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Microbial Colonization of Intravascular Catheters Inserted in Newborn Babies: A Descriptive Study

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Abstract

Introduction: Colonization and subsequent bloodstream infection of the intravascular catheters is the common cause of nosocomial bloodstream infection in newborn babies. This study was performed to determine the microbial colonization of intravascular catheters inserted in newborn babies in Special Care Baby Unit (SCBU) of 550-bedded Children Hospital, Mandalay from January to September, 2015.

Methods: Eighty-four newborn babies with or without clinical sepsis were chosen as the study population and their intravascular catheters were cultured by semi quantitative (roll plate) method. Peripheral blood samples from 35 patients with clinical sepsis in the presence of intravascular catheter were cultured by conventional method. Antimicrobial susceptibility test was performed according to CLSI.

Results: The occurrence of microbial colonization was 17.9% (15/84) and no case of catheter-related bloodstream infection (CRBSI).Coagulase-negative staphylococci (CoNS) was the predominant microorganism (8/53.3%), followed by *Staphylococcus aureus* (5/33.3%), *Enterococcus* species (1/6.7%) and *Enterobacter* species (1/6.7%). 25% of CoNS were methicillin-resistant and methicillin-resistant *Staphylococcus aureus* (MRSA) was occurred in 80% of the species. Isolated Enterococcus species was resistant to cloxacillin, oxacillin and *Enterobacter* species was resistant to gentamicin and cefotaxime.

Conclusions: Therefore, this study elicited the occurrence of microbial colonization on inserted intravascular catheters and their susceptibility patterns which will help the pediatricians in the choice of antibiotics and will give a useful healthcare advice on the control of nosocomial bloodstream infection.

Keywords: Colonization; CRBSI; Newborn babies

Introduction

Intravascular catheters are an integral part of the care for many hospitalized patients. Unfortunately, a major consequence of these medical devices is colonization of the catheter by either bacteria or fungi, which can lead to catheter infection and serious bloodstream infection. This consequence is a major nosocomial source of illness and even death [1].

Neonates, whether born in term or pre-term, are at an increased risk for nosocomial infection owing to diminished immunity to infection. Nosocomial infections that are encountered in the neonatal intensive care unit (NICU) include bloodstream infections (BSI), which is most commonly catheter related (CRBSI), as well as other focal infections causing neonatal sepsis [2].

Vascular access is an essential element of modern medical care in neonatal intensive care units. Intravascular catheters interrupt the protective barrier of the skin and enable microorganisms to gain access to the bloodstream [3]. For microorganisms to cause CRBSI, they must first gain access to the extra luminal or intraluminal surface of the device where they can adhere and become incorporated into a biofilm that allows sustained infection and hematogenous dissemination [4].

The skin insertion site is the major source of colonization for short-term catheters, whereby organisms migrate along the external surface of the catheter and the subcutaneous segments, leading to colonization of the intravascular catheter tip, which may lead to bloodstream infection [5]. After catheter insertion, fibrin sheath and biofilm production is known to occur within 24 hours of catheter placement [6].

Because of the skin of the patient and hands of medical personnel are the main sources for the colonization of catheters, staphylococci, particularly coagulase-negative staphylococci and *Staphylococcus aureus* are the leading causes of catheter-related bloodstream infections (CRBSIs). Most of the gram negative bacilli causing CRBSIs are acquired from the hospital environment and *Candida* species also colonize on the hands of medical personnel and are also associated with glucose-containing infusion and total parenteral nutrition [5].

The presence of central venous catheters is the single most important risk factor for the occurrence of nosocomial candidaemia and *Staphylococcus aureus* bacteraemia [4]. Preterm infants are at higher risk of infection than mature infants because of immature immune responses, decreased immunoglobulin concentrations and poor gut barrier function. Breakdown of the barrier function of the skin is another host-related factor that contributes to the risk of nosocomial sepsis and CRBSI [2].

Very low birth weight infants (VLBW) are vulnerable to infections with the smallest and most immature infants being at the greatest risk. Catheter related bloodstream infection contribute to increased morbidity and mortality, prolonged hospitalization and the need for additional therapies [7]. In recent years, the emergence and subsequent increase in the incidence of resistance to antimicrobial agents has become a serious threat. The rates of methicillin resistant *Staphylococcus aureus* (MRSA), vancomycin resistant enterococci (VRE) and other resistance patterns are also increasing all around the world [8].

