is shortening. There is little support of the former in the literature and only Grade III support for the later.

Casting can be applied to either the upper and lower limbs to improve range of motion. It is done in a serial fashion by therapists, surgeon or anyone trained in the careful application of plaster dressings. Weekly or biweekly cast changes are done for between three and four castings. Range of motion activities are necessary then to avoid cast induced stiffness and pain. Casting may restore range in order to prepare a patient for bracing, but his too has its limits.

**Orthotic indications**

As stated in the ISPO Consensus Conference on the Orthotic Management of Cerebral Palsy (ISPO ), orthotic treatment can be indicated for one or a combination of four desired outcomes; to prevent and /or correct deformity; to provide a base of support; to facilitate training in skills; to improve the efficiency of gait. All of these are valid reasons for undertaking orthotic management in treating patients with cerebral palsy.

Perry and Gage have developed five attributes which help in appreciating where efforts can be directed when treating an ambulatory patient with cerebral palsy. They are, stability in stance, clearance in swing, pre-positioning the foot in terminal swing, adequate step length and energy conservation. Stability in stance aids in balance and the reduction in proprioceptive feed-back which challenges a poorly integrated central nervous system. Adequate clearance in swing insures that a child will not be tripping due to a plantargrade foot. Pre-positioning of the foot in terminal swing is important so that at heel strike the foot is in the proper position to accept weight loading and adequate step length is necessary or an individual will not be able to get from here to there. Energy conservation as measured by Oxygen consumption is the anticipated benefit of improving functional gait by addressing all of the other attributes. Consider these attributes when evaluating an ambulatory patient with cerebral palsy. A functional approach to orthotic prescription writing, addressing impairments in the above attributes of gait will help ensure better functional outcomes from an intervention and will work to improve ambulation. Orthoses may not be the only answer, but a functionally based approach rather than a deformity based approach is guaranteed to lead to a better outcome. Vernon Nichol once said, “Functional gait is 30 feet in 50 seconds.” Thirty feet is the distance across a street and 50 seconds is how long the light remains green.

**References**

Bleck EE. 1987. Orthopaedic management in cerebral palsy. MacKeith Press, London pp142-212.

Boyd R and Grahm HK. 1997. Botulinum toxin A in the management of children with cerebral palsy: indications and outcome. Eur J Neurol 4:S15-S22.

Cosgrove AP, Corry IS, Grahm HK. 1994. Botulinum toxin in the management of the lower limb in cerebral palsy. Dev Med Child Neurol 36:386-696.

Creedon SD, Dijkers MP, Hinderer SR. 1997 Intrathecal Baclofen for severe spasticity: a meta-analysis. *The Cochrane Library*, *issue 2, 2000. Oxford: Update Software.*

Crenshaw S, et al. 2000. The efficacy of tone-reducing features in orthotics on the gait of children with spastic diplegic cerebral palsy. J Pediatr Orthop 20:210-6.

Gage JR. 1991. Gait analysis in cerebral palsy. MacKeith Press, London

Grahm HK, et al. 2000. Recommendations for the use of Botulinum toxin type A in the management of cerebral palsy. Gait and Posture 11:67-79.

Hagberg B, Hagberg G, Beckung E, Uvebrant P. 2001. Changing panorama of cerebral palsy in Sweden. VIII Prevalence and origin in the birth year period 1991-94. Acta Paediatr 90(3):271-277.

Scherzer AI. 2001. History, definition and classification of cerebral palsy. In: Early diagnosis and intervention therapy in cerebral palsy. 3rd Edition. Dekker Inc: Basel. pp1-25.

Taylor F. 2001. National Institute of Neurological Disorders and Stroke (US), Office of Science and Health Reports. Cerebral palsy: hope through research. Bethesda, Md: Th Institute.

Vles JSH, deLouw A 2000. Associated disorders in static encephalopathies of infancy and childhood. The upper motor neuron (UMN) or corticofugal syndrome. In: Kinderneurologie, Maastrich ISBN 90-9014173-1.pp17-25.

# Cerebral palsy: orthotic aspects

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In cerebral palsy, muscle growth is reduced in the presence of spasticity. Subsequently, deformities may develop. The goal of lower limb orthotic management is to control abnormal and excessive muscle activity which can lead to deformities and causes biomechanical abnormalities during stance and walking. The specific objectives are: (1) to prevent and/or correct deformity, (2) to provide a base of support, (3) to facilitate training in skills, and (4) to improve the dynamic efficiency of gait. Recent findings in lower limb biomechanics, soft tissue adaptation and motor learning also support the use of orthoses in conjunction with therapy to achieve various aims (Condie and Meadows 1995).

Ninety-one percent of children who have cerebral palsy present with spasticity (Barnhart and Liemohn 1995). A "hemiplegic" patient has unilateral flexion of the upper limb and marked equinus of the foot and ankle. A "spastic-diplegic" has bilateral abnormal hip flexion, adduction, and internal rotation along with flexed knees and equinus at the feet and ankles. A "quadriplegic" has the whole body affected, either spastic and/or athetoid, and is often dominated by extensor patterns (James and Sharon 1990).

Nearly half of the children with cerebral palsy are spastic diplegia. Although 90% of them achieve ambulatory status, most children are unable to stand with good balance. Anteverted femoral alignment, excessive hip adduction and internal rotation, as well as flexion contractures are often found. When the child walks, the limbs are internally rotated. The ankle equinus causes a toe-walking pattern with excessive knee hyperextension moments. In case of hypotonicity, the child walks with a crouched gait. The ankle is excessively dorsiflexed and the knee is extremely flexed. Walking with this gait pattern increases metabolic costs. Spastic diplegic children ambulate at 31% efficiency when compared to normal children (Damiano and Abel 1996; Campos et al. 1994).

Orthotic intervention for children with cerebral palsy may be considered as relating to three levels of function: pre-standing, standing and walking (Condie and Meadows 1995). The objectives of orthotic intervention for the pre-standing child are to minimize or prevent deformity and hence maintain joint ranges of motion and to achieve trunk control and thereby sitting balance, thus promoting upper limb function and allowing the child to interact with the environment. There is an additional objective, to facilitate the standing child to achieve efficient balanced standing by providing the minimum appropriate support and thus creating an environment within which it will be possible to develop optimum strategies. The walking child should also be facilitated to attain efficient purposeful gait by facilitating desirable patterns of motion and resisting undesirable joint patterns of motion, thereby allowing the child to participate in activities of daily living.

The information which is required to determine the appropriate orthotic intervention includes: (i) the medical history, (ii) the diagnosis, (iii) the functional gross motor status and hence any specific motor or sensory impairments, (iv) skeletal abnormalities, (v) the home, school and other environment, (vi) the behavioural features, (vii) the standing posture, (viii) a balance assessment, and (xi) a gait assessment (Condie and Meadows 1995). The Gage criteria (Gage 1991) for efficient gait are recognized as an appropriate tool for gait assessment.

The criteria are:

(i) Stability of the supporting leg during stance phase: requiring an appropriate foot-floor contact area, minimizing the external moments acting on the knee, and creating adequate hip abduction power to prevent the pelvis dropping on the unsupported side.

(ii) Clearance on the foot from the ground during swing phase: requiring adequate hip and knee flexion and ankle dorsiflexion of the swinging limb.

(iii) Appropriate prepositioning of the limb at the end of swing phase: created by knee extension and ankle dorsiflexion.
(iv) Achieving an adequate step length: by hip extension of the stance limb and unrestricted advancement of the swinging limb.
(v) Conservation of energy expenditure through reduced excursion of the centre of mass of the body.

Orthotic devices for children with cerebral palsy can be ranged from different kinds of positioning, sitting, standing, head and trunk, upper limb and lower limb orthoses. The use of orthoses for resting to prevent muscle contracture is common in cases where the child is severely affected and mobility is not possible. Special seating designs are also applied to provide trunk and limb support for those who spend long periods in wheelchairs. The area of lower limb orthotics has a more dominant role in the standing and walking functions, though not limited. The lower limb orthoses should be fitted with appropriate shoes to achieve the functions required. The shoe should have an upper of sturdy construction, with wide toe box and extra depth to accommodate the orthosis, a non-slip sole and a secure closure.

External shoe alternation can be tried as the initial intervention. A raised sole shoe is used to accommodate leg length discrepancies. Heel lifts are applied to accommodate ankle plantar flexion contracture and minimize knee hyperextension through mid-stance. Medial or lateral sole wedges aim to compensate foot varus or valgus. Flares and buttresses are used to enhance stability.

Foot orthoses improve the condition either through ground reaction force control or 3-point pressure control. They are prescribed to control foot alignment, as well as subtalar, mid-foot and forefoot instability or deformities. The foot that is lacking of voluntary dorsiflexion control, with moderate to severe spasticity, or with fixed equines is contraindicated for the use of foot orthoses. The function of an orthoses is depended on the material used and the trim line designed.

Ankle-foot orthoses (AFOs) are applied to: (i) control joint motion, (ii) redistribute load acting on a joint, (iii) control spasticity/contracture, (iv) affect limb alignment, (v) induce external moment to proximal joints and (vi) enhance stability.

Non-articulated AFOs with an anterior opening are prescribed to children with: (i) poor balance or instability in stance, (ii) inability to transfer weight onto affected leg in stance, (iii) moderate to severe foot abnormality, (iv) moderate to severe hypertonicity, (v) mild genu recurvatum or instability. An articulated AFO is prescribed to children with: (i) ankle dorsiflexor weakness only, (ii) passive or active range of ankle dorsiflexion, (iii) a need for ankle dorsiflexion for sit-to-stand or stair climbing. A dorsiflexion stop is required to control knee flexion instability and a plantar flexion stop is required to control knee hyperextension. Supramalleolar orthoses (SMO) that allow controlled ankle movement are prescribed to children with mild spasticity. The SMO is less effective than an AFO in controlling plantar flexion angles (Condie and Meadows 2004).

Foot deformities are common in bilateral spastic cerebral palsy. Foot orthoses in combination with appropriate footwear may be sufficient to enhance stability, improve load bearing capacity of the foot, prevent deformity and assist function. More complex cases may require the use of AFOs. An AFO is prescribed for equinus deformities in cases with little or no mediolateral ankle foot misalignment.

In children with hemiplegia, inversion, varus and equinus often develops as a result of the spasticity of the tibialis posterior muscle. An articulated or non-articulated AFO adequately controls mild to moderate plantar flexor spasticity and provides toe clearance (Buckon et al. 2004). An articulated AFO is prescribed in cases where passive dorsiflexion attains a minimum of 10°. The articulated device allows dorsiflexion during the stance phase when the ground reaction line imposes a dorsiflexion moment about the ankle. An SMO can be applied for mild spastic cases.

Genu recurvatum is more frequent in diplegia and quadriparesis than in hemiplegia. It may be unilateral or more severe on one side, as spasticity is rarely symmetrical. The knee hyperextension is secondary to the equinus position of the ankle. A dorsiflexed AFO (5-10° dorsiflexion) will encourage knee flexion and assist in overcoming the hyperextension moment. It is rare to apply a knee-ankle-foot orthosis (KAFO) to control knee alignment in the sagittal plane in cerebral palsy. Hyperextension of the knee should be initially considered with AFO intervention. In most cases, a KAFO is used initially to facilitate gait training and is disregarded when sufficient progress is achieved. Crouch gait, which is presented with an exaggeration of abnormal hip and knee flexion, can be improved with the application of floor reaction ankle-foot orthoses (FRAFO) with limited ankle dorsiflexion (Betsy 1995; Gabriella 1995). The orthosis exerts an extension force through the pre-tibial shell to affect the knee.

The adductor tone in children with diplegia and quadraplegia is increased. The children walk with a narrow base or adopt a scissor gait. In severe cases, the children cross their legs and have great difficulty to develop a consistent motion pattern. It is difficult to attain toe clearance as the feet are in an equinus position. The bodyweight is mostly supported on the toes or forefoot. Genu valgum is usually a secondary deformity induced by the overactive hip adductors. Additional deforming forces can be induced by tight hamstrings and an equinovalgus foot. Knee orthoses are of little value as the origin of the problem is hip related. A hip orthosis, consisting of a pelvic section and two thigh portions joined by sidebars is required to control the adduction motion. Ideally, the orthotic hip joints should allow free hip flexion and extension and abduction but limit the degree of adduction.

Rotational deformities of the hip can be reflected by an in-toeing gait pattern. The orthosis applied should be able to generate externally rotated force to counter the internal rotated hip movement. The use of conventional hip-knee-ankle-foot orthosis (HKAFO) would impose excessive restraints on the degree of movement at other sites. Derotational orthoses or twisters can be used. The devices may be fabricated with metal or plastic material. The device should consist of a hip section and long cables which descend on the lateral surface of each leg, with anchoring points at both above the knee and the leg/foot regions so that the external rotating force generated by the torsion cables are transmitted to the hip joint. The effectiveness of the orthosis is questionable and is now not commonly prescribed. New versions of the orthosis are made of fibre material.

The appropriate prescription of an orthotic intervention depends on an accurate assessment and its result. The approach to stabilize the distal joint of the lower limb joints to control proximal joint motion is supported. It is believed that “static” positioning is less effective than the “dynamic” application of force in preventing or correcting deformities. The evidence for a specific tone reducing or tone inhibiting effect of an orthosis is inconclusive; however, it is clear that a close fit with accurate anatomical contouring will optimize the function attainable. Orthotic care cannot be effective if it is provided in isolation. Orthotic intervention and other related treatment/intervention have to be fully coordinated if an optimum outcome is targeted (Carlson et al. 1997; Crenshaw et al. 2000; Romkes 2002; Condie and Meadows 1995; Lam et al. 2005).

**References**

Barnhart RC, Liemohn WP. 1995. Ambulatory status of children with cerebral palsy: a retrospective study. Perceptual and Motor Skills 82:571-574.

Betsy K.D et al (1995). Rehabilitation of congenital and developmental conditions in children. In: Sammarco GJ (ed). Rehabilitation of the foot and ankle. St. Louis: Mosby Year Book Inc. pp.173-188.

Buckon CE, Thomas SS, Huston SJ, Moor M, Sussman M, Aiona M.2004. Comparison of three ankle-foot orthosis configurations for children with spastic diplegia. Devel Med Child Neur 46:590-598.

Campos da Paz A, Burnett SM, Braga LW. 1994. Walking prognosis in cerebral palsy: a 22-year retrospective analysis. Devel Med Child Neur 35:130-134.

Carlson W, Vaughan C, Damiano D, Abel M. 1997. Orthotic management of gait in spastic diplegia. Phys Med Rehabil 76(3): 219-225.

Condie DN, Meadows CB. 1995. Conclusions and recommendations. In: Condie DN, Meadows CB (eds). Report of a Consensus Conference on the Lower Limb Orthotic Management of Cerebral Palsy. Copenhagen: International Society for Prosthetics and Orthotics. pp15-19.

Condie E, Campbell J, Martina J. 2004. Conclusions and recommendations. In: Condie E, Campbell J, Martina J (eds). Report of a Consensus Conference on the Management of Stroke Patients. Ellecom, The Netherlands: International Society for Prosthetics and Orthotics.

Crenshaw S, Herzog R, Castagno P, Richards J, Miller F, Michaloski G, Moran E. 2000. The efficacy of tone-reducing features in orthotics on the gait of children with spastic diplegic cerebral palsy. J Pediatr Orthop 20(2):210-216.

Damiano DL, Abel MF. 1996. Relation of gait analysis to gross motor function in cerebral palsy. Devel Med Child Neur ;38:389-396.

Gabriella, E. M. 1991. Orthotics management of children. In: John BR (ed). Orthotics: clinical practice and rehabilitation technology. New York: Churchill Livingstone Inc. pp137-170.

Gage JR. 1991. Gait analysis in cerebral palsy. London: MacKeith Press.

James PR, Sharon HV. 1990. Coordinated treatment in cerebral palsy; where are we today? JPO, 2(1):68-81.

Lam WK, Leong JCY, Li YH, Hu Y, Lu WW. 2005. Biomechanical and electromyographic evaluation of ankle foot orthosis and dynamic ankle foot orthosis in spastic cerebral palsy. Gait Posture 22:189-197.

Romkes J, Bruner R. 2002. Comparison of a dynamic and a hinged ankle-foot orthosis by gait analysis in patients with hemiplegic cerebral palsy. Gait Posture 15:18-24.

**Plenary Discussion "Lower limb orthotics practice - Polio"**

**Chair: Mel Stills**

**Rapporteur: Jo Nagels**

## Discussion

***Polio paralysis: orthopaedic aspects***

Diagnosis and prescription was extensively debated. Prescription can only be carried out on basis of a diagnosis. If there is not a full clinic team, e.g. no doctor, the education of the orthotist should be increased in order for them to have the capacity to prescribe.

The "team" needs to be brought into the right perspective. The example of playing cards was given, whereby one has a team with equal players who act according to an established set of rules. A football team served as a second example with an attacker, mid-field and goalkeeper. Different players who all form part of a team and importantly, are coached in to do different jobs.

It was suggested by Fisk that medical diagnosis and functional diagnosis should not be done by an orthotist who does not have the clinical know-how to make a diagnosis. An orthotist is required to understand the diagnosis and prescribe the orthosis. It was also commented that there are less orthotics clinicians available compared to orthopaedic surgeons.

Far too often policymakers do not know what rehabilitation is. Mainstream prosthetics and orthotics needs to be included in all Ministries of Health. How can WHO influence the awareness when WHO has only 3 staff in their headquarters? Resources from WHO must be combined with those from ISPO.

**Polio paralysis: orthotic treatment**

Thinking outside the "box" was considered by the group to be a positive initiative.

It was considered important that efforts to improve aesthetics should not be ignored.

In discussing one of the designs presented it was suggested that possibilities to use metal springs in orthotic designs might be restricted by availability of materials. The "thickness" of materials needed to be better identified.

**Post-polio syndrome: clinical aspects**

Watts indicated that polio is not a brain disease but a central nervous deficiency. It is a lifetime disease that currently focuses too much on children without considering developmental levels for the middle-aged and elderly patient. Polio sequelae is considered to be polio paralysis but not post-polio syndrome.

Khasanabis indicated that polio is not a lifetime "disease". The word "disease" seemed an inappropriate choice of word, it was suggested that polio should be considered a lifetime "condition" instead.

From the user point of view it was indicated that surgery did not prevent orthotic bracing because after a while the next joint gets "affected".

Regarding leg lengthening or leg shortening of the sound leg the psychological consideration of being a smaller person cannot be ignored.

**cerebral palsy: orthotic aspects**

Two to three out of one thousand children in the US is born with cerebral palsy. It is too often true in developing countries that people present to clinics too late, when severe complications have already occurred. Often orthotic treatment or "orthotic control" does not result in the most adequate outcome. Orthoses should be prescribed only when control of function is a possibility. The physical therapists point of view was that too much focus is on function and not enough on weakness.

Dr Watts indicated that the cost of Botox and vertebral inserts is expensive. Low cost interventions such as phenol and alcohol was not considered an option as with alcohol treatment, if any mistakes are made, there is no return of function and phenol injections are considered an operation intervention. But lobbying for a cheaper Botox injections should be seriously considered.

Countries with a high child mortality rate such as Angola have a small CP caseload. Hong Kong also has few CP cases.

It was suggested that people with CP eventually stop using orthoses; adults get tired of the device. Ambulation, education and communication are the three main factors. to be considered.

Some discussions regarding bracing were raised. The main comments were that there is no scientific evidence of the effectiveness of prescribing and using AFOs. Nevertheless, the subjective feedback is that the child is "happier" when the AFO permits a greater range of motion. Parents are desperate and anecdotal evidence can be based on bias. The topic of AFO prescription seems to be an area for future research.

Japanese encephalitis as a cause of CP was mentioned. What is identifiable as cause is the creation of CP in the immature brain Fever induced CP after birth has a better prognosis since there might be a neurological memory. CP will not go away, and needs to be controlled

# Clubfoot: clinical aspects: conventional approach and serial casting

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## Introduction

The term "clubfoot" (also known as talipes equinovarus) can refer to several conditions. Usually it refers to a congenital condition where the ankle is in equinus, the subtalar joint is in inversion and there is mid-foot varus and supination through the talonavicular joint. The features of the mid-foot varus have, in the past, been incorrectly referred to as "forefoot".

A clubfoot can be:

-*part of a syndrome:*
Freeman-Sheldon; Diastrophic dwarfism; Larsen's; Smith-Lemli Opitz
-*associated with other conditions*:
Myelodysplasia
-*can be "teratogenic"* in that the foot has multiple abnormal parts.

For this discussion, we are referring to the Idiopathic Congenital Clubfoot, which is not part of another syndrome.

There is also another condition known as "Metatarsus Adductus" or "Metatarsus Varus" which is sometime erroneously described as being "one third of a clubfoot". That condition is separate, and is not what we are evaluating at this conference.

### *Incidence*

The clubfoot deformity is seen worldwide. The incidence is usually given at approximately 1 per 1000 births.

## Etiology

The etiology is not known. While there are a number of hypotheses, none provide a total explanation.

Because the etiology is unknown the various hypotheses have led to a variety of focuses to attempt correction:

- Lloyd Roberts: Talus externally rotated in the ankle mortise ("the horizontal breach") (Carroll 1990).
- Goldner: Talus internally rotated in the ankle mortise.
- McKay (1979): Introduced the concept of "medial spin" of the os calcis under the talus (the current view of the pathomechanics of clubfoot) (McKay 1982; 1983).

## Treatment

*Non-surgical: manipulation and orthoses*

Earliest written description: Hippocrates 460-377 (Carroll 1990)
Nicolas Andry: Orthopaedia 1743: wet dressings to loosen ligaments, daily manipulations and subsequent splinting.

The basic process has been the manual manipulation to *achieve* correction and some means to *maintain* the correction gained by the manipulation (sandbags for Hippocrates; fixation splints of cardboard, wood and iron for Andry; plaster casts and orthoses in recent centuries).

Manipulation was always stressed as being “gentle” until the advent of “forceful manipulation” in the 1890s culminating in the use of the infamous Thomas wrench. Since then, manipulation has returned to the gentle version although some have advocated using wedging casts that are more forceful.

Jean Andre Venel (1740-91) designed a boot to correct clubfoot (Carroll 1990).

Denis Browne devised his very popular “splint” in 1930. Various “corrective” shoes and braces have been developed: While there have been many attempts to gain correction with orthoses, the usual opinion has been and still is that correction requires some other means and the orthoses are used for maintenance of the correction.

In the USA in the 1930s Dr. J. Hiram Kite of Atlanta, Georgia, (Kite 1939) popularized serial manipulation to gain correction which was then maintained in a plaster cast. For newborns, the plaster casts were often replaced by adhesive tape. He urged that treatment be started as close to birth as possible. He even joked that if the baby was arriving by breech presentation, the feet should be manipulated while waiting for the head to deliver. Manipulations were repeated frequently (every one or two days in newborns, to weekly in older infants). He divided the manipulation into steps to correct what he considered to be separate components of the deformity. He directed his attention first to the forefoot adduction, then heel varus, then equinus. Cavus was not addressed and his method tended to aggravate cavus by pronating the forefoot on the hindfoot. In the USA, orthopedic surgeons usually performed the treatment, although in some institutions, physical therapists did the treatments.

Kite’s method became the worldwide standard. However, the time required for correction was often prolonged, and frequently resulted in only partial correction. Recurrences were commonly noted, and long-term results often showed bony distortion, especially flattening of the talar dome, due to excess pressure.

By 1993 manipulation followed by casting was almost given up (Zimbler 1993). Simon’s book “The Clubfoot” (Simons 1993) (in which he reviewed a world conference on the subject) consisted of 587 pages only 9 of which were devoted to non-surgical treatment (bracing: 4 pages; cast treatment: 3 pages; and discussion: 2 pages) compared to 320 pages for surgical treatment

The late 1990s saw the revival of manipulation-casting in a technique promoted by Ponseti (about which Dr. Norgrove Penny will elaborate). This technique exploded onto the scene over a few months and within about 10 years, the method has become the universal standard. However, it needs to be stressed that Ponseti’s technique is designed for use on very young infants usually under six months of age. While the method relies on the use of an orthosis following the initial series of manipulations, it is important to stress, that the orthosis does not correct the clubfoot but is used to maintain the correction achieved by the manipulations.

*Non-surgical: other treatments*

Constant passive motion (France: Henri Bensahel and Alain Dimeglio) and electrical stimulation are two of the other non-surgical treatments available to manage clubfoot. These methods are still in the developmental stages and are not part of the focus of this conference.

*Surgery*

Lorenz in 1784 introduced heel cord lengthening for clubfeet (Carroll 1990). The advent of anesthesia in 1846 made the surgical correction of clubfoot easier. Solly performed the first osteotomy for clubfoot in 1854 and Phelps introduced an extensive soft tissue release in1884 (Carroll 1990).

In the first half of the 20$^{th}$ century, most surgery was usually piecemeal and primarily directed to equinus of the ankle.

In 1971 Turco introduced his one stage, postero-medial correction with internal fixation (Turco 1979). This was an aggressive “total release” of the soft tissues of the club foot (that included

a release of the interosseous ligament) which was often followed the complication of the hindfoot valgus. Nontheless, the procedure did provide marked correction for children who previously had been denied a workable foot.

McKay (1983) introduced the concept of “medial spin” of the os calcis under the talus and stressed the importance of not cutting the interosseous ligament.

Giannestrus had developed the “Cincinnati Incision” later popularized by Alan Crawford. This allowed for an easier total one-stage McKay operation (Crawford et al. 1982). Subsequently the name “Cincinnati” became misused to describe McKay’s operation.

Wound healing problems have been the major source of difficulty when applying extensive soft tissue surgery for the neglected clubfeet in older children. Gradual correction using mechanical distraction was popularized in the 1950s by Dr. Morris of Boston using a turnbuckle distractor without any hinges. Later this technique was greatly expanded by Ilizarov. His hinge locations, however, were not anatomic (Ilizarov et al. 1983). Since then, many surgeons have used variations of the technique. While the cosmetic results are often excellent, the process takes many months and often leaves the child with prolonged hyperesthesia of the feet.

**Current status of surgery**

As stressed above, Ponseti’s technique is designed for use on very young infants usually under six months of age. In developing countries, many of the children with clubfeet do not get orthopaedic attention sufficiently early. This leaves them little option but surgery for the correction. Dr. Norgrove Penny will elaborate in his presentation on the surgical principles and practice for these children.

**References**

Carroll N. 1990. Clubfoot. In: Lovell and Winter's Pediatric Orthopaedics. Morrissey RT (ed). Philadephia, Lippincott. 2: 927-956.

Crawford AH, Marxen JL, et al. 1982. The Cincinnati incision: a comprehensive approach for surgical procedures of the foot and ankle in childhood. J Bone Jt Surg 64A:1355.

Ilizarov GA, Shevtzov VI, et al. 1983. Results of treatment ofr equinus foot deformity. Ortop. Travmatol. Protez 5:46-48.

Kite JH 1939. Principles involved in the treatment of congenital clubfoot: the results of treatment. J Bone Jt Surg 21:595-606.

McKay DW. 1982. New concept of and approach to clubfoot treatment: section I - principles and morbid anatomy. J Pediatr Orthop 2:347.

McKay DW. 1983. New concept of and approach to clubfoot treatment: section II - correction of the clubfoot. J Pediatr Orthop 3:10.

Simons GW. 1993. The clubfoot: the present and a view of the future. New York: Springer-Verlag.

Turco VJ. 1979. Resistant congenital clubfoot–one stage postero-medial release with internal fixation: a follow-up report of 15 years experience. J Bone Jt Surg 61A:805.

Zimbler S. 1993. Nonoperative management of the equinovarus foot: long term results. In: The clubfoot: the present and a view of the future. Simons GW (ed). New York: Springer-Verlag. pp191-193.

## Clubfoot: clinical aspects: Ponseti approach

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### Introduction

Worldwide, the clubfoot deformity is the most common birth defect causing locomotor impairment. The incidence varies amongst population groups from between 0.6 per 1000 live births in China to 6.8 for every 1000 in Hawaiian Polynesia. A conservative worldwide average is 1 per 1000. The projected annual numbers of infants born with clubfoot deformity is 136,500. Congenital talipes equinovarus (clubfoot) is a true congenital deformity, probably arising during the third trimester of pregnancy.

The cause of congenital clubfoot is unknown but is likely multi-factorial related to a genetic predisposition and intrauterine factors such as space available for the foetus. The deformity consists of contracture of the medial and posterior soft tissues resulting in cavus, adduction, varus and equinus positions of the foot.

Dr Hiram Kite in the 1930s taught and popularised serial plaster correction for clubfoot deformity. His method attempted to break up the corrective manoeuvre into its component parts, correcting first the forefoot adduction, then the heel varus, then the equinus. Cavus was not addressed and his method tended to aggravate cavus by pronating the forefoot on the rear-foot.

Variations of Dr Kite's method became standard and were practiced by most clinicians worldwide. Experience proved that the time required for correction was prolonged, usually 6 months or more, and only partial correction was obtained. Major surgical operations were then required to complete the treatment, with a substantial complication rate.

Dr Ponseti, from Iowa, USA recognized the importance of utilizing subtalar joint kinematics in the correction and applied a different manipulation technique.

### Ponseti management of the clubfoot deformity

The salient features and sequence of correction is as follows:

1. First correct the cavus. Supinate the forefoot.
2. Abduct the forefoot. Pressure/fulcrum is the head of the talus.
3. Do not touch the calcaneus…let it move naturally.
4. Above knee casts. Foot abduction cannot be controlled in below the knee casts.
5. Abduct serially to 50°+, not just neutral. Usually 4-6 casts.
6. Percutaneous tenotomy. Do not dorsiflex against the Achilles tendon (causes a rocker-bottom foot)
7. 3 weeks post-tenotomy cast in 70° abduction, maximal dorsiflexion.
8. Abduction bracing long term. 3 months full time, 3+ years night-time and naps.
9. Repeat casting for relapses
10. Tibialis anterior transfer for recurrent relapses after age 2 years

Dr Ponseti's technique was largely overlooked until a landmark independent study by Cooper and Dietz was published in 1995 showing outstanding long term results. Dr Ponseti published his book in 1996 and there has been an international revolution in clubfoot care ever since. Excellent results with 96%+ initial correction rate and dramatically reduced surgery necessity have been reproduced and reported around the world.

Most importantly, the technique has been proven to be effective in some of the most resource-poor nations on earth. The Uganda and Malawi clubfoot projects have proven that the technique is easy to teach and learn, effective, efficient and economical. It can be

practiced by non-specialist physicians and paramedical professionals. These results have been reproduced in several other developing nations in Africa, Asia and Latin America.

A detailed description of the technique is freely available on-line in pdf format from global-help.org and has been translated into several languages in order to facilitate dissemination of information to health providers in countries with limited resources.

### The importance of the Ponseti method

We have a proven first class treatment tool that is appropriate for the developing world. It is low tech and cost effective. It has the potential to eliminate a major disabler of children if it can be applied broadly and universally.

### The challenge

Can we overcome the obstacles to compliance in brace wear? Relapse and failure rates are directly related to compliance with long term foot abduction bracing. There is a lot of innovation in orthoses development occurring at the present time in the developed world attempting the make the orthoses easier to use. A cost-effective orthoses (the Steenbeek Foot Abduction Orthosis SFAB) has been developed for use in Africa.

### References

Cooper DM, Dietz FR. 1995. Treatment of idiopathic clubfoot; a thirty year follow-up note. J.Bone Joint Surg 77A:1477.

Ponseti IV. 1996. Congenital clubfoot. Oxford University Press. ISBN 0 19 262765 1

Clubfoot: Ponseti management. Staheli L, (ed). Global-Help Publications (www.global-help.org).

**Clubfoot: clinical aspects: CBR clubfoot treatment after the Ponseti method**

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**CBM International, Kampala, Uganda**

## The Ponseti method of clubfoot treatment

The Ponseti method of clubfoot treatment is a specific method of sequential manipulation and casting of the clubfoot to obtain full correction. In 90% of the cases a percutaneous tenotomy of the tendo-Achilles is recommended. Maintaining this correction requires the use of a foot abduction orthosis according to a specific protocol: full time use for 2-3 months and consequently for 2-4 years at night. The Ponseti post-correction bracing protocol is a lengthy one and is purely focussed on maintaining position and not at increasing correction.

Compliance to orthosis use as part of the clubfoot treatment is essential to avoid recurrence of the clubfoot deformity. Ponseti (2002) found recurrence of the clubfoot deformity in 7% of the compliant patients and in 78% of the non-compliant patients. Dobbs (2004) found respectively 0% and 76% recurrence rates. Non-compliant patients were 183 times more likely to have a relapse over compliant.

Reliance upon expensive imported orthoses will exclude most infants afflicted in developing countries from treatment. Providing a cheap, readily available and effective foot abduction orthosis will stimulate adherence to treatment and avoid recurrence of deformity.

In Uganda a foot abduction orthosis has been developed and tested, the Steenbeek Foot Abduction Brace (SFAB) (Steenbeek 2002) which:

- is easy to make;
- is manufactured from locally available materials (leather, plywood, mild steel);
- makes use of locally available technology;
- is easy to use and effective;
- costs less than US$7 when prefabricated in large quantities; and
- is often re-usable.

Figure 1

The SFAB (Figure 1):

- has open toed straight last leather shoes with a lace closure;
- a well moulded leather heel-cup;
- has a low posterior cut to avoid the foot slipping out of the shoe;
- has an inspection hole is on the medial side; and
- a 7 mm round mild steel abduction bar which is adjustable by bending, to control for foot abduction and dorsiflexion.

The design of the low posterior cut (Figure 2) of the heel leather, as compared to high-topped shoes, is of utmost importance in order to keep the foot in the shoe.

Explaining the importance of this mechanism is often overlooked. When the top edge of the heel leather ends at the same level or distal to the anatomical ankle joint (Figure 3), the

person will not be able to pull up his or her heel during plantarflexion without help/holding the shoe (Figure 4). However, if the heel leather is increased in height and the top edge on the posterior side reaches above the anatomical ankle joint (Figure 5), it will create a point of fixation proximal from the ankle joint. This occurs when, during plantarflexion, the heel leather presses against the posterior side of the lower leg proximal from the ankle. This point of contact between the posterior side of the leg and the heel leather will then act as a fulcrum. It now allows the patient to pull up the heel when attempting to plantarflex (Figure 6).

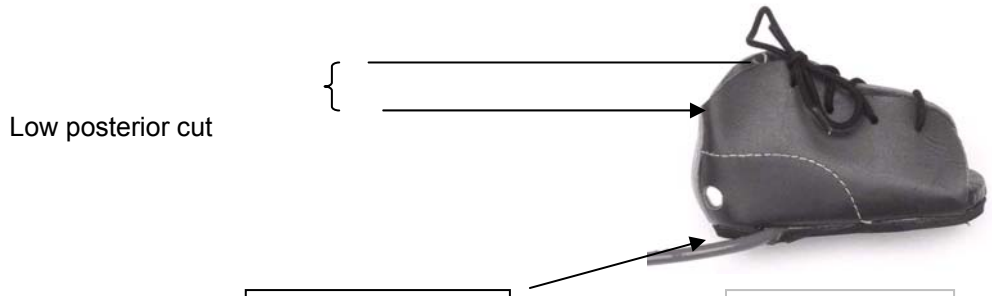



Figure 2

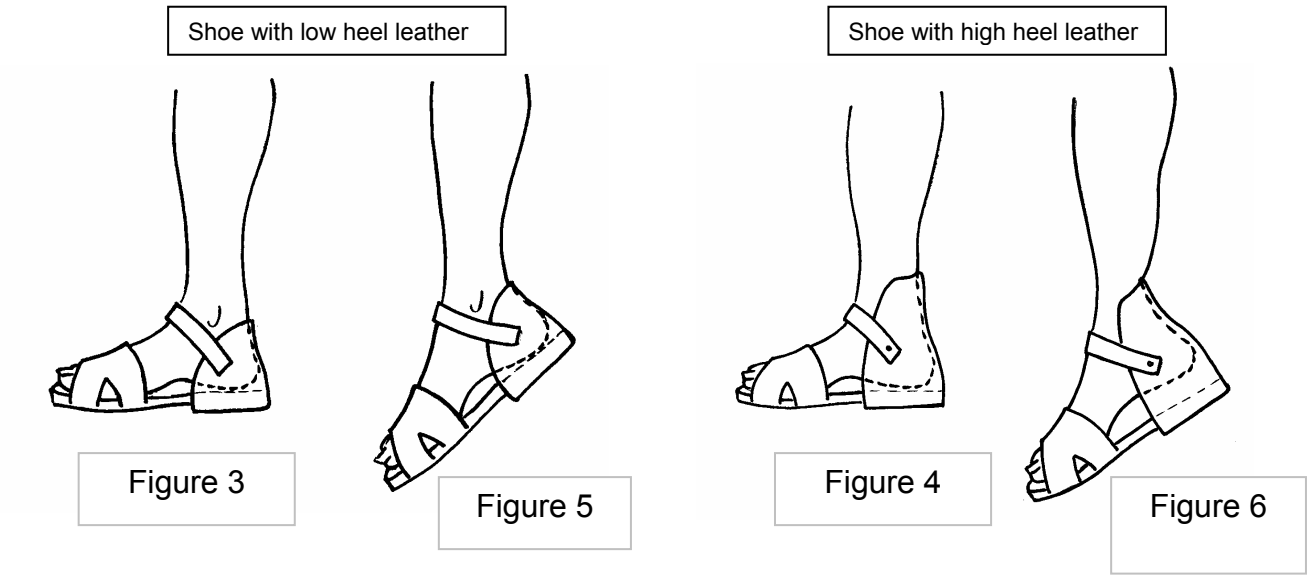



Figure 3 Figure 5 Figure 4 Figure 6

There has been 6 years of experience in Uganda with the SFAB and it is currently also produced and used in some other countries in Africa and Asia as well as Central and South America.

**Follow-up study**

From the year 2000 a study was performed in the main government hospital clubfoot clinic in Kampala, Uganda. The study looked at the effectiveness of the orthosis in preventing recurrence of the clubfoot deformity during treatment of congenital clubfoot by the Ponseti method.

***Methodology***

A parental questionnaire and foot examination is used to collect data. Some 135 clubfeet in 86 children were assessed during 220 follow-up visits (average of 2.6 visits per patient). The

time of follow-up varied from 2 weeks to 24 months (mean 5.75 months) with follow-up intervals of 2 to 12 weeks. Parents were interviewed regarding orthosis compliance and ease of use. Infants' feet were inspected for recurrence and orthosis irritation. Recurrence was judged according to the Columbian Clubfoot Score/Pirani Clubfoot Score (an increase of 1 point or more)

***Results***
The following results were found:

- 95% of the parents reported no difficulties applying the orthosis;
- children in this group tolerated the orthosis well and were unable to kick it off at night;
- 3 feet in 2 children (2.3%) had irritation and minor blisters as a result of friction just above the lateral malleolus (note that in Africa children seldom wear socks); and
- 13 clubfeet in 8 children recurred. This included 1 compliant patient (unilateral) and 7 patients (87%) who were non-compliant with the orthosis protocol.

**Conclusion**.
It was possible to produce "easy to use" and inexpensive foot abduction orthoses in Uganda using local materials and technology. Post-corrective bracing suggests good results for acceptance and for preventing recurrence in the short term.
A full colour production manual with patterns is freely available on www.global-help.org (Steenbeek and David 2006).

**Appendix: Community based rehabilitation**:
Adherence to clubfoot treatment, especially during the bracing phase is an immense challenge for the parents and caregivers and a concern for the treating medical professionals. The term 'non-compliance' has, whether intended or not, a blaming connotation in the medical profession. It is a term that implies choice: a choice in whether or not to follow through with a treatment.

An ethnographic survey conducted in Uganda between July and September 2005 highlighted, among many others, issues regarding clubfeet and barriers to adherence to clubfoot treatment (McElroy et al. 2005). This study confirmed that there were a number of significant barriers to adherence to treatment and that very few of these related to non-compliance due to a lack of will. Poverty of caregivers, distance to health facilities, lack of paternal support, caregivers' other responsibilities, challenges of the treatment process, scarce resources of service providers, regional imbalances in service provision, and a lack of follow up services were the major themes.

'Compliance' is not as simple as a choice to abide or not abide by a treatment regime. Barriers are the cause, and adherence behaviours are the outcome. This is especially true in developing countries where most of the rural populace live in poverty.

As providers of rehabilitation services, we are in a position to help and overcome some of the negative influences and barriers to adherence to treatment for the benefit of all involved. A workable solution is to create a national program for the management of clubfeet utilising community based rehabilitation (CBR) programmes and integrating this with other existing government and NGOs recognised and operated programmes. Such an approach will reduce some of the barriers by bringing awareness of all aspects of treatment, counselling and follow-up closer to the community.

CBR is a strategy for rehabilitation, equalization of opportunities, poverty reduction and social inclusion of people with disabilities (WHO 2004).

From 1996 a comprehensive and integrated CBR programme was established in parts of Uganda targeting orthopaedically disabled children (Penny et al. 2006). This became known as the "Children's Orthopaedic Rehabilitation Project". In central, east and west Uganda, central referral units were developed. Each unit consists of a surgical facility with a rehabilitation centre, a physiotherapy unit and an orthopaedic workshop. Collaborating up-country "satellite" CBR programmes are responsible for identification, referral and follow-up of

clients. Some of these satellite programmes also have rehabilitation hostels and provide services of physiotherapy, post-surgical wound care and appliance workshops.

