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RESEARCH

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Insights into bloodstream infections in South African paediatric burn patients: implications for antimicrobial stewardship

Michael Christie[1*], Theunis Avenant[1], Masindi Nembudani[1], Anelisa Mnqandi[2], Chris Muller[3], Mariza de Villiers[2] and Zeenat Bhikhoo[2]

Abstract

Introduction Bloodstream infections (BSIs) significantly contribute to the morbidity and mortality in paediatric burn patients from low- and middle-income countries; with common pathogens like *Staphylococcus aureus, Escherichia coli*, and *Pseudomonas aeruginosa* frequently being multidrug resistant (MDR). Due to the growing prevalence of MDR BSIs, antimicrobial stewardship needs to be improved with perhaps more targeted initial antimicrobial use.

The study describes the aetiology, and timing of burn-associated BSIs and MDR infections in paediatric burn patients admitted to two paediatric surgery units in Tshwane District, South Africa.

Methods This multi-centre retrospective review analysed paediatric burn patients (ages 0–12 years) admitted between January 2020 and December 2022 to two public hospitals in Tshwane District, South Africa. Collected data was from patient records and the National Health Laboratory System TrakCare database. BSIs were defined according to the CDC criteria.

Results Of 245 burn patients admitted, 18.8% ($n=46$) developed BSIs. From 63 positive blood cultures, the most common isolates were *S. aureus* ($n=19$; 30%), *Acinetobacter baumannii* ($n=18$; 29%), and *P. aeruginosa* ($n=10$; 16%). Collectively, gram negative bacteria were responsible for most BSIs ($n=41$; 65%). *Candida* spp accounted for 9% ($n=5$). Thirty-five pathogens (56%) were MDR; this included methicillin-resistant *S. aureus* (MRSA) ($n=7$; 11%), carbapenem-resistant *A. baumannii* ($n=16$; 25%), and *P. aeruginosa* ($n=6$; 10%). The median time to the first positive blood culture was 5 days (IQR: 3–12) (gram positive organisms: median: 5 days [IQR: 3–15}); gram negative organisms: median: 8 days [IQR: 4–20]; Fungal: median: 9 days [IQR: 8–27]; *p*-value 0.37).

In the first week, *S. aureus* caused 32% of infections, including five MRSA cases. Gram negative bacteria dominated weeks two and three, with fungal and polymicrobial infections mainly in weeks two and four.

Conclusion Our findings show that as gram positive and gram negative infections predominantly occurred early in the admission period, while polymicrobial infections are more frequently observed later. Consequently, initial targeted narrow-spectrum antimicrobial use is not possible. Instead, antimicrobial de-escalation should be prioritized once culture results are available. Efforts should shift from a focus on treating BSIs to preventing them through wound care and infection control measures. Broad-spectrum antibiotics should be used judiciously and quickly de-escalated to minimise antimicrobial resistance development.

*Correspondence:
Michael Christie
michael.christie@up.ac.za
Full list of author information is available at the end of the article

Highlights

- The most common initial isolate was *Staphylococcus aureus.*
- *Acinetobacter baumannii* was the leading cause of gram negative bloodstream infections, in contrast to the global trend where *Pseudomonas aeruginosa* is more commonly implicated.
- The majority of gram positive and gram negative pathogens identified were multidrug resistant.
- Central line-associated bloodstream infections accounted for nearly one-third of all bloodstream infections.

Keywords Paediatric burn injuries, Bloodstream infections, Antimicrobial stewardship, Sepsis, Antibiotics

Introduction

Paediatric burn injuries pose a significant public health challenge in low- and middle-income countries (LMICs), where children under 10 years old account for approximately 80% of cases and experience the majority of burn-related fatalities [1, 2].

Among the many burn-associated complications, bloodstream infections (BSIs) emerge as a crucial contributor to burn-related morbidity and mortality, presenting a formidable obstacle for healthcare providers [3]. Burn patients have an increased susceptibility to infection due to the compromised protective dermal barrier, which, when lost, enables pathogen invasion. Factors further contributing to this susceptibility include burn-induced immunosuppression, young age, large total body surface area affected by burns, prolonged antibiotic administration and hospital admission, and the use of invasive medical devices such as urinary catheters, endotracheal tubes, and central lines [4–7].

