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Study of Ventilator- Associated Pneumonia (VAP)

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A B S T R A C T

Pneumonia is the second most common nosocomial infection in the United States and is a leading cause of death due to hospital-acquired infections. Ventilator-associated pneumonia (VAP) is a form of nosocomial pneumonia that occurs in patients receiving mechanical ventilation for longer than 48 hours. The incidence of VAP is 22.8% in patients receiving mechanical ventilation, and patients receiving ventilatory support account for 86% of the cases of nosocomial pneumonia. Furthermore, the risk for pneumonia increases 3 to 10-fold in patients receiving mechanical ventilation. Ventilator-associated pneumonia (VAP) is a major cause of hospital morbidity and mortality despite recent advances in diagnosis and accuracy of management. However, as taught in medical science, prevention is better than cure is probably more appropriate as concerned to VAP because of the fact that it is a well preventable disease and a proper approach decreases the hospital stay, cost, morbidity and mortality. The aim of the study is to critically review the incidence and outcome, identify various risk factors and conclude specific measures that should be undertaken to prevent VAP. We studied patients randomly, kept on ventilatory support for more than 48 h.

Keywords: Azithromycin, Oro-dispersible tablet, Optimization, Disintegration time, FT-IR; Simplex lattice, wetting time.

A R T I C L E I N F O

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1. Introduction

Pneumonia is the second most common nosocomial infection in the United States and is a leading cause of death due to hospital-acquired infections. Ventilator-associated pneumonia (VAP) refers to bacterial pneumonia developed in patients who have been mechanically ventilated for duration of more than 48 h. It ranges from 6

to 52% and can reach 76% in some specific settings. Hospital-acquired pneumonia (HAP) is the pneumonia after 48 h or more after admission, which did not appear to be incubating at the time of admission. The presence of HAP increases hospital stay by an average of 7–9 days per patient also imposes an extra financial burden to the hospital. The risk of VAP is highest early in the course of hospital stay, and is estimated to be 3%/day during the first 5 days of ventilation, 2%/day during days 5–10 of ventilation and 1%/day after this.Interventions to prevent VAP begin at the time of intubation and should be continued until extubation. With the extreme shortage of nurses and the resultant increase in the number of less experienced nurses in the intensive care unit, education on the prevention of VAP is essential, because the occurrence of nosocomial infections is directly related to the adequacy of staff. Nurses need to understand the pathophysiology of VAP, risk factors for this type of pneumonia, and strategies that may prevent the disease.

The onset of VAP can be divided into 2 types: early and late.

1. Early-onset VAP occurs 48 to 96 hours after intubation and is associated with antibiotic-susceptible organisms.
2. Late-onset VAP occurs more than 96 hours after intubation and is associated with antibiotic-resistant organisms. Interventions to prevent VAP should begin at the time of, or if possible, before intubation.

The pathophysiology of VAP involves 2 main processes: colonization of the respiratory and digestive tracts and micro-aspiration of secretions of the upper and lower parts of the airway.

Bacteria associated with ventilator-associated pneumonia

Colonization of bacteria refers to the presence of bacteria without an active host response.Bacterial colonization of the lungs can be due to spread of organisms from many different sources, including the oropharynx, sinus cavities, nares, dental plaque, gastrointestinal tract, patient-to-patient contact, and the ventilator circuit.Inhalation of colonized bacteria from any of these sources can cause an active host response and, ultimately, VAP. The presence of an endotracheal tube provides a direct route for colonized bacteria to enter the lower respiratory tract. Upper airway and oral secretions can pool above the cuff of an endotracheal tube and line the tube, forming a bio-film. Starting as early as 12 hours after intubation, the bio-film contains large amounts of bacteria that can be disseminated into the lungs by ventilator-induced breaths. In addition, the bio-film may become dislodged by instillation of saline into the endotracheal tube, suctioning, coughing, or repositioning of the endotracheal tube. Endotracheal tubes cause an abnormal interruption between the upper airway and the trachea, bypassing the structures in the upper airway and providing bacteria a direct route into the lower airway. Because the upper airway is bypassed, a decrease occurs in the body's ability to filter and humidify air. In addition, the cough reflex is often eliminated and/or decreased by the presence of an endotracheal tube, and mucociliary clearance can be impaired because of mucosal injury during intubation. An endotracheal tube provides a place for bacteria to bind in the trachea, a situation that further increases production and secretion of mucus. The impairment of these natural host defense mechanisms increases the likelihood of bacterial colonization and subsequent aspiration of the colonized organisms.

