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A DESCRIPTIVE STUDY ON THE INCIDENCE AND BACTERIOLOGICAL PROFILE OF DEVICE ASSOCIATED INFECTIONS (DAI) IN INTENSIVE CARE UNITS (ICUS) AT A TERTIARY HEALTH CARE CENTRE IN CENTRAL INDIA

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ABSTRACT

Introduction: The advent of life supporting medical devices has been a medical boon in modern critical care but have also increased the risk of Device Associated Infections among patients, particularly Intensive care patients. **Objectives:** To study the incidence and bacteriological profile of DAIs in the Intensive Care Units (ICUs) of our tertiary healthcare Centre. **Materials & Methods:** A total of 567 of clinically suspected DAI patients were received and processed for identification and antimicrobial susceptibility profile. Patients' demographic details, clinical history and device days were taken from Hospital Infection Control (HIC) data maintained by HIC nurse (HICN). **Results:** The incidence rate of DAI was found to be 8.3 per 1000 device days with VAP, CAUTI and CRBSI rate of 12.7, 7.3 and 3.6 per 1000 device days respectively. The bacterial pathogens isolated included Klebsiella pneumoniae (35.45%), Pseudomonas aeruginosa (21.81%), Escherichia coli (16.36%) and Acinetobacter baumannii (15.45%). Gram positive isolates were less common and included Staphylococcus aureus (2.7%) and Enterococcus spp. (4.5%). The isolates exhibited a high degree of antimicrobial resistance. 38.8% of E. coli and 30.7% of K. pneumoniae strains are ESBL producers. 40% of the Enterococcus spp. strains were found to be Vancomycin resistant and 66.7% of the S. aureus were resistant to Methicillin. **Conclusion:** Studies report the incidence of DAIs as two to five times higher in Intensive Care Units as compared to the general wards. Lack of a proper surveillance in place makes it difficult to establish the exact DAI burden in our country. A proper and active surveillance is necessary to strengthen the Infection Prevention and Control practices and to monitor and contain the emerging antimicrobial resistance.

KEYWORDS : Device Associated Infections, VAP, CRBSI, CAUTI

INTRODUCTION:

The advent of life- supporting medical devices has created a new category of patient population with increased susceptibility to infections.[1] Patients admitted to ICUs are more critical and are at higher risk of contamination and cross infection.[1,2] Device Associated Infections (DAIs) are infections occurring in patients, 2 calendar days after being inserted with medical devices, viz., central lines, urinary catheters or ventilators.[3,4]

The major DAIs include Catheter Associated Urinary Tract Infection (CAUTI), Ventilator Associated Pneumonia (VAP) and Catheter Related Bloodstream Infections (CRBSI).[5] It is a global health problem associated with increased morbidity, mortality, treatment expenditure and prolonged hospital stay.[5,6] Its incidence depends on frequency and duration of use of medical devices, device types, infection control practices and patient's immune status.[6] ICUs are also conducive to emergence of antimicrobial resistant microorganisms, making their treatment difficult.[1,6]

MATERIALS & METHODS:

This is a prospective study to determine the incidence, bacteriological profile and antibiogram of DAIs in our ICUs for a period of 1 year i.e., from October 2022 to September 2023. Two ICUs were included in this study – a 40 bedded Medicine ICU (MICU) and a 40 bedded Surgery ICU (SICU). Approval from the Institutional Ethics Committee was taken. Patient's demographic details, clinical history and device days were collected from the data maintained by Hospital Infection Control Nurse (HICN).

Study Population:

Patients admitted in MICU and SICU, having one of the medical devices for ≥ 2 calendar days with signs and symptoms of infection.

Patients with a known focus of infection and whose devices were inserted outside our ICUs were excluded.

The following case definitions are used for diagnosis of the three infections.

I. Catheter Associated Urinary Tract Infection (CAUTI):

a. Patient with indwelling or intermittent urethral or suprapubic catheterisation for ≥ 2 calendar days.
b. Development of fever, rigors, altered mental status, malaise, lethargy, suprapubic/ flank pain, etc. with no identified cause.
c. ≥1 microbial species isolated from a single urine culture and a colony count of $>10^3$ CFU/mL.[3]

II. Ventilator Associated Pneumonia (VAP):

Pneumonia occurring 2 calendar days after endotracheal intubation or mechanical ventilation and characterised by:

a. Presence of a new or progressive infiltrate on chest X- ray.
b. Fever / leukocytosis / leukopenia
c. Deteriorating oxygen saturation
d. Changes in sputum characteristics
e. Detection of a microbiological pathogen.[4]

III. Catheter Related Bloodstream Infection (CRBSI):

Development of clinical symptoms like fever, chills, hypotension, 48 hours after insertion of central lines with the isolation of the same microbial agent from central line tip and percutaneous blood.[6]

Sample Collection & Processing:

Following samples were received from suspected patients:

i. CAUTI – Urine sample from the catheter. Sample was screened for presence of leucocytes and inoculated on Blood & CLED agar.
ii. VAP – Endotracheal secretions. Gram stain is done and sample is inoculated on Blood and MacConkey agar.
iii. CRBSI – Peripheral blood in blood culture bottles and distal 5cm tip of the central venous catheter. Blood culture is processed by conventional method and CVC tip by Semiquantitative Roll Plate Method. Growth of ≥ 15CFU is considered significant.[6]

Identification was done by standard bacteriological methods. Antimicrobial Susceptibility was performed according to CLSI 2022.[7]

RESULTS:

A total of 180 endotracheal samples of suspected VAP cases, 240 samples of 120 suspected CRBSI cases, and 147 samples of suspected CAUTI cases were received. The rate of VAP, CRBSI and CAUTI was found to be 12.74, 3.6 and 7.3 per 1000 device days respectively, bringing the overall DAI rate to be 8.3 per 1000 device days.