The gold standard for diagnosing bloodstream infections (BSIs) remains isolating disease-causing organisms from sterile blood cultures. Common pathogens causing BSI include gram positive bacteria such as *Staphylococcus aureus*, *Enterococcus* species (spp), *Streptococcus pyogenes* well as gram negative bacteria like *Escherichia coli, Pseudomonas aeruginosa*, *Klebsiella* spp. Many of these pathogens belong to the difficult-to-treat group of emerging multidrug resistant (MDR) "superbugs" which exhibit high levels of antimicrobial resistance (AMR) against most available antimicrobial agents [8]. The steady rise in the incidence of MDR infections has become a major global concern, with factors commonly associated with burn-related BSI—such as prolonged hospital stays and invasive devices—identified as important contributors to the development of MDR infections [9, 10].

To address the rise of AMR and enhance antimicrobial stewardship, a more targeted antimicrobial approach, focusing on the most likely causative pathogen, is essential [11]. Understanding the temporal relationship between burn injuries and the pathogen causing BSI may be helpful for selecting appropriate antibiotics. During the first week post-burn injury, gram positive bacteria are usually the predominate cause of BSIs, followed by a shift to gram negative bacteria and fungi thereafter [12].

The study aimed to describe the aetiology and incidence of BSI's, including the prevalence of MDR infections, among paediatric burn patients admitted to two paediatric surgery units in Tshwane District, South Africa.

Material and methods

Study design

We conducted a multi-centre, retrospective review of paediatric burn cases involving children aged 0 to 12 years, admitted to the paediatric surgery units of Steve Biko Academic Hospital (SBAH) and Kalafong Provincial Tertiary Hospital (KPTH) in the Tshwane District, South Africa, between January 2020 and December 2022. Data was collected from routinely collected paediatric surgery unit records and the National Health Laboratory System (NHLS) TrakCare database.

Study setting

Tshwane District, South Africa, is divided into seven health districts, catering to a population of approximately 4 million people, with 23% being under the age of 14 years. Within the district 14% of households are characterized as informal dwellings, and 9% lack access to electricity thereby utilising open flames [13]. There are two public hospitals, Steve Biko Academic Hospital and Kalafong Provincial Tertiary Hospital, in Tshwane District that offer paediatric surgery services. Steve Biko Academic Hospital is the main quaternary hospital and referral centre and is equipped with a Paediatric Intensive Care Unit (PICU), and specialised paediatric and surgical subdisciplines. At Kalafong Provincial Tertiary Hospital, children with stable burns receive treatment, while those with larger burns or requiring intensive care are transferred to SBAH until they are stable enough to be transferred back to KPTH. At the onset of any clinical sign of sepsis during the course of the children's admission, blood cultures were promptly obtained from either a peripheral site or a central venous catheter.

In both surgical units, Piperacillin/Tazobactam is the first-line therapy for suspected sepsis in children hospitalised for over 48 h, regardless of central venous catheter (CVC) placement. If there is a poor response after 48 h, antibiotics are escalated to Meropenem and Vancomycin. In the PICU, Meropenem and Vancomycin are the first-line therapy for suspected sepsis in this population.

Study population

All children aged 0 to 12 years admitted to the SBAH and KPTH paediatric surgery units for burn injuries between January 2020 and December 2022 irrespective of mechanism of burn injury or affected body surface area.

Study procedure

The data from the paediatric surgery unit records included patient demographics, mechanism of injury, dates of burn injury, admission, and discharge/death, as well as total burn surface area (TBSA). Blood culture and antimicrobial sensitivity data were sourced from the National Health Laboratory System (NHLS) TrakCare database.

Blood culture bottles were incubated in the BacT-ALERT® automated blood culture system (BioMerieux, France) for five days. Positive cultures were subjected to direct gram staining and inoculated onto Chocolate, Blood, and MacConkey agars. Depending on the gram stain result, additional inoculations were performed: Mannitol Salt and Bile-Aesculin agar and DNAse agar if only gram positive cocci were observed, and Colistin Nalidixic Acid plate if both gram positive cocci and gram negative bacilli were observed. Sabouraud dextrose agar was used if fungal culture was requested or if yeasts were observed on direct gram stain. Positive blood cultures with monomorphic gram negative bacilli were directly inoculated into the VITEK2® (BioMerieux, France) instrument for identification and susceptibility testing.

