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Original article

Ventilator-associated pneumonia in adult intensive care unit prevalence and complications

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ABSTRACT

Background: Ventilator-associated pneumonia (VAP) remains a common cause of intensive care unit (ICU) and hospital morbidity and mortality despite advances in diagnostic techniques and management. We aimed to determine the prevalence, possible complications and in-hospital prognosis of VAP in mechanically ventilated patients.

Methods: This prospective observational, case-control study, was carried out from September 2012 to August 2013. Forty-eight adult patients maintained on mechanical ventilation for more than 48 h in our ICU were enrolled in the study. VAP was diagnosed as new persistent pulmonary infiltrates on chest radiographs and, at least two of following: (1) fever of $\geq$38.3 °C, (2) leukocytosis of $\geq$12,000\mm^3, and (3) purulent tracheobronchial secretions. Endotracheal aspirate (ETA) samples of suspected cases were collected and processed as per standard protocols.

Results: The primary underlying diagnosis was acute exacerbation of chronic obstructive pulmonary disease (AECOPD) in 25 patients, congestive heart failure in 10, pneumonia in 6, post-operative in 5, neurological diseases in 2 patients. VAP developed in 17 patients (35.4%), gram-negative agents were the major offending pathogen (*Pseudomonas aeruginosa* accounting for 22.9%). The length of ventilation (LOV) and the length of ICU stay (LOS_{ICU}) were significantly higher in the VAP group (P = 0.001, 0.0001 respectively). Severe sepsis/septic shock, acute respiratory distress syndrome (ARDS), atelectasis, and infection with multi-drug resistant organisms were more common in the VAP group. *Conclusion:* Ventilator-associated pneumonia was associated with a significant increase in ICU length of stay, time on mechanical ventilation and different complications.

1. Introduction

Patients in intensive care units (ICU) are usually at high risk of mortality not only from their critical illness but also from secondary complication such as nosocomial infection. Nosocomial pneumonia, a common ICU infection, affects 27% of all critically ill patients, where 86% of it is associated with mechanical ventilation [1].

According to the infectious diseases society of America / American thoracic society (IDSA/ATS) guidelines (2016), hospital-acquired/nosocomial pneumonia (HAP) is pneumonia that occurs 48 h or more after admission and did not appear to be incubating at time of admission. On the other hand, VAP is a type of HAP that develops more than 48–72 h after endotracheal intubation [2].

Moreover, VAP occurs in 28% of patients who receive mechanical ventilation, where its rate of occurrence varies with the duration of mechanical ventilation. Estimated rates are 3% per day for the first 5 days, 2% per day for days 6–10, and 1% per day after day 10 [3]. The diagnostic clinical Triad for VAP consists of *Pulmonary infection* signs including fever, purulent secretions, and leukocytosis, together with *bacteriologic* evidence of pulmonary infection, and *radiological* suggestion of pulmonary infection [4].

The mortality rate for VAP ranges between 27 and 76%. Pseudomonas or Acinetobacter pneumonia is associated with higher mortality rates than those associated with other organisms.

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Studies have consistently shown that a delay in starting appropriate and adequately dosed antibiotic therapy increased the mortality rates [5]. Furthermore, VAP has been associated with prolonged ICU length of stay (LOS_{ICU}), and higher costs for medical care since ICUs incur an important part of hospital expenses. Therefore, prevention of VAP could reduce the care utilized during hospitalization and decrease resource utilization and subsequent expenses [6]. The aim of our study was to determine the prevalence of ventilator-associated pneumonia in adult patients in our hospital, as well as to identify the possible complications related to it and to determine its relation to in-hospital prognosis.

2. Patients and methods

This is a prospective, observational, case-control study, conducted at King Fahd hospital, Saudi Arabia during the time period from September 2012 to August 2013. Forty-eight adult (>18 yrs.) patients were enrolled in the study. Inclusion criteria were: hospitalized, intubated and mechanically ventilated more than 48 h.

