Diagnosis of endemic diseases in village cattle herds in southeast Uganda: a low technology decision support system

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Summary
A colour-coded chart -the Decision Support Card - was designed based on a combination of pattern-matching and colour-banding techniques using quantitative information on the diagnostic value of clinical signs of eight bovine diseases: trypanosomosis, theileriosis, anaplasmosis, babesiosis, cowdriosis, parasitic gastroenteritis, schistosomosis and fasciolosis, to aid field veterinarians, animal health assistants and community animal health workers in the diagnosis and treatment of disease cases in rural areas. The chart utilizes scores ranging from 0 to 4 and colour bands: black, grey, yellow, orange, and red to reflect the weight of a sign state in the event that a disease is present. Differential diagnosis is performed by comparing observed clinical signs with disease profiles and construction of ranked lists of diseases based on overall scores. The disease with the highest total is considered the leading differential diagnosis. A tie for the top rank is considered to signify a case of concurrent disease involving more than one disease. Dissemination of this tool for routine use is yet to be undertaken until field trials using a prescribed protocol and a large-scale evaluation by independent potential end-users have been conducted.

The prototype Decision Support Card in use

Introduction
Endemic diseases of cattle in Uganda such as trypanosomosis, East Coast fever, anaplasmosis, babesiosis, cowdriosis, parasitic gastroenteritis, schistosomosis and fasciolosis are a major constraint to livestock productivity and are responsible for the bulk of cases field veterinarians have to contend with (Anon., 1996; Magona *et al.*, 1997; Magona and Musisi, 1998; Magona *et al.*, 1999). Effective control of these diseases requires appropriate diagnosis and treatment of individual cases in the field. Unfortunately, many of the existing parasitological and molecular diagnostic tests for these diseases are more suitable for epidemiological research work rather than for diagnosis of individual cases for treatment. Despite the availability of parasitological and molecular tests for laboratory diagnosis of the above mentioned diseases, there are no simple pen-side diagnostic tests for field-level diagnosis of cases. Moreover, in Uganda like in many African countries, veterinary diagnostic laboratories are either poorly equipped or have fallen into disuse due to under-utilisation by fee-paying farmers and absence of public support (Kenyon

and Nour, 1991). Detection of clinical disease may be facilitated by use of a combination of clinical signs, simple diagnostic tests and diagnostic decision support systems. Diagnostic decision support systems are useful when used by non-experts (Cockcroft, 1999) such as animal health auxiliaries, who normally play an important role of recognition, treatment and control of animal diseases in circumstances when there is shortage of qualified veterinarians.

This paper describes the development of a decision support system to aid field veterinarians, animal health assistants and community animal health workers in the diagnosis and treatment of disease cases in rural areas.

Materials and methods

A simple diagnostic decision support tool was developed based on quantitative information on the diagnostic value of clinical signs of eight bovine diseases: trypanosomosis, theileriosis, anaplasmosis, babesiosis, cowdriosis, parasitic gastroenteritis, schistosomosis and fasciolosis, obtained from a panel of animal health experts through a Delphi survey as described by Linstone and Turoff (1975).

A total of 64 veterinary scientists and 64 field veterinarians were initially sent questionnaires. After two rounds of the Delphi survey, responses were received from 46 participants who included 32 veterinary scientists and 14 field veterinarians.

Data received from experts, consisting of scores of clinical signs of the targeted diseases is shown in Table 1. This data was incorporated into a colour-coded chart - the Decision Support Card. The chart was designed based on a combination of the pattern-matching and colour-banding techniques (Cockcroft, 1999; Middleton, 2001).

Results

The chart, shown in the photograph, utilizes scores ranging from 0 to 4, in which 0, 1, 2, 3 and 4 represent values (colours), 0 (black), >0% (grey), >9% (yellow), >14% (orange) and >21% red), respectively. The colour band and the score reflect the weight of a sign state in the event that a disease is present.

