Original Article

Central Venous Catheter Related Bloodstream Infections in Medical Intensive Care Unit Patients in a Tertiary Referral Centre

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Abstract

Aims. To determine the incidence of central line associated bloodstream infections (CLABSIs) in the medical intensive care unit (ICU) and ward setting at All India Institute of Medical Sciences (AIIMS), New Delhi.

Settings and Design. The study was conducted in the medical ICU, a 9-bedded ICU at the AIIMS, a tertiary care teaching hospital. The study design was a prospective observational study.

Methods. One hundred patients admitted to medical ICU and the ward at AIIMS with an indwelling, non-tunnelled central venous catheter (CVC) in place at admission and those with a hospital stay with indwelling CVC for more than 48 hours were monitored. These patients were followed daily for the development of new onset sepsis 48 hours after insertion of CVC, in which case three sets of blood samples for culture were drawn over a span of 24 hours.

Statistical Methods. Incidence of CLABSIs was measured per 1000 central line days.

Results. One hundred patients hospitalised for an aggregate 1119 days acquired 29 hospital-acquired infections (HAIs), a rate of 38.8% or 31.2 HAIs per 1000 hospital days. The incidence of bloodstream infections (BSIs) in this group was 6.8%. No case of laboratory confirmed CLABSIs could be demonstrated. Incidence of clinical sepsis was 27.6% or 8.2 per 1000 CVC days. There were 9 cases out of the 29 patients (39.7%) who had evidence of HAIs with no apparent focus of infection. Only one of these cases had evidence of BSI with isolation of *Staphylococcus aureus* in both CVC tip culture and the simultaneous blood culture; however the antibiograms were different.

Conclusions. The low rate of BSIs in the present study and the absence of occurrence of a laboratory confirmed CLABSI should be interpreted in the light of the small sample size of the study and the multitude of antibiotics received before the development of HAI. **[Indian J Chest Dis Allied Sci 2014;56:85-91]**

Key words: Central line associated bloodstream infection, Hospital acquired infection.

Introduction

Central line associated bloodstream infection (CLABSI) is a major contributing factor to in-hospital mortality and morbidity, extending the in-patient stay by 10 days and expenditure per patient by US$30,000.[1] In the intensive care unit (ICU) setting, the incidence of infection is often higher than in the less acute in-patient or ambulatory setting. In the ICU, central venous access might be needed for extended periods of time; patients can be colonised with hospital-acquired organisms, and the catheter may be manipulated several times daily for administration of fluids, drugs, and blood products. Moreover, some catheters may be inserted in urgent situations, during which optimal attention to aseptic technique might not be feasible. By several analyses, the cost of central venous catheter (CVC) associated bloodstream infections (BSIs) is substantial, both in terms of morbidity and in terms of financial resources.[1]

Several studies have been conducted at various point in time on various aspects of epidemiology, aetiology and prevention of CLABSIs, which have contributed significantly to the current knowledge of causation of disease and its implication in the management. Most published studies on the incidence of ICU-acquired infections and CLABSIs have come from developed western countries.[2-4] Some information on the scenario in developing countries has become available with the establishment of the International Nosocomial Infection Control Consortium (INICC) in 1998.[5] The rate of CLABSIs in limited-resource countries ranged from 1.6 to 44.6 cases per 1000 central line (CL) days in adult and paediatric ICUs and from 2.6 to 60.0 cases per 1000 CL days in NICUs[6] (Table 1).

Various authors have reported variable data on CLABSIs from India.[7-9] Notably, Mehta *et al*[7] reported an overall hospital associated infection (HAI) rate of 4.4% and 9.1% per 1000 ICU-days and a CLABSI rate of

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7.9 per 1000 catheter-days from a prospective surveillance carried out between July 2004 and March 2007 in 12 ICUs of the seven hospital members of the INICC in seven Indian cities. 10835 patients hospitalised for 52518 days acquired 476 health care associated infections. Recently Kaur *et al*[8] and Patil *et al*[9] from hospitals in India reported CLABSI rate of 2.8 per 1000 catheter days and 18.5%, respectively.

