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Incidence of Ventilator-Associated Pneumonia at Intensive Care Unit of Shar Hospital in Sulaymaniyah/ Kurdistan Region

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ABSTRACT

Ventilator-associated pneumonia (VAP) is a hospital acquired pneumonia that develops 48 hours after patient received mechanical ventilation using an endotracheal tube or tracheostomy. It is known as the second most common nosocomial infection in the intensive care unit (ICU) which occurs when the lower respiratory tract and lung parenchyma are invaded by microorganisms. Here, the incidence of VAP have been studied in the ICU of Shar Hospital in the city of Sulaymaniyah, Kurdistan Region of Iraq. From 31 August 2020 to 7 November 2020, the patients who were mechanically ventilated for more than 48 hours were monitored to find out the development of nosocomial pneumonia. Out of 52 patients, 30 (57.69%) cases were cultured positive for VAP, in which 14 (46.67%) were polymicrobial pneumonia and 16 cases (53.33%) were monomicrobial pneumonia. The common bacteria associated with nosocomial pneumonia were found to be *Acinetobacter baumannii* (31.3%), *Staphylococcus aureus* (27.2%), *Pseudomonas aeruginosa* (18.8%), and *Escherichia coli* (15.6%). Whereas, Candida species were the only recorded fungal isolate related to all 12% of fungal pneumonia infections in this study. The antibiotic sensitivity pattern shows that 17 (65.38%) of the isolate were resistant to trimethoprim/sulfamethoxazole, however, gentamicin was appeared to be the most effective antibiotic. To the best of our knowledge, this is the first study to show the incidence of VAP among patients in Shar Hospital.

Keywords: Ventilator-associated pneumonia, Nosocomial infection, Tracheostomy, Prolonged mechanical ventilation, Risk factors

1. Introduction

Despite of their critical illness, the patients of the intensive care unit (ICU) are often vulnerable to the number of health complications including nosocomial infections[1]. These infections occur in the patients during the course of health treatment, and they are not present in the patient at the time of admission to the hospital[2]. Among nosocomial infections, nosocomial pneumonia is known as the second most common infection, after urinary tract infections, among critically ill ICU patients[3]. Ventilator-associated pneumonia (VAP) is a serious nosocomial pneumonia that develops after 48 hours from the onset of mechanical ventilation (MV) and endotracheal intubation[4, 5]. According to the International Nosocomial Infection Control Consortium (INICC), the overall rate of VAP is 13.6 per 1000 ventilator days, while the incidence can vary among patients and hospital settings [6]. Mortality rate of VAP is ranged between 16.2-74.1%[7]. In a study by Ali *et al.* ,(2016)[8], the mortality rate by VAP was 23.6%. Whereas, the death rates can go higher as 78.95% as it was reported in a study by Bozorgmehr *et al.* (2017)[9]. Only in 2017, more than 2.5 million people died from pneumonia; almost a third of all victims were children under 5 years old and this has made VAP a leading cause of death for children under the age of 5 years[10]. Moreover, VAP also prolongs the length of staying in ICU, which in return, increases patient cost and management[11, 12]. Several pathogens can contaminate the mechanical ventilators and cause infection and increase the risk of developing pneumonia[13]. Among Gram negative bacteria, *Acinetobacter* species and *Pseudomonas aeruginosa* are found the leading cause of the VAP[1, 12], however,

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Staphylococcus aureus is the most frequently isolated Gram positive bacteria from VAP patients[12].

Many risk factors contribute to the development of VAP, these are including the age of the patient, trauma, burn, prolonged mechanical ventilation, coma, prior antibiotic therapy[11]. Other factors include: aspiration related to the body position of the patient (supine position), invasive operations like re-intubation are also thought to be associated with VAP[11]. Although patients who are admitted to the ICUs are intrinsically more susceptible to nosocomial infections due to their impaired immune status, the ICU environment can be a reservoir of spreading those infections[14]. This risk is greatly influenced by the length of ICU stay[15], exposure to invasive devices[16], and healthcare personnel hygiene who are either exposed to the microbes directly from the patients or indirectly from the hospital surfaces[17, 18]. Hand hygiene plays a critical role as they can be contaminated with transient flora with antimicrobial-resistant that can be transmitted to the next patient or surface through invasive devices or wound sites[18].

VAP is a serious cause of morbidity and mortality on ICU patients[19]. Therefore, the present study aims to determine the incidence of VAP cases among ICU patients at Shar Hospital in Sulaymaniyah/ Kurdistan Region of Iraq.

2. Methodology

2.1 Study design

This cross-sectional study was conducted at the Intensive Care Unit of Shar Hospital in Sulaymaniyah over 10 weeks, from 31 August 2020 to 7 November 2020. All the patients who were admitted to the ICU and required mechanical ventilation were included in the study. However, those patients who were on the mechanical ventilators for less than 48 hours, and also those who developed pneumonia before their mechanical ventilation were excluded from the study.

