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Prevalence of Hospital-Acquired Infections in Neurosurgical Critical Care Units

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Abstract:

Introduction: Patients admitted to the intensive care units (ICU) are at higher risk for hospital-acquired infections (HAIs) due to a greater prevalence of immunosuppression, increased frequency of mechanical ventilation, and indwelling catheters. Growing knowledge about HAI will make the introduction of different types of preventive measures probable.

Aim of the study: To detect the prevalence of HAIs in neurosurgical critical care units at Fayoum University Hospitals.

Subjects and Methods: A cross-sectional study was carried out at the neurosurgical critical care units in Fayoum University hospitals. Patients with symptoms and signs of HAIs were included in the study. Different specimens were collected: blood samples, wound swabs, urine, and endotracheal aspirates. Microorganisms isolation and identification were performed following the conventional microbiological methods.

Results: Out of 488 patients, 92 (18.8%) showed signs of HAIs. Gram-negative bacteria represent 56/92 (60.8%), gram-positive bacteria were 22/92 (24%), and 14/92 (15.2%) were *Candida* species (spp.). *Pseudomonas aeruginosa* (*P. aeruginosa)* was the most common isolated gram-negative bacilli [20/56 (35.7%)] followed by *Klebsiella* spp. [15/56 (26.7%)]. Catheter-associated urinary tract infection (CAUTI) is the most common type of HAI among patients.

Conclusions: Neurosurgical critical care patients experience difficult infectious disease challenges, we reported the prevalence of HAIs accounts for (18.8%) and *P. aeruginosa* was the most common organism followed by *Klebsiella spp.* and CAUTI is the most common type of HAIs. It is important to increase the preventive strategies in the ICU to decrease the prevalence of HAI.

Keywords: Hospital-Acquired Infections; Neurosurgical Patients; Urinary Tract Infection.

1. Introduction

Infections acquired in healthcare facilities become apparent after forty-eight hours after the patient is admitted to the hospital [1].

Worldwide, hospital-acquired infections (HAIs) are related to more than 140,000 deaths each year. HAIs such as central line-associated bloodstream infections, ventilator-associated pneumonia, surgical site infections, and catheter-associated urinary tract infections have detrimental effects on patients. They increase mortality and morbidity, prolong hospital stays, and impose additional financial burdens on patients [2].

The bacteria associated with these disorders often exhibit multidrug resistance due to the selective pressure exerted by many antibiotics [3]. Data from the Infectious Disease Society of America (IDSA) and the Center for Disease Control (CDC) have revealed that all HAIs have been over-reported, resulting in extreme antibiotic usage [4].

Patients in intensive care units (ICU) have higher rates of HAIs than patients in other wards due to the invasive procedures they undergo upon admission, such as urine catheterization or the placement of an intravenous line [3]. It is thought that postoperative ICU monitoring is crucial after surgeries, especially cranial surgeries, and neurosurgical critical care units consistently have a prominent and important role for neurosurgery patients [5].

Patients undergoing neurosurgical critical care are exposed to many risk factors, including multiple trauma, altered awareness, and impaired defensive reflexes [6]. Furthermore, HAIs in patients undergoing neurosurgery were found to be associated with advanced age, pre-existing chronic conditions, prolonged mechanical ventilation, a glass-cow coma score below 15, the use of venous catheters, as well as the presence of neurosurgical-specific devices such as lumbar or ventricular catheters [7].

In neurosurgical critical care units, brain insult is a mainly strong predictor of HAIs, causing problems such as hyperglycemia, coma, and hypothermia. Therefore, the care of the patient aims at evading factors that cause secondary brain

damage, which is one of the essentials of prevention of HAIS in this patient group [8].

The rate of HAIs reaches up to 36 % among patients admitted to the neurosurgical critical care units. 40% develop at least one infection, especially in patients undergoing craniotomy, pneumonia being the most common (38 %), followed by urinary tract infections (9%), and surgical site infections (9%) [9].

Following neurosurgery, patients are continuously at risk of HAIs especially, with multidrug-resistant organisms. Therefore, continuous surveillance is mandatory to monitor HAIs. Hence, we aimed in the present study to ascertain the prevalence of HAIs in the neurosurgical critical care units of Fayoum University Hospitals.