The basis of this chart is comparison of clinical signs observed with disease profiles. A list of differential diagnoses is constructed ranked in the order in which the disease profiles match the clinical signs observed. To make differential diagnosis, scores of the various sign states of each disease are added up and overall scores of the possible differentials are ranked. The disease with the highest total is considered the leading differential diagnosis. A tie for the top rank is considered to signify a case of concurrent disease involving more than one disease.

Discussion

In the present study, a simple diagnostic decision support tool was developed based on quantitative information on the diagnostic value of clinical signs of eight bovine diseases. In an initial evaluation by 15 pairs of experts in comparison to the Decision Support Card using cases of known aetiological and clinical diagnosis, the Decision Support Card detected 15 out of 16 (93.8%) cases, while the 'experts' detected 12 out of 16 (75%) cases.

Whereas the Decision Support Card misdiagnosed only one case of fasciolosis that presented with anaemia, diarrhoea and weight loss for parasitic gastroenteritis, the experts misdiagnosed four cases: two cases of fasciolosis and two cases of schistosomosis for parasitic gastroenteritis and trypanosomosis. Distinction of parasitic gastroenteritis from fasciolosis and schistosomosis, and trypanosomosis from schistosomosis and fasciolosis is difficult since these diseases present with similar signs. The Decision Support Card was better than the experts at distinguishing parasitic gastroenteritis from schistosomosis and schistosomosis and fasciolosis from trypanosomosis, when enough information on clinical signs (at least 3) is provided.

Rank	Anaplasmosis	Babesiosis	Cowdriosis	Fasciolosis	PGE	Schistosomosis	Theileriosis	Trypanosomosis
1	Constipation	Haemoglobinuria	Ataxia/locomotor dysfunction	Weight loss	Diarrhoea	Weakness	Lymph node enlargement	Anaemia
2	Pyrexia	Pyrexia	Pyrexia	Anaemia	Anaemia	Weight loss	Pyrexia	Weight loss
3	Anaemia	Icterus	Anorexia	Weakness	Pot belly (calves)	Pallor of mucous membranes	Dyspnoea	Staring coat
4	Anorexia	Anaemia	Abnormal behaviour/ consciousness	Pallor of mucous membranes	Stunted growth	Anaemia	Reduced milk yield	Lymph node enlargement
5	Depression	Weakness	Weakness	Staring coat	Weight loss	Stunted growth	Coughing	Pallor of mucous membranes
6	Pallor of mucous membranes	Anorexia	Depression	Submandibular/ ventral oedema	Submandibular/ ventral oedema		Lacrymation	Abortion
7	Weakness	Depression	Reduced milk yield	Stunted growth	Age		Breed	Weakness
8	Reduced milk yield	Pallor of mucous membranes		Reduced milk yield	Pallor of mucous membranes		Weakness	Reduced milk yield
9	Icterus	Reduced milk yield			Staring coat		Anorexia	
10					Weakness		Petechial haemorrhages	

Table 1. *Lists of key clinical signs for diagnosis of endemic bovine diseases arranged in order of their diagnostic value for the respective diseases*

However, the Decision Support Card still needs refinements to allow it to distinguish parasitic gastroenteritis from fasciolosis, especially when cases of fasciolosis present with diarrhoea in addition to anaemia and weight loss.

of anaemia and diarrhoea has been assigned higher diagnostic scores for parasitic gastroenteritis than for fasciolosis, while presence of weight loss and submandibular oedema have been assigned higher diagnostic scores for fasciolosis than

Despite the impressive performance of the Decision Support Card for the majority of diseases, including anaplasmosis, babesiosis, cowdriosis, East Coast fever and trypanosomosis, one needs sufficient information on clinical signs in order to use this tool.

