A Prospective Cohort Study on the Infections Associated with Indwelling Medical Devices in a Tertiary Care Hospital in South India

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Abstract
Devices associated infections (DAIs) have major impact on patient morbidity. This study was aimed to evaluate the active prospective surveillance to measure the prevalence of three common DAIs like catheter associated urinary tract infection (CAUTI), ventilator-associated pneumonia (VAP) and intra vascular catheter related bloodstream infection (IV-CRBSI) in different ICUs/wards in a tertiary care centre. Urine was collected by aspiration of the catheter in CAUTI, endotracheal aspirate in VAP, catheter tips and blood samples in IVCRBSI were collected and processed as per the standard microbiological techniques. Descriptive analysis of the data was done and DAI rate was expressed as number of DAI per 1000 device days. The overall infection rate for CAUTI, VAP, IV-CRBSI were found to be 7.03, 34.84 and 0.47 per 1000 device days, respectively. Major organisms isolated were Escherichia coli, Acinetobacter baumannii, Klebsiella pneumoniae, and Pseudomonas aeruginosa,. Most of them were multi drug resistant. High rates of DAIs and antimicrobial resistance require strengthening the infection control, instituting surveillance systems, and implementing evidence-based preventive strategies.
Keywords: *Devices associated infections, multi drug resistant, urinary tract infection, ventilator-associated pneumonia.*

Introduction

The development in technology has allowed the use of wider and newer varieties of medical devices in the treatment and diagnosis of various diseases to improve the health or to save the lives of patients. The number of intravascular catheters, urinary catheters, endotracheal tubes and other temporary devices inserted each year probably ranges in millions. The variety of available devices and the frequency with which they are implanted will be undoubtedly increasing in the coming years. The development in the field of Geriatrics and consistently growing number of inserted devices are likely to escalate the

occurrence of medical devices related infections. Medical devices are associated with definite risk of bacterial and fungal infection[1]. The consequences of device related infections can be disastrous which include potentially life threatening systemic infections. Furthermore, infections of devices may result in device malfunction that hence may require device removal, often complicated by tissue destruction[2]. Surveillance of hospital acquired infections helps in determining the prevalence, risk factors and in planning the preventive strategies[3-4]. The present study targets on three common Device associated infections (DAIs) such as Catheter associated urinary tract infections (CAUTI), Ventilator -associated pneumonia (VAP) and Intravenous catheter-related bloodstream infections (IV-CRBSI). The knowledge of prevalence of these infections, their etiological agents and antibiotic susceptibility pattern may direct the optimum antibiotic treatment that can be installed. This study aims to measure the prevalence of three common DAIs like catheter associated urinary tract infection (CAUTI), ventilator-associated pneumonia (VAP) and intra vascular catheter related bloodstream infection (IV-CRBSI) in different ICUs/wards.

Methodology

This prospective cohort study was performed over a period of one year in a 1500 bedded tertiary hospital with the approval from the Research and Ethical committees of the institution and informed consent from each patient's next of kin. The study targeted at three common DAIs like CAUTI, VAP, and IV-CRBSI. Patients with Foleys catheter in situ of duration of >3days in neurology, urology wards and neurology intensive care unit (NICU) and patients kept on mechanical ventilation for more than 48 hours in the neonatal ICU (NNICU) and Neurosurgery ICU (NSICU) were selected for the study. In patients presented with clinical symptoms and signs of septicemia after venous and arterial catheterization blood samples were collected for culture. Out patients,

patients with devices of short duration i.e. <48 hours and patients not willing to enroll were excluded.

Subjects and sample collection

Along with the patient's demographic details such as name, age and sex, the details of date of hospital admission, diagnosis, type of devices, time and date of device insertion were collected. Device days were recorded every day. Physicians' notes and investigation reports were observed for any signs of infection. If infection was suspected, the appropriate clinical sample for the type of device was collected.

Urine- Two ml was collected by puncturing the catheter tubing with a needle and syringe after cleaning with 70% ethyl alcohol. Samples were transported without delay.

VAP- Endotracheal aspirate was collected by using a sterile 12G endotracheal suction catheter tube[5]. Suction catheter was connected to the suction pump and passed through endotracheal tube for a distance of approximately 25 cm. Samples were transported immediately.

IV–CRBSI-Catheter tips were collected from all the patients at the removal of catheter. Catheter was removed with sterile forceps after cleaning the skin with 70% alcohol. The terminal 2-3 inches of the tip was cut with sterile scissors and transported to the laboratory as soon as possible[6,7].

Blood samples from peripheral veins were collected from the patients with clinical evidence of sepsis. 1ml of blood in pediatric patients and 3-4 ml in adult patients were collected with aseptic precautions in BAC T/ALERT culture bottles.

