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# BACTERIOLOGICAL PROFILE OF VENTILATOR ASSOCIATED PNEUMONIA IN INTENSIVE CARE UNIT

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## ABSTRACT

Interventions to prevent pneumonia in the ICU should combine multiple measures targeting the invasive devices, microorganisms, and protection of the patient. VAP is particularly common in patients with ARDS, after tracheotomy, in patients with COPD, and in injured and burned patients. It is the most common cause of hospital acquired infection and death among patients admitted in ICU. So we aimed to study the incidence of VAP, their microbiological profile in the intensive care unit of Kamineni Hospitals. A Prospective study conducted on 300 randomly selected Patients after Institutional Ethics Committee clearance has been taken. The diagnosis of VAP was established on the basis of Clinical Pulmonary Infection Score. A MiniBAL sample was collected Culture was done on blood agar and Mac Conkey agar 97 patients developed VAP. Results were tabulated Incidence of VAP was found to be 32.3 %, the organisms isolated in VAP patients are Acinetobacter- 65.9%, Klebsiella pneumoniae - 15.46%, E.coli - 7.21%, Pseudomonas - 6.18%. Conclusion: Clinicians must focus on eliminating or minimizing the incidence of VAP through preventive techniques. The causes of VAP and the likelihood of infection by an antibiotic-resistant strain can be predicted based on the patient characteristics, the duration of hospitalization, the duration of mechanical ventilation, prior exposure to antibiotic therapy,

and prior colonization patterns. Local microbiology and antibiotic susceptibility data are essential for making informed antibiotic treatment choices.

**KEYWORDS**: Ventilator-associated pneumonia (VAP), Aerobic Gram negative bacteria (AGNB), Bronchoalveolar lavage (BAL), Clinical Pulmonary Infection Score (CPIS).

## INTRODUCTION

Use of Mechanical ventilation has increased many folds since its first usage in polio epidemics in 1950s. Ventilator-associated pneumonia (VAP) refers to pneumonia that occurs more than 48 hours after endotracheal intubation. It is the most common cause of hospital-acquired infections among patients admitted in ICU [1]. The incidence of VAP ranges from 6.8% to 44% and its occurrence is associated with increased length of hospital stay, mortality, and financial burden[2]. VAP does seem to be associated with a significantly higher risk of death [3-9].

## PATHOPHYSIOLOGY

Pneumonia represents the host's inflammatory response to the microbial invasion of the normally sterile lung parenchyma. The magnitude of this response depends on the size and type of the inoculum, the virulence of the organisms involved, and the competence of the host's immune system. There are only four routes through which bacteria can reach the lower respiratory tract to cause VAP: contiguous spread, hematogenous spread, inhalation, and aspiration. Hematogenous or contiguous routes of invasion are very rare. Contamination of the ventilator circuits is universal and has no clinical implications. Therefore, the ventilator circuit change interval does not affect the incidence of VAP [10].

VAP are caused by the aspiration of infected secretions from the oropharynx [11, 12] Critical illness leads to the rapid colonisation of the oropharynx with potentially pathogenic bacteria caused by changes in host defences, previous antibiotic exposure, and changes in either the bacterial adhesins or host surface receptors [13]. Aerobic Gram negative bacteria (AGNB) and Staphylococcus aureus rapidly replace normal flora. It remains contentious whether the aspiration of infected material from the stomach plays an important role [14, 15, 16]. However, alkalinisation of the normally acid environment in the stomach leads to overgrowth with AGNB, providing a potential pool of infected material [17].The presence of the cuff on the tracheal tube does not prevent the passage of infected material into the airways [18]. Contaminated secretions pool above the high volume low pressure cuff of the tracheal tube

commonly used in ICU, and gain access to the trachea along folds in the cuff. These organisms can then gain access to and colonise the biofilm that rapidly coats the inner surface of the tracheal tube [19]. This is commonly followed by colonisation of the trachea with pathogenic organisms. The infected material is then propelled into the distal airways by the inspiratory flow provided by the mechanical ventilator. Occasionally, contaminated nebulisers, ventilation circuits or humidifiers may be the source of the infected material [20].

## MATERIALS AND METHODS

A Prospective study was conducted after Institutional Ethics Committee clearance has been taken in Kamineni Hospitals. 300 Patients admitted in the emergency / ICU, requiring intubation and mechanical ventilation for more than 72 hours was considered eligible for inclusion. Written informed consent was obtained from nearest relative of the patients.The lack of specificity of a clinical diagnosis of VAP has led to efforts to improve the diagnostic criteria. A simplified strategy for the management of suspected VAP Adapted from Torres et al [21]. The Clinical Pulmonary Infection Score (CPIS) [22] was developed by weighting of the various clinical criteria usually used for the diagnosis of VAP was used by this study. A Mini-BAL was performed on all ventilated patients for identification of VAP pathogens. The microorganisms isolated were identified based on standard bacteriological procedures including Gram's stain, colony morphology on blood agar and Mac Conkey agar, and biochemical reactions [23].

