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Longer duration of mechanical ventilation was found to be associated with ventilator-associated pneumonia in children aged 1 month to 12 years in India

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Abstract

Objectives: To determine primarily (1) the incidence of ventilator-associated pneumonia (VAP) among ventilated patients aged 1 month to 12 years and secondarily (2) the risk factors for VAP and (3) common organisms causing VAP.

Study Design and Setting: Prospective study in a tertiary care center in India. Consecutive ventilated patients aged ≥1 month and ≤12 years and requiring mechanical ventilation (MV) for ≥48 hours were included after written informed parental consent. For the diagnosis of VAP, National Nosocomial Infections Surveillance System criteria of 1996 were used.

Results: Incidence of VAP among patients aged 1 month to 12 years was 36.2% (38/105; 95% confidence interval [CI]: 27, 46). In unconditional logistic regression analysis controlling for the presence of underlying illnesses, risk factor for VAP was >4 days of MV (adjusted odds ratio, 3.76; 95% CI: 1.41, 10.02; $P = 0.008$). Reintubation within 72 hours of extubation and more than two attendants at the time of recruitment showed increased tendency for the development of VAP but did not reach statistical significance. Endotracheal and endobronchial aspirates were positive for organism in 19.05% (20/105) and 37.14% (39/105) of patients, respectively.

Conclusion: Almost one-third of ventilated patients develop VAP. Vigilance for the development of VAP has to be kept on those requiring >4 days of MV. *Klebsiella* and *Staphylococcus aureus* were common bacterial isolates in such patients.

Keywords: Ventilator-associated pneumonia; Intensive care unit; Risk factors; Attendants; Bacterial isolates

1. Introduction

Ventilator-associated pneumonia (VAP) continues to complicate the course of 9−27% of patients receiving mechanical ventilation (MV) [1]. The attributable mortality rate for VAP ranges from 24% to 50% [2] and can reach 76% [3] in some specific settings or when lung infection is caused by high-risk pathogens. Etiologic organisms widely differ according to the population of the patients in an intensive care unit (ICU), duration of hospital stay, and prior antimicrobial therapy [4].

Although described as an important cause of mortality and morbidity among the patients in ICU, there is paucity of data on the incidence, risk factors, and microbiology of the causative organism of VAP in developing countries such as India. Also, there is a need to know the organisms causing VAP in a particular ICU, which may be different in different ICUs. Knowledge of these factors will help in the prevention and management of VAP in specific settings. Therefore, the present study was undertaken to determine primarily (1) the incidence of VAP among patients aged 1 month to 12 years and secondarily (2) the risk factors for VAP among such patients and (3) common organisms causing VAP.

2. Materials and methods

This was a prospective hospital-based study. The study was conducted between September 2008 and August 2009 in the pediatric ventilatory units of the Departments of Pediatrics and Microbiology, Chhatrapati Shahuji Maharaj Medical University, Lucknow, after approval from the institutional ethics committee. This is a tertiary care teaching hospital with two ventilator units, one with six ventilators and the other with three ventilators.

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Consecutive ventilated patients aged ≥1 month and ≤12 years and requiring MV for ≥48 hours were included after written informed consent and followed for the duration of MV. No one refused to give consent for enrollment. For the diagnosis of VAP, National Nosocomial Infections Surveillance (NNIS) System criteria of 1996 were used [5]. According to these criteria, VAP is diagnosed when a new and persistent pulmonary infiltrate (unexplained) appears on the chest radiograph after 48 hours of MV and any three of the following criteria are positive: (1) temperature instability (fever with temperature >38°C or hypothermia with temperature <35°C); (2) leukopenia (total leukocyte count <4,000/mm^3) or leukocytosis (total leukocyte count >10,000/mm^3); (3) positive endobronchial aspirate and/or positive endotracheal aspirate culture for bacteria; (4) wheezing, rales, or rhonchi; (5) bradycardia (heart rate <60 beats per minute) or tachycardia (heart rate >120 beats per minute); and (6) increased ventilator demand or increased supplemental oxygen requirement ($Pa_{O_2}/F_{IO_2} < 240$, in which F_{IO_2} stands for fraction of oxygen delivered by ventilator).