2.2 Data collection

The following data were collected from the patients such as name, age, gender, date of admission to the ICU, primary diagnosis of the case, duration of MV, and patient's body temperature and White Blood Cell Counts (WBC)s. The patients were monitored after two or three days of being admitted to the ICU for VAP development following previously described clinical pulmonary infection score (CPIS)[20]. In addition, microbiological tests of the blood and endotracheal aspirate (ETA) samples of the patients were carried out. The data were recorded from the patient's drug charts, complete blood count tests and laboratory examination reports.

2.3 Clinical diagnosis of VAP

Diagnosis of VAP is done based on clinical, radiographic, and microbiological criteria. VAP is detected when the person develops infiltrates on chest radiograph, leucocytosis and tracheobronchial secretion after at least 48 hours from the admission to ICU. Microbiological analysis of ETA cultures was performed to detect the pathogens causing VAP for the patients. Endotracheal aspirate (ETA) samples which are collected from the patients and cultured on blood, MacConkey, and chocolate agar separately and bacterial identification and antibiotic susceptibility testing were done using VITEK 2 system (bioMérieux). Moreover, leukocytes and fever were both monitored during the process of data collection. All these parameters were taken into consideration to VAP cases, using the Clinical Pulmonary Infection Score (CPIS)[20].

3. Results and Discussion

Due to their health circumstances, ICU patients are often vulnerable to different types of infection including pneumonia; particularly mechanically ventilated (MV) patients who are at high risk of developing VAP[9, 11]. During the 10 weeks of the study, 52 patients were admitted to ICUs, however, only 30 (57.69%) of those patients fulfilled the criteria of VAP. The age of the ICU patients admitted to ICU was ranged between 16 to 80 years, a mean of 60.8 ± 10. The highest percentage of those suffered from VAP is recorded among patients that are older than 60 years which is 11 out of 13 (84.6%) patients as it is shown in Figure (1).

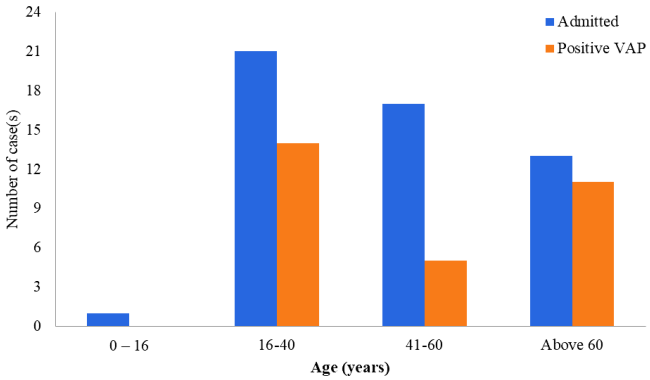

Figure 1: The number of positive VAP cases among the different age groups admitted to the Shar Hospital.

Previously, it has been reported that the chance of a patient to get a VAP increases by more than 1.15-fold per a year increase in the age of the patient[21]. The high rate of VAP cases among elderly patients could be due to some physiological conditions such as impaired gag reflex, reduction of elasticity of the lung tissues, weakened protective cough reflex and impaired immunity[4, 22]. Moreover, chronic bronchitis, which occurs due to prolong smoking, also predispose factor to pneumonia, chronicity of this condition may lead to degrees of lung damage that further increases the chance of having pneumonia in the patient. Additionally, ageing can be correlated with impairment of the alveolar macrophage function and increases of cellular apoptosis during sepsis that leads to a greater chance of infection[23].

While it is confirmed by some clinical trials that the age below 60 is an independent risk factor for VAP susceptibility[24, 25], there are only a few studies that show increased risk of VAP among ages of 16-40, due to overrepresentation of patients of that range of ages in neurosurgery and traumatology[26].

In the present study, 14 of the 21 patients admitted to ICU, who were between 16-40 years old, were culture positive for VAP where traumatic injuries and neurological disorders were significant reasons.

In addition to the age, gender distribution among the admitted cases versus positive cases was analysed. The percentage of the male contacted VAP was found to be higher (59.3%, 19 out of 32 cases) compared to 55% (11 out of 20 cases) among positive female cases (Figure 2).

