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Ventilator Associated Pneumonia and Its Correlation with Oral Cavity Bacteria

Jyoti Shamrao G[1], Dr. A. D. Urhekar[2]

[1]Tutor, Department of Microbiology, MGM Medical College and Hospital Kamothe, Navi Mumbai, Maharashtra, India.
[2]Emeritus Professor, Department of Microbiology, MGM Medical College and Hospital Kamothe, Navi Mumbai, Maharashtra, India.

Corresponding Author: Jyoti Shamrao G

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ABSTRACT

Introduction: Ventilator-associated pneumonia (VAP) is a critical concern in intensive care units (ICUs), defined as pneumonia occurring within 48 hours of intubation and mechanical ventilation. It is often linked to prolonged hospital stays and poses a significant threat to patient well-being. Diagnosis of VAP relies on a set of criteria, including clinical symptoms, radiological evidence, and bacteriological confirmation, with the caveat that these signs were absent upon initiation of ventilation.
Aim: This study aims to investigate the potential correlation between oral/mouth flora and their role as causative pathogens in VAP among patients in tertiary care units.
Material and Methods: This is a Retrospective study conducted in Department of Microbiology, MGM Medical College and Hospital Kamothe, Navi Mumbai from August 2019 to December 2020. Patients on ventilator admitted in MICU, SICU and EMS ICU were included in the study. Endotracheal tube aspirate/ Endotracheal tube tip and oral secretions of the patient diagnosed with VAP were collected with aseptic precautions using sterile material. Samples were transported to laboratory as soon as possible OR stored in refrigerator at 2°C to 8°C. Examination of bacterial flora in the oral/mouth cavity of patients using standard microbiological techniques by collecting oral swabs. Statistical r value was calculated to establish relationship between oral cavity bacteria and VAP causing bacteria.
Results:
•Culture of ET tip showed maximum presence of klebsiella 24% followed by Acinetobacter 23% pseudomonas spp, Citrobacter spp and staph aureus.
•Bacteriological culture of oral secretion showed klebsiella 16%, Acinetobacter 11%, Staph aureus 18% and CONS
•The number of patient's samples having similar bacterial pathogens in ET tip and Oral secretion were 76%
•The calculated correlation coefficient (r value) for the two sets of data is 0.372. which is considered to be statistically significant.
Conclusion: This study underscores the significant proof that in majority of cases, bacteria in oral cavity gain access to lower respiratory and causes VAP development. While further research is needed to fully elucidate the mechanisms involved, our findings suggest a potential link between oral pathogens and VAP. Understanding this connection may offer new insights for the prevention and management of VAP, ultimately improving patient outcomes in ICUs.

Keywords: Oral Bacteria, Endotracheal Tube, Respiratory Pathogens, Ventilator Associated Pneumonia.

INTRODUCTION

Ventilator-associated pneumonia (VAP) stands as a formidable challenge within the realm of critical care medicine. Its definition, "Ventilator-associated pneumonia (VAP) is defined as pneumonia in a patient intubated and ventilated at the time of or within 48 hours before the onset of the event" [1]. Evidently, VAP does not adhere to a stringent timeline, making it a menace lurking in the corridors of intensive care units, particularly affecting those enduring prolonged hospitalization due to traumatic injuries or other underlying conditions [1]. This research explores how alterations in the oral and upper airways microbiota may influence the development and progression of VAP in critically ill patients.

The diagnosis of VAP involves a triad of crucial components, all of which must converge to paint the clinical picture with clarity: systemic symptoms signalling an underlying infection, the appearance of new or deteriorating infiltrates on chest radiographs, and compelling bacteriological evidence pinpointing an infection within the pulmonary parenchyma [2]. Equally vital is the exclusion of these components from the time of mechanical ventilation initiation, drawing a sharp distinction between pre-existing conditions and the ominous onset of VAP [2].

As the prevalence of VAP fluctuates across diverse patient populations and healthcare settings, the causative microorganisms exhibit a remarkable diversity. Traditionally, aerobic Gram-negative bacteria (GNB) have been the chief culprits, accounting for over 60 percent of VAP cases. [3] Among these GNBs, Pseudomonas aeruginosa and Acinetobacter spp. reign supreme, closely followed by Proteus spp., Escherichia coli, Klebsiella spp., and Haemophilus influenza [4]. However, recent observations indicate a shifting landscape, with Gram-positive bacteria, notably Staphylococcus aureus, ascending to prominence [5].