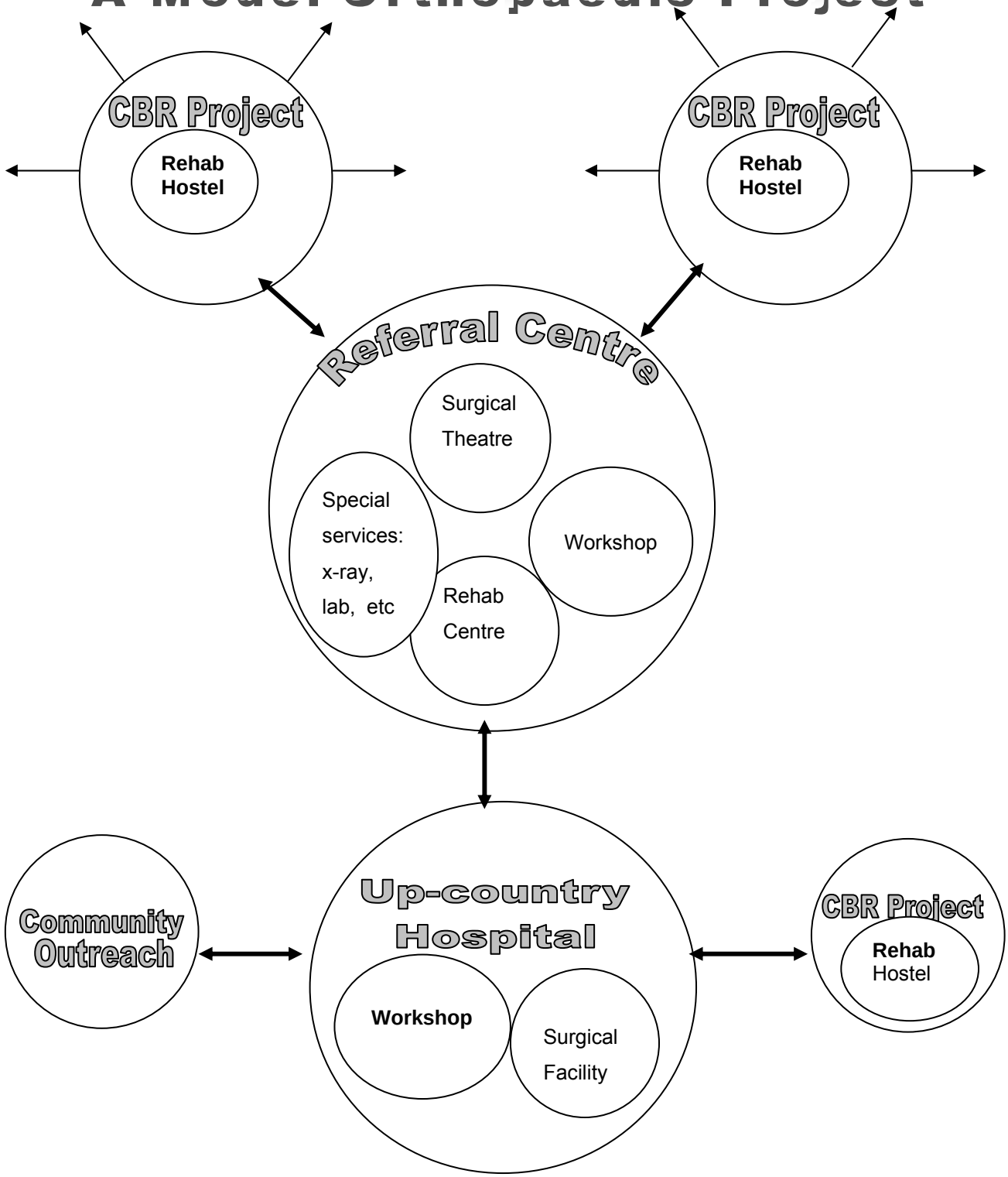
This integrated system became the perfect platform on which to build the Uganda Clubfoot Project, which is a nationwide awareness and early intervention programme for clubfoot deformity using Dr. Ponseti's method.

In this context, the necessary ingredients for a successful physical rehabilitation (clubfoot) programme are:

1. Community (outreach) identification, referral and follow-up programme
2. Transportation system
3. Physiotherapy
4. Corrective surgery
5. An appliance workshop
6. Rehabilitation Hostels

Omitting one of the above will impede success.

# A Model Orthopaedic Project



## References

Dobbs M. 2004. Factors predictive of outcome after use of the Ponseti method for the treatment of idiopathic clubfeet. J Bone Jt Surg 86-A:1:22-27.

Penny N, Zulianello R, Steenbeek M. 2006. Community based rehabilitation and orthopaedic surgery for children with motor impairment in an African context. Submitted for publication to *Disability and Rehabilitation* January 2006.

Ponseti IV. 2002. Relapsing clubfoot: causes, prevention, and treatment. Iowa Orthop J 22:55-56.

Steenbeek HM. 2002. The Steenbeek foot abduction brace; preventing recurrence of deformity in developing nations during the treatment of congenital clubfoot by the Ponseti Method. Third International Clubfoot Congress, August 2002, San Diego, California.

Steenbeek M, David OC. 2006. Production manual for the Steenbeek foot abduction brace. (available at www.global-help.org)

McElroy T, Konde-Lule J, Gitta S, Neema S. 2005. Understanding clubfoot in Uganda: a rapid ethnographic survey. Internal report, The Institute of Public Health, Makerere University Uganda and the Department of Health Care and Epidemiology, University of British Columbia.

WHO. 2004. CBR: a strategy for rehabilitation, equalization of opportunity, poverty reduction and social inclusion of people with disabilities: a joint position paper/ILO, UNESCO, WHO. ISBN 92-4-159238-9

# Clubfoot: the neglected clubfoot

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*(Adapted from: Penny JN. 2005.The neglected clubfoot. Techniques in Orthopaedics 20(2):153-166.)*

## Introduction

The neglected clubfoot deformity is a problem of poorer developing countries. Approximately 80% of children born with a clubfoot deformity are born in the developing world and a significant majority of these do not have access to appropriate medical care. The obstacles of poverty, lack of awareness, and lack of appropriate medical resources in accessible locations mean that treatment is either not initiated or incompletely performed.

The neglected clubfoot is one in which there has been no initial treatment or perhaps very inadequate and incomplete initial treatment. The deformity is made worse at the time the child starts to walk because weight bearing takes place on the side or dorsum of the foot exaggerating the abnormal shape and causing further deformation. The contracted soft tissues on the medial side of the foot are encouraged to contract further. The bones are compressed unnaturally at a time when they are plastic and deform into abnormal shapes. Bones which normally support the arch of the mid-foot now bear axial load, which they were never intended to do. The sole of the foot never experiences proper weight bearing and it is impossible to wear normal shoes. A thickened callous and large bursa develops over the prominent weight-bearing head of talus on the dorso-lateral side of the foot, often associated with deep fissures which are vulnerable to breakdown and infection.

## Pathologic anatomy

The continuing contractile forces of the soft tissues on the medial and posterior side of the clubfoot result in progressive bony deformity. There is significant bony deformity in the neck and head of talus, shape of the navicular, subluxation of the cuboid, and dramatic obliquity of the calcaneocuboid joint. Soft tissue release alone cannot fully restore bony anatomy and the relapse rate in the older child with neglected clubfoot will be high because of the tendency of the bones to revert to their deformed position. Of particular importance is the obliquity of the calcaneocuboid joint and surgical procedures on the neglected clubfoot must address this bony incongruence as a primary consideration.

## Patterns of deformity

There are varying degrees of stiffness and patterns of deformity in a clubfoot. The degree of fixed cavus will determine how the child walks. If the cavus is not severe, or is flexible, the child will tend to walk on the lateral border of the foot with the forefoot still facing forwards. With large degrees of fixed cavus deformity the foot may face backwards. In both clinical scenarios the degree of equinus of the rearfoot is not readily apparent when standing but becomes obvious when the forefoot adductus is corrected. Dramatic and fixed equinus remains the most problematic of the clubfoot deformities to correct at all ages and degrees of neglected deformity.

## The disability of neglected clubfoot deformity

Children with neglected clubfoot deformity do learn to walk without the use of crutches or walking aids. They can often run over short distances. Many adults seem to cope with the deformity. Is it warranted therefore to consider surgical intervention in children with neglected

clubfeet? Qualitative research in Uganda indicated that the neglected clubfoot deformity was indeed a significant disability for village children, preventing access to education and other social activity (Penny 2001). The stigma is a very obvious one and children are often considered cursed or unworthy of advancement in education or social status. There is pain and difficulty with locomotion over longer distances. The pain occurs primarily in the skin and subcutaneous tissues on the dorsum of the foot. There is also abnormal pressure distribution across the mid-tarsal joints and through the malaligned ankle joint causing pain. Recurrent skin breakdown with infections is not uncommon in the skin bearing weight on the dorsal and lateral aspect of the foot. Severe ulceration in adults can lead to amputation. There is an inability to wear footwear, which aggravates all of the above problems. The objective of obtaining a plantigrade foot that can fit shoes is worthwhile even if feet do not have normal mobility or shape, or have some degree of residual pain. Success of treatment of the neglected clubfoot can be evaluated by two primary indicators: weight bearing on the skin of the sole of the foot and the ability to wear normal shoes. Yadav (1981) has reported 87% acceptable results using these criteria.

**The Ponseti method of clubfoot treatment in developing countries**

There are anecdotal reports of children with neglected clubfeet up to two years of age, or even older, who have been corrected by the conservative means of the Ponseti technique (Lourenco et al. 2002). The upper age of usefulness of the technique is not known but it is likely that the technique is particularly useful in children who have a more flexible clubfoot deformity with considerable osseous remodeling potential. As the technique has taken hold in Africa, the need for open soft tissue release has diminished dramatically in children less than two years of age. Percutaneous tenotomy of the tendo-achilles under local anaesthesia is the only operative intervention required. Sengupta (1987), in Calcutta, has reported on the utility of isolated percutaneous Achilles tendon and plantar fascia release followed by serial casting in large numbers of children up to walking age having neglected clubfeet.

There is obviously a significant role for corrective casting in newborns and young infants with clubfeet. In Uganda it was found useful to apply serial casts prior to surgical correction in all children up to age twelve with clubfeet. Casting allowed for stretching of the contracted tissues and skin on the medial side of the foot, reducing the risk of post-operative skin necrosis. Some correction of the bony deformity was achieved, minimizing surgical resections. Protecting the skin in casts allowed for healing of ulcers and fissures in the callus on the dorsolateral side of the foot. Preliminary casting, however, requires supervision in rehabilitation facilities. This is often not possible in rural up-country outreach surgical situations.

**General considerations**

The treatment of the neglected clubfoot is largely surgical yet there is very little literature available on such surgery. The dilemma in the developing world is the large number of cases presenting, with a shortage of skilled surgeons. These surgeries are difficult and time consuming; post-operative care is prolonged and requires access to bracing. There are difficulties with limited anaesthesia technology. It is preferable to delay surgery until a child is at least 9 months of age as anaesthesia is safer. It is also better to avoid prone positioning on the operating table to make anaesthetic monitoring easier. Malnutrition, anaemia and chronic diseases such as malaria are common. Children live in unhygienic circumstances and the skin of the foot is often ulcerated or infested with parasites. A preliminary admission to hospital or a rehabilitation unit is useful to allow for nutrition priming and treatment of skin lesions. Children are kept bed-bound for 24-hours prior to surgery and washed frequently to ensure cleanliness of the skin. In bilateral cases, it is usually best to do both feet in one sitting due to transportation and follow-up difficulties in rural environments. This might be the child's only opportunity for correction. The use of pins and internal fixation devices in up-country outreach situations may be compromised because of concerns for infection and pin care after the surgeons have left. CBR projects offer the best support in post-operative care and follow-up.

There is little or no indication for surgical treatment in the skeletally mature teenager or adult. The patient has adapted to the deformity. Although not impossible, surgery is traumatic and likely to result in a painful foot. In these cases it is better to recommend adaptive footwear.

### Algorithmic approach to surgical treatment of the neglected clubfoot

There is no single surgical procedure that can resolve all clubfoot scenarios. A full armamentarium of procedures must be at the ready. An algorithmic approach to the neglected clubfoot proved useful in the low technology environment of East Africa (Penny 2005)). Depending on age, severity and degree of flexibility, there is a progression from soft tissue surgery alone through soft tissue release combined with mid-foot osteotomies to osteotomy and arthrodesis in isolation. Many times decisions have to be made in the operating room during the case. Age is not necessarily a predictor of the type of surgery; pattern of deformity and intrinsic flexibility are more important.

### Soft tissue release

This is the most common surgical procedure in younger children up to about 4 years of age. In ages older than this, osteotomies are often required as well (Cummings et al. 2002). The pathologic contracted connective tissues on the medial, posterior and lateral sides of the foot and ankle are released or lengthened. Occasionally, with the use of preoperative serial casting, only a posterior release is required in more flexible feet. Posterior release involves release of the posterior capsule of the ankle and subtalar joint as well as open Achilles tendon lengthening. After surgery, casts are necessary for 6-12 weeks, then either a foot abduction brace in younger children, or plastic ankle-foot orthoses (AFOs) in older children. Relapses are common after soft tissue surgery alone and longer term follow-up is important. Bracing needs to be prolonged to maintain correction.

### Mid-foot osteotomies

Soft tissue release alone may not fully correct the deformity because of secondary bony deformity. If this is not addressed at surgery the foot will not only be left incompletely corrected, but will relapse. The combination of the above soft tissue release with mid-foot osteotomy is usually required in children between approximately 4 and 12 years of age with neglected clubfeet. The bony lateral column is longer than the medial column resulting in mid-foot adductus. Shortening osteotomy through the lateral column is required and should occur through the calcaneus, or calcaneocuboid joint. Sometimes calcaneal osteotomy is also required.

The combination of radical soft tissue release and calcaneal shortening osteotomy is the most common operative procedure required in children between ages four and eleven, giving satisfactory results in the majority (Herold and Torok 1973; Hersh and Fuchs 1973).

Casts are needed for 12 weeks post-operative, followed by at least one fitting with a plastic AFO. When bony procedures are needed there is more residual stiffness of the foot, but there is less need for long term bracing or follow-up. Once the bone is solidly fused, the correction should be maintained.

### Triple arthrodesis

More severe cases in older children or teenagers require a triple arthrodesis. Triple arthrodesis is a versatile procedure used to correct major deformities in children. In the developed world triple arthrodesis is used primarily as a salvage procedure for pain after previous surgical correction (Davidson 2003). In the developing world context, with reference to neglected clubfeet, the procedure has its versatility in correction of large degrees of deformity. In the severe deformity, particularly with marked cavus where the foot is facing backward, soft tissue release and osteotomy is unlikely to achieve full correction. In this case triple arthrodesis can be very useful (Bitariho and Penny 2003). Conventional orthopaedic wisdom recommends triple arthrodesis not being performed before advanced skeletal

maturity, at age 10 to 12, to avoid growth retardation by removal of cartilage involved in enchondral ossification. However, triple arthrodesis has been used in children as young as age 6 years without seeing adverse growth characteristics. Moreover, discrepancy in the size of the feet is seldom more than a cosmetic nuisance, and in bilateral cases not relevant. In neglected clubfoot a specific method of arthrodesis is required, with particular reference to correction of equinus. A modification of the classic Lambrinudi triple arthrodeses, originally described for polio equinus deformity, has been described and is necessary (Lambrinudi 1927; Penny 2005).

After triple arthrodesis, casts are necessary for 12 weeks. Once the bone is fused, no further immobilization or support is necessary. Triple arthrodesis, therefore, becomes a practical procedure for rural village locations in very poor areas where follow-up and orthoses management are difficult or impossible. Once the bone is healed, the problem is resolved and correction should be maintained permanently.

### Ilizarov correction

The Ilizarov apparatus is a powerful means of obtaining correction of severe foot deformities and it can be applied to neglected clubfoot surgery (Heurta 1994). Progressive correction can be accomplished with safety regarding blood supply and skin. Rings are fixed to the tibia connected to half rings for the calcaneus and the forefoot. Asymmetric distraction corrects the various deformities. For more severe deformities osteotomies are added. Joshi has developed a simple frame based on Ilizarov concepts that has been used extensively in India and elsewhere with good results (Suresh et al. 2003). This frame is less bulky than a similar Ilizarov frame, is less expensive, and simpler to apply. Recent reports from India adapting Ilizarov correction to the Ponseti technique have also been encouraging (Chaudhary 2003). There is a vulnerability to relapse in older children because of the osseous deformity, notably the obliquity of the calcaneo-cuboid articulation. Combining Ilizarov corrections with osteotomy through the calcaneus is more likely to produce a lasting effect (Paley 1993).

Because the clubfoot is a complex three dimensional deformity, these are complex and difficult corrections requiring considerable expertise. Use of Ilizarov instrumentation is limited in the developing world by the large number of cases requiring treatment, the lengthy operating time involved, the availability of the instrumentation and intra-operative imaging, and the logistics of adequate post-operative care. Although promising, this technique is not appropriate for the majority of practitioners in the developing world or for volunteer surgeons on short-term assignment. The foot after Ilizarov correction is very stiff, as stiff as following osteotomy procedures. Follow-up studies have shown a high rate of relapse and unsatisfactory results. Triple arthrodesis remains the procedure of choice in resource-poor environments.

### Post-operative care

Discharging children back to the village environment post-operatively can be problematic with destruction of the plaster-of-Paris and subsequent loss of position. Construction of rehabilitation hostels in outreach areas to house and supervise children has proved beneficial, particularly if attached to a community based rehabilitation project. Where ever possible community based rehabilitation (CBR) principles should be utilized (Penny and Steenbeek 2002).

### Orthotic needs

<u>The orthotic needs are</u>:

1. Foot abduction brace (FAB) in younger children after soft-tissue release or Ponseti treatment. Night-time foot abduction braces for two or more years will reduce the risk of relapse. The Steenbeek foot abduction brace has been developed in Africa and is a low cost appliance made of locally available materials (Staheli 2003;,Steenbeek 2002).
2. Thermoplastic AFOs in children older than 3 or 4 years undergoing soft tissue release with or without osteotomy.
3. Adaptive footwear for the older child or adult for whom surgery is not an option.

It is impossible to obtain perfection in the treatment of the neglected clubfoot. The object should be to obtain a foot that is more or less plantigrade, with weight bearing on the plantar skin, and able to fit shoes. Children obtaining this result will be happy in the majority.

**References**


Bitariho D, Penny JN. 2003. Triple arthrodesis in children for severe neglected clubfoot deformity. Presented at the Association of Surgeons of East Africa. December 3-5, 2003. Kampala.

Chaudhary M. 2003. Using Ponseti principles for external fixation treatment of older children with residual and recurrent clubfoot. Presented at the Baltimore Limb Deformities Pre-course. September 2003. Baltimore.

Cummings RJ, Davidson RS, Armstrong P, et al. 2002. Congenital clubfoot. AAOS instructional course lecture. J Bone Jt Surg (Am) 84A:290-308

Davidson RS. 2003. Clubfoot salvage: a review of the past decade's contributions. J Pediatr Orthop 23:410-418

Heurta F. 1994. Correction of the neglected clubfoot by the Ilizarov technique. Clin Orthop 301:89-93

Herold HV, Torok G. 1973. Surgical correction of neglected club foot in the older child and adult. J Bone Jt Surg (Am) 55A:1385-1395

Hersh A, Fuchs LA. 1973. Treatment of the uncorrected clubfoot by triple arthrodeses. Orthop Clin North America 4: 103-115

Lambrinudi C. 1927. New operation on drop-foot. Br J Surg 15:193

Lourenco AF, Prata SD, Sodre H, et al. 2002. Conservative treatment of clubfoot after walking age. Presented at the Third International Clubfoot Congress. August 27-28, 2002. San Diego.
Paley D. 1993. The correction of complex foot deformities using Ilizarov's distraction osteotomies. Clin Orthop 293:97-111

Penny A. 2001. School access: children with motor disabilities in rural Uganda. MA thesis dissertation. University of Victoria..

Penny JN. 2005. The neglected clubfoot. Techniques in Orthopaedics 20(2):153-166.

Penny JN, Steenbeek M. 2002. Community based rehabilitation (CBR) in the management of clubfoot deformity in Africa. Presented at the Third International Clubfoot Congress. August 27-28, 2002. San Diego.

Sengupta A. 1987. The management of congenital talipes equinovarus in developing countries. Int Orthop 11:183-187

Staheli L (ed). 2003. Clubfoot: Ponseti management. Seattle: Global-HELP Publications. Available at: http://www.global-help.org/publications/ponseti-cf.html

Steenbeek M. 2002. The Steenbeek foot abduction brace (SFAB): Preventing recurrence of deformity in developing nations during treatment of congenital clubfoot by the Ponseti method. Presented at the Third International Clubfoot Congress. August 27-28, 2002. San Diego.

Suresh S, Ahmed A, Sharma VK. 2003. Role of Joshi's external stabilization system fixator in the management of idiopathic clubfoot. J Orthop Surg (Hong Kong) 11:194-201

Yadav SS. 1981. Observations on operative management of neglected clubfoot. Int Orthop 5:189-192

# Clubfoot: orthotic management

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## Summary

The clubfoot deformity is one of the most common congenital deformities, occurring in one to two per thousand live births (Lehman and Wallace 1980). The deformity is partly characterized by impaired function but all the normal components are present. The abnormal position of the foot may be described as consisting of four components:

- Equinus
- Varus
- Adduction
- Cavus

The important requirement for the treatment of clubfoot deformity is to start the treatment as early as possible, preferably the first day. This should involve interventions such as:

- Orthopaedic Surgery.
- Orthotic application.
- Physiotherapy.
- Family member involvement.

With careful negative casting technique and positive cast modification methods, an AFO can be fabricated to meet the requirements for treatment of post surgical clubfoot care. The negative cast is obtained with maximum achievable correction and the positive cast modified using three-point pressure system. However, one of the problems with AFO provision is the impact of cost in most of the Low-income countries. One must recognise that treatment a severe clubfoot deformity is a continuous process until the child reaches the age of maturity.

## Introduction

Most families with children suffering from talipes equinovarus do not have adequate income to meet their day to day living cost let alone meet the cost of treating a child with clubfoot deformity. These costs are long term as treatment is a continuous process until the child attains skeletal maturity.

The deformity can be very difficult to treat in low-income countries simply because patients are unable to attend the clinics regularly due to several factors which include:

- Financial inability to meet traveling costs, accommodation and meals, especially in cases where patients have to travel long distances.
- Lack of awareness regarding the possibilities available to manage the treatment of the deformities.
- The belief in some parents is that such a deformity is God's wish and therefore one should not attempt to do any thing for the foot.
- Most of the parents/guardians reside in areas where they do not get early and proper advice as to what they should do for their children.
- Even though the parents are well trained in how to proceed with correction of the feet manually at home, they rarely attempt to do so.
- Lack of the professional knowledge in fitting a well functioning clubfoot orthosis.
- Many birth attendants, particularly in rural areas are unaware of the clubfoot deformity and the need for early referral for treatment.

- Poor or non-existence of members of the Orthopaedic Clinical Rehabilitation Team. In some areas it is difficulty to find all of the rehabilitation team members in one location
- Long distance and high cost make it difficult to change the old orthosis.
- In some countries it is difficulty to get the appropriate materials/components that can be used for the fabrication of different splints or orthosis e.g. mechanics ankle joint which assist/resist specific movements.
- Community Health workers who work and resides in rural areas do not have knowledge on alternative treatment modules e.g. Orthotic intervention

**Orthotic treatment approach**

There are a number of orthotic designs in use worldwide. One of the orthosis, which is currently practiced in Tanzania as one of the post-operative treatments of the clubfoot is the non-articulating AFO and articulating AFO (Figure 1).

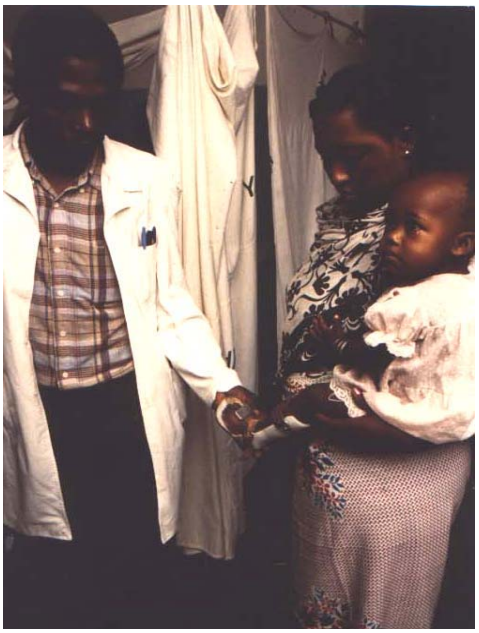

Fig 1a Non-articulating AFO
Fig 1b Articulating AFO

**Materials and components**

The AFO is fabricated using 4 mm or 6 mm polypropylene, depending on the size of the child with a Pelite varus protection pad placed just proximal to the lateral malleolus. It is delivered with Velcro pre-tibial and ankle straps.

**Casting technique**

The negative cast position is obtained according to the following sequence: if the left foot is being corrected, the orthotist's right hand should be holding the calcaneus in a neutral position while pressing the thumb proximal to the lateral malleolus to produce a medially directed force and prevent varus at the ankle. The orthotist's left hand should be pushing the forefoot into as much abduction as possible while maintaining the ankle at 90°, the knee joint is also flexed to allow or reduce the planterflexed foot and the forefoot should be at a neutral position of pronation/supination. Positive modifications are based on three-point pressure systems for maximum overcorrection. One three-point pressure system consists of a varus prevention pad above the lateral malleolus, the medial border of the foot, and the proximomedial area of the calf (Figure 2). These three-point pressure system acts on the ankle joint and the subtalar joint to prevent or block varus. The modification of the varus prevention pad is accomplished by removing approximately 3 mm of plaster from the model at the position of the thumbprint left from the impression procedure proximal to the lateral

malleolus. Wrapping the excavation anteriorly (toward the tibial crest) will result in a varus pad that will reduce the tendency of the AFO to rotate medially around the leg; otherwise medial spin will not be controlled.

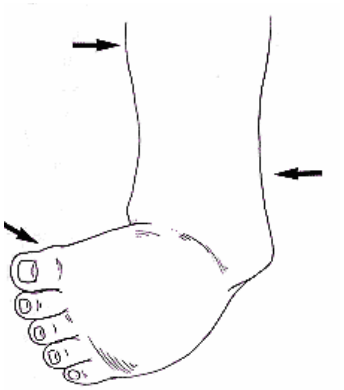

Figure 2. Three-point pressure system to control hindfoot supination, which consists of pressure above the lateral malleolus, with counter forces at the medial border of the foot and the proximo-medial medial area of the cuff.

A second three-point pressure system (Figure 3 ) consists of two forces directed laterally. One should be in the area of the first metatarsal head, one other at the medial side of the calcaneus and the final force a directed medially just proximal to the base of the fifth metatarsal and cuboid. This three-point pressure system increases the length of the medial column through the mid-tarsal, talo-navicular and calcaneo-cuboid joint(s). This is achieved through plaster removal at the medial forefoot of the model. Beginning at the space between the second and third digits, plaster is removed to a point just proximal to the metatarsal heads (essentially removing the first two toes) (Figure 4 ).This places the forefoot and mid-foot in an abducted position in the AFO, which is fabricated with a high medial wall. This over correction should be maximal (to an extent tolerable by the patient). The tendency is that the younger the child, the more over correction possible. Plaster removal to the third digit is appropriate on an infant. A 5-year-old on the other hand, may tolerate plaster removal only partially through the first digit.

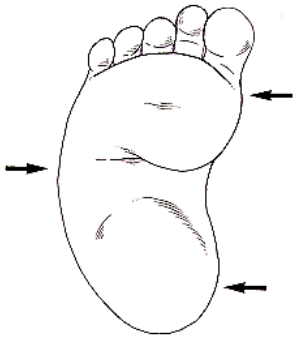

Figure 3. Three-point pressure system for the control of shortened medial column. These consist of two laterally directed forces, one at the area of the first metatarsal head and the other at the medial border of the calcaneus, and one medially directed force just proximal to the base of the fifth metatarsal.

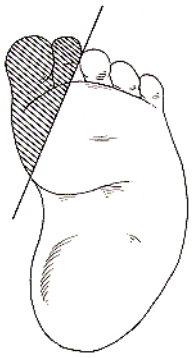

Figure 4. Shaded area represents the portion of the cast where plaster removal is indicated, from the space between the second and third digits to just proximal to the head of the first metatarsal. This procedure will place the foot in the desired position of abduction.

Approximately 3 mm of plaster also must be removed from the positive model at the medial border proximal to the first metatarsal head to provide relief for the metatarsal head. The plaster removal on the medial side must be compensated for on the lateral side by the addition of an amount of plaster equal to that removed (see Figure 5). Plaster build-ups are also added over the malleoli for the older child. The infant normally has enough extra tissue and buildups produce a sloppy fit. Addition of plaster over the heel is avoided to maintain good calcaneal control in the neutral position.

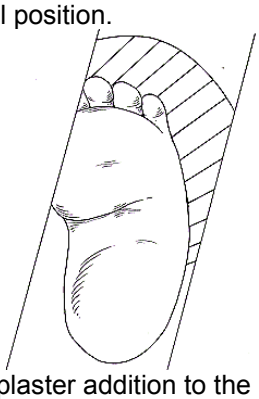

Figure 5. Shaded area represents plaster addition to the model on the lateral side of the foot in an equal amount to the plaster removed previously from the medial border. This assures complete coverage of the plantar surface of the foot in the completed AFO.

The third three-point pressure system employed maintains the foot at a 90° angle to the shin (see Figure 6). This three-point pressure system works through the ankle joint to resist equinus. This is the standard force system seen in most AFOs, which directs one upward force at the plantar aspect of the metatarsal heads, another anteriorly directed force at the proximal-posterior calf and a third obliquely directed force at the instep (provided by an ankle strap and/or shoe laces).

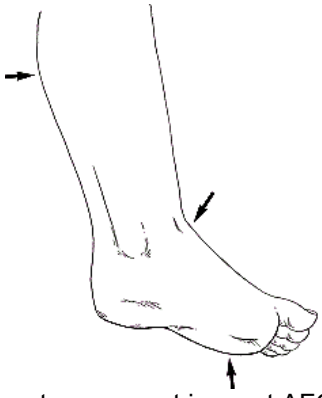

Figure 6. Three-point pressure system present in most AFOs to control equinus deformity. Forces include an upward force at the plantar aspect of the metatarsal heads, an anteriorly directed force at the proximo-posterior calf and an obliquely directed counterforce at the instep of the foot provided by an ankle strap and/or shoe laces.

The toe plate is extended to encompass the full plantar surface of the foot to ensure the medial wall of the footplate will extend to the end of the toes; this provides the pressure for the overcorrected, abducted position in which the foot is held.

Once the plaster buildups are added and plaster removal is completed, the positive model is checked to be sure the hindfoot (subtalar joint) is in a neutral inversion/eversion position, the ankle joint is at 90°, and the medial column is lengthened. The model is then smoothed, the trim lines are drawn, and the cast is prepared for plastic vacuum-forming with the Pelite varus prevention pad in place over the aforementioned excavation.

Complications

- Complications in performing this procedure include slippage of the AFO distally due to recurrent equinus/heel rise, skin rash and/or breakdown, and shoe-fitting problems.
- Skin rash and breakdown is most often caused by the 23 to 24-hour per day wear of a plastic orthosis. Instructing parents to dress their children in white cotton socks and to change them frequently has alleviated this problem. A ventilation or "weep" hole may be placed in the posterior-distal area of the calcaneus. To prevent problems of shoe fit, soft sneakers with the innersole(s) removed and long opening are recommended.

**Delayed orthotic interventions in clubfoot deformity**

Children with this kind of disability are quite often socially and economically disadvantaged if the condition is not addressed in the early stages as it will lead a child to a permanent deformity which will definitely interfere with his daily activities (Figure 7).

Figure 7. A typical neglected clubfoot

Most individuals who visit orthotics service delivery centres with a deformity to the degree shown in Figure 7 will end up with only supportive orthopaedic footwear as can be seen in Figure 8 which does not really address the problem but only provides relief to the planter surface of the foot. The individual gait pattern has been interfered with and the alignment of the lower limbs been disturbed by the existence of the neglected clubfoot. When the individual is bilaterally affected there are more serious problems in locomotion

Figure 8. Bilateral neglected clubfoot

**Early orthotic intervention and its effect on clubfoot deformity**

Early orthotic intervention will be effective in combating progression of the deformity if correct orthotic appliances are provided and that the child has not reached maturity (Figure 9). Regular follow-up schemes should be developed and understood by the parents or guardians

Fig 9. Static bilateral AFOs

An ankle foot orthosis that will address forefoot adduction, varus of the calcaneous, equinus and cavus of the foot is necessary to maintain the foot in normal position as seen in Figure 9.

As mentioned earlier, in order to maintain the corrected position of such a child, commitment and concerted efforts from both the parents and the orthotics rehabilitation team must be developed if we really do not want to see such children ending up with permanent deformities as has been visualized earlier on. These regular visits for follow-up and evaluation of the fit of the orthosis can only be feasible if the family is able to cover the costs. For some children who come from very poor families such corrections may be a dream, if social security funds do not exist and therefore denying such a disadvantaged child the right to the proper treatment of the deformity

**Conclusion**

The negative casting procedures and positive model modification techniques described in this paper have been effective in producing an orthosis that maintains the correction of clubfoot deformities that have been treated through manipulation, serial casting and/or surgery. The described AFO has been seen to be acceptable to the rehabilitation team involved and the patient's family in preventing recurrence of the clubfoot deformity. The modifications address all aspects of the deformity: shortened medial column, hindfoot supination, equinus and medial rotation. The method described herein is recommended as an option for the treatment of clubfoot.

**References**

Lehman, WB. 1980. The Clubfoot. Philadelphia, PA: JB Lippincott Co.

**Plenary Discussion "Lower lomb orthotics practice - Polio"**

**Chair: Sepp Heim**

**Rapporteur: Kim Dunleavy**

## Discussion

- Although the Ponseti method was described as universal, it is not always used worldwide. Sudan, Tanzania and a lot of other places are using other methods. It was suggested that ISPO take on this method as the most effective method and promote it as such.

  The method was described as a common gold standard rather than used everywhere.

- *If you consider mechanics of the foot, it looks so obvious, how did it take so long to come up with an effective surgical model?*
  Ponseti method is not that new, but the information is more readily available due to internet and improved means of communication. The technique itself has been around for 40 years. It is all based on the biomechanics of the subtalar joint.

- *With a 93% success rate and 78% relapse – how do you match those statistics?*
  93% were corrected with the casts and manipulation; there is a possibility of relapse without compliance to the use of the brace (78%)

- *Treatment is not success rate at 6 weeks – the start to finish success time should be looked at.*
  We were really strict about what a complete success is, if the forefoot lifts off the ground 3 mm it was defined as a relapse rather than the original position

- *You did not talk about tibialis ant tendon transfer, you do not have to use an orthosis.*
  The Ponseti method of holding the foot in 70 degrees of abduction and bracing has decreased the need of tibialis anterior transfers.

- *Obviously the Ponseti method has had very good results with early intervention – with the referral from CBR. Could you enlighten some of my prosthetist/orthotist colleagues as to the contribution of CBR?*
  The CBR was a huge success factor; the earlier the babies were presenting the better the results. This was unique because of the awareness. We are learning all the time, I am now as confident with babies before 1 year of age as new born babies, no longer such a rush for the management. CBR was magic.

- *The presentation was very encouraging and all of us agree this is the way to go, why has it taken so long for this method to become known?*
  Once this gets into the training schools it will become more widely known. There are so many obstacles to treatment, despite the results there were a number of people who did not complete the programme – largely poverty related in Africa. The huge distances and poverty related factors were the contributors – not the practitioners.
- Malawi – 80% not compliant with brace, not usually successful without brace or without support of CBR.

- *The tendon release looks like fairly easy – do we need orthopaedic surgeons to do the surgery?*
  I believe that Orthopaedic officers would be able to do it, but in Uganda the MOH officials would not allow it. We provided an education program for general medical officers.

- *Who is financing the whole system and what is the cost for Uganda to see if it could be applied to other countries?*
  NGOs are financing all of the components in collaboration and in constant partnership with MOH. The initial part of the program which was training the orthopaedic officers and setting up the program consisted of 4 consecutive training grants of $ 20000 from Rotary. This included the provision of braces.

- *The abduction orthosis – what is going on in terms of positional criteria?*
  The terminology is confusing, particularly the word abduction. We are putting maximal stretch on the medial aspect of foot to 70° to match the position from the end of the serial casting.

- *What is the role of the orthotist?*
  It depends on how the tasks are divided – shoemakers are best to make the braces, fully trained prosthetists/orthotists do not want to do this type of device, but if there are a lot of workshops they will say the prosthetists/orthotists need to do it. The bracing does however need to be done through official workshops. The prosthetist/orthotist could do the actual corrections themselves. Can prosthetist/orthotists take this responsibility?

- *If the average number of casts is 5 times, what is the time in between casts?*
  Usually weekly intervals (from the timing of the cast clinic). Dr. Ponseti has said that you can accelerate that to every few days. On MRI the cartilage is adjusting within 24 hours. For rural mothers who do not have transportation – it may be possible to do it within 2 weeks, no science at this point, but it is still about the comfort of the baby, however you can probably drop the time period. The most stretch of the ligaments will occur in the first few days.
- Initial results in Malawi is that it can be done in 2 weeks, the mother and baby can stay as an inpatient.

- *What are orthopaedic officers ?*
  The classification is unique to Africa. They are trained paramedics with intense training in orthopaedics, more than the normal medical officer; they provide casts, fractures, traction and debridement of compound wounds. It is not normally the doctors who apply the casts but the orthopaedists. Every country would need to look at their needs. I believe it can be done by other paramedicals or prosthetist/orthotists if you understand the principles. You do not have to be a doctor. It does, however, depend on the teams.

- *You showed an example at 6 yearsrs old, is that the oldest you can do it?*
  We are learning as we go, we are pushing the age limit, but it depends on the flexibility of the foot. The bones progressively deform and there is a need to change the shape of the bones. If you have facilities try casting on everyone and you may get benefit. Often feet become infected, then we admit them to the rehabilitation centre and use casts to stretch out soft tissue before casting.

- *What about amputation to deal with clubfoot?*
  Not unless infected. We sometimes do a talectomy for a very stiff foot, for arthrogryposis we must do calcaneocuboid fusions. There are post-surgical complications to big surgeries.

- *During the modification process and removal of the positive cast, you mentioned using a 3mm plaster wedge; do you use this as a standard? How often do you have discomfort with fitting?*
  Only approximation, feeling of how much you can correct foot, depends on flexibility.

- *AFOs that you can walk on like a shoe; do you have long-term results in Tanzania?*
  No data at this point, but have achieved quite good results.

We see how important it is to collect data and make real records available otherwise we cannot see the progress. We started an incidence survey in Uganda in February with 100,000 clubfeet. I hope will be able to bring the results in 4 years.

In Cambodia they have only just started using the Ponseti method at national level with all NGOs in the rehabiltation sector, realizing that previous techniques were not getting good results with the calcaneus adjustment. We did not have measurement or scoring to evaluate the consecutive results of the casting before and the Ponseti model is a very good model to show the team. We will conduct an evaluation of 200 babies in 2 years and all babies treated before the use of this method to see the differences. We do not really have CBR but do have an awareness programme with MOH and impact is excellent, the presenting babies have increased by 25-30%.

- The Ponseti method followers are very enthusiastic about the technique which is not the usual response! We are all very enthusiastic about this promising method but of course there is a need to see long-term results and how it works in different countries and with different factors.

## Lower limb orthotic practice: trauma - clinical aspects

**Steve Mannion**

**Christoffel Blinden Mission, Blackpool Victoria Hospital, Blackpool, UK**

It is recognised that there is a huge burden of pathology of traumatic origin in the developing world. By the year 2020 injuries from road traffic accidents will be the third leading cause of death worldwide and the majority of these accidents will be in the developing world. The injuries sustained by survivors of these incidents will be mostly orthopaedic in nature. In the developing world there is a gross under provision of trained orthopaedic surgeons to appropriately treat these patients. Some 80% of orthopaedic surgeons practice in the developed world (26 of the 191 nations) and there are only 40 such surgeons for the entire East African region of 200 million people. Problems include recruitment and training of surgeons, medical migration and the lack of appropriate resources to treat the orthopaedically injured.

For the most part, orthopaedic trauma in the developing world will be treated by cast immobilisation or traction, with a smaller proportion of cases undergoing operative fixation than in Europe or North America. Orthotics has a role in the later treatment of orthopaedic injuries, typically following bony union. In the upper limb, for example, an orthosis might be required to splint a wrist drop complicating a humeral shaft fracture. One particularly important role of orthoses is in the management of spinal fractures. Hard collars, often in short supply in the developing world are crucial in the initial immobilisation of the pending exclusion of cervical spine injury. In the confirmed bony injury without neurological compromise SOMI type orthoses enable early patient mobilisation. In the spinal cord injured patient standing frames benefit pulmonary function and help prevent pressure sores. Ankle-foot orthoses are useful in preventing equines deformities of the ankle.

Much of developed world post-trauma orthotics practice relates to ligamentous injuries about the knee, typically occurring in the course of sporting activity. Particularly of note are those orthoses designed to compensate for anterior cruciate ligament (ACL) deficiency, possibly in combination with collateral ligament instability patterns. These orthoses are commercially available and fitted “off the shelf”. Costs are high, with a typical ACL orthosis retailing at $600 - $1000. Knee injuries without gross instability can be treated with a cheaper, less rigid neoprene orthosis. In certain cases surgical reconstruction of the ACL may be indicated; but the indications for such surgery needs to be carefully considered in the developing world given the often minor degree of handicap and the undoubted ever present burden of cases of greater surgical priority.