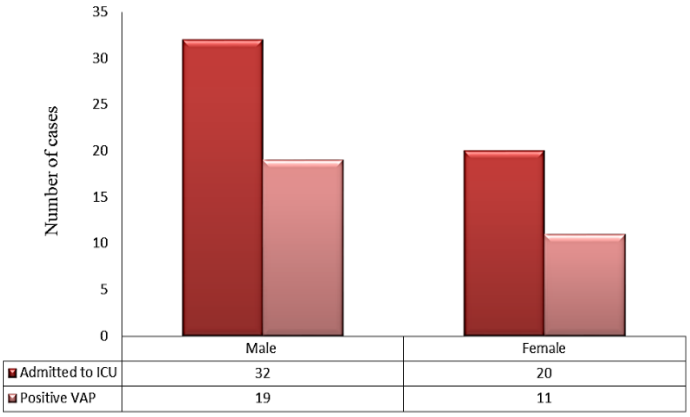

Figure 2: Sex Distribution of patients on Ventilator-Associated pneumonia (VAP).

Previously, it has been reported that the incident of VAP is higher among male compared to female[27, 28]. One factor which might have contributed to conclude the higher incidence of VAP among male is that the number of males admitted to ICU was higher than female patients (32 male and 20 female). In addition, female hormones estrogen has shown to play important roles in controlling the health status of the lungs and protecting them from inflammation[29]. In the study, female mice shows a greater immunological resistance to pneumococcal pneumonia compared to male mice, and injecting estrogen to the male mice reduced inflammation in the lungs and improve the bacterial clearance of the male mice[29]. Moreover, alveolar macrophages from female humans and mice are better at killing off ingested bacteria, and estrogen-treated male mice have a stronger ability to kill off ingested bacteria in the lungs[29].

VAP is usually caused by bacteria, while fungi and viruses are rarely involved too[30]. In many cases, VAP can be caused by more than one pathogen (polymicrobial infection)[31]. In our study, 14 out of 30 culture positive patients had more than one pathogen associated with their infection. Similarly, a recent study performed in the medical and surgical ICUs in a hospital in Spain showed that 32 out of 147 VAP cases were infected with more than one pathogen[32].

In terms of etiology of VAP, 64% of the cases in Shar hospital were caused by Gram-negative bacteria, 24% by Gram-positive bacteria, and 12% of the cases by fungal infection of Candida spp., particularly, candida tropicalis.

Acinetobacter baumannii (31.3%) was the most common Gram-negative bacteria associated with VAP. This was followed by Pseudomonas aeruginosa and Escherichia coli which were 18.8% and 15.6%, respectively. The rest of the Gram-negative bacteria found in this study are shown in Table (1).

Table 1: Number of the Gram-negative bacteria identified among VAP positive cases.

Organisms (Gram Negative)	N (%) (N=32)
Acinetobacter baumannii	10(31.3)
Pseudomonas aeruginosa	6(18.8)
Escherichia coli	5(15.63)
Klebsiella pneumoniae	3(9.4)
Proteus spp	3(9.4)
Proteus mirabilis	2(6.3)
Pseudomonas spp.	1(3.13)
Serratia marcescens	1(3.13)
Burkholderia cepacia	1(3.13)

Numbers of studies have focused on the causative microorganisms responsible for VAP cases among ventilated patients in ICUs. In Iran, the most prevalent bacterial cause of VAP in surgical ICU is Acinetobacter baumannii (24.6%), followed by P. aeruginosa (20.2%), and Enterobacter spp. (13.0%)[33]. Another study conducted in 73 hospitals in Asia, Acinetobacter spp. (33.5%) was identified as the most common isolated pathogen among VAP patients, and then P. aeruginosa (23.9%), K. pneumoniae (15.4%), and S. aureus (13.8%)[34].

There are several factors that are involved in prevalence of the Acinetobacter A. baumannii among VAP patients such as bacterial nutritional requirements and genetic make-up. A. baumannii has a minimal nutritional requirement and can survive on diverse-surfaces in the form of biofilm as well as in the aqueous environments[35, 36]. Outer membrane protein A (OmpA), an abundant protein in *A. baumannii*, aids in the biofilm formation which is essential to survive on various surfaces in the hospital environment[37, 38]. Despite its virulence characteristics, A. baumannii has capability to acquire various antimicrobial-resistance genes which leads to multidrug resistance[35, 39].

A few (11 isolates) of Gram positive were also identified among bacteria associated with VAP; methicillin-resistant Staphylococcus aureus was found to be the most common (27.2%) bacteria (Table 2). S. aureus is known as the most frequently isolated pathogen in both community and hospital acquired infection[40]. The prevalence of S. aureus could be due to the ability of the bacterium to survive in the hospital environment through formation of biofilms[41], and also, they can be easily transmitted through fomites or any contaminated objects causing infection[42, 43]. A study by Hamid et al. (2020)[44] reported that S. aureus was most frequently present (17.8%) among gram-positive bacteria among ventilated patients. Moreover, Ahmad et al. (2017)[45] studied VAP etiology among admitted patients in one of Pakistan hospital ICU and concluded that causative organisms were MRSA (40%), followed by Enterobacteriaceae (22%), K. pneumoniae (30%), and Enterobacter cloacae (10%).

