Original Article

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Healthcare Associated Infection in Paediatric Intensive Care Unit-A Tertiary Care Hospital Experience

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ABSTRACT

Introduction: Healthcare Associated Infections (HAI) are those that are acquired in a health care setting or one that is acquired in the hospital environment by a patient who had been admitted to the hospital for a different reason. The HAI are one of a cause of increased morbidity and mortality of hospitalised patients, especially the ones admitted to an Intensive Care Unit (ICU). The study of incidence of HAI in the ICU of tertiary hospitals has been conducted previously with significant results but there is a lack of data exist regarding HAI in the Paediatric Intensive Care Unit (PICU). Hence a study was conducted in the PICU of a tertiary care hospital to estimate the incidence of HAI and study the clinical and microbiological profile, so as to acquire knowledge regarding the prevailing conditions in the PICU. The knowledge thus, obtained may then be applied in lowering the further incidence of HAI and serve to establish better patient care services.

Aim: To estimate the incidence of HAI in the PICU of a tertiary care hospital and to study the clinical, microbiological profile and analyse the same to understand the probable risk factors involved, thereby developing effective infection control measures and strategies.

Materials and Methods: A prospective, descriptive, observational study was conducted in the PICU of a tertiary care hospital over a period of one year (August 2013 to July 2014). The present study included children of the age group between 1 month and 12 years admitted in the PICU, who were suspected to have acquired HAI during the hospital stay. Relative frequencies of known risk factors like age, anaemia, malnutrition, and duration of PICU stay were studied in these patients. Microbiological culture and antimicrobial sensitivity were done by using standard techniques in the microbiological laboratory.

Results: During the study period, out of the 588 patients admitted to PICU, a total of 68 (11.56%) developed one or more HAIs. It was found that the clinical outcome of the patients with HAI did not have any statistically significant relationship to the parameters such as age or sex distribution, nutritional status, degree of anaemia, duration of hospital stay or the site of HAI. But highly significant correlation was established between the duration of mechanical ventilation of a patient and reintubation with the clinical outcome of the patient. The most common HAI identified in the PICU was vascular site infection, identified in 41 patients, contributing to more than half (53%) of all the HAI. This was followed by ventilator related infections in 13 patients (17%), primary blood stream infections in 12 patients (16%) and the others that occurred in minor frequencies included those of the skin, pneumonias, infections of the urinary tract and surgical site. The most common microorganism isolated from the patients with HAI in the PICU was *Klebsiella* species. The antibiotic to which majority of microbial isolates including *Klebsiella* were sensitive was Amikacin.

Conclusion: It is recommended to follow strict hand hygiene and aseptic precautions during intravascular catheterisation procedures. The antibiotic Amikacin may be considered in the empirical treatment of suspected HAI while culture reports are being awaited. The challenges for the future are to minimize HAI in the PICU and ensure better clinical outcome for all.

Keywords: Anaemia, Antimicrobial sensitivity, Hospital acquired, Nosocomial

INTRODUCTION

Centres for Disease Control and Prevention (CDC) defines HAI as "a localised or systemic condition resulting from an adverse reaction to the presence of an infectious agent(s) or its toxin(s) that was not present on admission to the acute care facility" [1]. In the ICU setting, HAI are those that occur after a period of 2 days of admission to the ICU or within a period of 2 days after transfer from the ICU [1]. HAI can result in major complications, specifically in very sick patients. The magnitude of this entity is highest in the setting of PICU [2]. PICU patients are at an increased risk of developing HAI due to the severity of their illness and the relatively compromised immunological state [3]. The use of life support equipment and placement of several monitors including the invasive equipments also add to the risk [4]. HAI result in increased mortality of patients in the concerned health care facility. They also lead to increased morbidity, thereby affecting the quality of life of the infected patient. It prolongs the hospital stay and increases the health care cost, thereby overburdening the national economy [5,6]. Studies conducted world wide have demonstrated that HAI are largely preventable. Practise of recommended protocols for patient care will result in improved health care and better clinical outcome. Although, this study has been conducted world wide the proportion of the number of participating hospitals out of the total number is quite less. This ratio is even lessor in developing countries, India being one among the list. There haven't been many of its kind prior to this. Hence survey regarding such infections will lead to better understanding towards HAI, thereby enable us to provide adequate infection control measures and reduce the incidence of HAI in the future [7]. Thus, the present study aim to estimate the incidence of nosocomial infections in the PICU of a tertiary care hospital and establish the clinical and microbiological profile.

