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Research Article

Multidrug-resistant Hospital-associated Infections in pediatric intensive care units

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ABSTRACT:
Background. The enormous burden that multi-drug resistant hospital acquired infection (MDR- HAI) lay on the lives in pediatric intensive care unit (PICU) in developing countries is scarcely studied. The present study was conducted to assess the incidence, epidemiological profile, underlying risk factors and outcome of children in PICU infected with MDR- HAI
Methods. This is a prospective cohort study conducted in 2 pediatric intensive care units in Cairo University Pediatric hospital. The study was conducted from 1st January 2015 to 1st of January 2016. All children who developed HAI defined, according to the CDC were included in the study.
ResultsThe present study encompassed 378 patient admitted to the intensive care over a period of twelve months. 57 patients developed 106 episodes of infection, making the incidence of HAI 28%.
Ages were between 1- 144 months. (56.1%) were males while 25 (43.0%) were females.
The number of infection episodes was 106 (range 1 – 7, with mean ± SD 1.6 – 1.1). 98 were MDR infections, while 8 were non-MDR organisms. The incidence of MDR-HAI was 92.45%
Infection with gram negative strains occurred in 89 (83.9%) of cases, while gram positive infections occurred in 17 (16.19%) cases. *Acinetobacter spp* (26.4%), and *Pseudomonas spp* (25.5%) were the most common gram negative infections. VAP occurred in 55 cases (51.9%), BSI occurred in 17 (16.0%) cases, while CLBSI occurred in 16 (15.2%), HAP in 7 (6.6%) surgical wound infection in 5 (4.7%), CRUTI in 4 (3.8%) and VP shunt infection in 2 (1.9%) .The insertion of ETT was statistically significant for the development of MDR-HAI (P value 0.049). *Klebsiella* was significantly related to non-MDR infection (p value < 0.001)
Conclusion: The incidence rate of MDR-HAI was alarming with high mortality rate. Gram negative bacteria were the most common organisms causing the infection with VAP being the most commonly prevalent. The insertion of ETT was a risk factor for MDR-HAI. The presence of malnutrition associated with MDR-HAI heralded mortality.

Keywords MDR, HAI, PICU, VAP, BSI, CRUTI

INTRODUCTION
Hospital-acquired infections (HAI) are a frequent problem, particularly in Intensive Care Units (ICU).
Sick children in Pediatric ICU (PICU) have more complexity with disease severity, longer hospital stay, compromised immunity and instrumentation which render children in intensive care more vulnerable to HAI.
The ICU population has one of the highest occurrence rates of (nosocomial) infections (20-30% of all ICU admissions. (Hanberger et al, 2009)
In the ICU antibiotic use is extensive, resulting in selective pressure for antibiotic-resistant pathogens. Antibiotic resistance is not a new phenomenon. Bacteria are capable of surviving in an environment containing antibiotics by the expression of one or more of many different potential antibiotic resistance mechanisms (Bradley JS et al 2011).

Among HAI, multidrug-resistance (MDR) bacteria pose an emerging threat worldwide in hospitalized children. (Ho, 2003). Due to this ongoing resistance to infections the ICU is considered the epicentre of infection and resistance (Brusselaers et al 2011).

The occurrence of infection and MDR causes substantial clinical and economic burden and boosts the deleterious impact of nosocomial infection. Salgado et al, 2005

Most studies on HAI are conducted in developed countries and on adult intensive care units, while data on hospital acquired MDR bacteria in pediatric intensive care units in developing countries is scarce.

In this study, we investigated the epidemiological profile of HAIs in a PICU in Egyptian tertiary care teaching hospital and the risk factors associated with these infections.

Methodology.

This study was conducted in two pediatric intensive care units (PICU) in Cairo University Pediatric hospital from 1st January to 1st December. This hospital is a tertiary teaching hospital located in the capital city with referral from all over the country.

The 2 PICU units consist of 28 beds in open ward design receiving medical and surgical patients.

Study design

This is a cross sectional prospective study to assess the incidence and risk factors for the development of MDR in PICU patients. All patients admitted to the unit are included in this study, those who developed infections after 48 hours of admission were considered eligible for the study and cases were classified as HAI - MDR as cases, while HAI-non MDR as controls.

Infection control practice in the unit:

Hand hygiene was supervised by infection control team in the hospital. Gloves are worn upon contact with body secretions. Alcohol–based hand gel is present at the point of care of each patient separately.