## RESULTS

97 patients developed VAP. The organisms identified as Acinetobacter, Klebsiella Pneumoniae, Klebsiella Pneumoniae, Pseudomonas, Cons, Staph. Aureus. The results are tabulated.

## DISCUSSION

VAP is the most common complication after mechanical ventilation with the incidence estimated to be 3% per day during first 5 days of ventilation, 2% per day between days 5 and 10 of ventilation and 1% per day thereafter [24] Akca*et al.* in their study have discovered following factors to be responsible for multi resistant bacterial infection of early onset – emergency intubation, aspiration, and Glasgow Coma Scale (GCS) less than 9 [25], Bronchard *et al* [26] have demonstrated that loss of consciousness more than tracheal intubation are independent risk factors for early onset VAP.

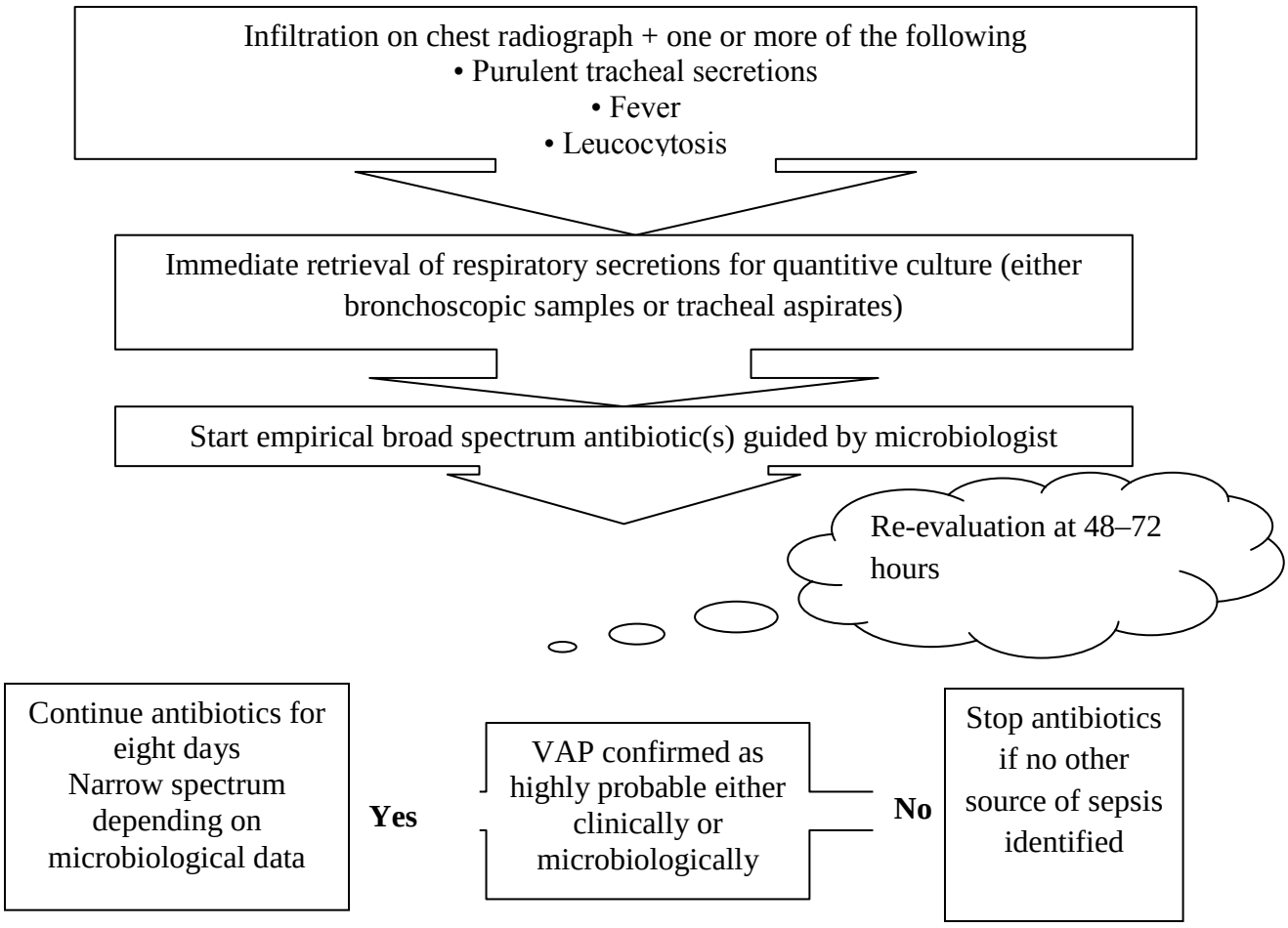
Our study included maximum number of patients needing intubation and mechanical ventilation with the diagnosis of head injury (28%), poisoning (4%), central nervous system disease (12%), respiratory failure (22%), RTA (22%),and others (12%). Association of emergency intubation, micro aspiration and low GCS were all associated in most of our patients and may have been responsible for a high incidence of early onset VAP compared to late onset VAP. After this study, VAP prevention bundles have been instituted to decrease the incidence of high early onset VAP. Risk factors for pneumonia include use of nasogastric tube, continuous enteral feeding, prolonged mechanical ventilation (>1 day), use of H2-receptor antagonist, sucralfate, muscle relaxants, corticosteroids, barbiturates, and inotropic agents, positive end-expiratory pressure, intense sedation, re-intubation, and tracheotomy.