This present prospective survey was conducted in medical ICU of AIIMS, New Delhi on all patients with CVCs to ascertain the incidence of CLABSI, to identify the organisms and to determine the occurrence of infection from the various sites — internal jugular and subclavian lines.

Table 1. Central Line–Associated Bloodstream Infection (CLABSI) Rates

Country	Year	ICU(s)	Total No. of CLABSIs (LCBIs+CSEP)	No. of CL Days	CLABSI rate (95% CI)[a]
Turkey[22]	2008	Multiple	3	721	4.1 (0.8–12.1)
Tunisia[21]	2007	Neonatal	26	1847	14.8 (9.2–20.5)
Thailand[20]	2004	Neonatal	15	5667	2.6 (1.4–4.3)
Peru[19]	2008	Medical-surgical	50	6514	7.7 (5.7–10.1)
Mexico[18]	2006	Medical-surgical-neurosurgical	149	6465	23.1 (19.5–27.1)
Iran[17]	2003	Burn	30[b]	1739	17.0 (11.6–24.5)
Columbia[16]	2007	Neonatal	23	1701	13.5 (8.5–20.2)
Columbia[15]	2006	Medical-surgical-coronary, paediatric	126	11110	11.3 (9.4–13.4)
Brazi[l14]	2007	Neonatal	215	69491	3.1 (2.6–3.5)
Brazil[13]	2008	Medical-surgical	86	9494	9.1 (7.2–11.1)
Argentina[12]	2004	Coronary	23	1618	14.2 (9.0–21.2)
India[7]	2001	Medical-surgical-neurosurgical	292	36857	7.9 (7.0–8.8)

Definitions of abbreviations: CI=Confidence interval; CL=Central line; CSEP=Clinical sepsis; ICU=Intensive care unit; LCBI=Laboratory-confirmed bloodstream infection.

[a] No. of CLABSIs per 1000 CL days.

[b] Studies that did not collect data on CSEP (only on LCBIs).

Material and Methods

Setting and Study Design

This study was conducted in the medical ward and ICU, a 9-bedded ICU at the All India Institute of Medical Sciences, a tertiary-care teaching hospital in Delhi. The Institutional Ethics Committee approved the study protocol and study was conducted according to the declaration of Helsinki.

This was a prospective observational study conducted between 2009 and March 2011, during which all patients admitted with an indwelling, non-tunnelled CVC in place on admission or during the hospital stay to the medical ICU and ward at our hospital were screened for inclusion in the study.

Patients Selection

Patients fulfilling the following criteria were included in the study: (1) age ≥18 years, (2) insertion of first CVC during the ICU stay or in the Department of Emergency Medicine or in the Medicine ward of our hospital, and (3) ICU stay with an indwelling CVC for more than 48 hours.

Patients Follow-up

The patients were followed-up from admission to the ICU or ward after placement of a central venous line for more than 48 hours until the removal of the catheter or discharge or death, whichever was earlier.

Work-up of Patients and Microbiological Study

All patients enrolled in the study were followed daily for the development of new onset sepsis 48 hours after the insertion of the CVC. Temperature, pulse rate, blood pressure and respiratory rate were measured twice daily. Total and differential leukocyte counts were obtained every alternate day or earlier if sepsis was suspected. New onset sepsis was suspected when two or more of the following conditions were present along with suspicion of the infection: fever (temperature >38 °C) or hypothermia (<36 °C), tachycardia (>90 beats per minute), tachypnoea (>24 breaths per minute) and leukocytosis (>12000/cumm) or leukopaenia (<4000/cumm).

