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REVIEW ARTICLE CLINICAL ASSESSMENT AND MANAGEMENT OF HOSPITAL-ACQUIRED INFECTIONS IN A TERTIARY CARE HOSPITAL

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ABSTRACT

Aim: To assess hospital-acquired infections and their management in a tertiary care hospital. **Materials and Methods**: A cross-sectional study was conducted in six month. The collected data were entered into Microsoft Office Excel, and statistical analysis was performed using SPSS version 25. **Findings:** The prevalence of hospital-acquired infections was found to be 6.1%. Among the study participants, 30% were female and 70% were male. Bloodstream infections (BSI) constituted the highest proportion of hospital-acquired infections, followed by hospital-acquired pneumonia (HAP) (17.20%), respiratory tract infections (RTI) (13.90%), and other types of HAIs. Klebsiellae pneumoniae was identified as the most common causative pathogen (15.46%). Laboratory investigations revealed that the majority of patients had Leukocytosis (61.47%), neutrophilia (59.83%), lymphopenia (78.68%), hyperglycemia (53.3%), and elevated C-reactive protein levels (81.13%). Most patients were treated with antibiotics, including Linezolid (15.98%), Meropenem (17.55%), and other medications **Conclusion:** Hospital-acquired infections represent a serious challenge for healthcare facilities and are among the most preventable adverse patient outcomes. They significantly contribute to increased mortality rates and healthcare costs. Continuous monitoring of antibiotic resistance, along with

evaluation of physicians' prescribing practices, can form the basis of effective infection control programs in hospitals. **Objective:**

- To assess the prevalence, associated risk factors, and management practices of hospital-acquired infections in a tertiary care hospital setting.
- To determine the incidence and distribution of various types of hospital-acquired infections among patients admitted to a tertiary care hospital.
- To identify the common causative microorganisms responsible for hospital-acquired infections.
- To evaluate the infection control practices implemented by healthcare personnel within the hospital.
- To propose evidence-based strategies to enhance the prevention, early detection, and effective management of hospital-acquired infections in a tertiary care hospital.

KEYWORDS: Nosocomial infections, hospital acquired infections (HAI), causative organisms, and prevalence.

INTRODUCTION

A hospital-acquired infection, also known as a nosocomial infection, develops in patients who were neither infected nor in the incubation period at the time of admission to the hospital. It includes infections acquired during hospitalization that become apparent 48 hours after admission or following discharge, as well as occupational infections among healthcare staff. According to the World Health Organization, at any given time, approximately 7 out of every 100 hospitalized patients in developed countries and 10 out of every 100 hospitalized patients in developing countries acquire at least one healthcare-associated infections. Globally, the incidence of hospital-acquired infections ranges from 3.6% to 19.1%. Low- and middle-income countries (LMICs) account for an incidence ranging from 5.7% to 19.1%, whereas high-income countries (HICs) report lower rates, ranging from 3.6% to 12%. Studies indicate that the prevalence of hospital-acquired infections in the United States is up to 4.5%, while European countries report prevalence rates between 5.7% and 7.1%. In contrast, the prevalence in low- and middle-income countries ranges from 5.7% to 19.2%.

The Different Types of Nosocomial Infection

According to the Centers for Disease Control and Prevention (CDC) and the National Healthcare Safety Network (NHSN), nosocomial infections are generally classified into

thirteen distinct categories based on the site of infection. These categories are defined using specific clinical and microbiological criteria. Common types of nosocomial infections include surgical site infections, bloodstream infections, respiratory tract infections, hospital-acquired pneumonia, nosocomial fungal infections, urinary tract infections, and infections caused by Mycobacterium tuberculosis.

The following are some plausible primary explanations of greater HAIs rates in developing nations

In some countries, hospital certification is not mandatory.

- Hospitals often experience overcrowding, shortages of medical supplies, and inadequate infection control training for nurses and other healthcare personnel.
- Many healthcare facilities lack formal infection control policies and standard operating procedures.
- Higher rates of hospital-acquired infections have been associated with poor nurse-to-patient staffing ratios.
- In several settings, there are no enforced legal requirements, such as national infection control guidelines, mandating the implementation of infection control programs.
- Even when a legal framework exists, compliance with established regulations is often inadequate.

