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Ventilator Associated Pneumonia: Incidence, Microbiological Profile, And Measures Taken To Reduce

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ABSTRACT:
Background: One of the most common hospital acquired infection in intensive care units is ventilator- associated pneumonia (VAP). The reported incidences range greatly, from 5 to 40%, depending upon the diagnostic criteria used and hospital setting. Extended periods of mechanical ventilation and lengthy ICU stays are linked to VAP. Ventilator associated pneumonia (VAP) accounts for 9-27% of mechanically ventilated patients.
Aim and Objective: To measure the incidence of VAP, the implicated pathogens, and efficacy of measures taken to reduce the incidence of VAP in a Tertiary care Hospital.
Material and methods: This was a combined retrospective and prospective active surveillance study carried out in a tertiary care setting in southern part of India over a period of four years. The study was performed in two phases. First phase was the assessment phase which was retrospective in nature while second phase was the intervention phase and was prospective in nature. In first phase CDC criteria were followed to identify VAP cases retrospectively from hospital data, lab reports and patient records (Hospital Information System [HIS]).
In the second phase multiple interventional measures were applied including introducing services of the above three mentioned health care professionals and effect on VAP rate was studied thereafter.
Results: In the present study the VAP rates in first phase were observed to be 12.83 per 1000 ventilator days. Modifications in the VAP treatment protocol like implementing VAP care bundle, use of frequent subglottic aspiration/suctioning technique, early weaning protocols, titrated sedation and presence of a full time intensivist, daily microbiologist rounds and involvement of a dedicated HICC nurse helped in reduction of incidence to 7.39 per 1000 ventilator days.
Conclusion: A multi-speciality approach along with strict adherence to standard protocols revealed reduction in VAP rate ($p < 0.001$).

Introduction:

Hospital acquired infections (HAI) are the fifth leading cause of death in acute care settings (1) (2).

Ventilator associated pneumonia (VAP) ranks high amongst hospital acquired infection as a predominant cause of fatalities (3). VAP accounts for increased ICU & hospital stay, increase in attributable mortality of 9% (1) and added health care cost (4).

VAP can be defined as parenchymal lung infection developing after 48 hrs of mechanical ventilation, caused by infectious agents not present or incubating at the time of mechanical ventilation (3,5). VAP has been reported in 9-27% of mechanically ventilated patients, with about five cases per 1000 ventilator days (1). The incidence of VAP varies considerably across the world. As per International Nosocomial Infection Control Consortium (INICC) data, incidence of VAP is 13.6/1000 mechanical ventilator days. (6) In Asian countries the incidence varies from 3.5 to 46 infections/1000 mechanical ventilator days (6) while in US is 4-14/1000 days (3).

This study was undertaken with a aim to see the efficacy of targeted interventions in reducing the incidence of VAP. The objectives of the study were to measure and correlate the

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incidence of VAP in pre and post

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intervention phases and identify and enumerate the implicated pathogens.

Material and methods:

This was a unique study which involved two limbs, a retrospective one and a prospective active surveillance limb. The study was conducted in the ICU of a tertiary care hospital in Southern part of India over a period of four years during years 2016 to 2019. The study was performed in two phases of twenty-four months each. First phase was the assessment phase which was retrospective in nature while second phase was the intervention phase and was prospective in nature. In first phase CDC criteria were followed to identify VAP cases retrospectively from hospital data, lab reports and patient records (Hospital Information System [HIS]and hospital infection control data). Standard treatment was followed during this phase but there were no full time intensivists manning the ICU, daily rounds did not happen in the presence of a clinical microbiologist and there was no active surveillance by a Hospital Infection control nurse HICC). Data of etiological agent, its antibiotic sensitivity pattern, and the clinical outcome was retrieved from records (HIS). In the second phase multiple interventional measures were applied including introducing services of the above three mentioned health care professionals and effect on VAP rate was studied thereafter.

Inclusion Criteria:

All the patients who received mechanical ventilation for more than 48 hrs were included in this study.

Exclusion Criteria:

All those who developed pneumonia within 48 hrs of ventilation were excluded from study.

All the patients were assessed using CDC criteria for diagnosis of VAP.

The Hospital has dedicated Hospital Infection Control Committee Team (HICC team) comprised of a microbiologist, intensivist, respiratory physician, surgeon, ICU nurse and HICC nurse. All the infection control practices were followed in earnest along with all the bundles. Various interventional measures applied during phase two included the following

a) Daily round with intensivist, microbiologist and additional HICC nurse in addition to standard existing practices of ICU rounds.
b) Use of endotracheal tube (ETT) with subglottic aspiration tube.
c) Early weaning protocol.
d) Additional dedicated HICC nurse.
e) Education and training of staff involved in ICU patient management.

