

Pattern and Frequency of Hospital Acquired Infections in Pediatric Intensive Care Unit at Abha Maternity and Children Hospital, Saudi Arabia

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Abstract

Objectives: To determine the pattern and frequency of hospital acquired infection (HAI) in pediatric intensive care unit (PICU) at Abha maternity and children hospital.

Subjects and methods: Retrospective analytical cohort study was carried out from 1 March 2017 to 28 February 2018 at Abha Maternity and Children hospital, Abha city, Kingdom of Saudi Arabia (KSA). All pediatric patients from 1 month to 12 years who had HAI in PICU were included. Information was collected regarding age, gender, length of hospital stay, underlying diseases, invasive procedures, types of HAI, causative organisms, and mortality rate. IBM SPSS software, version 25 was utilized for data entry and analysis.

Results: Out of 585 pediatric patients admitted to PICU, Abha Maternity and Children hospital throughout the study period (1 March 2017 - 28 February 2018), there were 42 acquired infections with 79 episodes, giving a rate of 7.2%, based on number of cases and 13.5% based on number of episodes. The age of 40.5% of them ranged between one and less

than 6 months. More than half of them (53.7%) stayed more than 30 days at the hospital. The number of HAI episodes was three or above, among 54.8% of cases. Concerning the type of infection, the commonest reported types were central-line associated bloodstream infection and ventilator-associated infection (52.4%), followed by bloodstream infection (42.9%), catheter-associated urinary tract infection (CA-UTI) and urinary tract infection (UTI) (21.4%). Regarding the causative organisms, Klebsiella pneumonia was the most frequent (34.3%), followed by Pseudomonas (11.4%), Candida tropicalis (7.6%) and Candida famata (6.3%). The commonest causative organism for CA-UTI was Enterococcus faecium (25%) whereas that of UTI was Klebsiella pneumoniae (55.5%). For bloodstream infection and central line associated blood stream infection, the commonest causative organism was Klebsiella pneumoniae (33.3% and 36.4%), respectively.

Conclusion: Hospital acquired infection is not very rare in PICU units. Also, mortality rate is relatively high and is related to number of hospital acquired infections.

Key words: PICU, hospital acquired infection, Frequency, causative organism

Introduction

Hospital acquired infections (HAI) are of important concern in the medical field, which places a great risk on patients and on the health care system (1). They are considered significant causes of morbidity and mortality in pediatric hospitals (2).

The recent medical developments including: increased use of broad spectrum antibiotics, urinary and central venous catheterization as well as endotracheal intubation put patients at an increased risk of contracting HAI in those who undergo long hospital stay and large treatment costs (3).

Although HAI in pediatric intensive care units occur universally, their frequencies vary greatly among different areas of the world. Indeed the prevalence might range from 6.1% to 26% (2,4-6). In developed countries, pediatric intensive care units' HAI rates in infants and children are lower than those reported for infants and children in developing countries. While in the Middle East, the incidence is 14.7% (2,4-6). Among these differences, highest incidence density was observed in the first 2 years of life. The three major sites of HAI are: blood stream, lower respiratory and urinary tract infections (7,8).

For instance, *Klebsiella pneumoniae* is found to be one of the common organisms isolated from blood stream infection followed by Coagulase-negative Staphylococci, and *Pseudomonas aeruginosa* respectively (8,9). Whereas, *Pseudomonas aeruginosa* followed by *Staphylococcus aureus* are the common HAI pathogens identified from lower respiratory tract infections (8,9). Furthermore the common HAI pathogens from urinary tract infections are *E. coli* followed by *Candida albicans* (8).

Incidence and prevalence of HAI could be decreased by 32% if infections surveillance were coupled with effective infection control programs (4). The frequencies of these hospital acquired infections among pediatric patients are variable in different countries and there is limited data available from KSA (7,9).

This study was carried out to determine the pattern and frequency of HAI in Pediatric Intensive Care Unit at Abha Maternity and Children Hospital (AMCH).

Subjects and Methods

A retrospective analytical cohort study was carried out from 1 March 2017 to 28 February 2018 at Abha Maternity and Children hospital, Abha city, Saudi Arabia. It is a public hospital of 200 beds with pediatric intensive care unit presenting 15 beds, offering secondary care. The study was approved by AMCH ethical committee.