Pneumonia was diagnosed as VAP when it occurs after 48 h of endotracheal intubation and mechanically ventilated. The criteria of diagnosis are: new persistent pulmonary infiltrates appearing on chest radiographs and, at least two of following: (1) fever of $\geq$38 °C, (2) leukocytosis of $\geq$12,000\ mm^3, and (3) purulent tracheobronchial secretions. In cases of clinically suspected pneumonia, endotracheal aspirate was sent for microbiology, and the diagnosis of VAP was established with a positive quantitative culture (cut-off point $\geq 10^6$ CFU/ mL).

To analyze the predisposing factors and in hospital morbidity, the following variables were evaluated: age, gender, other comorbidity (diabetes mellitus, COPD on admission), the clinical diagnosis at time of hospitalization, length of ICU stay, mechanical ventilation days, development of complications and the need for tracheostomy.

2.1. Statistical analysis

Statistical software (SPSS version 9; SPSS; Chicago, IL) was used for data analysis. Case patients were compared with subjects using χ^2 test or Fisher Exact Test when appropriate for qualitative variables, and Mann-Whitney *U* test for quantitative variables. Results are presented as frequency (%) for qualitative variables or mean ± SD for quantitative variables. Continuous variables were compared using Student's *t* test for normally distributed variables. All p value lower than 0.05 were considered significant.

3. Results

Forty-eight patients were enrolled in the study with a mean age 55 ± 15 (range 27–88 yrs.), 28 male (58.3%). VAP occurred in 17 out of 48 patients (35.4%, VAP group). Comorbidities included diabetes in 24 patients, COPD in 25 patients, CHF in 10 patients, while 5 patients were admitted for post-operative care.

By assessing the risk factors for VAP in mechanically ventilated patients, there was no statistically significant difference between VAP and non-VAP groups regarding the age sex, or underlying comorbidities (Diabetes, COPD, CHF) [Table 1]. On the other hand, the duration of mechanical ventilation (LOV), as well as the length of ICU stay (LOS_{ICU}) were significantly higher in the VAP group (P = 0.001, 0.0001 respectively).

Complications different significantly among VAP and non-VAP groups, where severe sepsis/septic shock, ARDS, atelectasis and infection with MDR organisms were significantly higher in the VAP group, on the other hand the incidence of pneumothorax and tracheo-bronchitis did not showed significant difference between both groups. Importantly, Tracheostomy use was significantly higher in the VAP group. The overall ICU mortality was 20.8% in all mechanically ventilated patients, however, there was no significant difference regarding the mortality, re-intubation or ICU re-admission between both groups [Table 2].

By evaluating the common infecting organism among all patients, *Pseudomonas aeruginosa* infection occurred in 11 patients (22.9%), *Klebsiella pneumoniae* in 4 patients, *Staphylococcus aureus* in 4 patients, *Escherichia coli* in 3 patients, others in 4 patients, and no microbiological data in 15 patients. In comparing both groups, only Pseudomonas aeruginosa infection was significantly higher in the VAP group, while other organisms showed no significant difference [Table 3].

4. Discussion

Overall incidence of VAP was 35.4% in our study. This figure is high, though comparable to the incidence reported by other investigators [15–58%] [7].

Such high incidence can be possibly related to the use of preventive strategies and the application of VAP bundle.

In our study the incidence of VAP was 36/1000 ventilator days, and it comparable to most of the ICUs in other developing countries [8]. The explanation for this high incidence in our study could be due to small number of cases and short duration, as compared to other studies which showed lower incidence. Other explanation could be lack of adequate nursing staff which may have adversely affected the quality of care given to patients [9].

Our study has shown that LOV and LOS_{ICU} were significantly higher in the VAP group. We may imply that the duration of mechanical ventilation significantly increases the incidence of VAP. This is line with an Italian study conducted on 724 adult ICU patients, which confirmed that the incidence of VAP increased from 5% for patients receiving mechanical ventilation for 1 day to 69% for those receiving mechanical ventilation for more than 30 days [10]. Alternatively, we may also infer, since VAP was detected in the first few days, that significantly increased the LOV, and LOS as a complication.