Impact on the outcomes and care of patients

The following factors can be used to measure the impact of Hospital Acquired Infection (HAI)

- Extensive hospital stays.
- Increased resistance to antibiotics.
- Long-term impairment.
- Financial strain on the health system increased.
- Expensive for both patients and their family.
- Mortality.

A study conducted in the cardiothoracic unit of a tertiary care hospital in North India revealed that the costs of hospital treatments for patients with healthcare-associated infections (HAIs) were six times higher than those for controls without HAIs in terms of medication costs, hospital stays, consultation fees, antibiotic costs, and investigations. Consequently, these infections' additional financial burden has a significant impact on the patients. Medication

resistance in hospitals has the potential to spread throughout the world due to the increase in medical tourism.4 HAI prevalence have been observed to range from 4% to 47% in recent investigations carried out at various sites across the globe.

MATERIALS AND METHODS

•**Study Design**: The study adopted a cross-sectional design.

•**Study period:** The study was conducted over a six-month period, from January to June 2022.

• **Study Setting:** The study was carried out in a 500-bed hospital located in Kannur, Kerala.

•**Total population:** we have approached 2000 patients, the number of patients who have participated is 122 Patients.

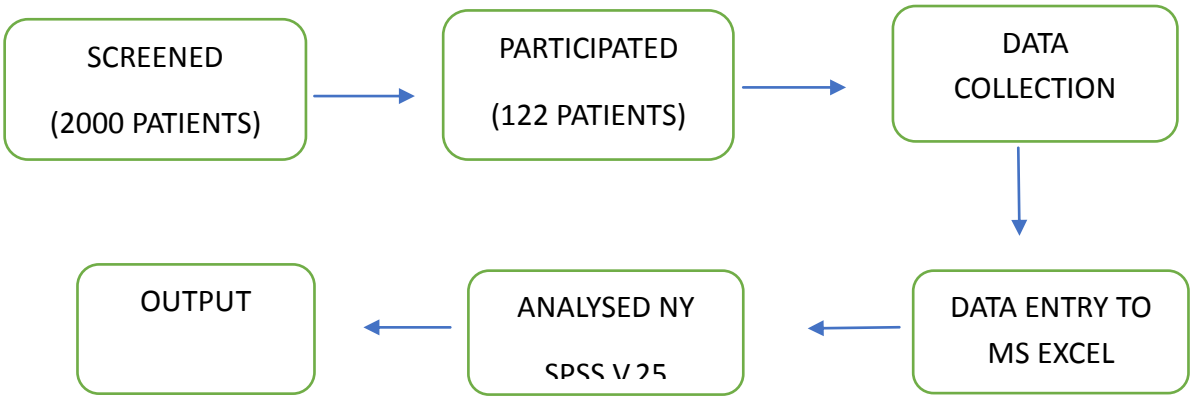
- **Study Methodology**

Participants were provided with comprehensive information about the study during their treatment at the tertiary care hospital. Those who agreed to participate provided written informed consent. Predesigned case record forms are used to collect data. Information regarding patients' demographic characteristics, lifestyle factors, and medication history was obtained through interviews and review of their drug profiles. Biochemical parameters were extracted from laboratory investigation reports included in the clinical records. Statistical analysis was carried out using Microsoft Office Excel and SPSS version 25.

Ethics and Consent

The study, submitted under 005/2021/CCOPS/IEC, was approved by the Crescent College of Pharmaceutical Sciences Institutional Human Ethical Committee to conduct the study was given by the chairperson of the Institutional Human Ethics Committee.

METHOD OF STUDY



RESULTS

This study was carried out over a six-month period in a 500-bedded tertiary care hospital located in Kannur. After applying the predefined inclusion and exclusion criteria, a total of 122 patients were enrolled in the study.

Characteristics of Sample

Out of the 122 participants, males constituted 70% (n = 85), while females accounted for 30% (n = 37). The largest proportion of hospital-acquired infection (HAI) cases was observed in patients aged 60–70 years (36.1%).

Hypertension was identified as the most frequent comorbidity (32.4%), followed by diabetes mellitus (30.8%). Multidrug resistance was detected in 11.5% of Methicillin-Resistant *Staphylococcus aureus* (MRSA) isolates and 7.4% of Methicillin-Resistant Coagulase-Negative *Staphylococci* (MRCONS). These results are summarized in Table 1.

