

## Healthcare-associated infections among pediatric oncology patients in Pakistan: risk factors and outcome

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### Abstract

**Introduction:** Pediatric oncology patients are at increased risk of contracting healthcare-associated infections (HAIs), which are responsible for increased morbidity and mortality rates as well as treatment costs. This study aimed to identify the frequency of HAIs among pediatric oncology patients and their outcome.

**Methodology:** Pediatric oncology patients admitted between January 2009 and June 2010 in a pediatric ward at Aga Khan University Hospital, Karachi, Pakistan, who developed HAIs, were analyzed.

**Results:** A total of 90 HAIs were identified in 32 patients in 70 admissions. The HAI rate among pediatric oncology patients was 3.1/100 admission episodes. Bloodstream infections (63 episodes, 90.0%) were the most common, followed by urinary tract infection (two episodes, 2.9%). Gram-positive infections were seen in 54 (60%) patients, followed by Gram-negative infection in 34 (37.8%), and fungi in 2 (2.8%) cases. Coagulase negative staphylococci was the most common Gram-positive and *Escherichia coli* and *Pseudomonas aeruginosa* were most common Gram-negative infections. Mortality rate among pediatric oncology patients who developed HAIs was 12.5% (4/32). Total parental nutrition use and length of stay longer than 30 days were the identified risk factors associated with increased mortality among pediatric oncology patients who developed HAIs.

**Conclusion:** We report an HAI rate among pediatric oncology patients of 3.1/100 admission episodes with a mortality rate of 12.5% in Pakistan. Further studies should be done, especially in the developing world, to identify the risk factors associated with increased mortality among pediatric oncology patients so that adequate measures can be taken to reduce the mortality among these patients.

**Key words:** healthcare-associated infections; pediatric oncology patients; bloodstream infection

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### Introduction

Healthcare-associated infections (HAIs) represent a worldwide health-care problem placing a substantial burden on both individual patients and on health-care systems, which results in major complications of serious illnesses [1]. However, employing new strategies such as the increased use of chemotherapy drugs, white blood cell stimulants, and broad-spectrum antibiotics has improved the outcome of pediatric oncology patients [2]. In spite of such advances, these patients experience long bouts when they are immunocompromised and must remain in hospital for long periods when they will likely require central venous catheterizations, urinary catheterizations, endotracheal intubations, and intravenous feeding tubes [2]. These factors moreover put oncology patients at an increased risk of contracting HAIs and substantially increase morbidity and mortality rates as well as treatment costs [2-4].

The incidence rate of HAI among pediatric oncology patients ranges from 5.2 to 13.3 per 100 hospital admissions and 7.0 to 17.7 per 1000 hospitalization days [2,3,6,7]. Some investigators report bloodstream infections (BSIs), while others report respiratory infections as the most frequent site of HAIs among pediatric oncology patients [2,5,7,8].

Gram-negative bacteria has been isolated most often in some investigations involving pediatric oncology patients, with *Pseudomonas aeruginosa* being the most common organism detected [5]. However, in other studies, a higher incidence of Gram-positive bacteria has been found with staphylococci being the most commonly detected organism [3,7]. Developing countries like Pakistan represent different health and environmental issues which might affect on rate of HAIs among high risk populations such as pediatric oncology patients. It would be interesting to assess the frequency of HAIs among pediatric oncology patients, infection sites,

and common microorganisms. Therefore, we conducted a retrospective surveillance study to identify the frequency of HAIs among pediatric oncology patients, the most common sites of infection, and organisms responsible for it in a hospital in Pakistan.

## Methodology

### *Setting*

This descriptive, cross-sectional study was conducted in the Department of Pediatrics and Child Health, in the oncology unit, at Aga Khan University Hospital in Karachi, Pakistan, from January 2009 to June 2010. The Aga Khan University Hospital (AKUH) is a 600-bed tertiary-care facility and is accredited by the international arm of the Joint Commission International Accreditation Survey (JCIA). There is a 10-bed, separate oncology ward along with a 5-bed special care unit within the Pediatric Department, run by the pediatric residents and pediatric oncology fellows under the supervision of a pediatric hematologist and oncologist..

### *Patient population*

Pediatric oncology patients one month to 18 years of age, who were admitted to the pediatric ward from January 2009 to June 2010, and who developed HAIs according to definitions set by the United States Centers for Disease Control and Prevention (CDC)/National Health Care Safety Network (NHSN) Guidelines [9] were included in the study. All patients received therapy according to ACCM/PALS 2002 [10] Guidelines for pediatric sepsis and multi-organ dysfunction [11].

### *Definitions*

HAI, bloodstream infection (BSI), urinary tract infection (UTI), ventilator associated pneumonia (VAP), pneumonia in immunocompromised patients (PNEU3), and gastrointestinal tract infection (GIT) were all defined according to the criteria established by CDC/NHSN Guidelines [9]. Sepsis related diagnosis was made according to the criteria established at the International Pediatric Sepsis Consensus Conference [11].