Importantly, Tracheostomy was significantly higher in the VAP group (17.6%), which again indicates the effect of VAP on the LOV, and in-turn would increase the possibility of Tracheostomy in this subset of patients.

It was suggested in a previous study that patients with VAP appear to have a 2-10-fold higher risk of death compared to ventilated patients without pneumonia [11]. However, our study did not show any significant difference regarding the mortality, re-intubation or ICU re-admission between both groups. Similarly, Tejerina et al., in evaluating more than two thousand patients concluded that VAP was associated with a significant increase in ICU length of stay but no increase in mortality [12].

By analyzing the differences between the two groups in terms of complications during MV, we observed that the patients with VAP developed severe sepsis/septic shock, ARDS, atelectasis, infection with multi-drug resistant organisms significantly more frequently than those in the non-VAP group. This may be explained by the longer ICU length of stay which exposed the VAP group to higher rate of complications. Ventilator-associated pneumonia increased the duration of mechanical ventilation, the number of complications, as well as the LOS_{ICU} and hospital stays. Alternatively, patients who developed those complications became more liable for the development of VAP (an association, whether cause or effect). The greater susceptibility to infection among these patients is justified by their impaired immunological state. Patients with ARDS are also predisposed to pulmonary infection (within 24 h of an ARDS diagnosis) between 34% and 70% of the cases,

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Table 1
Risk factor for VAP in mechanically ventilated patients.

		VAP (n = 17)	Non-VAP (n = 31)	95% CI	P value
Gender	Male n (%)	10 (58.9%)	18 (58%)	1.15–1.67	0.86
Age (yrs.) mean (SD)		58.1 ± 15	53.1 ± 16	49.1–63.3	0.9
Comorbidities					
Diabetes n (%)		7 (41.1%)	17(54.8%)	1.1–1.7	0.22
COPD n (%)		10 (58.8%)	15(48.3%)	1.2–1.8	0.08
CHF n (%)		5 (29.4%)	5(16%)	1.01–1.5	0.28
PO n (%)		2 (11.7%)	3(9.6%)	1.3–1.6	0.6
Use of steroids n (%)		6 (35.2%)	11 (35.4%)	1.2–1.7	0.12
LOV (days) mean (SD)		17.4 ± 10	5.7 ± 2.4	4.8–22.9	0.001
LOS_{ICU} (days) mean (SD)		20.1 ± 10	7.9 ± 2.7	6.8–24.9	0.0001

COPD: Chronic Obstructive Pulmonary Disease, CHF: Congestive Heart Failure; PO:post-Operative.
LOV: length of ventilation, LOS_{ICU}, length of stay in ICU.

Table 2
Complications among the mechanically ventilated patients.

	VAP (n = 17) n (%)	Non-VAP (n = 31) n (%)	P value
Sever sepsis/Septic shock	9 (52.9)	6 (19.3)	0.01
ARDS	6 (35.2)	2 (6.4)	0.01
Pneumothorax	3 (17.6)	1 (3.2)	0.8
Atelectasis	10 (58.8)	6 (19.3)	0.02
MDR	9 (52.9)	6 (19.3)	0.01
Tracheobronchitis	6 (35.2)	8 (25.8)	0.13
Tracheostomy	3 (17.6)	0	0.01
Mortality	5 (29.4)	5 (16.1)	0.28
Re-intubation	6 (35.2)	5 (16.1)	0.13
Re-admission	2 (11.7)	4 (12.9)	0.8

MDR: multi drug resistant organism.

Table 3
Infecting organism among the studied group.

	VAP (n = 17) n (%)	Non-VAP (n = 31) n (%)	P value
Pseudomonas aeruginosa	7 (41.1)	4 (12.9)	0.02
Klebsiella pneumoniae	2 (11.7)	2 (6.4)	0.5
Staphylococcus aureus	3 (17.6)	1 (3.2)	0.2
Escherichia coli	2 (11.7)	1 (3.2)	0.5
Others	2 (11.7)	2 (6.4)	0.2
Unidentified	9 (52.9)	6 (19.3)	0.9

frequently leading to sepsis, multiple organ dysfunction syndrome and death [13].

