Risk Factors for Central line – associated Bloodstream Infections

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Objective: To carry out surveillance of central line – associated bloodstream infections in a Pediatric intensive care unit (PICU) and determine associated risk factors.

Methods: This prospective study was conducted over 1.5 years in the PICU. CDC definitions for these infections were followed and associated risk factors were identified.

Results: Of 265 enrolled children with central line, 13 developed blood stream infections (incidence density 5.03/1000 central-line days). Significant risk factors included changing the central-line, especially triple lumen, and frequently accessing the central-line.

Conclusion: Central-line associated bloodstream infections are preventable primary bacteremias and intervention strategies for prevention should be based on evidence generated to devise future protocols.

Keywords: *Bacteremia, Central venous catheterization, ICU, Nosocomial infections*

Healthcare-associated bloodstream infections (BSI) are associated with high mortality and morbidity, and increase duration of hospitalization of patients substantially [1]. Vascular access, especially central lines, is responsible for almost 60% of these infections, [2]. Clear definitions for central line-associated bloodstream infections (CLABSI) and their surveillance using standard protocols is necessary, as correct diagnosis can avoid indiscriminate removal of central line if the sepsis is not related to central line. In developing countries, situation of CLABSI has not been systematically analyzed [3]. In a previous study done in our Pediatric intensive care unit (PICU), the incidence density of catheter-related blood stream infection was 8.3/1000 patient days [4]. In developed countries, zero CLABSI rates are considered as the standard of healthcare, and are an important parameter for accreditation process of a healthcare facility.

We carried out the surveillance of CLABSI in our PICU [5], and aimed to determine the risk factors and bacterial profile of CLABSI.

METHODS

This prospective cohort study was conducted in PICU of All India Institute of Medical Sciences, New Delhi, for a period of 1.5 years (August 2011 to January 2013). Ethical clearance was obtained from Institutional Ethics Committee.

Children, who stayed in PICU for more than 48 hours and had no infection incubating at the time of admission, were included in the study. The definition of CLABSI, their incidence density and antimicrobial profile has been published elsewhere [5]. The definition for CLABSI was based on CDC criteria [6], and incidence density was calculated as episodes of CLABSI per 1000 central line days.Central-line days were calculated by daily count of enrolled patients on central line, admitted in PICU.

All children on central line were monitored. Type of central line inserted, frequency of access/day [for drugs, total parenteral nutrition(TPN), gastric acid blockers, blood products] was noted.

Statistical analysis: Multiple parameters to determine risk factors associated with CLABSI were analyzed, which included the type of central line inserted, frequency of access/day and the affect of receiving various infusates through the central line.Data were managed on MS Excel and analyzed using Stata software, version 7.0 (Stata Corp., College Station, TX). Statistical significance between morbidity and mortality parameters was assessed by Two-sample Wilcoxon rank sum (Mann-Whitney) test and by Pearson chi-square test.

RESULTS

During the study, 349 patients were enrolled. Nineteen developed BSI, of which 13 (68.4%) had CLABSI and 6 (31.6%) secondary BSI. Central line was placed in 265

(75.9%) patients (172 males) in PICU. Of these, 129 (48.7%) had triple lumen, 117 (44.1%) single lumen, 15 (5.7%) PICC line and 4 (1.5%) had umbilical catheters. Type of central line inserted was not related to development of CLABSI (*P*= 0.533).

Majority (55.8%) of the patients were <2 years of age, 31.6% were in the age group of 5-15 years and 12.6% were 2-5 years. Most common presentation/ systems involved in patients who were put on central line were respiratory (28.7%), CNS (15%), cardiopulmonary (11.3%), sepsis/shock (10.2%), renal (8.3%), metabolic disorders(6.8%). Less commonly, gastrointestinal tract involvement (5.7%), blood disorders (3.0%), autoimmune diseases (2.3%) were noted.

Central-lines were changed in 66 (24.9%) patients. Changing central line was associated with higher incidence of CLABSI (*P*=0.024), especially with triple lumen CL change (*P*= 0.017) (*Table* I).

Majority (89.8%, *n*=238) of central lines were inserted in femoral vein; others in subclavian, brachial and umbilical vein. Site of central line insertion and development of CLABSI showed no relation (*P* =0.761). Also, no higher risk of CLABSI incidence was found in patients who received total parenteral nutrition (166 *vs* 99) or gastric acid blockers (167 *vs* 98).