The agar plates were incubated at 37 °C, in 5% carbon dioxide for 18 – 24 h. VITEK ® MS PRIME (BioMerieux, France) was used to identify pathogens and VITEK 2® (BioMerieux, France) was used for susceptibility testing as per the instrument's information manual. Additional antibiotic susceptibility testing using disk diffusion, E-tests, broth microdilution and determination of carbapenemase production, were performed when deemed necessary according to the laboratory's standard operating procedures and the Clinical and Laboratory Standards Institute's (CLSI) criteria [14].

Definitions

Bloodstream infections were defined as an infection caused by a recognised pathogen that is not considered a common skin contaminant, such as Diphtheroids, *Bacillus* spp, *Propionibacterium* spp, coagulase-negative *Staphylococci* or *Micrococci* spp. The infection was confirmed by the presence of the pathogen in two or more sterile blood cultures or, alternatively, a single positive blood culture if clinical signs of sepsis were present. If a common skin contaminant was cultured from two or more sterile blood cultures drawn on separate occasions in the presence of clinical signs of sepsis, it was also considered a bloodstream infection [15]. A central line-associated bloodstream infection (CLABSI) was defined is a primary BSI in a patient that had a central line within the 48-h period before the development of the BSI and is not bloodstream related to an infection at another site [16]. Hospital-acquired infections were defined as infections that become clinically evident 48 h or later after admission to a healthcare facility [17]. Sepsis was defined by life-threatening organ dysfunction resulting from a dysregulated host response to infection. It was indicated by an acute change of ≥ 2 points in the total Sequential Organ Failure Assessment (SOFA) Score following infection [18]. Mixed growth was defined as the presence of any 2 or more different pathogenic organisms (gram positive, gram negative or fungus) on a single sterile blood culture. Carbapenem-resistant *Enterobacterales* (CRE) are *Enterobacterales* that are non-susceptible (either intermediate or resistant) to a carbapenem.

Data analysis

Collected patient and blood culture data were exported to a password protected Excel 365 workbook (Microsoft, USA) for analysis and anonymized using unique study numbers.

Descriptive statistics were used to describe baseline characteristics. Mean, median, inter-quartile ranges and standard deviation were used for numeric values. Categorical data were summarized using proportions and tabulated or represented graphically. Chi-Square, Fisher Exact and Wilcoxon Signed-Rank tests were used to test significance. Significant difference was shown if $p < 0.05$.

Results

Baseline characteristics of all admitted patients

A total of 245 children were admitted for burns and more males were admitted. The majority of burn injuries occurred in infants and toddlers aged ≤ 3 years ($n = 166$; 68%) and scalds were the most common mechanism of injury ($n = 212$; 87%). BSI was diagnosed in 18.8% of children ($n = 46$). The incidence rate was 26.1 infections per 1,000 patient-days. Children with BSIs had significantly longer hospital stays and larger mean TBSA. Twenty-eight children had documented CVC inserted; 14 children developed BSI of which 8 (57%) were classified as CLABSI ($p = <0.0001$). The CLABSI incidence rate was 26.5 per 1,000 central line days. The average time to CLABSI was 5.5 days (SD = 2.3 days). (Table 1).

Bloodstream infections pathogens amongst paediatric burn patients

Among the 46 children who developed BSIs, 63 positive blood cultures results were obtained from peripheral or central line samples during the children's admission, of which 12 blood culture results (19%) were polymicrobial. The most common isolates being *S. aureus* ($n = 19$; 30%), *A. baumannii* ($n = 18$; 29%) and *P. aeruginosa* ($n = 10$; 16%). Overall, Gram negative organisms accounted for most isolates ($n = 41$; 65%). (Fig. 1) *Candida* spp isolates accounted for 9% ($n = 5$) of isolates (*Candida albicans*: $n = 1$; 2%; *Candida parapsilosis*: $n = 2$; 3%; *Candida tropicalis*: $n = 1$; 2%; *Candida auris*: $n = 1$; 2%)"and all occurred in TBSA > 21%. (Fig. 1; Table 2) There was no significant difference between the isolate groupings according to age, gender or TBSA. (Table 2).