In a case of new onset sepsis, three sets of blood samples were drawn, two percutaneously and one through the CVC for culture over a span of 24 hours. An attempt to exclude other sources of infection was made by focused physical examination and relevant investigations including urine cultures, sputum cultures, tracheal aspirates, imaging studies etc depending upon the clinical profile of the patient. If no other apparent source of infection was found, then a BSI was suspected and the CVC was removed using a sterile technique. The distal 10 cm segment of the catheter was cut with a sterile blade into two equal pieces; one piece placed in a sterile transport tube and cultured using the semi-quantitative method described by Maki *et al*, (the Maki's Roll Plate Method) and the other piece was cultured for fungal isolates. Simultaneously, a peripheral blood sample was sent for culture from the same patient. The flow chart for the methodology is shown in figure 1.

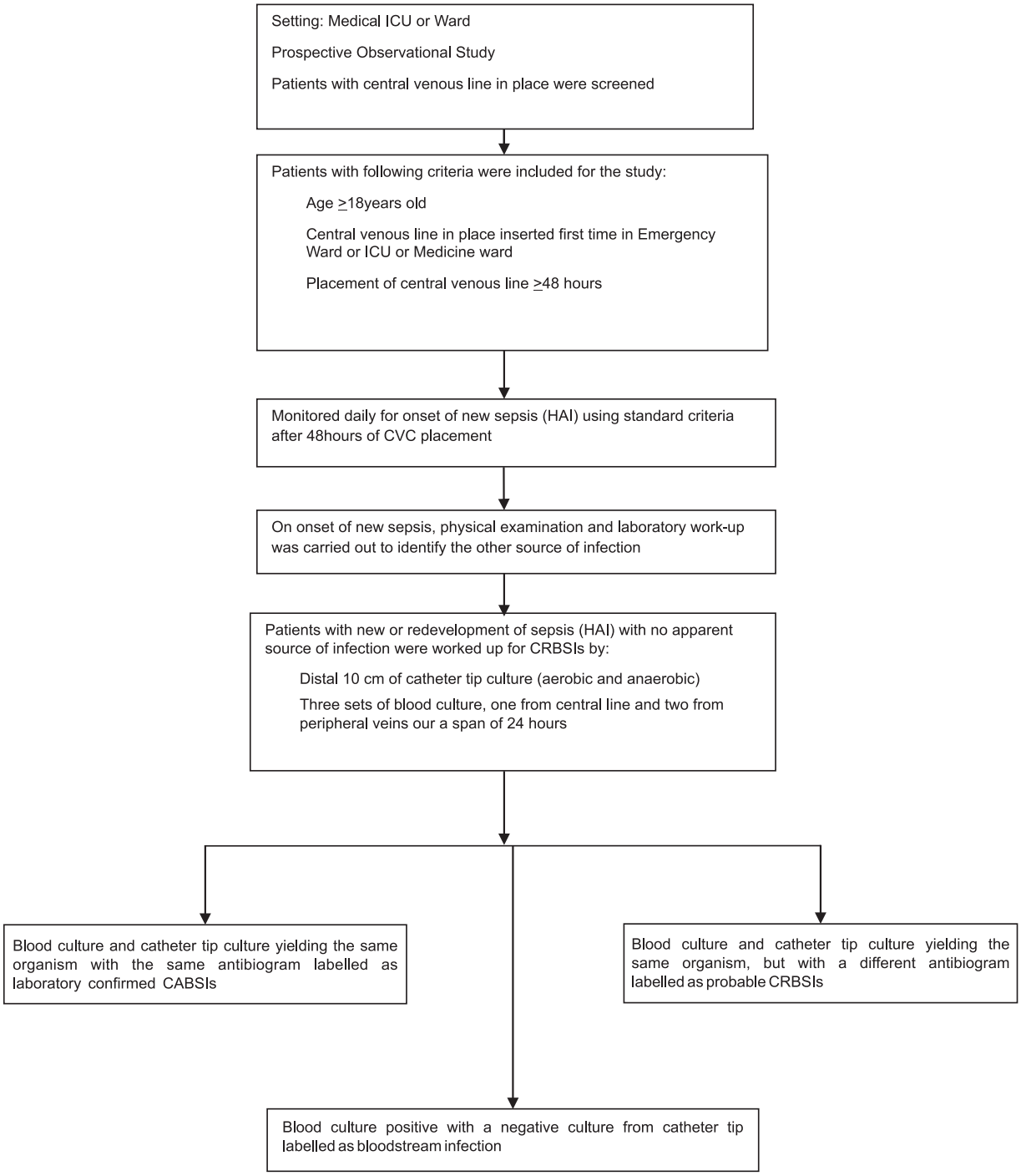

Figure 1. Flow-chart showing methodology of study.

Data Collection

For each patient, following data were recorded at inclusion: age, gender, co-morbidities, current diagnosis, site and duration of CVC insertion, indication for CVC insertion, other invasive devices present, findings on thorough general examination and systemic examination, chest radiograph at the time of admission, complete blood counts, liver function tests and renal function tests at admission, presence or absence of antimicrobial therapy at the time of inclusion.

Definitions

Central line associated bloodstream infection (Laboratory confirmed). A positive culture of the CVC tips whereby the same organism (species and anti-biogram) was isolated from the catheter segment and peripheral blood specimen in a symptomatic patient with no other apparent source of infection was labelled as CVC related BSI. For catheter tip culture, a semi-quantitative culture yielding 15 or more colony forming units (CFUs) was considered positive.

Probable CRBSIs. It has defined as positive blood culture with catheter tip culture yielding a micro-organism different from that isolated from the blood.

Catheter Day. A catheter day is defined as a single day on which a patient had one or more catheters.

CLABSI Rate. Number of catheter associated infection per 1000 central catheter days