Type of Hospital Acquired Infection

Bloodstream infection (BSI) was the most prevalent HAI, accounting for 41.8% of cases. This was followed by hospital-acquired pneumonia (HAP) at 17.2%, along with other types of HAIs. The detailed distribution is provided in Table 2.1.

Table 1: Characteristics of sample.

Variables	Characteristics	No.	(%)
Gender (*n*=122)	Male	85	70%
	Female	37	30%
Age groups (years)	20-30	1	0.8
	31-40	11	9.0
	41-50	13	10.7
	51-60	13	10.7
	61-70	44	36.1
	Above 80	40	32.8
Co-morbidities	HTN	60	32.4
	DM	57	30.8
	CAD	25	13.5
	CKD	15	8.1
	COPD	13	7.02
	Dyslipidemia	8	4.32
	CVA	7	3.78
Bacteriological Testing done for such infections	Yes	112	91.8%
	No	10	8.2%
Drug Resistance	MRSA	14	11.5%
	MSSA	1	0.8%
	MRCoNS	9	7.4%
	None	98	80.3%
Covid Status	Positive	52	42.6%
	Negative	70	57.4%
POST Covid Status	Yes	17	13.9%
	No	105	86.1%

Table 2:Distribution of sample according to HAI.

Hospital Acquired Infection	Frequency	Per-centage
Surgical Site Infection (SSI)	1	0.80%
Catheter-Associated Urinary Tract Infection (CAUTI)	1	0.80%
Septicaemia	2	1.60%
Ventilator-Associated Pneu-monia (VAP)	5	4.10%
Catheter-Related Blood-stream Infection (CRBSI)	7	5.70%
Urinary Tract Infection (UTI)	8	6.60%
Bacteraemia	9	7.40%
Respiratory Tract Infections (RTI)	17	13.90%
Hospital-Acquired Pneu-monia (HAP)	21	17.20%
Bloodstream Infection (BSI)	51	41.80%

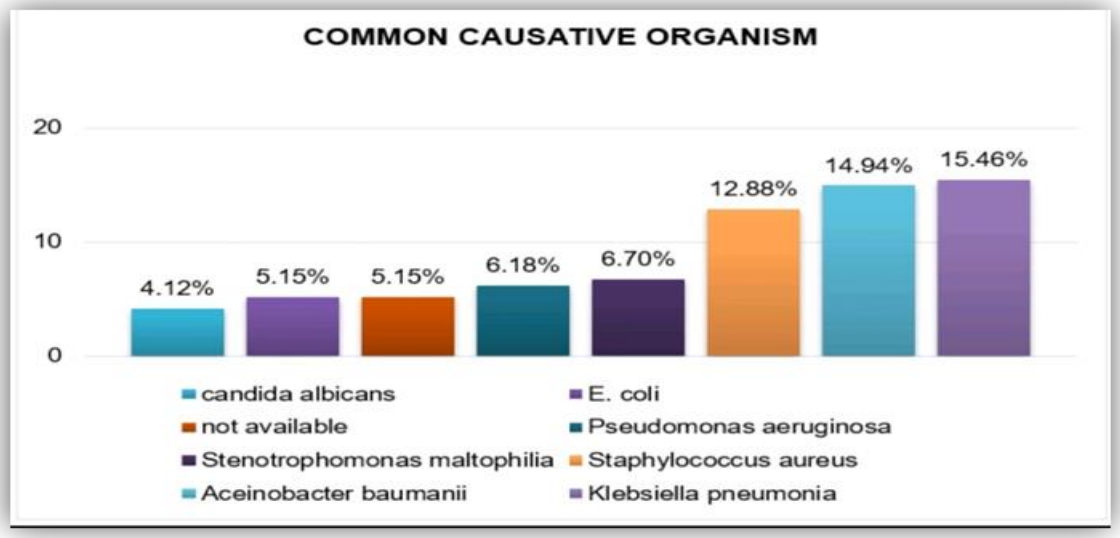


Figure 1: Distribution of sample according to common causative organism.