2. Subjects and Methods

2.1 Subjects

From June 2022 to December 2022, a cross-sectional study was carried out on the patients who showed symptoms and signs of HAIS. For bloodstream infections (BSI): fever, tachycardia, and increased total leukocyte count. For pneumonia: purulent sputum or cough, or dyspnea or tachypnea. Ventilator-associated pneumonia (VAP) occurs when the patient is on mechanical ventilation for more than 2 days on the date of the incident. Non-catheter-associated Urinary Tract Infection (Non-CAUTI): the patient has at least one of: fever, suprapubic tenderness, costovertebral angle pain or tenderness, urinary frequency, urinary urgency, dysuria. Catheter-associated Urinary Tract Infection (CAUTI): A UTI where an indwelling urinary catheter was in place for more than 2 days, and the patient has clinical signs and symptoms of UTI. Signs of surgical wound lesion: warmth, erythema, pain, and pus from the wound [10].

2.2 Methods

Samples Collection

Blood samples, wound swabs, urine, and endotracheal aspirates from ventilated patients were taken from the patients. The samples were processed at Fayoum University's Department of Medical

Microbiology and Immunology, Faculty of Medicine.

Every sample was meticulously labelled and collected under sterile conditions to accurately identify it. Samples were transported as soon as possible.

Microorganisms identification

Specimens were inoculated onto several culture media, including MacConkey agar, blood agar, mannitol salt, CLED, and sabaraud dextrose agar (Oxoid, The United Kingdom), under aerobic conditions. The cultures were then incubated at 37 ºC for 24 hours. The isolated organisms were identified following standard microbiological methods such as gram staining, colony morphology, and a set of conventional biochemical assays including catalase, slide and tube coagulase, oxidase, indole production, citrate consumption, H_2S production, urease, and triple sugar iron fermentation test [11].

2.3 Statistical analysis of data

The data analysis was conducted using the statistical software SPSS version 24, while data input was done using Microsoft Excel 2013. Simple descriptive statistics, specifically standard deviation and arithmetic mean, were used to summarize and analyze the quantitative data. Cross tabulation was employed to demonstrate the bivariate relationship, while Fisher exact tests and chi-square tests were utilized to compare proportions when deemed relevant. The probability (*P*) value cutoff for significance was fixed at 0.05.

3. Results

Of the 488 patients, 92 patients showed signs of HAIs [92/488 (18.8 %)]. The age range was 1 to 90 years old, with a mean age of 47.46 ±18 years. Regarding the type of HAI, our results reported that CAUTI were the most common (47.8 %), followed by VAP (35.9 %), while the least infection was surgical site infection (SSI) (5.4 %) (**Figure1).**

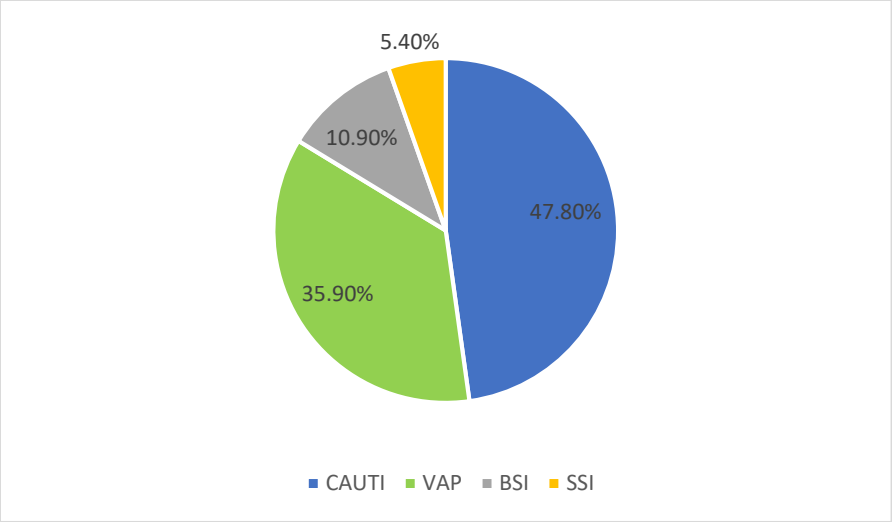

Figure 1: Types of HAIs among the studied patients. CAUTI: Catheter-associated urinary tract infections/ **VAP**: Ventilator-associated pneumonia/ **BSI:** Bloodstream infections/ **SSI**: Surgical site infections.

The prevalence of different microorganisms in the studied patients is shown in **Table 1.** *P. aeurginosa* had the highest prevalence [20/92 (21.7%)] followed by *klebsiella* spp. [15/92 (16.3%)].