VAP bundle was maintained as semi recumbent position, oral antiseptics use, orotracheal intubation, stress ulcer drugs are used when needed, change of patients circuits when visibly soiled, and suctioning of respiratory secretions was on demand. (Coffin et al, 2008)

Data analysis

Medical charts of the patient were studied to evaluate demographic data as age and sex. Medical data were collected as underlying disease, length of hospital stay, prior intake of antibiotics, nutritional state, immunological state, and invasive devices inserted.

Microbiological methods

All microbiological specimens were submitted to the microbiology laboratory of the specialized pediatric Cairo university hospital. All specimens were inoculated on blood agar, chocolate agar, Maconkey agar. All plates were incubated overnight at 35 c and chocolate agar plates were incubated in 5% candle jar. The isolated organisms were identified by standard microbiological techniques.

Detailed susceptibility analysis was carried out by the disc diffusion method according to CLSI guidelines and interpretative criteria (imipenem, meropenem, cefoxitin, ceftazidime, ceftriaxone, piperacillin, piperacillintazobactam, amoxicillin/ clavulanic acid, amikacin, gentamicin, trimethoprim/sulfamethoxazole, and Flourorquinolones . (Mast Diagnostics, Merseyside, UK).

The extended spectrum β-lactamase (ESBL) phenotypic screening and confirmatory tests were done according to CLSI guidelines. (CLSI, 2010). AmpC β-lactamases were screened by the standard disk diffusion test using 30-µg cefoxitin disks. Isolates with zone diameters of less than 18 mm were considered AmpC positive.

Gram negative bacilli were defined as multidrug-resistant (MDR) when they showed resistance to three or more antimicrobial classes. (Magiorakos et al, 2012) . Isolated Staphylococcus strains were tested for methicillin resistance using cefoxitin (FOX : 30 µg) for prediction of mecA gene mediated methicillin resistance in the staphylococcus species , as recommended by CLSI (CLSI, 2010)

Definitions

HAI: PICU-acquired HAIs were defined according to the Centre for Disease Control and

Prevention (CDC). Infections that commenced at or after 48h after admission to the PICU were included as PICU-acquired infections. (Horan, 2008)

MDR : organisms are considered MDR if they were found to be resistant to at least three of the following antibiotic classes: antipseudomonal cephalosporins/penicillins, macrolides, carbapenems, fluoroquinolones, and aminoglycosides. MRSA; extended- spectrum β-lactamase-producing gram-negative Enterobacteriaceae, such as Klebsiella spp., E. coli , and Proteus spp.; P. aeruginosa resistant to ceftazidime or carbapenems; other pan-resistant Enterobacteriaceae bacteria or those sensitive only to carbapenems; sulfonamide-resistant Stenotrophomonas spp.; Acinetobacter spp. resistant to ampicillin, ampicillin/sulbactam, or carbapenems; and vancomycin-resistant Enterococcus spp. Other organisms were considered

VAP. Ventilator-associated pneumonia (VAP) was defined as infection in a mechanically ventilated patient with a chest roentgenogram with progressive infiltrates with at least one of the following criteria: new onset of purulent sputum or change in sputum character, fever > 38.2°C or leucocytosis > 12,000 mm^3; or isolation of an etiologic agent from a specimen obtained by tracheal aspirate, bronchial brushing or bronchoalveolar lavage, or biopsy. (Koenig SM, Truwit, 2006)

BSI: was defined as occurring when a patient had a recognized pathogen isolated from one or more blood cultures after 48 hours of hospital admission that was not related to an infection at another site, while central line-associated bloodstream infection (CLA-BSI) was defined if the BSI occurred after 48 hours of central line insertion. The patient also had at least one of the following signs or symptoms: fever (temperature ≥ 38 °C), chills, or hypotension. For skin commensals (i.e. diphtheroids, ropionibacterium spp., coagulase-negative staphylococci), the organism had to be recovered from two or more blood cultures.

CAUTI. Catheter-associated urinary tract infection (CAUTI) was defined when one of the following two criteria were met; first patients with a urinary catheter had one or more of the following symptoms with no other obvious cause of infection: fever (temperature ≥ 38 °C), urgency, or suprapubic tenderness and a positive urine culture (≥than 10^5 colony-forming units (CFU) per mL), with no more than two microorganisms isolated ,second was positive dipstick analysis for leukocyte esterase and pyuria (≥ 10 leukocytes/mL).