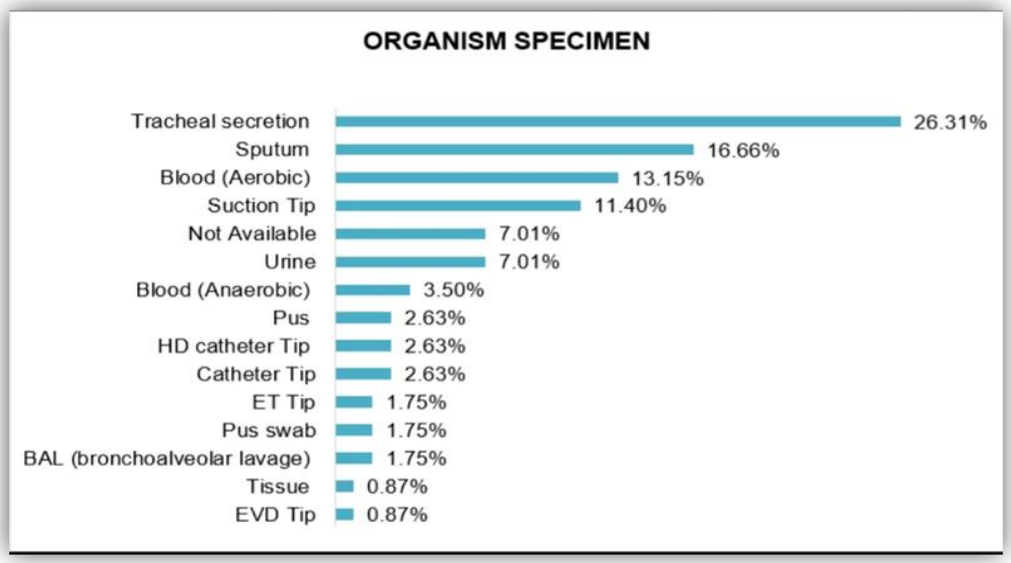


Figure 2: Distribution of sample according to specimen.

Causative Organism:

As shown in Figure 1, Klebsiella pneumoniae was identified as the most frequent causal pathogen (15.46%), followed by Klebsiella pneumoniae (14.94%). The bulk of the organism was found to be in the tracheal secretion, as shown in Figure 2.

Table 3: Distribution of sample according to type of antibiotic prescribed.

Drugs	F.	%	Drugs	F.	%	Drugs	F.	%
Meropenem	56	17.55	Ceftriaxone + Sulbactam	6	1.88	Cefepime	2	0.62
Linezolid	51	15.98	Cefoperazone + Sulbactam	5	1.56	Teicoplanin	2	0.62
Piperacillin + Tazobactam	35	10.97	Cefuroxime	4	1.25	Minocycline	2	0.62
Levofloxacin	21	6.58	Ceftazidime	4	1.25	Imipenem + cilastatin	2	0.62
Doxycycline	15	4.70	Amikacin	4	1.25	Nitrofurantoin	2	0.62
Polymixin B	13	4.07	Clindamycin	4	1.25	Itraconazole	2	0.62
Vancomycin	12	3.76	Amoxicillin + Clavulanate	4	1.25	Faropenem	2	0.62
Ceftriaxone	10	3.13	Voriconazole	4	1.25	Moxifloxacin	1	0.31
Trimethoprim + Sulfamethoxazole	10	3.13	Azithromycin	4	1.25	Ceftazidime + Avibactam	1	0.31
			Cefixime	3	0.94	Rifampicin	1	0.31
Fluconazole	10	3.13	Gentamicin	3	0.94	Fusidic Acid + Betamethasone	1	0.31
Metronidazole	8	2.50	Clarithromycin	3	0.94	Rifaximin	1	0.31
Ciprofloxacin	7	2.19	Aztreonam	3	0.94	Cefpodoxime + Ofloxacin	1	0.31

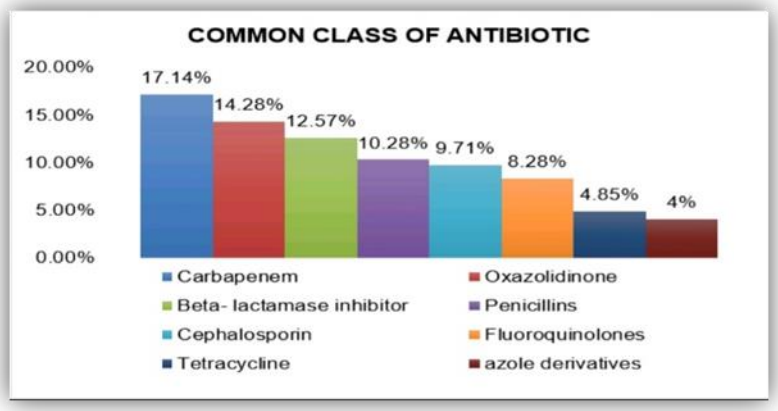


Figure 3: Distribution of sample according to common class of antibiotic prescribed.

