

Healthcare-associated infections including neonatal bloodstream infections in a leading tertiary hospital in Botswana

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ABSTRACT

Background: Healthcare-associated infections (HAIs) increase morbidity, mortality, length of hospital stay and costs, and should be prevented where possible. In addition, up to 71% of neonates are prone to bloodstream infections (BSI) during intensive care due to a variety of factors. Consequently, the objectives of this study were to estimate the burden of HAIs and possible risk factors in a tertiary hospital in Botswana as well as describe current trends in bacterial isolates from neonatal blood specimen and their antibiotic resistance patterns.

Methods: Point Prevalence Survey (PPS) in all hospital wards and a retrospective cross-sectional review of neonatal blood culture and sensitivity test results, with data abstracted from the hospital laboratory database.

Results: 13.54% (n = 47) of patients had HAIs, with 48.9% (n = 23) of them lab-confirmed. The highest prevalence of HAIs was in the adult intensive care unit (100% – n = 5), the nephrology unit (50% – n = 4), and the neonatal intensive care unit (41.9% – n = 13). One-fourth of HAIs were site unspecific, 19.1% (n = 9) had surgical site infections (SSIs), 17% (n = 8) ventilator-associated pneumonia/complications, and 10.6% (n = 5) were decubitus ulcer infections. There were concerns with overcrowding in some wards and the lack of aseptic practices and hygiene. These issues are now being addressed through a number of initiatives. Coagulase Negative *Staphylococci* (CoNS) was the commonest organism (31.97%) isolated followed by *Enterococci spp.* (18.03%) among neonates. Prescribing of third-generation cephalosporins is being monitored to reduce *Enterococci*, *Pseudomonas* and *Acinetobacter spp.* infections.

Conclusions: There were concerns with the rate of HAIs and BSIs. A number of initiatives are now in place in the hospital to reduce these including promoting improved infection prevention and control (IPC) practices and use of antibiotics via focal persons of the multidisciplinary IPC committee. These will be followed up and reported on.

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1. Introduction

Healthcare-associated infections (HAIs) refer to any systemic or localized conditions that result from the reaction by an infectious agent or toxin from a health-care setting [1]. HAIs are increasingly seen as a global public health threat as they are associated with increased morbidity and mortality, hospital length of stay, as well as appreciably increased overall costs [2–7]. HAIs have become more common as medical care has become more complex with more complicated patients, which has resulted in the increased use of invasive central line catheters, urinary catheters and ventilators, predisposing patients to potential HAIs [4,8,9].

Recent publications from the US suggest central line-associated bloodstream infections are the most costly HAI at

\$45,814 per case, followed by ventilator-associated pneumonia at \$40,144, and surgical site infections (SSIs) at \$20,785 per case, with catheter-associated urinary tract infections the least costly at \$896 per case [10]. Preventing 70% of HAIs in the US is estimated to save from US\$25billion to US\$31.5billion per year [8,10], with the current median length of stays in hospitals approximately 2-fold higher in patients with HAIs compared with those without [11]. National targets have recently been introduced in the US to further lower HAI rates from approximately one in 25 hospital patients to lower [12,13]. In Europe, the prevalence of HAIs varies from 4.8% in district (primary) hospitals up to 7.2% in tertiary hospitals, with respiratory tract infections (pneumonia – 19.4%, and other lower respiratory tract infections – 4.1%), SSIs – 19.6%, urinary tract infections – 19.0%, and

bloodstream infections – 10.7%, the most common [13,14]. HAIs are appreciably more common in low and middle-income countries (LMICs) than higher-income countries averaging up to 8% to 15% or higher among hospital patients [4,7,13,15–17]. In LMICs, the situation is compounded by a number of countries lacking effective infection prevention and control (IPC) programs exacerbated by the lack of antibiotic policies, poor laboratory support, limited resources, suboptimal adherence to safe practices and typically limited compulsion to report HAIs [18–20].