HAI. It was defined in this study as re-appearance of sepsis or new onset of sepsis in patients after 48 hours of hospitalisation.

Results

The clinical characteristics of the enrolled patients are shown in table 2. The mean age of the patients was 50.1 years and the majority of patients (54%) were above 50 years of age with a slight male predominance. The total number of central line days was 1119 over the period of the study duration. Of the 100 patients enrolled, the rate of use of devices other than CVC was 99%; comprising of 765 ventilator days and 1022 urinary catheter days. Other devices used included double lumen femoral or jugular catheters (15%), intercostal drains (5%), pigtail catheters (1%), peritoneal dialysis catheters (5%) and EVD system (1%).

Of the 100 patients enrolled in the study, there was evidence of sepsis on presentation in 73 patients (Figure 2). Of these, 25 patients showed resolution of sepsis on discharge, while, 25 patients had persistent unresolved sepsis followed by death and 23 patients showed resolution of sepsis followed by re-development of sepsis due to a HAI. The median time for the development of a new infection in this subset was nine days (3-18 days). Of the 27 patients who did not have sepsis on presentation, six patients showed development of sepsis due to a HAI. The median time of development of a new infection in this subset was 6.5 days (3-15 days).

Table 2. Baseline characteristics of patients enrolled in the study

Parameters (n=100)	Values
Age (years) (mean±SD)	50.11±19.53
Agee≥ 50	54
Agee≥ 60	35
Gender	
Male	69
Female	31
Length of ICU stay	
Mean duration (mean±SD)	11.19±7.84
Range (days)	3-46
Site	
Subclavian	74
Internal Jugular	26
Indication	
Monitoring of central venous pressure	83
Venous access	17
Presence of septic focus elsewhere	72
Repeated catheterisation	4
Insertion circumstance	
Elective	92
Emergency	8

Thus, of the 100 patients enrolled, 29 had HAIs, a rate of 38.7% or 31.2 HAIs per 1000 hospital days. The incidence of BSIs in this group was 6.7%. The organisms isolated included ESBL+ve *Klebsiella pneumoniae,* HLAR+*E. faecium*, S. *aureus*and, ß lactamase+ *Acinetobacter* sp. Though no case of laboratory confirmed CLABSI could be demonstrated, the CLABSI rate according to the surveillance definition was 1.3% or 1.03 per 1000 CVC days. The incidence of clinical sepsis was 27.6% or 8.2 per 1000 CVC days.