Sample processing

Urine- samples were examined by macroscopy as clear/turbid/blood stained. By direct microscopy the finding of ≥ 3 leucocytes per HPF of unspun urine was considered as significant[8].

Semi quantitative culture was done on sheep blood agar (SBA) and MacConkey agar (MA) and the plates were incubated aerobically at 37°C for 18-24 hrs.

Endotracheal aspirate- Direct microscopy was done by smear preparation & Gram staining with the purulent portion of the samples. Semi quantitative culture method by using standard calibrated loop was followed after homogenization of the sample by vortexing for 1 minute. Inoculation was performed onto SBA, MA and Chocolate agar media. The plates were incubated at 37ºC aerobically for 18-24 hrs.

Catheter Tip-Semi quantitative method used by Maki et al (Roll over plate method) was followed for culture[6,7]. The tip was rolled back and forth across the entire surface of media like SBA and MA using sterile forceps and exerting slight downward pressure and incubated at 37ºC aerobically for 18-24 hrs.

Blood sample- Blood culture was performed by automated method. BAC-T /ALERT bottles were loaded in the equipment. Sub culture was done on SBA and BA and incubated at 37ºC for 18 - 24 hrs from the samples with alert.

All isolates were subjected to identification tests by conventional and automation (vitek 2). Antibiotic susceptibilies were determined according to CLSI guidelines. For data collection and analysis, two important parameters were considered.

They were:

Denominator data

This included all patients exposed to the particular device during surveillance period. A total number of device days were thus calculated.

Numerator data

This included number of patients who developed bacteriologically confirmed infection on a particular device as per standard definitions. Device – associated infection rate was expressed as the number of DAIs per 1000 device days, as calculated by dividing the number of persons developing device-associated infection by the total number of device days and multiplied by 1000.

Results

One hundred and fifty urine samples were collected from neurology ICU and wards and urology wards (Table 1). Of these 36 samples yielded significant growth (24%). The predominant isolate was *Escherichia coli* followed by Candida species. *Pseudomonas aeruginosa* was the third predominant. Other organisms were *Klebsiella pneumoniae*, *Enterococcus fecalis* (Fig1). Among the candida isolates Candida albicans was the commonest followed by Candida tropicalis.

A total of 98 endotracheal aspiration samples were collected from neurosurgery and neonatal ICUs (Table 2). 30 samples grew significant isolates (30.6%). The major pathogens isolated from these samples were Gram negative bacilli. *Acinetobacter baumannii* was found to be predominating (31%) followed by *Klebsiella pneumonia* (25%). *Pseudomonas aeruginosa*, *Escherichia coli* and MRSA were other pathogens isolated (Fig 2).

Two hundred and forty intravenous cannula tips sere collected for microbiological study (Table 3). Organisms found to be colonizing were Coagulase negative staphylococcus (32%) followed by Candida spp and *K. pneumonia* and *Enterococcus fecalis* (Fig 3). The only isolate causing blood stream infection in the present study was *K. pneumonia*, resulting an infection rate of 0.41%. A very high resistance was observed in our syudy. 84.21% of the total Gram negative isolates of the present study were found to be extended spectrum betalactamase producers (Table 4). All Gram positive isolates were susceptible to Vancomycin & Linezolid. 75% *S.aureus* isolates were Methicillin resistant. Ventillator associated pneumonia (30.6) was the commonest DAI followed by Catheter associated urinary tract infection (24%) and IV catheter related blood steam infection (0.41%) in our hospital (Table 5).
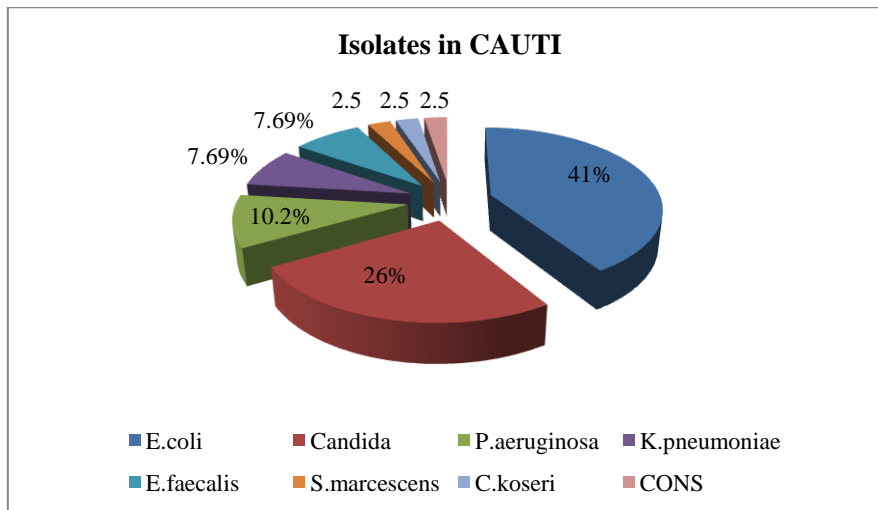
Isolates in CAUTI

