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ORIGINAL ARTICLE

Frequency of Ventilator associated Pneumonia (VAP), Central line associated Blood Stream Infections (CLABSI) and Catheter Related UTI in PICU.

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ABSTRACT… Objective: To assess the incidence of catheter-related urinary tract infections (UTIs), central line-associated blood stream infections (CLABSIs), and ventilator-associated pneumonia (VAP) in the paediatric intensive care unit (PICU). **Study Design:** Prospective Cross sectional Study. **Study Design:** Pediatric Intensive Care Unit, Fatima Memorial Hospital, Lahore. **Period:** January 10, 2023 to July 9, 2023. **Methods:** All 120 children of either gender admitted at PICU having age 1 month to 12 years who stayed in PICU for ≥48 hours were included in study. Data was recorded on the proforma containing basic demographic information along with diagnosis, mechanical ventilation, central line, urinary catheter and associated infections with information related to length of stay and outcome of the children. SPSS v25 was used to input and analyse the data. All of the variables were subjected to a descriptive analysis. Using stratification, we were able to regulate for potential moderators of the effects, such as age and gender. Chi-square/Independent t-tests were performed after stratification, with a p-value 0.05 indicating statistical significance. **Results:** Total 120 children admitted at PICU having age 1 month to 12 years who stayed in PICU for ≥48 hours were included in study. Gender distribution showed that, 77(64.2%) were males and 43(35.8%) were females. The mean age of the children was 26.6±31.95 months. The mean stay in PICU was 4.82±4.19 days and mean stay in hospital was 5.98±4.08 days. Among 120 children, 21(17.5%) were on ventilator and among them, 11(52.4%) had ventilator associated pneumonia, 14(11.7%) had CVL and 10(8.3%) had BSI and among them, 5(50.0%) had CVL associated BSI, while 22(18.3%) had catheter insertion and among them, 6(27.3%) had CA-UTI. According to outcome of children, 9(7.5%) expired. **Conclusion:** For developing countries, active surveillance is essential to reduce the burden of Healthcare-associated infections (HAIs) in high risk groups.

Key words: Catheter Related Urinary Tract Infection (UTI), Central Line Associated Blood Stream Infections (CLABSI), Ventilator Associated Pneumonia (VAP), Pediatric ICU.

INTRODUCTION

The global burden of disease, death, longer hospital stays, and higher healthcare expenses attributable to hospital-acquired infections (HAIs) is substantial. Patients in paediatric intensive care units (PICUs) are at a higher risk of infection due to the significant use of invasive equipment. More than 20% of all nosocomial infections occur in intensive care units (ICUs) in hospitals worldwide. In the United States, PICU patients have a point frequency of between 12 and 15 percent for PICU-acquired infections.[1-2]

In both low- and high-income nations, Intensive Care Unit (ICU) patients face additional challenges due to the presence of device-associated healthcare-associated infections (DA-HAI). Longer times spent in hospitals, greater likelihood of permanent impairment, bacteria developing resistance to antibiotics, higher overall healthcare expenditures, higher financial burdens on patients and their families, and even preventable deaths are all possible outcomes. The incidence of central line-associated bloodstream infections (CLABSIs) in medical and surgical PICUs in the United States is 1.43 per 1,000 central line-days.[3]

The rate of ventilator-associated pneumonia (VAP) is 0.77 per 1,000 ventilator-days, whereas the rate of catheter-associated urinary tract infections

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(CAUTIs) is 2.71 per 1,000 urine catheter days. The World Health Organization (WHO) conducted a systematic study to determine the prevalence of DA-HAIs in the intensive care units of low- and middle-income countries. There were 12.2 cases of CLABSI, 12.2 cases of CAUTI, and 23.9 cases of VAP for every 1,000 central line days, 1,000 urine catheter days, and 1,000 ventilator days, respectively.[4-6]

In prospective study by Azza et al in Turkey showed that 195 children admitted for ≥48 hours and 25 HAIs events has occurred in 16 children. There were 12.8 HAIs for every 100 admissions to the PICU and 15.6 HAIs for every 1000 PICU days. The only type of HAIs found were DAIs. Nosocomial infections occurred most frequently due to VAP (72%), then CLABSI (24%), and CAUTIs (4%). 25 different microbes were isolated during the research period.