MATERIALS AND METHODS

This Prospective, observational study was conducted in the PICU of a tertiary care referral hospital in Tamil Nadu, India for a period of one year (August 2013 to July 2014). Ethical clearance for the study was obtained from the Institutional Ethical Committee. The study included children of the age group between 1 month and 12 years,

admitted in the PICU, who were suspected to have acquired HAI, after a period of 2 days of admission to the PICU or within a period of 2 days after transfer from the PICU. Patients were suspected to have developed HAI if they had unexplained fever (>38ºC), leukocytosis (>12000/mm^3 or leukopenia <4000/mm^3), purulent sputum of new onset, worsening cough, rales or bronchial breath sounds, worsening gas exchange, new infiltrates on chest X-Ray, persistent tracheal aspirates or secretions, turbid urine, supra pubic or costovertebral angle tenderness, urgency or frequency of urination, dysuria, thrombophlebitis, purulent discharge from wound or surgical site with localised redness, tenderness or swelling of wound edges [1]. Those having fever prior to admission to the PICU, or any other clinical features of infection secondarily acquired in the wards prior to transfer to the PICU were excluded from the study. Informed written consent was obtained from the parent of children included in the present study. Detailed history and clinical examination of all the patients taken up for the study were done at the time of admission to the PICU. Routine laboratory investigations done for all PICU patients included complete blood count, X-ray chest, renal function test, liver function test, urine examination and blood culture and sensitivity. Relative frequencies of known risk factors like age, anaemia, malnutrition, and duration of PICU stay were studied in patients who developed HAI. Detailed clinical examination of all patients taken up for the study was done on a daily basis. Specific site related investigations that were done as applicable to the individual case included the following: Blood culture and sensitivity whenever the clinical picture of the patient suggested the possibility of acquisition of HAI, culture and sensitivity of sputum samples, tracheal aspirate and swabs obtained from endotracheal suction catheter tips, culture and sensitivity of urine samples obtained from urinary catheters or midstream clean catch specimen and culture and sensitivity of appropriate samples relevant to the clinical symptoms like swabs taken from the infected surgical or other wound sites along with simultaneous blood culture. Meticulous care was taken to maintain strict asepsis during the procedures for collection of blood and other specimen. Microbiological culture and antimicrobial sensitivity were done by using standard techniques in the microbiological laboratory at the hospital.

STATISTICAL ANALYSIS

The collected data were analysed with SPSS 16.0 version. To describe about the data, descriptive statistics, frequency analysis, percentage analysis were used for categorical variables and for continuous variables the mean and S.D were used. To find the significant difference between the bivariate samples in independent groups, the Independent t-test was used. To find the significance in categorical data, Chi-Square test was used. In all the above statistical tools, the probability value of <0.05 was considered as significant level.

RESULTS

During the one year study period, all PICU admissions complying with the inclusion criteria accounting to a total of 588 children were included in the present study. Among these 588 children, 68 (11.56%) developed one or more HAI. Of the 68 patients with HAI, eight had more than one site HAI including one patient who had three different site infections, contributing to a total of 77 sites HAI. The salient findings from the present study are as follows.

Vascular site infection was seen in 41 (53%) patients, ventilator associated event in 13 (17%) patients, blood stream infection in 12 (16%) patients, skin infection in 5 (6%) patients, pneumonia in 3 (4%) patients, urinary tract infection in 2 (3%) patients and surgical site infection in 1 (1%) patient. The study revealed that the most prevalent HAI in this hospital were the vascular site infections, contributing to more than half (53%) of all the HAI. Hence, it is recommended to follow strict hand hygiene and aseptic precautions during intravascular catheterisation procedures to control and prevent the further occurrence of HAI in the PICU [8].

Of the study population, 34 (50%) patients were on mechanical ventilation. The clinical outcome of the patients on mechanical ventilation was studied [Table/Fig-1]. The correlation between mechanical ventilation and clinical outcome was found to be of high statistical significance with p-value of 0.002.