### *Data collection*

All pediatric oncology patients, one month to 18 years of age, who were admitted to the pediatric ward from January 2009 to June 2010, and who developed HAIs according to guidelines set by the Centers for

Disease Control and Prevention (CDC)/National Health Care Safety Network (NHSN) [9] were registered in the study. Informed consent was taken from the guardian or parents. The data included demography of the patients' registration number, age, gender, weight, and height. Data also included primary diagnosis, site of HAIs, and common organism responsible for it. Clinical data, *i.e.* temperature, heart rate, blood pressure, and pertinent laboratory data such as hemoglobin, total leukocyte counts, absolute neutrophil counts, and platelet counts were also included to identify the sepsis related diagnosis according to the guidelines of the International Pediatric Sepsis Consensus Conference [11]. Length of stay, history of blood transfusion, total parental nutrition (TPN), mechanical ventilation (MV), central venous catheters (CVC), and urinary catheter usage were also identified. The final outcome in terms of discharge from the ward or expired was identified.

### *Statistical analysis*

The overall frequency of pediatric oncology patients who developed HAIs during the study period was determined by dividing the total number of admissions to pediatric oncology patients with HAIs with the total number of admissions to the pediatric oncology unit. For analysis, SPSS version 16 (IBM, Chicago, USA) was used. Descriptive frequencies were computed for qualitative variables and mean, and ranges were computed for quantitative variables. Pediatric oncology patients who survived after developing HAIs were compared with those who expired after developing HAIs and chi square was used to calculate the P value among these patients.

## Results

The total number of admissions in the pediatric oncology unit was 2,241. A total of 90 episodes of HAIs were identified in 32 patients in 70 admissions. The HAI rate among pediatric oncology patients was 3.1 HAI /100 admissions. Most of the patients had acute leukemia and lymphomas 62/70 (88.6%), followed by solid tumors (Table 1). The characteristics of patients who developed HAIs are given in Table 2. More than 50% of the patients had hemoglobin counts less than 10gm/dl, white blood count less than 1000/cm, absolute neutrophilic count (ANC) less than 500/cm, and platelet counts less than 50,000/cm. Central venous catheter (CVC) was present in 46 out of 70 (65.7%) patients, in which

**Table 1.** Diagnosis of admitted pediatric oncology patients who developed HAI

	Number n (%)
<b>Acute leukemia</b>	<b>51 (72.9)</b>
Acute Lymphoblastic Leukemia	37 (52.9)
Acute Myeloid Leukemia	14 (20.0)
<b>Lymphoma</b>	<b>11 (15.7)</b>
Non Hodgkin Lymphoma	10 (14.3)
Hodgkin disease	1 (1.4)
<b>Solid tumors</b>	<b>8 (11.3)</b>
Synovial carcinoma	5 (7.1)
Osteogenic sarcoma	1 (1.4)
Hepatoblastoma	1 (1.4)
Rhabdomyosarcoma	1 (1.4)

(n =70)

38/46 (82.6%) were portal catheter, 7/46 (15.2%) were peripherally inserted central catheter (PICC) line, and 1/46 (2.1%) was femoral line. The most common type of infection was bloodstream infection (BI) 63/70 (90%), followed by urinary tract infection (UTI). Gram-positive organisms constituted 54/90 (60%) isolates, followed by Gram-negative organisms at 34/90 (37.8%), and fungi at 2/90 (2.2%). Coagulase negative staphylococci were the most common Gram-positive bacteria, and *Escherichia Coli* and *Pseudomonas aeruginosa* were the most common Gram-negative organisms details (Table 3). The mortality rate among pediatric oncology patients who developed HAIs was 12.5% (4/32). Total parental nutrition (TPN) use and length of stay longer than 30 days with significant P values were the only identified risk factors associated with increased mortality among patients who developed HAI (Table 4).

## Discussion

We report a lower frequency of HAIs among pediatric oncology patients compared to the rates of 5.2-13.3/100 hospital admissions observed in previously reported studies [2,3,5,6]. The frequency of HAIs in our cohort was relatively low because we did not include the clinical CDC/NHSN criteria, as our cohort only included the culture-positive results according to CDC/NHSN criteria [9].

In our study, BSI (90%) was the most common HAI, as seen in other cohorts [2,3,7,12]. The most common organism detected in our patients was Gram-positive bacteria, a finding that supports the reported trend of Gram-positive bacterial predominance since the 1980s, [3,13,14], with coagulase-negative staphylococci being the most common bacteria detected, as seen in other cohorts

[3,7,15]. The higher rate of Gram-positive bacteria as causal organism for HAIs in European countries could be due to the fact that in European countries central venous catheterization is a commonly performed procedure, as seen in our patients. In our cohort, greater than 70% were severely neutropenic, which might explain the risk factor associated with fungal infections; however, it was difficult to calculate positive correlation due to the small number of fungal infected samples. Therefore, as noted in one study involving oncology patients who had low absolute neutrophil counts for a prolonged period of time, care should be taken to guard against bacterial as well as fungal infections [16].