Case presentation	Field diagnosis	Experts' diagnosis	Decision Support Card diagnosis
Anaemia, Icterus, Pyrexia, Weight loss	Anaplasmosis	A (67%); S/T (17%)	A/T; B, S
Ataxia, Pyrexia, Weakness	Cowdriosis	C (79%); E (13%)	C; B
Anaemia, Anorexia, Haemoglobinuria, Pyrexia	Babesiosis	B (63%); A (29%)	B; A; C/T
Depression, Dyspnoea, Lymph node enlargement	East Coast fever	E (83%); T (17%)	E
Anaemia, Lymph node enlargement, Staring coat, Weight loss	Trypanosomosis	T (58%); A (17%); F (17%)	T; S; F/P
Abnormal behaviour, Anaemia, Pyrexia	Cowdriosis	C (79%); E (13%)	C; A; B
Anaemia, Constipation, Pyrexia, Weight loss	Anaplasmosis	A (75%); B (21%)	A; T; S
Anaemia, Lymph node enlargement, Weight loss	Trypanosomosis	T (67%); E (17%)	T; S
Anaemia, Anorexia, Lymph node enlargement	East Coast fever	E (63%); T (33%)	E; A/T
Anorexia, Depression, Haemoglobinuria, Weakness	Babesiosis	B (83%)	B; C
Anaemia, Diarrhoea, Weight loss	Fasciolosis	P (50%); T (33%) ; S (17%)	P; S; T; F
Anaemia, Dysentery, Weight loss	Schistosomosis	P (58%); E (25%)	S; T
Diarrhoea, Stunted growth, Weight loss	Parasitic gastroenteritis	P (67%); F (17%); S (13%)	P; F/S
Anaemia, Dysentery, Staring coat, Weakness	Schistosomosis	S (33%); T (33%); F (17%)	S; T; F; P
Staring coat, Submandibular/ventral oedema, Weakness, Weight loss	Fasciolosis	T (38%) ; P (33%); F (13%)	F ; T ; P/S
Anaemia, Pot belly, Staring coat	Parasitic gastroenteritis	P (58%); F (33%)	P; S/T; F

A = Anaplasmosis, B = Babesiosis, C = Cowdriosis, E = East Coast fever, F = Fasciolosis, P = Parasitic gastroenteritis, S = Schistosomosis, T = Trypanosomosis

Table 2. *Comparison of diagnoses by experts and the Decision Support Card*

Weight loss is an important clinical sign of chronic gastrointestinal nematode infections in older cattle, while anaemia, oedema, diarrhoea and anorexia are associated with severe cases of parasitic gastroenteritis observed in younger cattle, with diarrhoea being the main clinical sign (Eysker and Ploeger, 2000; Ganaba *et al.*, 2002). Weight loss and anaemia are also associated with mild or chronic fasciolosis in cattle (Urquhart *et al.*, 1996). Presence

for parasitic gastroenteritis in the Decision Support Card. This leads to misdiagnosis of cases of fasciolosis that present with anaemia, diarrhoea and weight loss, but without submandibular oedema. However, such cases are unusual. Veterinarians could deal with such situations by applying broad-spectrum anthelmintics that clear both gastrointestinal nematodes and flukes.

This tool is not useful for cases that present with only one sign. In case of concurrent disease, the second place diagnosis needs to be considered as well.

Field trials using a prescribed protocol need to be undertaken before the Decision Support Card can be released for evaluation by a larger number of independent potential end-users before dissemination for routine use.

How effectively can smallholder farmers manage the diseases in their livestock ?

During the Nairobi workshop, the results of an exercise to help evaluate the new decision support tool described in this paper was carried out and the results presented back to the particiants. Workshops participants working in pairs, one of whom was a veterinarian, were presented with sets of symptoms and asked to make a diagnosis, based on the list of symptoms, from a list of possible endemic diseases. The diagnosis made by workshop participants was then compared by the 'definitive' diagnosis made in the field by project veterinary staff and also by the decision support tool. The result of this comparison was that the workshop participants and the 'tool' both came up with diagnoses that matched that made by the projects vets in the field for trypanosomiasis and tick-borne diseases but the workshop participants and the tool was less successful at diagnosing parasitic gastro-intestinal infections, fascioliasis or schistosomiasis. The team developing the tool resolved to further refine and test their simple diagnostic tool.

With this demonstration of the possible strengths and weaknesses of a simple decision support tool, the issue of how effectively can smallholder farmers manage the diseases of their livestock was considered in plenary.