These high rates of HAIs in LMICs are a concern with a number of studies demonstrating the effectiveness of different interventions to prevent HAIs [8,21–23]. This includes audit and feedback, improving environmental hygiene, increasing the use of antiseptic products, instigation of antimicrobial stewardship programs (ASPs) as well as sterilization of devices [8,24–27]. Surveillance of HAIs is also a critical component of any future strategy to reduce HAIs within hospitals [7,28].

The prevalence of HAIs in Botswana hospitals is currently unknown. Whilst some hospitals in Botswana have started embarking on monitoring of HAIs due to the requirements of the health-care accreditation process, this is currently not standardized. There are also concerns with the inadequacy of reporting. This is particularly important in Botswana given the high prevalence of HIV among in-patients [29,30] that are immunocompromised. Ways to address this include recognizing and explaining HAIs; subsequently, implementing interventions to decrease infection rates and limit antimicrobial resistance [31]. In addition, promoting effective infection control mechanisms within a hospital including establishing an IPC team to coordinate activities. Consequently, accurate quantification of current HAI rates is needed to help justify any allocation of resources dedicated to IPC teams and surveillance strategies. In view of this, we sought to ascertain current rates of HAIs within a tertiary hospital in Botswana to help develop pertinent strategies for this hospital and later throughout Botswana to reduce HAIs if current rates were found to be a concern.

Concomitant with this, we also sought to specifically assess the current prevalence of neonatal bloodstream infections (BSIs) and current antimicrobial resistance (AMR) rates within the hospital to help target future intervention programs if BSIs are a concern. This is also a priority area across countries with up to ten million neonates worldwide dying within 5 days of birth, and most of these in LMICs due to BSIs [32,33]. Overall, up to 71% of neonates are prone to BSIs during intensive care, with neonatal infections contributing substantially to the morbidity and mortality of infants [34–36]. This is due to risk factors such as low birth weight, gestational age, administration of parenteral nutrition as well as the use of invasive devices and procedures [37]. Indiscriminate antibiotic use, coupled with poor IPC practices, leads to high infection rates and emergence of AMR [38]. However, screening for Group B *Streptococcus* (GBS) among mothers can avoid early onset of GBS among infants and help reduce mortality alongside considering intrapartum antibiotic prophylaxis [36,39,40]. Currently, the trends in the prevalence of neonatal BSI and the current antibiotic sensitivities are unknown in this hospital and wider to inform future IPC initiatives as well as any ASPs. Consequently, this study aims to describe current trends in bacterial isolates from neonatal blood specimens as well as

their antibiotic resistance patterns, and subsequently estimate the burden of HAIs and possible risk factors in the hospital.

2. Methodology

The study consisted of two parts and the study site chosen was Nyangabgwe Hospital, a tertiary hospital in northern Botswana with a total bed capacity of 572. The first part used a Point Prevalence Survey (PPS) design to ascertain the prevalence of HAIs in the hospital and possible risk factors based on previous publications. The second part involved a retrospective cross-sectional review of blood culture and sensitivity results of neonates.

2.1 PPS to ascertain current HAI rates

In the first part, the PPS was performed on a single day across the entire 15 admitting wards of the hospital in November 2017. This method was chosen due to the unavailability of previous hospital-wide surveillance data for IPC activities. Fifteen admitting wards with 510 beds were included in the survey. We excluded the psychiatric wards as they do not admit patients with infectious conditions and the labor ward as they admit only women who are in active phase of labor and are discharged thereafter to the post-natal ward. Medical records of all admitted patients on the day of the survey were reviewed. HAIs were defined as infections that were not present or incubating during the time of admission to the hospital. Cases were identified as those that became pyrexial 48 h after admission and assessed using CDC-definitions, similar to other studies [7,14,17,41,42].