Seven (28% of the total) of the 25 different microorganisms were Gram-positive and 17 (72%) were Gram-negative bacteria (GNB). Klebsiella spp., Acinetobacter spp., and Staphylococci spp. (each at 12%) were the most often isolated pathogens. Stenotrophomonas spp., Diphteroids spp., and the Streptococcus viridans group each accounted for 8%. VAP (44.4%), CLABSI (83%), and CAUTI (100%) were all caused by Klebsiella spp.[4]

In another retrospective study by Anwar ul Haq and others in Aga Khan Hospital, Karachi showed that out of total 1378 patients, 2.1% incidence of device associated infections (DAIs) occurred. Eighty-three percent of all DAIs were CLABSIs, 13.6 percent were VAPs, and 3.4 percent were CAUTIs (catheter-associated urinary tract infections).

Most DAIs were due to central line-associated bloodstream infections (7/1000 CVC days), followed by ventilator-associated pneumonia (1.17/1 000 VAP days) and catheter-associated urinary tract infections (0.24%/1000 UCD days). 71.4 percent of all isolates were gram-negative bacteria; 18 percent of DAIs were poly-microbial; 67 percent of isolates were multi-drug-resistant; and 38 percent of isolates were carbapenem-resistant. Overall mortality was 14.5 percent, with a case-specific death rate of 27 percent.[7]

Considering the above facts and the potential need to reduce the morbidity as well as mortality among the pediatric population through preventing the occurrence of HAIs caused by the device inserted must be targeted in the Lahore. So, this study is planned to have insight in to the matter and in turn to categorize the DAIs (VAP, CLABSI, and CAUTI).

METHODS

The research was carried out at the Fatima Memorial Hospital's Paediatric Intensive Care Unit in Lahore between January 10 and July 9, 2023 after ethical approval (FMH-25/10/2022-IRB-1141). Children as young as one month old and as old as twelve years old were enrolled in the study, for a total of 120 children. Children with PICU stays shorter than 48 hours were not included in the analysis. A sample of size 120 was selected using 95% confidence interval with 7% margin of error and 83% anticipated proportion of CA-UTI among DAIs.[7]

The demographic, admission diagnostic, daily clinical and laboratory data, risk factors for HAIs acquisition, outcomes of HAIs including length of stay (LOS) and mortality data of 120 paediatric patients who met the inclusion criteria were collected with the permission of the hospital administration. Data was recorded on the proforma containing basic demographic information along with diagnosis, mechanical ventilation, central line, urinary catheter and associated infections with information related to length of stay and outcome of the children.

Pediatric population was labeled as the children having age 1 month to 12 years. Case definitions from the CDC and the National Health Surveillance Network were used in the research.[8-9] Patients with pneumonia who have been using a ventilator for more than 2 days are considered to have ventilator-associated pneumonia (VAP). Image analysis, clinical signs, and laboratory tests all play roles in making the diagnosis.[10] A

new and persistent (>48 hours) or progressive radiographic infiltration, in addition to two of the following: fever of >38°C or 36°C, blood leucocyte count of >10,000 cells/ml or 5,000 cell/ml, purulent tracheal secretions are the criteria for the suspicion of VAP.[11-12]

CLABSI stands for central line associated blood stream infection. It is a bloodstream infection that has been proven by a laboratory and occurs when a central line (CL) or umbilical catheter has been in place for more than 2 calendar days and the line was also in place on the day of the incident or the day before.[13] The same organism must be recovered in both the blood culture and the catheter tip quantitative (>15 colony forming units) culture (paired quantitative culture) for this to be considered a true positive.[14]

Infections of the urinary tract caused by catheters are referred to as catheter-associated urinary tract infections (CAUTI). A CAUTI is a urinary tract infection that is proven by a urine culture and sensitivity test and occurs when an indwelling urinary catheter has been in place for more than 2 calendar days and an indwelling UC was in place on the day of the event or the day before.[13] The results were classified as in-hospital days, paediatric intensive care unit days, transfers, lamas, home discharges, and fatalities.