The origins of these infections trace back to the insidious aspirations of potential pathogens inhabiting the oropharyngeal airways. Patient intubation not only breaches the natural oropharyngeal-tracheal barrier but also creates a conduit for bacteria to infiltrate the lungs, facilitated by the pooling and seepage of infectious secretions around the cuff of the endotracheal tube, an occurrence particularly pronounced in the supine position [6]. Patients newly admitted, even without prior complications, may fall prey to the presence of normal oral flora or community-acquired pneumonia-associated pathogens. In contrast, patients hospitalized for more extended durations, often exceeding five days, are more likely to host GNBs and S. aureus, mirroring the upper airway's colonization [6].

The exact reasons behind how oral cavity bacteria end up being causative agents of VAP are still being studied. It's probably a mix of several factors, like changes in mouth bacteria due to long-term illnesses, changes in the hospital environment, and specific shifts happening in the mouth itself [7]. Given this complex situation, our study is focused on understanding the connection between mouth bacteria and the germs that cause VAP in specialized healthcare units. Against this intricate backdrop, this study aims to investigate the potential correlation between oral/mouth flora and their role as causative pathogens in VAP among patients in tertiary care units.

The Objective of the study is to understand the complex interplay between oral flora and VAP development, this research seeks to contribute to improved prevention and management strategies for this life-threatening condition.

MATERIALS & METHODS

This is a Retrospective, Experimental and Analytical study conducted in Department of Microbiology, MGM Medical College and Hospital Kamothe, Navi Mumbai, During August 2019 to December 2020.

Inclusion criteria: Patients on ventilator admitted in MICU, SICU and EMS ICU.
Exclusion criteria: Patient who are not diagnosed with VAP.
Sample Size: 50 Paired samples (ET tip and secretion and Oral secretion for each patient)
Specimen Type: Endotracheal tube aspirate/ oral secretion for culture.

Study Procedure:
1. Sample Collection:
Paired samples of Endotracheal aspirates and oral secretion were collected for the study.

a) Endotracheal Aspirate (ETA) Collection
Endotracheal aspirate samples were collected using a non-bronchoscopic procedure by qualified respiratory staff. The following steps were followed:

Collection Procedure
A 12-F suction catheter of a 22-inch ramson was utilized.
The catheter was gently introduced for a distance of approximately 25-26 cm via the endotracheal tube (ETT). Gentle aspiration was carried out without instilling saline. The catheter was then carefully extracted from the endotracheal tube (ETT). Subsequently, 2 mL of sterile 0.9 percent normal saline was injected into the catheter using a sterile syringe to flush the exudates into a sterile container for further collection. Samples obtained from the endotracheal aspirate (ETA) were processed immediately for further analysis.

b) Oral Secretion Collection
Oral secretion samples were collected using sterile swabs provided by the microbiology laboratory at the institute.

2. Microbiological Analysis
Inoculation and Culturing:
Collected samples from both the endotracheal aspirate (ETA) and oral secretions were inoculated onto culture media as follows:
A 5 mm nichrome wire loop (Hi-media, Mumbai, India) carrying 0.01 mL of the sample was streaked onto Sheep blood agar, Chocolate agar and MacConkey's agar plates. The inoculated plates were incubated for 24 hours at 37°C
Samples were subjected to direct Gram staining to identify bacterial morphology. Isolation and identification of microorganisms were carried out by conventional biochemical tests. Antimicrobial susceptibility testing was conducted using a panel of antibiotics in accordance with CLSI (Clinical and Laboratory Standards Institute) guidelines. [8] The Kirby-Bauer disc diffusion method was employed.

STATISTICAL ANALYSIS

Statistical Analysis:
•Statistical r- value was calculated to establish the probable correlation between Endotracheal aspirate isolates and oral cavity isolates.
•Statistical p- value was calculated to verify the significance of correlation between Endotracheal aspirate isolates and oral cavity isolates.