Multidrug-resistant pathogens such as A. baumannii, Klebsiella pneumoniae, *P. aeruginosa*, and E. coli were found to be the common organisms causing VAP. This highlights the need for treatment of the VAP cases with second-line antibiotics effective against these MDR pathogens. This finding also emphazises the need for stringent preventive measures against VAP, as the treatment of an established VAP becomes very expensive, with case fatality rate [27]. Emergence of A. baumannii as a causative organism for VAP many of whom were carbapenemase producing (31.25%) is a new finding in our study. A. baumannii are aerobic Gram-negative bacilli and is known for being an opportunistic pathogen responsible for a number of significant opportunistic infections and possession of various intrinsic drug resistance gene. Multidrug resistant and carbapenemase nonfermenters were chiefly responsible for late onset VAP. In our study the rate of carbapenemase-producing bacteria among all GNB was 29.39% which is higher than other studies published in recent past [28]. Various other studies from India have shown a rate between 18.75 and 26% [29, 30]. Relatively high rate of carbapenemase may be due to increase prevalence of these bacteria as cross colonizer in hospitals, especially in developing countries with poor maintenance of infection control practice. The increase incidence of carbapenemase production might be as a result of rampant use of carbapenem group of antibiotics and natural selection tool of bacteria like plasmid and chromosomal-mediated gene transfer among species of carbapenemase-producing Enterobacteriaceae. It is fast becoming a major health threat among ICU of developing countries [31]. The study also indicated that there was less correlation between the initial prophylactic antibiotic and the bacterial sensitivity. The cause maybe multifactorial, common causes being change in microbial flora causing infection from time to time, lack of awareness of causative organism, and their sensitivity pattern, continuation of initial antibiotic being administrated for some other primary infection. A more stringent hospital

antibiotic policy is warranted to decrease the misuse of these drugs. Following this study a stringent antibiotic policy was instituted with the collaboration of intensivist, physicians, microbiologists, and hospital infection control team. We had observed that Cephalosporins were the most favored drug as first-line treatment but its effectivity was found to be poor [32]. A high sensitivity was seen for Tigecycline and Polymyxin B against Gram-negative isolates and Vancomycin and Linezolid for Gram-positive isolates. It may be so because these drugs were reserved as second-line of antibiotic therapy [33]. A limitation of our study was it being conducted in a resource-limited setting, with small number of patients with VAP and in a single center, few patients being lost as they left against medical advice due to financial constraint and increased cost of treatment. We suggest further multi-centric study with larger patient population to confirm our findings, in particular the high incidence of carbapenemase along with other MDR pathogen in Indian ICU.

**Diagnosis of VAP; Adapted from Torres et al**

**Clinical suspicion of VAP**



**The Clinical Pulmonary Infection Score (CPIS)**

| Clinical Pulmonary Infection Score (CPIS) | |
|---|---|
| **Criterion** | **Score** |
| **Fever (°C)** | |
| 38.5 but 38.9 | 1 |
| >39 or <36 | 2 |
| **Leukocytosis** | |
| <4000 or >11,000/L | 1 |
| Bands >50% | 1 (additional) |
| **Oxygenation (mmHg)** | |
| $Pa_{O2}/F_{IO2}$ <250 and no ARDS | 2 |
| **Chest radiograph** | |
| Localized infiltrate | 2 |
| Patchy or diffuse infiltrate | 1 |
| Progression of infiltrate (no ARDS or CHF) | 2 |
| **Tracheal aspirate** | |
| Moderate or heavy growth | 1 |
| Same morphology on Gram's stain | 1 (additional) |
| Maximal score[a] | 12 |
| [a]At the time of the original diagnosis, the progression of the infiltrate is not known and tracheal aspirate culture results are often unavailable; thus, the maximal score is initially 8–10. | |
| ***Abbreviations:*** ARDS, acute respiratory distress syndrome; CHF, congestive heart failure. | |