SPSS v25 was used to input and analyse the data. All of the variables were subjected to a descriptive analysis. Quantitative data were reported as mean (SD) or median (interquartile range) based on their distribution, whereas qualitative variables were provided as frequency and percentages. The correlation between socio-demographic variables and DAIs was examined using the Chi-square test and the independent t-test. Statistical significance was assumed when the p-value was less than 0.05. Using stratification, we were able to regulate for potential moderators of the effects, such as age and gender. Chi-square/Independent t-tests were performed after stratification, with a p-value 0.05 indicating statistical significance.

RESULTS

Total 120 children admitted at PICU having age 1 month to 12 years who stayed in PICU for ≥48 hours were included in study. Gender distribution showed that, 77(64.2%) were males and 43(35.8%) were females. The mean age of the children was 26.6±31.95 months. According to age distribution, 109(90.8%) of the children had ages ≤72 months, while 11(9.2%) had ages >72 months.

The mean stay in PICU was 4.82±4.19 days and mean stay in hospital was 5.98±4.08 days. Among 120 children, 21(17.5%) were on ventilator and among them, 11(52.4%) had ventilator associated pneumonia, 14(11.7%) had CVL and 10(8.3%) had BSI and among them, 5(50.0%) had CVL associated BSI, while 22(18.3%) had catheter insertion and among them, 6(27.3%) had CA-UTI. According to outcome of children, 20(16.7%) discharged home, 90(75.0%) discharged to ward, 9(7.5%) expired and 1(0.8%) had LAMA.

According to stratification of ventilator associated pneumonia, CVL associated BSI and CA-UTI with respect to gender and age, insignificant difference was observed (p>0.05). According to stratification of stay in PICU and hospital stay with respect to gender and age, insignificant difference was observed (p>0.05).

Gender	Frequency	Percent
Male	77	64.2
Female	43	35.8
Age Groups		
≤72 months	109	90.8
>72 months	11	9.2
Oxygen Requirement		
Yes	71	59.2
No	49	40.8
Ventilated or not		
Not ventilated	99	82.5
Ventilated in PICU FMH	21	17.5
Ventilator Associated Pneumonia (VAP)		
Yes	11	52.4
No	10	47.6
VAP Organism		
E. coli	2	18.2
Klebsiella	2	18.2
Acinobacter	1	9.1
Enterobacter	4	36.3
Pseudomonas auroginosa	2	18.2
Central Venous Line (CVL)		
Yes	14	11.7
No	106	88.3
Site of CVL		
Femoral	12	85.7
Subclavian	2	14.3

Table-I. Frequency distribution of demographic variables

Blood Stream Infection (BSI)	Frequency	Percent
Yes	10	8.3
No	110	91.7
BSI organism		
Klebsiella	1	10.0
Salmonella typhi	9	90.0
CVL associated BSI		
Yes	5	50.0
No	5	50.0
CVL associated BSI organism		
E. coli	4	80.0
Klebsiella	1	20.0
Urinary catheter inserted		
Yes	22	18.3
No	98	81.7
Urinary catheter related UTI		
Yes	6	27.3
No	16	72.7
CA-UTI organism		
E. coli	4	66.7
Klebsiella	2	33.3
Outcome of patient		
Discharged home	20	16.7
Discharged to ward	90	75.0
Expired	9	7.5
LAMA	1	0.8

Table-I. cont'd

	Age in Months	Length of Stay in PICU (days)	Length of Stay in Hospital (days)	Number of Days of Ventilation	Number of Days of CVL Insertion
Mean	26.58	4.82	5.98	0.98	0.65
Std. Deviation	31.95	4.19	4.08	3.40	3.07
Minimum	1	1	1	0	0
Maximum	144	38	38	32	31

Table-II. Mean values of different variables

Variables		Ventilator Assisted Pneumonia (VAP)		P-Value
		Yes	No	
Gender	Male	10(76.9%)	3(23.1%)	0.054
	Female	1(12.5%)	7(87.5%)	
Age groups	≤72 months	9(50.0%)	9(50.0%)	0.059
	>72 months	2(66.7%)	1(33.3%)	

Table-III. Stratification of ventilator assisted pneumonia (VAP) with respect to gender and age