Among the eight children who developed CLABSIs, gram negative organisms similarly accounted for most isolated pathogens ($n = 7$; 78%); this included *A. baumannii* ($n = 4$; 44%), *P. aeruginosa* ($n = 1$; 11%), *Enterobacter cloacae* ($n = 1$; 11%), and *Klebsiella pneumoniae* ($n = 1$;

Table 1 Baseline demographic and clinical characteristics of paediatric burn patients admitted to SBAH and KPTH between January 2020 and December 2022

	No BSI ($n = 199$)				BSI ($n = 46$)				
	n	%	Median	IQR	n	%	Median	IQR	*p*-value
Gender									
Male	102	54			26	57			0.32*
Age (mo)			24	16–48			24	15–50	0.73#
0–12	39	20			8	17			
13–36	94	48			26	57			
37–48	25	12			6	13			
49–72	34	17			-				
73–144	5	3			6	13			
Mechanism of injury									0.94$
Chemical	1	1			-	-			
Electric	5	2			1	2			
Flame	12	6			4	9			
Oil	4	2			1	2			
Scalds	173	89			40	87			
Length of hospital stay			6	3–11			16	11–22	< 0.0001#
Total burn surface area (%)	**n**	**%**	**Mean**	**± SD**	**n**	**%**	**Mean**	**± SD**	
1–10	89	46	14.4	10.1	5	12	23	10.7	< 0.0001#
11–20	66	34			17	40			
21–30	29	15			8	19			
31–40	6	3			11	26			
41–50	4	2			2	5			
> 50	1	1			-	-			
Documented central venous catheter (CVC) insertion	14	7			14	30			< 0.0001$
CVC Duration			10.4	8.6			12.0	8.4	0.64#
Demised	7	4			13	28			< 0.0001$

BSI Bloodstream infection, *CVC* Central venous catheter, *SBAH* Steve Biko Academic Hospital, *KPTH* Kalafong Provincial Tertiary Hospital, *IQR* inter-quartile range, *mo* month, *SD* standard deviation

* Fisher's Exact

Wilcoxon Rank Sum

$ Chi-Square Exact

Significant difference shown if $p < 0.05$

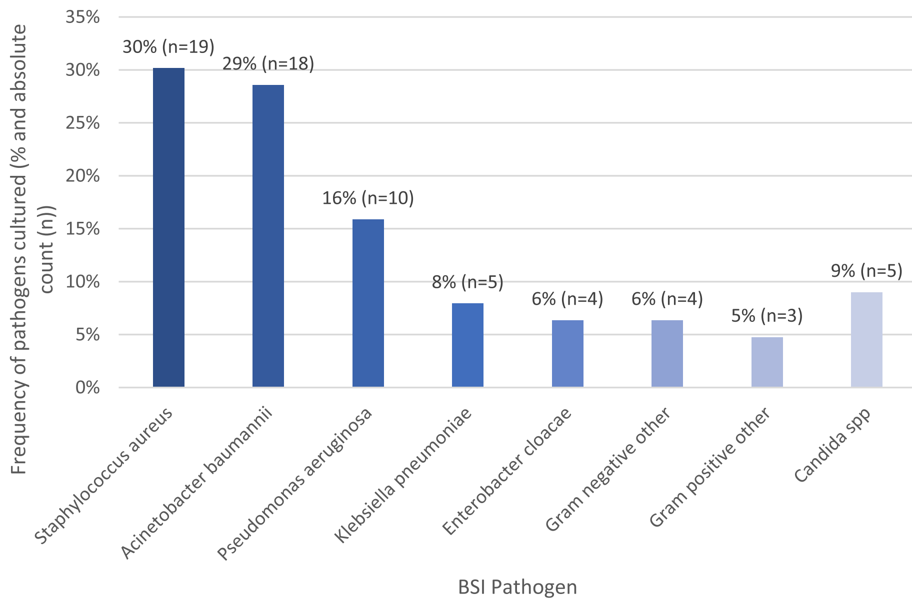

Fig. 1 Frequency of BSI pathogens per total positive blood cultures* amongst paediatric burn patients admitted to SBAH and KPTH between January 2020 and December 2022