Among our studied groups, the isolated *Pseudomonas aeruginosa* infection was significantly higher in the VAP group (p = 0.02), however, there was no difference in other various organisms between both groups. Such distribution of identified pathogens was similar to that observed in National Nosocomial Infections Surveillance (NNIS) system data from 1992 to 1997 and in other studies, including high frequencies of *P. aeruginosa* and *S. aureus* [14].

5. Study limitations

The small sample size in our study, however, the turn-over in our ICU in a developing country was not high enough for a larger number of prospective cases. We could not get microbiologic data in 15 ventilated patients, this was due to insufficient sampling in those patients.

6. Conclusion

Ventilator associated pneumonia is a common and serious ICU complication, that is associated with a longer ventilation duration, ICU/hospital stay, and increased in-hospital morbidity and mortality which may lead to higher treatment costs. Effective nursing care and application of VAP bundle should be rigorously applied in developing countries for VAP prevention.

References

[1] Richards MJ, Edwards JR, Culver DH, Gaynes RP, et al. Nosocomial infections in medical intensive care units in the United States. Crit Care Med 1999;27:887–92.
[2] Kalil AC, Metersky ML, Klompas M, et al. Management of adults with hospital-acquired and ventilator-associated pneumonia: 2016 clinical practice guidelines by the infectious diseases society of America and the American thoracic society. Clin Infect Dis 2016;63:e61.
[3] Baker, A.M., J.W.Meredith, andE.F.Haponik. 1996. Pneumonia in intubated trauma patients. Microbiology and outcomes. Am. J. Respir. Crit. Care Med. 153:343–349. (10, 41, 43, 96, 161.
[4] Fàbregas N, Ewig S, Torres A, El-Ebiary M, Ramirez J, de La Bellacasa JP, et al. Clinical diagnosis of ventilator associated pneumonia revisited: comparative validation using immediate post-mortem lung biopsies. Thorax 1999 Oct;54 (10):867–73.
[5] Cook DJ, Walter SD, Cook RJ, Griffith LE, Guyatt GH, Leasa D, et al. Incidence of and risk factors for ventilator-associated pneumonia in critically ill patients. Ann Intern Med 1998 Sep 15;129(6):433–40.
[6] Fagon JY, Chastre J, Hance AJ, et al. Nosocomial pneumonia in ventilated patients: a cohort study evaluating attributable mortality and hospital stay. Am J Med 1993;94:281–8.
[7] Morehead RS, Pinto SJ. Ventilator-associated pneumonia. Arch Intern Med 2000;160:1926–36.
[8] Rodrigues DO, Cezário RC, Filho PP. Ventilator-associated pneumonia caused by multidrug- resistant Pseudomonas aeruginosa vs. other microorganisms at an adult clinical-surgical intensive care unit in a Brazilian University Hospital: Risk factors and outcomes. Int J Med Med Sci. 2009;1:432–7.
[9] Hugonnet S, Uçkay I, Pittet D. Staffing level: a determinant of late-onset ventilator-associated pneumonia. Crit Care 2007;11:R80.
[10] Langer M, Mosconi P, Cigada M, Mandelli M. Long-term respiratory support and risk of pneumonia in critically ill patients. Intensive Care Unit Group of Infection Control. Am Rev Respir Dis 1989;140:302–5.
[11] Craven DE, Kunches LM, Kilinsky V, Lichtenberg DA, Make BJ, McCabe WR. Risk factors for pneumonia and fatality in patients receiving continuous mechanical ventilation. Am Rev Respir Dis 1986;133:792–6.
[12] Tejerina E, Frutos-Vivar F, Restrepo MI, et al. Incidence, risk factors, and outcome of ventilator-associated pneumonia. J Crit Care 2006 Mar;21 (1):56–65.
[13] Chastre J, Fagon JY. Ventilator-associated Pneumonia. Am J Respir Crit Care Med 2002;165(7):867–903.
[14] Kollef MH, Morrow LE, Niederman MS, et al. Clinical characteristics and treatment ventilator-associated pneumonia. Chest 2006;129:1210–28.

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