The diagnosis of nosocomial infections (including CRBSI) in neonates is challenging to pediatricians in the NICU. Neonates with sepsis commonly present with nonspecific signs, infectious foci are sometimes difficult to detect and the interpretation of the clinical significance of microbiological results (especially CoNS) is also challenging [2]. Catheter related bloodstream infections are often difficult to treat and antimicrobial prophylaxis and treatment have become increasingly difficult due to multidrug-resistant organisms, and timely and accurate epidemiological information is needed for guiding appropriate empirical therapy.

Therefore, this study was done to isolate and identify microorganisms colonizing on intravascular catheters and causing CRBSI among neonates. Moreover, drug resistant microorganisms were also identified and antimicrobial susceptibility testing was performed in order to establish the *in vitro* activities of antimicrobial agents against local isolates as early as possible.

Method and Materials

A hospital and laboratory based case-series observational descriptive study was conducted in SCBU, 550-bedded Children Hospital, Mandalay from January to September in 2015. Eighty-four newborn babies with or without clinical sepsis were selected to detect the bacterial colonization of intravascular catheters. Among them, only neonates with clinical sepsis decided by pediatricians in the presence of intravascular catheter were chosen for blood culture to detect CRBSI. Contaminated catheters during removal and neonates with clinical sepsis decided by pediatricians on admission were also excluded during the study period.

From each patient, one intravascular catheter tip whether routinely replaced (once for 3 days) or removed after appearance of signs of inflammation was collected under aseptic condition. The distal end was cut with sterile scissors, placed into sterile container and taken to the laboratory as soon as possible. Each catheter tip was cultured by semi quantitative (roll plate) method on blood agar media. After overnight incubation, the finding of more than 15 colony forming units (CFUs) of bacteria in culture was considered as colonization of bacteria. These siliconized intravascular catheter tips made of Teflon were collected on every Monday and Tuesday.

When bacterial growth was seen from catheter tip culture, colonial morphology and haemolysis pattern of colonies were observed. Gram-stained smear was done and the representative colony was sub-cultured on appropriate culture media (mannitol salt agar for gram-positive cocci, MacConkey agar for gram-negative bacilli). Catalase test, slide and tube coagulase tests for *Staphylococcus aureus* and coagulase-negative staphylococci, bile esculin test for *Enterococcus* species and indole test, Methyl Red test, Voges-Proskauer test, citrate utilization test, urease test, sugar fermentation test and motility test for *Enterobacter* species were performed for identification of the above isolated microorganisms.

Among 84 newborn babies, peripheral blood samples from 35 patients with clinical sepsis decided by pediatricians in the presence of intravascular catheter were cultured by conventional method. About 1 ml of blood was collected under aseptic condition, added to sterile blood culture bottle containing 10 ml of brain heart infusion broth and taken to the laboratory as soon as possible. The inoculated blood culture bottles were incubated and examined daily for up to 7 days for signs of bacterial growth.

When visible growth was seen, gram-stained smear was done and subcultures were performed on appropriate culture media. If there was no visible growth, blind subculture was done on blood agar and MacConkey agar media on seventh day. It was reported as sterile if bacterial growth was not seen on subculture plates. Antimicrobial susceptibility test was also done by using modified Kirby-Bauer disc diffusion method. The Clinical and Laboratory Standards Institute (CLSI) zone size interpretation charts were used to identify the susceptible and resistant isolates. Data were collected in proforma and entered into data master sheet. After checking data completeness, data were entered and analysed by STATA13 statistical software.

Results

Out of 84 catheter tips, intravascular catheter colonization was occurred in 15 (17.9%) catheters. All were short-term intravascular catheters and no central venous catheters (CVCs) during the study period. From 35 newborn babies with clinical sepsis decided by pediatricians, both blood samples and intravascular catheter tips were taken to detect CRBSI. Among 35 blood samples, microorganisms were isolated from 4 blood samples but there was no growth in the intravascular catheter tip samples. Therefore, CRBSI was not detected during the study period (Figure 1).

