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Research Article

Hospital-acquired pneumonia and ventilator-associated pneumonia in adults at Tripoli Hospitals: incidence of infection, etiology, and clinicaloutcomes

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Abstract

Background: the ventilator-associated pneumonia (VAP) and the hospital-acquired pneumonia (HAP) are significant public health issues worldwide and associated with increased mortality and increased hospital costs.

Objective: to demonstrate the incidence, risk factors and possible causative agents of nosocomial pneumonia (HAP and VAP) in adult patients who were hospitalized in both medical wards and ICUs of a general hospitals in Tripoli/ Libya.

Methods: hospital-based-records for admitted cases specifically to medical wards and/ or ICUs, who developed HAP or VAP (as defined by the American thoracic society (ATS) and the infectious diseases society, IDSA).

Results: out of a total of 109 patients admitted over a period (from February 2018 to October 2019) ninety four cases (86.2%) had VAP and only fifteen patients (13.7%) had HAP. The onset of pneumonia after admission varied among the cases. Many patients in the ICUs have received different indwelling devices, nearly 75 patients with endotracheal intubation or tracheostomy (68.8%), 66 patients with nasogastric intubation (60.5%) and 70 patients with urinary catheterization (64.2%).

Conclusion: in this study the incidence of HAP was significantly lower than VAP. Nonetheless, receiving proton pump inhibitor, nasogastric tube, endotracheal intubation and or using opened suction tube system all of these were found as predisposing factors that increase the incidence of HAP and VAP at Tripoli hospitals.

Keywords: Nosocomial pneumonia, incidence of Hospital-Acquired Pneumonia, Ventilator-Associated Pneumonia.

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Introduction

Nosocomial pneumonia (NP), refers to all infections that occur within or after 48hours of hospital admission excepting any infection acquired at the time of admission [1]. NPhospital-acquired and ventilator-associated pneumonia (HAPand VAP, respectively), is one of the most common nosocomial infection worldwide and associated with substantial

mortality rate per year, mainly because of an extreme resistance of different antibiotics among the causative agents [2]. Based on the guidelines in 2016 and American thoracic society and Infectious diseases society of America HAPand VAP are belong to two different distinct groups, where (HAP) refers to the pneumonia not associated with mechanical ventilation [1, 2, 3].

The most common age groups are associated with nosocomial pneumonia are children less than 2 years old, and persons greater than 65 years of age; persons who have severe underlying disease, immunosuppression, depressed sensorium, and/or cardiopulmonary disease; and persons who have had thoracic-abdominal surgery [4]. Although patients who are comatose and on mechanically assisted ventilation do not represent a major proportion of patients who have nosocomial pneumonia, they are at highest risk for acquiring the infection. The infection with bacterial nosocomial pneumonias mostly occur by aspiration of bacteria colonizing the oropharynx or upper gastrointestinal tract of the patient [2].

On the other hand, the reported distribution of etiologic agents that responsible for the infection with nosocomial pneumonia differs between hospitals due to the differences in patient populations and the applied diagnostic technique [5]. Generally, however, bacteria have been represented as the most frequent isolated pathogens [6]. It has been reported that, pneumonia infection known to be higher in patients who are admitted to ICU than in general ward patients, and even more higher in comatose patients who are under mechanical ventilation [7]. In addition, in comparison with other hospital acquired infections the mortality of VAP has been reported higher by approximately 24~76% [8].

It has been reported that, bacterial health care associated pneumonias are frequently polymicrobial [9], and the predominant organisms are usually gram-negative bacilli. On the other hand, recently gram positive cocci such as*Staphylococcus aureus* (in specific methicillin-resistant *S. Aureus* [MRSA]) and *Streptococcus pneumoniae* [9, 10], have emerged as considerable isolates. Furthermore, *Homophiles influenza*has also been isolated from cases supported with mechanical ventilation and had acquired pneumonia within 48-96 hours post-intubation. Nonetheless, by using the clinical criteria *Escherichia coli, Pseudomonas aeruginosa*, *Klebsiella pneumoniae, Serratia marcescens* and Enterobactersp, constitute nearly 50% of the microbes isolated from respiratory tract specimens that obtained from patients with NP[10, 11].