All pediatric patients aged from 1 month to 12 years who acquired HAI in PICU at Abha Maternity and Children Hospital were included. PICU-acquired HAI was defined according to the Center for Disease Control and

Prevention (CDC) as infections that started after 48 hours from admission (10). All patients who were admitted with fever or who developed fever in the 1st 48 hours were excluded.

In order to establish the diagnosis of urinary tract infection, the patient must have at least one of the following with no other recognized causes: fever ($>38^{\circ}\text{C}$), urgency, frequency, dysuria, and positive urine culture with counts $\geq 10^6$ colony-forming units per milliliter (CFU/ml) (10).

Patients who develop pneumonia with new pulmonary infiltrate on chest radiograph after 48 hours from admission are considered to have HAIs if they have two of the following: leukocytosis ($>12,000/\text{mm}$ or leukopenia ($<4,000$ hyperthermia ($>38^{\circ}\text{C}$) or hypothermia ($<35^{\circ}\text{C}$), purulent sputum, tracheal aspirate bacterial count of $\geq 10^6$ CFU/ml. Bacteremia is confirmed by positive blood culture (10).

Data were collected using a specialized data collection form from infection control practitioner records and patients' medical records. The information included patients' age, gender, length of hospital stay, types of nosocomial infections, causative organisms, and the outcome.

Patients' names were not disclosed and all information about them was kept confidential.

IBM SPSS software, version 25 was utilized for data entry and analysis.

Results

Out of 585 pediatric patients admitted to the PICU, Abha Maternity and Children hospital throughout the study period (1 March 2017 - 28 February 2018), 42 acquired infections with 79 episodes giving an incidence rate of 7.2%, based on number of patients as demonstrated in Figure 1 whereas if we consider the number of episodes, the rate would be 13.5%.

Table 1 presents the basic characteristics of the children with HAI. The age of 40.5% of them ranged between one and less than 6 months whereas that of 19% was 3 years or more. The cases were equally distributed between both genders. More than half of them (53.7%) stayed more than 30 days at the hospital.

The number of HAI episodes was three or above among 54.8% of cases whereas it was only one among 33.3% of them as illustrated in Figure 2. Concerning the type of infection, the commonest reported types were central-line associated bloodstream infection and ventilator-associated infection (52.4%), followed by bloodstream infection (42.9%), catheter-associated urinary tract infection and urinary tract infection (21.4%). (Figure 3)

Regarding the causative organisms, *Klebsiella pneumoniae* was the most frequent (34.3%), followed by *Pseudomonas* (11.4%), *Candida tropicalis* (7.6%) and *Candida famata*

(6.3%) as demonstrated in Table 2. The commonest causative organism for CA-UTI was *Enterococcus faecium* (25%) whereas that of UTI was *Klebsiella pneumoniae* (55.5%). For bloodstream infection and central line associated blood stream infection, the commonest causative organism was *Klebsiella pneumoniae* (33.3% and 36.4%), respectively. Also for ventilator-associated infection, *Klebsiella pneumoniae* was the commonest

causative organism (31.8%). There was no statistically significant association between type of hospital-acquired infection and causative organism as illustrated in Table 3. As obvious from Figure 4, death rate was 48.8% whereas rate of home discharge was 46.3. There was a linear association between the number of HAI episodes and the mortality rate, $p=0.017$.

Table 1: Basic characteristics of children with Hospital acquired infection, Abha Maternity and Children hospital, Abha city, Saudi Arabia (1 March 2017 - 28 February 2018)

	No.	%
Age		
1-<6 months	17	40.5
6-<12 months	9	21.5
1-<3 years	8	19.0
≥3 years	8	19.0
Gender		
Male	21	50.0
Female	21	50.0
Length of hospital stay (days) (n=41)*		
≤30	19	46.3
>30	22	53.7

* Missing information

Table 2: Isolated causative organisms among children admitted to PICU, Abha Maternity and Children hospital, Abha city, Saudi Arabia (1 March 2017 - 28 February 2018)