Table 1: Prevalence of microorganisms in the studied patients (n =92).

Microorganism		**N**	**%**
Gram-negative bacteria	*P. aeurginosa*	20	21.7 %
	Klebsiella spp.	15	16.3 %
	Acinetobacter baumannii	11	12 %
	Escherichia coli	10	10.8 %
Gram-positive bacteria	*Staphylococcus* spp.	22	24 %
	Candida spp.	14	15.2 %

4. Discussion

Hospital-acquired infections are widespread in ICUs, particularly among persons with weakened immune systems. This study was conducted to assess the

prevalence of HAIs in neurosurgical ICU. Our results reported that the prevalence of HAIs in neurosurgical ICUs was (18.8%). Similarly, Arunodaya (2001) reported that HAIs prevalence in neurosurgical ICUs was 18% [12]. Also increased HAIs in ICUs have been recorded by Orsi et al. (2006) who reported that 21.7% HAI prevalence [6]. Zolldann et al. (2005) reported a lower prevalence rate than our result (12.2%) [13]. As well, Abulhasan et al. (2020) stated the rate was (11.9%) [14]. Nevertheless, Chaturvedi et al. (2019) reported a 2.03% HAIs prevalence [15], while the rate of HAI was (6.67%) according to Agarwal et al. (2017) [16]. However, Menon et al. (2020) had a prevalence of about 4.6% [2], while Rafa et al. (2022) reported the incidence rate was 3.1% [8].

ICUs have higher rates of HAIs compared to other hospital areas due to the presence of critically ill patients who are more susceptible to opportunistic infections [10].

The current study's findings showed that among our neurosurgical patients, the most frequent HAIs were CAUTI (47.8%) followed by VAP infection (35.9%). Chaturvedi et al. (2019) partially agree with our results as the most frequent infection was UTIs, followed by BSI [15] and Sachdeva et al. (2017) reported VAP incidence as (70%) [17]. But, Orsi et al (2006) had different results as the most common HAIs were pneumonia, BSI, and UTIs [6].

The most frequent isolated bacteria were *P. aeruginosa*, and *Klebsiella* spp. in the current study. According to La Fauci et al. (2018), the most prevalent bacteria recovered were *A. baumannii*, *Klebsiella* spp., and *P. aeurginosa,* which partially agrees with the current study [18]. Also, Erayman et al. (2016) partially agree with the current study as the most common organisms were *Acinetobacter* spp., *P. aeruginosa*, and *Klebsiella* spp. [19]. In contrast to Russo et al. (2019) the most prevalent organisms were *S. aureus*, *Candida albicans*, and *E. coli*. This may be due to a higher proportion of immune system dysfunction, and a higher regional prevalence percentage of different bacteria [20]. Also**,** Chaturvedi et al. (2019) reported that the most common organisms causing HAIs were *K. pneumoniae*, and *E. coli* [15]. *E. coli, K. pneumoniae* and *Enterococcus faecium* were the common isolated pathogens causing HAIs according to Agrwal et al. (2017) [16]. As well, Yue et al. (2017) stated that *A. baumannii*, *K.*

pneumoniae, and *E. coli* were the most common pathogens in the neurosurgical critical care unit [21]. Nonetheless, *Klebsiella* spp., *E. coli*, and *P. aeurginosa* were the most predominant isolates according to Abulhasan et al. (2020) [14]. Contrary to Menon et al. (2020) who declared *K. pneumoniae*, *E. coli*, and *Pseudomonas* spp. as the predominant organisms [2]. Unlike, Tsitsopoulos et al. (2016) who reported coagulase-negative *S. auries*, *K. pneumonia*, and *P. aeruginosa* as the most common bacteria causing nosocomial BSI [22].

Preventing HAIs is a major focus in neurosurgical critical care units to decrease the prevalence of infection [23].

5. Conclusion

In the present study, the prevalence of HAIs accounts for (18.8%) and *P. aeruginosa* was the most common organism followed by *Klebsiella* spp. The alarming rise in HAIs needs proper implementation of preventive measures to decrease the infection rates.

Ethical committee approval: The Ethics Committee in Fayoum University and Faculty of Medicine approved this study and numbered M590 in its session on 13/3/2022, the details of the study were provided to each participant.

Competing interests: There are no conflicts of interest for the authors.

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