BSI: bloodstream infection; SBAH: Steve Biko Academic Hospital; KPTH: Kalafong Provincial Tertiary Hospital; spp: species. *Total positive blood cultures = 63. Candida spp: *Candida albicans*; *Candida parapsilosis*; *Candida tropicalis*, *Candida auris*. Gram negative other: *Pseudomonas oleovorans*; *Salmonella enteriditis*; *Stenotrophomonas maltophilia*; Gram positive other: Coagulase negative *Staphylococcus*; *Aerococcus viridans*

Table 2 Baseline demographic and clinical characteristics of paediatric burn patients with bloodstream infections admitted to SBAH and KPTH between January 2020 and December 2022 categorised by isolated pathogens

Variable	Fungal (n = 5)				Gram positive organisms (n = 23)				Gram negative organisms (n = 45)				p-value
	n	%	Mean	± SD	n	%	Mean	± SD	n	%	Mean	± SD	
Gender													
Male	1	20	-	-	10	43	-	-	25	56	-	-	0.35[$]
Age (mo)													
0–12	-	-	31.2	7.2	3	13	33.7	23.6	10	22	31.9	24.8	0.74[#]
13–24	2	40			8	35			16	36			
25–48	3	60			10	43			14	31			
49—72	-	-			-	-			-	-			
73 – 144	-	-			2	9			5	11			
TBSA (%)[a]													
≤ 10	-	-	37.0	11.1	2	9	28.4	12.0	2	6	26.9	11.9	0.69[#]
11–20	-	-			3	14			11	31			
21–30	2	50			6	29			10	29			
31–40	-	-			5	24			8	23			
> 40	2	50			5	24			4	11			

SBAH Steve Biko Academic Hospital, *KPTH* Kalafong Provincial Tertiary Hospital, *mo* month, *SD* standard deviation, *TBSA* Total burn surface area

[a] Missing data

[#] Wilcoxon Rank Sum

[$] Chi-Square Exact

Significant difference shown if $p < 0.05$

11%). The remaining isolates were *S. aureus* (*n* = 1; 11%) and *C. parapsilosis* (*n* = 1; 11%).

Antibiotic susceptibility

The antibiotic susceptibility of the most common isolates was analysed. Thirty-five pathogens (51%) were MDR. This included methicillin-resistant *S. aureus* (MRSA) (*n* = 7; 10%), and carbapenem-resistant *A. baumannii* (*n* = 16; 24%), *P. aeruginosa* (*n* = 6; 9%) and *Enterobacter cloacae* (*n* = 1; 2%). Four *K. pneumoniae* (6%) and one *Enterobacter cloacae* (2%) were extended-spectrum β-lactamase-producing *Enterobacterales*. (Fig. 1).

All CLABSI-causing organisms, except *S. aureus* which was methicillin-sensitive, exhibited some degree of antibiotic resistance.

Timing of BSI

The median time to the first positive blood culture was 5 days (IQR: 3–12) (Gram positive organisms: median: 5 days [IQR: 3–15}); Gram negative organisms: median: 8 days [IQR: 4–20]; Fungal: median: 9 days [IQR: 8–27]; *p*-value 0.37). Most pathogens (*n* = 37; 54%) were cultured within the first week after the burn injury, during which *S. aureus* accounted for one-third of isolates (*n* = 12; 32%), including 42% (*n* = 5) identified as MRSA. *A. baumannii* followed with 27% of isolates (*n* = 10). Gram-negative organisms predominated in subsequent weeks, with *A. baumannii* most common in the second week (*n* = 4; 36%) and *Klebsiella pneumoniae* in the third week (*n* = 3; 43%). *Candida* spp. isolates were predominantly cultured in the second week (*n* = 2; 18%) and after the fourth week post-injury (*n* = 2; 15%) (Fig. 2).

The median time to polymicrobial isolation was 9 days (IQR: 8–22).