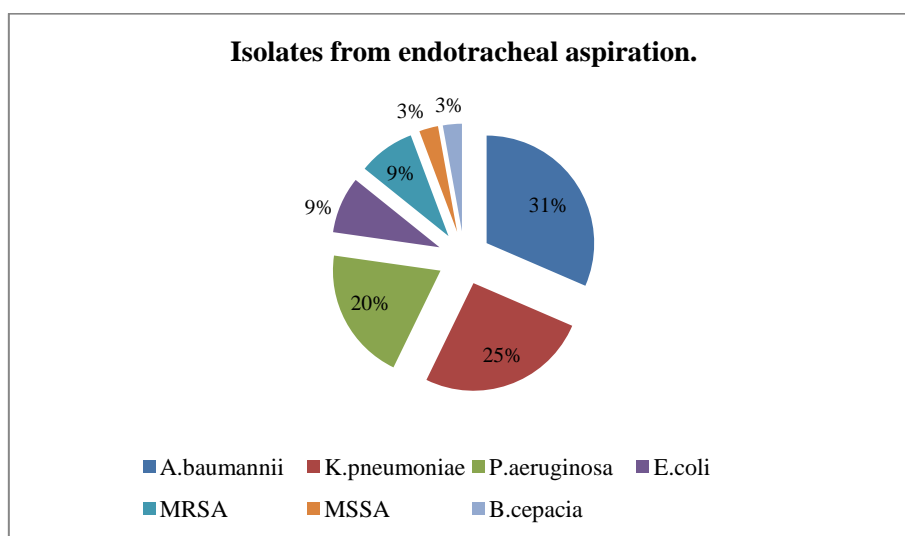**Fig 1.** Distribution of isolates in CAUTI

Isolates from endotracheal aspiration.

Figure 2 Distribution of bacteria in VAP

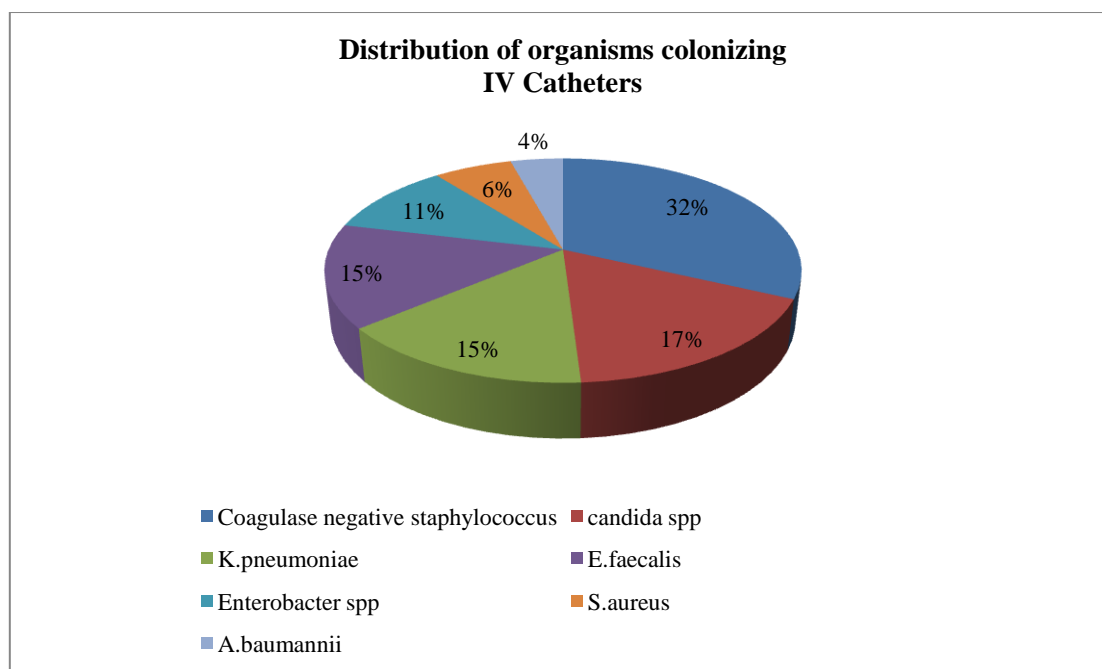**Distribution of organisms colonizing IV Catheters**

Fig 3. Distribution of bacteria in IV-CRBSI

Table 1 Distribution of patients on indwelling urinary catheter.

