Assessment of Ventilator-Associated Pneumonias and risk Factors Identified in the Intensive Care Unit

Tarannum Sayyed¹, Aishwarya Phirange¹, Pooja Kumari¹, Ramesh C¹, Shital V Waghmare², Seeta Devi³

¹PBBSC 2nd Yr., ²Asst. ³Asst. Professor, Symbiosis College of Nursing, Symbiosis International (Deemed University)

Abstract

Objectives: Ventilator-associated pneumonia (VAP) is a significant cause of hospital-related infections, one that must be prevented due to its high morbidity and mortality. The purpose of this study was to evaluate the incidence and risk factors in patients developing VAP in our intensive care units (ICUs).

Methods: This retrospective cohort study involved in mechanically ventilated patients hospitalized for more than 48 hours. VAP diagnosed patients were divided into two groups, those developing pneumonia (VAP (+)) and those not (VAP (-)).

Results: We researched 1560 patients in adult ICUs, 1152 (73.8%) of whom were mechanically ventilated. The MV use rate was 52%. VAP developed in 15.4% of patients. The VAP rate was calculated as 15.7/1000 ventilator days. Mean length of stay in the ICU for VAP (+) and VAP (-) patients were (26.7±16.3 and 18.1±12.7 days (p<0.001)) and mean length of MV use was (23.5±10.3 and 12.6±7.4 days (p<0.001)). High APACHE II and Charlson co-morbidity index scores, extended length of hospitalization and MV time, previous history of hospitalization and anti-biotherapy, re-intubation, enteral nutrition, chronic obstructive pulmonary disease, cerebrovascular disease, diabetes mellitus and organ failure were determined as significant risk factors for VAP. The mortality rate in the VAP (+) was 65.2%, with 23.6% being attributed to VAP.

Conclusion: VAPs are prominent nosocomial infections that can cause considerable morbidity and mortality in ICUs. Patient care procedures for the early diagnosis of patients with a high risk of VAP and for the reduction of risk factors must be implemented by providing training concerning risk factors related to VAP for ICU personnel, and preventable risk factors must be reduced to a minimum.

Key Words: Ventilator associated pneumonia, Intensive care unit, Infection

Introduction

Intensive care units (ICUs) are life support units intended to care for patients requiring intensive care due to organ failure, that are equipped with advanced technology, where vital signs are monitored and where treatment is administered.¹ The majority of patients monitored in these units receive mechanical ventilation (MV) support and invasive procedures such as central venous catheterization. However, patients develop a disposition to infections as a result of these procedures.² Ventilator-associated pneumonia (VAP) is the most common infection in intensive care patients, and can lead to prolongation of intensive care and an increased risk of mortality.² Compromise of patient defence mechanisms, colonization by pathogen micro-organisms and the presence of micro-organisms with high virulence all occupy an important place in the pathogenesis of VAP.

Objective: Of this study was to determine the incidence and risk factors in patients developing VAP in our ICUs.

Methods: Patients hospitalized in the ICU for longer than 48 hour and administered MV between January 1, 2020 and 31st March 2020 were included in the study. Due to nurse shortages, the nurse-patient ratio in our ICUs ranges between 1:3 and 1:4, and may even rise to 1:6 on some nights. Patients’ demographic and clinical characteristics were recorded onto study forms by examination of medical files, infection control committee surveillance data, ICU records, pharmacy records and processing data. The Acute Physiology and Chronic Health Evaluation (APACHE) II scores
used were those calculated in the first 24 hour of hospitalization. Charlson co-morbidity index scores were obtained by examining all patients’ medical records. Identification of microorganisms and testing for antimicrobial susceptibility were conducted using the Phoenix system (Becton Dickinson), the disk diffusion test, and classic methods. Patients’ demographic and clinical characteristics (APACHE II score, Charlson co-morbidity index. Length of hospitalization, treatments administered and invasive procedures performed) and prognoses were recorded. VAP was diagnosed on the basis of CDC criteria. Patients were divided into two groups, those developing pneumonia (VAP (+)) and those not developing pneumonia (VAP (-)).

Statistical Analysis: Descriptive statistical analysis was performed for all parameters. The Kolmogorov-Smirnov test was used to determine the eligibility of variables. Data in conformity with normal distribution were analysed using Student’s t-test, and those not conforming to normal distribution were analysed using the Mann Whitney-U test. Data obtained by measurements are given as mean ± standard deviation. Data obtained by counting are given as numbers (%); analyses were performed using the Chi-square test. P<0.05 was regarded as significant.