Data collection was undertaken by a trained multidisciplinary IPC team, which included a clinical microbiologist, using a structured data collection tool that incorporated the CDC case definitions for accurate identification of HAI cases and possible risk factors. A pilot survey was conducted in the previous year and the structured data collection tool was revised as required to enhance accuracy in identifying cases. Data were analyzed using MS-Excel 2013 and the results of categorical variables including possible risk factors were presented as percentages. No attempt was made to calculate odds ratios or relative risk in view of the nature of the study design as the study was undertaken to improve local quality of care. The findings of the study were first discussed in the hospital IPC committee with the study abstract approved by Health Research and Development Division at the Ministry of Health and Wellness Botswana (HPDME-13/18/1) before submission for potential publication.

2.2 Neonatal basis

The second part involved a retrospective cross-sectional review of neonatal blood culture and sensitivity test results that was undertaken from January 2014 to December 2017. The study setting was a 28 bedded special care baby unit (SCBU) with six neonatal intensive care beds with an annual bed occupancy rate of 80% to 85%. Neonates were defined as babies aged less than 28 days irrespective of their gestational age based on patients' notes and BSIs were pathogenic bacteria isolated from blood cultures drawn from neonates

admitted in SCBU. Whilst considered as a contaminant as per laboratory procedures, Coagulase Negative *Staphylococci* (CoNS) is treated as pathogenic if the same isolation is observed in two simultaneous blood cultures from two different sites correlating with the clinical signs and symptoms for infection. This differentiation is observed as a collaborative diagnosis made by the treating clinician in consultation with the microbiologist during the provision of care and documented as such in patient medical records [43].

Data were collected from the hospital microbiology lab database; the hospital laboratory was accredited by the Southern African Development Community Accreditation Services (SADCAS). The results were sorted for the tested positive blood specimens and analyzed using MS-Excel 2013. The prevalence of isolated bacteria and their resistance to antibiotics were presented in percentages. The findings of this part of the study were also discussed in the Hospital IPC committee. The abstract was approved by the Health Research and Development Division at Ministry of Health and Wellness (MoHW) Botswana (HPDME-13/18/1) before submission for publication.

3. Results

3.1 PPS for HAIs

The bed occupancy rate on the date of the survey was 68% (n = 347). Overall, more than 1 out of 10 patients (13.54%, n = 47) were identified as having a HAI. Of the identified cases, 48.9% (n = 23) were laboratory confirmed. The prevalence of HAIs was highest in the adult intensive care unit (100% – n = 5), the nephrology unit (50% – n = 4), the special care baby unit (41.9% – n = 13), and the paediatric medical ward (33.3% – n = 8) (Table 1).

In terms of the sites of infections, approximately one-fourth of the HAIs were site unspecific and mostly observed in neonates. The highest prevalence of HAIs was observed from surgical sites including post-surgical osteomyelitis and intracranial infections (23.4% – n = 11) followed by ventilator-associated conditions/infections (17% – n = 8 from 126 mechanical ventilation days), decubitus ulcers (10.6% – n = 5), laboratory-confirmed bloodstream infections (8.5% – n = 4) and urinary tract infections (6.4% – n = 3) (Table 2).

Regarding the possible risk factors for HAIs, 51% (n = 178) of patients had received antibiotics of which 79.2% (n = 141) received injectable antibiotics and 32.5% (n = 58) had received more than 2 antibiotics. Forty-eight percent (n = 166) of patients had an intravenous catheter, and 24% of patients received an invasive procedure that required an incision in the body. The risk of acquiring a ventilator-associated infection is 0.06 per mechanical ventilation day. Other risk factors are shown in Table 3.

3.2 Neonatal BSI study

Of the total 366 isolates, 56.01% were from male neonates. 62.3% of blood cultures were ordered within the first week of life. Coagulase Negative *Staphylococci* (CoNS) was the commonest organism (31.97%) isolated followed by *Enterococci spp.* (18.03%). Other bacteria and their prevalence are contained in Box 1.