ICU/Ward	No of patients studied
Neurology ward	76
Neurology ICU	44
Urology ward	30
Total	150

Table 2: Distribution of patients in Ventilator

ICU	No of patients studied
NSICU	60
NNICU	38
Total	98

Table 3 Distribution of patients in IV-CRBSI

ICU	No of patients studied
Neonatal ICU (NNICU)	116
Multiple critical care unit (MCCU)	37
Medical ICU (MICU)	24
Neurology ICU (NICU)	22
Pediatric ICU (PICU)	16
Neurosurgery ICU	25
Total	240

Table 4 Antibiotic susceptibility pattern of ESBL producing pathogens from the total Gram negative isolates

No of Isolates	Susceptible to (percentage)		
	IPM	TGC	CL
E.coli(n=16)	11(68.75)	15(93.75)	16(I00)
A.baumannii(n=11)	4(36.36)	11(I00)	11(I00)
K.pneumoniae(n=12)	10(83.3)	12(I00)	12(I00)
P.aeruginosa(n=8)	7(87.5)	-	8(I00)
S.marcescens(n=1)	1(I00)	1(I00)	1(I00)

IPM –Imipenem, TGC- Tigecycline, CL- Colistin

Table 5: Prevalence of dais

Type of infection(DAIs)	Total no of cases studied	Prevalence (%)	Prevalence per 1000 device days
CAUTI	150	24	7.03
VAP	98	30.6	34.84
IV-CRBSI	240	0.41	0.47

Discussion

In the present study, a prospective surveillance of three common DAIs like catheter-associated urinary tract infection (CA-UTI), ventilator-associated pneumonia (VAP) and IV-catheter-related bloodstream infections (IV-CRBSI) to determine the prevalence, etiology and antibiotic susceptibility pattern of the isolates was carried out between June 2012 and May 2013, in different wards/ICUs in a tertiary care centre in Kerala.

A total number of 150 catheterized patients were studied. Only 36 cases of CAUTI were confirmed microbiologically. The overall prevalence rate of CAUTI was 24% or in other words 7.03 per 1000 catheter days in our study, which is high compared to earlier studies[9,10]. An Indian study by Singhai et al. reported high prevalence rate of 26.6% similar to the present study[11]. Rates will vary in studies according to how long the patients have been catheterized and how often urine cultures are performed. Similar to earlier studies,[9-11] in the present study, we found the Gram negative bacilli were the major isolates comprising Enterobacteriaceae (53.84%) and Nonfermenters (10.25%) . *E.coli* was predominant (41%) which was consistent to the previous

studies[9-11] followed by Candida spp, *P. aeruginosa, K. pneumonia* and *E. faecalis*. Manish et al. had reported that 100% of *E. coli* isolates were susceptible to Imipenem, 82.46% to Nitrofurantoin and 87.7% to Amikacin. In our study, *E. coli* were found to be susceptible to Amikacin (68.75%), Imipenem (68.75%), Cefoperazone + Sulbactum (62.5%), Nitrofurantoin and Piperacillin+Tazobactam (56.25% each).

Increasing antibiotic resistance is a major clinical problem faced by clinicians in treating infections by these microorganisms.. Similar to other reports, [11-13] in the present study also majority of the uropathogens in the catherized patients were resistant to Ampicillin, Ciprofloxacin, Cotrimoxazole and Gentamicin. Among the *E. coli* isolates 81.25 were extended spectrum beta lactamase (ESBL) producers. Dugal et al. [13]has reported 70.9% ESBL producing *E. coli* isolates in catheterized patients. The rate of antibiotic resistance of the isolates in our study was found to be high compared to other Indian studies.[11-13]

VAP is an important DAI as a result of mechanical ventilation in the available studies [14-17] 98 patients kept on ventilation for > 48 hrs were included in the study. Out of the clinically suspected cases, 30 patients were confirmed microbiologically ensuing an infection rate of 30.6% or in other words 34.84 infections per 1000 ventilator days. The rate of VAP in the present study is high similar to other Indian studies[14-16]. The causative organisms vary with the patients demographics in the ICU, the method of diagnosis, the duration of hospital stay and the institutional antimicrobial policies. VAP may be caused by a wide spectrum of bacterial pathogens. In the present study , Gram negative bacteria were the most common pathogens of VAP, as observed in other studies.[14-17] Earlier studies[15,16] had shown that *Pseudomonas* and *Klebsiella* were the common organisms. In contrast to previous studies in the present study, *Acinetobacter baumannii*was found to be the most common organism causing VAP followed by *K. pneumoniae, P. aeruginosa, E. coli, B. cepacia* and *S. aureus*. Similar bacteriological profile was found in recent studies by Chawla et al[18] and Ranjit et al[17].