Out of the 29 patients (39.7%), who had evidence of HAI, nine had with no apparent focus of infection. Only one of these cases had evidence of BSI with isolation of *S. aureus* in both central line tip culture and the simultaneous blood culture; however the anti-biograms were different with the species isolated from blood culture being methicillin sensitive and the species isolated from CVC tip culture being methicillin resistant.

The other eight patients had no evidence of BSI though cultures of the CVC tips were positive in seven of these patients. The most common organism isolated was methicillin-resistant *S. aureus* in four (45%) followed in equal frequency by methicillin-sensitive *S. aureus, Klebsiella pneumonia, Enteroccus* species and *Acinetobacter* species (Figure 3).

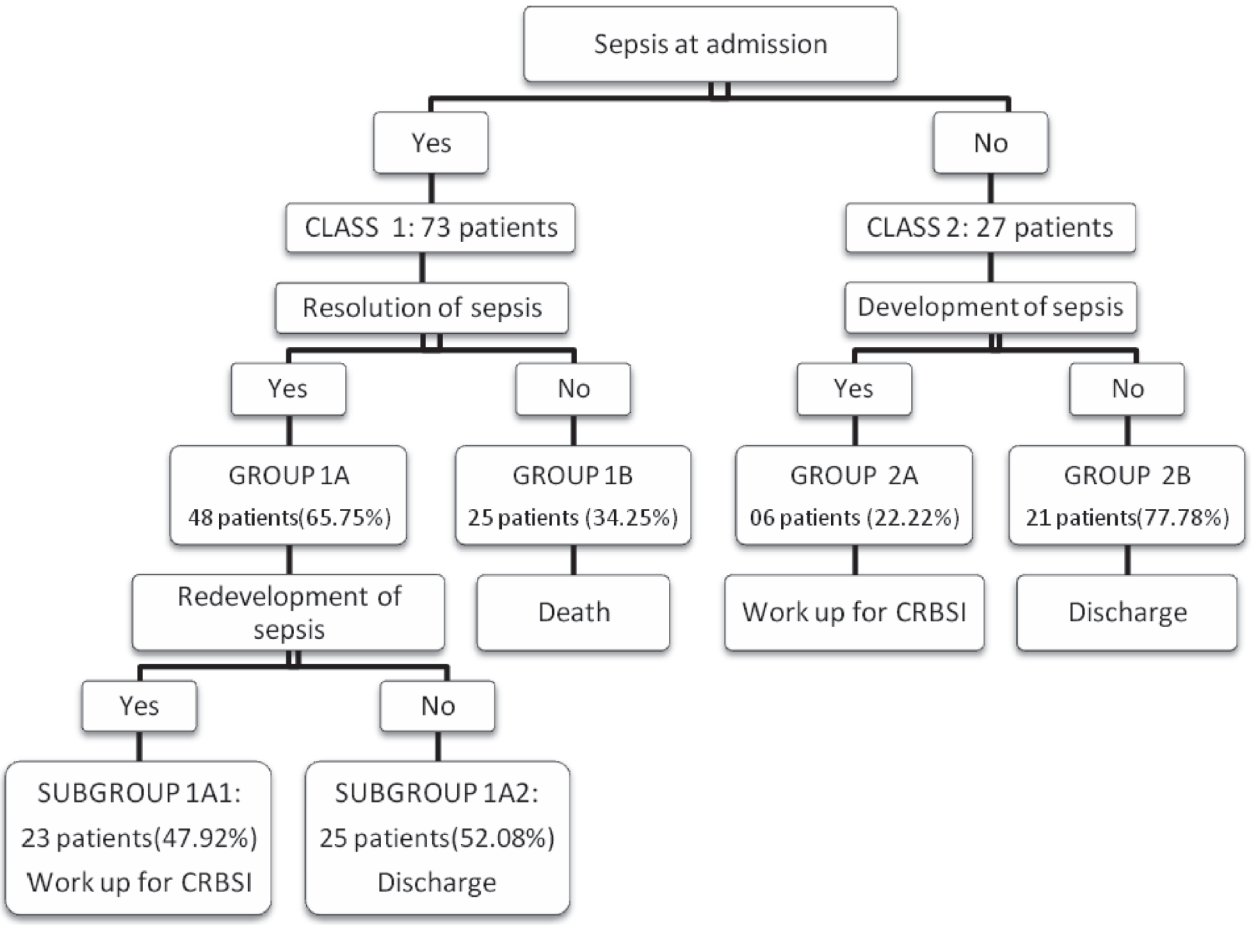

Figure 2. Algorithm showing the course during hospital stay of the 100 patients enrolled in the study.

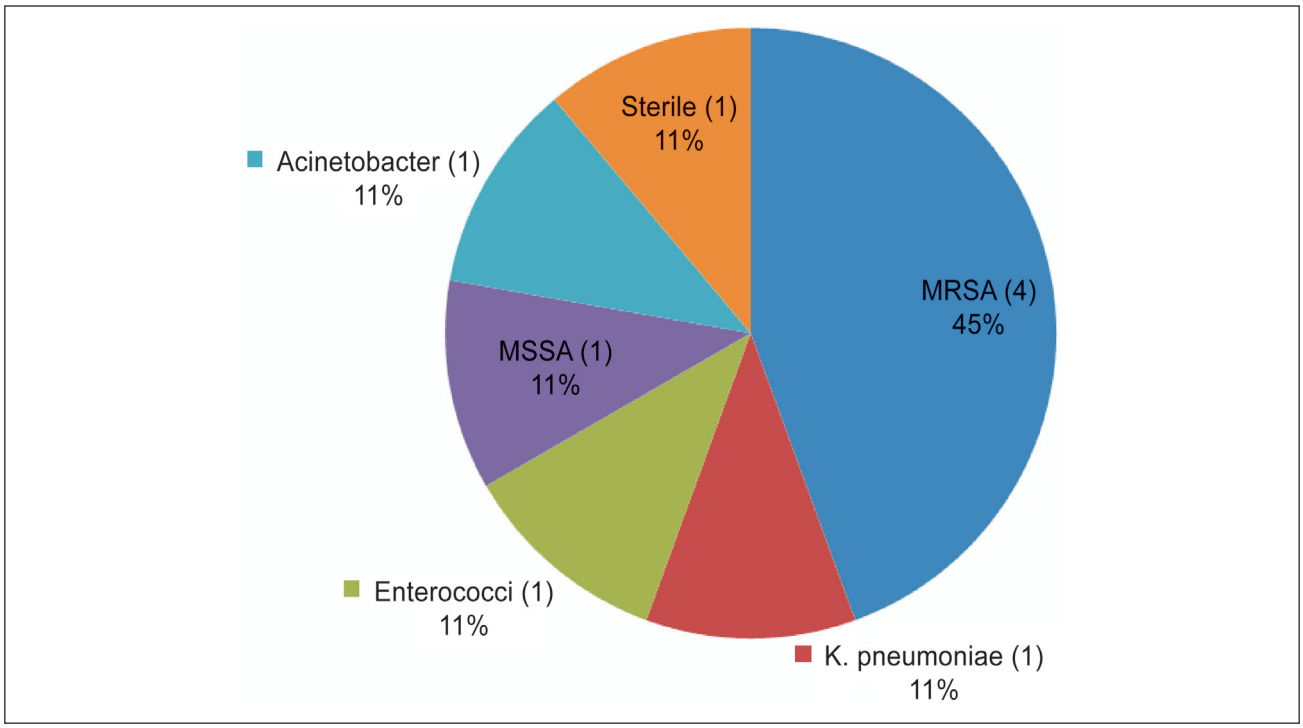

Figure 3. Organism isolated from CVC tip cultures in patients with HAI with no apparent focus of infection (n=9).