Outcomes

A higher inpatient mortality rate was observed in children with bloodstream infections (BSIs) (5.3%) compared to those without BSIs (2.9%) (p= < 0.0001). (Table 1) Using logistic regression, the relationship between survival and potential risk factors for mortality was analysed. Increased TBSA burnt, flame burns, and young age were identified as factors significantly associated with mortality. No pathogen grouping was shown to be significantly associated with mortality. (Table 3).

Discussion

Retrospective data analysis of paediatric burn cases from two paediatric surgery units in Tshwane District, South Africa revealed 18.7% of admitted children developed BSIs, equating to a BSI incidence rate of 26.1 infections per 1,000 patient-days. While most BSIs were caused by gram negative organisms, *S. aureus* was the most common single isolate. Additionally, 48% of the infections were caused by MDR organisms, posing a risk to future antibiotic choice and patient outcomes.

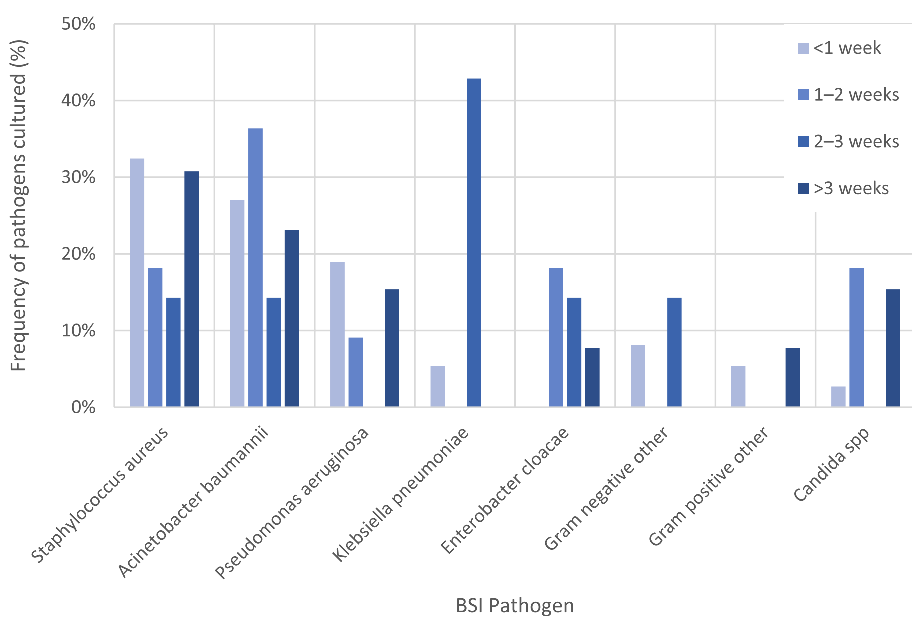

Fig. 2 Time distribution of BSI pathogens amongst paediatric burn patients admitted to SBAH and KPTH between January 2020 and December 2022

BSI: bloodstream infection SBAH: Steve Biko Academic Hospital; KPTH: Kalafong Provincial Tertiary Hospital; spp: species; Gram negative other: *Pseudomonas oleovorans; Salmonella enteriditis; Stenotrophomonas maltophilia,* Gram positive other: Coagulase negative *Staphylococcus; Aerococcus viridans;Candida spp: Candida albicans; Candida parapsilosis; Candida tropicalis*

Table 3 Factors influencing survival among paediatric burn patients admitted to SBAH and KPTH between January 2020 and December 2022 by Cox proportional hazards regressions

	Hazard Ratio	95% Hazard Ratio Confidence Limits		p-value
Age (mo)	0.95	0.92	0.98	0.001
Gender (Female)	0.68	0.21	2.17	0.51
TBSA (%)	1.11	1.08	1.15	< 0.0001
Mechanism of injury[a]				
Electric	16.12	1.13	230.84	0.04
Flame	28.60	6.07	134.78	< 0.0001
Pathogen				
Gram positive organisms	0.24	0.02	2.72	0.25
Gram negative organisms	0.47	0.09	2.41	0.36
Fungal	1.59	0.18	14.18	0.68
Mixed growth	1.06	0.21	5.37	0.94

SBAH Steve Biko Academic Hospital, *KPTH* Kalafong Provincial Tertiary Hospital, *mo* month, *TBSA* Total body surface area