	Frequency N=79	Percentage
<i>Klebsiella pneumoniae</i>	27	34.3
<i>Pseudomonas</i>	9	11.4
<i>Candida tropicalis</i>	6	7.6
<i>E coli</i>	3	3.8
<i>Acinetobacter</i>	2	2.5
<i>Candida famata</i>	5	6.3
<i>Steno. Ciferrii</i>	2	2.5
<i>Serratia Marcescens</i>	2	2.5
<i>Candida Gullermandii</i>	2	2.5
<i>Staph. Aureus</i>	2	2.5
<i>Enterococcus faecium</i>	3	3.8
<i>Kluyvera Ascorbata</i>	1	1.3
Others	15	19.0

Table 3: Association between the type of HAI and causative organisms among children admitted to PICU, Abha Maternity and Children hospital, Abha city, Saudi Arabia (1 March 2017 - 28 February 2018).

Type of nosocomial infection							
7 N (%)	6 N (%)	5 N (%)	4 N (%)	3 N (%)	2 N (%)	1 N (%)	
2 (100)	7 (31.8)	8 (36.4)	5 (33.3)	0 (0.0)	5 (55.6)	0 (0.0)	<i>Klebsiella pneumoniae</i> (n=27)
0 (0.0)	7 (31.8)	0 (0.0)	2 (13.3)	0 (0.0)	0 (0.0)	0 (0.0)	<i>Pseudomonas</i> (n=9)
0 (0.0)	0 (0.0)	1 (4.5)	1 (6.7)	0 (0.0)	3 (33.3)	1 (12.5)	<i>Candida tropicalis</i> (n=6)
0 (0.0)	1 (4.5)	1 (4.5)	0 (0.0)	0 (0.0)	1 (11.1)	0 (0.0)	<i>E coli</i> (n=3)
0 (0.0)	1 (4.5)	1 (4.5)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	<i>Acinetobacter</i> (n=2)
0 (0.0)	0 (0.0)	3 (13.6)	1 (6.7)	0 (0.0)	0 (0.0)	1 (12.5)	<i>Candida famata</i> (n=5)
0 (0.0)	0 (0.0)	1 (4.5)	0 (0.0)	0 (0.0)	0 (0.0)	1 (12.5)	<i>Steno. Ciferrii</i> (n=2)
0 (0.0)	0 (0.0)	2 (9.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	<i>Serratia Marcescens</i> (n=2)
0 (0.0)	0 (0.0)	1 (4.5)	0 (0.0)	0 (0.0)	0 (0.0)	1 (12.5)	<i>Candida Gullermandii</i> (n=2)
0 (0.0)	1 (4.5)	0 (0.0)	1 (6.7)	0 (0.0)	0 (0.0)	0 (0.0)	<i>Staph. Aureus</i> (n=2)
0 (0.0)	0 (0.0)	1 (4.5)	0 (0.0)	0 (0.0)	0 (0.0)	2 (25.0)	<i>Enterococcus faecium</i> (n=3)
0 (0.0)	0 (0.0)	0 (0.0)	1 (6.7)	0 (0.0)	0 (0.0)	0 (0.0)	<i>Kluyvera Ascorbata</i> (n=1)
0 (0.0)	5 (22.7)	3 (13.6)	4 (26.7)	1 (100)	0 (0.0)	2 (25.0)	Others (n=15)

- 1: Catheter associated urinary tract infection
 2: Urinary tract infection
 3: Surgical site infection
 4: Bloodstream infection
 5: Central line associated bloodstream infection
 6: Ventilator associated pneumonia
 7: Others

$\chi^2=77.83$, $df=72$, $p=0.299$

Table 4: Association between the number of HAI episodes and the outcome of HAI among children admitted to PICU, Abha Maternity and Children hospital, Abha city, Saudi Arabia (1 March 2017 - 28 February 2018).