All patients were ventilated by an orotracheal tube, which was changed only if blocked or displaced. Patients were ventilated in synchronized intermittent mandatory ventilation mode using either a reusable or disposable ventilator circuit with a heated humidification system. Ventilator circuits were changed (if disposable) or sterilized (if reusable) after every 1-week use for each patient. An open method was used for suctioning of secretions. Frequency of endotracheal tube suction depended on the amount of secretions, and it varied from patient to patient. Patients were ventilated in supine position with frequent changing to right lateral and left lateral decubitus positions. An orogastric tube was inserted in all patients. No prophylactic topical oropharyngeal antibiotic and selective digestive tract decontamination was done in any of the patients. Temperature was recorded 4 hourly by clinical thermometer from the axilla. Patients were clinically assessed for heart rate, respiratory rate, temperature, and blood pressure (both systolic and diastolic) 4 hourly. At the time of recruitment, endotracheal and endobronchial aspirates were taken. The endotracheal aspirate was obtained for microbiological culture after hand washing, and while wearing sterile gloves. Endotracheal secretions were collected by instilling 5−10 mL of sterile normal saline through an infant feeding tube inserted 30 cm into the endotracheal tubes and then aspirating with a sterile 10-mL syringe. The endobronchial aspirate was collected by instilling 5−10 mL of normal saline through an infant feeding tube and aspirating back by using a mucus extractor. One end of the mucus extractor was connected to the infant feeding tube and the other end to an open suction pump. Both specimens were immediately transported to the laboratory and processed according to the standard protocol [6]. All the bacterial isolates were identified to species level by standard biochemical tests, and their antibiotic susceptibility testing was performed by the Kirby−Bauer disk diffusion method on Mueller−Hinton agar as per the guidelines of the Clinical and Laboratory Standards Institute [7].

Data were collected on demographic variables such as age, sex, primary diagnosis, and indication for MV. Data were also collected on risk factors such as duration of MV, number of reintubations within 72 hours of extubation, number of endotracheal suctions done in the last 6 hours, number of attendants at the time of recruitment, type of ventilator circuit used (disposable or reusable), history of prior hospitalization, and breach in continuity of skin.

Sample size was calculated to assess VAP incidence of 30% with a precision of 9% and an alpha level of 95%. Hundred patients were to be recruited for this purpose.

Data were collected in a preformed questionnaire and entered into an Excel file (Microsoft, Redmond, WA). Univariate analysis was done to assess the distribution of baseline variables. Thereafter, Student *t*-test and chi-square test were used to compare continuous and categorical variables, respectively, between patients with and without VAP. Unconditional logistic regression (LR) analysis was done controlling for the presence of underlying illnesses to find the risk factors associated with VAP among those that had univariate association with VAP with *P*-value <0.1. We also reported the adjusted odds ratio (OR) with 95% confidence interval (CI) and *P*-value.

3. Results

From September 2008 to August 2009, 105 patients were enrolled of which 72.4% ($n = 76$) were males. Table 1 shows the primary diagnosis of patients enrolled in the study, which was similar in those who developed or did not develop VAP. Using NNIS System criteria (1996) [5], we found the incidence of VAP among patients aged 1 month to 12 years who are on MV to be 36.2% ($n = 38$; 95% CI: 27, 46). Table 2 shows the results of univariate analysis for association of various risk factors with VAP. In univariate analysis, patients who required >4 days of MV had increased chance to develop VAP (OR, 2.81; 95% CI: 1.15, 6.97; $P = 0.012$).

Table 3 reports the findings of unconditional LR analysis to find the association of various risk factors with VAP, controlled for the underlying diagnosis, using cancer as the comparator because it had the lowest frequency count. In

Table 1. Primary diagnosis of patients put on mechanical ventilation and incidence of VAP

Primary diagnosis	Total *N*	VAP, *n* (%), *P* = 0.55
Septicemia	21	9 (42.86)
Neurologic	48	19 (39.58)
Cardiac	12	3 (25.00)
Cancer	7	1 (14.28)
Other[a]	17	6 (35.30)
Total	105	38 (36.20)

Abbreviation: VAP, ventilator-associated pneumonia.

[a] Includes acute renal failure, tetanus, diarrhea with dehydration with shock, and dengue shock syndrome.