Another lower limb application of orthotics in the developed world post-traumatic patient is that relating to ankle injuries. In the no- fracturing inversion injury the ligament most commonly injured is the anterior talo-fibular ligament. Studies have shown that significant injuries of this ligament are better treated by functional orthotic support than plaster immobilisation. Ankle fractures, once the cast has been removed following bony union, can also be treated with orthotic support pending the regain of range of motion, stability and proprioception.

Orthotics may also have a role in the late treatment of the severely injured limb in which, acutely, the question arises as to whether reconstruction or amputation should be undertaken. In this regard an overall assessment of the “limb inventory” should be undertaken, assessing each of the distal perfusion, skin coverage, muscle injury, distal innervation and the severity of bone injury. Published lower limb salvage scores such as MESS, PSI, LSI and NISSSA are often unwieldy to apply, not user friendly and often poorly relate to certain spectra of injury. Additionally none of these scores have been validated outside their originating institution. Most authors advocate primary amputation in Gustillo IIIC open tibial fractures, i.e. open fractures with traumatic distal vascular insufficiency. Until recently an insensate foot in a severely injured limb was also judged to be a poor prognostic indicator in terms of potential

limb reconstruction. However, a paper by Bosse et al. (2005) quoted over 50% of an insensate group who underwent reconstruction went on to ultimately regain sensation in the foot. Bosse questions whether presence or absence of an insensate foot should be part of the limb salvage algorithm. Many of such salvage severely injured limbs will require orthotic support in the prolonged recovery and rehabilitation phase.

Overall, although many severely injured limbs can be salvaged the literature is divided on the functional outcome when compared to amputation. Georgiadis (1993) found that limb salvaged patients saw themselves as more disabled, had been treated at higher cost and had a longer period of disability when compared to amputated patients.

**References**

Bosse et al. 2005. The insensate foot following severe lower extremity trauma: an indication for amputation? J Bone Joint Surg Am 87:2601-2608.

Georgiadis GM, Behrens FF, Joyce MJ, Earle AS, Simmons AL. 1993. Open tibial fractures with severe soft-tissue loss. Limb salvage compared with below-the-knee amputation. J Bone Joint Surg Am. 75:1431-1441

**Lower limb orthotics practice: trauma:**

**orthotic management: post-trauma paralysis**

**Munazza Gillani**

**PIPOS, Peshawar, Pakistan**

## Background

By definition paralysis is “loss or impairment of the ability to move a body part, usually as a result of damage to its nerve supply” or “loss of sensation over a region of the body”. One of the most common causes of post trauma paralysis is due to spinal chord injury.

Spinal chord injury (SCI) usually happens when a traumatic incident such as a fall, gunshot, road trauma accident etc. causes damage to cells within the spinal chord or severs the nerve tracts that relay signals up and down the spinal chord.

It is one of the catastrophic injuries, which is most complex. It has a significant impact on the injured person's functional, medical, psychological and economic well-being.

The most common types of SCI include:

- Contusion (bruising of the spinal chord)
- Compression (caused by pressure on the spinal cord and involve failure of the anterior column with the middle column being totally intact) (Gavin 2001)
- Lacerations (severing or tearing of some nerve fibres, such as damage caused by a gun-shot wound).
- Central chord syndrome (specific damage to the cortico-spinal tracts of the cervical region of the spinal chord).

Severe SCI often causes paralysis (loss of control over voluntary movement and muscles of the body) and loss of sensation and reflex function below the level of injury, including autonomic activity such as breathing and other activities such as bowel and bladder control.

Other symptoms such as pain or sensitivity to stimuli, muscle spasms, and sexual dysfunction may develop over time. SCI patients are also prone to develop secondary medical problems, such as bladder infections, lung infections, and pressure sores.

In order to understand the difficulties of curing paralysis, one should first understand the nature of spinal chord injury. When the spinal chord is injured due to trauma, there is localized death of the nerve cells.

Modern and recent advances in emergency care and rehabilitation allow many SCI patients to survive although methods for reducing the extent of injury and for restoring function are still limited. Immediate treatment for acute SCI includes techniques to relieve chord compression, prompt drug therapy with cortico-steroids to minimize cell damage, and stabilization of the vertebrae of the spine to prevent further injury.

Traumatic spinal chord injuries are associated with skeletal and ligamentous as well as intraspinal pathology. The most common cervical level for spinal chord injury is C5, followed by C6 and then C4. T12 is the most common thoracic level for spinal chord injury (McEvoy and Bradford 1985).

The American Spinal Injury Association has defined the ASIA Impairment Scale for spinal chord injury. This taxonomy supersedes the previously well-used Frankel Classification system.

- A = Complete: No motor or sensory function is preserved in the sacral segments S4-S5.

- B = Incomplete: Sensory but not motor function is preserved below the neurological level and extends through the sacral segments S4-S5.

- C= Incomplete: Motor function is preserved below the neurological level and the majority of key muscles below the neurological level have a muscle grade of less than 3.

- D = Incomplete: Motor function is preserved below the neurological level and the majority of key muscles below the neurological level have a muscle grade greater than or equal to 3.

- E = Normal: Motor and sensory function is normal.

**Rehabilitation**

Rehabilitation of the spinal chord injured patient is complex. It is a continuum of treatment provided by specially-trained professionals who assist the patient in learning to deal with his or her new disability. Intervention should begin as early as the day of injury and continue throughout the patient's lifetime. Despite being permanently disabled, patients have the potential to be as independent as they can, provided they are given appropriate tools and training. Comprehensive spinal chord injury rehabilitation can create accomplishment and independence from catastrophe and disability, offering hope and optimism to patients with spinal chord injury.

**Orthotic management**

***Spinal orthoses***

In case of paralysis due to SCI, Orthotic intervention can be needed in many forms. The most common condition is spinal fractures. For spinal fractures current usage of spinal orthoses depend on the amount of support or stabilization required and varies with injury.

Mild injuries are at low risk of progression of injury and require minimal immobilization with orthoses while the more severe injuries that have marginal stability, but do not require surgery, need orthoses that offer maximum stabilization and resistance to further progression of the deformity.

For non-operative management of the more severe compression fracture, an orthosis must not only reduce gross trunk motion but also must reduce segmental motion at the injured segment and provide sagittal plane hyperextension. The Hyperextension Spinal Orthoses (Jowett) (Figure 1) has long been the standard orthoses for this treatment although in recent years another hyperextension orthoses (Cash) (Figure 2) has been an acceptable alternative.

Both of the above mentioned Hyperextension Spinal Orthoses (Jewett and Cash) function well in the sagittal plane, but both lack the ability to decrease motion in the coronal and transverse planes. To treat the severe compression fracture that is at the uppermost limit of non-operative treatment, the orthoses must provide sagittal three-point hyperextension control as well as reduce gross trunk and segmental motion in all three planes. This is best accomplished with a custom molded TLSO, fitted in hyperextension (Figure 3).

Figure 1: The Jewett hyperextension orthosis. This orthosis proves excellent three point loads on the sagittal plane but does very little in motion reduction in the coronal and transverse planes.

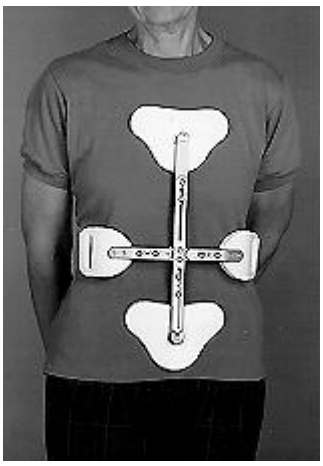

Figure 2: The Cash hyperextension orthosis. This orthosis is similar to the Jewett in that it provides excellent sagittal hyperextension and does not immobilize the coronal and transverse planes. Unlike the Jewett, the Cash is lightweight and more cosmetic.

Figure 3: The custom molded TLSO. Note that the sagittal appearance of the TLSO shown here suggests that this TLSO is in hyperextension. This orthoses is also excellent for sagittal plane hyperextension control but will also reduce coronal and transverse plane motion.

Flexible spinal orthoses made out of flexible clothes and belts are usually prescribed to help relieve low back pain associated with:

- Trauma.
- Degenerative disc disorder (formation of bone spurs that irritate nerve roots),

- Postural fatigue (weak muscles that cannot help support the back).
- At times, spinal orthoses are also prescribed to provide some stability to the spine. They typically are made of cotton, nylon, or rayon fabric (Figure 4).

Figure 4: Flexible spinal orthosis

Rigid orthoses are used to immobilize the spine. An example of a rigid brace is the custom-molded, which is made of high-temperature thermoplastic, like polypropylene. The orthosis is often used to treat people who have scoliosis or who have had surgery to fuse portions of the spine. It applies firm forces in all directions to prevent spinal motion, and it puts pressure on the abdomen. By applying pressure, the brace immobilizes the spine and relieves it if stress. Because a properly molded spinal orthoses achieves total contact with the torso, pressures and forces are distributed over the widest possible area. This serves to increase comfort as well.

The Orthotic treatment also depends upon the level of injury of the spinal chord, i.e., if the level of injury is in the cervical region, then only spinal orthoses can be intervened for provision of stabilization and support to the trunk for sitting posture management. The efficacy of any spinal orthoses is questionable in cases of rigid and structural deformities in the bony structures of the spine.

***Hip-knee-ankle-foot and knee-ankle-foot othoses (HKAFOs and KAFOs)***

HKAFOs and KAFOs can be employed if the level of injury is at T-10 or T-12 as in these cases the hip flexors are not functional and the patient needs a walking and postural support.

An important category of post trauma orthotic management is the functional fracture orthosis. Functional fracture bracing usually includes crossing a joint whose range of motion needs to be restricted or limited. Fracture bracing has evolved from the use of plaster and metal hinges at the joint to the use of low-temperature thermo-moldable plastics

In Pakistan the use of metal KAFO and HKAFO with leather straps is still common. Although they are heavy and have cosmetic drawbacks they still prove to be helpful, particularly in cases of paraplegic patients, whose SCI level is at T10 or T12.

For custom moulded KAFO the knee joint selection is very important. Usually three hinge type joints are used:

- Long Style Hinge – gives additional leverage (Figure 5A)

- Pediatric Hinge- for children (age 2-10 yrs) (Figure 5B)
- Spring Locking Hinge – recommended for Patients with extension and / or flexion weakness (Figure 5C)

A

B

C

Figure 5: Orthotic knee joints for custom moulded KAFOs

***Ankle-foot orthoses (AFOs)***

Custom molded thermoplastic AFOs can be utilised for the management of post-trauma paralysis. These AFOs have proved to be very effective in varying degrees for various problems, e.g., weak dorsiflexors (dropfoot).

A dropfoot AFO can be modified according to the need of degree of movement at the ankle joint. (Figure 6)

Figure 6: Varied stiffness ankle trimlines on polypropylene ankle-foot orthoses

The left AFO in Figure 6 is trimmed to provide dorsiflexion assist plantar flexion and resist paralytic equinus. The AFO in centre is trimmed with a stiffer ankle to provide a plantar flexion stop and dorsiflexion assist. This is helpful for multiplanar ankle instabilities and correctable deformities with instabilities. In addition, the orthosis will resist genu recurvatum (hyperextension of the knee).

Figure 7: The articulated ankle AFO (articulated with Gillete type ankle joints).

Figure 7 depicts an articulated AFO. This AFO will allow free range of passive or active dorsiflexion while preventing dorsiflexion beyond a fixed stop (usually 90° from the floor when in a shoe). This may be used for paralytic equinous (dropfoot) or to resist genu recurvatum (hyperextension of the knee) and has many other indications. It can be recommended for assisting children with neuromuscular disorders.

**Conclusion**

The types of disability associated with trauma, particularly SCI, vary greatly depending on the severity of the injury, the segment of the spinal chord at which the injury occurs, and which nerve fibres are damaged. Most people with SCI regain some function between a week and 6 months after the injury, but the likelihood of spontaneous recovery diminishes after 6 months.

Rehabilitation through orthotic intervention helps to minimize long-term disability. It requires comprehensive medical and therapeutic patient management. It is a multi-step process that begins sometimes immediately after the accident and in some cases continues for the remainder of the patient's life.

**References**

Gavin T. 2001. Orthotic treatment for traumatic spinal fractures. Retrieved March 2006 from http://www.orthotic.com/injury.html

McEvoy RD, Bradford DS. 1985. The management of burst fractures of the thoracic and lumbar spine: experience in 53 patients. Spine 10(7):631-637.

NINDS Spinal Cord Injury Information Page: NINDS. Retrieved March 2006, from http://www.wrongdiagnosis.com/artic/ninds_spinal_cord_injury_information_page_ninds.htm).

Purdue University School for Veterinary Medicine. Retrieved March 2006 from http://www.vet.purdue.edu/.

Williamson, B. J. 2003. Management of spine in cerebral palsy, J Curr Orthopaedics 17:118-119.

**Orthotic management: fracture management and post-trauma deformities**

**Bakht Sarwar**

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**Introduction**

Trauma is becoming one of the major causes of contractures and deformities of the limbs in developing countries. Prosthetics and orthotics practitioners often come across patients who develop preventable deformities after trauma including surgery. Most of these cases are:

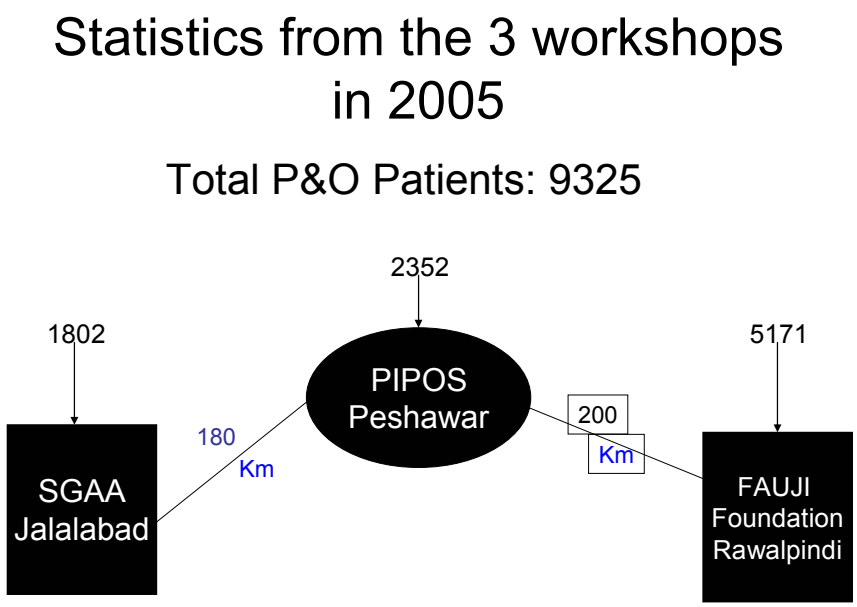
- Non-union, delayed union , mal –union of fractures
- Mal –alignment , shortening of limbs
- Balance problems from loss of sensation or movement disorders
- Infection (osteomyelitis)
- Ischaemic contracture leading to multi-axial deformities:
  - angular
  - translational, and
  - rotational deformities, such as equinocavovarus foot and ankle deformities

**Data from orthotics and prosthetics centres**

The current situation in the three main orthotics and prosthetics rehabilitation centres in Pakistan and Afghanistan are presented to demonstrate the problems arising due to post-surgical and traumatic deformities. The centres reviewed are:

1. PIPOS (Pakistan Institute of Prosthetic and Orthotic Sciences) Patient Care Centre Peshawar, Pakistan
2. Artificial Limb Centre, Fauji Foundation Hospital(FFALC), Rawalpindi, Pakistan
3. SGAA (Sandy Gall's Afghanistan Appeal) Workshop, Jalalabad, Afghanistan

In the year 2005 a total 9325 patients were seen in these three centres which are situated in the big cities and are connected to hospitals in the respective areas.



The ratio between prosthetics and orthotics patients in these centres in the year 2005 were as follows:

| O&P facility | Total patients | Prosthetics | Orthotics | Percentage |
|---|---|---|---|---|
| PIPOS | 2352 | 420 | 1932 | 82 % |
| SGAA | 1802 | 534 | 1268 | 70 % |
| FFALC | 5171 | 1520 | 3651 | 70 % |
| TOTAL | 9325 | 2474 | 6851 | 73 % |

Out of total 9325 patients, 6851 (73%) were orthotics patients while in PIPOS the percentage was even higher (82%), the reason being that PIPOS has a close collaboration with teaching hospitals in these areas.

The aetiology based distributions of these cases are:

| O&P facility | Patients | Polio | Clubfoot | CP | Others | Trauma | Percentage |
|---|---|---|---|---|---|---|---|
| PIPOS | 1932 | 488 | 341 | 134 | 503 | 456 | 23 % |
| SGAA | 1268 | 642 | 204 | 55 | 206 | 161 | 12 % |
| FFALC | 3651 | 1586 | 787 | 111 | 601 | 566 | 15% |
| TOTAL | 6851 | 1316 | 1332 | 300 | 1130 | 1183 | 17 % |

It is obvious that trauma patients (17 %) comprise a large number of the total patients seen by orthotics rehabilitation services. PIPOS again has a higher percentage due to the fact that it has close collaboration with other medical professionals and has created awareness among the allied health professions. The majority of the cases referred to these centres were:

- Fractures
- Soft tissue injuries
- Peripheral nerve injuries
- Post-surgical complications

Amongst the causes of the trauma the following were noted:

- Road trauma accidents
- Bullet injuries
- Burn accidents
- Fall injuries
- Post-surgical cases
- Blasts (mines, bombs, etc)

The orthotic management of post-trauma cases can be divided into the following three phases depending on the status of trauma and patient.

***Early phase*** (patient is still in hospital): In early phase early joint motion is good for muscular activity and blood supply. The focus/characteristics of early phase orthoses should be:

- to immobilize the selected anatomical areas to impose rest to the inflamed tissues
- to accommodate oedema reduction or change of contour of a wound area.
- to accommodate changes in the volume of the fractured extremity being protected and immobilized.
- to provide stability while eliminating/limiting motion
- to allow gradual correction of angular, translational, and rotational deformities simultaneously.

***2nd phase*** (patient discharged): When deformities are still flexible, the orthosis focuses on:

- preserving joint mobility,
- strengthening affected muscle groups,
- regaining motion or function in the limb
- implementing correction, and

- providing accommodative footwear.

***3rd phase*** (patient /doctor have given up): When deformities are fixed, orthosis must meet the following criteria:

- respect anatomy
- accommodate the deformity
- provide/encourage mobility
- provide comfort in walking

At the present time the advances in materials, components and application of some engineering principles make it possible to make appropriate orthoses for each of the above phases.

**Low-temperature thermomouldable plastics**

The application of these materials can be used for:

- easy modification of orthotic function and design to provide for appropriate immediate and aftercare
- ability for close contouring to the anatomy of the limb
- creation of the desired degree of flexibility or rigidity

**Hydrostatic pressure**

The major engineering principle of hydrostatic compression, the ability to properly control the soft tissue mass on the fractured limb between the proximal and distal joints can be used for:

- early weight bearing
- optimal pressure distribution

Similarly the availability of prefabricated systems, series of hook and loop type closures and innovation of modular setups and systems make possible:

- the availability of great number of orthoses for emergency and aftercare
- accommodation of changes, adjustments and better fitting
- control of range of motion of the anatomical joint and to maintain its use
- to maintain best hygienic procedures

**Conclusion**

The increased outcome awareness has influenced advances in manufacturing and prefabricated orthoses. The orthotist has a big role in developing countries in the orthotic management of post-trauma deformities. The continuing trend of an increased awareness of outcomes management in medical care has to be translated in the use of orthoses as a method of improving the outcomes of post-trauma management.

**Plenary Discussion "Lower lomb orthotics practice - Trauma"**

**Chair: John Fisk**

**Rapporteur: Nerrolyn Ramstrand**

## Discussion

Steve Manion

- It is impossible to get orthoses for trauma in the developing world. If you could get them what would you wish for?
    - Spinal orthoses and Sarmiento braces for humeral fractures. Then lower limb orthoses for the very seriously injured limb (eg: AFO's, KAFO's).
- Do these orthoses need to be commercially available or can we fabricate them locally
    - With the skills we have we can absolutely fabricate them locally
- From a temporary point of view, physiotherapists tend to fit many of these devices. Are orthotists doing this in the developing world?
    - At times we must improvise. In the disaster management team the orthotist becomes an important member of the team.
- What are your thoughts on treatment of fractures in the developing world with amputation? I ask because it is so difficult to get a prosthesis and wonder is amputation really the best thing to do or should we concentrate on reconstruction?
    - Because prosthetic care is so very bad, one performs an amputation believing that the patient will never be fitted with a prosthesis.

Munazza Gillani

- How are you addressing the issue of repair of orthotic devices when the device is a little more complicated and requires attendance at an orthotic clinic for repair.
    - CB programs with small orthotic units. We encourage our students to return to the rural place from which they came.
- Do your spinal cord injured patients who get mobilised early actually become mobile when back in their community,
    - We really lack follow-up in the community.
- Is there any studies that address energy consumption regarding wheelchair use versus KAFO and HKAFO?
    - No

Bakt Sarwar

- How much are your materials reused
    - Yes we reuse our materials many times.
- In the acute phases is the orthotist involved in closed management (eg: traction etc.)
    - Not so much but the orthotist is involved in fracture management after initial casting.
- During the earthquake there were a large number of NGO's whishing to set up P&O centres. This was way above the need. What involvement did you have?
    - We ended up setting up 5 centres. It was important that they were sustainable. We are coordinating the centres and communicating with all the NGO's

**Lower limb orthotics practice:**

**Stroke/traumatic brain injury: clinical aspects**

**Carolina Schiappacasse**

**Rehto Rehabilitation Center, Buenos Aires, Argentina**

**Recovering from a brain injury – Assessment and treatment**
It is important to recognise that changes happen up to six months after the initial injury and the condition is not considered stable for 18-24 months.

Recovering from a brain injury requires;
- Clinical stabilization
- Reabsorption of edema
- Prevention of secondary damage
- Brain neuroplasticity

The following general considerations should be made when developing a treatment plan;
- Begin treatment in the acute stage in terms of neuroplasticity
- Adapt treatment to case polymorphism
- Continue with treatment in those areas where patients show some progress

Patients are categorized according to basic functional level, dependent or independent together with a Glasgow coma score (GCS). Referral for treatment is based upon the Glasgow outcome scale.
- GOS 2 – maintainance of care and established stimulation plan at the rehab center or at home.
- GOS3 or 4 (moderate or severe) – referral to rehabilitation center until family is adequately integrated and trained. Then continue ambulatory treatment or home treatment.
- GOS 5 – Ambulatory treatment and follow up.

During the acute phase, rehabilitation actions are aimed at the following;
- Prevention of damage due to immobilization
- Iniciation of multisensorial stimulation and specific treatment and medication
- Family support and councelling
- Referral to continue adequate treatment

Prevention of secondary damage following immobilization involves;
- Respiratory care
- Preventing thromboemboli
    - Use of pneumatic boots or elastic bandages
    - Antiagreggates
- Care of the skin and mucosa to prevent pressure ulcers
- Postural care
- Maintaining articular ranges
- Nutritional care
- Transitory fitting

Pressure ulcers are graded according to the following;
- Grade 1 – erythema and oedema

- Grade 2 – scaling and cracking with vesicles
- Grade 3 – up to subcutaneous cell tissue
- Grade 4 – up to muscle or bone

Postural care in confused or agitated patients involves;
- Verbal and physical support
- Close bodycontact
- Keeping the patient aligned
- Padding external fixators
- Medication – transitory and dynamic

It is necessary to remember to pad areas, needles and sharp objects appropriately to protect the patient and caretakers from injury.

When the patient is independent and ready for final fitting of an orthotic device one must consider;
- Motor and sensitivity assessment
- Cognitive assessment
- Social assessment

Motor issues of importance include;
- Significant tone variations
- Posture and spontaneous movements
- Sensory afferents involved
- Weakness and muscle hypertrophy
- Secondary mechanical disorders following fractures, calcification, nerve injury etc.

Cognitive issues of importance include;
- General slowness
- Fluctuation state of awareness
- Memory problems
- Attention deficit
- Association difficulties
- Integration deficit
- Difficulty to transfer learned behaviors
- Difficulty to manage abstract situations

Behavioral issues of importance include;
- Emotional and psychiatric issues
    - Sleep disorders
    - Aggressiveness
    - Disinhibition
    - negativism
- Sexual issues
    - Denial od deficits
    - Lubile attention
    - Apathy
- Social disabilities
    - Lack of hedonism
    - Depression, anxiety
    - Manic behaviour
    - Psychosis
    - Family integration

# Lower limb orthotics practice: orthotic management of stroke and traumatic brain injury

**Robert James Bowers**

**National Centre for Training and Education in Prosthetics and Orthotics, University of Strathclyde, Glasgow, Scotland, UK**

## Introduction

While the population of stroke and traumatic brain injury (TBI) survivors is clearly not homogeneous, the similarities in the common sequelae of stroke and TBI mean that comparable orthotic approaches may be adopted in the management of both conditions.

Historically, the use of lower limb orthoses in the treatment of persons who have sustained a stroke or TBI has been resisted by some in the rehabilitation community, particularly those in the therapy professions who have been trained in certain neurological and neurodevelopmental approaches. The belief that the orthoses may in some way interfere with the normal physiological recovery of the patient is being replaced by an increasing acceptance that orthotic intervention, as an adjunct to other therapeutic interventions, can form an integral component of the rehabilitation of these patient populations. The all too common practice of considering the use of orthoses almost as a last resort, at a late stage in the rehabilitation process, is also changing as the benefits of early intervention are being recognized.

When considering orthotic treatment, it is important that prescription of the orthosis is based on a thorough biomechanical analysis of the patient's functional deficit, involving the establishment of clearly defined objectives. Over the years, a variety of designs of orthoses have been employed with mixed success in the rehabilitation of persons who have survived a stroke or TBI. Some are made in traditional materials like metal and leather, but nowadays the most commonly used and the most effective are made from plastic, a material which has many benefits, including the ability for close contouring to the anatomy of the limb, and optimal pressure distribution. The most common orthotic intervention is the ankle-foot orthosis (AFO), and discussion of the various designs of this orthosis will form the bulk of the remainder of this paper.

## Prescribing the correct orthosis

The decision about which orthosis to use in any given circumstance is confusing to many clinicians. The range of available options is extensive and some of the published research is confusing, often providing inadequate detail about the design characteristics of the orthosis being studied, thereby preventing the reader drawing adequate conclusions, from which treatment decisions can me made with confidence. The available literature includes well conducted research on orthoses that are either inappropriately prescribed, or have been poorly fitted, as well as studies on well-designed orthoses that have been subjected to poor research methodology. Useful information on the evidence for the use of different designs of ankle-foot orthoses in the management of stroke is available in the ISPO report of a consensus conference on the orthotic management of stroke patients (Bowers 2004; Hoy and Karas Reinthal 2004) and will not be reproduced in detail here. Rather, this paper will review the recommendations of this consensus conference, before going on to discuss some of the finer points of AFO selection and alignment.

It should be clear at the outset that an understanding of the features of normal gait, coupled with an ability to comprehensively identify the various elements of the pathological gait of the patient, and recognition of the biomechanical requirements of the orthosis, are necessary prerequisites to informed prescription. When considering the use of any orthosis, it is vitally important to remember that many of the problems encountered in hemiplegic gait are directly related to the abnormal biomechanical situation facing the patient. Logically, this means that

the objective of any orthotic treatment should be to attempt to “normalise” the biomechanical environment, inasmuch as this is possible.

While some plastic AFOs can be purchased ready-made, these are of limited value, and should be considered useful only as a temporary, evaluation orthosis or where there is a need for early mobilisation before a custom orthosis can be provided (ISPO 2004). Many of these ready-made (or off-the-shelf) AFOs are made in the style of a Posterior Leaf Spring (PLS), an orthosis that has very specific prescription criteria. The PLS orthosis should be used only in situations where there is isolated weakness of the dorsiflexor muscles, and importantly, no significant problem of tone or spasticity, no significant mediolateral instability of the foot, and no requirement for orthotic influence on the knee and/or hip criteria which will clearly rule out many stroke and TBI patients (ISPO 204). Obviously, care must therefore be taken when using a PLS as an evaluation orthosis, as its function may be markedly different from a custom-made AFO. The use of a readily available, but biomechanically inappropriate evaluation orthosis may easily mislead the clinician to draw the conclusion that an orthosis is of little or no value in rehabilitation after stroke or TBI, when in truth a different design of orthosis might be extremely beneficial.

The best AFOs are designed and custom-made by a trained orthotist for the individual patient to be treated, based on a thorough assessment of their biomechanical deficit, and clearly identified functional outcomes. Some have mechanical ankle joints to allow or assist motion in one direction, while preventing or limiting it in another, while others rely on the characteristics of the plastic to create the desired degree of flexibility or rigidity to achieve this control. The best AFOs will exert their influence on the knee and the hip, as well as the foot and ankle.

**Functional deficit**

Frequently the rationale for prescribing an AFO is to address the problem of a “dropped foot”, but it should be obvious that this group of patients faces many more significant challenges to their mobility than simple swing phase equinus. While it is true that in the early stages of recovery the foot and ankle may indeed often be flaccid, leading to difficulty clearing the toes during swing phase, over time the picture commonly changes to one in which the foot and ankle posture into a more typical position of persistent plantar flexion and supination. Although the population of stroke and TBI survivors is not homogeneous, a number of commonly encountered gait problems may be identified. Hemiparetic gait can be characterized as slow and stiff, with a reduction in both cadence and step length (Richards et al. 1995). Poor coordination of movement leads to primary and compensatory gait deviations and a considerable increase in energy cost (Lehmann et al. 1987) Hemiparetic gait is also markedly asymmetrical, with the step-length of the affected limb being greater than that of the unaffected side, while stance is shorter and swing is longer on the affected side. This is associated with difficulty bearing weight through the affected limb (Ryerso and Levit 1997; Olney and Richards 1996). Initial contact of the foot on the ground typically occurs with the lateral aspect of the forefoot, due to tone-induced equinovarus deformity. Persistence of supination throughout stance affects ankle stability and balance. Knee hyperextension in mid- to late stance is common, and tibial progression in second rocker is impeded by the abnormally plantar flexed position of the foot. In swing, hip and knee flexion and ankle dorsiflexion are reduced (Perry 1992) with hip circumduction the compensatory mechanisms commonly employed to aid ground clearance.

The reviews of literature undertaken for the ISPO Consensus Conference uncovered evidence of beneficial effect of AFOs in respect of improving the energy cost of gait, walking speed and cadence, step length, gait symmetry, weight bearing through the affected leg, equinus and varus, and hyperextension of the knee (Bowers 2004; Hoy and Karas Reinthal 2004). No evidence was found to support the view that AFOs could improve spasticity, or that it could have a beneficial effect on the hip joint

### Discussion of AFO use

Many problems affect the gait of stroke and TBI survivors. With the recognition of the fact that the problems encountered in stance phase are typically more challenging than those of swing phase, should come the realisation that an orthosis, most commonly an AFO, can potentially have much greater influence on stance than on swing. One important objective should be to address the problem of stance phase instability associated with uncontrolled pronation, or more typically supination of the foot, which often affects the patient's ability to bear weight safely through the affected limb. This lack of stability while bearing weight through the affected extremity has consequent effects on the symmetry of gait, and the length and quality of swing phase of the unaffected leg.

As well as experiencing the effects of unwanted plantar flexion in swing phase, the gait of many stroke and TBI patients is adversely affected by stance phase plantar flexion, due to an increase in plantar flexor tone or spasticity, or shortening in the plantar flexor muscle group. This is an issue that must be addressed. The presence of stance phase plantar flexion has implications for the design of the AFO, which, in some cases, must be strong enough to resist a considerable spastic plantar flexion moment. To be successful therefore, a plastic AFO to control spastic equinus must have a greater degree of stiffness than an AFO that is required simply to control flaccid equinus in swing phase. An ankle strap to improve plantar flexion control is a useful addition to the orthosis. Alternatively, if an AFO with a mechanical articulation at the ankle is to be considered, then the ankle joint should limit plantar flexion, either with a stop, or a spring to resist plantar flexion and assist dorsiflexion. When considering allowing dorsiflexion to occur however, consideration must be given to the important issues of plantar flexor shortening or spasticity, which are contraindications to this approach.

The biomechanical effect of stance phase plantar flexion is anterior displacement of the origin of the ground reaction force (GRF), with the consequence that a significant extension moment is generated at the knee throughout stance phase, together with an equally problematic flexion moment at the hip. As a result, knee hyperextension and hip flexion/retraction are common. The correct application of an appropriate AFO achieves two things. First, by controlling the alignment of the talocrural joint there is a consequent realignment of the proximal joints of the leg. Second, realigning the talocrural joint to a more dorsiflexed position allows the patient to bear weight through the whole plantar surface of the foot rather than only the forefoot. This realigns the origin of the GRF posteriorly to the mid-foot and further aids in beneficially modifying its relationship to the knee and the hip. The net result is reduction of the knee extension moment and the hip flexion moment manipulating and realigning the GRF close to the centres of the knee and the hip throughout stance, thereby reducing the demand on the neuromuscular system, and facilitating switching" of moments from say, flexion to extension, implying transfer in neuromuscular demand, replicating a more normal state (Bowers and Meadows 2004).

In an ideal situation the orthosis should help to facilitate the generation of extension moments at both the knee and the hip joints in mid-late stance, which is a biomechanically normal condition. The orthosis can therefore influence both swing and stance, but has its greatest effect in stance phase.

### Dorsiflexion or tibial inclination?

Clearly then, when considering the design characteristics of any AFO, one important factor would appear to be the angle of plantar flexion or dorsiflexion at which the talocrural joint is to be positioned or limited by the orthosis. Not only will this influence swing phase clearance, but as we have seen, it is also highly significant in terms of optimising second rocker and influencing the kinetics and kinematics at the knee and the hip. A number of authors have reported on the importance of this angle in controlling hyperextension of the knee. Lehmann et al. (1987) was successful in realigning the knee and controlling hyperextension using a metal solid AFO set in 5° dorsiflexion. Miyazaki et al. (1997) found that a dorsiflexion angle of 7° ensured good results, while Oshawa et al. (1992) recommended 10°. From the evidence in the literature, it would appear therefore that some angle of dorsiflexion is necessary to

achieve the normalisation of bending moments about the knee, which is essential if we are to control knee recurvatum, as well as in ensuring the effective forward progression of the body over the affected limb. However, this is rather an over-simplification. In truth it is the angle of inclination of the tibia relative to the ground in stance that is the important factor, rather than the angle of dorsiflexion per se. While dorsiflexion and tibial inclination are the same in the barefoot situation, in practice they are related, but different. If an orthosis is made which holds the ankle in plantar flexion, for example in the presence of a contracture, the angle of tibial inclination can still be made to be reclined, vertical or inclined, depending on the heel height of the footwear and the use of heel wedges to "tune" the orthosis. Some degree of tibial inclination is normal in mid-stance (Winter 1990) and in normal gait the tibia, from a reclined position at initial contact, rotates anteriorly to an angle of approximately 10° inclined, at which position it pauses while the thigh rotates forward over the knee, facilitating maximum knee extension in late stance. At end stance, both the tibia and the femur should be inclined (Owen 2004). This is necessary if we are to successfully align the GRF in front of the knee and behind the hip, creating the desired extension moments at both joints which are so important in enabling the support of body weight in late stance (Meadows 1984). Effective stable support in late stance also facilitates improved swing of the opposite leg.

Following a stroke or TBI, shortening of the plantar flexor musculature is very common (O'Dwyer et al. 1996; Sinkjaer and Magnussen 1994; Thilman et al. 1991) particularly in the gastrocnemius muscle. It is therefore possible to dorsiflex the talocrural joint further when the knee is flexed, than with the knee extended. While it may be tempting to cast the patient for the AFO with the talocrural joint at 90°, or even in a dorsiflexed alignment, care must be taken to avoid dorsiflexing the foot in the orthosis beyond the position permitted by the length of the gastrocnemius, (i.e. the range available when the knee is extended). Doing so will result in the gastrocnemius contracture limiting the range of knee extension available in late stance phase, and will actually prevent the achievement of the desired hip and knee extension moments. The limiting factor to dorsiflexing the foot must always be the length of the gastrocnemius. Thereafter, wedging is utilised to align, or "tune" the orthosis (Owen 2004), which is as important to optimising gait as is the alignment of a prosthesis.

### Articulated or non-articulated?

Controlling the kinematics of the tibia is critical to the success of the AFO. Whether this should be done by adding mechanical ankle joints to the orthosis, or making a non-articulated design can sometimes be confusing. It is tempting to think that gait with orthosis which has a moving ankle must be superior to that in a design in which the ankle is fixed, but this is not necessarily so (Beckerman et al. 1996; Kakurai and Akai 1996). Mechanical ankle joints permitting ankle dorsiflexion are indicated only in the presence of adequate dorsiflexion range. There is no evidence that gastrocnemius length can be increased by allowing free dorsiflexion to take place in the orthosis. In fact, the only way that dorsiflexion can occur in the presence of a short gastrocnemius is at the expense of full knee extension, in which case the desired inclinations of the tibia and the femur are lost. In order that the gastrocnemius can be passively stretched by extension of the knee in late stance, the orthosis actually needs to block dorsiflexion.

### Control of the knee

Uncontrolled knee flexion due to weakness of the quadriceps, or of the plantar flexors, or a combination of the two, clearly places the patient at considerable risk of falling. A knee-ankle –foot orthosis (KAFO) may be the best and safest way for more severely affected patients to transfer or for ambulation to occur, particularly in the early stages of rehabilitation, improving postural alignment and enabling better weight bearing through the affected limb. It may be possible to reduce the KAFO prescription to an AFO following reassessment of the patient's requirements (Kakurai and Akai 1996) [20].

Hyperextension of the knee is common following stroke or TBI, and should not be ignored due to its effect on gait and its potential for progression (ISPO 2004). Knee hyperextension during stance phase may be the result of hypertonus of the ankle plantar flexors, the presence of a plantar flexion contracture, weakness of the hamstrings or compensation for knee extensor

weakness, although this is less likely in the stroke population. Orthotically, the problem may be addressed in a variety of ways. The most obvious solution would appear to be to use an orthosis that structurally bridges the joint, such as a knee orthosis (KO). KOs, however, are rarely of value in this patient population due to the fact that the knee instability typically coexists with deformity or instability at the foot and ankle, requiring concurrent treatment. A KAFO may therefore be regarded as a better option, as in this way the problems of the knee and the ankle-foot can be addressed simultaneously. It should be remembered, however, that the use of KAFOs in the stroke and TBI population often requires that the mechanical knee joint be locked in order to provide knee stability, with consequent increase in the energy cost of walking. Indirect control of the knee using an AFO should therefore be the approach of first consideration.

### Control of the hip

Direct control of the hip using either a hip orthosis or hip-knee-ankle-foot orthosis is impractical in the stroke/TBI population, and these devices are rarely if ever used to good effect. A more pragmatic approach to the commonly encountered problems of hip flexion and retraction may be to use an AFO to control the sagittal plane alignment of the ankle, thereby manipulating the ground reaction force and modifying its relationship with the hip. Following a stroke or TBI, the plantar flexed position of the foot typically has the consequence of aligning the ground reaction force anterior to the hip joint. This exacerbates the flexed position of the hip, making it more difficult for the hip extensor muscles to extend the joint. Abnormal GRF alignment contributes significantly to the abnormal position and kinematics of the hip joint. While evidence is lacking on the ability of an AFO to influence the hip joint in this way in the stroke/TBI population, a free paper presented at the ISPO World Congress in Hong Kong in 2004 provides some supporting data from early research results (Bowers and Meadows 2004). It seems reasonable to assume that evidence of this effect from the literature on the orthotic management of cerebral palsy may be extrapolated to stroke and TBI patients (Meadows 1984).

### Conclusion

Although the use of orthoses, particularly AFOs, in the rehabilitation of patients with stroke and TBI has long been a recognised treatment option, there remains disagreement regarding what constitutes best practice, a problem that is exacerbated by the fact that the existing scientific evidence for their effectiveness is generally at low levels. There is a clear need for further, high level research to further investigate the benefits of this treatment modality. In addition, future research must include explicit detail of the design and biomechanical features of the AFO being studied to enable the reader to reproduce the work. Adopting an analytical and biomechanically sound approach to identifying the functional deficit facing the patient remains an essential prerequisite to the selection of an appropriate orthosis.

### References

Beckerman H, Becher J, Lankhorst GJ, Verbeek ALM. 1996. Walking ability of stroke patients: efficacy of tibial nerve blocking and a polypropylene ankle-foot orthosis. Arch Phys Med Rehabil 77:1144-1150.

Bowers RJ. 2004. Non-articulated ankle-foot orthoses. In: Report of a consensus conference on the orthotic management of stroke patients. Condie ME, Campbell J, Martina JD, (eds). Copenhagen: ISPO.

Bowers RJ, Meadows CB. 2004. Case study: the effects of a solid ankle foot orthosis on hemiplegic gait. In: Proceedings of the 11th World Congress of the International Society for Prosthetics and Orthotics, Hong Kong, China, August 1-6, 2004.Copenhagen: ISPO.

Hachisuka K, Ogata H, Tajima F, Ohmine S. 1998. Clinical evaluations of dorsiflexion assist controlled by spring ankle-foot orthosis for hemiplegic patients. J Univ Occup Environ Health 20(1):1-9.

Hoy DJ, Karas Reinthal MA. 2004. Articulated ankle foot orthosis designs. In: Report of a consensus conference on the orthotic management of stroke patients. Condie ME, Campbell J, Martina JD (eds). Copenhagen: ISPO.

ISPO. 2004. Report of a consensus conference on the orthotic management of stroke patients Condie ME, Campbell J, Martina JD (eds). Copenhagen: ISPO.