		Total number of patients (n=68)		p-value
		Ventilated (n=34)	Not ventilated (n=34)	
Clinical outcome	Death	12 (85.7%)	2 (14.3%)	0.002
	Discharge	22 (40.7%)	32 (59.3%)	

[Table/Fig-1]: Correlation of mechanical ventilation and clinical outcome. Significant at p≤0.05

Of the 13 patients with ventilator associated event, 9 (69%) had been reintubated one or more times while the remaining 4 (31%) had not been intubated more than once. *Klebsiella* was found to be the major isolate in tracheal aspirate as well as blood, amounting to 18 out of 35 culture positive isolates (51%) [Table/Fig-2]. This was followed by Coagulase Negative Staphylococcus (CoNS)–8 isolates (22%) and *Acinetobacter*-3 isolates (9%), *Staphylococcus aureus*–2 isolates (6%), Enterococci-2 isolates (6%), *Escherichia coli*-1 isolate (3%) and *Pseudomonas*-1 isolate (3%). From the culture sensitivity reports obtained from the microbiological laboratory, *Klebsiella* was found to be highly sensitive to Amikacin (15 out of 18 isolates, 83%) and Imipenam (16 out of 18 isolates, 89%), followed by Ciprofloxacin (12 out of 18 isolates, 67%), Ceftazidime (8 out of 18 isolates, 44%), and Gentamycin (8 out of 18 isolates, 44%). CoNS was also found to be highly sensitive to Amikacin (7 out of 8 isolates, 88%), followed by Gentamycin (6 out of 8 isolates, 75%) and Vancomycin (6 out of 8 isolates, 75%) [Table/Fig-3]. The other sensitive antibiotics for CONS included Ciprofloxacin (5 out of 8 isolates, 63%), Cefotaxime (2 out of 8 isolates, 25%), Cephalexin (1 out of 8 isolates, 13%), Cotrimoxazole (1 out of 8 isolates, 13%) and Erythromycin (1 out of 8 isolates, 13%). The other microorganisms isolated including *Acinetobacter, Staphylococcus aureus, Enterococci*, *E. coli* and *Pseudomonas* were also found to be sensitive to Amikacin.

Of the 68 (11.56%) patients with HAI, distribution based on age and sex were analysed and the mean age of the study population was calculated to be 2.01years. Of these, 26 (38%) were female and 42 (62%) were male children, the male:female ratio being 3:2. According to the IAP classification of nutritional status, the study population were categorised into 4 grades [9]. About 22 children

S.No	Microorganism	Tracheal aspirate	Blood	Urine	Surgical site	Vascular site	Skin	Total
1	*Klebsiella*	11	7	-	-	-	-	18
2	CoNS	3	4	-	1	-	-	8
3	*Acinetobacter*	1	2	-	-	-	-	3
4	*S. aureus*	1	-	1	-	-	-	2
5	Enterococci	1	-	1	-	-	-	2
6	*E. coli*	1	-	-	-	-	-	1
7	*Pseudomonas*	1	-	-	-	-	-	1

[Table/Fig-2]: List of microorganisms isolated according to the site of infection.
CoNS-Coagulase-negative staphylococci; *S. aureus-Staphylococcus aureus; E. coli- Escherichia coli*

Antibiotic	*Klebsiella* (n=18)		CoNS (n=8)		*Acinetobacter* (n=3)	
	No.	%	No.	%	No.	%
Amikacin	15	83	7	88	2	67
Amoxyclav	2	11	-	-	1	33
Ampicillin	-	-	1	13	-	-
Bacitracin	-	-	-	-	1	33
Ciprofloxacin	12	67	5	63	3	100
Cefotaxime	-	-	2	25	-	-
Cephalexin	-	-	1	13	-	-
Ceftazidime	8	44	-	-	-	-
Cotrimoxazole	-	-	1	13	1	33
Erythromycin	-	-	1	13	-	-
Gentamycin	8	44	6	75	2	67
Imipenam	16	89	-	-	-	-
Norfloxacin	-	-	-	-	-	-
Vancomycin	-	-	6	75	-	-

[Table/Fig-3]: Antibiotic sensitivity pattern.
CoNS-Coagulase-negative staphylococci

(32%) were of normal nutritional status. Of the remaining, 18 children (27%) were in Grade 2, 13 children (19%) in Grade 1, 10 children (15%) in Grade 3 and 5 children (7%) in Grade 4 malnutrition. The presence or absence of anaemia was also evaluated and further grading of anaemic children was done as per WHO guidelines [10]. Of the 68 patients, 10 (14.7%) had no anaemia and the remaining anaemic population were categorised into three grades according to the severity of anaemia as mild, moderate or severe anaemia. Of these, 42 (61.7%) had moderate anaemia, followed by 14 (20.6%) with mild anaemia and 2 (3%) with severe anaemia.