Aspiration of gastric contents is another potential cause of VAP, because the stomach serves as a reservoir for bacteria. Most patients receiving mechanical ventilation have a nasogastric or an orogastric tube in place for enteral feedings and administration of medications or for gastric decompression. The presence of a nasogastric or an orogastric tube interrupts the gastroesophageal sphincter, leading to increased gastrointestinal reflux and providing a route for bacteria to trans-locate to the oropharynx and colonize the upper airway. Enteral feedings increase both gastric pH and gastric volume, increasing the risk of both bacterial colonization and aspiration.

Clinical Diagnosis

Clinical diagnosis has been criticized to have poor accuracy and reliability. Thus, the Centers for Disease Control and Prevention has introduced a new definition based upon objective and recordable data. Institutions are nowadays reporting a VAP zero rate in surveillance programs, which is in discrepancy with clinical data. This reduction has been highlighted in epidemiological studies, but it can only be attributed to a difference in patient selection, since no additional intervention has been taken to modify pathogenic mechanisms in these studies. The principal determinant of VAP development is the presence of the endotracheal tube (ETT). Contaminated oropharyngeal secretions pool over the ETT cuff and subsequently leak down to the lungs through a hydrostatic gradient

Microbiologic Diagnosis

Blood and pleural fluid cultures.

Although VAP spreads to the blood or pleural space in <10% of cases, if an organism known to cause pneumonia is cultured in the setting of clinically suspected pneumonia, treatment is warranted. Consequently, most experts recommend that two sets of blood cultures and a thoracentesis for nonloculated pleural effusions of ≥10 mm in diameter on a lateral decubitus chest radiograph should be part of the evaluation of suspected VAP. If the effusion is loculated, ultrasound guidance may be required. However, it is important to keep in mind not only that the sensitivity of blood cultures for the diagnosis of VAP is less than 25% but also that when positive, the organisms may originate from an extra-pulmonary site of infection in as many as 64% of cases and even when VAP is present.

Non-quantitative or semi-quantitative airway sampling

Gram staining, non-quantitative and semi-quantitative cultures of tracheal secretions have the advantages of reproducibility and of requiring little technical expertise and no specialized equipment or technique. However, these studies add little to the sensitivity and specificity of the clinical diagnosis of VAP, as the upper respiratory tract is rapidly, within hours of intubation, colonized by potential pulmonary pathogens, even when pneumonia is not present. Thus, if an organism is cultured or noted on Gram stain,

one does not know if it is the cause of the pneumonia or simply colonization. In a study of 48 patients with respiratory failure, concordance between tracheal non-quantitative cultures and cultures of lung tissue from open lung biopsy was only 40%. In that study, of those patients with pneumonia on lung histology, endotracheal aspirate (ETA) had a sensitivity of 82% but a specificity of only 27%. In addition, routine surveillance cultures of ETAs to anticipate the etiology of a subsequent pneumonia can be misleading in a significant percentage of patients, though recent data indicate that quantitative ETAs may be here.

Quantitative cultures of airway specimens.

To potentially improve the specificity of the diagnosis of VAP and the consequent unnecessary antibiotic use and its associated problems, numerous studies have investigated the role of quantitative cultures of respiratory secretions. These have included non-bronchoscopic methods such as quantitative cultures of ETAs (QEAs) and sampling of secretions from distal airways "blindly" via an endobronchial catheter. Blind bronchial sampling (BBS), PSB, protected telescoping catheter (PTC), BAL, and protected BAL (mini-BAL) samples can be obtained via the latter method. Bronchoscopic sampling methods permit quantitative cultures of PSB, PTC, and protected and non-protected BAL specimens.

2. Materials and Methods

This study was conducted in medical ICU of tertiary care hospital for 4 months. The study was approved by the hospital infection control members. We enrolled patients from 24 to 80 yrs, who required ventilator support for the preceding 48 hrs. for each patient prevention ventilator bundle checklist by CDC was followed , which include 7 strategized to reduce VAP incidence and mortality rate.