Outcome			Episodes of HAI
At hospital N=2 N (%)	Death N=20 N (%)	Home discharge N=19 N (%)	
0 (0.0)	4 (30.8)	9 (69.2)	One (n=13)
0 (0.0)	2 (40.0)	3 (60.0)	Two (n=5)
2 (8.7)	14 (60.9)	7 (30.4)	≥Three (n=23)

Chi-square for trend=5.67, $p=0.017$

Figure 1: Frequency of Pediatric HAI, PICU, Abha Maternity and Children hospital, Abha city, Saudi Arabia (1 March 2017 - 28 February 2018)

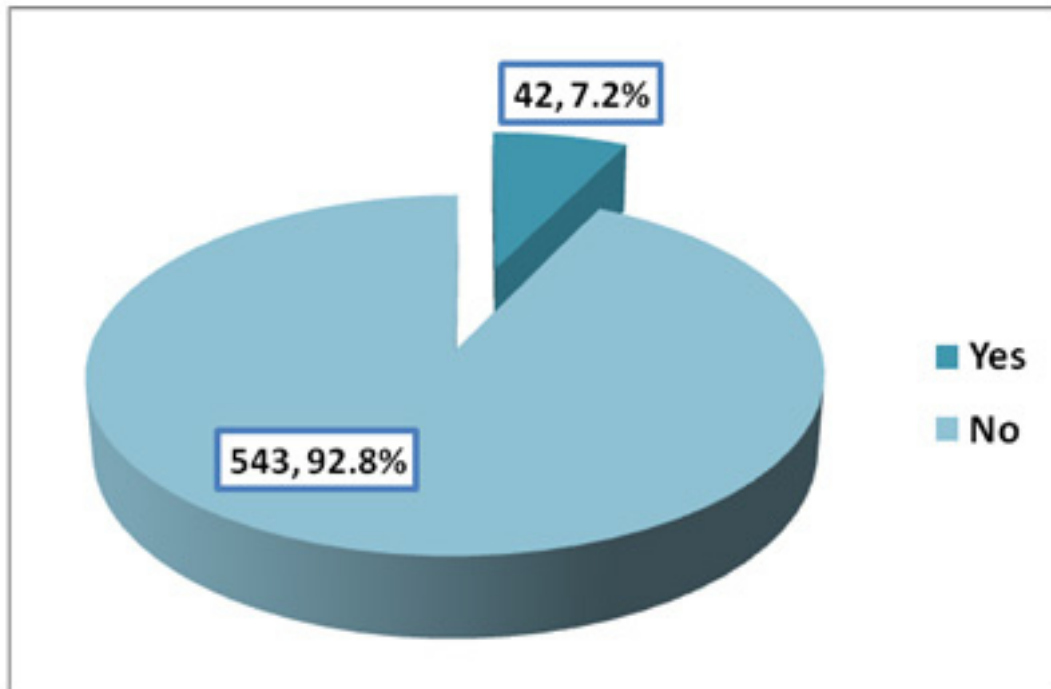


Figure 2: Number of HAI episodes among children admitted to PICU, Abha Maternity and Children hospital, Abha city, Saudi Arabia (1 March 2017 - 28 February 2018)