On analysing the primary disease condition, it was found that the majority of these HAI patients had been admitted to the PICU for primary respiratory cause 30 (44%) patients, followed by CNS disorders-15 (22%), congenital heart diseases 4 (6%), viral haemorrhagic fever 4 (6%), renal condition 2 (3%), diarrhoea 2 (3%) and road traffic accident 2 (3%). The remaining 9 (13%) patients had their own individual diagnosis that was not included in any of the aforesaid disease groups. On analysis of the duration of PICU stay, 47 (69%) patients stayed for over seven days, while the remaining 21 (31%) patients had PICU stay of less than seven days.

With regard to the clinical outcome, mortality was reported in 14 (21%) patients while 51 (75%) got improved and later discharged from the ward. Of the remaining patients, 2 (3%) were discharged against medical advice and 1(1%) patient was referred to higher centre for speciality management.

The various parameters of the study population have been compared with the clinical outcome for the same. The outcome has been discussed in terms of either mortality or discharge from the hospital. The results and the statistical analysis for the same are as follows.

From the study it was found that the clinical outcome of the patients with HAI did not have any statistically significant relationship to the parameters such as age (p-value 0.579) or sex distribution (p-value 0.146), nutritional status (p-value 0.177), degree of anaemia (p-value 0.701), duration of hospital stay (p-value 0.591) or the site of the nosocomial infection (p-value 0.177). But highly significant correlation was established between mechanical ventilation and the clinical outcome of the patient (p-value 0.002) as well as reintubation and the clinical outcome of the patient (p-value 0.026) [Table/Fig-1,4].

Group		Outcome		p-value
		Death (n=14)	Discharge (n=54)	
Sex	Female	3 (21.4%)	23 (42.6%)	0.146
	Male	11 (78.6%)	31 (57.4%)	
Nutritional status	I	1 (7.1%)	12 (22.2%)	0.177
	II	3 (21.4%)	15 (27.8%)	
	III	2 (14.3%)	8 (14.8%)	
	IV	3 (21.4%)	2 (3.7%)	
	Normal	5 (35.7%)	17 (31.5%)	
Anaemia	No	2 (14.3%)	8 (14.8%)	0.701
	Mild	2 (14.3%)	12 (22.2%)	
	Moderate	9 (64.3%)	33 (61.1%)	
	Severe	1 (7.1%)	1 (1.9%)	
Age range	<1 year	8 (57.1%)	33 (61.1%)	0.579
	1 to 5 years	5 (35.7%)	13 (24.1%)	
	Above 5 years	1 (7.1%)	8 (14.8%)	
Reintubation	No	9 (64.3%)	48 (88.9%)	0.026
	Yes	5 (35.7%)	6 (11.1%)	
Site of NI	BSI	2 (14.3%)	10 (18.5%)	0.177
	PNEU	1 (7.1%)	2 (3.7%)	
	SSI	0 (0%)	1 (1.9%)	
	UTI	0 (0%)	1 (1.9%)	
	VAE	0 (0%)	5 (9.3%)	
	VAE/SKIN	3 (21.4%)	2 (3.7%)	
	VAE/VASC	1 (7.1%)	2 (3.7%)	
	VASC	7 (50%)	31 (57.4%)	

[Table/Fig-4]: Correlation of various parameters with clinical outcome and statistical analysis.
NI-Nosocomial infection; BSI-Blood stream infection; PNEU-*Pneumonia*; SSI-Surgical site infection; UTI-Urinary tract infection; VAE-Ventilator associated event; VASC-Vascular site infection
Significant at p≤0.05

DISCUSSION

The knowledge of prevalence of HAI in a hospital is the most essential in planning appropriate preventive strategies in that particular hospital. This information also stays as a baseline value for future comparison of results following any interventions taken in this regard. While present study showed the incidence of HAI as 11.56%, a similar study conducted by Deep A et al., of T.N. Medical College and BYL Nair Hospital of Mumbai revealed the rate of nosocomial infections as 27.3% with an incidence of 16.2 per 100 patient days [6]. Another such study conducted in a developing nation by Abramczyk ML et al., showed an incidence of HAI about 18.3% [11]. El-Nawawy AA et al., has reported from Alexandria an incidence of 23% in their PICU [12]. A survey for nosocomial infection conducted by WHO in 14 countries (Europe, Eastern Mediterranean, South-East Asia and Western Pacific) including a total of 55 hospitals showed an average of 8.7% hospital patients acquiring nosocomial infections [13].