Previous study reported that all patients who had infected with NPafter applying mechanical supported ventilation were investigated by taken protected-specimen brushings (PSB) cultures, thus, approximately 75% of the isolates were gram-negative bacilli; and roughly 40% of these cultures were polymicrobial [12, 13].

In healthcare associated setting especially in intensive care units the inappropriate use of antimicrobial agents for NP treatment, is markedly being recognized as an abundant cause of morbidity and mortality. Therefore, the recommended therapy for NPis usually supportive, along with the administration of antibiotics. The selection of the correct antimicrobial therapy against NPinfections, and the starting point of admiration, play an important role and was shown to reduce mortality among critically ill patients with NP[14].

The objectives of the study were to determine incidence of infection of HAPand VAP, risk factors of HAPand VAP, clinical implication of antimicrobial agents, and treatment outcomes of adult patients with HAPand VAP at Tripoli Hospitals (including; University Tripoli Hospital, Alkhadra Hospital, Abu Seta Hospital for Respiratory Diseases and Tripoli Central Hospital).

Material and Method

Study design and study population

In this study, hospital-based data for hospitalized adults diagnosed with NPwas used from February 2018 to October 2019. All cases included in the current project were from different hospitals in Tripoli and admitted for at least 24 hours. The cases with any of the following criteria was excluded in this study: immunocompromised patient or the patients who are on daily use of immunosuppressive agents and steroids for more than two weeks, splenectomy cases, the case who stay in organ transplantation department, and the cases who had the infection caused by non-bacterial pathogens for instance viral and fungal agents. Data collection and variables, In the current study all patients were incorporated from both units and ICU admission. Upon admission, for each patient a daily data collection sheet was filled with different information. All information used to complete patient data collection sheet were clinical records, including

results of laboratory investigations and serious chest radiological examinations, direct observation of the patients and consultations of healthcare team. For each case different variables were collected involving: gender, age group, death (up to 48 h after discharge from the ICU), NP (both ventilator acquired pneumonia and NPnot related to ventilation).

Statistical analysis

Statistical calculations were performed using the Microoft excel software version 2010. Variables are expressed as mean+standard deviation, whereas frequency and percentile were used for the remaining variables unless otherwise stated. Differences in-continuous variables were compared using a two-tailed student's t-test after ensuring normal distribution to obtain probability $p < 0.05$.

Results

Characteristics of patients

In the current study the total number of 109 patients were included (Table. 1)

		Total (n=109)	HAP(n=15)	VAP (n=94)
Gender	Male	58 (53.2%)	10 (66.7%)	48 (51.06%)
	Female	51 (46.8%)	5 (33.3%)	46 (48.9%)
Mean age	Years (SD)	71.1	70.2	71
Onset of pneumonia	Early-onset	29 (26.6%)	4 (26.7%)	25 (26.6%)
	Late-onset	80 (73.4%)	11 (73.3%)	69 (73.4%)
Diagnosis on admission	Neurological disorders	30 (27.5%)	3 (20%)	27 (28.7%)
	Respiratory disorders	35 (32.1%)	6 (40%)	29 (30.9%)
	Cardiovascular diseases	19 (17.4%)	2 (13.3%)	17 (18.08%)
	GIT disorders	16 (14.7%)	1 (6.7%)	15 (15.9%)
	Trauma	6 (5.5%)	2 (13.3%)	4 (4.3%)
	Other conditions	3 (2.8%)	1 (6.7%)	2 (2.1%)
Location of the patient at diagnosis of pneumonia	General medical ward	20 (18.3%)	1 (6.7%)	19 (20.2%)
	Surgical ICU	30 (27.5%)	3 (20%)	27 (28.7%)
	General surgical ward	15 (13.8%)	2 (13.3%)	13 (13.8%)
	Medical ICU	40 (36.7%)	8 (53.3%)	32 (34.04%)
	Emergency room	4 (3.7%)	1 (6.7%)	3 (3.2%)
Presence of indwelling devices	Nasogastric tube	70 (64.2%)	3 (20%)	67 (71.3%)
	Urinary catheter	90 (82.6%)	10 (66.7%)	80 (85.1%)
	Endotracheal tube	85 (77.98%)	0	85 (90.4%)
	Tracheostomy	30 (27.5%)	2 (13.3%)	28 (29.8%)
	Central venous catheter	40 (36.7%)	0	40 (42.6%)