We report a mortality rate of 12.5%, which is lower than that reported in another investigation which showed a mortality rate of 19.6% [2]. Although we found TPN use and length of stay greater than 30 days to be statistically significant with a high mortality rate among pediatric oncology patients, we were not able to calculate the other risk factors associated with it because of the low mortality rate in our study; however, this observation suggests another area for future research.

In conclusion, we report a low HAI rate among pediatric oncology patients from a hospital in Pakistan. We identified TPN use and length of stay longer than 30 days to be the associated risk factors leading to increased mortality among pediatric oncology patients. However, further studies had to be done to identify the risk factors associated with high mortality rate among pediatric oncology patients, especially in the developing world, so that adequate measures should be taken to reduce the mortality and health care costs.

**Table 2.** Characteristics of admitted pediatric oncology patients who developed HAI (n = 70)

<b>Characteristics</b>		<b>Number (%) or Mean (Range)</b>
<b>Age in years</b>		6.5year (1-16.5)
1 month - 5 years		31 (44.3)
5 years - 10 years		27 (38.6)
10 years - 18 years		12 (17.1)
Male		45 (64.5)
Weight (kg)		20.9 (5-51.5)
Height (cm)		108.8 (74 - 150)
<b>Site of infection</b>	BSI	63 (90)
	UTI	2 (2.9)
	BSI + PNEU 3	2 (2.9)
	BSI + VAP	2 (2.9)
	GIT	1 (1.4)
<b>Sepsis related diagnosis</b>	Sepsis	67 (95.8)
	MOD	3 (4.2)
<b>Hemoglobin (gm/dl)</b>	< 10gm/dl	60 (85.7)
	> 10gm/dl	10 (14.3)
<b>WBC /cm</b>	< 1000/cm	38 (54.3)
	> 1000/cm	32 (45.7)
<b>ANC /cm</b>	< 500/cm	51 (72.9)
	> 500/cm	19 (27.1)
<b>Platelets /cm</b>	< 50,000/cm	38 (54.3)
	> 50,000/cm	32 (45.7)
<b>Length of stay (days)</b>		18.2 (4-102)
<b>TPN given</b>		17 (24.2)
<b>Blood transfusion</b>		60 (85.7)
<b>CVC</b>		46 (65.7)
Porta catheter		38 (82.6)
PICC line n (%)		7 (15.2)
Femoral line		1 (2.1)
<b>Mechanical ventilation</b>		4 (5.7)
<b>Foleys catheter</b>		4 (5.7)
<b>Outcome</b>	Discharged	66 (94.3)
	Expired	4 (5.7)

HAI: Hospital acquired infection; BSI: Blood stream infection; UTI: Urinary tract infection, PNUE3: Pnuemonia in immunocompromised; VAP: Ventilator associated pneumonia; GIT: Gastrointestinal tract infection; MOD: Multiorgan dysfunction; WBC: White blood cells; ANC: Absolute neutrophil counts; TPN: Total parental nutrition; CVC: Central venous catheter

**Table 3.** Organisms isolated

	Number (%)
<b>Gram positive organisms</b>	<b>54(60)</b>
Coagulase negative staphylococci	37 (40.7)
<i>Staphylococcus aureus</i>	4 (4.4)
<i>Streptococcus</i> Species	7 (7.8)
<i>Corynebacterium</i> Species	5 (5.6)
<i>Bacillus</i> species	4 (4.4)
<b>Gram negative organisms</b>	<b>34 (37.8)</b>
<i>Escherichia coli</i>	7 (7.8)
<i>Pseudomonas aeruginosa</i>	7 (7.8)
<i>Klebsiella pneumoniae</i>	6 (6.7)
<i>Acinetobacter</i> Species	4 (4.4)
<i>Enterobacter</i> Species	4 (4.4)
<i>Pseudomonas cepacia</i>	1 (1.1)
<i>Pseudomonas stutzeri</i>	1 (1.1)
<i>Stenotrophomonas maltophilia</i>	1 (1.1)
<b>Fungi</b>	<b>2 (2.2)</b>
<i>Candida tropicalis</i>	1 (1.1)
<i>Aspergillus flavus</i>	1 (1.1)

(n = 90)

**Table 4.** Characteristics of admitted pediatric oncology patients with HAI who discharged and expired

	Expired		<i>P</i> value
	Discharged (n = 66)	(n = 4)	
	Number (%)	Number (%)	
Male	41 (62.1)	4 (100)	0.289
5 years - 10 years	24 (36.4)	3 (75)	0.165
Hemoglobin < 10gm/dl	56 (84.8)	4 (100)	0.251
WBC < 1000/cm	34 (51.5)	4 (100)	0.222
ANC < 500/cm	47 (71.2)	4 (100)	0.637
Platelets < 50,000/cm	34 (51.5)	4 (100)	0.166
Length of stay (> 30 days)	7 (10.6)	4 (100)	0.001
TPN given	13 (19.7)	4 (100)	0.035
Blood transfusion	56 (84.8)	4 (100)	0.532
CVC	42 (63.6)	4 (100)	0.627

HAI: Hospital acquired infection; WBC: White blood cells; ANC: Absolute neutrophil counts; TPN: Total parenteral nutrition; CVC: Central venous catheter

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