**Table –** 1. **Age distribution of patients requiring Mechanical ventilation**

| Age | Frequency | |
|---|---|---|
| | **2012** | **2013** |
| 0-9 yrs | 0 | 1 |
| 10-19 yrs | 3 | 2 |
| 20-29 yrs | 11 | 4 |
| 30-39 yrs | 8 | 4 |
| 40-49 yrs | 10 | 4 |
| 50-59 yrs | 21 | 2 |
| 60-69 yrs | 16 | 3 |
| >70 yrs | 4 | 4 |
| TOTAL | 73 | 24 |

**TABLE – 2.**

| COMORBID CONDITION OF PATIENTS WHO DEVELOPED VAP | NO |
|---|---|
| RTA | 22 |
| RTA WITH HI | 16 |
| HI | 11 |
| CAPSULOGANGLIONIC BLEED | 5 |
| HEMIPLEGIA | 1 |
| SEIZURES | 4 |
| GBS | 2 |
| COPD | 9 |
| PULMONARY KOCHS | 2 |
| ASPIRATION PNEUMONIA | 11 |
| SEPSIS | 4 |
| POISONING | 4 |
| DENGUE | 1 |
| POST SURGICAL | 3 |
| CARDIAC | 1 |
| OBSTRETICAL | 1 |
| TOTAL | 97 |

**TABLE – 3.**

| ORGANISM PATTERN IN VAP PATIENTS | NO | % |
|---|---|---|
| STAPH.AUREUS | 1 | 1.03 |
| CONS | 4 | 4.12 |
| E.COLI | 7 | 7.21 |
| KLEBSIELLA PNEUMONIAE | 15 | 15.46 |
| PSEUDOMONAS.AERUGINOSA | 6 | 6.18 |
| ACINETOBACTER.BAUMANII | 64 | 65.9 |

**TABLE – 4.**

| **OUTCOME** | | |
|---|---|---|
| | | % |
| SURVIVED | 93 | 95.8 |
| DEAD | 4 | 4.12 |

**TABLE – 5.**

| **ANTIBIOTIC SENSITIVITY PATTERN** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **GRAM POSITIVE COCCI** | **OX** | **ERY** | **CIP** | **GM** | **AK** | **RIF** | **TIECO** | **VAN** | **LZ** |
| Staph | 0 | 0 | 0 | 0 | 0 | 0 | 100% | 100% | 100% |
| CONS | 0 | 25% | 50% | 0 | 50% | 75% | 100% | 100% | 75% |

**TABLE – 6.**

| ANTIBIOTIC SENSITIVITY PATTERN | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| GRAM NEGATIVE BACILLI | CIP | GM | AK | NETIL | CEF+SUL | PIP+TAZ | IM | MM | P-B | COL |
| ECOLI | 0 | 0 | 28.50% | 14.20% | 57.10% | 57.10% | 71.40% | 85.40% | 57.10% | 57.10% |
| KLEBSIELLA | 6.60% | 0 | 26.60% | 20% | 26.60% | 26.60% | 78% | 80% | 80% | 80% |
| PSEUDOMONAS | 33.30% | 33.30% | 83.30% | 83.30% | 83.30% | 83.30% | 83.30% | 83.30% | 50% | 50% |
| AINETOBACTER | 7.80% | 6.25% | 6.25% | 23.40% | 25% | 25% | 80% | 85% | 82.80% | 82.80% |

## CONCLUSION

Clinicians must focus on eliminating or minimizing the incidence of VAP through preventive techniques. Interventions to prevent pneumonia in the ICU should combine multiple measures targeting the invasive devices, microorganisms, and protection of the patient. VAP is particularly common in patients with ARDS, after tracheotomy, in patients with COPD, and in injured and burned patients. Careful monitoring, MiniBAL sample surveillance and implementation of VAP bundles are important in preventing and for early diagnosis of complications of mechanical ventilators. The microbial causes of VAP are many and varied. Most cases are caused by routine bacterial pathogens that reach the lung after aspiration of oropharyngeal secretions or direct inoculation into the airways. The causes of VAP and the likelihood of infection by an antibiotic-resistant strain can be predicted based on the patient characteristics, the duration of hospitalization, the duration of mechanical ventilation, prior exposure to antibiotic therapy, and prior colonization patterns. Local microbiology and antibiotic susceptibility data are essential for making informed antibiotic treatment choices.

Simple and effective preventive measures can be instituted easily and at minimal costs. Such measures might include NIV, diligent respiratory care, hand hygiene, elevation of head, oral and not nasal cannulation, minimization of sedation, chest physiotherapy, prone positioning, the timing of tracheostomy, institution of weaning protocols, judicious use of antibiotics, de-escalation, and leveraging PK/PD characteristics for antibiotics administered. More costly interventions should be reserved for appropriate situations.

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