Table. 1 shown the characteristics of the patients involved in this study. Of all patients, the number of male cases was slightly higher than female cases (53.21% and 46.78%, respectively) (Fig. 1). The majority of cases were between the age of (61 and 90) with mean age of 71.1 years of all patients (Fig. 2). Ninety four cases (86.2%) had VAP and only fifteen patients (13.7%) had HAP. The onset of pneumonia after admission varied among the cases, the majority of the cases had late-onset pneumonia 80 patients (73.4%) with an average day of onset 9 days (Fig. 3). Whereas patients on ventilator had median day onset after mechanical ventilation was 6 to 7 days. The cause of admission were evaluated for all patients, the majority of cases with approximately equal number were admitted with diagnosis of neurological disorders and respiratory disorders 33 patients (30.2%) and 32 patients (29.3%)

respectively. Whereas patients with cardiovascular diseases represented 28 patients (25.6%), and 16 cases with sepsis (14.6%) (Fig. 4).

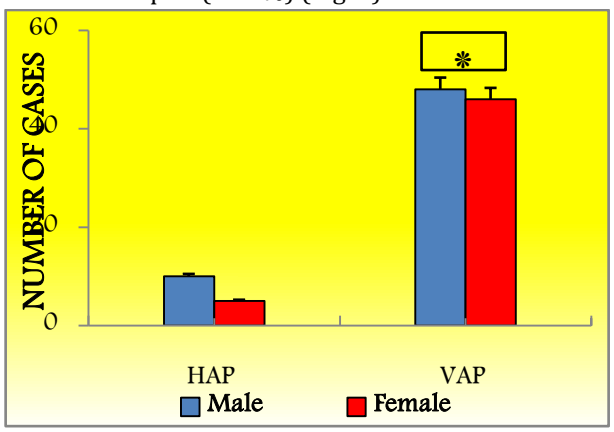

Fig. 1: Shows hospitalizations for pneumonia, by gender (*** p<0.05, n=109). The error bars represent the standard deviation between replicate samples.

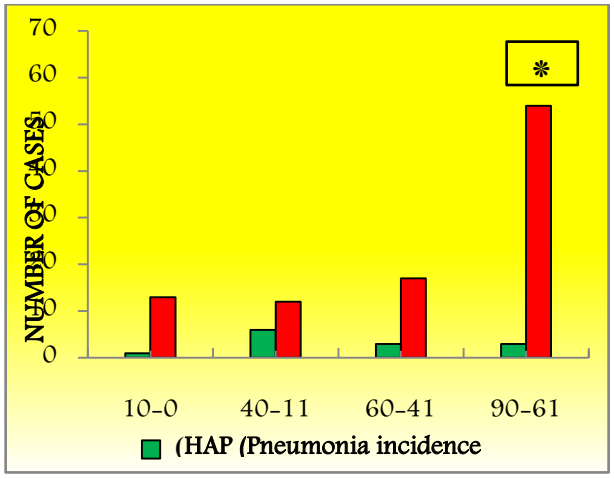

Fig. 2: Shows hospitalizations for pneumonia, by age group (*** p<0.05, n=109). The error bars represent the standard deviation between replicate samples.