Variables		CVL Assisted BSI		P-Value
		Yes	No	
Gender	Male	4(30.8%)	9(59.2%)	0.281
	Female	1(11.1%)	8(88.9%)	
Age groups	≤72 months	4(21.1%)	15(78.9%)	0.637
	>72 months	1(33.3%)	2(66.7%)	

Table-IV. Stratification of CVL assisted BSI with respect to gender and age

Variables		CA-UTI		P-Value
		Yes	No	
Gender	Male	4(30.8%)	9(69.2%)	0.658
	Female	2(22.2%)	7(77.8%)	
Age groups	≤72 months	6(33.3%)	12(66.7%)	0.176
	>72 months	0(0.0%)	4(100.0%)	

Table-V. Stratification of CA-UTI with respect to gender and age

Variables		Outcome of Patients				P-Value
		Discharged Home	Discharged to Ward	Expired	LAMA	
Gender	Male	9 (11.7%)	61 (79.2%)	6 (7.8%)	1 (1.3%)	0.232
	Female	11 (25.6%)	29 (67.4%)	3 (7.0%)	0 (0.0%)	
Age groups	≤72 months	16 (14.7%)	84 (77.1%)	8 (7.3%)	1 (0.9%)	0.304
	>72 months	4 (36.4%)	6 (54.5%)	1 (9.1%)	0 (0.0%)	

Table-VI. Stratification of outcome of patients with respect to gender and age

Outcomes	Gender	n	Mean	Std. Deviation	P-Value
Length of stay in PICU (days)	Male	77	4.85	2.89	0.918
	Female	43	4.77	5.89	
Length of stay in hospital (days)	Male	77	5.95	2.72	0.900
	Female	43	6.05	5.81	

Table-VII. Stratification of length of PICU and hospital stay with respect to gender

Outcomes	Age groups	n	Mean	Std. Deviation	P-Value
Length of stay in PICU (days)	≤72 months	109	4.77	4.35	0.654
	>72 months	11	5.36	2.11	
Length of stay in hospital (days)	≤72 months	109	5.94	4.23	0.690
	>72 months	11	6.45	2.12	

Table-VIII. Stratification of length of PICU and hospital stay with respect to age

HAIs		Outcome of patients				P-Value
		Discharged Home	Discharged to Ward	Expired	LAMA	
VAP	Yes	2(18.2%)	4(36.4%)	5(45.5%)	0(0.0%)	0.232
	No	0(0.0%)	6(60.0%)	4(40.0%)	0(0.0%)	
CLABSI	Yes	0(0.0%)	3(60.0%)	2(40.0%)	0(0.0%)	0.304
	No	0(0.0%)	14(82.4%)	3(17.6%)	0(0.0%)	
CAUTI	Yes	0(0.0%)	3(50.0%)	3(50.0%)	0(0.0%)	0.333
	No	2(12.5%)	10(62.5%)	4(25.0%)	0(0.0%)	

Table-IX. Comparison of outcome of patients with HAIs

Outcomes	VAP	n	Mean	Std. Deviation	P-Value
Length of stay in PICU (days)	Yes	11	13.0	8.74	0.001
	No	10	4.2	1.97	
Length of stay in hospital (days)	Yes	11	13.6	8.50	0.001
	No	10	5.2	2.66	

Table-X. Comparison of length of PICU and hospital stay with VAP

Outcomes	CLABSI	n	Mean	Std. Deviation	P-Value
Length of stay in PICU (days)	Yes	5	15.6	12.97	0.001
	No	17	5.5	2.99	
Length of stay in hospital (days)	Yes	5	16.2	12.66	0.001
	No	17	6.7	3.1	

Table-XI. Comparison of length of PICU and hospital stay with CLABSI

Outcomes	CAUTI	n	Mean	Std. Deviation	P-Value
Length of stay in PICU (days)	Yes	6	10.4	14.19	0.001
	No	16	6.4	3.48	
Length of stay in hospital (days)	Yes	6	11.2	13.76	0.001
	No	16	7.3	3.44	

Table-XII. Comparison of length of PICU and hospital stay with CAUTI

DISCUSSION

Health care-associated infections (HAIs) affect more children in underdeveloped countries than they do in industrialized nations. HAIs continue to be a leading cause of morbidity and mortality in the paediatric critical care unit, despite recent improvements in the field. The incidence of HAIs is highest in the intensive care units and the operating rooms, and lowest in the medical wards.[15] Active surveillance for HAIs is an important part of infection management in the PICU and might lead to better patient outcomes. There is a wealth of information on the epidemiology of HAIs in the PICU from developed nations, but much less is known about the situation in developing nations like Pakistan.