[a] Scalds used as reference category

Gram positive organisms: *Staphylococcus aureus, Enterococcus faecium*, Coagulase negative *Staphylococcus, Aerococcus viridans*

Gram negative organisms: *Acinetobacter baumannii, Enterobacter cloacae, Klebsiella pneumoniae, Pseudomonas aeruginosa, Pseudomonas oleovorans, Salmonella enteriditis, Stenotrophomonas maltophilia*

Fungal: *Candida albicans, Candida parapsilosis, Candida tropicalis, Candida auris*

Mixed growth: Presence of any 2 or more different pathogenic organisms (Gram positive, gram negative or fungus)

Significant difference shown if p < 0.05

The high infection rate among burn patients is concerning as most burn injuries occur in infants and toddlers [19–21]. Consequently, most children in our study were under the age of three years. Consistent with published literature, scalds were also the most common mechanism of injury [21–23].

The risk of sepsis is closely related to affected TBSA and burn depth [4, 24]. Because of this, the reported incidence of BSIs varies in literature based upon the mean reported TBSA [22]. In our study, the mean TBSA was 23%, with a BSI incidence rate of 18.7%; this is consistent with other studies reporting similar mean TBSA [25, 26]. Factors contributing to increased BSI susceptibility were corroborated in our study [4–7, 27]: we found that most children who developed BSIs were under two years of age, had longer hospitalizations, and suffered from greater TBSA burned. Bloodstream infections typically occurred early in the admission period, with a median time of 5 days. Recognising sepsis at this stage can be challenging because the initial hypermetabolic inflammatory response post burn injury complicates the diagnosis, especially in large TBSA burns. A high index of suspicion for a possible infection is thus needed. To facilitate diagnosis, several criteria based on physiological parameters have been developed, such as the American Burn Association (ABA) Sepsis criteria and the SOFA score, but they have shown limited efficacy. [18, 28]. Procalcitonin has been identified as a useful acute-phase protein for sepsis diagnosis, but only when interpreted in conjunction with changes in physiological parameters [18].

In our study, CLABSIs accounted for nearly one-third of all bloodstream infections, and central venous catheter (CVC) use was significantly associated with developing BSIs. These findings were consistent with previous finding which showed that CVCs increase the risk of BSIs more than fourfold and that the likelihood of developing a CLABSI increases with prolonged catheterization [29, 30]. With an incidence rate of 26.5 CLABSIs per 1,000 central line days, our setting shows a considerably higher risk than previously reported [31]. Both hospitals adhere to similar infection prevention and control (IPC) practices, such as proper hand hygiene, sterile barrier precautions, pre-cleaning with 2% chlorhexidine, careful selection of catheter insertion sites, and prompt removal of catheters when no longer necessary. Despite these measures, the high rate of CLABSIs in this study indicates a clear need to strengthen the implementation of CLABSI prevention bundles through stricter oversight by each hospital's IPC committee [32, 33]. The use of peripherally inserted central catheters instead of central venous catheters is associated with lower CLABSI rates and could be considered for adoption into routine clinical practice [34].

As in other studies, *S. aureus* remained the most common initial isolate [23, 35, 36]. These organisms, which commonly colonise the epidermis, can withstand the initial burn injury and colonise the wound within 12 h post-injury [28, 37]. Our MRSA incidence rate of 37% was lower than rates reported in China, Australia, and the UK, where incidence exceeded 90% [21, 23, 35]. One case of MRSA BSI was diagnosed within 24 h of admission.

Overall, gram negative infections are the leading cause of BSIs in burn patients, with most cases linked to *P. aeruginosa* [23, 28]. In our study, *A. baumannii* was the predominant cause of gram negative BSIs followed by *P. aeruginosa* and *K. pneumoniae*. These findings are consistent with a study conducted among adults in Johannesburg, South Africa; however, no comparable regional data for paediatric patients is currently available [38]. Despite being cultured early during hospital admission, with the median time of five days to first positive culture [IQR: 3–8 days], most of these pathogens exhibited some level of antimicrobial resistance. *A. baumannii* had a resistance rate of 80%, lower than previously documented rates in China [39]. Whereas in Tanzania, 69% of *Acinetobacter* spp were multi-drug resistant. Our study showed similar levels of *Enterobacterales* spp resistance, mirroring resistance patterns seen elsewhere in Africa [40]. The variation in causative pathogen and associated resistance pattern could be attributed to differences in IPC protocols and variations in antimicrobial stewardship (AMS) practices. Polymicrobial and fungal BSIs mostly occurred in children who were admitted for more than seven days or more extensive TBSA burns. Such children are generally more ill, need multiple courses of broad-spectrum antibiotics, undergo numerous operations and receive prolonged parenteral nutrition via central venous catheters [36].