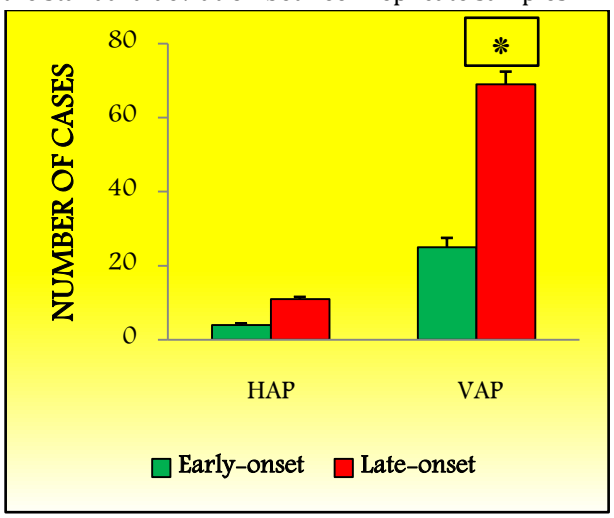

Fig. 3: Shows characteristics of patients at onset of pneumonia gender (*** p<0.05, n=109). The error bars represent the standard deviation between replicate samples.

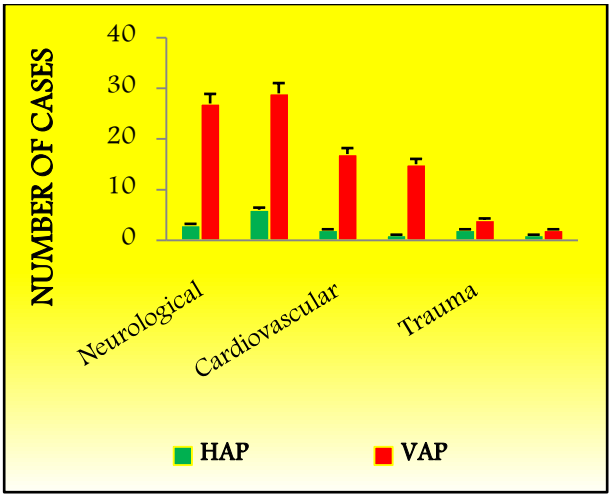

Fig. 4: Shows characteristics of patients and the diagnosis at the admission. The error bars represent the standard deviation between replicate samples.

Many patients in the ICUs with VAP and have received different indwelling devices, nearly 75 patients with endotracheal intubation or tracheostomy (68.8%), 66 patients with nasogastric intubation (60.5%) and 70 patients with urinary catheterization (64.2%) (Fig. 5).

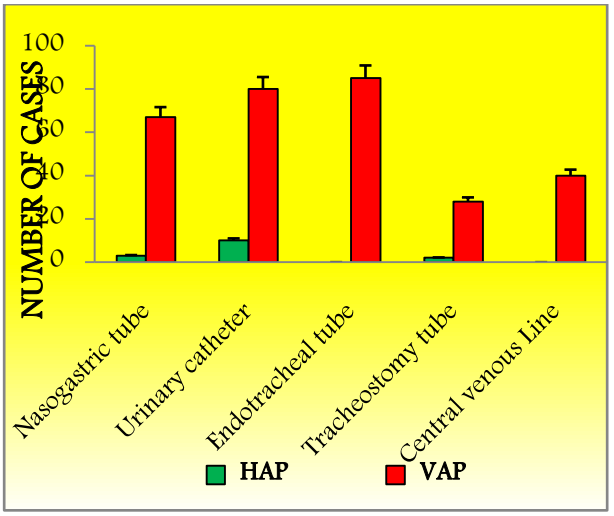

Fig. 5: Shows characteristics of patients who have received different indwelling devices. The error bars represent the standard deviation between replicate samples.

The significance differences between the two groups VAP and HAPpatients were that VAP groups are less likely to spent time in the general admission surgical wards because they had more seriously ill diseases and had received invasive interventions (catheter, intubation) more often than the HAPpatients who

come into hospital for surgery or other clinical condition (Fig. 6).