Death was considered due to infection, if it occurred within 7 days of diagnosis of infection, and that the presence of HAI was the primary cause of death.

Sampling

Blood samples.

Adequate preparation of the skin with povidone was installed to the site of needle insertion with aseptic techniques using sterile gloves.

Central lines are removed and aspetic techniques and the distal 5 centimeter end of the catheter was removed and cultured

ETT aspirate was done using aseptic techniques with the application of closed suction methods. A deep tracheal aspirate was cultured and gram-stained.

Urinary catheter samples are taken from the sampling port of the urinary catheter

Standard laboratory methods were used to identify microorganisms, and a standardized susceptibility test was performed.

Ethical consideration

The aim and nature of the study were explained for each parent before inclusion. An informed written consent was obtained from parents or caregivers before enrolment. The study design conformed to the requirements of latest revision of Helsinki Declaration of Bioethics (WHO). The Scientific Research Committee of Pediatrics Department-Faculty of Medicine - Cairo University revised and approved the study design.

Statistical analysis

Data were statistically described in terms of mean standard deviation (SD), median and range, or frequencies (number of cases) and percentages when appropriate. Comparison of numerical variables between the study groups was done using Student *t* test for independent samples in comparing 2 groups when normally distributed and Mann Whitney *U* test for independent samples when not normally distributed. Non-normal numerical variables between more than two groups were compared using Kruskal Wallis test. For comparing categorical data, Chi square (^{2}) test was performed. Exact test was used instead when the expected frequency is less than 5. *p* values less than 0.05 was considered statistically significant. All statistical calculations were done using computer program SPSS (Statistical Package for the Social Science; SPSS Inc., Chicago, IL, USA) release 15 for Microsoft Windows (2006).

RESULTS

The present study encompassed 378 patient admitted to the intensive care over a period of twelve months. 57 patients developed 106 episodes of infection, making the incidence of HAI 28% (58.85% per 1000 patient days).

Ages were between 1- 144 months (median 7 and IQR4-13.5). 32 (56.1%) were males while 25 (43.0%) were females.

Patients were referred from another hospital PICU, emergency department (ED), general ward or a surgical ward (Table 1).

Length of PICU stay ranged between 6- 201 (mean ± SD = 31.5 ± 31.7). Total patients' days were1798; while the length of PICU stay before the development of MDR ranges between 2 -66 days (11.1 + 12.3 mean ± SD)

The underlying diseases were described in Table 2.

Mortality related to infection occurred in 31/57 (53.8%) of cases

The number of isolates recovered was 11 isolates with 4 gram positive and 7 gram negative isolates. More than one isolate was detected in 25 patients

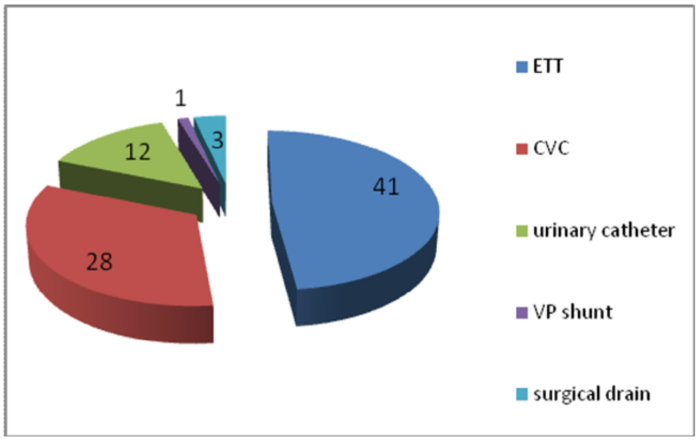
The number of infection episodes was 106 (range 1 – 7, with mean ± SD 1.6 – 1.1). 98 were MDR infections, while 8 were non-MDR organisms. The incidence of MDR-HAI was 92.45%

All patients received antibiotics before the development of HAI, whether prophylactic or therapeutic, throughout the length of stay. 43 of the infection episodes were preceded by the intake of one antibiotic, while 63were on more than one type of antibiotics.

52 out of the 57 patients had an invasive device inserted. Figure 1

41 patients were on mechanical ventilation reporting, developed 55 VAP episodes, while 28 patients had central line inserted developed 16 (29.6%) episodes of CLBSI, 12 patients had a urinary catheter inserted , however 4 developed CRUTI.