Discussion

Central line associated bloodstream infection remains a serious and the most common cause of HAIs worldwide.[2, 3] While in the United States the pooled mean ICU CLABSI rate and the pooled mean in-patient ward CLABSI rate are 1.6 and 1.1 per 1000 CL days, respectively; in the developing countries the ICU CLABSI rate ranges from 1.6 to 44.6 cases per 1000 CL days in adult and paediatric ICUs and from 2.6 to 60.0 cases per 1000 CL days in neurology ICUs.[6,10]

A study by Peng and Lu[23] from China showed a CLABIS rate of 11.0 per 1000 catheter days, while a rate of 11.5 per 1000 catherter days was reported from Greece by Tarpatzi *et al*.[24] On the other hand, Wittekamp *et al*[25] from Netherlands reported a lower rate of CLABSI at 1.2 per 1000 catheter days for central venous cathether and 2.1 per 1000 catheter days for arterial catheters. According to one study from India,[7] the CLABIS rate in ICU was 7.9 per 1000 catheter-days. In the present study five cases of BSI were identified in patients who developed HAI (39.8%) with a CVC *in situ*. There were another five (25%) cases of BSI in the patients in subset that had persistent sepsis since admission; however, these cases were not included in the final analysis as it was not possible to determine whether the bacteraemia was due to the infection present at admission or was hospital acquired. Thus, the incidence of BSI was 17.2%; however, this might be an under-estimation of the rate of BSI since this latter subset (1B) was not included. No case of laboratory confirmed CVC related BSI was identified. However of the five cases (17.2%) with BSIs, one case with no other apparent source of BSI with isolation of *Staphylococcus aureus* in both CVC tip culture and the simultaneous blood culture. However, the anti-biograms were different with the species isolated from blood culture being methicillin-sensitive and the species isolated from CVC tip culture being methicillin-resistant. It may be a case of probable CLABIs arising from a colonisation of the catheter tip with methicillin-resistant *S. aureus* through migration from skin in ICU.

There were eight out of the 29 patients (39.7%) who had evidence of HAI with no other apparent focus of infection. These patients had no evidence of BSI but cultures of the CVC tips showed positivity in seven of these patients with improvement in the clinical condition with resolution of sepsis in four patients upon removal of the CVC and institution of antimicrobial therapy guided by sensitivity testing. Thus, in at least four out of 29 patients (13.8%), the source of clinical sepsis was associated with an infected CVC though these cases met neither the clinical nor the surveillance definition of CLABSI. The rate of localised CVC colonisation in the patients with HAI was 57.7%.

The low rate of BSIs in this study and the absence of a laboratory confirmed CLABSI should be interpreted in the light of the small sample size of the study and the multitude of antibiotics including anti staphylococcal antibiotics received by the patients before the development of HAI.

Over the years, there has been a change in the aetiology and sensitivity patterns of CLABSIs with increased incidence of Gram-negative bacteria, coagulase-negative *Staphylococci*, followed by *Enterococci*.[11] In the present study, there was a paucity of isolation of coagulase negative *Staphylococcus* species and gram negative bacteria. Instead, *S. aureus* was the most common organism isolated, but Gram-negative aerobes were as common as *S. aureus*. This has implications for the catheter care practice. While staphylococcal infection is due to migration of skin organisms at the insertion site into the cutaneous catheter tract with colonisation of the catheter tip, infusate contamination and handling by health care personnel is associated with CLABSI due to Gram-negative aerobes.

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