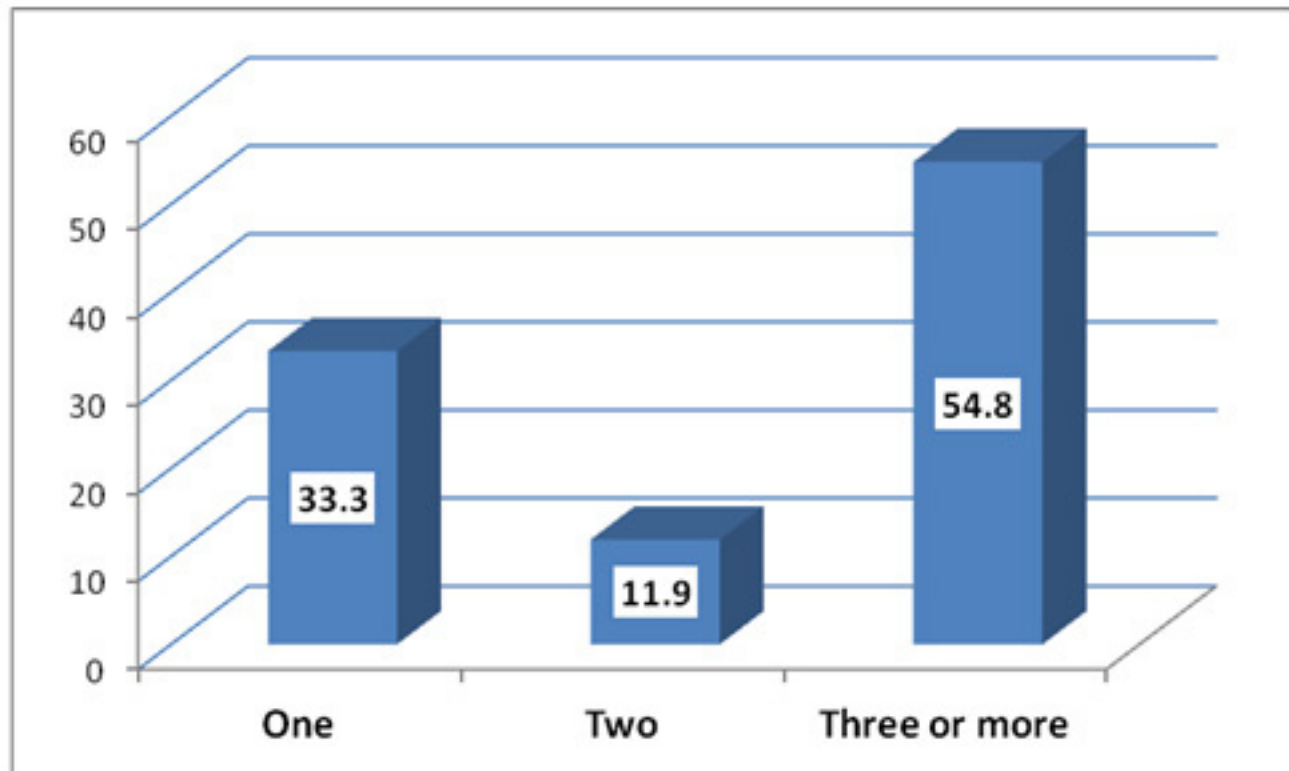
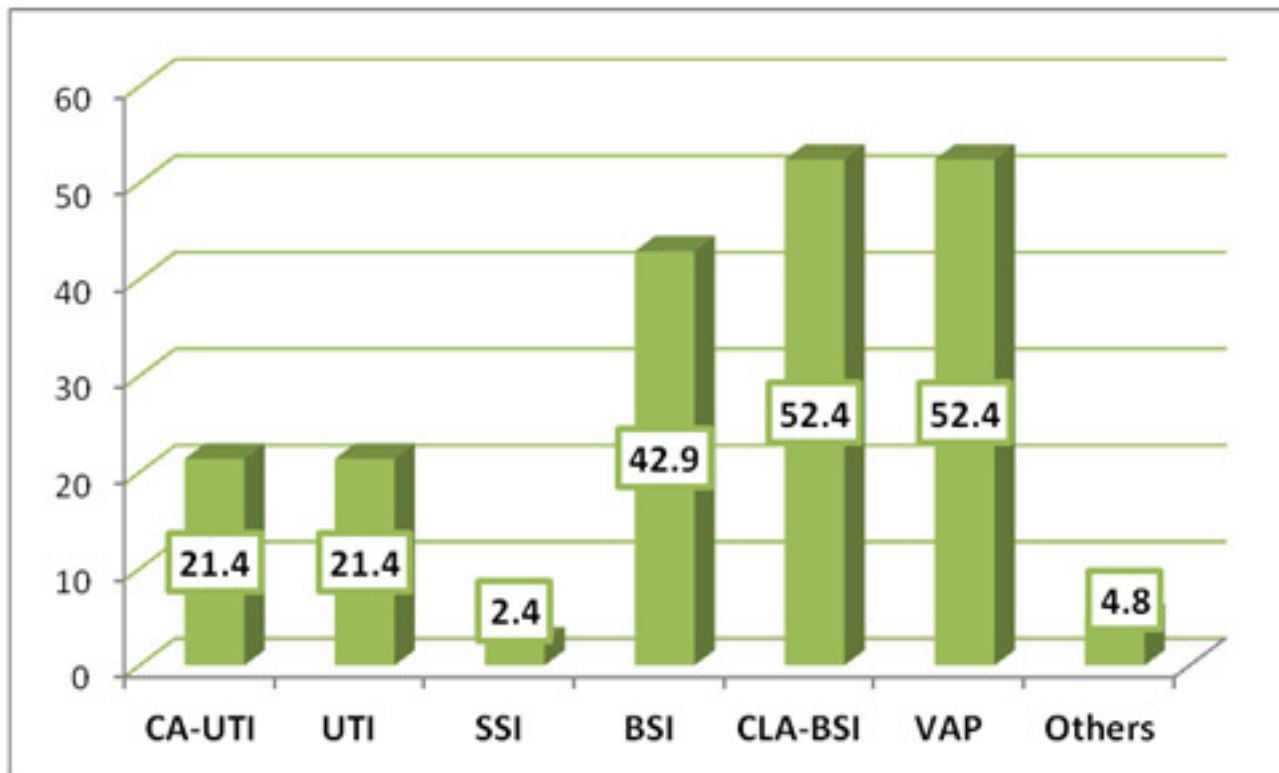