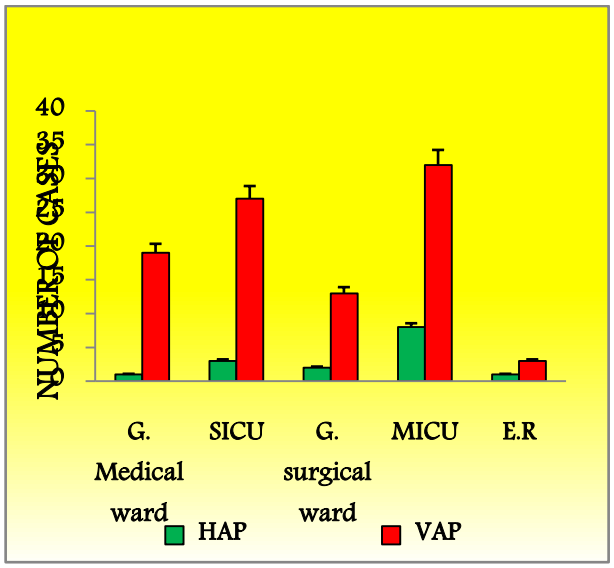

Fig. 6: Shows location of the patient at diagnosis of pneumonia. The error bars represent the standard deviation between replicate samples.

The majority of the cases had the same clinical observations including tachycardia, fever, leukocytosis, tachypnea, anemia, hypoalbuminemia and increased liver enzymes. At diagnosis of patient with pneumonia 25% of them were had hypoxemia. Chest x-ray were applied for all cases and the radiological results shown that 69.9% of cases with unilateral lesions, 50.2% with bronchopneumonia and 12.3% with pleural effusion. In contrast between the HAPand VAP groups based on the clinical manifestations the main characteristic difference was that the patients with HAP had hypoxemia more often than the VAP patients.

Discussion

The current active surveillance was directed to fulfil the locally relevant information on NP(HAPand VAP) among hospitalized adult patients at Tripoli hospitals, and all of this information need to be used properly for infection control, management, and prevention of NPatTripoli hospitals. In fact, due to the limitations in hospitals capacity and inability of several ICUs among different hospitals in Tripoli to accommodate all patients who needed intensive care, therefore patients who diagnosed with NPwere treated in the general medical wards. In the current study, the incidence of VAP compared with HAPwas significantly higher (86.2% and 13.7%, respectively) (p. value 0.002, n=109). More than that, the incidence of VAP at Tripoli hospital ICUs was higher in compared with incidence of VAP in the united states 9–27%, and globally 10–28% [15]. HAPrepresented as the second most common nosocomial infection with a crude overall rate of 6.1 per 1000 discharges [16]. By comparison, the infection rate for nosocomial urinary tract infection, the most common hospital-acquired infection, is 11 per 1000 discharges. The incidence of VAP based on data obtained from Asian countries varying from 3.5 to 46 per 1000 ventilator days[17, 18]. Whereas,the incidences of VAP from Thailand found of 10.8 per 1000 ventilator days in an adult ICU[17], and from the National Nosocomial Infections Surveillance (NNIS) data is 7.6 cases per 1000 ventilator-days[19]. These differences are possibly due to the differences in used methods, definitions of HAP, and/ or differences in the characteristics of the hospital populations studied[20].

According to the study conducted in Canada out of 1014 ventilated patients for 48 h or more, 177 patient (17.4%) developed VAP with median duration from the time of ICU admission to the onset of VAP was seven days[21]. Which is similar to the obtained results in this study, where patients on ventilator had median day onset of VAP after mechanical ventilation was 6 to 7 days, and the majority of the cases had late-onset pneumonia 80 patients (73.4%) with an average day of onset 9 days. Thus, late-onset HAP or VAP occurs after 5 days or more of hospitalization and is more likely associated with multidrug-resistant pathogens[16, 21].