Figure (1) types of invasive device inserted



Infection with gram negative strains occurred in 89 (83.9%) of cases, while gram positive infections occurred in 17 (16.19%) cases.

Staphylococcus was the most commonly detected gram positive infection where coagulase- negative staphylococcus (CONS) occurred in 9 (8.5%), and methicillin resistant *Staphylococcus* (MRSA) in 5 cases (4.7%). *Enterococcus* was detected in 2 (1.9%) of cases, *Strep pneumoniae* in 1 case (0.9%) .

All Staphylococcus infections were resistant to methicillin and sensitive to vancomycin.

Gram negative (GN) infections

GN infections constituted the majority of infections (89 episodes); *Acinetobacter spp* (28/106, 26.4%), *Pseudomonas spp* in (27, 25.5%) of cases each, *Klebsiella spp* in(23 ,21.7%), *E .Coli* in (4, 3.8%), *Stenotrophomonas maltophilia* in (3 , 2.8%) cases, *Enterobacter spp* in (3, 2.8%) cases, while *Serratia* occurred in 1 (0.9%) of cases.

Antibiotic susceptibility of GN infections

Antibiogram of GN infections was presented in Table 3

Sensitivity to one type of antibiotic occurred in 41 infection, while sensitivity to more than one type occurred in 61. Four cases were extensive-drug resistant (EDR); two *Pseudomonas*, 1 *klebsiella* and 1 *Escherichia coli.*

Pseudomonas susceptibility to carbapenams was very low (17.8%), aminoglycosides (21.4%), ciprofloxacin (10.7%), cotrimoxazole (10.7%), and colistin (82.14%).

Acinetobacter susceptibility to aminoglycosides was (32.1%), trimethoprium sulfatriamoxasole (32.1%), and to colistin (67.8%), carbapenam and ciprofloxacin resistance was 100%.

Klebsiella infections were mostly non-MDR and it was statistically significant
(p value < 0.001)

One of 3 cases of *Stenotrophomonas maltophilia* was trimethoprium sulfatriamoxasole- resistant.

The highest rate of hospital acquired infections was related to the development of VAP which occurred in 55 cases (51.9%), BSI occurred in 17 (16.0%) cases, while CLBSI occurred in 16 (15.2%), HAP in 7 (6.6%) surgical wound infection in 5 (4.7%), CRUTI in 4 (3.8%) and VP shunt infection in 2 (1.9%) . Figure (7)

For VAP *Pseudomonas* was the most common organism (19, 34.5%), followed by *Acinetobacter* (17, 30.9%). Other organisms are *Klebsiella* (13, 23.6%), MRSA (3 , 5.5%), E. Coli(1, 1.8%) , *Seratia* (1, 1.8%) and *Strepneumoniae* (1, 1.8%).

For CLBSI infections, CONS was the most common organism responsible for (4, 15%) episodes, *Klebsiella (3*, 18.75%) and *Acinetobacter* in *(3*, 18.75%) , MRSA (2, 12.5%) and *Stenotrophomonas* in (2, 12.5%) , E.*coli* (1, 6.25%) and *Enterobacter* in (1, 6.25%).

Among BSI, *Acinetobacter* was the most frequent organism (5, 29.4%). Other organisms are CONS (4 , 23.5%), *Pseudomonas* (3, 17.6%), *klebsiella* (2, 11.8%) and *Enterococci* in (2, 11.8%) and *Stenotrophomonas (*1, 5.9%).

For CRUTI, Klebsiella in (2, 50%), Pseudomonas (1, 25%) and Enterobacter (1, 25%)

HAP occurred in 7 episodes, *Acinetobacter* (3, 42.9%), *Pseudomonas* (2, 28.6%), and *Klebseilla* (1, 14.3%)and *Enterobacter* in (1, 14.3%).

Wound infections were caused by, E.*coli* in (2, 40%) and CONS, *Pseudomonas* (1, 20%) and *Acinetobacter* in (1, 20%).

Finally VP shunt infections occurred in 2 cases one with CONS and the other with *Pseudomonas*.

There was no statistically significant difference between the two studied groups regarding age, sex, length of PICU stay before the development of HAI, total length of stay, underlying diseases, the number of antibiotics used before the development of HAI, stress ulcer prophylaxis, the nutritional state or the type of HAI. For the invasive devices used the insertion of ETT was statistically significant for the development of MDR-HAI (P value 0.049). Table 4

As for the type of organisms in relation to MDR, *Klebsiella* was significantly related to non-MDR infection (p value < 0.001)

There was no relation between the spectrum of antibiotic resistance to the outcome of the patients.