Sample processing

Procedure (for gram negative organism)

- 10 microliter (loopful) of sample transferred on to dehydrated media plates on mac conkey agar plate.
- Make smear of sample for gram staining.
- Streaked with sterile inoculation loop.
- Plates then inoculated at 37^0 centigrade for 24 hrs.
- After 24 hrs of inoculation see the growth on mac conkey agar plates, if significant growth found then passed colonies into peptone water[Perform oxidase test of colonies if colonies are NLF (non lactse fermenting)]
- Incubate the tubes of peptone water at 37 centigrade for 4 hrs.
- Apply biochemicals and incubate for 24 hrs at 37^0 centigrade.
- Next day add reagents of biochemicals like kovac's reagent (indole), biurret reagent (vogesproskaeur)

Procedure (for gram positive organism)

- 10 microliter (loopful) of sample transferred on to dehydrated media plates on blood agar.
- Make smear of sample for gram staining.
- Streaked with sterile inoculation loop.
- Plates then incubated at 37^0 centigrade for 24 hrs.
- After 24 hrs of incubation see the growth on blood agar plates, if significant growth found then passed colonies into glucose broth (perform catalase and coagulase test when white opaque colonies present)
- Incubate the tubes of glucose broth at 37 centigrade for 4 hrs.
- Apply sensitivity on Mueller hinton agar.

Antibiotic Management

The ATS has recently published guidelines to guide empirical antibiotic choices. These guidelines are divided into those for patients at risk for VAP caused by multidrug-resistant organisms and those for patients without such risk. Risk factors for multidrug-resistant organisms include prior antimicrobial therapy in the preceding 90 days, current hospitalization exceeding 5 days (not necessarily ICU days), high frequency of resistance in the community or local hospital unit, and immunosuppressive disease and/or therapy. In addition, the clinician must consider risk factors for health care-associated pneumonia, as such a pneumonia may present with multidrug-resistant organisms even upon hospital admission. Such risk factors for the intubated patient include a hospitalization for >2 days within the preceding 90 days, residence in a long-term care facility, chronic dialysis within 30 days, home wound care, home infusion therapy (inclusive of antibiotics), and a family member with a multidrug-resistant pathogen.In the absence of risk factors for multidrug-resistant bacteria, the clinician should choose empirical therapy for Streptococcus pneumoniae, Haemophilus influenzae, methicillin-sensitive Staphylococcus aureus, and antibiotic-sensitive gram-negative enteric organisms. Antibiotic choices include ceftriaxone, quinolones (levofloxacin, moxifloxacin, or ciprofloxacin), ampicillin/sulbactam, or ertapenem. When risk factors for multidrug-resistant organisms are present, the clinician must consider not only the organisms listed above but also Pseudomonas aeruginosa, Klebsiella, Enterobacter, Serratia, Acinetobacter, Stenotrophomonasmaltophilia, Burkholderiacepacia, and methicillin-resistant S. aureus. Empirical therapy is broadened to include (i) either an anti-pseudomonal cephalosporin (cefepime or ceftazadime), an anti-pseudomonal carbepenem (imipenem or meropenem), or a β-lactam/β-lactamase inhibitor (pipercacillin-tazobactam) plus (ii) an anti-pseudomonal fluoroquinolone (ciprofloxacin or levofloxacin) or an aminoglycoside (amikacin, gentamicin, or tobramycin) plus linezolid or vancomycin.

3. Results and Discussions

This study is done for 4 months in tertiary care hospital.

Discussion: In the study of our set up, males predominated (62%). Although the incidence of VAP was also high in males, it was statistically not significant. The incidence of VAP in our setting was 37%. In the era of advanced diagnosis and early management of possible complications, the incidence tends to be lower. In recent studies, the reported incidence is very low, ranging from 15 to 30%. The high incidence in our study may be due to a lower number of cases (i.e., 100) and lack of adequate nursing staff (which should ideally be 1:1 as compared to 4:1 in our

institute) which may have adversely affected the quality of care given to the patients. The results are given below