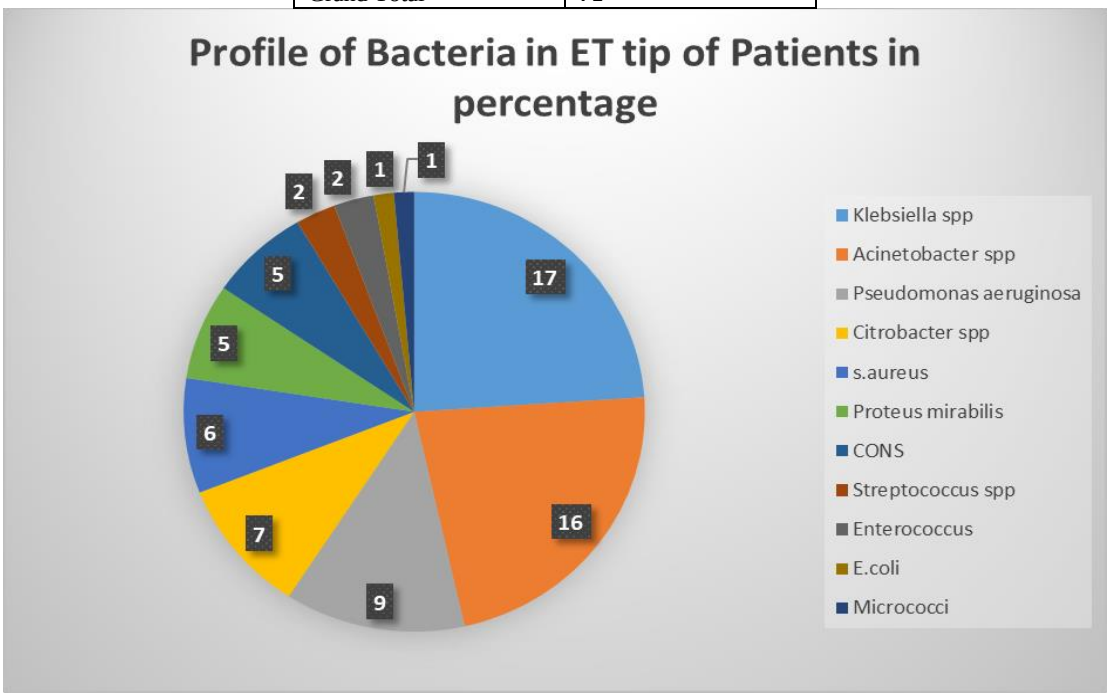
RESULT

50 paired (ET tip and secretion and Oral secretion for each patient) samples were studied for bacterial isolation and identification. The Profile of total number of different organisms was isolated which is given in the (Table/Fig 1). However more than one organisms were isolated in some the samples bringing the total isolates to 71 (40%). Culture of ET tip showed maximum presence of klebsiella 24% followed by Acinetobacter 23% pseudomonas spp , Citrobacter spp and staph aureus. (Table/Fig 1). Bacteriological culture of oral secretion showed klebsiella 16%, Acinetobacter 11%,

Staph aureus 18% and CONS (Table/Fig 2). The number of patient's samples having similar bacterial pathogens in ET tip and Oral secretion were 76% (Table/Fig 3). The calculated correlation coefficient (r value) for the two sets of data is 0.372. The two-tailed P value equals 0.032 was obtained which is considered to be statistically significant. Hence the Hypothesis being bacterial contamination originating from the oral cavity, transmitted to the lungs during intubation, plays a crucial role in VAP development was accepted.

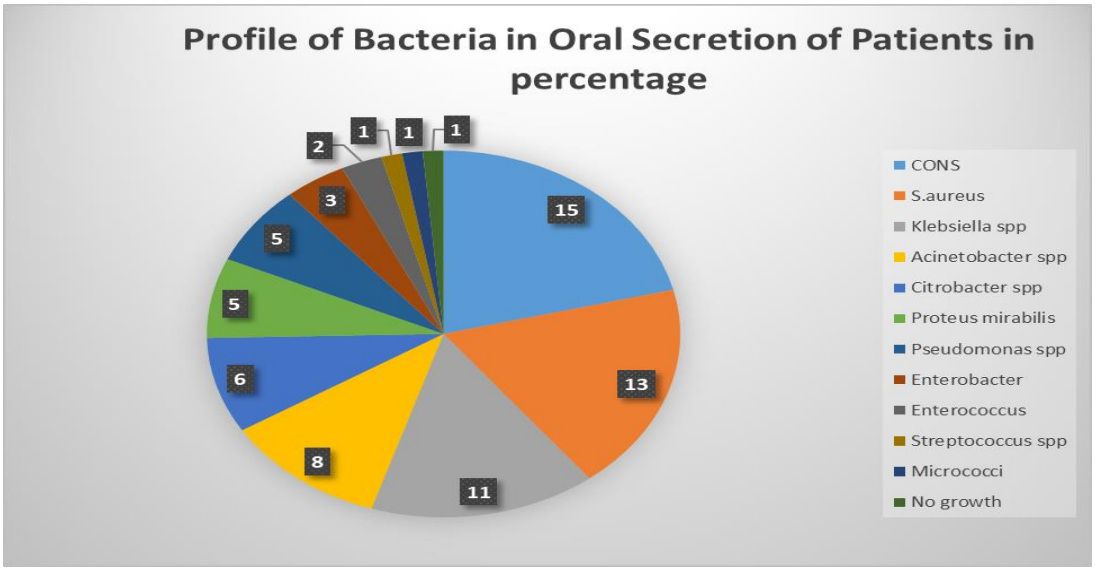
Table/Fig 1 Profile of Bacteria in ET tip of Patient.