Bacteriological Profile:

VAP:

K. pneumoniae (40%) was the most common organism isolated followed by *P. aeruginosa* (25%), *Acinetobacter baumannii* (21.6%), *E. coli* (5%), *Enterococcus spp.* (5%) and *S. aureus* (1.6%).

CAUTI:

E. coli (35%) was the most common pathogen followed by *K. pneumoniae* (30%), *P. aeruginosa* (19%).

CRBSI:

Pathogens isolated were *K. pneumoniae* (30.7%), *P. aeruginosa* (15.3%), *A. baumannii* (15.3%), *B. cepacia* complex (15.3%), *E. coli* (15.3%), and *S. aureus* (7.6%). Catheter tip colonisation was 23.3%.

Table 1: Bacterial pathogens isolated:

Bacterial Isolates	VAP	CAUTI	CRBSI	DAI
K. pneumoniae	24	11	4	39
E. coli	3	13	2	18
Citrobacter freundii.	-	2	-	2
P. aeruginosa	15	7	2	24
A. baumannii	13	2	2	17
Burkholderia cepacia complex	-	-	2	2
S. aureus	2	-	1	3
Enterococcus	3	2	-	5
Total	60	37	13	110

Table 2: Resistance pattern of Enterobacteriaceae isolates:

Antimicrobials	K. pneumoniae (n=39)	E. coli (n=18)	Citrobacter freundii (n= 2)
CX	89.75	83.33	100
GEN	79.49	66.66	100
TOB	92.31	83.33	100
COT	84.62	88.88	100
CXM	87.18	88.88	100
CTX	89.75	88.88	100
CPM	89.75	83.33	100
PIT	87.18	77.77	100
MRP	87.18	72.22	100
AK	71.79	83.33	100
NIT	79.49	55.55	100
FO	-	61.11	-

Table 3: Resistance pattern of Non fermenter isolates

Anti-microbials	P. aeruginosa (n=24)	A. baumannii (n =17)	Burkholderia cepacia complex (n= 2)
CAZ	87.5	94.11	100
PIT	75	76.47	-
GEN	75	82.35	-
TOB	79.16	82.35	-
CPM	87.5	76.47	-
AT	79.16	-	-
MRP	70.83	70.58	50
AK	66.67	70.58	-
LE	62.5	76.47	50
NET	58.33	-	-
AMS	-	58.82	-
MI	-	82.35	50
COT	-	88.23	50

Resistance Pattern of Gram-positive isolates –

S. aureus (n=3) – 66.7% of the isolates were resistant to Methicillin, Cotrimoxazole and Doxycycline. 33.3% were resistant to Erythromycin, Clindamycin, Linezolid and Gentamicin.

Enterococcus spp. (n=5) – Isolates were 80% resistant to High level Gentamicin, 60% to Doxycycline and Linezolid, 40% to Vancomycin and High- level Streptomycin, 20% to Teicoplanin and 100% to Penicillin.

DISCUSSION:

The current study reported DAI rate of 8.3/1000 device days which is higher compared to 2.6/ 1000 device days rate reported by Singh et al (2010)[2] but comparable to 9.06/ 1000 device days rate reported by the International Nosocomial Infection Control Consortium (INICC, 2007),[8] and a 7.40/ 1000 device days rate reported by Khan et al (2021).[15] A much higher rate of 24.6/1000 device days was reported by Kashyap et al (2016)[10].

Here, VAP was the most prevalent DAI with a rate of 12.7 which is in concordance with Kashyap et al, 2016 (16.74/ 1000 device days).[10]

CAUTI rate was 7.3/ 1000 device days, comparable to rates observed by Rosenthal et al, 2006 (8.9/ 1000 device days)[8].

CRBSI rate was 3.6/1000 device days comparable to Khan et al, 2021 (2.53/ 1000 days).[9]

Overall, *Klebsiella pneumoniae* (35.45%) was the most common pathogen isolated. This is in concordance with Khan et al[9] (24.6%) and Kashyap et al[10] (40.74%). Other common isolates include *Pseudomonas aeruginosa* (21.81%), *Escherichia coli* (16.36%) and *Acinetobacter baumannii* (15.45%). Gram positive isolates were less common and included *Staphylococcus aureus* (2.7%) and *Enterococcus spp.* (4.5%).

The isolates showed high degree of resistance to multiple classes of antimicrobials. 38.8% of *E. coli* and 30.7% of *K. pneumoniae* strains were ESBL producers. 40% of the *Enterococcus spp.* strains were Vancomycin resistant and 66.7% of *S. aureus* were resistant to Methicillin. This data is in concordance with Chavan et al (2017)[11] and K. Chopdekar et al (2011)[12].

CONCLUSIONS:

Several studies reported the incidence of DAIs in ICUs to be two to five times higher than in general wards.[1] The efficiency of surveillance has been demonstrated in a lot of Healthcare Associated Infections (HAI) related studies, in developed countries. However, there is no proper surveillance system yet in our country.[4,13] Regular and active surveillance is necessary

to strengthen the Infection Prevention and Control (IPC) practices, monitor and contain the emerging antimicrobial resistance and to provide helpful information to clinicians and administration with respect to formulating guidelines on their policies.[13]

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