The trends in the prevalence of bacterial pathogens causing bloodstream infections showed a mixed pattern of increases and decreases over the period of the study (Figure 1). The highest prevalence was observed with CoNS, which after a significant drop in 2014 steadily increased thereafter. This is followed by *Enterococci spp.* showing a high prevalence, but with a decline after 2016. As in most other settings, ESKAPE (*Enterococcus faecium*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, and *Enterobacter* species) organisms are the most common pathogens isolated. Whilst there was a decline of *Klebsiella pneumoniae* from 2014, this changed in 2016 with a steady increase thereafter. This was similar to the situation seen with *Staphylococcus aureus*. On the other hand, the prevalence of *E. coli* remained high between 2014 and 2016; however, declining after that. There was a low prevalence of *Pseudomonas aeruginosa* throughout the study, and *Acinetobacter spp.* showed moderate fluctuations (Figure 1).

Regarding the prevalence of drug-resistant pathogens in 2017, extended spectrum beta-lactamase (ESBL) producing *Klebsiella pneumoniae*, *Enterobacter spp.* and *E. coli* were at 55%, 15.38%, and 11.11%, respectively. *K. pneumoniae* and *E. coli* showed an increasing trend in ESBL producing strains although no KPC (*Klebsiella pneumoniae* carbapenemase)

Table 1. Prevalence of HAIs in different wards.

Ward	Admissions	Bed capacity	Bed occupancy (%)	HAI cases	HAI cases (%)
Adult Intensive Care	5	6	83.3	5	100.0
Private (Housing Nephrology patients)	8	20	40.0	4	50.0
Special Care Baby Unit with Neonatal ICU	31	40	77.5	13	41.9
Paediatric Medical	24	40	60.0	8	33.3
Female Medical	29	50	58.0	3	10.3
Male Medical	39	50	78.0	4	10.3
Gynaecology II	13	15	86.7	1	7.7
Male Surgical	61	50	122.0	4	6.6
Post Natal	54	50	108.0	3	5.6
Gynaecology I	21	35	60.0	1	4.8
Female Surgical	27	50	54.0	1	3.7
Ante Natal	13	30	43.3	0	0
Isolation	6	24	25.0	0	0
Paediatric Surgical	15	30	50.0	0	0
TB	1	20	5.0	0	0
Overall	347	510	68.0	47	13.54

Table 2. Prevalence of HAIs at Various Sites.

Ward	Surgical		Decubitus		Lab		Intracranial		Gastroenteritis		CD- Pneumonia in Immune Compromised		Ventilator Associated Condition		Infection related Ventilator Associated Condition		Possible Ventilator Associated Pneumonia		Probable Ventilator Associated Pneumonia		Urinary Tract Infection		Hospital Acquired Pneumonia		Catheter Related Infections (Other than UTI)		% of cases		
	Post-Surgical Osteomyelitis	Burns Infection	Circumcision Site Infection	Ulcer Infection	Bloodstream Infection	Confirmed Infection	Intracranial Infection	Gastroenteritis	Omphalitis	Hepatitis	Ventilator Associated Condition	Ventilator Associated Condition	Possible Ventilator Associated Pneumonia	Probable Ventilator Associated Pneumonia	Urinary Tract Infection	Hospital Acquired Pneumonia	Catheter Related Infections (Other than UTI)	Site Unspecific	Total	% of cases									
SCBU	1				1	1					1			2															
PMW					1																								
ICU				1	2																								
MMW				3																									
MSW	2																												
PVT																													
FMW				1																									
PNW																													
FSW																													
GNW I																													
GNW II																													
ANW																													
ISO																													
PSW																													
TB																													
Total	2	7	0	5	4	4	2	1	0	3	3	3	1	3	3	1	3	1	3	1	3	3	3	0	0	0	0	0	0
% of cases	4.3	14.9	0.0	10.6	8.5	8.5	4.3	2.1	0.0	6.4	6.4	6.4	2.1	6.4	6.4	2.1	6.4	2.1	6.4	2.1	6.4	6.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NB: SCBU-Special Baby Care Unit with Neonatal ICU; PMW-Paediatric Medical Ward; ICU-Adult Intensive Care; MMW-Male Medical Ward; MSW-Male Surgical Ward; PVT-Private Ward; FMW-Female Medical Ward; PNW-Post Natal Ward; FSW-Female Surgical Ward; GYN I-Gynaecology Ward 1; GYN II - Gynaecology Ward 2; ANW-Ante Natal Ward; ISO-Isolation; PSW-Paediatric Surgical Ward; TB-Tuberculosis Ward.