Age, length of stay, underlying diseases, the length and type of antibiotic prophylaxis, steroid intake, stress ulcer prophylaxis and referral were not related to patient mortality.

Also the type of the organism and the HAI had no statistical impact on the outcome of the patients.

VAP mortality was high 36/55, but it was not significant statistically, although the mere presence of ET tube was associated with higher mortality (p value 0.025).

Nutritional state of the patients was significantly related to the outcome, where malnourished children had the highest mortality (p value 0.048)

DISCUSSION

Antimicrobial resistance is associated with high rates of mortality and high medical costs. MDR hinders disease control by aggravating the possibility of diffusion of resistant pathogens. The cost of treatment is also increased as the pathogens have become resistant to the commonly used drugs, with sensitivity transpose to more expensive therapies. (Tanwar et al, 2014)

The rates of antimicrobial resistance among pathogens causing healthcare associated infection are increasing, mainly among gram-negative organisms (P aeruginosa, A baumannii and K pneumoniae) (Boucher et al., 2009).

Cairo University Pediatric hospital is a tertiary care central with case referral from all over the country, which presents with more severe illness and lower socioeconomic standards.

It has been stated that the university/teaching hospitals that usually operate as referral hospitals generally report higher infection rates (Nejad et al, 2011)

PICUs in developing countries, in contrast to developed countries, often admit more critically ill children, with lower ages and socioeconomic level, and with medical conditions rather than surgical. (Tantaleán et al, 2003)

Also we have a longer PICU stay than other countries (6- 201days) due to the inclusion of neuromuscular cases. This long stay paved the way for the development of multiple episodes of infections with more and more resistant strains that was evident from the results, though not reaching a statistical significance.

In our study the incidence of HAI was 28 %. However, the incidence of MDR-HAI was seriously high in our study representing 92.45% of infections.

In Europe, incidence of HAI ranges from 1% in general pediatric wards to 23.6% in PICUs. (Raymond et al, 2000). While a nation point prevalence study of PICU in the United States found the incidence to be 11.9%. (Grohskopf et al,)

Incidence of HAI in PICU in developing countries ranges from 18.3-19.5% (Abramczyk, 2003 – and in Turkey PICU is 37% (Eda eta al, 2015)

Mortality due to MDR in the current study was (53.8%), matching overall mortality of HAI in pediatric intensive care unit between 10%.-53.6 % (Folgori et al, 2014, Slota et al, 2001, Siddiqui, 2014, Ylipalosaari et al,2006)

Staphylococcus aureus (MRSA) in MDR organisms is already dethroned as the most feared one by the emerging MDR gram-negatives. Brusselaers et al, 2011.

Staphylococcus was the most common gram positive organism detected in the current study and it was 100% methicillin-resistant. While all gram positive infections detected were vancomycin-sensitive.

GN infections, as in most PICU, were the most commonly detected microbes in our unit (84%) of infections.

Acinetobacter species are aerobic gram-negative bacilli that have emerged as an important cause of HAI as they can survive for prolonged periods in the environment and on the hands of healthcare workers (Jawad et al, 1998). The increasing development MDR in this pathogen had vastly restricted the therapeutic choices available for infected patients, and increased the length of stay in ICUs and mortality (Falgas et al, 2006).

Acinetobacter followed by *Pseudomonas* species were the most frequently detected organisms in the current study. Resistance to carbapenam was 100% in *Acinetobacter*, and 82.2% in case of *Pseudomonas.*

Acinetobacter carbapenam resistance in other studies varied (62- -94.5%)

(Katragkou et al, 2006) (Sritippayawan et al, 2009) (Sunenshine Et al, 2007), (Kapil et al, 2014)

Contrasting with our study, *Klebsiella* species were the most frequent organism detected in other PICUs. (Folgori, et al, 2014, Singhi et al, 2008)

In UK, third-generation cephalosporins resistant *E. Coli* strains had increased (5- 10%), and most of the resistant strains (80%) also harboured resistance to ciprofloxacin. (Marcel et al, 2008)

The Centre for Disease Control and prevention (CDC) issued a report stating that more than 70% of bacteria responsible for HAIs are resistant to at least one of the antimicrobials commonly selected to treat them. (Siegel RE[1], 2008)

In the current study VAP represented the most common HAI (51.9%).