Kakurai S, Akai M. 1996 Clinical experiences with a convertible thermoplastic knee-ankle-foot orthosis for post-stroke hemiplegic patients. Prosthet Orthot Int 20:191-194.

Lehmann JF, Price R, Condon SM, De Lateur BJ. 1987. Gait abnormalities in hemiplegia: their correction by ankle-foot orthoses. Arch Phys Med Rehabil 68:763-771.

Meadows CB. 1984. The influence of polypropylene ankle-foot orthoses on the gait of cerebral palsied children. PhD Thesis. Glasgow: University of Strathclyde.

Miyazaki S, Yamamoto S, Kubota T. 1997. Effect of ankle-foot orthosis on active ankle moment in patients with hemiparesis. Med Biol Eng Comput 35:381-385.

O'Dwyer NJ, Ada L, Neilson PD. 1996. Spasticity and muscle contracture following stroke. Brain 119:1737-1749.

Olney SJ, Richards C. 1996. Hemiparetic gait following stroke. Part I: characteristics. Gait and Posture 4:136-148.

Oshawa S, Ikeda S, Tanaka S et al. 1992. A new model of plastic ankle-foot orthosis (FAFO (II)) against spastic foot and genu recurvatum. Prosthet Orthot Int 16:104-108

Owen E. 2004. Shank angle to floor measures and tuning of ankle-foot orthosis footwear combinations for children with cerebral palsy, spina bifida and other conditions. MSc Thesis. Glasgow: University of Strathclyde

Perry J. 1992. Gait analysis: normal and pathological function. Thorofare, NJ: Slack Inc.

Richards CL, Malouin F, Dumas F, Tardif D. 1995. Gait velocity as an outcome measure of locomotion after stroke. In: Gait analysis: theory and applications. Craik RL, Oatis CA (eds). St. Louis: Mosby.
.
Ryerson S, Levit K. 1997. Functional movement reeducation. New York: Churchill Livingston.

Sinkjaer T, Magnussen I. 1994. Passive, intrinsic, and reflex-mediated stiffness in ankle extensors of hemiparetic patients. Brain.117:355-363.

Thilmann AF, Fellows SJF, Ross HF. 1991. Biomechanical changes at the ankle joint after stroke. J Neurol Neurosurg Psychiat 54:134-139.

Winter DA 1990. Biomechanics and motor control of human movement. 2nd edition. New York: John Wiley & Sons.

# Feet lacking protective sensation: clinical management

**Steve Mannion**

**CBM, Blackpool Victoria Hospital, UK**

*(Editors' Note: Manuscript not submitted. This paper is based on the PowerPoint presentation made at the conference)*

## Neuropathy

- Loss of protective sensation
- Causes :
  - **Diabetes**
  - Syphilis
  - Leprosy
  - Chronic alcoholism
  - Congenital indifference to pain
- Results in:
  - Neuropathic ulcers
  - Charcot arthropathy

## Neuropathic ulceration

- "Mal perforant"
- Painless
- Round
- Surrounded by callus
- Foot is warm, dry and pink
- Commonest sites:
  - Metatarsal head
  - Plantar surface of toe

## Pathophysiology

- Loss of protective sensation
- Limited joint mobility
- Motor neuropathy:
  - Claw toes
  - MTPJ hyperextension
- Migration of plantar fat pad
- Prominent MT heads
- Soft tissues less pliable
- Autonomic neuropathy
- 15% of diabetics will have foot ulcer in their lifetime

## Classification

- Meggitt & Wagner
  - Grade 0: Callosity over bony prominence
  - Grade 1: Superficial ulcer
  - Grade 2: Deep ulcer, penetrating to tendon or joint capsule
  - Grade 3: Joint violated, septic arthritis or osteomyelitis
  - Grade 4: Gangrene

**Treatment: Grades I & II**

- Prevention!
- Weight relief:
  - Crutches/walker
  - Wheelchair if bilateral
- Total contact casting (Brand):
  - Distributes forces over entire foot
- Custom moulded orthosis:
  - Redistributes pressure
  - Absorbs compressive and shear forces
  - Controls ankle & foot motion

**Treatment: Grade III**

- (Diabetic control)
- Treatment of infection
- Excisional debridement

**Treatment: Grade IV**

- Gangrene of all or part of the forefoot
- Partial foot amputation, ankle disarticulation or higher ray resection(s):
  - Transmetatarsal amputation
  - Lisfranc & Chopart…little place
  - Syme
- Primary vs delayed closure vs open management

**Charcot arthropathy**

- Progressive condition
  - Joint dislocation
  - Pathologic fractures
  - Debilitating deformities
- Any joint, but most common in ankle

**Aetiology**

- Any condition which causes sensory or autonomic neuropathy
- **Diabetes**
- Syphilis
- Leprosy
- Meningomyelocele
- Spinal cord injury

**Pathophysiology**

- 2 theories
- Neurotraumatic:
  - Unperceived trauma
  - Osseous destruction with ambulation
- Neurovascular:
  - Autonomic neuropathy causes inc blood flow
  - Osteopenia and collapse
- Probably combination of two

**Clinical presentation**

- Varies:

    - Mild swelling/no deformity
    - Severe swelling and deformity
- Acutely – signs of inflammation:
    - Swelling, heat, erythema, effusion, bone resorption
- **Pain – in over 75%**
- Patterns of deformity:
    - Bony prominence
    - Clubfoot
    - Rocker bottom foot
- 40% will also have ulceration:
    - Need to exclude osteomyelitis

**Treatment of Charcot arthropathy**

- Primarily non-operative
- Acutely: Immobilisation and stress reduction:
    - Total contact casting
    - Non/partial weight bearing
- Life-long protection and patient education:
    - Foot care
    - Orthoses
- Prolonged healing times

**Surgical treatment**

- Less than 25% of cases
- Exostectomy of bony prominence
- Osteotomies
- Arthrodeses
- Internal fixation
    - *All prolonged healing times…*
- Amputation

**Summary**

- The insensate foot is subject to:
    - Neuropathic ulceration
    - Charcot arthropathy
- Prevention where possible
- Treatment primarily conservative:
    - Limited / protected weight bearing
    - Total contact casting
    - Orthoses
- Limited role for surgery
- Treatment is prolonged

**Lower limb orthotics practice: feet lacking protective sensation: orthotic aspects**

**Heinz Trebbin**

**University of Don Bosco, San Salvador, El Salvador**

## Introduction

Diabetes mellitus affects approximately 16 million Americans, or 5% of the population. Unfortunately, one-third of those with the disease remain undiagnosed and are not even aware that they have it. About 15% of people with diabetes will develop an open sore on their feet at some time in their life. The consequences of these sores can be devastating. Diabetes is the leading cause of non-traumatic lower limb amputations in the United States. Recent statistics reveal that there are over 86,000 lower limb amputations performed each year on people with diabetes. Foot disease in people with diabetes costs the USA more than $1 billion each year.

## Problems

The causes of foot problems in people with diabetes are related mainly to two factors. First and foremost, diabetes can cause nerve damage, called diabetic neuropathy, in the feet and legs. This leads to loss of feeling and loss of protective sensation, leaving people with diabetic neuropathy unable to feel injury to their feet. Even seemingly minor injuries, such as pressure in their shoes or a scrape to their toes, are not able to be sensed. When an injury occurs, there is no pain response to prompt them to look at their feet and evaluate the problem. Therefore, minor injuries can progress to major injury, infection, tissue loss, and amputation.

Secondly, diabetes can also affect the circulation in the feet and legs. Most commonly, people with diabetes develop calcifications within the arteries of the feet and legs. This usually starts in the small blood vessels of the toes and can progress higher into the legs. If an injury or open sore occurs, these people do not have adequate circulation to heal their wounds. With the combination of neuropathy, poor circulation, and an injury, it is easy to imagine why there are so many amputations in people with diabetes.

Patients with diabetes do, however, have reason to be optimistic. It is estimated that two-thirds of diabetic related amputations can be prevented with appropriate foot care. Just because one has poor circulation or neuropathy, it does not mean that an amputation can not be avoided. Amputation usually requires an "event" (some injury or sore on the foot) that leads to an infection that does not heal. Consequently, there are very concrete self-management practices and professional evaluation and treatment can prevent and reduce the risk of amputations.

## Orthotics and pressure relieving interventions

All pressure relieving interventions need to be correctly fitted and regularly reviewed in order to avoid trauma. As the patient may have an insensitive foot they may not be aware of any damage being caused.

*Callus removal*: Calluses press into the soft tissue causing pressure, ulceration and a possible entry point for infection.
*Hosiery*: Padded hosiery may protect the feet, reduce plantar pressure and reduce callus build up.
*Special shoes*: These are usually extra-depth shoes that are ”made to-measure" with soft leather uppers and room to accommodate foot deformities and/or orthoses. These are worn with the aim of improving the function of the foot and redistributing the loading on the foot.
*Orthoses*: Orthotic devices are specially made insoles (either for conventional footwear or special shoes) that provide cushioning and the redistribution of pressure loading. Insoles can be made from a number of materials e.g. cork, rubber etc.

*Total ontact casts*: These are used for the treatment of diabetic foot ulcers and work on the principle of providing pressure redistribution and reduction of mechanical loading.
The use of pressure platforms has shown that the site of ulceration in diabetic patients correspond to the location of highest pressures on the foot and have confirmed the decrease of toe loading in diabetic patients. They concluded that structural deformities result in areas of abnormally high pressure and recommend pressure assessment as part of routine foot screening in the early stages of the patient's disease. When deformities are found in the presence of neuropathy or peripheral vascular disease the foot is at a high risk of ulceration. Ulcers may be prevented by orthoses and modified footwear designed to reduce foot deformity-induced areas of high pressure.

Custom-moulded orthoses are recognised and recommended as an adjunctive measure in the management of the diabetic foot. The custom-moulded orthoses function by redistributing pressure, absorbing compressive or shear forces, reducing internal mechanical stress and immobilizing or controlling motion of the foot and ankle. The goal is to prevent trauma, foot ulceration and associated morbidity, specifically amputation of digits and lower limbs.

Treatment of the neuropathic foot requires accommodation, relief of pressure/shear forces, and shock absorption. Regardless of materials used for accommodative inserts, the combination of materials must be compressible by one half of the original thickness to accommodate for pressure relief through the gait cycle.

It is important to evaluate the materials used in the manufacture of inserts. There are different types of inserts, including soft (cushioning/accommodation, improves shock absorption), semi-rigid (some cushion/accommodation; affords pressure relief), and rigid (hard, single layer of plastic; it controls abnormal foot and leg motion).

By combining materials over a cast model of the foot, the composite type of insert can achieve all goals of the accommodative insert and provide a life of about 1 year.

The Prosthetics and Orthotics Center of the University of Michigan has developed a so called dynamic foot orthosis for patients with ulcers. The design is based on basic concepts of stress, strain, shear, torsion and its relationship with each other. The Dynamic foot orthosis incorporates a "rolling and sliding motion" at the fore foot eliminating shear, friction and torque generated during gait. The orthosis is particularly designed for the treatment of foot ulcers in diabetic neuropathy

**Conclusion**

Loss of protective sensation is the primary factor in foot ulceration in diabetes. Mechanical stresses resulting from joint deformity, hyper mobility and poor foot care/footwear are important in the causal pathway of both neuropathic and ischaemic foot ulcers. Infection is a major factor in ulcer complications and is aggravated by repeated mechanical stresses.

Foot ulcers are common in people with diabetes, especially those with problems in the nerves or arteries of their legs. Weight and mobility problems can lead to ulcers. Complications can lead to amputation (surgical removal of part of the limb). The review of trials found that orthotics (in-shoe devices) that cushion or redistribute pressure may be able to prevent foot ulcers in people with diabetes.

Clinical evidence and investigation related to off-loading of neuropathic foot ulcerations is very poor.

Many lesions in the diabetic foot are preventable or treatable with patient education, properly designed and fitted orthoses and footwear, and careful periodic monitoring. A diabetic foot programme based on assessment of risk factors, especially sensory loss, deformity, joint limitation and poor circulation provides a database for early and appropriate management of foot problems.

It is necessary to investigate and develop a method to protect the foot from high repetitive pressures that is effective, easy to apply, low in cost and accepted for use by the patient.

**Bibliography**

American Diabetes Association. 1999. Consensus development conference on diabetic foot wound care. Diabetes Care 22(8):1354-1360.

Armstrong DG, Nguyen HC, Lavery LA, Lan Schie CHM, Boulton A J M, Harkless LB. 2001. Off-loading the diabetic foot wound, Diabetes Care 24 (6):1019-1022.

Brodsky JW, Kourosh S, Stills M, Mooney V. 1988. Objective evaluation of insert material for diabetic and athletic footwear. Foot Ankle 9(3):111-116.

Caputo GM, Ulbrecht JS, Cavanagh PR. 1997. The total contact cast: a method for treating neuropathic diabetic ulcers, Am Fam Physician 55(2):605-611.

Chantelau E. Haage P. 1994. An audit of cushioned diabetic footwear: relation to patient compliance. Diabet Med 11:114-116.

Davies S, Gibby O, Phillips C, Price P, Tyrrell W. 2000. The health status of diabetic patients receiving orthotic therapy, Qual Life Res 9(2):233-240.

Lavery LA, Vela SA, Fleischli JG, Armstrong DG, Lavery DC. 1997. Reducing plantar pressure in the neuropathic foot. Diabetes Care 20(11):1706-1710.

Litzelman DK, Marriott DJ, Vinicor F. 1997. The role of footwear in the prevention of foot lesions in patients with NIDDM, Diabetes Care 20(2):156-162.

Mayfield JA., Reiber GE, Sanders LJ, Janisse D, Pogach LM. 1998. Preventive foot care in people with diabetes. Diabetes Care 21(12):2161-2177.

Miller OF. 1994. Chronic foot wounds in diabetics and total contact casting, Clin Dermatol 12(1):39-45.

Mueller MJ. 1997 Therapeutic Footwear Helps Protect the Diabetic Foot. J Am Podiatr Med Assoc 87(8):360-364.

Murphy EF, Burstein AH.1985. Physical properties in materials including solid mechanics. In: Atlas of Orthotics. American Academy of Orthopedic Surgeons. 2nd Edition. St. Louis: CV Mosby. pp 6-33.

Spencer S 2002. Pressure relieving interventions for preventing and treating diabetic foot ulcers. Issue 1. Oxford, UK: The Cochrane Library.

White J. 1994. Therapeutic footwear for patients with diabetes. J Am Podiatr Med Assoc 84(9):470-479.

**Feet lacking protective sensation: footwear aspects**

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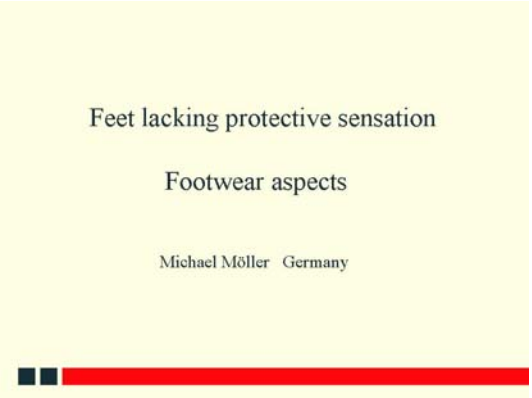
*Editors note: Manuscript not submitted. Powerpoint presentation made at conference below.*

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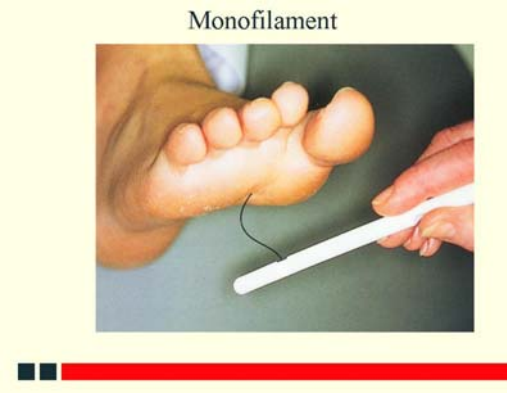


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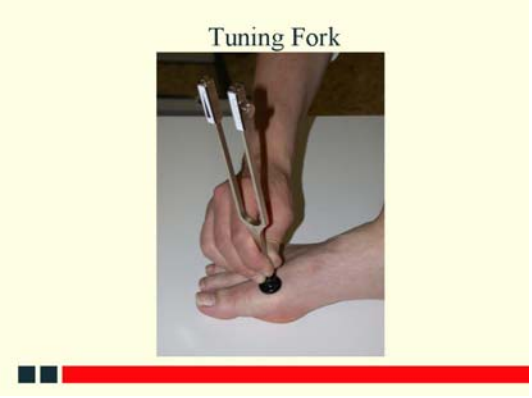


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Necrotic foot from burn

9

Attempt at reconstruction failed

10

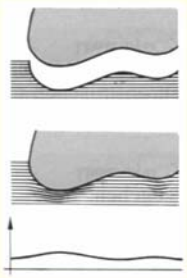
First metatarsal excised

11

Dorsal skin flap for closure

12

Shape and Material



Pressure area improved

13

The positive mould

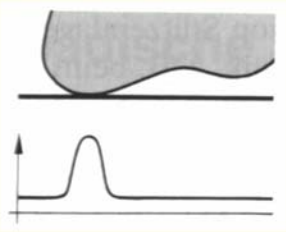
14

The shape and the material of the

padding is important

15

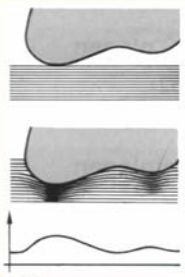
Shape



Pressure area

16

Material



Pressure area

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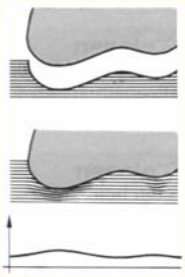
Shape and Material



Pressure area

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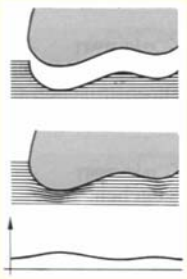
Shape and Material



Pressure area improved

19

The positive mould

20

Translucent plastic mould to determine areas of pressure and relief

21

Material:

Structure of material

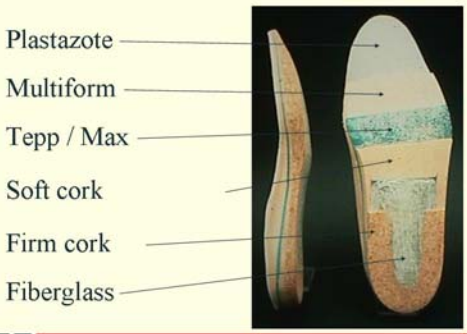
from soft (proximal )

to firm ( distal )

22

Vacuum moulding

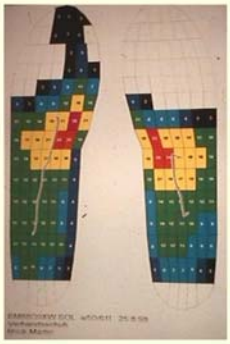
23




24

Pedobarograph

Without padding



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Padded insole

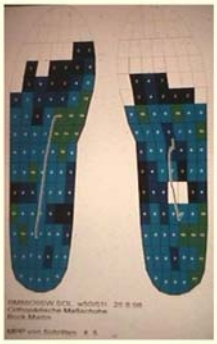
Rocker sole

Stiffened sole

26

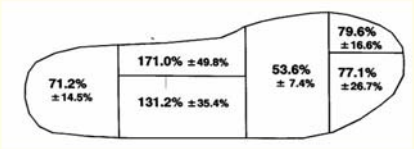
Pedobarograph

With padding



27

Study from University of Münster
Effect of shoe modification and
padded insoles on pressure measurement




Result: Sandwich padded insoles can
control pressure distribution

28

Using sand to make an impression. Fill
with plaster of paris for positive and
make sandwich padding

29

Reducing step length reduces pressure

Elastic leg leash to restrict step length

- Adjustable to leg length (constant angle between thighs)
- Elastic: reminder for training

30

Ankle stabilization can be added

31


32

Patellar tendon bearing orthoses

33

Neuropathic feet now and in the future are a global problem.

In coming years we expect many more patients with neuropathic foot.

The solution is not to give an orthoses or a shoe.

.

The solution is to educate people in prevention.

34

So we should always watch the feet

Thank you

35

Ambitious supply
only possible through
interdisciplinary cooperation

ISPO

Thank you

36

**Plenary Discussion "Lower lomb orthotics practice – Stroke/traumatic brain injury"**

**Chair: Hugh Watts**

**Rapporteur: Claude Tardif**

## Discussion

No discussion of note was recorded

# Orthotics technology in developing countries: the development of appropriate orthotics technology

**Michael Rechsteiner**

**ICRC, Democratic Peoples Republic of Korea**

This paper presents a variety of orthotic technological developments in lower limb orthotics in non-industrialized countries, as encountered by the author during his work in prosthetics and orthotics in several African and Asian countries. It also includes reflections from his personal experiences as a practitioner on the success or otherwise of those systems.

When Huckstep started to develop his calipers in the sixties in Uganda, the orthoses being manufactured were conventional orthoses, mainly copies of the European and North American designs. According to him, these were exorbitantly expensive, the production rate appallingly low and therefore, because of the lack of support, hundreds of patients remained unable to walk. He also judged the open-toed boots made by local shoemakers impractical and expensive and inadequate for supporting the foot. Huckstep believed that any appliance, provided that it is comfortable and supports the joint or joints it is intended to support, is better than no appliance at all and that having 50 patients walking in sturdy, unsophisticated supports is better than having one patient in a well-fitting orthosis. In taking this approach, he showed his philosophy regarding appropriate orthotic technology was a pragmatic one rather than one that followed sound orthotic principles (http://www.worldortho.com). Time and circumstances have changed since. Nevertheless, in some East African countries the calipers and other simple mobility devices designed by Huckstep are still manufactured, applied and used in the very same way.

The few organizations working in the late seventies in the field of orthotics tended to focus on children, specifically with paralytic polio. Some simply flew in from countries such as Switzerland and Belgium for measurements and cast taking, then went back home for the manufacturing of the devices and returned, often several weeks later, for delivery. As a consequence, appropriate patient management and follow-up was rarely guaranteed. Other institutions, among them many charitable organisations, sent expatriates (often non-professionals) to be permanently based in those countries and to assist in existing or newly opened workshops. Among the 'non-professionals' working in the field, the technology of the devices manufactured was mostly copied from textbooks and built according to what they saw as common sense, rather than based on sound orthotic principles.

Among the professionals, the common technology used was the previously mentioned conventional or segment orthoses. Built according to, and based on basic principles, this type of orthosis covered a much wider range of pathologies. The materials used were either aluminum or steel and leather. For logistical reasons, production started mostly with imported materials and components. At a later stage, for financial reasons or to try to create sustainability, locally available materials replaced the imported materials. AFOs, KAFOs or HKAFOs were custom designed, made from plaster models or based on outlines drawn on paper. The orthosis could consist, according to the functional requirements, of an orthotic sandal or a shoe fixed with a shoe-connection plate, both with or without compensation, ankle, knee or hip joints with motion control, tibial, femoral or pelvic bands or calf and thigh corsets. This orthosis could, if made with an orthotic sandal, be worn with any appropriate shoe or footwear (Franke 1983). This device however needed to be manufactured by a well-trained and skilled technician. Segment orthoses, therefore, were the main orthotic technology to be taught in the few training centres throughout the developing world. In these facilities, very specific cases could also be treated with laminated devices (Heim 1983).

With the arrival of thermoplastics in prosthetics and orthotics, orthotic technology in non-industrialized countries was influenced as well. Terre des Hommes Lausanne, a Swiss based humanitarian organization provided technical assistance to orthopaedic workshops and institutions in North and West Africa, mainly focusing on children with paralytic polio and polio

related clubfoot deformities. Confronted with the growing cost of the manufacturing of tailor made devices and due to the large quantities and varieties of materials needed to be stocked, they decided to design a standard, mass-produced orthosis for their programmes.

Lutz Wollstein, a German expatriate prosthetist/orthotist in Morocco designed the “Joconde”, a device consisting of either a hand-made closed or half-closed shoe, attached to a dorsal shell and fixed with knee-cap and leather straps. A shoe was connected to a 5° externally rotated steel pipe and fixed with a bolt to the stirrups to act as a pseudo ankle joint. The prefabricated dorsal shell was made of ortholene, available in 8 sizes and could be adapted as a AFO or KAFO. For the control of the knee flexion, for children of school age, a self-made “Swiss lock” knee joint was applied. Shoes, kneecaps and straps were produced by vocational centres in Morocco, assisted by Terre des Hommes, while private manufacturers in Italy and Switzerland produced the steel footplates and the inox stirrups. In the field, the “Joconde” reduced the range of specified functional applications again to the basics just as the Huckstep caliper had done, though the Huckstep caliper at least had the possibility of limitation in the ankle joint, if required. Furthermore, the ortholene shells often didn’t fit properly and needed major adjustments and the shoes and leather straps wore out easily especially during the rainy season.

For juvenile polio patients, a custom designed shell with a supportive foot component, designed in the late seventies by Rudi Welz, a German expatriate prosthetist/orthotist in Togo, was established as the standard. For fitting and delivery, the orthosis was fixed with a knee-cap and leather straps and fitted into plastic sandals. Even though sub-ortholene had a much lower density then ortholene, a smooth vacuum molding was very difficult to acquire. The main advantage of this device was the prevention of contractions, combined with its low weight and comfortable fit (Welz 1979).

Since the young patients were quickly outgrowing the devices and regular adjustments were needed, Yves Devreese, a Belgium expatriate prosthetist/orthotist in Senegal, modified this low-weight orthosis into a prefabricated device, made out of polypropylene and PVC. The posterior shell of the KAFO was made out of locally produced PVC water pipes. To economize on imported materials, PP was only used for the supportive foot component. The overlapping components were used for extension in case of growth. For the posterior shell he created aluminum moulds in two sizes and for the foot part moulds in various sizes.

In the late eighties, when Handicap International replaced Terre des Hommes in assisting some of the workshops, technicians at HI France simplified the manufacturing process of the low-weight orthosis further and adapted it to their working context in Pondicherry, India. The KAFO, even though not jointed, nor really functional according to other requirements besides prevention and compensation, was also considered suitable for adults. The book “A Plastic Caliper for Children”, published in 1994, explains the details of the developed technology (HI France 1995).

In addition to governmental and non-governmental institutions, private enterprise also developed an interest in the service delivery of orthotics to the physically disabled in non-industrialized countries. With vast experience from the earlier mentioned short-term orthopaedic missions, Jacques van Rolleghem, a Belgian prosthetist/orthotist and businessman, was one of the key figures in this field. In collaboration with a private company, he developed the limb extension brace (LEB), a prefabricated lower limb orthosis based on the Huckstep principles. Designed for rapid fitting, the device was adjustable in length and width. A foot part made of a rubber-like material replaced the sandal and could, with its flexibility, also act as a pseudo ankle-joint. Two to three posterior aluminum bands, velcro straps and a kneecap were intended to stabilize the affected limb. With its very limited range of application in the field, the LEB never played an important role in orthotic technology (van Rollegham 1987).

In the nineties, compared with prosthetics services, orthotic management and service delivery still remained less supported. However, due to the impact of the ICRC’s polypropylene Colombian alignment system (PPCAS) and therefore the wider availability of thermoplastics, machinery and tools in the workshops using this technology, the use of polypropylene for

orthotic technology in non-industrialized countries steadily increased. By including lessons in the plastic technology in their education programmes, the growing number of training centres played an important role in disseminating the advantages of this technology. Custom designed and made from plaster models, this orthoses could cover a wider range of complex clinical cases than the conventional segment orthoses and the reduced weight and easy handling was much more patient friendly. Keeping the footwear as a separate component improved hygiene and brought further advantages like night bracing and fracture treatment. Also, the patient got a certain freedom in the choice of his or her footwear and could wear ready-made shoes.

However, certain workshops and rehabilitation centres management, mostly under pressure for economical reasons, would not follow the change in technology and continued to produce orthoses more by quantity than quality. Others saw a threat to the employment of their shoemakers and therefore, despite all the advantages, the thermoplastic technology did not become standard. Nowadays, through the influence of well-trained young orthopaedic and orthotic technologists, returning after several semesters of structured training in one of the professional training and education centres, the attitude towards this technology and orthotic management in general has changed. Thermoplastic orthoses, custom designed according to sound biomechanical and orthotic principles, finally became the main standard in non-industrialized countries.

In 1998, Jean-Claude Vesan, a French expatriate prosthetist/orthotist in Vietnam, started to develop a KAFO which, with exception of the straps and lock, was solely made of polypropylene. The main aim of his work was to avoid the use of metal joints and sidebars and therefore to further reduce the weight of the device. An increase in stability by overlapping the polypropylene components should result in an improvement in the parallel alignment of the joints and in distributing the pressure in the posterior shells over a larger surface, particularly in cases of genu recurvatum. Eventually, some patients were successfully fitted. An article, published in the July 2003 issue of the OrthoLetter (Vesan 2003), further explains the details of the developed technology. However, despite all the effort that was invested in this device, its impact was rather insignificant and it had no influence on new standards.

The newest device among the wide range of lower limb orthotics for non-industrialized countries is the prefabricated knee-ankle-foot orthosis (PFKAFO), developed by Mobility India. The aim of this technology is the improvement of the patients' mobility and their reintegration into mainstream activities through the rapid fitting of an appropriate, low cost, mass-produced orthosis (Khasnabis 2004; Mobility India, 2006) The development and the preliminary evaluation of the device will be discussed in the following presentations.

As a personal reflection from my long experience as an orthotist, I would like to stress that a mass-produced orthosis, even if it is available in various sizes, can never meet the standards of fit and function as a custom designed orthosis. The correct placement of the mechanical knee axis and the proper alignments of the joints are, even for an experienced technician, difficult to handle and therefore often compromised. Uniform designs of the foot parts cannot meet the individually indicated needs of sound fit and function and the standard lack of motion control in the ankle joint further increases loss of comfort and function. Considering today's circumstances, with more and more well-trained and educated professionals working in the field of orthotics, I consider the renewed approach towards using prefabricated and mass produced devices in developing countries to be inadequate.

In the report of the ISPO Consensus Conference on Appropriate Prosthetic Technology for Developing Countries, Phnom Penh 1995 (ISPO 1996), the definition of appropriate technology was endorsed as follows:

*"Appropriate technology is a system providing proper fit and alignment based on sound biomechanical principles which suits the needs of the individual and can be sustained by the country at the most economical and affordable price".*

It was further agreed that it applies to orthotics as well as prosthetics.

I therefore would like to conclude my paper by expressing one more personal opinion. although we have to cope with such a broad range of factors, I feel that materials and components are rather secondary in appropriate orthotics technology. The primary factors leading to successful orthotic management are personal qualities; knowledge, gained through continued training and competence-based practice and a sound professional ethic, combined with a multidisciplinary and patient centred team approach.

**References**


Franke J. 1983. Practical report as developing assistant in Malaysia. Ortho Technik. 11.

Heim S. 1983. TATCOT a training centre for the english speaking part of Africa. Ortho Technik 11.

Huckstep RL. 2006. http://www.worldortho.com

HI France. 1995. Low-cost PVC/polypropylene orthosis. OrthoLetter 5.

ISPO 1996. Report of the ISPO consensus conference on appropriate prosthetic technology for developing countries. Phnom Penh, Cambodia ,5-10 June 1995. Day HJB, Hughes J, Jacobs NA (eds). Copenhagen: ISPO.

Khasnabis C. 2004. Mobility India summary report. January.

Mobility India. Comfortable life with PFKAFO. Retrieved March, 2006 from, http://www.mobility-india.org/R&D_Technical%20Manual_files/pfkafo_manual.pdf

van Rolleghem J. 1987. Orthotic management of poliomyelitic lower extremities Ortho Technik 1.

Vesan JC. 2003. Lower limb orthosis with polypropylene articulation. OrthoLetter 11:2.

Welz R. 1979. Problems of orthotic management of juvenile polio patients. Ortho Technik 1.

# Orthotics technology in developing countries: development of prefabricated knee-ankle-foot orthosis (PFKAFO)

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## Background and need

In India, about 10 million people (1.0%) need prosthetic and orthotic devices. The majority of this population requires orthoses and of this group, the need for lower limb orthoses is greatest. The world's largest population of people with polio lives in India. The majority is poor and lives in rural areas whereas most of the rehabilitation services are available in cities. The government of India scheme (ADIP) guarantees the poor can get prosthetics, orthotics and other rehabilitation service free of cost. But according to available statistics, among the people who need such services, only 5% can access it. The probable reasons could be as follows:

- Lack of proper service delivery mechanism
- Lack of prosthetic and orthotic facilities
- Lack of trained manpower
- People from rural India often find it difficult to come again and again into a city workshop to get the orthotics devices
- Outdated technology which is heavy, cumbersome and has poor cosmesis
- Distributed of care through "Camps" with very poor follow-up
- Limited choice, this is a free service so the poor have to no right to demand quality
- Orthotic service is not a priority even by majority of the service providers

As a result of these factors, many patients develop deformities and as the person grows the deformity increases. Many start crawling while lucky ones settle with wheelchairs or tricycles. Environmental barriers and lack of services often lead to isolation and exclusion. Lack of prosthetic, orthotics and rehabilitation services often results in people lacking the means to participate in education and the training programmes. As a result many fail to lead a quality life and contribute to the development process. Lack of income ensures people with disabilities remain poor and thus unable to afford prosthetic, orthotic and rehabilitation devices which are usually, available in the private sector. This scenario needs to be changed; Mobility India's effort to develop prefabricated knee-ankle-foot orthoses (PFKAFOs), is one important step towards this change.

## Mobility India's interventions

Mobility India is a NGO based in the southern state of Karnataka, India and directs its activities to addressing the above issues. The focus is to make rehabilitation services accessible to people with disabilities, especially those who are poor and live in rural areas. Mobility India believes in appropriate technology, a good scientific technology which can be available, affordable and sustainable.

Millions of people in India and other low-income countries are affected by poliomyelitis or other neuromuscular conditions. Mobility India realised that most of them need good lower limb orthoses, specifically knee-ankle-foot orthoses (KAFOs). Conventional metal callipers have a long history in India and its neighbouring countries. Even today the majority can access these through the ADIP Scheme. Realizing the shortcomings of the metal callipers and the higher cost of production of custom made plastic lower limb orthoses, Mobility India's effort was to come up with an appropriate alternative, prefabricated knee-ankle-foot orthoses (PFKAFOs). Its development started in the year 1997. The PFKAFO took 5 years to develop and another 2 years to optimise.

## Methods

Anthropometric data were collected, 6000 measurements of polio legs and feet of various age groups were analysed, with support from the National Institute of Design (NID), Ahmedabad and Defence Bioengineering and Electromedical Laboratories (DEBEL), Bangalore.The data were summarised into technical information necessary for designing of the dies to produce plastic shells, lower and upper. Lots of prototypes were developed and trialled and data were optimised to produce ten sets of moulds. While injection moulded dies were considered optimal, it was decided to manufacture the plastic prefabricated shells using blow mould technology due to financial constrains.

Some 40 dies have been developed so far; 10 lower left, 10 lower right, 10 upper left and 10 upper right. Polypropylene (PP), high density polyethylene (HDPE) and copolymer were trialled to manufacture the prefabricated shells. After several trials, it was decided to utilise copolymer rather than PP or HDPE. Beside development of plastic shells Mobility India also developed stainless steel drop lock knee joints in two sizes as well as uprights made from aluminium alloys. The straps and other accessories were also developed at the same time. To date, Mobility India has developed a complete system to make prefabricated KAFOs in 10 different sizes for both sides.

Initial fitting of PFKAFOs on users led to further die modifications, some small changes in the design and choice of materials.

## Results

More than 3000 users were fitted with PFKAFOs over a span of 6 years. The feedback from the users has been collected. It revealed shrinkage of the plastic shells and cracks at the region of the toe break.

The shape of the heel area of the shell was not uniform and created pressure on the heel of some users. The pressure below the lateral malleoli was more in some of the shells. The corrugations provided for strength were quite broad and took extra space inside the footwear. The difference in the dimensions of the shells was not uniform mediolaterally as per the sizes.

## Interventions

Leading chemical engineers were contacted to test the composition of the plastic. Chemical composition of the shells was changed and new shells were developed using a new grade of copolymer. It was also suggested by the chemical engineers to do heat treatment (annealing process) for all the shells before being cut at a certain fixed temperature. The process has helped to reduce the shrinkage to a considerable extent. The breakage at the toe break area has also reduced. Feedback regarding the new shells is quite encouraging.

The dimensions of the dies were changed and further optimised On the basis of feedback received from the users; more space has been created at the lateral malleoli and the area around the heel. The shape and the size of the corrugations has also been reduced.

## Advantages and disadvantages

The PFKAFO is not for all. However, the assumption is that it can be made suitable for 60-70% of the population who need it and that it would make a huge difference to the life of millions of people all over the world. Present experience indicates that PFKAFO as it stands fits 50-60% of the population. Another 20-25% of the population need custom moulded AFOs while the thigh section can be manufactured from the PFKAFO upper shell. The PFKAFO is not a replacement for custom moulded KAFOs but it is an alternative for many. It has many advantages, some of which are:

- The technology could fit large number of people at lower cost.
- The components could be assembled in few hours time to make a KAFO and does not require sophisticated machinery or a large workshop space.

- Any properly trained orthotics technician could assemble a prefabricated KAFO within 6 hours.
- Users do not need to visit the workshop multiple times to get one orthosis - they can receive the orthosis the same day with some gait training.
- Requires less maintenance.
- Light and cosmetically more acceptable.
- Spin offs like AFOs and night splint also can be produced at a much lower cost.

The PFKAFO has certain challenges too:

- The PFKAFO will not fit all.
- Legs should be free from deformities or contractures
- It does not have ankle movement but that can be added.

The PFKAFO has made possible the theory of quality assured rapid production with affordable cost.

**2000-2004**

The PFAKFO has been successful in reaching out to large numbers of children and persons with disabilities in India. The technology, owing to its unique features for assembly, ease of selection criterion, and need for minimum equipment has been widely accepted by many orthotic service providers.

The technology has been presented to the national level institutes for their feedback and acceptance in India. The modifications made on the design based on the users feedback has helped in making the technology more accepted by the users and technicians.

A series of hands on workshop are organised in different regions of India in collaboration of National Institutes and local NGOs and philanthropies. The main aim is to transfer the technology among the professionals and technicians at all levels. Mobility India also wants to ensure that the technology is handled properly and professionally for maximum benefit of the users.

The PFKAFO was evaluated by the ISPO in India at various levels of community, rural workshops and service centres and at the institute.

**2005-2006**

In September-October 2005 PFKAFO technology was introduced to Ethiopia.

Objective:

- Trials of the PFKAFO in Ethiopia for people with polio below 18 years of age.
- To assess 100 children and fit the PFKAFO
- To introduce the technology to the technicians in the country through a 4 days hands-on workshop at the Prosthetics and Orthotics Centre (POC), Addis Ababa, Ethiopia.
- To continue the trial fitting with the local technicians
- To do the follow-up of the children fitted after 6 months with ISPO representatives.

Statistics of PFKAFO fittings in Ethiopia:

- Total number of people assisted: 104
- Total number of PFKAFOs fitted: 74
- Total number of PFAFO fitted: 01
- Total no of combination KAFO fitted: 15
- Total number of custom made KAFOs fitted: 02
- Total no of appliances made: 92

**Future recommendations**

Mobility India introduced an appropriate prefabricated technology in the field of orthotics, probably the first of its kind in the world. The technology has demonstrated tremendous possibilities for further development. Mobility India would like to work with international communities to make it better and more appropriate. We are looking forward to develop PFKAFO resource centres in collaboration with others so that people from other continents, especially Africa, can access an orthosis to take the next step forward.

**Bibliography**

Disabled people at the heart of disability research. Retrieved March 2006, from, http://www.disabilitykar.net/.

ISPO. 2004. Proceedings of then11th ISPO World Congress: Innovations for Quality Living.1-6 August 2004, Hong Kong. Copenhagen: ISPO.

Minstry of Social Justice and Empowerment India. 2001. District Rehabilitation Report.

WHO. 2005. Guidelines for training personnel in developing countries for prosthetics and orthotics. Geneva: WHO.

# Orthotics technology in developing countries: preliminary evaluation of the the prefabricated knee-ankle foot orthosis (PKAFO) system

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## Introduction and objectives

The majority of polio victims require knee-ankle-foot orthoses (KAFOs) to stabilize the knee, ankle and foot regions for the accommodation or correction of the resulted deformities, or to prevent further deterioration. However, only a small percentage of these people in developing countries can access the required service. As reported by Mobility India, conventional metal calipers are still commonly fitted in India. The slow and expensive process for the provision of these conventional orthoses, limit the number of potential users. The rejection rate of the cumbersome design has also been high. Thermoformed high density polyethylene (HDPE) knee-ankle-foot orthoses (KAFO) were introduced in India more than 20 years ago. The thermoformed orthosis is light weight and allows the user to alternate footwear. This kind of orthosis has not been popular however because of the need for advanced manufacturing techniques and the high cost involved. Appropriate technology (ISPO 1996) is required.

The prefabricated knee-ankle-foot orthosis (PFKAFO) system was a component kit developed by Mobility India for polio victims and patients with similar neuromuscular conditions. The design aims to prevent further disability and enhance mobility. The structure and design of the PFKAFO system were based on the computational results of lower limb measurements of 6000 subjects who suffered from poliomyelitis. The system consists of 10 sizes each, from 0 to 9, for the prefabricated thigh and leg shells. It was reported that there had been more than 2500 persons fully or partially fitted with PFKAFO systems. About 60% of the patient population was fitted with complete PFKAFO systems. Half of the remaining 40% needed custom made or measure-to-make leg shells. Another 20% were fitted with custom made KAFOs (Ghosh et al. 2004).