strains were identified. Of the *S. aureus* isolates, 19.35% were methicillin resistant (MRSA) while 6.06% of *Enterococcus spp.* were resistant to vancomycin (VRE) and were isolated only in 2017. *Acinetobacter spp.* showed 100% resistance to meropenem, cephalosporins, aminoglycosides, and fluoroquinolones. *Candida spp.* contributed 3.28% to positive isolates.

4. Discussion

The overall point prevalence of HAIs in this hospital was 13.5%, which is similar or lower than other LMICs [4,13,15–17,44]. Not surprisingly, a higher prevalence of HAIs occurred in the intensive care and dialysis units (Table 1) consistent with other studies [15,44–47]. The majority of the patients admitted to the ICU and neonatal ICU had undergone invasive procedures, had more complicated conditions with a long period of hospitalization and had long-term use of antibiotics predisposing them to the risk of acquiring multidrug-resistant infections. In neonates, gross prematurity and related immature immunity remain a risk factor for acquiring infections [48,49]. Risk factors that predispose to respiratory infections include the use of a ventilator, intubation, incision, non-standardized performance of sputum aspiration, improper oral care, as well as a poor ward environment [50].

HAIs were principally found in surgical incision sites, the respiratory tract and decubitus ulcers (Table 2), again similar to other studies [45,46]. Even though different studies have reported different sites of infection, the respiratory tract, surgical incision sites, and urinary tracts are among the most commonly reported sites for HAIs in published studies [13,18,45,46].

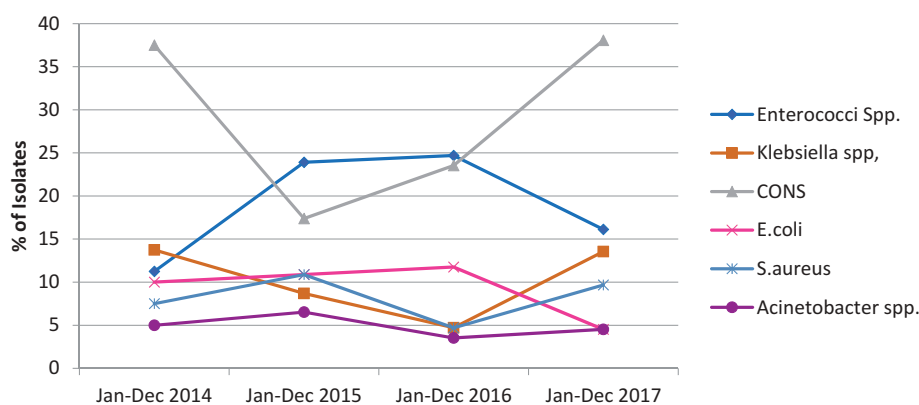
During this study, it was observed that male surgical and post-natal wards were overcrowded with floor beds due to bed occupancy rates above 100% (Table 1). The patient to nurse ratio was also a concern in a number of units including the special care baby unit (SCBU) with ratios typically around one nurse to each neonate in NICU [51,52], with every extra patient added to the workload known to increase the chances of patients being re-admitted, prolonging hospital stays or dying [52,53]. In addition, whilst preoperative bathing is recommended by the WHO and others, this is not currently being routinely practiced in this hospital exacerbated by the lack of nurses and overcrowding in some wards [54,55]. On the other hand, whilst the use of razors for removal of hair at the surgical sites has been shown to increase the rate of surgical site infections (SSIs) in some studies, with no scientific basis in others [55–58], this is still observed in our hospital potentially increasing the risk of SSIs.