The most frequent class of antibiotics were Carbapenem (n =60, 17.14%), Oxazolidinone (n =50, 14.28%), and Beta-lactamase inhibitor (n =44, 12.57%), results depicted in Figure 3.

Microbial Profile

The pathogen spectrum was dominated by Gram Negative Bacilli (57.14%) and Gram Positive Bacilli (28.04%). The majority of patients had lymphopenia (78.68%), neutrophilia (59.83%), and leukocytosis (61.47%). Additionally, the patients' blood sugar (53.3%) and C-reactive protein (88.5%) levels were increased.

Class of Antibiotic Prescribed

Table 4: Distribution of sample according to statistical test.

Variables Total		HAI	Chi-Square Value	*p*-Value
No. of Days in Hospital	>= 7days	91	22.703[a]	.007*
	< 7 days	31		
Gram Positive Bacilli	YES	48	30.318[a]	.034*
	NO	64		
	Not Available	10		
Gram Negative Bacilli	YES	75	30.035[a]	.037*
	NO	37		
	Not Available	10		
Klebsiella pneumonia	YES	30	11.087[a]	.270
	NO	92		
Klebsiella pneumoniae	YES	29	20.355[a]	.016*
	NO	93		
Carbapenem	YES	59	3.812[a]	.923
	NO	63		
Oxazolidinone	YES	49	7.364[a]	.599
	NO	73		
Beta Lactamase Inhibitors	YES	44	16.685[a]	.05*
	NO	78		

Statistically significant. Type of Antibiotic Prescribed The most frequent antibiotics were Meropenem (n =56, 17.55%), Linezolid (n =51, 15.98%), and Piperacillin + Tazobactam (n = 35, 10.97%), as shown in Table 3.

Number of Days of Hospital Stay

According to Table 4, there was a statistically significant increase in the frequency of HAI among patients who stayed in the hospital for more than or equal to seven days as opposed to less than seven days. The average length of hospital stay for patients with HAI was found to be 15 days.

Prevalence

The prevalence of Hospital Acquired Infection (HAI) was discovered to be 6.1%.

DISCUSSION

In an effort to determine the prevalence of hospital-acquired infections (HAIs) over a six-month period in a tertiary care hospital, the prevalence was found to be 6.1% (Mehrdad Askarian, 2012). Similarly, a prevalence rate of 11.7% for healthcare-associated infections (HCAIs) was reported in a study conducted in a tertiary care facility (Animesh Gupta, 2015). Bloodstream infections (BSIs) were identified as the most common type of nosocomial infection, accounting for 41.80% of cases, followed by hospital-acquired pneumonia (HAP) at 17.20% (Mehrdad Askarian, 2012). The high incidence of BSIs may be attributed to the presence of multiple risk factors, including prolonged hospital stays, increased use of intravascular lines in hospital wards, and other contributing factors. Continuous surveillance of nosocomial infections is essential to improve patient outcomes and reduce the burden of hospital-acquired infections. Among the 122 patients included in the present study, 70% were male (n = 85) and 30% were female (n = 37), indicating a male predominance in the development of hospital-acquired infections. The majority of affected patients belonged to the 60–70-year age group (36.1%). Hypertension (32.4%) and diabetes mellitus (30.8%) were the most common comorbid conditions observed. These underlying conditions may compromise immune function, thereby increasing susceptibility to hospital-acquired infections.

Klebsiella pneumoniae was identified as the most common causative organism, accounting for 15.46% of infections, followed by Acinetobacter baumannii (14.94%) (Deebya R. Mishra, 2020). Gram-negative bacilli constituted the majority of the pathogen spectrum (57.14%),

while gram-positive bacilli accounted for 28.04% (V. Narendrnath, 2017). Multidrug resistance was observed in 11.5% of methicillin-resistant Staphylococcus aureus (MRSA) isolates and 7.4% of methicillin-resistant coagulase-negative staphylococci (MRCONS) (Degu Abate, 2018; Shazia Damji, 2021). The frequency of hospital-acquired infections was significantly higher among patients with a hospital stay of seven days or more compared to those hospitalized for less than seven days, with the association being statistically significant (Maumita De, 2018; Animesh Gupta, 2015).