The International Society for Prosthetics and Orthotics (ISPO) has conducted an assessment programme to evaluate the PFKAFO system. The presenting work conducted in Bangalore, India served as the preliminary evaluation of the PFKAFO system (Leung 2004). The specific objectives of the preliminary study were to examine the following questions:

- Can pre-fabricated components be modified sufficiently to meet individual patient's needs?
- Can effective total contact control over the limb be achieved?
- Can HDPE be effectively used in lower limb orthotics?
- Is it durable enough?
- Are appropriate components incorporated into the design for effective orthotic management?

## Method

The Lower Limb Orthotics Evaluation Form developed by ISPO was used to collect information about (i) description of patient and disease, (ii) patient compliance with the orthosis, (iii) patient assessment, (iv) orthosis construction, (v) orthosis assessment, and (vi) failure of orthosis. The evaluation was performed by the author and assisted by Soikat Ghosh, Training and Partner Programme Manager, Mobility India.

Fifty-six patients with full or partial PFKAFO intervention of at least 6 months were examined. There were 27 female and 29 male patients. The average age of the patients was 18 (+/- 4.53) years. The patient's were seen at the Grameena Abyudaya Seva Samasthe (GASS) in Doddaballapur, Bangalore Rural District; the Rural Development Trust (RDT) centres including: the Orthotics Workshop at Bathla Palli, the Kadiri Ortho-Work Shop, the Low Cost Aid's Workshop for Physically Disabled in Kalyandurg and the Orthopedic Centre of Kuderu; and the Mobility India Field Offices in LR Nagar and Banshankari Bangalore.

## Results

### *Description of patient and disease*

Among the 56 patients, 44 patients (78.6%) were affected unilaterally and 12 patients (21.4%) were affected bilaterally at the lower limb region. Twenty-nine patients (51.8%) had previously received orthotic intervention. Seventeen patients (30.3%) had undergone surgical intervention. Seven patients (12.5%) had previously received both orthotic intervention and surgery. Three patients (5.4%) had not undergone prior treatment. The prior orthotic interventions included 35 KAFO's and 1 hip-knee-ankle-foot orthosis (HKAFO). The prior surgery included 15 soft tissue releases, 7 lengthenings, 3 soft tissue release plus tenotomy and 1 soft tissue release plus osteotomy at various regions of the lower limb.

### *Patient compliance with orthosis*

Among the 56 patients, 46 of them (82.1%) were students, 9 of them (16.1%) were skilled workers and 1 of them (1.8%) was an unskilled worker. Fourteen patients (25%) lived in undulating slum areas and 42 patients (75%) lived in dry rural areas. Ten patients (17.9%) needed to walk on hills. Thirty-six patients (64.2%) walked on unpaved surface. The remaining 10 patients (17.9%) walked on paved surface. Fifty patients (89.1%) used orthoses for more than 5 hours a day. Three patients used orthosis for less than 5 hours and the other three patients used orthosis for less than 1 hour a day. Seven patients (12.5%) complained about pain. Four cases (7.1%) were caused by the orthotic intervention.

With the orthosis all patients walked with good stability except 1 patient (1.8%) whose ankle was unstable. All patients could walk independently. Forty-three patients (76.8%) walked with the orthosis only. Thirteen patients (23.2%) used walking aids. Forty-three patients (76.8%) walked with the orthosis for more than 2 km a day. Seven patients (12.5%) could walk from 1 to 2 km. Three patients (5.4%) walked from 500 to 1000 km. Three patients (5.4%) walked for less 100 m a day. Twelve patients (21.4%) were very satisfied with the orthotic interventions. Forty-three patients (76.8%) were satisfied and 1 patient (1.8%) was unsatisfied.

### *Patient assessment*

Muscle testing was performed on hip flexors and extensors, hip abductors, knee flexors and extensors, and ankle dorsiflexors and plantar flexors. There were various degrees of weakness in individual muscle groups. Eight patients (14.3%) had their hip joint dislocated. Fifteen patients (26.8%) had a hip flexion contracture. Two patients (3.8%) had hip adduction contractures. Twenty-one patients (37.5%) had knee flexion contractures. The occurrence of knee hyperextension, valgum and varum were 5 (9%), 17 (30%) and 1 (1.8%) respectively. Fixed ankle equinus occurred in 7 patients (12.5%). Calcaneus, valgus, varus and claw feet without dorsiflexion occurred in 1 (1.8%), 5 (9%), 3 (5.4%) and 21 (37.5%) patients respectively. Eight patients (14.3%) did not have passive dorsiflexion. Ankle laxity was observed in 4 patients (7.1%). Forty patients (71.4%) had leg length discrepancies.

### *Orthosis construction*

The orthotic shells were all made of rigid thermoplastics. The uprights were made of aluminum alloy and articulated by stainless steel drop-lock knee joints. Ankle joints were not used. Fifty-six patients were fully (55.4%) or partially (44.6%) fitted with prefabricated knee-ankle-foot orthosis (PFKAFO) systems. Thirty-one were fitted with completed PFKAFO

systems. Twenty-five partial PFKAFOs consisted of either custom moulded or off-the-shelve ankle-foot orthoses (AFOs). Six partial PFKAFO systems consisted of either custom moulded or off-the-shelve thigh shells. Two patients were also fitted with custom moulded AFOs too. Moulded rubber insole or outsole was used for compensation of leg length discrepancy.

***Orthosis assessment***

The PFKAFO thigh shells fitted the limbs appropriately except in 1 case when the thigh shell was too big. There were pressure points along the walls of the thigh shells in 3 patients. In one case the walls poorly matched the contours of the limb. The knee alignments of 5 orthoses were poor. One PFKAFO leg shell poorly matched the leg. There were pressure points along the walls of one leg shell. The alignment of 5 orthotic knee joints was not properly set.

***Failure of orthosis***

Minor failures of the PFKAFO components were found; in 1 case wearing of the mechanical knee joint; in 2 cases small cracks in the foot shells.

## Discussion

Results of the examinations showed that the major orthopaedic problems of the patients were hip dislocation (14.3%), hip flexion contracture (26.8%), knee flexion contracture (37.5%), knee hyperextension (9%), genu valgum (30%), fixed ankle equinus (12.5%), claw feet without dorsiflexion (37.5%), no dorsiflexion movement (14.3%) and leg length discrepancy (71.4%). This group of patients mainly needed control of alignment in the sagittal plan to correct or accommodate the knee and ankle alignment and prevent further deformities. Although some patients had genu valgum, the deformities were usually static. Insoles and shoe raises were required to compensate the leg length discrepancy. Knee-caps, insole or shoe raises were included when necessary. The alignments of 5 orthoses were not properly set. There were minor failures of the mechanical knee joint and the foot shells. The knee joint issue can be improved by enhancing the alignment procedures. The durability of the foot shell can also be improved if outsole or shoe will be put outside the foot shell.

All the patients were arranged by Mobility India or its outreach programmes for evaluation. They were all suffered from poliomyelitis and had a similar socio-economic background. In general, the orthoses could control the limb alignment and facilitate the patients' walking activities. The PFKAFO systems provided were all with drop-lock knee joints and without ankle joints. Although not all the patients had the ankle-foot conditions, such as fixed equinus and no passive dorsiflexion, that were contraindications for the inclusion of orthotic ankle joints, orthotic ankle joint was not used. Staff of Mobility India explained that, since all the patients typically lived in slum or dry rural areas, they needed to walk on unpaved and undulating surface, the inclusion of orthotic ankle joints would affect the stability, and at the same time, the rate and cost for maintenance would be high.

## Conclusions

An evaluation of the PFKAFO system was done from 14-19 November, 2004. Fifty-six patients fully or partially fitted with the PFKAFO systems were examined. Twelve patients (21.4%) were very satisfied with the orthotic intervention. Forty-three patients (76.8%) were satisfied and one person (1.7%) was unsatisfied. The compliance was considered acceptable as 43 persons (76.8%) walked with the orthoses for more than 2 km a day and 7 persons (12.5%) walked with the orthoses from 1 to 2 km a day. The PFKAFO system components are considered acceptable for general use in the presented patient group.

The results of the evaluation process were specific to this presented group. However, the results could be a reference for the planning of a clinical trial to assess the potential of the further contribution of the PFKAFO system components to improve the quality of the orthotics service in the developing world.

## Further work and progress

A clinical trial in Addis Ababa, Ethiopia has been conducted to assess the potential of the further contribution of the PFKAFO system components to improve the quality of the orthotics service in the developing countries. The clinical trial was divided into 2 stages. The 1st stage was done 26-30 September 2005 (Lastring 2005). The objectives were to examine whether (i) the sizing of the PFKAFO system components were appropriate, and (ii) the local technicians can apply the technology after the completion of a 5-day short training courses. Forty-eight patients, who were fitted with orthoses before were seen. Twenty-five patients were fitted with the PFKAFO systems during the period. Another 23 patients were measured and supposed to be fitted with the PFKAFO system in the following week. The 2nd stage of the clinical trial (Mtalo 2006), a follow-up session was conducted 19 – 23 March 2006. The objectives were to study (i) the clinical performance of the orthotic intervention, and (ii) the durability of the orthosis. Forty patients were examined. Data reduction and analysis will be done for the comparison of the performance between the old and the PFKAFO system interventions.

## References

Ghosh R, Kumar A, Ghosal D. 2004. Development of prefabricated knee ankle foot orthosis (PKAFO). In: Proceedings of the 11th World Congress of the International Society for Prosthetics and Orthotics, 1-6 August 2004, Hong Kong. Copenhagen: ISPO. p393.

ISPO 1996. Report of ISPO Consensus Conference on Appropriate Prosthetic Technology for Developing Countries. Phnom Penh, Cambodia, 5-10 June 1995. Copenhagen: ISPO.

Lastring L. 2005. Transferability of prefabricated knee-ankle-foot orthosis, designed by Mobility India, to other low-income countries. ISPO Internal Report.

Leung AKL. 2004. Evaluation of prefabricated knee-ankle-foot orthosis designed by Mobility India, 14-19 September 2004. ISPO Internal Report,

Mtalo LB. 2006. Evaluation of prefabricated knee-ankle-foot orthosis designed by Mobility India. 19-23 March 2006. ISPO Internal Report.

# Orthotics technology in developing countries: innovations in the use of local available materials

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## Introduction and background

The authors of this presentation have their work experiences in Nepal and Timor Leste (East Timor). Nepal has 10-11 prosthetics and orthotics workshops (population 24 million), East Timor has 2 workshops (population 1 million). Both countries are among the poorest of the Asian region. In Nepal 2-4 workshops receive international support from Handicap International (HI) and the International Committee of the Red Cross (ICRC). In East Timor one prosthetics and orthotics workshop receives international support from Cambodia Trust and is using the ICRC polypropylene technology. International support usually relates to important areas such as: technical and management support, prosthetics and orthotics training, access to materials/components and funding. For different reasons, however, not all workshops benefit from international support. The products delivered by these places have to be paid for by the client, or through another support system. The choice of products/materials in this situation often depends on the financial capacity of the client. Stock in those, often private, workshops is limited. Materials are bought when they are needed. Particular challenges faced here are the access of suitable materials and procurement of special tools and equipment. These small scale workshops often need to be very inventive in the use of local materials for the production of devices.

## Local materials and their processing

Import of specific prosthetics and orthotics materials (polypropylene sheets/components) often turns out to be expensive and logistically difficult. Therefore locally available materials will first be considered. Suitable materials found locally are: steel, aluminium, PVC pipe, PE pipe/barrels/buckets, foam mattresses for padding, POP, resin and stockinette (Huckstep 1975; Öberg 1991; Pradip et al. 1999; Sethi 1989). Suppliers of these materials are construction or hardware shops and sometimes pharmacies.
For Nepal, the materials that have proven to be very useful are steel, HDPE and PVC pipe, camping foam mattresses and POP. Many of the smaller materials, e.g. buckle, rivets, Velcro, leather and nylon belts are purchased from the clothing and footwear industry.

HDPE child-KAFO made at Green Pastures

For Nepal and Northern India, the thermoplastic high density polyethylene (HDPE) is a material which has proven to be very useful (ESCAP 1997; Meanley 1997; Meanley and Reed 1998; Öberg 1991; Schuch 1990; Theuvenet et al.1994). After heating, ideally done by use of an oven, the hot thermoplastic is draped over a plaster of Paris cast and pinched together at the opposite side. This forms a seal and as the plastic starts to cool down it shrinks towards the cast. Accurate shaping of the orthosis is aided by use of vacuum extraction. It is also possible to obtain an adequate shape by wrapping the hot HDPE with elastic bandages. Minor modifications can be carried out with the use of a heat gun. The technician needs to be aware that the HDPE will shrink in the longitudinal direction of the original pipe (10-30%) during the heating process. Experience has also demonstrated that the quality of the HDPE pipe can vary over time.
In Nepal and India small orthoses are being made of PVC as well. The Samadhan workshop in Pokhara is using the techniques described by Werner (1998; 1999) in the production of PVC orthoses (see picture below). PVC is however more prone to cracks; it is less elastic and care needs to be taken not to overheat it. Working with thermoplastics requires certain technical skills that are uncommon for craftsmen working with leather, wood or metal. Werner (1998; 1999) in his books explains the basics of the use of thermoplastics.

PVC moulding, at the Samadhan workshop

**Innovations**

HDPE and PVC are not new in prosthetics and orthotics workshops. They have been used for the past 10-15 years (Schuch 1990; Theuvenet et al. 1994). During this period some places

have been able to make innovations in the applications of these materials. More complex products are being made and there is a trend to make prefabricated components.
For example, the Orthopaedic Appliance Centre of Green Pastures Hospital and Rehabilitation Centre in Pokhara, gained a good level of experience with the use of HDPE. Complex items produced in this workshop are for instance the paediatric KAFO, and the AFO with ankle joints (both full HDPE, except for the axes).The KAFO is made according the design described by Vesan (2003). For adults the HDPE- KAFO is combined with locally made steel drop-lock joints. Other examples of more complex HDPE items are prosthetic knee joints and the Minerva and Halo braces.
Anandaban, the TLMI Leprosy Hospital near Kathmandu (Nepal), is producing HDPE drop foot AFOs (Schwarz and Brandsma (2004) in different sizes. The Nepalganj workshop (Nepal), has a system to produce PVC KAFOs parts in large numbers as prefabricated components, similar to the system reported in South East India (Werner 1998).

**Further state of the local prosthetics and orthotics art**

In East Timor the St. Franciscus workshop in Alieu is mainly using materials from the (Indonesian) region. Metal is being used to produce the KAFOs. PVC was not chosen because of the potential toxic hazards. Attempts took place to make clubfoot orthoses out of leather and, donated synthetic fibres were not successful due to the unavailability of POP and the high costs. This workshop is using cement to make moulds.
Items like buckles and leather straps are completely self-made. In addition, some useful tools for taking measurement and manipulating materials (e.g. bending irons) have been also made here.

Local tools use at the St. Franciscus workshop in Alieu, East Timor

Heim (2002) reports about the private workshop of Mr Dotzi in Togo where part of the tools are also self-made and the required standards are met for the prosthetics and orthotics products. The author concludes that this illustrates that private care operations can usefully complement the existing public facilities and contribute to the social security of those affected.
A similar contribution for Nepal is provided by Orthopedica (Kathmandu), a private prosthetics and orthotics company. The owner, Gyanendra C. Shrestha, has been able to build up a good reputation as one of the main prosthetics and orthotics suppliers in Nepal. His company delivers directly to clients, and is also supplying other workshops both with components and off-the-shelf prosthetics and orthotics products.
Orthopedica is purchasing materials/products from India, China and some from the West. The first choice is to make a product with locally available materials. His workshop is a very interesting mixture of local and modern prosthetics and orthotics production technology and materials.
In general, for the workshops in Nepal, the Indian prosthetics and orthotics industry is an interesting source of reasonably priced components. ALIMCO (Artificial Limbs Manufacturing Corporation of India) and Mobility India have a broad selection of prosthetics and orthotics components and tools. Because labour is cheap in Nepal, the use of labour intensive products is financially more attractive than the use of Western components. If, instead of Western products, the cheaper Indian components are being used then there is less reason

for total self-production. Although Indian components have better possibilities for (re-)adjustment, logistically it can be difficult for the Nepalese workshops to actually use them (Visser 2004).

## Summary

In the field of prosthetics and orthotics roughly two types of workshop can be distinguished: those that receive international support and those who do not. Whether a place receives support or not is often reflected in the choice for materials/products. The small scale (often private) workshops need to be inventive in the use of local materials. Besides the more traditional materials such as steel and aluminium, thermoplastics are nowadays commonly used. More and more experience with thermoplastics is gained and innovations are taking place. This becomes obvious in the fact that more complex products and pre-fabricated products are now being made. Finally, the choice for materials/components often depends on availability, logistics and labour cost.

## Conclusions

- Locally available thermoplastics are increasingly being used for more complicated products.
- Locally available thermoplastics are being used for pre-fabrication.
- Price for complete self-production and use of Indian components are competitive.
- Small workshops often face logistical and financial constraints, which leave them no other choice than the use of local available materials.
- Small, inventive workshops which meet general prosthetics and orthotics standards can fulfil a role in complementing existing public services.

Because local materials are and will continue to be used in prosthetics and orthotics, sufficient attention needs to be paid towards this. It is recommended that prosthetics and orthotics training institutions continue to pay attention to the possibilities, benefits and challenges of the use of different locally available materials.

## References

ESCAP. 1997. Economic and Social Commission for Asia and the Western Pacific: Production and distribution of assistive devices for people with disabilities. New York:United Nations Publications.

Heim S. 2002. Private workshops: a complement to public facilities. OrthoLetter 11:8-9.

Huckstep RL. 1975. Poliomyelitis: a guide for developing countries - including appliances and rehabilitation for the disabled. London: Churchill Livingstone.

Meanley S 1998. Descriptions of appropriate orthopaedic appliances. Pokhara.

Meanley S, Reed NK 1998. An “appropriate technology” trans-femoral prosthesis, using materials available in Nepal. Prosthet Orthot Int 22:123-128.

Öberg K. 1991. Cost-benefits in orthopaedic technology by using thermoplastics in developing countries. Prosthet Orthot Int 15:18-22.

Pradip D, Poonekar MD, Pradhat KG. 1999. A look at the health care and prosthetic/orthotic services in India. Prosth Orthot World 2:24-34.

Schuch CM. 1990. Thermoplastic applications in lower extremity prosthetics. J Prosthet Orthot 3:1-8.

Sethi PK. 1989. Technological choices in prosthetics and orthotics for developing countries. Prosthet Orthot Int 13:117-124.

Schwarz R, Brandsma W. 2004. Surgical reconstruction and rehabilitation in leprosy and other neuropathies. Katmandu.

Theuvenet WJ, Ruchal SP, Soares D, Roche P. 1994. Advantages, indications and the manufacturing of melted PVC waterpipe splints. Lepr Rev 65:385-395.

Vesan JC. 2003. Lower limb orthosis with polypropylene articulation. OrthoLetter 12, 8-10.

Visser C, Nepali DP, Chetri HB, Made in Nepal, A Trans Femur Prosthetic Concept from HDPE Drainpipe, ISPO conference paper, 2004
.
Werner D. 1998. Nothing about us without us: developing innovative technologies for, by and with disabled persons. Palo Alto: HealthWrights.

Werner D. 1999. Disabled village children: a guide for community health workers, rehabilitation workers and families. Berkeley: The Hesperian Foundation

# Orthotics technology in developing countries: the LETOR orthosis

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## Foreword

In an attempt to achieve consensus, one should consider the experiences of the past together with currently available knowledge. One should also consider the predicted trends of the future. Consensus should address biomedical, technical, economic and cultural conditions.

Consensus, if to be reached, requires the term “appropriate” to be defined. Fascination with modern technology, new materials and digital techniques leads sometimes to over-fascination in the prosthetics and orthotics field where physiology is a major factor that can not be modified nor neglected. To achieve the goals and to avoid disillusion the term “appropriate” should be adopted rather than the term “best available”.

Consensus should develop an equilibrium between the expectations and interests of clients, and the beliefs and interests of equipment providers. Subjective self-assessment of an appliance by its user should not be overruled by data and/or categorization regarded as objective because it was developed as by standards, directives or recommendations of professionals with the use of advanced hardware and sophisticated methods. Without ones own practically verified experience no one should argue against well confirmed data analysis. Not listening to our patients leads to their frustration, and to our alienation.

Consensus, if achieved, should be long-lasting.

## Origin

The Lower Extremity Telescopic Orthosis (LETOR) was developed at the Rehabilitation Center in Konstancin in cooperation with the Polish Academy of Sciences Institute of Biocybernetics and Biomedical Engineering (Pokora 2004). The design has proven to be appropriate in various environments and in different cultures.

Guidelines for the prefabricated modular orthosis were given by the late Professor Marian Allan Weiss (1921-1981), founder of Konstancin 700-bed comprehensive rehabilitation facility.

## Background

Despite their similarities, orthotics compared to prosthetics is always a challenge (Pokora 2001). To substitute lost function if one uses the space available after amputation is not easy, but, as in the case of spinal cord injuries (SCI), facilitating function of a flaccid limb with a device of minimal weight is even more difficult. Biomechanical factors are often offset by clinical ones. For instance, an orthosis for the lower limbs of an infant patient should maintain high stability in order to prevent deformity. In contrast, orthoses for adults may feature certain “underbracing” in order be as light weight as possible.

The energy cost of using a reciprocal gait orthosis after SCI is 6-8 times larger than that required for normal gait in norm (Gordon et al 1956). This is a major reason why about 50% of SCI patients cease using prescribed and customized orthoses (Jung 2001).. Moreover, can customized aids be perfect if those personalized by different specialists for the same patient’s use differ (Osborne 2004)? Mobility of severely disabled can be improved in a wheelchair but activities in upright position should not be eliminated. At least balance exercises should be performed to facilitate inner organ function.

## Aim

The goal of the LETOR project was to analyze a comprehensive spectrum of factors - from biomechanics, medical and therapeutic conditions, to psychology and social aspects within a group of patients after SCI, in order to design a relatively simple, lightweight, adjustable, clinically efficient, easy to don-doff, low-cost prefabricated KAFO for effective standing and reciprocal gait exercises.

## Method

The LETOR philosophy (2001[a,b]) is based upon factors which together combine to facilitate mobility. It is a working tool for physiotherapists which incorporates the following characteristics:

- sufficient alignment - allowing the orthosis to be fitted immediately on the patient,
- easy donning - externally over trousers and regular sport shoes,
- comfortable sitting - for necessary relaxation between periods of activity,,
- active standing - with appropriate posture and stability to maintain body balance,
- enhanced walking – facilitated by built-in propulsive dynamic features which compensate for lost functions,
- controlled underbracing - to prevent blocking the process of neurological restoration, and
- effective training - with the use of reduced knee orthotic support whenever it is permitted.

The LETOR is prefabricated in one standard adult-size. It is adjustable, attached from rear and incorporates a telescoping single upright splint fixed in 3½ points and fastened over the trousers with sport shoes acting as part of the system. The telescopic orthosis is designed to stabilize the paralysed lower limbs at the knee and ankle joints in order to provide the necessary biomechanical conditions for standing and bipedal ambulation. Most patients fitted with the device are post-SCI, however cases of polio, stroke, neoplasm, Wegener and Guillain-Barré were also successfully treated leading to an improvement in the patient's body balance, mobility and independency (Pokora 2001[a]; 2004).

## Static

The LETOR is designed for safe and easy standing exercises. A rigid stirrup holds the foot from the rear (Figure 1) stabilising the ankle joint for a better sense of body balance in standing. For effective, safe and comfortable limb support the cuffs feature angular self-alignment to match the individual's thigh and calf shapes. Widths are adjustable by bending the cuffs made of aluminum. Three Velcro closures are applied together with an optional above-knee strap. Quick lock (Mark 3) is adopted for easier fixation of the telescopic set. The lock and the tube bolted clamp provide longitudinal and transverse alignments.

Displacement of instantaneous centre of rotation in biologic joints in vivo is load-dependent, thus uneasy to duplicate in an external mechanical structure, even with the use of polycentric hinges. Biomechanical compliance during limb flexion for comfortable sitting is achieved in the LETOR in a most natural way. This is by flexing the knee joint alone after thigh support is lowered down and relocated within the shank area.

A moderate forward slant of the orthoses column by 6° encourages a lordotic posture. Standing in such a position can not be considered as appropriate in a normal population but after SCI enhanced lordosis is helpful for compensation of postural neuromuscular dysfunction, provided there are no contraindications.

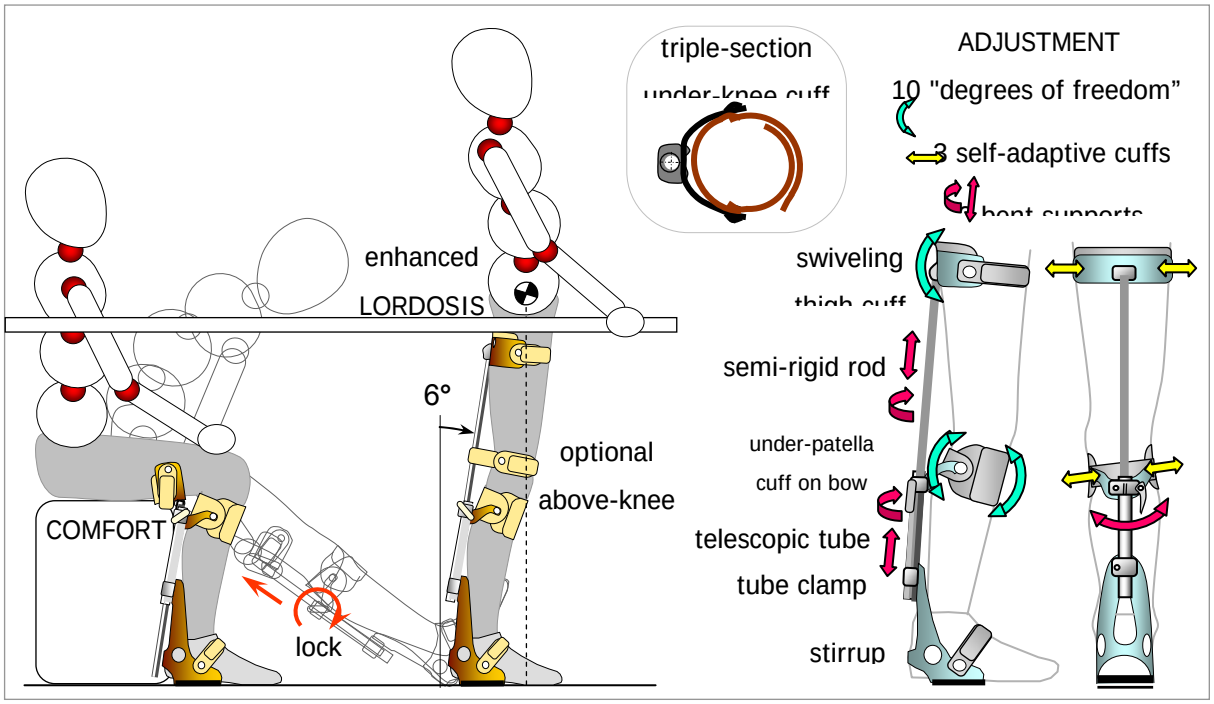


Figure 1. LETOR features: operation, orthotic fixation and shape *adjustment*

**Kinematics**

The LETOR is designed for energy-efficient ambulation efforts are spared by:

- external donning and doffing of the orthoses;
- the propulsive properties of the stirrup, splint column and cuffs;
- the semi-rigid splint column and spine ligaments which function to store energy.

The forefoot section of the orthosis is semi-elastic to facilitate easier ambulation. The heel section aims to correct the limb rotation in hip joint thus set the foot straight at each heel-on event. The stirrup frontal slant cut facilitates lateral body shift after passing the mid-stance phase and facilitates a compensatory swing (Figure 2). Reduction of spine/trunk flexibility by enforced lordotic posture not only facilitates the body balance in standing but also initiates compensatory swing. Due to tension stored in the ligaments of the spine, the flaccid limb, once released off the ground, has a tendency to move forward, augmented by a pendulum effect due to posterior splint attachments shifting the centre of mass of the limb backward.

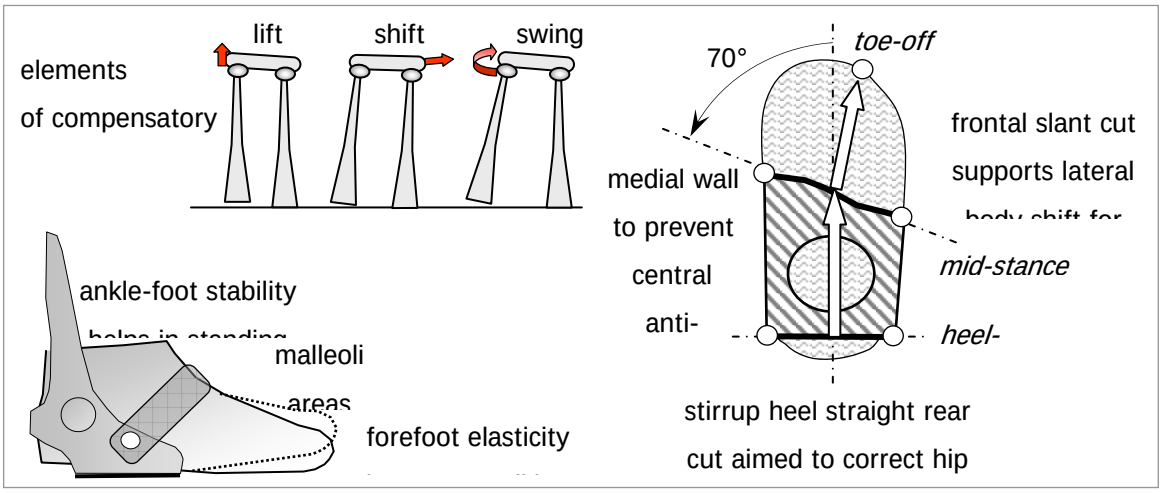


Figure 2. Stirrup details shaped for purpose

## Dynamics

During walking in any stabilising orthoses, variable ground reactions cause cyclic propulsive effects (Pokora 2001[a]) (Figure 3). After heel strike, it appears to push the patient forward through the thigh cuff. This propulsive force is gradually reduced to zero at mid-stance. While stepping forward, a counter-propulsive effect appears, i.e. pulling the body backwards, it gradually increases and then decreases again to zero at toe-off. Due to the 6° forward slant of the orthosis and the proportions of the heel section, the pushing effect in the LETOR acts on a limb sector approximately 3 times wider than in the pulling backwards phase which is 3 times stronger instead. Hence, the overall gravity-linked influence is fairly balanced. Experienced users using upper-body musculature, supporting appliances and trunk inertia can reduce the pulling force and augment the pushing effect by appropriate synchronization of pelvic rotation. The direction of this pelvis rotation is natural for gait but timing is crucial and experience is needed.

## Underbracing

As little as possible orthotic support speeds-up recovery through reduction of inhibiting effects. Carefully selected shapes and materials create the properties of the LETOR which at the first glance are hidden as improvement due to the proprioception is unconscious. Due to the limited elasticity of the calf band and semi-rigid telescoping column, the knee joint fixed by the LETOR orthosis is purposely set in a subtle 2-3° of flexion. Thus little play in the knee is permitted in gait which augments the kinaesthetic signalling. Further, if functions return, a gradual lowering of the thigh cuff allows the use of the LETOR in a reduced support (RS) mode (Figure 4) in which gait restitution may be enhanced by a smooth shift of the knee flexion-extension control from the orthosis to reactivated muscles. This feature is particularly useful in incomplete SCI and in stroke.

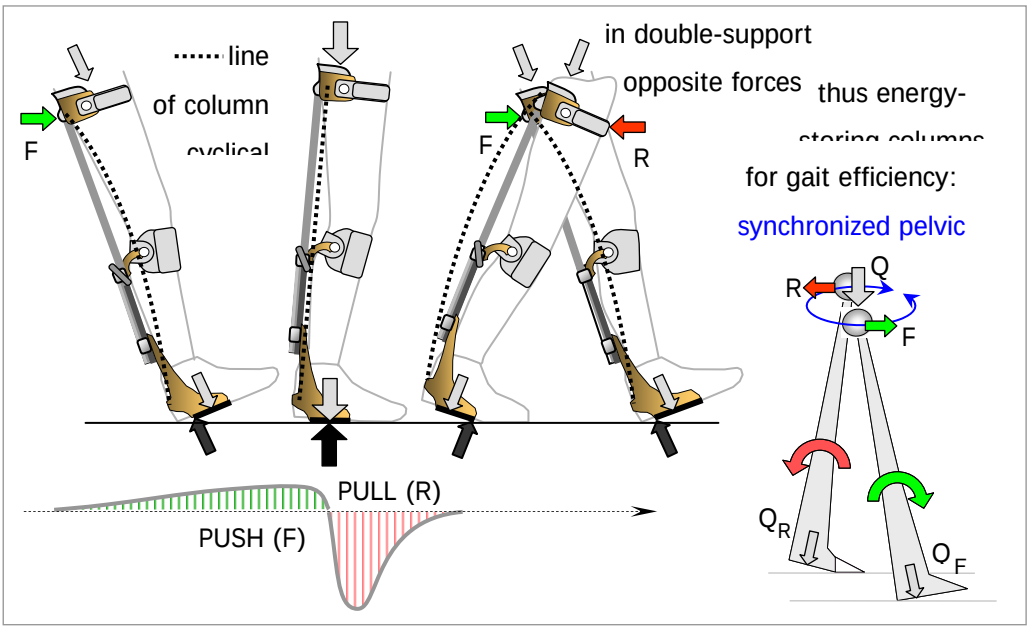


Figure 3. Cyclical variable PUSH-PULL forward/reverse effects from gravity-linked *ground reactions*

**Initial**

First sales (s) and system were laces:

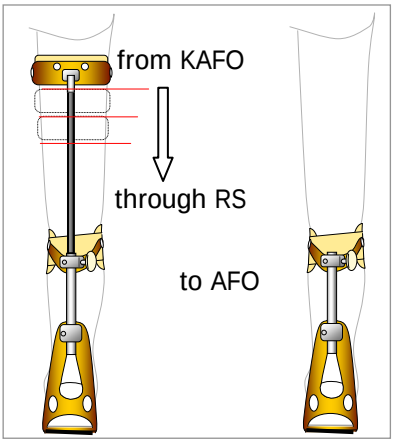


Figure 4. Reduced support

**assessments**

clinical testing (t) of the LETOR arranged in 1985-87 at following

1. STOCER Metropolitan Rehabilitation Center, Medical Academy - Konstancin, Poland (t)
2. Clinic and Department of Rehabilitation, Silesian Medical Academy - Repty, Poland (t)
3. Institute of Orthopedics and Rehabilitation, Medical Academy - Poznań, Poland (t)
4. County Hospital of Traumatic Surgery - Piekary Śląskie, Poland (t)
5. County Center of Orthopedic Services - Łódź, Poland (t)
6. County Orthopedic Supplies - Bytom, Poland (t)
7. EFTO Unit for Applied Orthotics - Jönköping, Sweden (s, t) / Svensk Handikappteknik AB (s)
8. DRI Dallas Rehabilitation Institute - Dallas TX, USA (s, t) / 3D Orthopedics Inc. (s, t)
9. De Hoogstraat Revalidatiecentrum - Leersum, The Netherlands (s, t) / Orthos b.v.
10. Royal Perth Hospital - Perth, Western Australia (s)
11. CEBELOR Orthopaedic Centre - Bruxelles, Belgium (s, t)
12. Workmen Compensation Traumatic Hospital - Frankfurt, Germany (t) / GOTEP mbH (s, t)
13. ORLAU Midland Centre for Spinal Injuries - Oswestry, England (t) / RTS Taylor Ltd (s)
14. NCTEPO University of Strathclyde - Glasgow, Scotland (s, t)
15. Royal National Orthopaedic Hospital - Stanmore, England (s)
16. Proteesisäätiő - Helsinki, Finland (s)
17. LIC Espanola de Ortopedia S.A. - Madrid, Spain (s)
18. Rodolfo Rodriquez Benitez Tecnico Ortopedico - Las Palmas de Gran Canaria, Spain (s)
19. National Institute for Medical Rehabilitation - Budapest, Hungary (t)
20. Safdarjang Hospital - New Delhi, India (t)
21. National Spinal Cord Injury Centre - Stoke Mandeville, England (t)
22. modified telescopic orthosis sent to India for barefoot walking polio patients (t)
23. samples with polyurethane sandals sent by courtesy of CEBELOR to Central Africa (t).

It should be acknowledged that samples for national testing have been sponsored by the Polish Orthopedic Association, ORTMED, and a few more devices were donated by our laboratory free of charge. With exception of 7 units, opinions were kindly provided as expected. Assessments were positive with the exception of one statement received from Stoke Mandeville: The LETOR was tried there on one SCI patient and in that case the orthosis had been found to be inappropriate and the next attempt planned was never reported. It seems that samples given for testing free apparently are being received by the recipients as the equipment of lesser usefulness.

Combined initial assessment of *LETOR* from other reporting facilities (Pokora 2001[a]) complies with the conclusions published by American authors (Limbird et al. 1989; Stills 1983-2006):

- useful in rehab centres for training and assessment;
- single upright stabilisation in most cases sufficient;
- eliminates drawbacks of conventional orthoses;
- adjustment is fast, simple and convenient;
- easy to don/doff due to external fitting;
- relatively lightweight: approximately 1 kg per unit;
- helpful in body balancing and propulsion;
- may also be good for use at home, when accepted.

After complaints about the early design of the telescoping being set by a tapping bolt, this component has been re-designed; the butterfly bolt was rearranged into the clamp and a fibreglass rod was replaced by a carbon fibre one. Recently a quick lock has been incorporated to ease operation. Leather or nylon straps are considered as options.

**Indications**:

- paraplegia after trauma or pathology;
- lower limb flaccid dysfunction due to head injury (stroke), neurological disease, polio;
- quadriplegia; for active standing exercises only with assistance and the supporting handrail.

**Contraindications**:

- stable contractures and/or significant spasticity, due to the lack of snap lock in the knee joint;
- excessive weight, excessive height and /or excessive level of neuromuscular dysfunction;
- affected integrity of the knee joint.

**Variants**

In the beginning the LETOR was manufactured in 3 lengths and 3 stirrup widths. Upon sales analysis the manufacturer adopted a policy to offer 1 standard size (suits approximately 90%). Two child-size prototype sets have been made and fitted but follow-up opinions have not been obtained. In 1987 single units for polio barefoot patients were made and sent to Africa and India. The letter received from India stated that the person in charge of testing went abroad for studies.

**Follow-up**

In 1982 a SCI patient was discharged with the telescopic prototypes that he was using for training at the Konstancin centre. Plans to retrieve the equipment were abandoned hence the very first definitive self-fitting was allowed to happen paving the way for legal fittings which later followed.

Over 22 years once a week, in average, a new patient has been fitted with a LETOR in Poland. a country of 38 million. In 2001, funds were obtained from the National Committee for Scientific Research (KBN) and purpose-designed questionnaires were sent to 154 potential respondents; the LETOR users identified in supplier's archive records (Pokora 2002). The one-page easy to tick comprehensive inquiry contained 143 questions grouped in 8 categories:

- dysfunction - health - influences
- mobility - activity - motivation
- equipment - self-assessment.

The anonymous procedure was guaranteed for reliability and the only reward offered was access to the final report: 72% of the sample responded. Respondents were encouraged to provide objective and subjective information. . Data was obtained from 57 users representing approximately 5% of the prescribed LETOR sets. The following data was collected:

- gender: 12 female, 45 male
- age range: 16-76 years; mean 37.4
- unreported genesis of disability: 10%
- trauma: 81% - SCI C6-S1; mean Th11 (Figure 5); 38% complete; in 3 sub-groups: 15x C6-Th5; 11x Th6-Th11; 25x Th12-S1
- pathology: 9% - 2 cases neoplasm; 2 cases post-operative; 1 case SM; 1 case Wegener; 1 case vascular deficiency
- weight range: 50-96 kg; mean 71.8
- height range: 153-192 cm; mean 175.1
- accompanying health disorders: 1-12 items
- period of LETOR use: 0.25-15 years; mean 3.0 years.

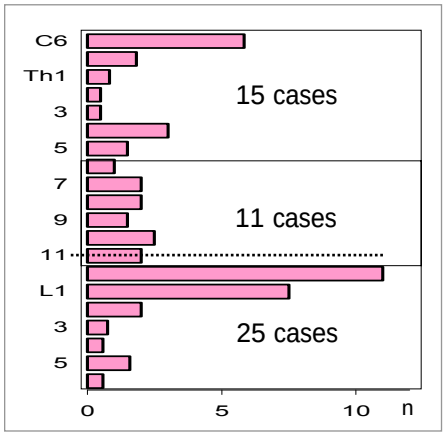

Figure 5. SCI sub-groups

In comparison to a 50% rejection rate quoted in literature (Jung 2001), respondents reported relatively high level of acceptance (Figure 6): 75% telescopic orthoses in use, 5% given away due to the functional recovery, and 20% abandoned: 9% definitely while 11% of unused devices were stored “just in case”. Respondents declared the following usage: for indoor activity 55%, for training 54%, outdoor 15%, while 9% of users combined all modes and 29% performed a mixture of exercises and indoor use.