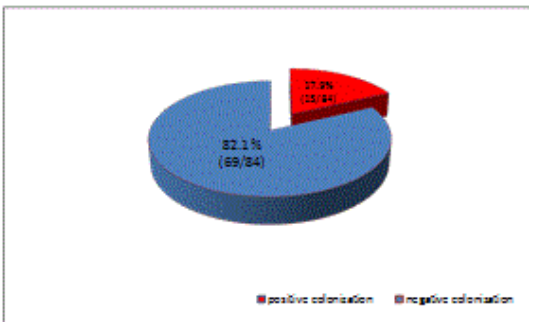

Figure 1: Microbial colonization of intravascular catheters.

Occurrence of microbial colonization of intravascular catheters was more common in preterm newborn babies (30%) whereas 11.1% in term babies. Occurrence of microbial colonization of intravascular catheters was the most common in very low birth weight newborn babies (60%), followed by low birth weight (25%), normal birth weight (8.7%) and extremely low birth weight newborn babies (0%)(Table 1).

Four types of microorganisms were isolated from 15 cases of intravascular catheter colonization (CoNS, *Staphylococcus aureus*, *Enterococcus* species and *Enterobacter* species). Coagulase-negative staphylococci was the most common organism accounting for 53.3%

(8 out of 15) followed by *Staphylococcus aureus* for 33.3% (5 out of 15), *Enterococcus* species for 6.7% (1 out of 15) and *Enterobacter* species for 6.7% (1 out of 15)(Figure 2).

Birth weight	No	Percentage
Normal (2500 - 4000g)(n=46)	4	8.70%
LBW (2499 - 1500g) (n = 32)	8	25%
VLBW (1499 - 1000g) (n = 5)	3	60%
ELBW (< 1000g) (n = 1)	0	0%

Table 1: Frequency distribution of microbial colonization of intravascular catheters according to birth weight.

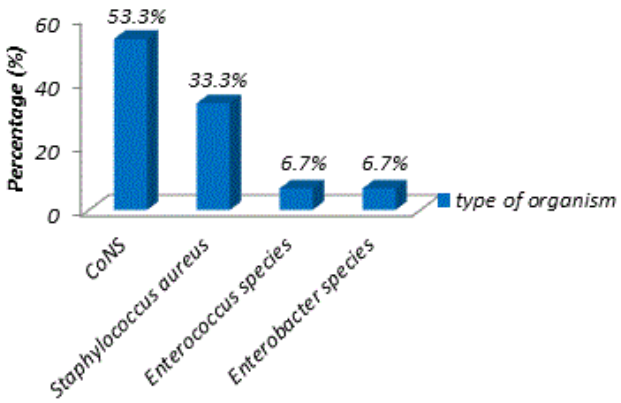

Figure 2: Microorganisms isolated from intravascular catheters.

Antimicrobial susceptibility testing was done by using 6 different antibiotic discs for gram-positive cocci. Coagulase-negative staphylococci were 100% sensitive to amoxicillin/clavulanic acid and vancomycin. Sensitivity to ampicillin, cloxacillin, oxacillin and amoxicillin/flucloxacillin were 75%, 87.5%, 75% and 87.5% respectively.

Staphylococcus aureus was 100% sensitive to amoxicillin/clavulanic acid and vancomycin but 100% resistant to ampicillin. Sensitivity to cloxacillin, oxacillin and amoxicillin/flucloxacillin were 40%, 20% and 40% respectively. *Enterococcus* species was totally sensitive to ampicillin, amoxicillin / flucloxicillin, amoxicillin / clavulanic acid, vancomycin and resistant to cloxicillin and oxacillin. 80% of MRSA was isolated in this study and simultaneous resistance was seen to ampicillin and cloxacillin.

Antimicrobial susceptibility testing also was done by using 6 different antibiotic discs for gram-negative bacilli. *Enterobacter* species was sensitive to imipenem, amikacin, ceftazidime, sulbactam / cefoperazone but resistant to gentamicin and cefotaxime.

Discussion

In the present study, 84 intravascular catheters were collected from patients with day one onwards with or without clinical sepsis. Microbial colonization of intravascular catheters was noticed in 15 out of 84 catheters (17.9%).

The result of the present study was compatible with that of Ohnmar-Kyaw-Myint [9] who reported that microbial colonization occurred in 11 out of 94 intravascular catheters (11.7%), studied in ICU of MGH in 2011. Comparing with other studies, the finding of the present study was not much different from that of Hnin-Phyu [10] who had shown that the occurrence of microbial colonization was 29.5% (18 out of 61) in blood dyscrasia patients at YGH in 2007.