Among patients with hospital-acquired infections, the mean length of hospital stay was 15 days. Nosocomial infections contributed to prolonged hospitalization, thereby increasing the need for extended inpatient care. Meropenem (n = 56; 17.55%) and Linezolid (n = 51; 15.98%) were the most frequently prescribed antibiotics (Pampita Chakraborty, 2016). The most commonly used antibiotic classes were Carbapenems (n = 60; 17.14%), oxazolidinones (n = 50; 14.28%), and beta-lactamase inhibitor combinations (n = 44; 12.57%). Statistically significant associations ($p \leq 0.05$) were observed between hospital-acquired infections and duration of hospital stay, beta-lactam use, Acinetobacter baumannii infection, gram-positive organisms, and gram-negative organisms. These findings are presented in Table 4 Exposure to invasive medical devices, prolonged hospital stays, immunosuppressed states, underlying comorbidities, surgical procedures, and antimicrobial therapy are among the major risk factors for hospital-acquired infections.

Effective surveillance systems, well-defined antibiotic policies, and continuous monitoring of epidemiological trends are essential for the optimal management of infections caused by resistant organisms. There is a clear need for multicenter studies across the country to facilitate coordination, standardization, and the development of evidence-based protocols addressing antibiotic resistance. Additionally, periodic modification and rotation of antibiotic prescribing patterns may contribute to a reduction in the development and spread of antimicrobial resistance. Meropenem is frequently used as a broad-spectrum carbapenem for the treatment of severe hospital-acquired and multidrug-resistant infections. While it is generally well tolerated and effective in critically ill patients, monitoring is important. The commonly observed adverse effects include gastrointestinal disturbances, skin rash, and injection-site thrombophlebitis, with occasional transient elevation of liver enzymes. Rare but serious reactions such as hypersensitivity, Clostridioides difficile–associated diarrhea, and

seizures particularly in patients with renal impairment—may occur. Hence, appropriate dose adjustment and antimicrobial stewardship are recommended to ensure safe and rational use.

CONCLUSION

In the present investigation, the prevalence of hospital-acquired infections was found to be 6.1%. Male patients constituted 70% of the study population, while females accounted for 30%. Hospital-acquired infections were more commonly observed among patients aged 61–70 years. Bloodstream infections were the most frequently reported type of infection (41.08%), and Klebsiella pneumoniae was identified as the most common causative organism (15.46%). The highest number of clinical isolates was obtained from tracheal secretions (26.31%). Most patients were treated with antibiotics such as Meropenem (17.55%) and linezolid (15.98%), along with other medications. The majority of patients had a hospital stay of seven days or more (74.60%).

Hospital-acquired infections pose a significant threat to healthcare facilities and represent one of the most frequently preventable adverse patient outcomes. They contribute substantially to increased healthcare costs and mortality rates. Globally, healthcare-associated infections remain highly prevalent and have a negative impact on patient health and the overall quality of healthcare delivery. Numerous studies in the scientific literature highlight the considerable global burden of hospital-acquired infections in terms of additional costs, morbidity, mortality, emotional stress, and other adverse outcome indicators. Effective infection control programs in hospitals can be established through continuous monitoring of antibiotic resistance patterns alongside evaluation of physicians' prescribing practices. With strengthened infection control measures, a substantial proportion of these infections can be effectively prevented.

ABBREVIATIONS

HAI: Hospital acquired infections;

BSI: Bloodstream Infection;

HTN: Hypertension;

DM: Diabetes Mellitus;

CAD: Coronary Artery Disease;

CKD: Chronic Kidney Disease;

COPD: Chronic Obstructive pulmonary Disease;

CVA: Cerebrovascular Accident;

MRSA: Methicillin Resistant Staphylococcus Aureus;

MSSA: Methicillin Sensitive Staphylococcus Aureus;

MRCoNS: Methicillin Resistant Coagulase Negative Staphyloccoci;

CRP: C-Reactive Protein;

ET: Endotracheal Tip;

HD: Hemodialysis;

EVD: External Ventricular Drain.

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