As both gram positive and gram negative infections occurred early during the admission period, and polymicrobial infections tended to be more common after a week, a targeted approach using narrow-spectrum antibiotics to initial and subsequent antimicrobial choice is impractical. Considering this, the fundamental AMS principle of de-escalating antibiotic therapy once blood culture results are available should be strictly followed. This principle should be applied in conjunction with broader efforts to reduce the risk of BSIs, which include strict adherence to IPC protocols, prompt wound care and dressing, utilising topical antimicrobial agents to reduce contamination, and regular reassessment of the need for invasive lines [18, 36].

Limitations

Limitations of the study include: the study's retrospective design and reliance on the NHLS TrakCare database for blood culture results might have resulted in missing data. In addition, the accuracy of the recorded data could not be verified. No distinction was made between primary and secondary BSIs, nor the impact of comorbid conditions, such as HIV and malnutrition, on patient susceptibility to infection. Blood cultures were assumed to be collected under standard sterile procedures; this could not be confirmed. As a result, the potential contribution of wound colonization or infection as the reason for the positive blood culture was not accounted for in this study. The relatively small sample size limited the study's statistical power, potentially affecting the validity of the findings.

Conclusions

Bloodstream infections caused by MDR pathogens amongst paediatric burn patients is a concerning complication with serious implications for patient outcomes. Our study's findings highlight the critical need for a shift in focus from merely treating these infections to preventing their development. To mitigate the risk of BSIs and curb the development of AMR, healthcare providers should prioritise proper wound and invasive medical device care, strict adherence to IPC principles and judicious use of antibiotics.

Abbreviations

ABA	American Burn Association
AMR	Antimicrobial resistance
AMS	Antimicrobial stewardship
BSI	Bloodstream infections
CLABSI	Central line-associated bloodstream infection
CVC	Central venous catheters
IPC	Infection prevention and control
KPTH	Kalafong Provincial Tertiary Hospital
LMIC	Low- and middle-income countries
MDR	Multidrug resistant
MRSA	Methicillin resistant *Staphylococcus aureus*
NHLS	National Health Laboratory System
PICU	Paediatric Intensive Care Unit
SBAH	Steve Biko Academic Hospital
SOFA	Sequential Organ Failure Assessment
Spp	Species
TBSA	Total burn surface area

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Clinical trial

Not applicable.

Authors' contributions

M.C., Z.B., C.M., M.D., and T.A. conceptualised and formally analysed the data. M.C., Z.B., M.N., and A.M. collected the data. M.C. and Z.B. prepared the original draft. All authors reviewed and edited the final draft and agreed to the published version of the manuscript.

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Data availability

Data is provided within the manuscript.

Declarations

Ethics approval and consent to participate

Ethics approval was obtained from the University of Pretoria Faculty of Health Sciences Research Ethics Committee (Reference number: 52/2024), as well as hospital management at each hospital and the Provincial Department of Health (NHRD Reference number: GP_202402_066). The study adhered to the principles of the Helsinki Declaration. As the analysed data were anonymised and routinely collected, informed consent was not necessary.

Consent for publication

All authors have agreed to the submitted version of the manuscript.

Competing interests

The authors declare no competing interests.

Author details

[1]Department of Paediatrics and Child Health, Faculty of Health Sciences, Kalafong Provincial Tertiary Hospital, University of Pretoria, Pretoria, South Africa. [2]Department of Paediatric Surgery, Faculty of Health Sciences, Steve Biko Academic Hospital, University of Pretoria, Pretoria, South Africa. [3]Department of Statistics and Actuarial Science, Faculty of Economic and Management Sciences, University of Stellenbosch, Stellenbosch, South Africa.

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