The incidence of VAP in pediatric patients varies from 5.1%-33.3%. (Sharma et al, 2009- **Asembergiene et al, 2009,** (Bigham et al., 2009).

Only two pediatric studies have found VAP to be the most frequent HAI in PICU (Raymond J 2000 and Abramczyk et al, 2003)

A surveillance study from the International Nosocomial Infection Control Consortium INICC identified higher VAP rates in academic compared to non-academic hospitals (Rosenthal et al., 2012).

Another surveillance study from the International Nosocomial Infection Control Consortium INICC identified higher rates in lower-middle income compared to upper-middle-income countries. Extreme PICU VAP rates have been reported from India (36.2%) (Awasthi et al., 2013) and Egypt (31.8/1000 ventilator-days) (Rasslan et al., 2012).

In Europe and North America S. aureus predominate (Srinivasan et al., 2009). In Asia, most pathogens are multidrug resistant gram negative bacteria in neonates. (Zhang et al, 2013).

In the present study BSI represented 16% of infection. Other studies reported BSI as the most common HAI in PICUs (28-52% of all) **(**urrea et al, 2003- Grohskopf et al, 2002- Gray et al, 2001 – Stover et al, 2001 – Vincent et al, 2009)

Almost 60% of CLBSI in PICUs are caused by gram-positive bacteria. (Smith, 2008). *Staphylococcus aureus* was the most common Gram-positive organism in Lakshmi et al 2007. In our study 53.5% of CLBSIs were GN, *Klebsiella* being the commonest.

Data from a nationwide surveillance study in the United States found that coagulase-negative staphylococci and *Staphylococcus aureus* account for 31% and 20%, respectively, of all health care–associated bloodstream infections. Gram negative organisms, however, have been found to be a more important cause of CLABSIs in some areas of the world. (Allegranzi et al, 2011)

For example, Taiwan, the Czech Republic, and Egypt have reported bloodstream infections more often due to Gram negative organisms (50%, 64.8%, and 66% of CLABSIs, respectively), most often due to *E. coli*, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa*. (saied et al, 2011)

Pathogen responsible for CL-BSI can change over time and varies among ICUs. It depends not only on the use of central venous catheters, but also other factors such as type of bacterial colonization on the skin and in the ICU environment, previous use of antibiotics (especially broad-spectrum), type and severity of the patient illness, patient care procedures, and adherence to HAI control guidelines.

Measures considered to be mandatory in PICUs of developed countries, as supervision of the catheter insertion procedure by a trained ICU nurse who is authorized to stop the procedure if a break in protocol is detected, utmost sterile barrier precautions during catheter insertion, and routine use of 2% tincture of chlorhexidine for cutaneous antisepsis, had been unfulfilled in the hospitals of most developing countries.

As most of our patients who developed HAI were MDR (92.45%), logistic regression analysis was not feasible between the case-control groups. Also all of our patients were on antibiotics, making use of antibiotics as a risk factor was untenable.

The only risk factor we detected associated with MDR in this study was the use of ET (P value 0.049).

Klebsiella was statistically significant to non-MDR development in the current study (p value < 0.001)

Other studies reported previous use of broad-spectrum antibiotics to be associated with the occurrence of MDR-*Acinetobacter* and *pseudomonas infections*. (Husni et al, 1999 and Jeena et al, 2001, Ortega et al, 2004).

Plenty of explanations can be extrapolated, the widespread abuse of antibiotics in the outpatient settings treating viral infections with aggressive antibiotics. The inappropriate dose and incomplete course of antibiotics, which fuel antimicrobial resistance, also plays a major role in developing MDR.

Surveillance of the antimicrobial susceptibility pattern and authorization of strict policy for antibiotic stewardship are a must in controlling the emergence of resistant strains.

Although infection control policies are enforced in our unit, still infection control awareness and adherence linger in nursing care practice.

Most resource-limited countries, like ours, do not have laws mandating HAI control programs. Funds and resources for infection control are very limited, nurse-to-patient staffing ratios are far lower on average than in ICUs of the developed countries, and there are larger proportions of inexperienced nurses,

CONCLUSIONS

The incidence rate of MDR-HAI was high in our PICU with high mortality rate. Gram negative bacteria were predominantly isolated from clinical samples. *Acinetobacter spp* was the most commonly isolated organism among MDR-HAI while *Klebsiella* was the most commonly isolated organism among the non MDR-HAI. VAP was the most commonly observed HAI, and the insertion of ETT was a risk factor for MDR-HAI. The presence of malnutrition associated with MDR-HAI heralded mortality.