Shortages of sterile dressing packs and drapes due to occasional downtime of boilers and autoclaves, as well as the lack of laundry equipment and alcohol hand rubs by patients' bedsides, may also have contributed to the quality of dressings during post-surgical care and managing decubitus ulcers thereby increasing HAI rates. Theatre temperatures were also observed to be elevated at times due to malfunctioning chillers and air-conditioners during surgery, further adding to potential HAIs. Shortages of single-use tracheal suctioning catheters also occurred in the hospital during the study, which resulted at times in the reuse of disinfected catheters in the same patients, which could also potentially increase the risks of HAIs. In addition, whilst studies have not shown significant differences between closed and open

Table 3. Risk Factors for HAIs.

Risk Factors	ANW	FMW	FSW	GYNAE I	GYNAE II	ICU	ISO	MMW	MSW	PMW	PNW	PSW	PVT	SCBU	TB	Total	%
No. of patients on antibiotics	1	16	11	14	5	5	6	15	36	17	18	9	6	18	1	178	51
No. of patients on injectable antibiotics	1	15	10	7	4	5	3	12	27	12	14	7	5	18	1	141	41
No. of patients with more than 2 antibiotics	0	3	4	5	1	1	5	2	13	5	2	3	2	12	0	58	17
No. of patients on urinary catheter	0	3	4	3	2	5	0	6	4	0	6	0	2	0	0	35	10
No. of patients on intravenous cannula	3	11	14	15	6	1	3	27	27	13	14	9	8	14	1	166	48
No. of patient on central venous catheter	0	1	0	0	0	4	0	0	0	0	0	0	0	0	0	5	1
No. of patients on other type of catheters	0	3	0	0	0	0	0	3	0	0	0	0	0	3	0	9	3
No. of patients received an invasive procedure	0	2	6	4	6	5	0	4	18	2	12	4	7	13	0	83	24
No. of patients previously hospitalized in 90 days	0	1	1	4	0	0	0	0	12	10	0	4	0	0	0	32	9
No. of patients on mechanical ventilators	0	0	0	0	0	3	0	0	0	1	0	0	0	5	0	10	3
No of days on mechanical ventilator	0	0	0	0	0	68	0	0	0	2	0	0	0	56	0	126	
No. of patients on mechanical devices	0	1	0	2	0	0	0	0	9	1	0	0	0	0	0	13	4
No of days on mechanical devices	0	41	0	0	0	0	0	0	2	0	0	0	0	0	0	43	
Total admissions	13	29	27	21	13	5	6	39	61	24	54	15	8	31	1	347	100

NB: SCBU-Special Baby Care Unit with Neonatal ICU; PMW-Paediatric Medical Ward; ICU-Adult Intensive Care; MMW-Male Medical Ward; MSW-Male Surgical Ward; PVT-Private Ward; FMW-Female Medical Ward; PNW-Post Natal Ward; FSW-Female Surgical Ward; GYN I-Gynaecology Ward 1; GYN II – Gynaecology Ward 2; ANW-Ante Natal Ward; ISO-Isolation; PSW-Paediatric Surgical Ward; TB-Tuberculosis Ward.

**Figure 1.** Trends in the prevalence of bacteria causing neonatal BSI.**Box 1.** Prevalence of bacteria causing neonatal BSI.