Discussion points included who should be targeted for field testing and validation of the tool. Opinion was divided as to whether this should be confined to fully trained vets and paravets or whether it should also be tested in selected livestock-focused Farmer Field Schools (see page 49). Eventually it was resolved that it could be tested at all three levels, but that in the case of the FFS it would be used together with lists of symptoms previously generated and recorded during past FFS sessions, i.e. it would not be used at this stage to make diagnoses of active cases. Cards would be distributed for testing by vets and paravets in southeast Uganda through LIRI.

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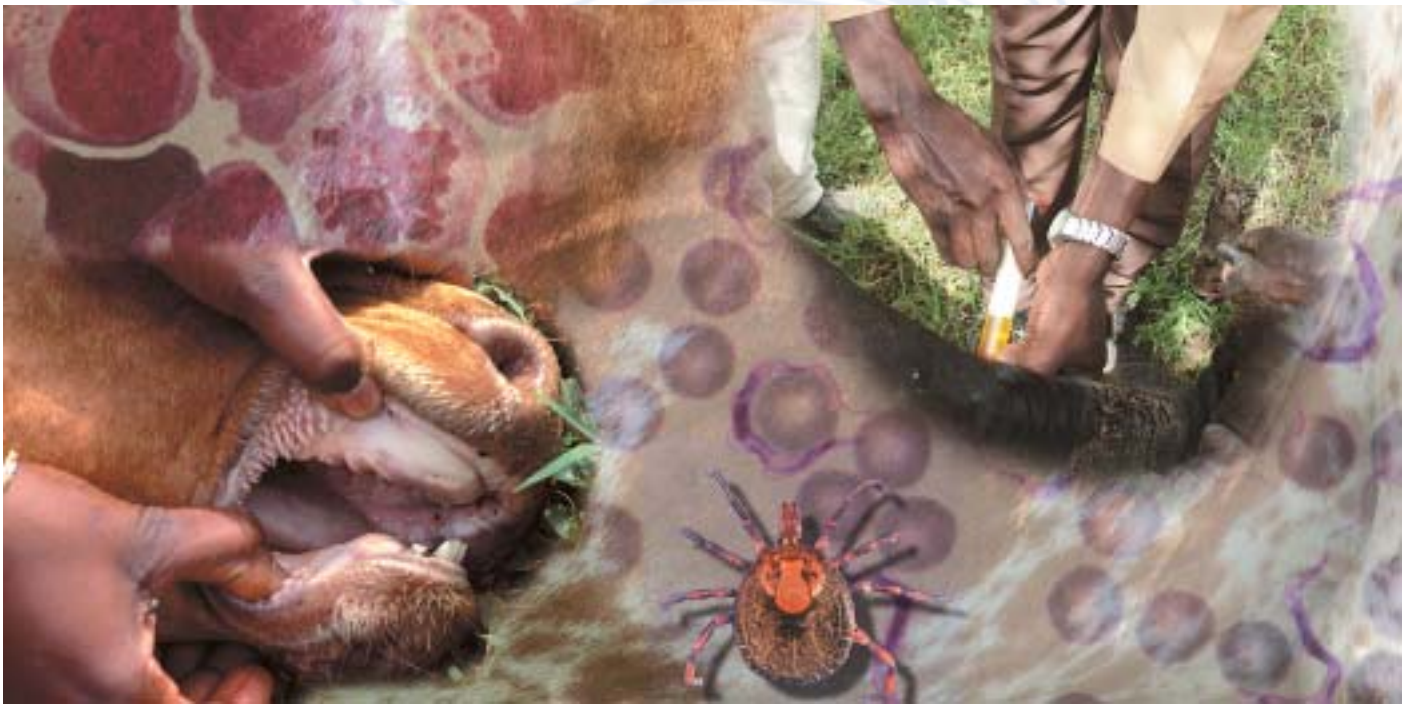
A variety of livestock diseases might be diagnosed and treated more appropriately with the use of an affordable decision support card



Photographs and composite Dave Elsworth