All the cases in phase II were intubated with endotracheal tube with a subglottic suction for subglottic secretion clearance. Subglottic secretions were suctioned manually at an hourly frequency and as and when required in addition. Every day all the ventilated cases were assessed for early weaning using the institutional weaning protocol. It included but was not limited to the ABCD model as under:

A) Airway or assessment: Is the airway intact? Does the initial assessment suggest possible weaning success?
B) Breathing: Is the patient able to initiate breathing?
C) Hemodynamic stability: Is there cardiovascular stability?
D) Diffusion: Has the underlying respiratory failure resolved? Is gas exchange or diffusion adequate?

Hospital has an HICC nurse for all infection control practices. One additional nurse trained in infection control practices was made available during second phase. Defined role and responsibilities were assigned to this dedicated nurse like onsite data collection, active monitoring of ICU infection practices, deep surveillance, antibiotic stewardship, and onsite training of all the paramedical staff involved in ICU care.

Hospital has regular schedule of training all medical and paramedical staff. In addition to it onsite regular training was given to everyone involved especially the nursing and paramedical staff in intensive care by the dedicated infection control nurse. A record of detail clinical history and assessment was maintained for all the patients as per VAP assessment form. All patients received standard ventilator care as described in the ventilator associated pneumonia care bundle which included head end elevation, peptic ulcer prophylaxis, subglottic suctioning, scrupulous oral hygiene and DVT prophylaxis. Initially all the cases were empirically treated using broad spectrum antibiotics which were later tailored based on the antibiotic sensitivity report. All the cases were followed up for their clinical progress and outcome.

Various clinical samples collected included tracheal aspirates, BAL, endotracheal tube tip culture and blood cultures. Chest x-ray was also done as per investigation protocol. All the microbiological samples were processed for identification and processing in Vitek instrument.

Growth of more than 10^5CFU/ml was considered as significant for endotracheal aspirates and growth more than 10^4CFU/ml for BAL. The collected data was analysed from the HIS at the end of first phase. In the second phase, a targeted approach was implemented to reduce the incidence of VAP by using a dedicated HICC

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nurse and various preventive interventions. Statistical analysis was carried out by using R software. Chi square test were carried out to analyse the significance of difference between two groups of phase I & phase II.

Results:

A total of 214 patients received mechanical ventilation for more than 48 hrs during first phase for 2338 ventilator days. In the second phase 126 patients were on the ventilator for 2876 days. The VAP rate revealed decreasing trend (Fig 1) in year 2018-19. The VAP rate in first and second phase was 12.83 and 7.39 respectively (Table 1)

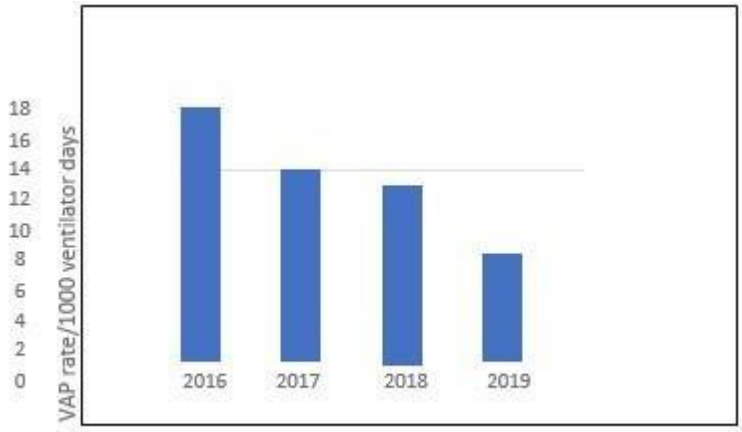

Fig1: VAP rate in respective year (2016-2019) of the study period

Table1: Details of VAP rate in first and second study phase		
	Phase I	**Phase II**
Number of VAP cases	30	21
Mechanical ventilator days	2338	2876
VAP rate/1000 MV days	12.83	7.39

Table 2: **Details of causative microorganisms in two study phases**

Isolate	Percentage Phase 1	Phase 2
Klebsiella pnemoniae	24.75%	22.7%
Acinetobacter spp	18.8%	13.6
Staphylococcus aureus	9.75%	9%
Pseudomonas spp	18%	22.7
E Coli	9.3%	13.6
Streptococcus Pneumonae	4.8%	9.4%
Burkholderia cepacia	4.8%	4.5%
CONS	4.8%	4.5%
Polymicrobial	5%	0%