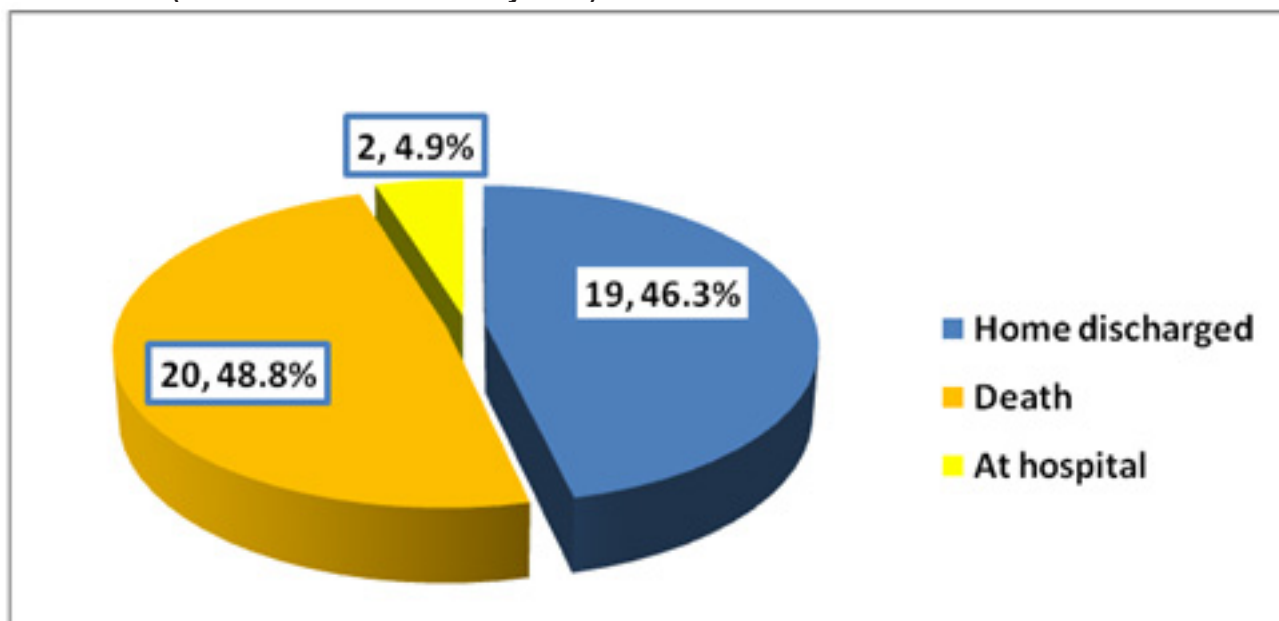