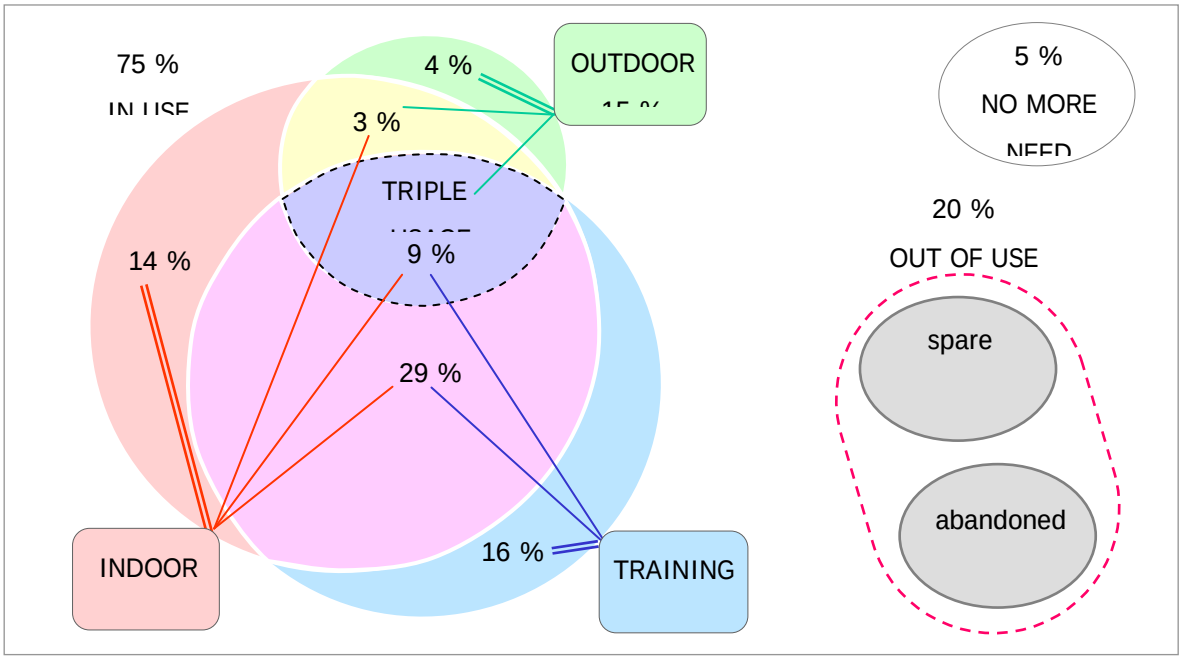

Fig. 6. Use of prescribed LETOR in all INDOOR-TRAINING-OUTDOOR

### International interest

LETOR was rated appropriate by clinicians and patients in Europe and USA, well received in India and China (Pokora 2004). System has been produced since 1984. LETOR is the registered trademark of the Lower Extremity Telescopic Orthosis. It has been licensed to companies in Sweden and the USA.

In 2005 the total volume of official versions reached 3,450 units. After a maturing period of 25 years the big scale use of the LETOR system in Poland resulted in getting experience and improving the comprehensive rehabilitation process provided on a regular basis with the following routines:

a) assessment - device is useful in various states, and stages from active standing to reciprocal gait;
b) training - with prefabricated orthosis the flaccid limb can be stabilized immediately, at low cost with low weight;
c) transient fitting - knee stability can be modified, usefulness can be tried before the order is made;
d) definitive fitting - record of about. 1,300 cases, mainly SCI, prescribed by doctor upon patient' choice.

### Conclusions

1. The LETOR prefabricated orthosis, due to its unique features, constitutes a valuable option among transient stabilizing lower limb orthotics for body balance exercises, gait training and assessment.

2. Motivated patients accepting external donning may also use it as a definitive splint for daily training. Due to its easy don-doff, fair adjustability and relatively low weight the device may bring benefits to those patients who feel the pressure to take care of their health through daily activity. Even if health benefits associated with standing and gait exercises declared by 2/3 of respondents could not be always objectively confirmed it is important to provide such an aid for their self-confidence.

3. Due to its relatively low cost and easy distribution the LETOR may become helpful in developing countries too, especially where number of traffic accidents is rising, and the shoes are in use.

4. Since the usefulness of telescopic splint can be checked before the order is placed, consensus yet to be reached that this feature should be regarded as LETOR advantage rather than disadvantage.

### References

Gordon E, Vandenvalde M. 1956. Energy requirements in paraplegic. ambulation. Arch Phys Med Rehabil. 37:276-285.

Jung P. 2001. Lower extremity orthoses for people with spinal cord injury. Orthop Technik 11:11-5.

Limbird TJ, Stills M, Elliott D, Wharton G. 1989. Lower extremity telescopic orthosis for immediate fitting in paraplegia. Orthopedics 12(6):851-854.

**Orthotics technology in developing countries: experiences in French-speaking Africa**

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**Handicap International, Lyons, France**

## Introduction: French-speaking Africa and the Handicap International experience

### *A context of poverty*

A "French-speaking" Africa is an artificially-created concept imposed on the African continent through its colonial history with France and Belgium. By common consent, a distinction is made between North Africa (Maghreb and Middle Eastern countries also speaking French) and the Indian Ocean countries (Madagascar, Comoros and Mauritius) and sub-Saharan Africa, a block of 47 countries of which almost half are francophone[1] and are located predominantly in the West and Central Africa[2]. Handicap International (and Handicap International Belgium) is extremely well established in both these regions and has worked with many State and associative organisations since the early 1990s, under priority funding from various cooperation programmes (with France, Belgium and Luxembourg) and the European Union.

Today Handicap International is directly or indirectly present in many countries in the region and is represented in Ouagadougou by a Central and West Africa Regional Coordination (CWARC).


Map of West and Central Africa based on the UNDP HDI classification; of the fifty poorest countries, 33 are located in sub-Saharan Africa

Africa, general map

and the CFA franc zone

### *A right to rehabilitation, services and accessibility for people with disabilities*

CWARC and its partners have identified common problem areas in these countries in terms of rehabilitation and orthotics and prosthetic professional practices; cross-cutting solutions have

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[1] Mauritania, Senegal, Guinea Conakry, Mali, Burkina Faso, Niger, Côte d'Ivoire, Togo, Benin, Chad, Cameroon, Central African Republic, Gabon, Congo, Democratic Republic of Congo (Kinshasa), Burundi, Rwanda and Djibouti.

[2] Most of these countries are classified under the Human Development Indicator (HDI) and the UNDP classification as having low human development and are also found on the list of least advanced countries.

been discussed in preference to individual ones, ultimately to increase efficiency as well as improve the participation of people with disabilities. The Togo programme is one such example, where investments have focused on restructuring the training provided to orthotists and prosthetists in Lomé, benefiting both the country and the region.
Orthotic development technology has been and still remains dependent on other favourable and unfavourable factors, like the recognition and application of care-management and orthopaedic fitting care, training developed in various formats, research and development dynamics by professionals in this specific sector and also the right of participation of the users/patients/customers (opinion, choice, feedback).

***Development of orthotics technology in West and Central French-speaking Africa***
The history of the development of orthotics technology in Fench-speaking Africa is inexorably tied to a number of factors, themselves interdependent[3]:

1) A recurring pathology until recently was post-poliomyelitis paralysis which required orthopaedic fittings

2) Post-colonial, French and German technical assistance
   a) In services:
      i) A model based on the creation of the National Orthopaedic Appliance Centres (CNAO) in the capitals and mobile clinic campaigns in the provinces:
         French assistance: this involved making technical aids and delivering prostheses to former combatants in several countries in the region. Only from the 1980s onwards did the civilian population gain access to these centres and orthotic services.
         German assistance: the Togolese National Centre intended right away to provide people with disabilities with fittings, with those suffering from the post-polio paralysis cared for under a network of provincial regional centres.

      ii) The development of applied research programmes to design orthopaedic material in line with the social, economic and climatic conditions in Africa.

   b) In-regional training of prosthetists and orthotists in Lomé, Togo:
      Development of a degree of expertise by the German technical assistance in conjunction with the National Centre.

3) Support by religious missions and non-governmental organisations (Terre des Hommes) using an innovative techniques based on PVC (polyvinyl chloride) pipes:
   a) Development of orthotic models using PVC and other plastic pipe materials. Moulded inner shoes sections for insertion into readily-available shoes also developed along with research into attaching an orthosis directly to a wooden sandal.

All these, non-exhaustive, factors together encouraged the emergence of specific techniques to fit polio victims at the end of the 1980s. This technique soon came to be known as the "PVC PP technique" (PVC for polyvinyl chloride and PP for polypropylene)[4].

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[3] Refer to Appendix A to this document for further details

[4] Refer to Appendix B to this document for further details.

Aluminium moulds and prefabrication system of thermoplastic shells at CNAO in Dakar. Photo HI Senegal, 2006

***Problems identified***

Problems already identified in the 1980s by various key players operating in the region remain valid in 2006 despite the continuous support from international associations.
General comments emanating from the Dakar Interregional Seminar (29 May-3 June 1989, WHO/ AIARF/ CRN) on orthopaedic technologies in developing countries are applicable to orthoses:

1) Insufficient production both in quantity and quality
   "Despite adopting multi-format initiatives, miscellaneous appliance manufacturing systems and training specialist personnel, progress has been far from the anticipated results; the quality of work has been well below standard in very many countries and production has only kept up with an infinitesimal portion of requirements."[5]
   "Orthopaedic workshops work in a variety of ways: whereas some of them carry out the full manufacturing process themselves, others purchase certain spare parts from outside and only do assembly work locally."[6]

2) The problem of transferring technology and skills
   "Ideally a production line would be set up to supply the same excellent product quality at an affordable price. But few experts are optimistic, believing that it is impossible to find a production system in this field that combines quality with a price the customer can afford."[7]
   Comment: "During the last few decades, it was proved beyond doubt that western technology could be transferred to developing countries without altering the quality, as has been the case for the textile and automobile industries, ship building, electronics, jewellery, etc.; why should it not be the same for what could be called the "health industry"?"[8]

As a result Handicap International, an international association well established in the region, have developed or strengthened its operations:

- A decentralised approach with the creation of regional orthopaedic appliance and functional rehabilitation centres (Senegal, Mali, Burkina Faso);
- Reinforcement of national and existing centres (Senegal, Burkina Faso, Mali, Togo);

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[5] Extract from an introductory document to the 1989 Seminar *(Orthopaedic technology strategies and problems)*

[6] Extract from an introductory document to the 1989 Seminar *(Orthopaedic technology strategies and problems)*

[7] Extract from an introductory document to the 1989 Seminar *(Orthopaedic technology strategies and problems)*

[8] Extract from an introductory document to the 1989 Seminar *(Orthopaedic technology strategies and problems)*

- Initial and on-going training of technicians;
- Training grants for rehabilitation doctors in the region's countries (Burkina Faso, Senegal);
- Work on training in Lomé;
- Alternative funding solutions to contribute to access to orthopaedic materials for all (Mali, Togo).

**Orthotic technology today**

***Update on the content of the training course on lower limb orthotics in the orthotics-prosthetics department of the National Medical Auxiliaries College (ENAM)***

For years the basic ENAM training course for orthotic technicians took casting techniques with plaster bandages and simple thermoforming as its reference standard. From the time the college was founded until 2000, 1st and 2nd year students did not work on patients; from 2001 onwards, students have worked directly on patients, progressing from "mechanically"-oriented training towards a clearly clinical orientation.

Current training conditions at ENAM have quite clearly improved over the past five or six years. Although the number of instructors is still limited (this problem will be resolved shortly). The miscellaneous equipment and materials available (funded by Handicap International as part of a project with the European Union and/or the Luxembourg Ministry of Foreign Affairs and the International Committee of the Red Cross, ICRC) are used to organise good-quality training.

The introduction of new techniques like the reinforced thermoplastic shells, new training objectives with work placements during the three-year course and the writing of a mini-dissertation at the end of the course by the students are just a few of the elements helping to improve quality.
The 2001/2004[9] intake was the first to benefit from improved training conditions, the new course content and ISPO accreditation, although several defects are still very apparent. The current 2004/2007[10] intake will very certainly be of even better quality.

[9] Intake of 14 students, including 2 women (9 from Togo, 3 from Benin, 1 from Burkina Faso and 1 from Senegal)

[10] Intake of 11 students, including 1 woman [8 from Togo (including 1 woman), 2 from Cape Verde and 1 from Burundi]

Orthotics-prosthetics department, ENAM, 2005

The six or so intakes trained between 1988 and 2000, with an average of fifteen students per intake, may be considered as part of the "difficult years for studies" and therefore followed a course which does not hold out much hope subsequently for high quality of work in the services.

No orthosis is seen during the second year of the course (focusing on prostheses), but students are required to make some during their second- and third-year practical work placements in the country's services.

| | **Year 1** | | **Year 3** |
|---|---|---|---|
| | Theoretical training | Practical training<br>600 hours | Practical training |
| Presentation of course content under the training curriculum put together by ENAM, Lycée Montplaisir and HI and validated by ISPO | - Definitions<br>- General<br>- Taking cast<br>- Measurement taking<br>- Rectification of the positive<br>- Design and manufacture of component parts and assembly for trying on<br>- Additionals at ankle<br>- Additionals at knee<br>- Additionals at hips<br>- Osteochondritis materials<br><br>- Theoretical study of orthosis tracing techniques | Manufacture of components<br>(120 h, semester 1):<br>- side-bars with single axis knee joint<br>- forked stirrups<br>- sidebars and stirrups<br>- cutting out and application of metal foot plate<br>Making up<br>(280 h, semester 2):<br>- measurement taking<br>- taking cast<br>- AFO (sidebars, 2 bands, metal foot plate)<br>- KAFO (sidebars, knee joint, 4 bands, thigh shell and metal foot plate)<br><br>Manufacture of standard forearm crutches | Weight bearing Ankle Foot Orthosis type "Sarmiento"<br><br>Ischial weight bearing orthosis type "Thomas splint"<br><br>Knee Ankle Foot Orthosis with ischial support |
| Teaching models | | Firstly 1 "fitting" student for one model student, then "guinea pig" patients. | Group of 3 students to create the Sarmiento, otherwise just one demonstration copy |
| | Support for one additional work on one "guinea pig" patient to improve practical skills if not quite up to scratch | | |
| Other comments | | Up to now, local components used; tomorrow use of orthotic components imported from ICRC (2005 donation of Otto Bock stainless steel components for adults and children[11]). | |

[11] Child's steel side-bars with knee joint with ring locks, Otto Bock ref. 17E1=2H / Child's steel side-bars with ankle joint with stirrup, Otto Block ref. 17E2=2H / Adult steel side-bars with knee joint with ring locks, Otto Bock ref. 17E1=1H / Adult steel side-bars with ankle joint with stirrup, Otto Block ref. 17E2=1H

| | | | |
|---|---|---|---|
| | | Possible production of a PP drop foot by the student (on another student) | |
| Professional work placements | 1 work placement of 165 hours (four weeks) directed by basic workshop techniques with <u>1 objective to:</u><br>- Assemble an Ankle Foot and Knee Ankle Foot Orthosis | 3 work placements (400 h, 10 weeks) directed towards clinical work and situation scenario with patient, with the <u>objectives to:</u><br>- Make an Ankle Foot and Knee Ankle Foot Orthosis up to finish and delivery<br>- Assess orthotic fitting criteria for a patient<br>- Perform a static and dynamic analysis of a fitted patient<br>- Advise the patient on servicing and future improvements to the manufactured fitting | 1 work placement (450 h, 12 weeks) directed towards clinical work and situation scenario with patient, with the <u>objectives to:</u><br>- Examine the patient clinically<br>- Assess orthotic fitting criteria for a patient<br>- Make all types of orthosis<br>- Align the various orthopaedic materials statically and dynamically<br>- Perform a static and dynamic analysis of a fitted patient<br>- Advise the patient on servicing and future improvement to the manufactured fitting |
| Number of orthoses produced by student | | 5 in training + those produced on work placement | those produced on work placement |
| Intermediate assessments (end of semester) | Yes | 1 component, such as pair of stirrups | Type 1 Ankle Foot Orthosis |
| Final assessment | Yes | Type 1 Knee Ankle Foot Orthosis on 1 patient | 1 orthosis should be made and applied to 1 patient, using components that are usually imported.<br>The student must also choose a subject (orthosis or prosthesis) and prepare a technical report on it at the end of the course; the report is presented in front of the examination panel. |

Knee-ankle-foot orthoses. Orthotics Department, ENAM,

Theoretically, if the ENAM training courses for orthotists/prosthetists continue to improve and new graduate orthotists/prosthetists can be hired, good fittings should hopefully be available in the centres in Togo and other countries in the region.

**Update on actual orthotic production in the various country centres**

Togo and Senegal are currently the only French-speaking countries in West Africa with all the recognised levels of expertise (Categories I, II and III).

Non-exhaustive data[12] which are nevertheless significant in the West Africa region with respect to homogeneity of professional practices indicate that knee-ankle-foot orthoses for lower limbs are in the main (with the exception of Abidjan, Côte d'Ivoire, very recently in Mali and shortly no doubt in Togo[13]) manufactured using:

- mild or stainless steel local component (knee joints with ring lock and ankle joints with stirrups + inner shoe, with possible variants)
- polypropylene (PP) and PVC for the thigh and tibial shells

PVC is used regularly by virtually all countries except Togo.

Ankle-foot orthoses are mainly manufactured from PP.

[12] Burkina Faso, Côte d'Ivoire, Mali, Senegal and Togo

[13] Due to major donations from the ICRC

**Typical orthoses made by the orthotics services for the most frequent pathologies in the region:**

| Frequent pathologies | Typical orthoses |
|---|---|
| Post-injection paralysis, hemiplegia | PP AFO |

Drop foot orthosis in PP for adults. Photo HI Sénégal, 2006

| | |
|---|---|
| Post-poliomyelitis paralysis | Knee-ankle-foot orthosis (KAFO) with local component and also imported articulated component (ICRC), in PP and PVC |

KAFO: tight and tibial shells in PVC, and drop foot in PP. Photo HI Senegal

KAFO: double shell and drop foot in PP. Photo HI

Stainless steel sidebars with single axis knee joint, with ring lock, manufactured locally.

KAFO: metal and leather shells, CNAOB, Burkina Faso, Jan 2006

100% PP Knee Ankle Foot orthosis - Abidjan, Côte d'Ivoire

| | |
|---|---|
| Necroses of the femoral head (primitive osteochondritis of the hip or Legg Calve Perthes disease, aseptic and avascular necrosis of the femoral head with gradual compression of the support zone in adults) | Ischial weight bearing orthosis (most frequently the Thomas splint) |
| Various deformities (genu varum, genu valgum, club foot, etc.) | PVC or PP splints |

PVC splint for genu valgum. CNAO, Lomé, Togo, February 2006

St Germain PVC splint, CNAO, Burkina Faso, January 2006

| Traumatism | Splints |
|---|---|

An exception: Côte d'Ivoire, which produces 100% PP KAFOs; this is not recommended for adults as it is too fragile, but is however suitable for children and small build adolescents.

KAFO 100% PP, knee and ankle joints, Abidjan, Côte d'Ivoire

**Price comparison of the most common orthoses[14] in the capital centres:**

| | PP AFO Adult size | | KAFO (local manufacture) Adult size | |
|---|---|---|---|---|
| **Burkina Faso** local mfr. sidebars+joint | CFA F15,000 | €23 | CFA F27,000 | €41 |
| **Côte d'Ivoire** 100 % PP mfr. | CFA F12,350 | €19 | CFA F83,850 | €128 |
| **Mali** local mfr. sidebars+joint | CFA F15,000 | €23 | CFA F35,000 | €53 |
| **Senegal** local mfr. sidebars+joint | CFA F5,000 | €8 | CFA F40,000 | €61 |
| **Togo** local mfr. sidebars+joint | CFA F35,000 | €53 | CFA F175,000 | €267 |

1 euro = CFA F656 and an average salary which varies between CFA F50,000 and 120,000 in the region (€76-183)[15].

Regarding calculation methods, it is known that some countries, currently using components that are almost all imported, have not changed the KAFO prices which are identical to the price of devices with locally-manufactured components (Mali).
Cost calculation tools are heterogeneous and specific to each country. The Lomé centre is currently applying the ISPO cost calculation tool and the results are virtually the same as the actual total costs already proposed in Togo, which seems the most reliable reference in our context.

**Orthopaedic fittings - quality of the services of the various countries in the region**

- Devices are prescribed by doctors in the four national centres of Dakar, Lomé, Ouagadougou and Abidjan, including occasionally rehabilitation doctors (Ouagadougou and Dakar). In the provinces however, they are mainly prescribed by physiotherapists and/or ortho-prosthetists.
- The delivery of the device depends mainly on the single Level II technician.
- Little attention is given to finishing in most countries:
  - An impact from the training work in Lomé has yet to be seen in all the services and not all long-standing technicians have benefited from on-going training;
  - The centres are far from all being equipped with vacuum pumps for thermoforming, guaranteeing a good finish;

Machine maintenance in the workshops is frequently non-existent, hence regular breakdowns resulting in orthoses with poor or rushed finishes.

**Assessing twenty years of history and development**
Professional practice in French speaking Africa is quite varied and dependent upon:

- years of training
- social and economic contexts
- practical and environmental conditions
- support from organisations, projects, and donations, etc.

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14 Taking into account consumables and manufacturing methods which remain variable (casting, mould, etc.)

15

| | | |
|---|---|---|
| Burkina Faso and Mali | CFA F50,000-70,000 | €76-106 |
| Senegal | CFA F70,000-100,000 | €106-152 |
| Côte d'Ivoire | CFA F100,000-120,000 | €152-183 |

Over the years the region has experienced problems in meeting production needs. Reasons for this may be attributed to the following:

- A paradoxal situation exists between the huge estimated needs and the actual activity in under-frequented centres.
- Services are equipped with capital equipment but filled with seemingly under-occupied teams[16].
- Personnel are difficult to motivate in terms of production efficiency and effectiveness.
- Cost recovery practices are poor, reducing access for all patients.
- Patients are frustrated by the quality problems in the services.

There are problems of aesthetic and sometimes functional quality of the devices which go beyond the framework of training alone. This is related to:

- Lack of supervision at Level I (perspective for initial training);
- Lack of on-going training at all levels;
- Production tools (infrastructures, equipment and materials) which still need boosting and support;

In addition one can often experience neglected finishes, poor quality local raw materials, poor dressing, etc.

Budgetary constraints which are limiting in terms of technical and technological choices:

- KAFOs are manufactured as often as possible from a tracing as the cost of plaster bandages is very heavy for Burkina Faso, The same situation is found in Mali where the cost of devices is reduced by assembling the bands from sheet metal instead of using thigh and leg shells.
- PVC is still very frequently used (thigh and leg shells, splints).
- Polypropylene AFOs are often made on prefabricated aluminium moulds. This is the case at CNAO in Dakar and Ouagadougou.
- Thermoforming does not always take place under vacuum (thermoforming without suction requires less surface area of polypropylene for cutting); but the quality suffers.
- The interface of the device to the skin is usually covered by leather. The sidebars and stirrups used are 95% locally manufactured in the workshops, except from Mali which today receives joints from the ICRC.

Products and materials used to make orthopaedic appliances are purchaced from massive donations (through projects with INGOs, technical “twinning” with French services, etc.):

- When financial donations are made rather than donations in kind, materials can be purchased locally, before purchasing imported goods.
- Use of materials found locally:
  - Small consumables and basic materials can be found in most countries: plaster, adhesive, plaster bandages, buckles, Velcro, PVC, tubular rivets, etc.
  - Skins and leathers may be found on site, but some poor quality skins are used for the skin protection (mediocre craft tanning) and make the finish mediocre (except skins and leathers in Burkina Faso).
  - Various thicknesses of foam pads can be found in Lomé (made in Nigeria) which are also used for skin protection.
- Use of imported products:
  Polypropylene has now become an essential material, used virtually everywhere. Orthotic components, until recently, were rarely used given their very high costs. There is a possibility that recent donations from the ICRC (Otto Bock orthotic components) to Togo (2005) and Mali may cause this to change.
- A “middle man” between local, regional and international purchases:

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[16] Note that the geographical division of personnel is frequently to the detriment of provincial centres and that the coverage rate of technicians compared with numbers of people with disabilities and in need of orthopaedic fittings remains low.

There is Proteor representative at Ouagadougou (Etablissements Orthoba) where imported materials may be purchased on a more one-off basis. This is more in line with the financial possibilities of centres which can buy single items directly from this supplier if necessary[17]; the price includes all administrative procedures (customs' duties, miscellaneous taxes, insurance, transport, packing, etc.) and the material is delivered to the door, even to extreme outlying areas, of all the countries bordering Burkina Faso (Niger, Togo, Côte d'Ivoire, Mali and Benin).

A process of technological change which is still far removed from the actual choices available to professionals in the region:

- Interdependence on offers and donations:
  During recent years, and with the support of development partners, orthopaedic device manufacturing techniques have changed radically. For example, the polypropylene ankle foot orthosis has gradually been replacing the stirrup. Thermoformable materials, particularly polypropylene and PVC now dominate are implementation techniques are continuously improving.
- The effects of improving the initial training of prosthetic and orthotic technicians is not yet apparent in the field in terms of quality[18];
  Many countries in the region are still lacking clinicians trained by a recognised body.
- Effect of on-going training seminars organised by the African Federation of Orthoprosthetic Technicians (FATO):
  - Since the ISPO/FATO seminar held in Lomé in January 2004, the technicians have learned to make articulated KAFOs in thermoplastic (thigh and tibial shells in PP). This type of thermoplastic KAFO was not made in all the CNAO centres before this date, as the technicians were not accustomed to making them. Previously technicians used metal instead of PP with just a PVC thigh shell and a PP knee shell (Lomé model).
  - The thermoplastic KAFOs taught during the seminar are not always accepted for use by the patient population. One reason is that the patients find them more difficult to cope with due to increased heat and sweating of those areas in contact with the plastic.

**A problem of fitting comfort from the patients' viewpoint, who rarely go to services following the Burkina example**

With a view to improving rehabilitation care in Burkina Faso, a beneficiary satisfaction survey of seventeen orthopaedic appliance and functional rehabilitation centres was carried out from the 27th of September to the 9th of November 2004[19]. The aim was to measure the degree of satisfaction by users of these centres. The approach used was a field survey based on an individual data collection sheet. At the end of this process, it was quite clear that the rehabilitation landscape was not frozen but, on the contrary, changing radically in terms of infrastructures, personnel and patients. Underlying a climate of overall satisfaction, areas of dissatisfaction were identified in work organisation, treatment information and, to a lesser degree, accessibility and hygiene of premises. Some 113 patients with an average age of 30, including a high proportion of children aged 0 to 15 (31%), were interviewed. This sample included 11% who had undergone physiotherapy and fitting care and just 1% fitting care alone. A total of 23% of patients found the devices fitted to be either moderately or less than comfortable. Subjects commented that the devices often felt too heavy, were unattractive and

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[17] e.g. 1 pad of 1*2 metres of PP, 4 mm thick, costs €64, 1 pair of sidebars with single axis joint - ref. 2J101 costs €138).

[18] As a reminder, the 2001/2004 intake was the first to benefit from this

[19] Ministry of Health, Handicap International (December 2004) *User satisfaction survey of orthopaedic appliance and functional rehabilitation centres in Burkina Faso,* Ouagadougou, Burkina Faso

occasionally unsuitable. This lack of comfort could explain, at least in part, the high rate of people who ceased wearing the devices (48.6%) as reported in a previous study by Charbonnier in 1997[20].

**Current and future issues**

1) Maintain quality regional training teaching techniques and technologies that may be used and practised on patients. Training projects should also move towards creating research and development ideals amongst professionals.

2) Negotiate abandoning unit production of component parts in the services in favour of totally imported parts, whilst maintaining and supporting multi-format initiatives such as;

   i) Standardised production runs, which can guarantee a certain quality in line with domestic realities, like the CNAO in Dakar which:
      - operates a production unit for orthopaedic components which produces the sidebars and the prosthesis knee joint. Under this system, technicians can concentrate on taking measurements, assembly and adjustment of devices.

   ii) The development of component production lines in small-scale industry could improve quality even further whilst escalating costs.

   iii) The development of at least one purchasing pool serving the whole region, promoting "key flagship products" and maintaining the service provision within national budgetary constrictions.

3) Encourage the participation of the min users, patients or customers:
   The results from the twenty years of development have shown that although the patient is the main link in the chain, he/she remains without doubt the least consulted in the design and manufacturing process. It is necessary to encourage consultation with organisations representing people with disabilities at the technical level. It is necessary to encourage the development of;
   i) tools for monitoring patients fitted with orthoses
   ii) patient satisfaction surveys, particularly addressing technical services
   iii) studies to analyse patient perceptions of technical accessibility to services and the social and economic impact of wearing an orthosis.

**Conclusion: a paradox**

Questions may be asked regarding the compatibility of these recommendations with policies of over-sustained donations that make it difficult to maintain and develop standardised production runs and to a lesser extent, component production lines in small-scale industry and a purchasing pool. These questions were already being asked for all practical purposes in the 1980s.
But how can the paradox be resolved between professionals seeking to use quality raw materials and orthopaedic components (which today means imported products) and the need to provide a continuous supply of devices at a cost that is able to be met?
It is important to recognise that although French speaking African countries are considered poverty stricken, people with disabilities are at the dawn of having their rights recognised. This must include the right to access services able to deliver quality devices.

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[20] Charbonnier, C., (May 1997) *Rehabilitation of people with physical disabilities in Burkina Faso.. Experience of a mission with Handicap International,* thesis for a PhD in medicine, University of Saint Etienne

**Bibliography**

Charbonnier C. 1997. Rehabilitation of people with physical disabilities in Burkina Faso. Experience of a mission with Handicap International, PhD Thesis. University of Saint Etienne.

ENAM. 2005 Training curriculum for orthotist/prosthetic technicians. Lomé, Togo.

Ministry of Health, Handicap International. 2004. User satisfaction survey of orthopaedic fitting and functional rehabilitation centres in Burkina Faso. Ouagadougou, Burkina Faso.

WHO. 1989. Orthopaedic technology strategies and problems, document presented to the Inter-regional Seminar on orthopaedic technologies in developing countries. Dakar, Senegal, 29 May-3 June 1989.

Rigal F, Verschoore P, Vesan JC, Lepetit J, Laot M, Faye B, Diouf A, Ba D. 1989. Use of polyvinyl chloride (PVC) and polypropylene (PP) for orthopaedic fittings in Africa. Presented at Inter-regional Seminar, Dakar, Senegal

Urseau I. 2003. An assessment tool to monitor links between training and employment. Towards quality professional insertion - case of professional health training in a developing country, Master's dissertation. Faculty of Dijon.

Osborne S. 2004. Can repeatability be improved when taking foam impressions of the foot? In: proceedings of ISPO 11th World Congress. Hong Kong. p.347.

Pokora M. 2001[a]. Model approach to activation of patients with paralyzed lower limbs towards body balance training and ambulation (in Polish). PhD Thesis, p 131.

Pokora M. 2001[b.] Quite intelligent choice in functional bracing - LETOR. In: Proceedings of ISPO 10th World Congress. Glasgow. Glasgow. TP1.1.

Pokora M. 2002 Research Grant № 4T11E00823 final report. (in Polish) (not published). National Committee for Scientific Research (KBN),

Pokora M. 2004. Supporting the bipedal locomotion on paralized limbs (in Polish). Monograph: Biocy-bernetics & Biomedical Engineering: Biomechanics & Rehab Engineering, Warsaw, 859-884,

Pokora M, Bian WG, Tian P, Mou P. 2004. LETOR orthosis for prevention of hypokinesia in SCI. In: Proceedings of 11th ISPO World Congress. Hong Kong. p.146,

Pokora M, Ober J, Milewski P. 1984. Lower extremity telescopic orthosis - LETOR. Prosthet Orthot Int 8:114-116.

Stills M. 1983-2006. Personal communications.

**Plenary Discussion "Orthotics technology in developing countries"**

**Chair: Hugh Watts**

**Rapporteur: Claude Tardif**

## Discussion

Why do professionals want imported materials that cannot be sustained and paid for?

*It was mentioned in the presentation that the advantage of the PFKAFO is that it is suitable for barefoot walking. How?*
Actually the PFKAFO is provided with a thin sole but used without a shoe. So the foot is only bare on the dorsum.

*There is so much post ischemic paralysis in East Africa. How can we prevent this?*
Indeed it is a big problem and many laws do not work. It is necessary to create inter-country awareness and run workshops. We should ask the African Rehabilitation Institute. There is also a language problem in the French speaking countries.
Comment: Language is a barrier. Not many contacts to French speaking countries. Many French speaking countries in Africa are very low-income countries and affected by civil wars.

*What is the next step for the PFKAFO? Is it appropriate or not? When is the report coming out? How about in Sri Lanka. Do we start using prefabricated devices?*
Internal conclusion is that stiff devices should not be used but but semi-stiff devices are OK to use. We are still awaiting the results of the independent evaluation.

*Does is cost less money and time for the PFKAFO?*
Yes it will be cheaper but by how much is not clear.

## Education and training of orthotics personnel in developing countries

**Dan Blocka**

**Toronto, Canada**

The face of education in prosthetics and orthotics is quite fascinating as it is in a state where there are many developments occurring and evolving. This is not only at the “front line” perspective between teachers and students but also in terms of the development and recognition of curriculum and programmes. There are more and more groups and individuals interested in attaining some sort of international status or formal recognition. ISPO is attempting to react to these developments by increasingly being available for consultations and formal inspections/examinations and continually developing/adjusting the various standards and procedures involved.

It is an interesting perspective when one looks back 20 to 30 years and takes stock of all the developments and changes that have occurred. The first thing that comes to mind are all the key organizations that have been involved in this development and continue to do be. The German Technical Cooperation Agency (GTZ) comes to the forefront historically with its impact beginning back in the later 70s and early 80s and continuing into the early 2000s. Cambodia Trust has also been instrumental to the development of Prosthetic and Orthotic education in Asia and continues to be so. ISPO has had a strong collaboration and cooperation with the World Health Organization (WHO) in developing international standards for the profession and education in Orthotics. The United States Agency for International Development (USAID) via the Leahy War Victims Fund (LWVF) has played a very key role since the early 2000s in this area, with funding support of related educational activities through its relationship with ISPO. NGOs such as the International Committee of the Red Cross (ICRC) and Handicap International (HI) are continuing their assistance worldwide by helping facilitate education in this area by supporting and developing programs in various countries where a need is established and there are no current education programmes. Both organizations have also supported the education of the profession by supporting students attending other ISPO recognized schools.

ISPO’s role in this activity goes back to the foundation of the Society which, from an educational point of view, is to encourage and promote research, development and evaluation related to prosthetics and orthotics, guide and support education and training and to encourage and facilitate a high level of uniform practice in prosthetics and orthotics.

As part of this role ISPO, in collaboration with the WHO, has developed a categorisation for prosthetic and orthotic practitioners which is:

- Category I - Prosthetist-Orthotist
- Category II - Orthopaedic Technologist
- Category III - Prosthetic/Orthotic Technician

The development of the categorisation for prosthetic and orthotic practitioners initially began with the Holte Report in 1968 (UN !969). The report came out of the United Nations Inter-Regional Seminar on Standards for the Training of Prosthetists. In 1990, a WHO Consultation on the training of personnel for prosthetic and orthotic services in developing countries was held in Alexandria, Egypt (WHO 1990). It is this second meeting where the formal categorisation for
prosthetics and orthotics practitioners was published. Since that time the categorisation was further refined and updated by the ISPO Education Committee. It has been ISPO’s approach that Category II is the most appropriate level for starting a training programme in developing countries with the possibility of then moving to a Category I level in time.

At the request of the WHO, ISPO coordinated a follow-up consultation in Glasgow, Scotland in September 2003 and has published a document from this meeting titled, “Guidelines for

training personnel in developing countries for prosthetics and orthotics services" (WHO 2005). At this meeting there was a high level of acceptance from the WHO and all participants of the entire education philosophy of ISPO. A breakthrough for the recognition of other forms of training, such as single discipline training and modular based training occurred. This document is available via the ISPO and WHO websites and contains the following sections; the need for personnel for prosthetics and orthotics, types of personnel, tasks of personnel, services, distribution, and community based rehabilitation. The appendices contain the professional profiles for the various categories of practitioners and the guidelines for training the various categories of practitioners.

The current categories for prosthetic and orthotic practitioners is as follows:

> **Category I : Prosthetist-Orthotist, or equivalent term.**
> Entry requirement: University entry level, or equivalent (12/13 years schooling).
> Training: three or four years formal structured and leading to University degree or equivalent.
>
> **Category II : Orthopaedic Technologist, or equivalent term.**
> Entry requirement: 'O' level or equivalent. The usual requirement for paramedical education in developing countries, normally 11 years schooling.
> Training: Three years formal structured and normally lower than degree level.
>
> **Category III : Prosthetic/Orthotic Technician, or equivalent term.**
> Entry requirement: Elementary school diploma.
> Training: Technical educational programme or on the job training.

With this categorisation, ISPO developed information packages for each category that are continually edited and updated. These packages are available from the ISPO website. Each package includes, the definition of roles and competency, curriculum essentials and a section on the recognition and final examination process. The recognition process is documented and entails the scrutiny of curricula, facilities and resources, an inspection of the premises, and participation in the examination procedures. What followed this was the need for a more detailed and elaborate protocol for the implementation and running of the final examination process at the Category II level.

In response to this, ISPO published a document in 2001 that sets the framework and procedure for the process. The protocol has now standardised the process of final examination allowing the standards for Category II to be measured more effectively while adopting a uniform approach within the recognition process. It also ensures there is a fair and equitable assessment of the candidates and that the examination process is reflective of the course content and the standards outlined in the Category II Information Package. Since this protocol has been implemented it has now brought about a validation to the process and also facilitates enhanced recognition by local authorities and related groups.

At the end of the full Category II process, involving the successful completion of a recognised course and final examination process, the graduates receive an ISPO Category II certificate and are officially registered at the ISPO head office in Copenhagen as an ISPO Category II prosthetics and orthotics practitioner.

ISPO is now at the point where the development of the Cateogory II level in developing countries is significant and has gained momentum worldwide. The established programmes that are recognized as ISPO Category II are in Tanzania, Vietnam, El Salvador, Pakistan and Cambodia. Recently, schools in Morocco and Togo have received full Category II recognition with the potential for other programmes in Sri Lanka, Malaysia, Indonesia, Argentina, and China to also attain full recognition.

Normally ISPO does not actively promote short term or fragmented training pathways as a means of achieving the ISPO standard. But the ISPO guidelines have exceptions to this policy when the circumstances are not ideal and another solution is indicated. As a result of this policy ISPO has worked with some organisations to give recognition to unique training

programmes that normally exist only for one intake of candidates or for a short duration of time. Examples of this were the ICRC training programmes in Azerbaijan and Georgia which were completed in 2001 and also the programme in Amman, Jordan under the auspicies of the Al Hussein Society in 2003.

A more recent development in orthotic education is the implementation of distance learning techniques and platforms. The first implementation of this method is in Central and South America by the University of Don Bosco in El Salvador. ISPO has collaborated on this project and has also given Category II recognition to the programme. The Society was present when the first graduates completed the programme in late 2004. This process is continuing with other intakes and also with the planned implementation of the program in Angola and also parts of eastern Europe.

ISPO collaborated with the ICRC on a working group to develop a standardized training systems for all ICRC projects involved in training. This working group finalized it's mission in the summer of 2003. The final training system was developed using three principles involving the use of the ISPO Category II professional profile as the basis for the system, to ensure the continuation of service provision and to allow for flexibility in the training. The complete training programme involves a sequence of modules leading to a full Category II level.

As mentioned previously, this modular approach is now recognised by ISPO and detailed in the ISPO/WHO guidelines document mentioned earlier. The ICRC has implemented this modular approach with the strandardised training system developed with ISPO in Ethiopia and Sudan. Both these programmes have gone through formal ISPO inspections and final examinations. The programme in Ethiopia completed the full module I in 2004 and module II in 2005, while the program in Sudan will have it's first ISPO inpection and final examination in July 2006.

It should also be mentioned, due to the fact the ISPO/WHO training guidelines document now recognises programmes involved in single discipline training, ISPO has now given full recognition to the single discipline programmes that exist both in Vietnam and Tanzania.

The next development ISPO has recently taken on in terms of education in the orthotics and prosthetics field, is the formalisation of the ISPO Category I level recognition process. It was widely thought that this process already existed, but it was not until March of 2004 that this process was actually implemented for the first time. In 2003, the ISPO education committee formed a sub-committee for this specific task with the initial approach and strategies formed at the ISPO Executive Board meetings in August, 2003. The first draft of the Category I protocol for inspection and documentation was then composed and since then has been edited and updated.

As was previously stated, the first implementation of this new protocol occurred in March 2004, with the formal Category I inspection of the Bundesfachshule für OrthopädieTechnik (BUFA) in
Dortmund, Germany and also the Prosthetics and Orthotics Degree Programme at Strathclyde University, Glasgow, Scotland. Both of the processes involving each training programme to become a professionally recognised orthotics and/or prosthetics practitioner, was given full Category I recognition by ISPO. This ISPO inspection process entailed the preparation of various documents and papers prior to the inspection dates and subsequently took place over a three day period and involved two ISPO inspectors. The inspection process implemented, was taken directly from the Category I protocol document developed.

In November 2005, ISPO recognized the Prosthetics and Orthotics Degree Programme at Tumaini University, Moshi, Tanzania at the Category I level making it the first ISPO Category I programme in a developing country to be fully recognised. Further Category I inspections will be taking place with the Hong Kong Polytechnic University (April 2006) and also the University of Applied Sciences in Geissen-Freidberg, Germay. It is likely that two or three other programmes will apply for full ISPO Category I recognition in the next couple of years.