It has been notedthat, HAP and VAP are associated with different risk factors include male sex, the presence of intubation or enteral feeding (NGT or OGT), use of paralytic sedative, mechanical ventilation, and supine position. Adding to that, the previous unsuitableuse of antibiotics for more than 2 weeks, reintubation because ofunsuccessful weaning, and extendstay in ICU founded to be additional risk factors[22]. In the current surveillance, similar risk factorswere found and strongly associated with the development of NP infections, out of 94 cases 75 patients with endotracheal intubation or tracheostomy (68.8%), 66 patients with nasogastric intubation (60.5%) and 70 patients with urinary catheterization (64.2%).

Furthermore, endotracheal and tracheostomy tube found to be the main cause for developing VAP among patients who were admitted to ICUs, and the open suction tube were the only type used. Klompas michael et al. Has reported that nearly 10% to 25%

cases who require invasive mechanical ventilation for more than 24-h acquired pneumonia associated with endotracheal tube [23]. Other previous study has conducted that, using closed suction decreased the incidence of VAP infection among ICU patients [24, 25].

However, in India david et al. Has performed prospective clinical trial to assess the expenses and the clinical results of using open and closed suction on 200 patients under mechanical ventilation; the obtained results showed that, applying closed suction on patients under mechanical ventilation reduced the incidence of VAP compared with those who had open suction. Adding to that, mortality rate and hospital stay in ICU were the same in both groups, while were higher in closed suction group [26].

In addition, receiving proton pump inhibitor such as (Esomeprazole, Lansoprazole, Omeprazole), nasogastric tube, all of these were found as predisposing factors that increase the incidence of HAP and VAP at Tripoli hospitals, which were similar to the factors linked with HAP and VAP reported in the literature [27].

In term of NP treatment, in the current study there were random use of antibacterial agents, and Meropenem found to be the first choice treatment for the VAP. Meropenem classified as highly potent and broad spectrum carbapenem against different bacterial agents include *Enterobacteriacae*, *Pseudomonas spp*, *Acinetobacter spp*, *H. influenzae* and anaerobic bacteria [28, 29]. Sigrid Santos et al has reported that meropenem showed efficacy as a drug of choice against nosocomial pneumonia infection in the ICUs, with 76% clinical improvement (48% cure, and 28% improvement) [30]. Moreover, fluoroquinolone (mainly ciprofloxacin alone) was also used against both HAP and VAP, and the treatment outcome was not as good asmeropenemmight be because of the reason, the majority of cases were acquired the infection after long stay at hospital. Previousstudy hasstated that, using fluoroquinolone alone (such as levofloxacin, moxifloxacin, or ciprofloxacin) recommended to be used against HAP and VAP acquired in the first four days post admission [31].

Lastly, there were several limitations have been faced in this study, including the number of the sample (sample size) analyzed is relatively small, some data were not available. Difficulty obtaining qualitative respiratory cultures with good-quality specimens to evaluated thoroughly, which may have impaired the accuracy of our analyses. Nonetheless, data was not enough to reflect the whole country and different types of ICUs.

Conclusion

Nosocomial pneumonia remains the important problem in hospitalized patients at Libya hospitals because of its' high morbidity and high mortality rate. VAP can be caused by variety pathogens depending on country, region, and hospital.In the current study, the majority of both VAP and HAP cases of VAP are those of late-onset VAP. Most episodes of inadequate antimicrobial treatment were attributed to potentially antibiotic-resistant gram negative bacteria. The responsible healthcare personnel should be aware of drug-resistant pathogens in causing nosocomial pneumonia and they should provide antimicrobial agents that are active against such common drug-resistant bacteria. Local demographic data like this need to be collected at all health care centers, as such information can be used as guidelines the use of appropriate therapy, which would be helping in decreasing mortality and morbidity.

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Author Contribution

All authors Contributed Equally.

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Abbreviations

NP	Nosocomial Pneumonia
VAP	Ventilator Associated Pneumonia
HAP	Hospital Associated Pneumonia
MRSA	Methicillin Resistance *Staphylococcus Aureus*
PSB	Protected Specimen Brushings
ICU	Intensive Care Unit
NNIS	National Nosocomial Infections Surveillance
ATS	American Thoracic Society
IDSA	Infectious Diseases Society

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