- Coagulase Negative *Staphylococci* (CoNS) – 31.97%
- *Enterococci spp.* – 18.03%
- *Klebsiella pneumoniae* – 10.93%
- *Staphylococcus aureus* – 8.47%
- *Escherichia coli* – 7.38%
- *Acinetobacter spp.* – 4.64%
- *Enterobacter spp.* – 3.55%
- Group-B *Streptococci* – 2.46%
- *Streptococci viridans* – 2.19%
- *Pseudomonas aeruginosa* – 1.09%

tracheal suctioning systems, the hospital currently uses an open suctioning system which combined with poor IPC practices may increase ventilator-associated infections. Closed tracheal suctioning systems are helpful in limiting environmental, personal and patient contamination [59]. In addition, at times there were few operational mechanical ventilators;

consequently, routine sterilization could be a problem adding to potential HAIs.

In view of the findings, there have been a number of initiatives put in place in the hospital in line with CDC recommendations [60]. These include routinely undertaking assessments to help ensure appropriate hand hygiene, cleaning and disinfection practices, adherence to isolation procedures, aseptic techniques, visiting procedures, proper wound and device care and ensuring commodity availability as part of IPC quality improvement activities. A series of measures for training, education, and evaluations are currently being implemented in the hospital to improve the awareness of ways to minimize HAI risks. Placement of posters as reminders for hand washing and precautions are also now placed in strategic locations in the hospital. Publication of a hospital IPC newsletter was also initiated. These measures are expected to reduce the risk of HAIs effectively [50,54]. Heads of departments, departmental focal persons and administrative staff have also been involved with measures to increase compliance to hand hygiene and for appropriate handling and

disposal of healthcare waste. The objectives of IPC have also been integrated into departmental annual performance plans and individual performance objectives to promote staff ownership of these measures to reduce HAI rates in the hospital, and this is being monitored.

Blood is the commonest specimen drawn from neonates for culture with two-thirds drawn within the first 7 days of life. As with other studies in premature neonates [43,61], CoNS were the predominantly isolated bacteria. Skin antisepsis prior to blood specimen collection is also emphasized to nursing staff to prevent specimen contamination. ESKAPE organisms, *E. coli* and *Streptococci spp.* were the most isolated pathogens, again similar to a number of other studies [32,33,36,61–63]. Recently the protocol for the treatment of neonatal infections were reviewed to reduce the use of third-generation cephalosporins to help reduce *Enterococci*, and *Acinetobacter spp.* infections, and this is being followed up. Efforts are also in place to prevent shortages of antibiotics and patients missing antibiotic doses, which has been a concern in point prevalence studies in Botswana [29,64]. These efforts are expected to reduce the emergence and spread of infections at the neonatal unit complemented by implemented IPC initiatives.

We are aware of a number of limitations with these studies. Firstly, the PPS survey involved a review of medical records of patients and therefore only patients with documented urinary tract infections had the possibility of inclusion and asymptomatic patients might have been left out. Moreover, urinary specimens were not collected from all patients who remained on a urinary catheter during the survey for active case finding. In this study again, no attempt was made to calculate odds ratios or relative risk in view of the nature of the study design. In addition, the study was only undertaken in one hospital. Never-the-less, we believe our findings are robust considering this was the second largest public hospital with also a neonatal setting, thus providing suitable direction to stimulate IPC activities in this and other hospitals in Botswana.

5. Conclusion

In conclusion, we found that more than 1 in 10 patients acquired infections during their stay in the hospital. Prioritized efforts are needed in adult intensive care unit, nephrology, neonatology, and pediatric wards to improve practices as there is a higher risk of patients acquiring HAIs in these wards due to the frequent use of invasive devices. Decongesting post-natal and surgical wards, strengthening nurse-patient ratios, and taking preventative measures to reduce surgical site infections, are critical to reducing the prevalence of HAIs in the future. Currently, approximately 50% of patients in the hospital received antibiotics and persistent efforts are essential to improve antibiotic use to further reduce the emergence of drug-resistant strains of bacteria including *Enterococci* and ESBL producing strains of *Klebsiella* among ESKAPE organisms. The ongoing initiatives are being monitored, and the findings will be used to develop additional programs if needed to reduce the rates of HAIs and BSIs in this hospital and wider in Botswana.

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Declaration of interest

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