This Category I process will have it's impact in developing countries as more Category II schools look at advancing themselves to the next level of orthotics and prosthetics education or find an acceptable pathway that facilitates the upgrading of Category II practitioners to the Category I level. This upgrading pathway has been developed in a collaborative venture between the Cambodian School for Prosthetics and Orthotics (CSPO) at the Prosthetics and Orthotics Programme at La Trobe University in Melbourne, Australia. It is hoped that eventually ISPO will be formally requested to evaluate the programme for full Category I recognition.

The bottom line of all this discussion, is to ask what are the outcomes of all this activity and investment in orthotics and prosthetics education. It is strongly felt that ISPO and other collaborators must do a formal study related to this question. It is clear though, that the impact of all the graduates are readily visible with the development of the profession in many areas where there was none before or where there was a very little organised professional structure.

The new guidelines published in the ISPO/WHO training document, have been positive to give flexibility to the training/education process. On the other hand, there is a very large challenge to meet the needs of those requiring orthotics care, to keep the professionals trained in the field and to expand this training to other related health professionals as it relates to orthotics.

For ISPO there are enormous demands to meet the ever increasing obligations due to the growth in this activity. There is also the continual demand on ISPO to improve the related procedures and standards and to recruit more individuals to assist ISPO in the process of formal inspection and final examination.

As a final note, it is fairly clear that the long term sustanance of the profession in various countries is dependent on the existance of a stable and politically recognized educational structure. It also shows historically, that taking "short cuts" in training orthotic and prosthetic practitioners  does not work as a long term strategy when the desire is to establish and grow the prosthetic and orthotic profession to be able to treat those in need of orthotic intervention for the long term.

**References**

ISPO. 2001.

UN. !969. Report of the United Nations interregional seminar on standards for the training of prosthetists. Holte, Denmark, 1-19 July 1968. New York: United Nations.

WHO. 1990. Guidelines for training personnel in developing countries for prosthetic and orthotic services. Geneva: World Health organisation.

WHO. 2005. Guidelines for training personnel in deloping countries for prosthetics and orthotics services. Geneva: World Health Organisation.

# The clinic tem in orthotics: use of an interdisciplinary clinic team for rehabilitation management in developing countries

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## Should interdisciplinary team facilitation be a goal for development projects for orthotic prescription and rehabilitation management?

The promotion of interdisciplinary teams for rehabilitation in developed countries has been prevalent since the 1960s (Lavin et al. 2001). Even though there is some evidence to support the use of clinic teams, there is still further research needed on effectiveness and contribution to rehabilitation outcomes and quality assurance (Kemper and von Wild 2002). Despite the prevalence of team concepts in the developed medical community, the use of clinic teams in less developed countries is not necessarily the standard or even promoted. The lack of team communication and organization in needs assessments and evaluations in developing countries has been documented repeatedly (Kay 1993; Derstine 1998; Derstine et al. 2003; O'Toole et al. 1996; Fisher et al. 1993; Handicap International 2003; Kay 2001; MSCI 1991), however, there are a number of questions related to the promotion of the use of clinic teams for rehabilitation in developing countries that still need to be addressed. Is the use of a team approach suitable to promote when planning and implementing orthotic and rehabilitation services in developing countries? Is the use of a team approach a system that is more effective and time and cost efficient? Will the team approach decrease duplication or prevent complications? Are there benefits for the clients receiving services or to the personnel implementing the services? What are the best methods of introducing, promoting and ensuring the development of teamwork?

These questions may not be possible to answer definitively without extended time periods for development or without more formal methods of research. This discussion will present some of the literature available on the effectiveness of both clinic teams and the educational approaches used to develop interdisciplinary team skills, describe the Health Volunteers Overseas project methods used to promote interdisciplinary rehabilitation improvements in Vietnam and pose some of the questions to be considered for projects to improve rehabilitation services in the developing world.

## Interdisciplinary health care; developed country trend

Although the use of multiple healthcare professionals in the medical community has been part of practice for as long as formal systems have been present, the use of interdisciplinary rehabilitation teams has only been common since the 1960s (Lavin et al. 2001) . Prior to the development of this interdisciplinary trend in developed countries, each individual profession had already developed their own identity, boundaries and scope of practice, which is not always the case in less developed countries. One of the driving forces behind interdisciplinary teamwork was the expansion of the medical provision model to include home care and outpatient services which require more formal and complex systems for communication, referrals and appropriate allocation of responsibilities to different professions (Harris 2006). The development of team organization and structure had been made even more important with the numerous professions involved in care, both to prevent duplication of services, and for cost-efficacy. Interdisciplinary care may involve a variety of methods of addressing patient management; however, key to the concept is contribution of the different professions to team communication, combined planning and negotiated goals.

## Benefits

- Improved communication, documentation
- Improved content base and coordination of team conferences

- Increased integration of function and handicap issues into management
- Improved domiciliary care referral and continuum (Rentsch et al. 2003)

In a study involving young adults with disabilities in England, an interdisciplinary team approach was compared to an ad hoc approach. The group that received interdisciplinary services were 2.5 times more likely than the ad hoc services group to participate in society. This was after adjustment for absence of complaints of pain, fatigue and stress (Bent et al. 2002). In another controlled research study of progressive implementation of the team approach for clients with amputations, authors concluded that only when the full team approach was adopted were the best results obtained. This study involved 233 patients over five years and documented a reduced in-patient stay of 20 days, a 94% decrease in the need for post-discharge physiotherapy and the possibility of utilizing a prosthesis increased by five times. The overall effectiveness of the rehabilitation was regarded as being three times more effective with a team approach than without a team approach (Ham et al 1987).

Most of the positive outcomes of studies related to teamwork include improved job satisfaction, increased efficiency of care and patient satisfaction, but there is little data to backup the desired financial cost-effectiveness (Harris 2006). In one of the few studies that has been performed for multidisciplinary rehabilitation management in developing countries, researchers surveyed the quality of life of people with disabilities in Cambodia and compared the impact of professional rehabilitation (prosthetics/orthotics and physiotherapy), community-based rehabilitation and labor market assistance. The 164 respondents were from a range of urban and rural settings. Quality of life scores were substantially lower in the group who received none of the rehabilitation services and the highest scores were evident when individuals received all of the services. The study supports an integrated approach, but did not look at mechanisms to integrate services or the referral mechanisms involved with a team approach (Powell et al. 2002).

## Goals of interdisciplinary teams

### *Improved patient management*

The intention of utilizing interdisciplinary teams is to improve overall patient management through consistent goal setting and adjustment of goals (Kemper and von Wild 2002), by providing a continuum of support for patients (Powell et al. 2002; Pearson 2001) and appropriate referrals (Handicap International 2003; Powell et al 2002). Division of team responsibilities to enhance complete management for patients in a timely manner (evaluation, education, discharge planning, referrals) and to prevent duplication of services is intended to make the rehabilitation timeframe more compact and more comprehensive. Some of the choices that would be served best by a team problem solving effort are the potential for rehabilitation; including the likelihood of compliance, timing of orthotic measurement (prior to surgical or physical interventions or afterwards), priorities of orthotic goals, and even whether orthotic interventions are needed. The team approach can also be valuable for communication related to fit, suitability of choices, and need for adjustments that lead to a comprehensive evaluation of outcomes and benefits for future management.

### Professional team support

In addition to patient benefits, there are also professional team benefits from professional socialization and training. Team conferences are valuable tools for learning the scope of other professionals' expertise and more about the possible interventions available. The support and motivation under ideal team models can minimize the geographic isolation that is so often found in developing countries.

### Efficiency

Although one of the main reasons for instigating team approaches is economics, the true contribution of an interdisciplinary team may be in the sharing of resources and time savings (eg. for history taking) rather than pure financial savings visible on budget (MSCI 1991) The benefits of time and interventions saved need to be weighed against the concentrated efforts of multiple professionals for one client.

### Identified need

The desire for a more involved rehabilitation team has been communicated by medical personnel during needs assessment processes (Fischer et al. 1993), ongoing project development (Handicap International 2003), as well as through external evaluations and observations (O'Toole et al. 1996; Fisher et al. 1993; MSCI 1991). In a rehabilitation upgrade project in Vietnam, the initial request for more involvement and input from physical therapists and nurses involved in rehabilitation came from the physicians. The lack of integration of services was observed consistently during an initial site visit (Kay 1993; O'Toole et al. 1996; Fisher et al. 1993). This led to a focus on development of educational seminars around a specific diagnostic category using a team approach from both the faculty and attendees.

In an evaluation visit for a project in El Salvador, the multidisciplinary team was in existence, however, the evaluation team noted: "These professionals work well with one another especially when they visit rural sites, but fall short of providing a team approach" (MSCI 1991). Their suggestions to address this goal were identification of a strong clinical leader, to provide management and sensitivity training, and provide collective training for all rehabilitation professionals to harmonize their patient management techniques and promote a team approach (MSCI 1991). The goal of the team leader was to integrate the members of the multidisciplinary medical team into a coordinated group that offer as much comprehensive rehabilitation as resources and institutional scope permit (MSCI 1991).

### Requirements for team approach

Some of the requirements for the multidisciplinary team approach include:

- Structure (Kemper and von Wild 2002)
- Leadership skills (Kemper and von Wild 2002; MSCI 1991)
- Group communication mechanisms/skills (Kemper and von Wild 2002)
- Conflict management strategies (Kemper and von Wild 2002; MSCI 1991)
- Decision making and problem solving skills (Kemper and von Wild 2002)
- Individual professional knowledge, skills (training, professional identity) (Harris 2006)
- Knowledge of other profession's expertise, methods
- Administrative and systems support and incentives (Harris 2006)

In a study of an interdisciplinary team working in a post-surgical neuro-rehabilitation unit in the United Kingdom, the most important elements of team effectiveness were concluded to be leadership, good structural organization of the team, awareness of basic communication rules, understanding typical group dynamics and stressors, conflict management and definite decision making. The authors propose that these characteristics increase productive interdisciplinary working and enable the team to continue to mature (Kemper and von Wild 2002). In opposition, the absence of strong skills in each of these above factors could sabotage the effectiveness of a team approach.

### Clinic team environment

In developed countries, teams are available and used in all environments from specialized tertiary referral hospitals and long-term rehabilitation units; to community and home care ((Lavin et al. 2001). In less developed countries; the logistics of few professionals, large geographic separation between referral centers, geographic barriers, and widely dispersed rural medical centers may preclude the effectiveness or even the feasibility of a team approach in certain areas. If a true team approach is used to provide rural services through travel, the pure logistics can overwhelm the desire to provide the best services possible (Stills and Dunleavy 2001). In a project in India, patients with spinal cord injuries were followed in the community by a team consisting of the home visit team of an orthopedic surgeon, physiotherapist, occupational therapist, prosthetist and orthotist, medical social worker, and a nurse. Although the number of hospital re-admissions decreased using this approach, the true-cost/benefit ratio would seem to be excessive when only a few individuals could receive services in a day (Prabhaka and Thakker 2004). The linkage with community resources; such as community-based rehabilitation programs or other local medical resources; should be a consideration for the more rural regions. The more complex the referral systems; the more difficult the follow-up options and continuity of care becomes. The complexity of a system in

environments with limited professional and economic resources is an important consideration in planning of interdisciplinary rehabilitation.

**Methods of initiating change**

- Role modeling - communication and interaction
- Change through established leader (ability to mould either education or practice)
- A plan which includes structured coaching, mentoring and modeling (Huczynski 1989)
- Reinforcement and reward
- Early culture change – educational systems
- Continuous support and infusion (education and practice)
- Integrated systems
- Integrated documentation
- Inclusion of administration in changes
- Professional development training (communication, problem solving, decision making, content – intra and inter disciplinary) (Fisher et al. 1993)
- Multiple professionals in needs assessment, planning, educational programs (delivery and recipient), support systems and evaluation (Fisher et al. 1993; Benjamin and al-Dafarzi 2000)

Most of the above interventions are day-to-day operations with major organizational change needs. They require change management and strategic development approaches. The use of training to assist with this type of organizational culture change is important however some of the responsibility will fall on leadership to implement and manage the new systems. A very successful intervention in Cambodia that modeled interdisciplinary team work at the governmental, non-governmental and educational levels is the use of the Disability Action Council (Stills and Dunleavy 2001; Gallay 2001; Horvath and Condor 2001; Tardif 2001). This type of approach allows for inter-professional communication and collaboration on all issues related to patient care and health provider education.

Tutoring and coaching on-the-job are regarded as powerful methods of applying new learning Huszynski 1989). The support of mentors and trainers is important with respect to any affective issues and development of interpersonal skills, problem solving skills and to negotiate change Visser 2002). However, these skills are complex and take time that is not always available in situations without extensive resources.

Possibly one of the reasons that interdisciplinary projects are not attempted is the complexity and need to promote changes at multiple levels within systems. Other types of projects have included multidisciplinary involvement successfully in order to disseminate information across multiple levels of the organizational structure. A public health project designed to assist with policy making that utilized evidence based data in Mexico, Bolivia, Cameroon and the Philippines. They targeted mid-level policy makers, program managers, and technical advisors in applied epidemiology, management and leadership, communications and economic evaluation in a multidisciplinary approach. This, US Centers for Disease Control and Prevention (CDC), initiative implemented the USAID Data for Decision-Making project (DDM) in these particular countries where decentralized systems had increased the need for sub-national policy makers and health officers improvement. Interdisciplinary in-service training was used to strengthen capacity to make effective data-based decisions. Results showed that the DDM strategy improved evidence-based public health. Subsequently, DDM concepts and practices have been institutionalized in participating countries and at the CDC (Pappaioanou et al. 2003).

**Providers**

The involvement of all professions that have an impact on patient care in the team may also involve recognition of the different roles, education and standards for professions. Although there has been considerable work to establish common international levels of Prosthetists/Orthotists, the same definition of levels of practitioner are not as consistent in other professions. When alternative models of provision are utilized, the knowledge of the

extent of skills and background is essential for team inclusion in decision making. In some developing countries, orthopaedic technicians or clinical officers take over some of the roles assigned to specialists in more developed countries. For example, there was only one orthopedic surgeon in Malawi in 1991 so the 35 orthopedic clinical officers treated over 150,000 patients in 24 district hospitals (Blair 1994). After receiving one and a half years of education and supervised practice beyond high school, the orthopedic clinical officers were taught to reduce and set fractures, apply splints and casts, dispense drugs and perform less complex surgery (Blair 1994. This type of practice model would result in a very different team dynamic than for a team including an orthopaedic surgeon with extensive experience in the use of orthotics and long-term rehabilitation.

The extent of training and type of function will dictate the involvement in a true clinic team. The same difficulty is present with different levels of Physical Therapy providers. Table I describes the different levels of Physical Therapy Providers in Cambodia along with the factors that have influenced the development of the provider model. As an example, a community-based rehabilitation worker may be able to provide information about the patient's social and physical environment, potential income generating possibilities and the community resources, while a professional physical therapist will be able to contribute towards a decision about the potential for a patient to be able to ambulate with or without orthoses. A Physical therapist assistant may be able to provide feedback on the client's response to a treatment program, but will not have the decision making capabilities on future potential after orthopaedic surgery. Table II describes the factors that may lead to development of the different types of provision systems.

**Difficulties in developing countries**

- Lack of trained professionals (Meier and Smith 2002)
- Lack of individual professional identity (Kay 1993; O'Toole et al. 1996; Fisher et al. 1993) or strong individual identity factors (Harris 2006)
- No role modeling
- Lack of faculty commitment to approach
- Work loads
- Disparity in knowledge amongst members of healthcare team
- Hierarchies
- Communication patterns
- Limited problem solving approaches

One of the basic factors that will preclude a true team approach with equal contribution from all members is a lack of knowledge and skills resulting from inadequate training. In the initial needs assessment for a rehabilitation upgrade project in Vietnam, physicians expressed a desire for contributions from other members of the rehabilitation community. The needs assessment team observed that the skill and knowledge standards of the physical therapists and the nurses not only led to a lack of confidence to communicate opinions to the physicians. They simply did not have the background to make recommendations or suggestions. In a number of developing countries that have been affected by war or isolated from international contact, the standards of education are typically two or three decades behind the developed world (Stills and Dunleavy 2001; Dunleavy 2006; Dunleavy et al. 20005). In addition to the lack of educators and experienced clinicians, the paucity of educational resources in local languages leads to passing

Table 1: Comparison of Rehabilitation Educational Models in Cambodia

| | Professional diploma/degree | Mid level Rehabilitation worker training | CBR | Community Follow-up |
|---|---|---|---|---|
| Education<br>Length of time for education | 3-4 years fulltime | 6-12 months, part-time | +/- _2 weeks and on-the job training | 2 days and on-the job training |
| Cost of education | Tuition, loss of income for study period sustained by student/government/ NGO | Productive time lost sustained by organization | Depends on volunteer or paid positions | Paid for by organization, ministry officials costs subsidized |
| Instructors | Requires professionals with minimum degree training and experience<br>Need formal teaching skills | Provided by rehabilitation personnel, do not necessarily have educational experience or skills | Multiple professionals from different fields | Professionals working in the field |
| Time for instructional preparation | Time required for preparation, but will use materials and methods annually | Time needed for preparation, teaching is not repeated regularly | No time required for intensive preparation, mostly practical training | No time for preparation, all practical training for those CFUs without rehabilitation experience |
| Provision of services | Higher level evaluation, goal directed treatment, | Treatment techniques with direction from professional<br>Lower level skills | Community advocacy, family support and encouragement<br>Continuation of home exercise programs<br>Provision of home modifications or assistive devices | Check up on assistive devices, function and home exercise programs<br>Family support |
| Knowledge level | Requires knowledge of pathology, biomechanics, psychology, management skills | Technical skills, basic anatomy, pathology | Layman's understanding of pathology<br>Duplication of instructions to make assistive devices from local materials, exercise programs<br>Social integration mechanisms<br>Community networks | Layman's understanding of pathology<br>Duplication of instructions to make assistive devices from local materials, exercise programs<br>Community networks |

| | | | | |
|---|---|---|---|---|
| Skill level | Technical skills good<br>Decision-making skills average (should be good to excellent to manage in developing country environment) | Technical skills fair, limited repertoire<br>Weak knowledge basis for decision-making strategies | Minimal skill level<br>Need for skills in wide variety of fields, diluting potential skill level<br>Limited decision-making skills | Extremely limited skill level<br>Procedure based delivery |
| Pre-requisite course content | High school education<br>Science coursework<br>Communication skills (written, spoken) | May not have completed high school | May not have completed high school | May not have completed high school |
| Employment | Ministry of Health (MOH) hospital positions<br>NGO rehabilitation centers<br>Private patients | NGO rehabilitation centers (limited to center trained in if reciprocal training not recognized) | NGO funded – per client (Volunteer, community reimbursement, govt funding not occurring in Cambodia) | NGO travel costs subsidized, small stipend |
| Recognition | Accepted by govt, NGOs<br>Not member of WCPT, no reciprocal arrangement or recognition of qualifications in developed countries | Recognized by Disability Action Council (members of govt, NGOs)<br>May not be recognized for positions in other organizations<br>Rehabilitation I and II categories can be achieved, no possibility for university entrance if no high school education | No recognized qualification<br>Community status increased | No recognized qualification, no formal recognition from govt section member works |
| Social issues | Students mostly from cities<br>Often from wealthy families or educated parents<br>May not want to work in rural areas<br>May treat patients as lower status | Rehabilitation workers trained on the border have skills and knowledge above new graduates without recognition<br>Disabled rehabilitation workers have a strong motivating influence on patients<br>Disabled rehabilitation workers are facing social stigma from Buddhist culture | Disabled CBR workers have a strong motivating influence on patients<br>Disabled CBR workers are facing social stigma from Buddhist culture<br>Living in same location and community as patients – will know the social and political structure<br>Accepted by the community<br>Do not have the automatic status level of a professional | Do not have the automatic status level of a professional |

| | | | | |
|---|---|---|---|---|
| Geographic distribution | Mostly cities, hospitals and rehabilitation centers | Mostly cities | Communities, especially rural areas | Communities, especially rural areas |
| Political issues | Khmer Rouge regime actively sought to eliminate professionals – professional status is now higher than before | Those rehabilitation workers trained on the border have experienced the hardships of the war first hand and are more likely to be active politically. | Communist political support with local communities supporting their own leaders. Appointed CBR workers are unlikely to have as much success as those elected by the community. CBR workers are likely to be keenly involved in their community activities. | Direct recruitment of government officials will be affected by changes in government or political power |
| Social status | University level has a high social status Income level provides social status emblems – house, car, motorbike, clothing, jewelry | rehabilitation workers have longer service records and more experience than new graduate professionals creating some resentment of hierarchies and salary scales that reward the professionals | Appointment as a CBR worker will increase status in a local community. Local workers are more likely to be accepted because of their same background and social status as recipient of services | CFU workers from govt units may acquire higher status because of their community visibility |

*From:* Dunleavy K: Physical Therapy Education and Provision in Cambodia: A Framework for Choice of Systems for Development Projects. *Disability and Rehabilitation* 2006, Submitted for review Feb 27, 2006. [29]

Table II. Framework for choice of physical therapy provider system

| | Professional Physio-therapists | Physio-therapy assistants/ mid-level rehabilitation workers | Community Based Rehab Workers | |
|---|---|---|---|---|
| Political stability | | | | Conflict |
| Centralized system (mostly urban) | | | | Diffuse system (mostly rural or widely dispersed) |
| Presence of established university system | | | | No established university system |
| Time availability for education | | | | Limited time for education |
| Long term sustainability focus | | | | Short term projects |
| Funding availability for training | | | | Limited funding |
| Presence of experienced educators | | | | No experienced educators |
| Established university systems | | | | No tertiary education systems |
| High school educational systems established and high standard of biology and science | | | | Limited high school science availability and standards |
| Presence of experienced clinicians | | | | Few experienced clinicians |
| Well developed medical referral systems | | | | Limited medical referral systems |
| Emphasis specialized services | | | | Basic services |
| Emphasis on standards of medical services or high value placed on medical status | | | | Emphasis on social mobilization and community orientation |

| | | |
|---|---|---|
| Developed social support structure – community acceptance of disability | | Lack of community acceptance of disability |
| Cultural importance placed on rehabilitation | | Limited importance placed on rehabilitation or assistance for persons with disabilities |
| Established social worker assistance | | No social worker assistance |

From: Dunleavy K: Physical Therapy Education and Provision in Cambodia: A Framework for Choice of Systems for Development Projects. Disability and Rehabilitation 2006, Submitted for review Feb 27, 2006.)

down knowledge obtained from the educators' initial training, whether from expatriates or local instructors (Kay 1993; Stills and Dunleavy 2001; Dunleavy 2006, Dunleavy et al. 2005; Kay 2001; Kay et al. 1999; Pechak 2000). The individual needs of professions are so great that the relative importance of multidisciplinary involvement is miniscule.

The individual professional identities are not always well defined in developing countries. This includes the role of Physiatrists or Rehabilitation Physicians with respect to other members of the medical community (Kay 1993). In some countries, the physicians decide if there is a need for rehabilitation and complete the physical assessment, determine the treatment program and reevaluate the patients. The role of the Physical Therapists, Prosthetists/Orthotists and other members of the team is at more of a technical rather than professional level. This lack of professional identity can preclude contribution to a team effort either by lack of status, established role definition and/or by lack of knowledge and experience of the type of communication and decision making contributions that are part of a team approach. Another aspect that leads to this professional identity mismatch is formal recognition mechanisms of professions such as licensure. In one of the Physical Therapy update courses in Vietnam, we discovered that not all members participating had been through formal training, but were practicing as Physical Therapists. This situation resulted from a stipulation that all hospitals employ Physical Therapists, without requirement of a formal diploma or degree qualification. There are no licensure or control mechanisms of who is allowed to practice in positions. This meant that these individuals who had had no training could not have contributed at all to a team process.

In cultures that have delineated hierarchies that involve status for education, gender or class, the contributions of those individuals lower on the hierarchy might not be recognized. This does not preclude the use of teamwork, but may require different strategies and protocols both during team communication and also for facilitation projects. The harder component is designing educational strategies where the trainers or leaders are from different cultural contexts. Table III describes the continuum of cultural context and the effect on communication characteristics.

Table III. Continuum of cultural context and its effects on communication in low and high context cultures.

| HIGH CONTEXT CULTURE | NATIONALITIES | LOW LEVEL OF EXPLICTNESS IN COMMUNICATION |
|---|---|---|
| ↓ | Japan<br>Middle East<br>Latin America<br>Africa<br>Mediterranean<br>England<br>France<br>North America<br>Scandinavia<br>Germany | ↓ |
| LOW CONTEXT CULTURE | Switzerland | HIGH LEVEL OF EXPLICITNESS IN COMMUNICATION |

From: AM Rojas & EM Zintel. Practicing human performance technology in a global business environment., In Handbook of Human Performance. p 920.

In low context cultures (e.g. Germany, North America), the efficient, direct and straightforward approach is both valued and utilized. There are expectations of candour, and possible conflict during communication, and there is also value placed on collective brainstorming (Carey 1998). In high context cultures (e.g. Asian and African cultures) people use a minimum of words, are not explicit and look for meaning and understanding of what is not said (Rojas and Zintel 1999). Conclusions may not be stated overtly and listeners are often left to make their own conclusions, particularly if direct confrontation is likely which is considered rude (Jezewski and Sotnik 2001). There is a strong hierachial structure that dictates who makes decisions and there is separation of roles, rank and contribution to the group. These cultural characteristics pose challenges to appropriate contribution if all professions and educational tiers are not equal within the clinic team. There is additional complexity if there are gender-based inequalities in status. Besides the difficulties in promoting organizational strategies, promoting involvement of the patient and entire patient care team, the modeling and coaching of these strategies by educators or clinicians who are from low context cultures (or outside the host culture) is at risk of being minimized. Decision making strategies are also culture dependant (Table IV), and some of the high context culture characteristics do not necessarily promote team efficiency such as the reliance on prior logical arguments, circuitous thoughts and face-saving analysis(Rojas and Zintel 1999). his does not preclude the use of group decision making, however, the cultural change process is slow and needs consistent buy-in and support from members of the culture who are respected and in a position to make changes.

**Education and training options**

Most educational interventions in developed countries are planned at the post-professional level, after individual professional identities and scope of practice have already been established. The post professional level may be the most effective stage to introduce teamwork concepts from an educational development standpoint, as the skills required are complex cognitive strategies and require base knowledge, ability to analyze and problem solve and make negotiated decisions.
However, there are also entry-level interventions that have shown increased interdisciplinary understanding, promotion of teamwork, effective utilization of resources and promotion of high quality patient care (Cooper et al. 2001).

Table IV. Decision making characteristics in low and high context cultures

| Low Context Culture | High Context Culture |
|---|---|
| Attempts to be objective, logical | Attempt to be subjective, personal |
| Emphasis on facts and measurement | Intuition and insight valued |
| Tendency to take risks | Risk avoidance |
| Linear thought | Circuitous thought |
| Cost-benefit analysis | Face-saving analysis |
| Valued placed on inductive reasoning | Value placed on deductive reasoning |
| Distrust of complexity | Distrust of simplicity |
| Attempts to simplify | Complexity valued |
| Experiments with reality | Reliance on prior, logical arguments |

Adapted from: Carey CE. 1998. Global links revisited: cross-cultural conditions affecting HPT. Performance Improvement 37(2):10.

Students found the experiences in early courses very beneficial prior to developing preconceived ideas about other professions. In a comprehensive literature review of the results of interdisciplinary educational interventions, educating students around a common content area, strong administrative support and an experienced faculty team who believe firmly in interdisciplinary teamwork were identified as being cornerstones of successful programmes (Cooper et al. 2001).
Part of the process of forming a team is the understanding of roles and the respect for other members' contributions and skills as well as one's own profession (Harris 2006). The use of interdisciplinary activities was found to improve awareness of overlap in knowledge and skills, realization of professional limitations and identified specific skills related to each discipline. The activities also altered stereotypical images about other professions and attitudes about the importance of professional autonomy versus shared responsibilities (Harris 2006). Some of the newer educational strategies that are being introduced are computer based case studies (Schultze-Mosgau et al. 2004), video based training (Holloway et al. 1999), and there has been a suggestion for a global school which provides multidisciplinary input (Hotez 2004).

**Health Volunteers Overseas Rehabilitation Upgrade Project funded by USAID Vietnam 1993-2006**

The focus of a Health Volunteers Overseas project to strengthen the performance of rehabilitation personnel in Vietnam was to train rehabilitation educators (academic and clinical) and support the development of professional identity (Fisher et al. 1993). One of the mechanisms chosen to achieve these goals included workshops involving multidisciplinary teams organized around pathology topics (LE trauma, spinal cord injury, brain injury, pediatric developmental issues, pediatric orthopaedic issues, amputations, upper extremity trauma, burns) (Derstine 1998; Derstine et al. 2003; O'Toole et al. 1996). The workshops were delivered by a team of professionals to provide role modeling and included both didactic discussion of the roles of each profession, team mechanisms such as conferences and practical patient sessions during which the team approach was modeled Kay 1995). The participants were selected by the Ministry of Health as a team Fisher et al. 1993).

Specific discipline initiatives were also utilized including assistance with curriculum development, clinical instructor training, specific discipline update courses, mentoring, provision of educational resources and support of professional organization development and activities (Derstine 1998; Derstine et al. 2003; O'Toole et al. 1996; Kay 2001; O'Toole and McConkey). In addition to both the multidisciplinary team workshops and individual professional initiatives, a few content areas were identified that were addressed with specific workshops. One of these workshops was offered to both physical therapists and physicians in the same workshop. The topic content was functional anatomy background for musculoskeletal dysfunction and included physical assessment tests in laboratory format. The inclusion of both professions was chosen as a mechanism to bridge some of the reticence for discussion between physicians and physical therapists as well as to provide the practical and applied content. The course utilized active learning approaches

with practical demonstration of techniques, case studies and development of treatment approaches.

"As in previous courses, there was a wide variety of expertise and understanding of the material. There were a number of the MDs who were extremely knowledgeable and applied the material very quickly, in particular two or three who had additional training overseas. There were a few participants who were not clinically orientated and had a lot more difficulty with the techniques and were more interested in demonstrating their book knowledge. The basic handling skills for evaluation techniques and knowledge of movement theory as well as the use of exercise were limited. I used a lot of interactive teaching techniques and this aspect was also noted as being beneficial by the participants. The inclusion of MDs and PTs in the same course had mixed reviews, but overall strengthened both the course and the interaction between the professionals. The participants did not necessarily attend in teams so it is unclear whether this relationship would be carried over once returning to their home environments" (Dunleavy 2000).

Of the 22 evaluations returned, 9 indicated completely satisfied (5/5), 12 indicated very satisfied (4/5) and one person was satisfied (3/5). The three instructors included one Physiatrist and two Physical Therapists. When asked how the participants felt about having physical therapists as instructors replies included:

Table V. Evaluations of combined physician and physical therapist continuing education course (Dunleavy 2000).

| | |
|---|---|
| How did you feel about having physical therapists as instructors? | Very good (4)<br>Good (7)<br>More details about pathology(1)<br>No problem if they have good knowledge about Functional Anatomy(1)<br>Good teaching method (2)<br>Very clear and easy to understand instructions were given (2)<br>Instructors were very responsible and enthusiastic (3)<br>Instructors are very knowledgeable and mastered their professional skill (3)<br>Very clear techniques demonstrated (4)<br>Instructors are very friendly, qualified and well organized<br>Very good but of course PT instructors must be foreigners<br>Very suitable (2) |
| How did you feel about sharing the class with doctors/PTs? | OK (1)<br>Good (10)<br>Very useful since doctors and PTs help, respect and work with each other for the sake of patients (3)<br>This is a very good learning model in order to facilitate "team work" concept and apply it in our working environment for comprehensive patient care (2)<br>Sharing the class was like working in the same department so we can help each other.<br>Very good since we have a chance to learn and to help each other.<br>Better to be separate doctors and PTs since the doctors focus on theory and pathology rather than practical session.<br>It will improve our working collaboration and relations.<br>In general speaking it is good since we have the same goals but there are some disadvantages since our knowledge is |

| | |
|---|---|
| | different.<br>We all worked very hard<br>Not suitable (1) |
| Have you been in a course that used practical hands on physical examination<br>format before? | Yes (12)<br>No (10) |
| Do you like the physical examination format? | 5 (18)<br>4 (4)<br>3 (0)<br>2 (0)<br>1 (0)<br>0 (0) |
| Suggestions/requests | More handouts<br>More specific criteria and description of the course content prior to the workshop |

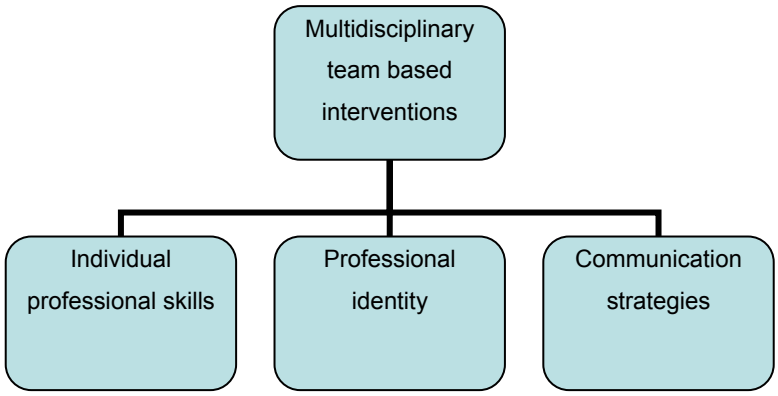
The evaluation of the overall outcomes of the team approach is an area that is not only very complex, but would require more qualitative evaluation in the field. There was no component of the project to specifically follow the teams who had attended the workshops and updates, or the students who were part of the new curricula, and this is an area in the future that would be recommended. However, the volunteers who traveled to Vietnam in subsequent years following the workshops provided qualitative reports of changes in standards of practice, use of team formats, professional interactions and professional behaviour (O'Toole et al. 1996; Kay 2001; Kay 2001; O'Toole and Mc Conkey 1998; Dunleavy 2000)..

Two particular excerpts from trip reports are as follows:
"Clinicians who attended the "Teamwork" workshops (from the Rehab Center) have instituted weekly rounds whereby physicians, therapists and nurses meet to discuss current inpatients. Prior to the workshop there was no venue for relaying information between various clinicians other than chart documentation. The staff remarked on the overall improved communication between the various disciplines and expressed interest in expanding on avenues for improved teamwork within the hospital. A specific change brought about by these weekly conferences is assignment of individual tasks and accountability for completing these patient care related tasks." (Gell 2001).

"Over 500 people attended the conference on Professionalism, Specialization, and Teamwork put on by the nursing and PT faculty in HCMC. I was very impressed by the sophistication of their program, the scheduling which included two simultaneous sections for two days, the turnout that represented the whole country, and the inclusion of ministry personnel from Hanoi. Since I have participated in the Team training done by HVO under the USAID grant, I was glad to see the acceptance of the team concept and the obvious interest that was expressed by speakers, attendees, and ministry people in learning more." (Kay 2001).

**Recommendations for future projects**

- Hierarchy of educational development – depending on the sophistication of individual systems, the individual professional development may need to be strengthened prior to multidisciplinary interventions.




- Some content can be delivered simultaneously, however the more homogenous the audience the easier the educational delivery.
- There are multiple options to provide multidisciplinary post professional training including more active learning approaches such as case based or problem based exercises. In the future the use of technology will provide more options for distance learning mechanisms with the increased availability of the internet.
- Modeling, coaching and mentoring is needed which requires selection of strong leaders with potential to make changes as integral parts of any project.
- The cultural elements of change management need to be built into the project which is difficult to assess in the early stages, but requires specific interventions.
- Involvement of administration throughout the process is important.
- Evaluation plans and accountability mechanisms need to be built into the project from the start. Follow-up mechanisms should be a required component of recipients of educational assistance.

"All health care disciplines share a common and primary commitment to serving the patient and working to the ideal health for all. While each discipline has its own focus, the scope of healthcare mandates that health professions work collaboratively and with other related disciplines. Collaboration emanates from an understanding and an appreciation of the roles that each discipline brings to the care delivery experience. Such professional socialization and ability to work together is the result of shared educational and practice experiences."

*(American Association of Colleges of Nursing)*

**References**

Benjamin S, al-Darazi F. 2000. A quality approach for conducting training needs assessments in the Ministry of Health, State of Bahrain. World Hospitals Health Services 36(2):2-5, 44-45.

Bent N, Tennant A, Swift T, Posnett J, Scuffham P, Chamberlain MA 2002. Team approach versus ad hoc health services for young people with physical disabilities: a retrospective cohort study. Lancet 360(9342):1280-1286.

Blair E. 1994. A training project for disability prevention in Malawi. World Health Forum 15:408-411.

Carey CE 1998. Global links revisted: cross-cultural conditions affecting HPT. Performance Improvement 37(2):8-13.

Cooper H, Carlisle C, Gibbs T, Watkins C. 2001. Developing an evidence base for interdisciplinary learning: a systematic review. J Adv Nurs 35(2):228-237.

Derstine JB. 1998. Creating a global society: the Neumann-Danang connection: Proceedings from the Second Annual World Congress on Allied Health. J Allied Health 27(1):35-38.

Derstine JB, Shepard MP, Nixon-Cave K, Kinneally M. 2003. An interdisciplinary pediatric rehabilitation project in Vietnam: the Temple team experience. Rehabil Nurs 28(3):92-95.

Dunleavy K. 2000. Evaluation of continuing education course for physical therapists and physiatrists Vietnam 2000. Washington DC: Health Volunteers Overseas.

Dunleavy K, Fischer R, Kelly N 2005. Site visit assessment: Sri Lanka. Washington DC: Health Volunteers Overseas.

Dunleavy K. 2006. Physical therapy education and provision in Cambodia: a framework for choice of systems for development projects. Disabil Rehabil Submitted for review Feb 27, 2006.

Fisher R, Kay E, Kelly N, O'Toole M. 1993. Vietnam rehabilitation project: site assessment report. March 3-18, 1993. Washington DC: Health Volunteers Overseas.

Gallay JF. 2001. Interview with J-F Gallay, Prosthetist/Orthotist, International Red Cross (ICRC) Cambodia. Chair Physical Rehabilitation Subcommittee. Phnom Penh, Cambodia; 2001.

Gell N. 2001. Vietnam site assessement: PTO Danang. Washington DC: Health Volunteers Overseas.

Handicap International. 2003. Activities final report: on improving the takeover for the persons disabled by mines or other causes and implementing anti-mines activities in Casamance. Arlington VA: USAID Development Experience Clearing House.

Ham R, Regan JM, Roberts VC. 1987. Evaluation of introducing the team approach to the care of the amputee: the Dulwich study. Prosthet Orthot Int 11(1):25-30.

Horvath R, Condor J. 2001. Disability Action Council - assessment report. Washington DC: USAID.Electronic report.

Harris BA. 2006. Interdisciplinary education: what, why and when? Pauline Cerasoli Lecture 2006. In: APTA Combined Sections Meeting, San Diego CA.

Holloway S, Lee L, McConkey R 1999. Meeting the training needs of community-based service personnel in Africa through video-based training courses. Disabil Rehabill 21:448-454.

Hotez PJ. 2004. Should we establish a North American school of global health sciences? Am J Med Sc 328(2):71-77.

Huczynski AA. 1989. Training designs for organizational change. Manag Decision 27(4):27-35.

Jezewski MA, Sotnik P 2001. Culture brokering: providing culturally competent rehabilitation services to foreign-born persons. In: CIRRIE monograph series. Ed: Stone J. Buffalo, NY: CIRRIE.

Kay E. 1993. HVO Vietnam Trip March3-18, 1993. Physical Therapy Report. Washington DC: Health Volunteers Overseas. 10.

Kay E. 1995. The rehabilitation team. Washington DC: Health Volunteers Overseas.

Kay E. 2001. Vietnam trip report:June 5-16, 2001. Washington DC: Health Volunteers Overseas.

Kay E, Dunleavy K, Fisher R. 1999. The management of orthopedic problems in developing nations: I. issues affecting management. Orthop Phys Ther Clin NA 8(2):257-270.

Kemper B, von Wild K. 2002. Requirements of team effectiveness in neurosurgical rehabilitation. Acta Neurochir Suppl 79:37-39.

Lavin MA, Ruebling I, Banks R, Block L, Counte M, Furman G, Miller P, Reese C, Viehmann V, Holt J: Interdisciplinary health professional education: a historical review. Ad Health Sc Ed Th Prac 6(1):25-47.

Meier RH, Smith WK: Landmine injuries and rehabilitation for landmine survivors. 2002. Phys Med Rehabil Clin NA 13(1):175-187.

MSCI. 1991. Strengthening rehabilitation services: first project evaluation USAID/El Salvador Funter Project No 519-0346. Washington DC: USAID.

O'Toole B, McConkey R. 1998. A training strategy for personnel working in developing countries. Int J Rehabilit Res 21(3):311-321.

O'Toole MT, Melli SO, Moore MN, Derstine JB. 1996. Global gladiators: a model for international nursing education. Nurse Educator 21(1):38-41.

Pappaioanou M, Malison M, Wilkins K, Otto B, Goodman RA, Churchill RE, White M, Thacker SB. 2003. Strengthening capacity in developing countries for evidence-based public health: the data for decision-making project. Soc Sc Med 57(10):1925-1937.

Pearson JS. 2001. Extending a rehabilitation pathway to include multiple providers: outcomes and pitfalls. Rehabil Nurs 26(2):54-57.

Pechak C. 2000. Trip report: Vietnam March 12-20, 2000. Washington DC: Health Volunteers Overseas.

Powell B, Mercer S, Harte C. 2002. Measuring the impact of rehabilitation services on the quality of life of disabled people in Cambodia. Disasters 26(2):175-191.
Prabhaka MM, Thakker TH. 2004. A follow-up program in India for patients with spinal cord injury: paraplegia safari. J Spinal Cord Med 27(3):260-262.