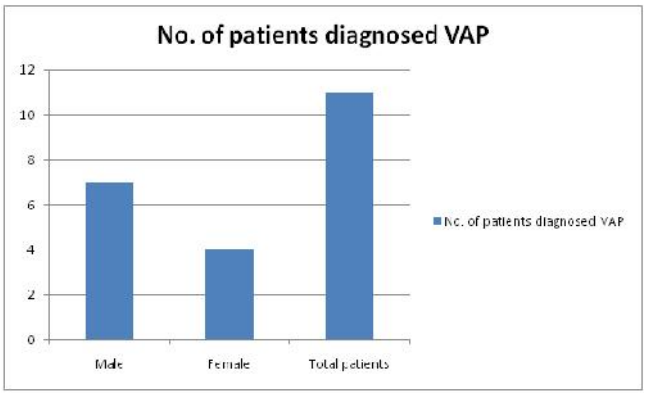

Figure 1

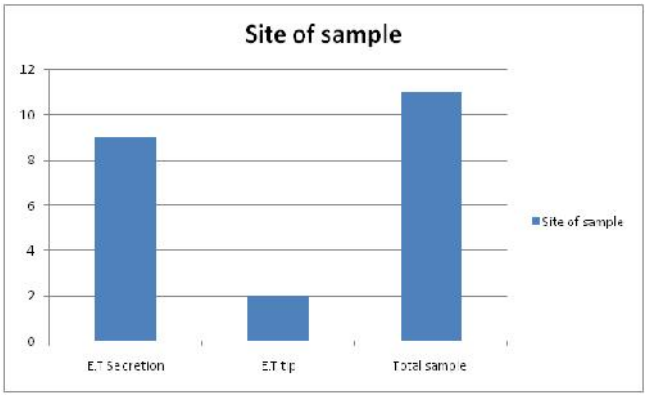

Figure 2

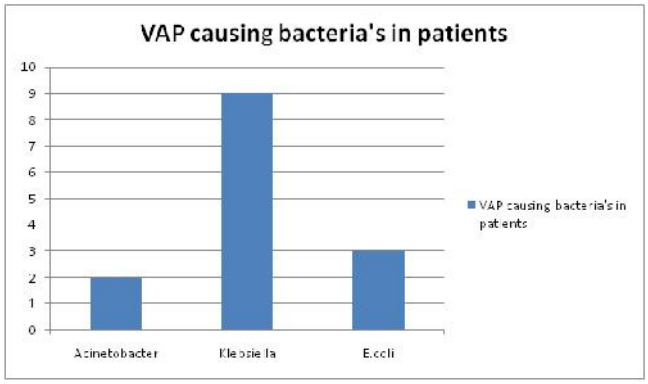

Figure 3

The most common organism associated with VAP is Pseudomonas (43.24%), followed by Klebsiella (18.91%). Also, the overall mortality rate was high in the Pseudomonas group (62.5%). In other studies, isolation of Pseudomonas ranges from 15 to 25%. Susceptibility testing could not be studied in all patients due to a lack of clinical microbiologic support as it is not done routinely and sending samples outside is not allowed by the hospital authority except in special cases.Hand washing is widely recognized as an important but underused measure to prevent nosocomial infections. According to the 2004 CDC (Center for Disease Control) guidelines, hands should be washed before and after patient contact and also in between patient contact. Chlorhexidine has been shown to be effective in the control of ventilator-circuit colonization and pneumonia caused by antibiotic-resistant bacteria. Oropharyngeal decontamination with Chlorhexidine solution has also been shown to reduce the occurrence of VAP in patients undergoing cardiac surgery.VAP, although often preventable, has a large impact on morbidity and mortality. Together with other health-care providers, nurses play a key role in preventing VAP. Many of the interventions are part of routine nursing care. Education for all healthcare providers should focus on the risk factors for VAP and on preventive measures. In order to further decrease the incidence of VAP, protocols and monitoring tools must be developed. VAP is not a new diagnosis, but education and research on the prevention of this life-threatening problem are ongoing.

4. Conclusion

- Incidence is directly proportional to duration of mechanical ventilation and re-intubation is a strong risk factor for development of VAP. Therefore, duration of ventilation has to be reduced to get rid of morbidity and mortality associated with mechanical ventilation, which can be achieved by administering a proper weaning protocol and titrating sedation regimens as per the need of the patients.
- Promoting nasogastric feeding. Although necessary for critically ill patients, it should be given keeping the patients in a semi-recumbent position.
- Pseudomonas is the most common organism in most of institution.
- Late-onset VAP is associated with poor prognosis as compared to the early-onset variety.
- Inappropriate antibiotic use prior to ventilatory support decreases the early-onset variety but predisposes to a high incidence of pathogens.

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