Figure 3: Types of HAI among children admitted to PICU, Abha Maternity and Children hospital, Abha city, Saudi Arabia (1 March 2017 - 28 February 2018)



- 1: Catheter associated urinary tract infection
- 2: Urinary tract infection
- 3: Surgical site infection
- 4: Bloodstream infection
- 5: Central line associated bloodstream infection
- 6: Ventilator associated pneumonia
- 7: Others

Figure 4: Outcome of HAI among children admitted to PICU, Abha Maternity and Children hospital, Abha city, Saudi Arabia (1 March 2017 - 28 February 2018)



Discussion

Pediatric HAI constitutes a major health problem as a result of associated high morbidity, mortality, and healthcare costs, particularly in pediatric intensive care units (PICU) (11). Despite patients in PICUs representing a small percentage of inpatients, they contribute to more than 20% of HAI (12).

There are numerous data regarding HAI in PICU, mainly expressed as infection rates per device/day or hospital/day (11,13). However, limited studies have been carried out in Saudi Arabia. Therefore, the present study was carried out to determine the pattern and frequency of HAI in the pediatric intensive care unit at Abha maternity and children hospital.

The rate of pediatric HAI in the present study was 7.2% which is comparable to the rates of other similar studies that ranged between 6.1% and 26% (6). Concerning the affected system, in accordance with numerous previous studies(8,11,14,15,16), bloodstream infections, were the most frequent, particularly central line associated infection, followed by respiratory system (ventilator-associated infection) and urinary tract infection (with catheter associated and without). In a previous Saudi study, the most common system affected was respiratory, followed by urinary tract infection and bloodstream infection. In a study carried out in Iran, the most common affected system was respiratory tract followed by urinary tract infection and bloodstream (2).

In this study, *Klebsiella pneumoniae* was the most frequent, followed by *Pseudomonas*, *Candida tropicalis* and *Candida famata*. In another study carried out in Saudi Arabia,(16) *Klebsiella* species were the commonest causative organisms for pediatric nosocomial infection, followed by *Candida* then *Pseudomonas aeruginosa*. In other studies, Coagulase-negative *Staphylococcus* species was the most frequent, followed by *Klebsiella*, *Pseudomonas aeruginosa* and *Staphylococcus aureus* (2,5,14).

The current study revealed that the commonest causative organism for VAI, was *Klebsiella pneumoniae*. Similarly, *Klebsiella pneumoniae* was the commonest causative organism for respiratory tract infection, followed by *Pseudomonas* in another Saudi study (16). Variable results have been reported from different international studies. *Staphylococcus aureus* and *Pseudomonas* were the most frequent reported causative organisms for respiratory tract infection in studies carried out by Richards et al (1999),(8) Porto et al (2012)(11) and Becerra et al (2010) (15).

It is reported in the present study that the commonest causative organism for bloodstream infection and central line associated BSI, was *Klebsiella pneumoniae*. This finding is in line with that reported by Alotaibi et al (2014) in Riyadh, Saudi Arabia (16). Different results were reported in other studies. For example, in Brazil, *E. fecalis* and *E. coli* was the commonest causative organism, followed by *Staphylococcus epidermis* (11). In another Brazilian study,

Candida species were the commonest causative organisms (15). In Estonia and USA, the most common organism was Coagulase-negative *Staphylococcus*(17, 8).

For CA-UTI, the most frequently reported causative organism was *Enterococcus faecium* whereas for UTI, it was *Klebsiella pneumoniae* in this study. In Riyadh (KSA), *Klebsiella pneumoniae* was the most common organism in UTI, followed by *Candida* and *E. coli* (16). Yeast and *E. coli* were the commonest organism for UTI reported in other studies (8,11,15).

Death rate in the present study was 48.8% and there was a linear association between the number of HAI episodes and the mortality rate. In a study carried out in Riyadh (16), KSA, higher mortality rate was reported (77%). In other international studies, mortality rate was below 40% (2,4,15,17). Further in-depth study is recommended to investigate the possible reasons for the relatively higher mortality rate observed in our study as well as in another Saudi study carried out in Riyadh compared to other overseas studies.

Some limitations of this study have to be discussed. Firstly, the relatively small number of children with HAI, which reduces the statistical power of the study. Secondly, information on the bacterial sensitivity was lacking as the present study depended upon having information from medical records, where this information was lacking. Finally, the study was carried out in one health institution which impacts the generalizability of results over other places.

In conclusion, HAI is not very rare in PICU units, particularly central-line associated bloodstream infection, ventilator-associated infection and catheter-associated urinary tract infection. Also, mortality rate is relatively high and is related to the number of HAI. Further studies are needed including a larger sample size and different institutions regarding PICU HAI.

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