Rentsch HP, Bucher P, Dommen Nyffeler I, Wolf C, Hefti H, Fluri E, Wenger U, Wälti C, Boyer I. 2003. The implementation of the 'International Classification of Functioning, Disability and Health' (ICF) in daily practice of neurorehabilitation: an interdisciplinary project at the Kantonsspital of Lucerne, Switzerland. Disabil Rehabil 25(8):411-421.

Rojas AM, Zintel DE 1999. Practicing human performance technology in a global business environment. In: Handbook of Human Performance Technology. Ed: Keeps EJ. San Francisco, CA: Jossey-Bass Pfeiffer. pp 916-935.

Schultze-Mosgau S, Thorwarth WM, Grabenbauer GG, Amann K, Zielinski T, Lochner J, Zenk J. 2004. The concept of a clinical round as a virtual, interactive web-based, e-learning model for interdisciplinary teaching. Int J Comp Dent 7(3):253-262.

Stills M, Dunleavy K. 2001. Veterans International technical and medical rehabiliation support services in Cambodia. Volume Displaced Children and Orphans Fund, Patrick Leahy War Victims Fund, USAID. Washington DC: USAID.

Tardif C. 2001. Comparative study 2001: actual situation of physical rehabilitation in Cambodia. Phnom Penh: Physical Rehabilitation Committee of the Disability Action Council Cambodia.

Visser J. 2002. Technology, learning and corruption: opportunities and hurdles in the search for the development of the mind in an international development context. Ed Tech Res Dev 50(2):85-100.

## The clinic team: the value of the user's participation in the clinic team

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Rehabilitation is a team work where besides the professionals, the user or family member is an equal member. In the changing scenario, often a person with a disability is considered as an expert of his or her chronic conditions and the environment she or he lives in. Issues related to life style falls into the domain of users rather than of professionals. User's active participation in the clinic team can assist the service providers to offer more appropriate choices which would be beneficial to all. Rehabilitation is not as straightforward an issue as giving medicine to cure a fever or an illness. It needs to be a combined decision to choose the best orthoses or rehabilitation intervention. The individual's socio-economic condition, environment and lifestyle all require consideration in the selection of the most appropriate orthosis. It is often the users, especially the experienced users, who know what will be best for them.

In the fifties and early sixties, India did not have trained orthotics personnel. Rehabilitation centres and orthotics workshops were rare. By listening to the interactions and discussions between the surgeon and the shoe maker or calliper maker and through personal use of the calliper itself, I learnt a few lessons. Similarly, other users' knowledge increases as they obtain orthoses from different workshops, meet different doctors and orthotists and make use of the increasing volume of information available via information technology sources. One could suggest that many users are often more experienced than the professionals who service them. It should be recognised, however, that often new suggestions are not well accepted by the service providers or the users. Technologies need time to develop and a mutual confidence must be established. Respecting each other makes the process faster. Rehabilitation is often more of a long term, complex affair. The relationship between user and service provider is subsequently crucial.

The user's role in motivating other people with disabilities is also a very important. The user's participation in the clinic team can assist other disabled persons to accept their disability better and to gain confidence in their new situation. This is more important for people who suddenly acquire a disability. As a long time user of orthotic devices, the user can become a counsellor/adviser to fellow users, i.e. be a "peer counsellor". An experienced user included in the clinic team can also be of tremendous help. Such a person would have had various types of experiences, especially in solving problems with his or her own inventions and would be able to offer tips which could help the new users to adapt more readily to the new situation.

The user could also be a good motivator for others. It took a long time for me to switch from the traditional calliper to the plastic orthoses (KAFOs). When I show my orthosis and share my experiences of this switching over and the benefits of the present orthosis, people with disabilities definitely pay greater attention to my words than to professionals saying the same thing. Experience counts a lot!

Some of the challenges I had to face as an orthotic user and now feel that I am able to share with other users include adapting a way of getting into the seat of a and how to use the Indian type of commode, in a squatting position. I had to gauge how long I could wear a new appliance before it started to hurt my affected limb and before chaffing began. I had to discover which surfaces would be easier to learn to start walking with when using the new appliance. How to negotiate stairs and gradients also posed a dilemma to me. These may appear simple tasks to the non-disabled professionals but let me emphasize that to the new orthotic user these are insurmountable problems.

Experienced users could explain to fellow new users what precautions are required to prevent chafing, itching, or formation of calluses. We may be able to demonstrate different ways of doing various chores while wearing the orthoses. In my opinion, an experienced user, if included in the clinic team, can advice

and counsel the new user on the advantages of using the device, especially to young users, more effectively, than another counsellor. ‘Seeing is believing‘. The former can point out to the latter what might be the result if these devices are not used. This will be of reassurance to parents of children with disabilities and who have to wear orthoses. Parents need to be advised about the importance of parental support to the user.

Asserting our rights is another way the user can help fellow users. Fellow users need to know their rights and what one should expect from others. To illustrate this point, airlines do allow a disabled passenger to carry an extra orthosis as free hand baggage, but how many times I have faced opposition from the ground staff. They have told me that the appliance would not fit in the overhead bin and I have to assert that I have measured the dimensions of the bag in which I carry my extra orthosis and that it will fit without any problem. Once, when a staff member still opposed me I told her the cost of the appliance, exaggerating a little and that the airline would be responsible if it breaks while sending it as a ‘checked in’ baggage. Needless to say I got my way when she heard of the cost of the orthosis.

Sometimes a user is embarrassed to remove a full length calliper while travelling long distance. No doubt an experienced user would have devised some method to do this without drawing the attention of fellow passengers. The user can advise on the right kind of clothing to be worn which would help easy donning and doffing.

A satisfied user also is the ambassador of the Clinic Team; if he or she gets quality service, he or she would definitely influence others to have similar experiences and lead a dignified life. Users can also play an active role in promoting the services of the clinical team and the organization. History shows that many changes, especially related to disability rights and laws, that took place after active lobbying by users, their parents and organizations involved in disability and rehabilitation work. As a satisfied user, it gives me tremendous motivation and encouragement to promote this sector knowing fully well, the impact of having a good team and quality orthotics services which can change the life style of millions of people who are still waiting to access rehabilitation services.

A healthy relationship between my orthotist, other team members and myself made me realise the importance of supporting the organization from where people like me get help and benefits. This fact motivated me to be a volunteer for the organization where the orthotist was working, achieving excellent results. I felt I owe my ‘alma mater’ something for making me what I am today; from a puss in ugly boots to a Cinderella with a glass slipper, not quite so, but with "Tewa brand" sandal! What does this all lead to? My belief is that if the user is happy and satisfied with the rehabilitation management or in my case the orthotics service, then the person can be an ambassador for the rehabilitation team of doctors, therapists and orthotists.

It would be better to value our participation in the whole process; we are the users, you exist because we exist or vice versa - we need each other. My plea to all of you rehabilitation professionals is: a partnership approach between the user and the rehabilitation professional. I am sure you are familiar with the slogan "Nothing about us without us". Thank you very much for giving me this opportunity; let us work together for the benefit of humanity and establishing a Rights Based Society, where disabled people will be able to access rehabilitation services to become equal citizens of society..

# Development of standards and quality assurance for rehabilitation programmes

**Paul Andrew**

**The Commission on Accreditation of Rehabilitation Facilities**

## Consumer-Based Design

Leaders in the human service industry understand that their only true assets are satisfied customers…those who will use the services again and again…those who will tell their friends. They achieve this outcome by focusing on providing incomparable customer service.

Providers of human services are also coming to this understanding. More and more organizations are moving from providing a continuum of treatments designed to "fix" consumers' deficits to offering individualized service options designed to meet unique wants and needs. Consumer-focused organizations begin by identifying customers (internal and external, primary and secondary) and then planning, developing, and continuously enhancing the focus of the organization on customer service. Customers are the persons receiving services (consumers) and other stakeholders such as family members of the persons receiving services, employers, donors, and purchasers of services.

To get and keep customers, service leaders focus on these keys:

- Listen, listen, listen.
- Take action.
- Measure reaction—that is, listen again.

## Listen, Listen, Listen

Providing customer-focused services begins with understanding customers' needs and wants. To accomplish this, numerous mechanisms can be used, such as focus groups, surveys, suggestion boxes, planning tools, direct observation, collecting information on past behavior, informal listening, gathering supporter information, and benchmarking. The specific method depends on the information required. Generally the more ways we use to listen to customers, the better. Some common methods used to obtain input are:

- Interview consumers and family members.
- Interview those who work directly with consumers.
- Interview the consumers' friends.
- Conduct surveys of donor/funders and referral sources and organizations.
- Attend person-centered planning meetings or team conferences.
- Establish advisory councils.
- Attend business advisory councils and business luncheons.
- Attend community meetings.
- Include consumers on your board of directors or board committees.
- Ask for consumers' input in everyday encounters.
- Establish a human rights committee.

**What distinguishes one service provider from another and builds loyalty?**

Typically, what matters to customers when choosing a service provider includes:

- Speed of service provision
- Friendliness
- Atmosphere
- Location
- Responsiveness
- Results
- Cost

These are the critical areas to focus on as we gather customer input. Questions are formulated in the context of the missions of funders, referral organizations, and referral sources.

Some questions that may be asked in various situations include:

- Are we meeting your needs?
- What can we do to improve?
- What do you like (or don't you like) about our services?
- What can we do better?

**Take Action**

Armed with customer input, the service provider takes action. Teams are established to analyze and improve key service areas and to develop new products. Direct service staff members are empowered to make decisions that impact customer satisfaction. Customer comments are distributed throughout the organization. Customers are informed of service improvements. Individual service plans are revised. These actions implement the following important concepts of a customer-based organization:

- Customers define quality.
- Quality is achieved through individualized services.
- Quality systems and services produce trust and confidence in the organization.
- Quality requires the service provider to continuously plan for improvement in individual services and organizational development.
- The development of an outcomes management system can assist the service provider in analyzing the impact on quality of its organizational policies.
- The service provider considers the demographics of the persons receiving services.

**Measure Reaction**

Once services have been provided, customers are asked again what they think of the services, how the services respond to their needs, and what else they would like. Information systems are created that help organizations evaluate their performance and plan for the future.

**Only the Customer Can Define Quality**

Implementing this concept requires the service provider to develop and maintain an outcomes management system to focus on positive occurrences in customers' lives, the development of the organization, and the resulting impact on the community. Quality outcomes management systems therefore focus on five types of outcomes:

- Effectiveness
- Efficiency
- Satisfaction of individuals receiving services with service outcomes
- Satisfaction of other stakeholders with services
- Access to services

This publication assists organizations providing employment and community services to develop their own outcomes systems—using a customer-driven approach.

**Achieving Quality Outcomes**

To put outcomes into perspective, we should ask ourselves this question: Where in our daily lives do we as customers expect quality? Answers to this question range from government services, education, and child care to food, water, transportation, and employment relationships. *In short, quality outcomes are highly individualized, and the quality of our services is defined by the customers who have a stake in our community-based organization.*

A successful organization makes a commitment to the continuous improvement of organizational quality and service excellence, including the development and use of an outcomes management system. There are five critical components of developing an outcomes management system.

The first component is obtaining input from consumers and other stakeholders to develop a useful outcomes system.

The second component is a requirement to measure or describe outcomes in five categories:

| | |
|---|---|
| • Effectiveness | Results of services |
| • Efficiency | Costs, responsiveness, timeliness, cost effectiveness, relationship between resource use and results |
| • Aggregated individual service satisfaction information | A compilation of the results of consumer satisfaction surveys conducted during occasions such as individual service planning sessions, exit interviews, follow-up contacts, or focus groups, or from annual satisfaction questionnaires |
| • Other stakeholder satisfaction information | A compilation of the results of satisfaction surveys from primary stakeholders (two primary stakeholders are usually selected) |
| Access to services | A measurement used to focus development and design new servies. |

The third component is the organization's data and information system, which is fundamental to the collection of timely, accurate information.

The fourth component is actually using information from the outcomes system. The provider demonstrates that it *continuously* uses the results of this system to improve individual services and the overall service delivery design. Continuous improvement consists of responding to the changing needs of

the people receiving services in a changing environment and constantly making services better within the mission and resources of the organization.

The fifth component of an outcomes system is sharing in appropriate reports the outcomes information and actions taken since the last report with the organization's internal and external customers.

The information from an outcomes management report is used to impact the delivery of and planning for services in the organization. Some examples of its use could be identifying efficient and effective methods of services, recognizing staff accomplishments, reassessing the mission, recruiting staff based on outcome goals, and identifying issues, concerns, or trends that should be considered in changing service delivery. One element of the outcomes system that can help with strategic business planning is gathering service satisfaction information (for example, by means of satisfaction questionnaires) from families, communities, funders, and referral sources. This provides the organization with valuable information about its impact on the community as well as the satisfaction of individual consumers.

**Development of an Organizational Outcomes Management System**

Following is a ten-step process that may be used to develop an outcomes management system. These examples were developed by more than 2,000 providers, funders, and consumers to help service providers develop and maintain their own systems and are not meant to imply that a service provider must use the listed items or is limited to tracking only these items. There are many ways a service provider can develop and continuously improve its outcomes management system. Using the process described in the following pages is but one pathway to a quality system.

**Step One: Conduct a Service Provider SWOT Analysis**

| |
|---|
| **S**trengths |
| **W**eaknesses |
| **O**pportunities |

In designing an outcomes management system, a service provider and its customer-driven planning team need to consider information that impacts expectations for customer outcomes with reference to the service provider's mission. The analysis should include the organization's internal **strengths** and **weaknesses**, as well as external considerations including **opportunities** to enhance the organization's business and **threats** in the community—from competitors or legislative changes, for instance—that may reduce or limit opportunities for the provider to conduct its services. Other considerations include the resources and priorities (mission) of the service provider and the community resources available to the organization.

Analysis of the organization's internal and external realities not only assists in establishing realistic outcomes measurements, but provides the foundation for development of short- and long-range planning strategies. This information can help you make decisions regarding:

- Resource allocation.
- Staff development, training, and recruitment.
- Marketing and community outreach.
- Strategic positioning of the organization.

The internal strengths of the service provider can be used in developing marketing and promotional brochures. Identifying these strengths illustrates to potential customers why they should use an organization's services. Identified strengths can also be used to help analyze the organization's position relative to its competition and to take advantage of opportunities, deal with threats, and possibly overcome corporate weaknesses.

Internal weaknesses are factors that inhibit the efficient and effective delivery of services to customers and may inhibit the service provider from taking advantage of various business opportunities. These may become the priority items for improvement.

External opportunities are those potential events that the service provider can create or take advantage of to expand its business.

External threats are those factors that may reduce or limit the opportunities for the provider to conduct its services, such as the resources in the community available to the organization, accessibility of the environment, policies, or the business climate.

**Step Two: Identify the Stakeholders of Your Services**

Services identify the organization's capabilities to its customers. Once the organization has developed its list of services, it should then identify the key customers. Since the outcomes system is to be customer designed and driven, the service provider should brainstorm with its customers to determine the outcomes of the service for which the system is being developed.

| Examples of Stakeholders | |
|---|---|
| ▪ Consumers and their families<br>▪ Friends of the persons receiving services and other natural supports<br>▪ Funders and donors | ▪ Policy makers<br>▪ Religious organizations<br>▪ Professionals technology providers, therapists, medical/clinical staff members, and so on |

**Step Three: Define Quality and Outcomes Expectations for Each Key Stakeholder**

Using the list of key stakeholders who comprise the team, the service provider should develop a list of quality outcomes expectations, prioritized for each type of customer. This list will be needed to develop measures of effectiveness, efficiency, and satisfaction in the next step.

The following tables show some examples of quality outcomes expectations for various groups of key customers.

| Consumers/Persons Receiving Services | |
|---|---|
| ▪ Timely, responsive services<br>▪ Involvement in individual planning<br>▪ Achievement of individual outcomes | ▪ Enhanced lifestyle quality of life<br>▪ Movement toward greater independence |

| Family Members | |
|---|---|
| ▪ Consideration of input<br>▪ Consumers' happiness with services | ▪ Safe environment<br>▪ Being kept informed |

| Community | |
|---|---|
| ▪ Less dependence on public supports<br>▪ Demonstrated cost benefits | ▪ Community recognition of successful outcomes |

### Step Four: Design the Outcomes System

In designing your outcomes system you will be putting together the information you have developed in the previous three steps.

The CARF ECS standards specify that every service area seeking accreditation must be addressed in the organization's outcomes system. However, there is no need for multiple systems if one system covers all services. This system must provide for measurement of at least the following four categories of outcomes data:

#### Effectiveness for Each Service

- Results and achievements for persons receiving services

#### Efficiency for Each Service

- Responsiveness, including timeliness
- Ratios of resource use to outcomes
- Cost-to-benefit ratios

#### Aggregated Individual Service Satisfaction

- Customers' responses regarding how they feel about their individual service plans and outcomes (information regarding satisfaction may be solicited during individual service planning sessions or meetings, at exit interviews, during follow-up contacts, etc.)

#### Aggregated Stakeholder Satisfaction

- Stakeholders' satisfaction with services

Successful service providers develop at least one measure for each of these four categories, though more measures may be included if desired. To focus on measuring outcomes, refer to the list of outcomes expectations developed in step three. Those outcomes not selected for this measurement can be included in customer satisfaction surveys and questionnaires to receive further consumer input.

### Step Five: Obtain Individual Consumer Satisfaction Information

A vital component of an outcomes management system is the collection of data regarding individuals' satisfaction with services. One purpose is to continually improve the services for each individual (within the organization's mission and resources). The second is to aggregate the individual responses by the persons receiving services and ascertain what the service provider must do to respond to consumer trends on an organizational planning and management level.

Assessment of an individual's satisfaction with specific services results in an indication of the person's overall satisfaction with the services he or she is receiving. The service provider may obtain this measurement by rating the responses to the questions asked as positive or negative overall. This procedure is repeated with each person receiving services. The total result can be expressed in terms of responses per question or as a percentage of the total number of persons receiving services.

To implement this aspect of the outcomes system, the service provider usually develops a questionnaire or satisfaction rating form with a list of questions to be asked during the individual planning session or after services have been provided. The organization does not need to do a satisfaction questionnaire for each distinct service it provides, but may relate this to the consumer's overall satisfaction with services from the organization.

The key is to determine what the consumers' expectations are and seek their opinions about how those expectations have been met. This portion of the outcomes system can have questions related to the

consumers' expected outcomes (as noted in step three), or they can be phrased to relate to the standards themselves. For instance, one may ask questions related to the standards for individual planning, such as, "Were you involved in developing your service plan?" Positive responses by consumers will illustrate to the donors, as well as to the organization, that the service provider is meeting the intent of the quality expectations.

**Step Six: Obtain Satisfaction Information from Other Stakeholders**

Satisfaction information from the organization's other customers, such as employers, funders, and community agencies, is vital to the overall improvement and modification of the organization's services. The list of an organization's stakeholders can be extensive and will vary depending on the unique aspects of the organization and the community. The service provider is not expected to develop formal measures for all stakeholders. Usually two key stakeholders, such as funding or referral sources, are identified and focused on for input through satisfaction surveys. Refer to the list of customers developed in step two to identify key stakeholders, then use the outcomes expectations listed for these stakeholders in step three to develop appropriate questions to survey their satisfaction.

**Step Seven: Obtain Follow-Up Information**

CARF's outcomes management standards are founded on the principle of obtaining and using consumer input not only during actual services but also after persons have exited services. Why pursue this follow-up information? The ultimate measure of outcomes will be the impact of services on the quality of life of the consumers. Where and how have their lives gained in meaning? How has receiving services changed their lives? How have services affected family integration, access to resources, and the ability to be aware of options and to make choices? Organizations are generally not paid for follow-up, but quality-driven organizations realize the payoff is in information to further improve services and outcomes.

Develop a method for obtaining post service follow-up information from all or a representative sample of consumers who have exited from or completed a service. Organizations use many different methods for follow-up. If another entity conducts the follow-up contacts, the organization obtains the resulting information to use in assessing the quality of its own services. The organization uses creative approaches in attempting to obtain post service information, since this information is critical to accurately assess the effectiveness of its services. Questions should focus on determining the impact of the services on the quality of life of the consumers. The tables on the following page provide examples of quality-of-life considerations and sample questions that may be used to develop appropriate questionnaires for use in obtaining follow-up information.

| Quality of Life Considerations | |
|---|---|
| ▪ nformed choice and control over continued services<br>• Independent decisions<br>• Feeling of control<br>• Stabilization, structure to lifestyle<br>▪ Self-advocacy and empowerment<br>• Upward mobility<br>• Asset to society<br>• Dignity, respect<br>• Friendships<br>▪ Community inclusion<br>• Improved social skills<br>• Sense of belonging<br>▪ Mobility/transportation | ▪ Health maintenance and safety<br>• Feeling good<br>• Absence of illness<br>• Stress management<br>• Safe environment<br>▪ Successful employment<br>• Satisfaction<br>• Job retention<br>• Sufficient wages; buying power<br>• Traditional benefits<br>• Periodic wage increases<br>• Career opportunities; marketable skills |

**Step Eight: Obtain Data on Consumer Characteristics**

Knowledge of the characteristics or demographics of those receiving services, as well as those awaiting and not accepted for services, helps the organization plan effectively and efficiently to strategically position the services it offers. It can help the organization compare its customer base to the population in the community, increase referrals, understand and explain customers' outcomes, and help in the preparation for organizational planning.

Below are some of the characteristics the service provider might track.

| Examples of Consumer Characteristics | |
|---|---|
| ▪ Age | ▪ Purpose of referral |
| ▪ Gender | ▪ Use of assistive technology |
| ▪ Ethnic background | ▪ Ability to drive |
| ▪ Educational background | ▪ Ability to use transportation |
| ▪ Living arrangements | ▪ Length of employment |
| ▪ Primary language | ▪ Work accommodations |
| ▪ Location of residence | ▪ Income sources |
| ▪ Resources | ▪ History of services |
| ▪ Disability | ▪ Previous jobs |

Knowledge of consumer characteristics can be a significant decision-making tool. It can help the organization to:

- Establish staffing patterns and configurations.
- Reconsider the organization's mission.
- Determine strategic positioning of the organization.
- Establish networks and partnerships with other agencies that can meet the diversity of consumer needs and expectations.
- Compare its customer base to the population in the community.
- Increase referrals.
- Explain or understand customers' outcomes.
- Conduct future SWOT analyses.

**Step Nine: Use the Measured Results to Continuously Improve Services**

An important part of an outcomes management system and the CARF standards is illustrating how the outcomes information is being used. Some of the ways this outcomes system could be used to impact the delivery of and planning for services in the organization include:

| ▪ **Ways to Use Results of Outcomes Information** | |
|---|---|
| ▪ Look for common issues, evaluate and brainstorm solutions, take action, and then follow up to assess results.<br>▪ Determine resource allocation.<br>▪ Continue or expand services or terminate services.<br>▪ Plan future quality assurance.<br>▪ Identify efficient and effective models of service.<br>▪ Develop plans for staff training and staff development.<br>▪ Conduct short- and long-range organizational planning.<br>▪ Identify personnel issues and do performance appraisals.<br>▪ Recognize staff accomplishments.<br>▪ Conduct fund-raising activities and write grant proposals.<br>▪ Refine techniques for communication and sharing information techniques.<br>▪ Adjust individual service goals and consumer plans. | ▪ Reasses the mission statement.<br>▪ Add service components, and then eliminate those that are ineffective.<br>▪ • Reassess the values and priorities of funders/referrers.<br>▪ • Use in continuous quality improvement task forces and committees.<br>▪ • Decide on ways to restructure services.<br>▪ • Develop new policies and implement new procedures.<br>▪ • Conduct budget planning.<br>▪ • Change staffing patterns.<br>▪ • Recruit staff and board members and volunteers based on outcomes desired and results.<br>▪ • Justify increased funding.<br>▪ • Improve marketing strategies and job development.<br>▪ • Develop public relations strategies, brochures, and promotional materials. |

**Step Ten: Share the Outcomes Information**

Sharing outcomes information with internal and external customers is a vital aspect of continuously improving the services of the organization. The CARF ECS standards require preparation of an outcomes management report that summarizes information from the outcomes system and communicates it to

consumers and other stakeholders. More than one version of the report may be developed and used to effectively communicate this information to all stakeholders. There are various other ways to communicate outcomes information, such as press releases, annual reports, and newsletters. The use of this information is important in short- and long-range planning, modifying services, financial management, and quality improvement. Some of the customers you might share this information with include:

| Customers for Outcomes Information | |
|---|---|
| ▪ Persons receiving services | ▪ Business advisory councils |
| ▪ All staff members | ▪ Parents and guardians |
| ▪ Funders and referral agents | ▪ Potential employees |
| ▪ Committee members | ▪ Case managers |
| ▪ Board members | ▪ Government officials |
| ▪ Chambers of Commerce | ▪ Transition school teams |
| ▪ Newspapers and media | ▪ Potential customers |
| ▪ CARF Surveyors | ▪ The United Way |
| ▪ Consumer groups | ▪ Neighbors |
| ▪ Employers | ▪ Foundationgs |
| ▪ Interfunder/referrer councils | ▪ University researchers. |

**Putting It All Together**

Following is an outline of the required elements of an outcomes management system that would meet the CARF ECS standards.

| Outcomes Management System |
|---|
| A. An outcomes management system exists and is consistent with the organization's services.<br>B. The system has been developed with input from consumers and the organization's stakeholders.<br>C. The system is consistent with the organization's services pattern.<br>1. The system contains essential measures/components:<br>(a) Effectiveness measures.<br>(b) Efficiency measures.<br>(c) Consumer satisfaction measures including post service follow-up information (aggregated from the individual measures).<br>(d) Other stakeholder satisfaction measures.<br>(e) Consumer characteristics.<br>2. Data and information are accurate and complete (reliability).<br>3. Data and information are relevant to the services (validity).<br>D. Data and information from the system are reported.<br>1. The contents of the reports include information that is pertinent to the services offered.<br>2. The reports are shared with:<br>(a) Persons receiving services.<br>(b) Staff members.<br>(c) Other stakeholders. |

(d) The governance authority.
(e) The public.

3. The reports are produced annually in a timely manner.

E. Information from the system is used in decision making at all levels of the organization to:

1. Develop strategic planning.
2. Improve individual service quality.
3. Review, modify, and improve the services provided.

# Use of the ISPO/USAID protocol on cost calculation

**Thierry Le Borgne**

**ICRC, Geneva, Switzerland**

## What the tool is and what it does

The objective of the calculation programme is to define the final cost and the price of an orthopaedic appliance only.

The programme, based on Excel, consists of 5 pages:

- 4 pages where we enter data related to the costs of:
  - Staff and wages
  - Direct labour cost
  - Indirect labour cost
  - Administrative cost

- 1 page where we enter data related to the cost of:
  - Material, involved in the fabrication of a specific prosthesis or orthosis
  - Components involved in the fabrication of a specific prosthesis or orthosis
  - Timing involved in the fabrication of a specific prosthesis or orthosis

Each of the 5 pages has specific links built into them. Once all the data has been entered into the 5 pages, the final result for one specific appliance appears automatically.

Data is entered in the blue cells, while yellow cells generate automatic calculations which cannot be modified.

To facilitate the entry of data there is a very useful tool "the red triangle" which gives explanations or definitions for the user of most of the cells.

Once the cost calculation is done for one type of device, an AFO for example, through copy/paste and some modifications the tool can be use for other specific devices and also from one year to another.

## How the use of the tool has influenced ICRC reporting and practice?

In 2004, the ICRC took the decision to adopt the ISPO/USAID cost calculation tool for all its projects.

To support its implementation, a training programme for expatriates, was developed and implemented (3 seminars in 2005, 29 participants).

To further support its implementation the ICRC has developed:

- A user manual (as none was provided with the programme),
- PowerPoint presentations: one long presentation focused upon training and one short presentation targeting partner organisations and providing only an introduction to the tool.
- A case study; and
- A presentation of prosthetic and orthotic photo tables.

For each seminar, training in the use of the programme lasts 8.5 hours (including presentations, exercises, and revisions).

Some of the participant's comments after the training were the following:

- Long and heavy process
- Not user-friendly
- Definitely too difficult for most of the local partners

For the ICRC what the ISPO/USAID cost calculation tool brings:

- a systematic method which covers all aspects involved in the cost calculation of an appliance,
- a common tool for all the centres,
- a possibility to compare from one project to another and
- a means to establish a base of discussion for an agreement of cooperation.

For the ICRC what the ISPO/USAID cost calculation tool does not bring:

- a user friendly tool,
- a quickly usable tool ( request special training),
- a total cost of patient ‘s treatment which includes the cost of the appliance + the additional costs such as the cost of medical treatment, accommodation , food, transport etc.

The ISPO/USAID cost calculation tool will influence ICRC reporting:

- The ISPO CC will not influence ICRC reporting as the CC of appliances do not cover the overall cost of services.
- However, it will help the local partner understand the cost of providing such services and in budget development.
- Internally, the CC will help to define, for each country, ways to diminish the running cost of assisted-centres.

The ISPO/USAID cost calculation tool will influence ICRC practice

- By introducing a new tool in all of its projects.
- By giving the possibility to compare from project to project the prices of similar appliances.
- By having a reference for an agreement of cooperation with a partner to define clearly for each type of P/O the ratio of participation to the reimbursement of P/O of each partner.

**Conclusions**

For ICRC this tool:

- will be implemented in all projects (which includes training the local partner),
- does provide some information enabling to compare CC from one project to another,
- does not provide information related to the overall cost of the treatment.

**Personal comments**

After one implementation and an in depth study due to the preparation of the training and 3 presentations to 29 colleagues I feel that it is a good tool:

- which requires one day training or a new manual user with case study/exercise and answers,
- which requests flexibility and common sense for questions without exact solution within the cost calculation,
- which allows comparison between organisations and within organisations,
- which allows also comparison with other cost calculation methods.

**Recommendations**

- ISPO should develop a training programme to ease the implementation of the programme.
- A user manual should be developed.
- The cost calculation should provide the total cost of patient‘s treatment which includes the cost of the appliance + the additional costs such as the cost of medical treatment, accommodation, food, transport etc.

**Plenary Discussion**

**Chair: Chapal Khasnabis**

**Rapporteur: Carson Harte**

## Discussion

Discussion related to Blocka paper;

- Great tool for P&O training we need guidelines for physiotherapists.
- It is very important to establish collaboration with physiotherapists at an international level.
- Note that ICRC have a physiotherapy committee,
- What is the best way to get a connection between ISPO/WHO and the university in my town?
    - if it is evolving, contact ISPO on a consultant basis. Do the ground work and put a proposal forward.
- Can the CatII single discipline be used to add up to a qualification?
    - Tatcot is evolving in this direction but Dan Blocka was not aware of any currently operating programs that do this.
- Programs need to be flexinble, some are developed around on the job training, some are full time in school.

Discussion related to Dunleavy paper;

- For physiotherapists, rehabilitation is only a small part of their work. They need to work as a team with the prosthetist/orthotist.
    - Consider that it takes 8 hours to make devicebut does it need 8 hours of physiotherapy for physical therapy training.
    - The real need is for polyvalent clinicians. The user MUST be at the centre of the process.
- Some patients need much more physiotherapy time. For example, stroke patients need much more physiotherapy.
- What is the role of the physiotherapist in community based rehabilitation?
    - The physiotherapy association is thinking about CBR – refer to the world federation website. Look it up. Papers being presented in Vancouver 2007.

Discussion related to Andrew paper;

- Paul Andrew was asked to coment on CARF accreditation. Paul Andrew indicated that he has good data on the accreditation process and tracking services in British Colombia. It was indicated that there was a major increase in service quality. And that the service increase is also sustained.

Other comments;

- Chapal Khasnabis worries that we are wandering away from team work in the third world.

- John Fisk suggested that we are not education of other professions. He proposed a meeting to discuss this issue.

**Appendix 1**

**Conference Programme**

**Monday 3 April**

| | | |
|---|---|---|
| 08.00 | **Opening Session** | |
| | Chairman: | Harold Shangali |
| 08.05 | ISPO | Harold Shangali |
| 08.10 | MOLISA | Dr. Dam Huu Dac |
| 08.35 | US Ambassador | Michael Marine |
| 08.40 | USAID | Rob Horvath |
| 08.45 | WHO | Chapal Khasnabis |
| 08.50 | GTZ | Guenter Riethmacher |
| 08.55 | Break | |
| 10.00 | **Introduction to conference** | Bakht Sarwar |
| | Chairman: | Bakht Sarwar |
| | Rapporteur: | Nerrolyn Ford |
| 10.05 | **Needs in developing countries for orthotics services** | |
| 10.10 | USAID/LWVF role in development of orthotics services in post-conflict countries | Mel Stills |
| 10.20 | Disability and prevalence data that determine the needs for orthotics services | Chapal Khasnabis |
| 10.35 | El Salvador country survey | Heinz Trebbin |
| | Prioritising orthotics services: | |
| 10.50 | i. The WHO viewpoint | Chapal Khasnabis |
| 11.05 | ii. The medical surgical viewpoint | Lawrence Museru |
| 11.20 | iii. The orthotist's viewpoint | John Carlos Camacho |
| 11.35 | iv. The user's viewpoint | Elizabeth Thomas |
| 11.50 | Discussion | |
| 12.15 | Lunch | |
| | Chairman: | Wilfried Raab |
| | Rapporteur: | Claude Tardif |
| 13.15 | **Current orthotics practice in developing countries** | |
| 13.20 | Africa | Longini Mtalo |
| 13.35 | Asia | Vinod Krishnan |
| 13.50 | Indian sub-continent | Vinod Bhanti |
| 14.05 | China | Zhao Huisan |
| 14.20 | Central and South America | Mónica Sibila |
| 14.35 | Discussion | |
| 15.00 | Break | |

| | | |
|---|---|---|
| 15.30 | **Syndicates A** | |
| 17.00 | Close | |
| 18.30 | Opening Reception at University of Labour and Social Affairs (ULSA) | |

**Tuesday 4 April**

| | | |
|---|---|---|
| | Chairman: | Rob Horvath |
| | Rapporteur: | Nerrolyn Ford/Chapal Khasnabis |
| 08.00 | **Reports and discussion Syndicates A** | |
| 09.30 | Break | |
| 10.00 | **Outcomes of previous ISPO consensus conferences** | |
| 10.05 | Poliomyelitis, CP and stroke | John Fisk |
| 10.25 | Appropriate technology for developing countries: Cambodia, Tanzania | Harold Shangali |
| 10.45 | Discussion | |

| | | |
|---|---|---|
| | Chairman: | Harold Shangali |
| | Rapporteur: | John Fisk |
| 11.15 | **Good practice strategies for orthotics services** | |
| 11.20 | Assessment of client, functional requirements and treatment plan: the doctor's viewpoint | Carolina Schiappacasse |
| 11.35 | Assessment of client, functional requirements and treatment plan: the orthotist's viewpoint | Carlos Zelaya |
| 11.50 | Discussion | |
| 12.10 | Lunch | |
| 13.10 | Biomechanical principles and control systems | Gordon Ruder |
| 13.25 | Criteria and standards for orthoses | Ludger Lastring |
| 13.40 | Fitting procedures/assessment of quality of fit/checkout procedures | Wilfried Raab<br>Nguyen Hai Thanh |
| 13.55 | Discussion | |
| 14.30 | Break | |
| 15.00 | **Syndicates B** | |
| 16.30 | Close | |

VISIT TO VIETCOT

**Wednesday 5 April**

| | | | |
|---|---|---|---|
| | Chairman: Mel Stills<br>Rapporteur: Jo Nagels | | |
| 08.00 | **Good practice strategies for orthotics services (continued)** | | |
| 08.05 | Implementation of quality management protocols in orthotics services | Prum Sovann | Olle Hjelmstrom |
| 08.15 | Information transfer and exchange, mentoring | Dan Blocka | |
| 08.25 | Outcome measures in lower limb orthotics | J Steen Jensen | |
| 08.35 | Discussion | | |
| 09.00 | **Reports and discussion Syndicates B** | | |
| 10.30 | Break | | |
| 11.00 | **Lower limb orthotics practice** | | |
| | **Polio** | | |
| 11.05 | Polio paralysis: orthopaedic aspects | Hugh Watts | |
| 11.15 | Polio paralysis: orthotic treatment | Christian Schlierf | |
| 11.35 | Post-polio syndrome: clinical aspects | John Fisk | |
| 11.45 | Post-polio syndrome: orthotic aspects | Ludger Lastring | |
| | **Cerebral palsy** | | |
| 11.55 | Cerebral palsy: clinical aspects | John Fisk | |
| 12.05 | Cerebral palsy: orthotic aspects | Aaron Leung | |
| 12.25 | Discussion | | |
| 13.00 | Lunch | | |
| 13.30 | **Syndicates C** | | |
| 15.30 | Break | | |
| | Chairman: Sepp Heim<br>Rapporteur: Kim Dunleavy | | |
| 16.00 | **Lower limb orthotics practice (continued)** | | |
| | **Clubfoot** | | |
| 16.05 | Clinical aspects: conventional approach and serial casting | Hugh Watts | |
| 16.20 | Clinical aspects: Ponseti approach | J Norgrove Penny | |
| 16.35 | Clinical aspects: CBR based clubfoot treatment after the Ponseti method | H Michiel Steenbeek | |
| 16.45 | Clinical aspects: the neglected clubfoot | J Norgrove Penny | |
| 16.55 | Orthotic management | Longini Mtalo | |
| 17.15 | Discussion | | |
| 18.00 | Close | | |

**Thursday 6 April**

| | | |
|---|---|---|
| | Chairman: | John Fisk |

| | | |
|---|---|---|
| | Rapporteur: | Nerrolyn Ford |
| 08.00 | **Lower limb orthotics practice (continued)**<br>**Trauma** | |
| 08.05 | Clinical aspects | Steve Mannion |
| 08.15 | Orthotic management: post-trauma paralysis | Munazza Gillani |
| 08.25 | Orthotic management: fracture management and post-trauma deformities | Bakht Sarwar |
| 08.45 | Discussion | |
| 09.15 | **Reports and discussions Syndicates C** | |
| 10.45 | Break | |
| 11.15 | **Syndicates D** | |
| 12.45 | Lunch | |
| | Chairman: | Hugh Watts |
| | Rapporteur: | Claude Tardif |
| 13.45 | **Lower limb orthotics practice (continued)**<br>**Stroke/traumatic brain injury** | |
| 13.50 | Clinical aspects | Carolina Schiappacasse |
| 14.00 | **Orthotic management** | Roy Bowers |
| 14.20 | Discussion | |
| 14.40 | **Feet lacking protective sensation** | |
| 14.45 | Clinical management | Steve Mannion |
| 14.55 | Orthotic aspects | Heinz Trebbin |
| 15.05 | Footwear aspects | Michael Möller |
| 15.15 | Discussion | |
| 15.45 | Break | |
| | **Orthotics technology in developing countries** | |
| 16.15 | The development of appropriate orthotics technology<br>The prefabricated KAFO | Michael Rechsteiner |
| 16.35 | Development of the PFKAFO | Ritu Ghosh |
| 16.45 | Preliminary evaluation of the PFKAFO | Aaron Leung, Ludger Lastring, Longini Mtalo |
| 17.05 | Innovations using locally available materials | Cornelis Visser<br>Dahn Prasad Nepali |
| 17.15 | The LETOR orthosis | Maciej Pokora |
| 17.25 | Experiences in French speaking Africa | Isabelle Urseau |
| 17.35 | Discussion | |
| 18.00 | Close | |

**Friday 7 April**

| | | |
|---|---|---|
| | Chairman: | Khasnabis |
| | Rapporteur: | Harte |
| 08.00 | **Reports and discussions Syndicates D** | |

| | | |
|---|---|---|
| 09.30 | **Break** | |
| 10.00 | Education and training of orthotics personnel in developing countries | Dan Blocka |
| 10.20 | The clinic team in orthotics | Kim Dunleavy |
| 10.40 | The value of the user's participation in the clinic team | Elizabeth Thomas |
| 10.50 | Development of standards and quality assurance for rehabilitation programmes | Paul Andrew |
| 11.05 | Use of the ISPO/USAID protocol on cost calculation | Thierry le Borgne |
| 11.20 | Discussion | |
| 11.45 | **Syndicates E** | |
| 13.15 | Lunch | |
| | Chairman: | Khasnabis |
| | Rapporteur: | Harte |
| 14.15 | **Reports and discussions Syndicates E** | |
| 15.45 | Break/Cose | |
| 19.00 | Conference Dinner: Brothers Restaurant | |

**Saturday 8 April**

| | | |
|---|---|---|
| | Chairman: | Heim/Jacobs |
| | Rapporteur: | Ford |
| 09.00 | Discussion on identified topics from the Syndicates | |
| 10.30 | Break | |
| 11.00 | Recommendations and conclusions | |
| 13.00 | Lunch | |
| 14.00 | Recommendations and conclusions (continued) | |
| 16.00 | Close of Conference | |

**Appendix 2**

**Conference participants**

| Name | Organisation | Address | E-mail |
|---|---|---|---|
| Paul Andrews | CARF | 6912 N. Table Mountain Road, Tucson, AZ 85718, USA | Pandrew52@aol.com |
| Vinod Bhanti | ISPO-India | K.F. 112, Kankeer Bagh Colony, Patna, Bihar 800020, India | Ispobhanti@sify.com |
| Dan Blocka | ISPO | Sunnnybrook & Women´s College, Health Science Centre, 2075 Bayview Avenue, Toronto, ON M4N 3M5, Canada | cocdan@ica.net |
| Kim Song Bo | HI | 13 Perriya Uppodai, Batticaloa, Sri Lanka | kimsong@motivationlk.org<br>songkim_793@hotmail.com |
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