While our PICU's HAI incidence (18.4%) was greater than that reported from affluent nations like the United States, it was not higher than that recorded from PICUs in poor countries like Mexico, Brazil, or Egypt.[16-18] Research conducted on 61 paediatric intensive care units in the United States between 1992 and 1997 found HAI rates of 6.1 per 100 patients and 14.1 per 1,000 patient-days.[19] HAI rates in 35 American paediatric intensive care units were 11.9% higher than the national average.[20] The prevalence research included 17 hospitals in Europe and found that the PICU HAI rate was 23.6%.[21]

When compared to a research conducted in Spanish PICUs, our prevalence is lower (29.8%).[22] The total HAI rate in Turkey was found to be 37% by a countrywide point-prevalence survey study of 50 PICUs.[23] In critically sick patients, HAIs are most commonly linked to the insertion of invasive medical equipment. According to research conducted by Richards et al., 91% of BSIs, 95% of episodes of nosocomial pneumonia, and 77% of HA-UTIs all occurred in patients who had central intravenous lines, ventilators, or urine catheters,

respectively, in 61 US PICUs.[24]

In this research, VAP was shown to be the most prevalent HAI (52.4%). HAIs in PICUs are most commonly caused by BSIs (28%), pneumonia (21%), and UTIs (15%) in the United States.[19] In a point-prevalence research including 50 PICUs across Turkey, Kepenekli et al. found that pneumonia (55%) was the most prevalent HAI, followed by BSIs (27%) and UTIs (7%).[23] The relative prevalence of various HAI categories may shift depending on hospital context, patient group, and service area.

In this research, among 120 children, 21(17.5%) were on ventilator and among them, 11(52.4%) had ventilator associated pneumonia, 14(11.7%) had CVL and 10(8.3%) had BSI and among them, 5(50.0%) had CVL associated BSI, while 22(18.3%) had catheter insertion and among them, 6(27.3%) had CA-UTI. According to outcome of children, 20(16.7%) discharged home, 90(75.0%) discharged to ward, 9(7.5%) expired and 1(0.8%) had LAMA.

Leblebicioglu H et al. published their findings of INICC in Turkish ICUs between 2003 and 2012. Their rates of CLABSI (11.1 per 1000 CLD), VAP (21.4 per 1000 VD), and CAUTI (7.5 per 1000 UCD) were also higher than the national average. The rates of DAI in Turkish ICUs were greater than those seen in the Global INICC Report and the U.S. NHSN. As with the United States' NHSN and INICC, the rates of antibiotic resistance seen in their ICUs were significantly higher. Overcrowding in hospitals, inadequate medical supplies, obsolete medical equipment, and a shortage of qualified nurses were cited as the causes of these rates.[25]

The incidence of DAI was studied by Salomao R et al. in the Brazilian PICU. Their rate of DAI per 1000 days in the ICU was 29.8. The rates of CLABSI (9.1 per 1000 CLD), VAP (20.9) per 1000 VD, and CAUTI (9.6 per 1000 UCD) were also device-specific. Due to a lack of legislation governing the execution of infection control programmes, noncompliance with infection control bundles, a deficiency in infection control surveillance, and an insufficient number of nurses per patient, they approved of these high rates.[26]

CONCLUSION

To lessen the impact of healthcare-associated infections (HAIs) on high-risk populations in developing nations, vigilant surveillance is crucial. Patient mortality and morbidity are significantly elevated due to HAIs.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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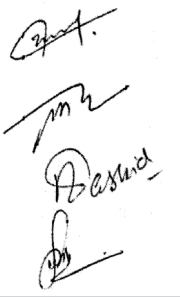
1	Aaveza Nazir	Study conception and design, Data collection, Data analysis, discussion writing, manuscript preparation.	
2	Abid Rafiq Ch.	Study conception and design, data analysis interpretation of results, review of article.	
3	Muhammad Rashid Ayub	Review of article.	
4	Muhammad Usman	Review of article.	