Table 2: Organisms isolated from patients with VAP:

Organisms (Gram Positive)	N (%) (N=11)
Staphylococcus aureus	3(27.2%)
Kocuria kristinae	2(18.18%)
Staphylococcus pseudintermedius	1(9.1%)
Staphylococcus epidermidis	1(9.1%)
Coryneforms spp.	1(9.1%)
Viridans streptococci	1(9.1%)
Enterococcus faecalis	1(9.1%)
Enterococcus spp.	1(9.1%)

Fungal associated VAP infections were also detected in 12% of the patients in the ICU of Shar Hospital. Candida species, especially *Candida tropicalis*, represented the only fungus associated with VAP in the present study. Previously, a study by Kothavade et al. ,(2010)[46] has shown that *Candida tropicalis* was a significant causative agent among other Candida-non-albicans group in Indian hospitals and that is believed to be due to its ability to produce biofilm[47].

In terms of antibiotic sensitivity pattern, 65.38% of the VAP-associated isolates were resistant to trimethoprim/sulfamethoxazole (TMP/SMX), following by 57.69% and 50% were resistant to ceftazidime and ceftriaxone, respectively (Table 3). Resistant of the isolates towards TMP/SMX is perhaps due to the long history of prescribing the antibiotic by the healthcare professionals, which was started since 1974[48] and this may have helped microorganisms develop resistant against it.

Table 3: Antibiotic sensitivity/resistance pattern of Gram positive and Gram-negative isolates associated with VAP in Shar Hospital.

Antibiotics	Resistance N (%) (N=26)	Sensitivity N (%) (N=26)
Ceftazidime	15 (57.69%)	7 (26.92%)
Cefepime	11 (42.31%)	8 (30.77%)
Imipenem	5 (19.23%)	13 (50%)
Meropenem	7 (26.92%)	14 (53.85%)
Gentamicin	9 (34.62%)	15 (57.69%)
Ciprofloxacin	11 (42.31%)	13 (50%)
Trimethoprim/ Sulfamethoxazole	17 (65.38%)	6 (23.08%)
Levofloxacin	8 (30.77%)	7 (26.92%)
Tetracycline	11 (42.31%)	2 (7.69%)
Ceftriaxone	13 (50%)	4 (15.38)

On the other hand, gentamicin was found to be the most effective antibiotic and 57.7% of the isolates were found to be sensitive to, this was followed by meropenem and imipenem with 53.85% and 50% sensitivity responses, respectively. Gentamicin as an aminoglycoside antibiotic, is a broad spectrum, bactericidal antibiotic that inhibits bacterial protein synthesis by binding to 30S ribosomes[49]. It is widely used to treat serious infection like pneumonia. Gentamicin has shown to be most effective against aerobic Gram-negative bacteria but can also be useful in killing Gram-positive bacteria when combined with other beta-lactam antibiotics. Beta-lactam antibiotics would break down the bacterial cell wall first, that allows gentamicin to get in to the cytoplasm toward its target, ribosomes[49]. Additionally, imipenem and meropenem are beta-lactam antibiotics which kill the bacteria by binding with penicillin-binding proteins (PBPs) and lead to cell lysis[50]. Since the risk of VAP applies on any intubated patient, the first goal is avoiding or limiting the time of mechanical ventilation whenever possible through using methods like non-invasive ventilators and daily sedation as were suggested by previous study[51]. Furthermore, pathogenic cross-contamination plays a key role in developing nosocomial infections including VAP. Therefore, healthcare staffs on practicing good hygiene and device disinfections are highly recommended[52].

The limitation of this study is the sample size which is due to the period of the data collection. Therefore, the results presented here can not imply to all the ICUs of the hospitals in Kurdistan region of Iraq. However, this is still the first study to investigate the incidence of VAP in the Shar Hospital and the results of this study can be used to minimize and prevent incident in the region.

4. Conclusion

VAP is a major healthcare issue worldwide. In the present study, 30 out 52 patients (57.69%) admitted to ICU of Shar Hospital were cultured positive for VAPs. The rate of the infection was higher among elderly patients (> 60 years old), and also among male patients (59.3%) in comparison to female patients (55%). A. baumannii (31.3%), P. aeruginosa (18.8), and E. coli (15.63%) were the top three predominant causative agents of VAP cases in Shar Hospital. Gentamicin appears to be an effective antibiotic against VAP bacteria. Standard protocol should be followed to minimize the VAP cases. Further studies and the larger number of samples in different seasons are required to be studied and the standard protocols should be followed to minimizing VAP.

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Conflict of interests

None.

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