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Table 1 Demographic data of the patients

	Frequency (n=57)	Percentage
Sex		
Male	32	56.1
Female	25	43.9
Referral		
ED [a]	51	89.5
Surgical	3	5.3
Ward	2	3.5
PICU	1	1.8

[a] ED; emergency department

Underlying disease	Subcategorization of the disease	no	Percentage %

Table (2) Underlying diseases among the patients

Neurologic (n=26)	Status epilepticus	11	19.3
	Coma	8	14.0
	TBI [a]	3	5.3
	Respiratory failure	2	3.5
	NMD [b]	2	3.5
Respiratory (n=14)	Bronchopneumonia	6	10.5
	Bronchiolitis	6	10.5
	Pneumonia	1	1.8
	Cystic lung	1	1.8
Cardiac (n=9)	Cardiac failure	9	15.8
Sepsis (n=3)	Septic shock	2	3.5
	Sepsis	1	1.8
Surgical (n=3)	Impending respiratory failure	1	1.8
	Shock	1	1.8
	Surgical	1	1.8
Renal (n=1)	Renal failure	1	1.8
Burn (n=1)	Burn	1	1.8

[a] TBI; traumatic brain injury [b] NMD; neuromuscular disease

Table (3) Gram negative antibiogram

	Acinetobacter (n = 28)	Pseudomonas (n = 27)	Klebsiella (n= 23)	E.coli (n = 4)	Steno (n = 3)	Enterobacter (n = 3)	Serratia (n = 1)
Amikacin	8 (28.57%)	4 (14.28%)	5 (21.7%)	4(100%)	0	0	0
Gentamycin	1 (3.57%)	2 (7.1 %)	3 (13.0%)	4(100%)	0	0	0
Tobramycin	0	0	0	1 (25%)	0	0	0
Imipenam	0	3 (10.7%)	14(60.8%)	4(100%)	0	2	0
Meropenam	0	2 (7.1%)	11(47.8%)	2 (50%)	0	2	0
Ciprofloxacin	0	3 (10.7%)	9(39.13%)	2(50%)	0	0	1(100%)
TMP	9	3 (10.7%)	9(39.13%)	2(50%)	2(66.6%)	0	0
Polymyxin E	19 (67.8%)	23 (82.14%)	2(8.69%)	2(50%)	1(33.3%)	3 (100%)	0

Table 4. Comparison between MDR-HAI and non-MDR-HAI

Characteristics of patients	MDR-HAI (no = 98)	Non-MDR-HAI (no = 8)	P value
Age (median)	7	7	0.736
Sex Female Male	 40 (40.8%) 58 (59.2%)	 2 (25.0%) 6 (75.0%)	0.474
Length of PICU stay prior to HAI (days) (median)	13	4.5	0.063
Length of PICU stay (days) (median)	27	16.50	0.094
Underlying diseases Neurologic Respiratory Cardiac Sepsis Post surgical Renal Burn	 44 (44.9%) 21 (21.4%) 12 (12.2%) 9 (9.2%) 8 (8.2) 3 (3.1%) 1 (1.0%)	 4 (50%) 2 (25%) 2 (25%) 0 0 0 0	0.894
No of antibiotics prior to HAI			

More than one One type	59.2% (60.2%) 39(39.8%)	4 (50%) 4 (50%)	0.712
Invasive devices used			
ETT	80 (82.5%)	4 (50%)	0.049
CVC	49 (50.5%)	5 (62.5%)	0.717
UC	22 (22.7%)	4 (50%)	0.102
VP shunt	3 (3.1%)	0	1
Surgical drain	4 (4.1%)	0	1
Type of HAI VAP CLBSI BSI HAP CRUTI Surgical wound infection VP shunt infection	51 (52.0%) 14 (14.3%) 17 (17.3%) 7 (7.1%) 3 (3.1%) 4 (4.1%) 2 (2%)	4 (50.0%) 2 (25%) 0 0 1 (12.5%) 1 (12.5%) 0	0.304
Nutritional state Fair Malnutrition	 42 (43.3%) 55 (56.7%)	 4 (50%) 4 (50%)	0.727
Stress ulcer prophylaxis	54 (55.7%)	4 (50%)	1