As seen from the present study, the maximum number of patients who developed HAI in the PICU were in the age group of 1 month to 1 year (41/68 patients). This higher incidence of HAI observed in the infant population, also supported by WHO publication on Prevention of hospital acquired infections [13]. The sex distribution of the study population is also comparable to a study conducted by Patra PK et al., showing boys:girls ratio of 1.9:1 [14].

The higher incidence of HAI in malnourished children seen in the present study also corroborates with the study by Deep A et al., [6]. From their study it was found that 64.2% of malnourished patients developed nosocomial infection compared to 52.8% in normally nourished (p<0.05). Also, maximum patients who developed HAI belonged to grade IV malnutrition of IAP classification. In present study, we analysed the duration of stay for the study population and found that higher incidence (69%) of HAI was seen in patients with a longer PICU stay, of more than a week. This is also in accordance with the study done by Urrea M et al., [15], reporting duration of hospitalisation for patients with and without infection as 22.5 and

9 days respectively (p<0.001). This could be explained by the fact when the period of hospital stay is prolonged; the contact between the patient and the health care system is also correspondingly extended, exposing the susceptible sick patient to the environmental pathogens for longer time periods, further investigative or therapeutic interventional procedures leading to higher incidence of HAI [15].

Of more importance in the present study is the various sites involved in HAI. Various previous studies have reported their findings which have been shown to be unique to the study. While vascular site infection was the most common in the present study, bronchopneumonia (31.6%) was the commonest HAI in a study by Abramczyk ML et al., and Bloodstream infections were the leading pattern (45.4%) in a study by Folgori L et al., [11,16]. Hence the importance in establishing one's own pattern of HAI with regard to the site of infection, thereby planning the necessary management activity is required.

Hence, from the study it is reported that longer the duration of mechanical ventilation, poorer is the clinical outcome for the patient. When the correlation between reintubation and the clinical outcome was analysed, it was also found to be of high statistical significance (p-value 0.026). There are other studies that have reported similar statistical significance of reintubation as a risk factor in developing ventilator associated respiratory complications. This includes the study conducted by Deep A et al., and that of Patra PK et al., [6,14].

The percentage of microbial isolation has been different in various studies. Despite the fact that each hospital has its own unique locally prevalent organism, Gram-negative bacteria as the most common isolate was also reported by another study conducted by Abramczyk ML et al., [11]. In a study by Singhi S et al., Gram negative organisms were the predominant isolates; commonest being Klebsiella pneumonia (20.1%), followed by *Enterobacter* species (16.6%) and *Acinetobacter* species (8.6%) [17]. Also, in a study by Deep A et al., *Klebsiella* was the major isolate [6].

As mentioned earlier, Amikacin has been found to be one antibiotic that is effective against most of the organisms isolated from patients with HAI in this hospital. Similar antibiotic sensitivity was also found in a study by Deep A et al., documenting the most common isolate *klebsiella* showing maximum sensitivity to Amikacin [6]. In today's world, despite enormous progress in the field of public health and hospital care, HAI continue to develop in hospitalised patients leading to compromised quality of life for the patient and additional financial burden for the family [18-20].

LIMITATION

Surveillance was not performed in the PICU environment or among health care workers to identify the probable exogenous source leading to such infections. Also, the effect of HAI on costs for PICU patients, the added economic burden to the family and the impact of HAI on cost of health care were not estimated.

CONCLUSION

HAI continue to remain a major threat to hospitalised patients because of the compromised quality of life and added financial burden. Also, prolonged hospital stay and added investigative or invasive procedures deplete the available hospital resources. HAI vary widely in their demographic characteristics, clinical and microbiological profile emphasising the need for institution based studies to lower their incidence and establish better patient care services.

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