Result

Table-I : Assessment of risk factors for development of VAP.

| Variables                              | VAP (+) n=178 (%) | VAP (-) n=974 (%) | P value | OR    | 95% CL |
|----------------------------------------|-------------------|-------------------|---------|-------|--------|
| Age                                    | 67.8±21.1         | 69.4±18.1         | 0.864   |       |        |
| Gender (Male)                          | 102(57.3)         | 526(54.0)         | 0.416   | 1.14  | 0.82-1.60 |
| APACHE II                              | 21.5±5.4          | 19.2±4.9          | <0.001  |       |        |
| Charlson co-morbidity index            | 3.9±1.6           | 2.7±3.0           | <0.001  |       |        |
| Length of hospitalization (days)       | 26.7±16.3         | 18.1±12.7         | <0.001  |       |        |
| Length of ventilation (days)           | 23.5±10.8         | 12.6±7.4          | <0.001  |       |        |
| Previous history of hospitalization    | 63 (35.4)         | 191(19.6)         | <0.001  | 2.25  | 1.57-3.22 |
| Previous history of anti-biotherapy    | 81 (45.5)         | 287(29.5)         | <0.001  | 2.00  | 1.42-2.80 |
| Steroid treatment                      | 46 (25.8)         | 235(24.1)         | 0.624   | 1.10  | 0.75-1.60 |
| Surgical procedure                     | 44 (24.7)         | 286(29.4)         | 0.208   | 0.79  | 0.54-1.16 |
| Re-intubation                          | 49 (27.5)         | 38 (3.9)          | <0.001  | 9.36  | 5.75-15.24 |
| Enteral nutrition                      | 146 (82.0)        | 611(62.7)         | <0.001  | 2.71  | 1.78-4.15 |
| Trauma                                 | 57 (32.0)         | 254(26.1)         | 0.100   | 1.34  | 0.93-1.91 |
| COPD                                   | 40 (22.5)         | 63 (6.5)          | <0.001  | 4.19  | 2.65-6.62 |
| Cardiac disease                        | 11 (9.6)          | 49 (5.0)          | 0.652   | 1.24  | 0.60-2.53 |
| Cerebrovascular disease                | 72 (40.4)         | 295(30.3)         | 0.007   | 1.56  | 1.11-2.20 |
| Diabetes mellitus                      | 35 (19.7)         | 113(11.6)         | 0.003   | 1.86  | 1.20-2.89 |
| Renal disease                          | 27 (15.2)         | 126(12.9)         | 0.492   | 1.20  | 0.75-1.93 |
| Organ failure                          | 38 (18.5)         | 132(13.6)         | 0.007   | 1.73  | 1.13-2.64 |
| Malignancy                             | 21 (11.8)         | 98 (10.1)         | 0.571   | 1.20  | 0.70-2.02 |
| Infectious disease                     | 57 (32.0)         | 244(25.1)         | 0.052   | 1.41  | 0.98-2.02 |
| Mortality                              | 116 (65.2)        | 512(52.6)         | 0.002   | 1.69  | 1.19-2.39 |
Table-II: Identified agents in the etiology of ventilator-associated pneumonia.

| Microorganisms                  | n (%) | (%)  |
|--------------------------------|-------|------|
| Acinetobacter baumannii        | 72 (31.0) | 31.0 |
| Pseudomonas aeruginosa         | 64 (27.6) | 27.6 |
| Staphylococcus aureus          | 35 (15.1) | 15.1 |
| Klebsiella spp                 | 15 (6.5) | 6.5  |
| Escherichia coli               | 13 (5.6) | 5.6  |
| Enterobacter spp               | 9 (3.9)  | 3.9  |
| Enterococcus spp               | 6 (2.5)  | 2.5  |
| Stenotrophomonas maltophilia   | 5 (2.2)  | 2.2  |
| Serratia marcescens            | 5 (2.2)  | 2.2  |
| Streptococcus pneumoniae       | 4 (1.7)  | 1.7  |
| Candida albicans               | 4 (1.7)  | 1.7  |

Discussion

Centers for Disease Control and Prevention data report an incidence of VAP of 0.0-5.8/1000 ventilator days in the ICUs of various hospitals.5 However, the incidence of VAP reported in studies in the literature is as high as 58. Although the incidence of VAP in our study was 58/1000 ventilator days. Although our findings are higher than that CDC data, they are better than those of other studies. The presence of various negative factors in terms of infection, such as the fact that our hospital data were obtained from ICUs in four different branches, the high number of patients per nurse in the ICU, the lack of isolation rooms, the low square meter area per bed and the distance between beds being less than two meters may be reasons for the incidence of VAP differing from the CDC.

VAP prolongs length of hospitalization and duration of MV 2. Mean duration of MV and length of stay in the ICU in this study were higher in patients with VAP than in VAP (-) patients (p<0.001). Every day that patients spend in the ICU and on MV increases the risk of infection. Factors facilitating infection include underlying diseases, comorbid factors, malnutrition, nasogastric tube use, gastroesophageal reflux, sedation, invasive procedures to the respiratory system and aspiration of contaminated secretions accumulating on the endotracheal cuff. MV indications in patients hospitalized in the ICU must therefore be assessed daily, and patients must be removed from MV and the ICU as quickly as possible.

Conclusion

VAPs are nosocomial infections that cause significant morbidity and mortality in ICUs and that prolong hospitalization. These infections are more common in patients with APACHE II score and Charlson co-morbidity index elevation, with extended hospitalization and MV use and with underlying predisposing diseases. Re-intubation increases the risk of VAP 9.3-fold. Guidelines must be adopted in the prevention of these infections, and every country, hospital and ICU must adopt infection control procedures in the light of its own local problems. Training must be provided for ICU personnel on the subject of VAP-related risk factors. Patients’ MV requirements must be assessed daily. The probability of re-intubation must be reduced
to a minimum, and prolonged MV must be prevented. Patients at high risk for VAP must be diagnosed early and patient care procedures to reduce risk factors must be implemented, and preventable risk factors must be reduced to a minimum.

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