Chawla et al[18] was demonstrated that *Acinetobacter* spp was found to be emerging in several countries, notably Malaysia, Thailand, Pakistan and India . Recent studies have shown that the increasing incidence of multidrug resistant pathogens are seen among the pathogens with VAP[14-17] Although the *Acinetobacter* species is less virulent than Pseudomonas, they are becoming more and more resistant to the commonly used antimicrobial agents. So in coming future infections by *Acinetobacter* may be a major problem in the similar clinical settings. Of the isolates in VAP in the present study,

*A. baumanii*was found to be the most resistant one. None of the *Acinetobacter* isolates were found to be susceptible to Ampicillin (AMP), Gentamicin (G), third generation cephalosporins, ciprofloxacin(CIP) and piperacillin +tazobactum (PT) combinations in the present study. 36.3% were found to be susceptible to Imipenem (IPM) , 18.1% to Amikacin (AK) & Cefoperazone+ Sulbactum (CM). *K. pneumoniae* isolated in this study was susceptible to CM (44.4%), AK (66.6%), PT (33.3%) and IPM (88.8%). *Pseudomonas aeruginosa* was found to be susceptible to PT (71.4%), CM (57.1%), AK (28.5%) and IPM (85.7%). All the Gram negative pathogens were susceptible to Colistin and Tigecycline.

In the present study all *S. aureus* isolates were susceptible to Vancomycin and Linezolid. The rate of antibiotic resistance among the isolates in our study is high, similar to other studies conducted in various institutions in India[14-16]. For IV- CRBSI surveillance, IV catheter tips of 240 patients were studied. CRBSI was confirmed only in one case, with an infection rate of 0.41% or in other words 0.47 infections per 1000 device days. The infection rate in present study is quite low in comparison to another Indian study[19]. In one recent study Singh et al has reported a rate of 0.48

per 1000 device days similar to the present study[9].

Colonization rate of IV catheter tips in the current study is low (19.5%) in comparison to the previous study[19]. The isolate obtained in CRBSI in the present study was *K. pneumoniae*. Gram positive organisms were the most common cause of blood stream infections in most of the previous studies[19,20]. Among the colonization associated organisms, Coagulase negative staphylococcus were the major isolates followed by Candida spp and *K. pneumoniae* similar to other Indian study [20]. The organisms commonly found in HAIs are nosocomial pathogens prevalent in the hospital environment. The organisms isolated in the present study were multi drug resistant *K. pneumoniae, E. coli, A. baumannii, P. aeruginosa, S. aureus, E. faecalis* and CONS; similar to the findings in other studies[9-10,14-17].

The DAI rates as evident in literature are highly variable, depending upon a number of factors such as type of patients admitted, prescribing habits of the clinicians, antibiotic policy and infection control programs of the institute. Surveillance of health care associated infections is important to understand the nature and extent of the problem. The present study proves that the DAIs were caused mainly by drug resistant bacteria. The varying resistance pattern of organisms isolated in our study, emphasizes the importance of studying the pattern of infection in every setting. Each institution and each ICU must have an antibiotic policy of its own which should be frequently revised by active surveillance programme.

Conclusion

Prevalence of CA-UTI was 24% or in other words 7.03 infections per 1000 catheter days. *E.coli* (41%) was the major isolate followed by Candida species (26%), *P. aeruginosa* (10.2%), *K. pneumoniae* (7.69%), *E. faecalis* (7.69%)). Candida albicans (60%) was the common fungal isolate followed by C.tropicalis (30%). Infection rate of VAP in our institution was found to be 30.6% or 34.84 per 1000 ventilator days.

A.baumannii (31%)was the predominant isolate followed by *K. pneumoniae* (25%), *P.aeruginosa* (20%), *E.coli* (9%) , MRSA(9%) , MSSA(3%), *B. cepacia* (3%) in VAP. CRBSI was confirmed only in one case, with an infection rate of 0.41% or in other words 0.47 per 1000 device days. Colonization rate of IV catheters in the current study was 19.5%. Isolate obtained in CRBSI was *K.pneumoniae* which was susceptible only to Tigecycline and Colistin. In this study major isolates were Gram negative bacilli (76%). Among the total Gram negative isolates, 84.21% were found to be ESBL producers.

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