However, other studies stated that microbial colonization was 37% in NICU ward of Namazee Hospital in Iran in 2008 by Hashemizade and Emami [11], 39.3% in critically ill neonates in Uberlandia University Hospital in Brazil in 2009 by Brito et al. [12], 39.02% in PICU of tertiary care teaching hospital in India in 2013 by Thomas et al. [13], 61.8% in adult patients at YGH in 2005 by Win-Win-Yee [14] and 48% in children admitted to YCH in 2011 by Win-Pa-Pa-Hlaing [15].

The lower culture positivity observed in the present study could be multifactorial. One possible factor may be due to collection of sample catheters from day one onwards. These catheters were also inserted under strict aseptic condition and routinely replaced (once for 3 days) by experienced healthcare staff. In the other studies, sample catheters were collected with long duration of catheter placement (3 days onwards) and therefore, high culture positivity was observed in their studies.

Other probable reason may be due to the inclusion of only peripheral venous intravascular catheters, not including central venous catheters (umbilical catheters and PICC). O'Grady et al. [16] stated that CVC carried a substantially greater risk for infection in compare with peripheral venous catheters. Another factor may be due to antibiotic therapy given because most of the study populations in SCBU were high risk patients who had already received early administration of empiric antibiotics. Moreover, catheters made of Teflon in the present study were less vulnerable to microbial colonization and subsequent infection than the other catheters made of polyvinyl chloride or polyethylene.

In the present study, no CRBSI was identified in patients with peripheral venous intravascular catheters. During the study period, no CVCs were collected and therefore, the occurrence of CRBSI associated with CVC couldn't be studied. Furthermore, the catheters were routinely replaced (once for 3 days) or removed by experienced healthcare staff when signs of inflammation occurred at catheter insertion site. Therefore, CRBSI was not detected in the present study.

The gestational age of study population comprised of both term (≥ 37 weeks) and preterm (< 37 weeks). Pre-term neonates are at an increased risk for infection than term neonates due to their immature immune system. Distribution of microbial colonization of intravascular catheters was not correlated with sex and in terms of birth weight distribution, 60% cases of microbial colonization of intravascular catheters were found to be occurred in very low birth weight infants. Some authors also reported that low birth weight and younger gestational age are the most important factors for the occurrence of microbial colonization and CRBSI [2].

Staphylococci are a major cause of catheter colonization because of their ability to form biofilms on indwelling polymeric devices [17]. Although fungi are the common microorganisms in very low birth weight infants, they were not isolated in the present study. This might be due to the antifungal prophylaxis (oral nystatin) which had already been given to that birth weight group of newborn babies.

High frequency of CoNS may be due to subsequent colonization of the catheter tips from migration of the skin flora which is the commonest route for the contamination of the short-term intravascular catheters. Vancomycin and amoxicillin/clavulanic acid were the most sensitive drugs to CoNS and *Staphylococcus aureus*. These are the second line antibiotics for multidrug resistant staphylococci, so that its usage is limited in the hospitalized patients. This factor may constitute for the highest sensitivity of vancomycin to staphylococci. All MRSA isolates were also susceptible to vancomycin and it was difficult to evaluate the result of antimicrobial susceptibility pattern of *Enterococcus* species and *Enterobacter* species because of very small sample size (i.e. only one for each).

Conclusion

Microbial colonization of intravascular catheters was found as 17.9% in SCBU of 550-bedded Children Hospital, Mandalay in spite of good insertion practices. Occurrence of microbial colonization of intravascular catheters was directly proportionate to gestational age and birth weight. Therefore, it was noticed that preterm low birth weight infants are more vulnerable to microbial colonization than term and normal birth weight infants. It was also highlighted that proper hand hygiene and aseptic technique for the insertion and care of intravascular catheters are major preventive measures for colonization and subsequent bloodstream infection. According to anti biograms obtained from this study, the recommended drugs to be given for gram-positive cocci were vancomycin, amoxicillin/clavulanic acid and for gram-negative bacilli were imipenem, amikacin, ceftazidime and sulbactam/cefoperazone.

Conflict of Interest

The authors declare that there is no conflict of interests

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