Mean number of times CL was accessed/day in patients who developed CLABSI was much higher (18.46 *vs*. 11.70; *P*<0.001). Mean length of stay of patients with CLABSI was longer (27.30 *vs*. 8.76 d) (*P*<0.001). Also,

TABLE I RELATIONSHIP BETWEEN CENTRAL LINE-ASSOCIATED BLOODSTREAM INFECTIONS AND CHANGE OF CENTRAL LINE

Central line	Total	Blood stream infections, No. (%)
Unchanged	199	6 (3.0%)
Triple lumen	105	3 (2.9%)
Single lumen	77	3 (3.9%)
Others	17	0
*Changed**	66	7
Triple lumen	24	5 (20.8%)
Single lumen	40	1 (2.5%)
Others	2	1
Number of times changed*		
Once	40	5 (12.5%)
Twice	23	2 (8.7%)
Thrice	2	0
Six times	1	0

*P<0.05.

CLABSI was associated with higher mortality of 38.5% (5/13) compared to 13.7% (46/336) in patients without CLABSI.

In six patients with secondary BSI, lower respiratory tract was primary site of infection for four episodes of BSI (2 *Acinetobacter* spp., 1 *Pseudomonas* spp. and 1 *Klebsiella* spp.), and urinary tract for two (*Candida spp.*). Broncho-alveolar lavage (BAL) and urine sample were taken for culture, respectively and same isolates were later cultured from blood samples.

Predominance of gram negative pathogens was found in our study. *Klebsiella spp.* caused 5 , *Pseudomonas spp.* 3 (23.1%), *S.epidermidis* 2, and *Acinetobacter spp.*, *Proteus spp.* and *Enterococcus faecium* each caused one episode of CLABSI. The antimicrobial susceptibility showed a high percentage of multidrug resistant bacteria with gram negative bacteria showing susceptibility to carbapenems and beta lactamase inhibitor combi-nations,while gram positive being susceptible to vancomycin and linezolid [5].

DISCUSSION

In this study, we found that triple lumen central line was the most common type of line used and femoral vein was the most common site of central line insertion. We did not find any relationship between these variables and CLABSI. Also, patients receiving TPN or gastric acid blockers did not show higher risk of developing CLABSI. Important risk factors associated with CLABSI were frequency of central line access/day and changing triple lumen central line once or more.

Limitations of our study include a small study population and short duration of the study. Catheter manipulation is a known risk factor in development of catheter-related sepsis [7,8], as chances of introducing patient's own skin flora or transferring an epidemic strain *via* hands of healthcare workers increases.

CDC recommends that central line should not be removed on basis of fever alone and clinical judgment be applied [9]. Central line was unchanged in six CLABSI patients and managed using systemic antimicrobial therapy. Of 66 patients, in whom central line was changed (catheter blockage, local site infection or suspicion of a BSI), 7 consequently developed CLABSI (central line in place for >2 calendar days).

Femoral vein is avoided in adults for central line placements because of higher colonization rates and risk of deep-vein thrombosis. But for pediatric population, CDC states "no recommendation can be made for a preferred site of central line insertion" [9].

WHAT THIS STUDY ADDS?

- Unnecessary change of central line and its frequent access predispose to central line-associated bloodstream infections.

Most common causative pathogens for CLABSI in the US are coagulase-negative staphylococci [10], *S. aureus*, enterococci, and *Candida* spp. Gram negative bacilli account for 19% of CLABSIs [11]. We found a predominance of gram-negative bacilli, similar to a study done on nosocomial BSI in Chandigarh, India [12]. A previous study done in our PICU also found 96.5% of bacterial isolates causing healthcare-associated infections to be gram-negative bacteria [4]. Thus, gram-negative bacill continue to dominate in developing countries where infection control practices are suboptimal. Moreover, approximately 31% of our isolates were nil-fermenters, which are now on the rise in healthcare settings. Emerging multi-drug resistant gram-negative bacteria are a major challenge in treatment of these infections, as also seen in our study.

Although, our hospital does not have a written antibiotic optimization policy, each department has antibiotic guidance protocols based on the local data of culture positive cases. The department of microbiology shares this data with the departments/units, which is updated regularly based on the spectrum of infections and antibiotic resistance pattern of organisms. Infection control nurse takes regular rounds and conducts surveillance of healthcare associated infections in various wards and ICU's of the hospital.

CLABSI are preventable primary bacteremias. Based on the present data, we suggest that the number of times the central line is accessed should be minimized and that too under strict aseptic precautions. Unnecessary change of line must be avoided and ongoing surveillance and evidence based studies should support such decisions. Healthcare workers should be educated about importance of hand hygiene and full barrier precautions [13].

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