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Thus, the effective implementation of targeted interventions by vigilant and committed ICU nursing resulted in 9% reduction in VAP rates in phase II as compared to phase I (p 0.0001, CI 6.6-11.38). The microbiological profiling of all tracheal aspirates and BAL samples revealed predominance of Gram negative isolates in both phases (Table 2). *Klebsiella pnemoniae* was the most common isolate followed by *Acinetobacter* and *Pseudomonas*. No polymicrobial growth noted in phase two. Predominant isolates in 'Early onset VAP' were *Klebsiella, Staphylococcus aureus* and *Streptococcus pneumoniae.* Late onset VAP pathogens were MDR pathogens like ESBL producing *Klebsiella, Pseudomonas* and Vancomycin Resistant *Enterococcus* and *Burkholderia cepacia.* Comparison of distribution of causative agents in both phases revealed almost similar pattern except for higher number (13.6%) of *E Coli* and *pseudomonas* (22.7%) as compared to first phase. Characteristically no polymicrobial infection noted in second phase.

Discussion:

VAP continues to be the most serious device associated infection resulting in increased length of hospital stay, significant increase in morbidity and mortality (7) (8). Implementation of multidimensional approach has proven to reduce VAP rates in various studies (8,9). The overall incidence of VAP noted in this study is 10.6/1000 mechanical ventilator days which is lower than INICC data of 13.6/1000 mechanical ventilator days, and still lower than data from other Indian studies like Ranjan et.al (57.14/1000 ventilator days) but higher than Ghosh et al, 2018 6.242/1000 ventilator days) (8,9,3,10). VAP is one of the most significant hospital acquired infections in mechanically ventilated patients, and it poses a serious risk to their recovery specially in intensive care unit.

Study demonstrated significant reduction in VAP rates in phase II (from 12.83 to 7.39) as compared to phase I (p <0.001). This could be attributed to the availability full time intensivists manning the ICU, daily rounds of a clinical microbiologist and active surveillance by a Hospital Infection control nurse (HICC). Two dedicated hospital infection control trained nurse were able to implement infection control practices in spirit, use of subglottic aspiration technique and strict adherence to weaning protocol.

Protective role of subglottic aspiration has been published in various studies and randomised multicentre trials (11,12,13). Critical decision of weaning plays important role in VAP. Both premature weaning and delayed weaning can cause harm to patient. Increase in number of ventilator days also puts patient on high risk for VAP. Prompt adaptation to standardized ABCD model of weaning during our study has helped in VAP reduction. Dedicated infection control nurse was boon to all critical cases. Her onsite recording of various parameters, surveillance activities and ability to impart education, training to health care workers has significant impact on VAP reduction. Hence the study highlights the urgent need for implementation of VAP bundle by multidisciplinary approach.

The causative agents of VAP tends to change according to the region or type of health care setting. During our study, Gram negative bacteria stands as the predominant organism in both early as well as late VAP. This finding is also seen in few other Indian studies.(3,6,7) The most common isolate was *Klebsiella* (24%) followed by *Acinetobacter* (17%) unlike other studies where *Pseudomonas* was the predominant isolate followed by *Klebsiella.(*7) Second phase of study had no polymicrobial aetiology. This reflects proper sample collection as well as appropriate patient care.

However, the diagnosis of VAP is often a problem. Accurate clinical and microbiologic diagnosis of VAP is essential for selection of appropriate antimicrobials and prevent emergence of multidrug resistant pathogens in the ICU [14]. As the organisms and their sensitivity pattern may differ in every ICU, the knowledge of the resident flora and their behaviour should be known for successful treatment.

The notable strengths of our study were that it was a mixed retrospective and prospective study conducted by multi-speciality team. Most of the studies on VAP infections are solely laboratory based and lacks the clinical approach. The study highlights multidimensional approach of team of clinical microbiologist, intensivist as well as infection control nurse for implementing VAP bundle and infection control interventions that has resulted in significant reduction in VAP rates in second phase.

Conclusion:

1. Significant reduction in VAP rate (p <0.001) in second phase by various interventions taken implies team efforts of HICC can really make significant change in reducing hospital acquired infection such as VAP.
2. Use of subglottic aspiration/suctioning technique, daily combined rounds of microbiologist and chest physician, availability of full time intensive care physician, proper weaning protocol (VAP bundle) and presence of dedicated HICC nurse has significantly helped to reduce VAP rates.

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Conflict of interest: None.
Author's contributions: SP conceptualized and designed the work, LV carried out microbiology rounds and collected the data. SP, LV, TMJ and AS interpreted the acquired data. SP and AS drafted the manuscript and finally revised the manuscript. All authors have read and approved the manuscript.

Consent for publication: Not applicable
Highlights: The study highlights

1. Multi-speciality approach to implement VAP bundles.
2. Need of frequent subglottic suction.
3. Regular assessment of weaning protocols.
4. Microbiological profile of etiological agents.

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