Name of organism	Number of organisms
Klebsiella spp	17 (24%)
Acinetobacter spp	16 (23%)
Pseudomonas aeruginosa	9 (13%)
Citrobacter spp	7 (10%)
S.aureus	6 (8%)
Proteus mirabilis	5 (7%)
CONS	5 (7%)
Streptococcus spp	2 (3%)
Enterococcus	2 (3%)
E.coli	1 (1%)
Micrococci	1 (1%)
Grand Total	**71**

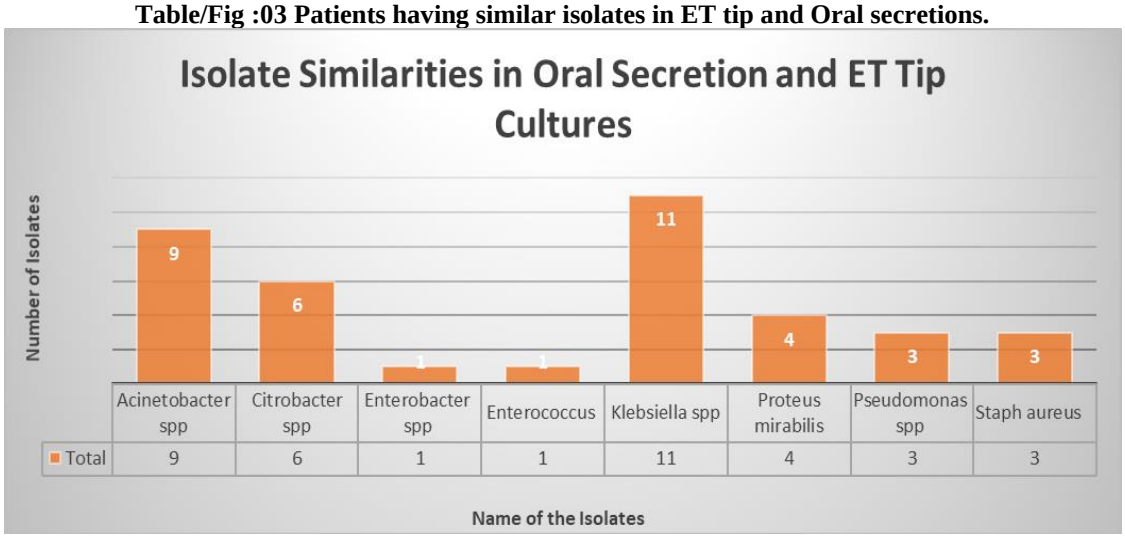


Table/Fig :02 Profile of Bacteria in Oral Secretion of Patients

Name of organism	Number of organisms
CONS	15 (21%)
S.aureus	13 (18%)
Klebsiella spp	11(16%)
Acinetobacter spp	8 (11%)
Citrobacter spp	6 (9%)
Proteus mirabilis	5 (7%)
Pseudomonas spp	5 (7%)
Enterobacter	3 (4%)
Enterococcus	2 (3%)
Streptococcus spp	1 (2%)
Micrococci	1 (1%)
No growth	1 (1%)
Grand Total	**71**



Table/Fig :03 Patients having similar isolates in ET tip and Oral secretions.



Statistical Analysis:

Group	Organism In Oral	Organism In Et Tip
Mean	4.26	24.48
SD	3.11	141.83
SEM	0.44	20.06
N	50	50

R value and statistical significance:

The two-tailed P value equals 0.032.
The calculated correlation coefficient (r value) for the two sets of data is 0.372

DISCUSSION

The study conducted in MGM Hospital Kamothe presents crucial insights into the microbial etiology of ventilator-associated pneumonia (VAP). Klebsiella, Acinetobacter, and Pseudomonas emerge as predominant isolates, aligning with similar Indian studies [9][14] . Notably, 76% of cases exhibit similar isolates in endotracheal tip and oral secretion samples, indicating a complex microbial ecosystem in VAP patients.

Findings resonate with Y. Mehtan Jaggi [10] and Saroj Golia et al. [15], emphasizing Klebsiella, Acinetobacter, and Pseudomonas as recurrent VAP agents in India.

Aligns with Mary Lou Sole and Elizabeth Pailillo [12], underlining the role of oral microbial contamination in VAP. Corroborates with Farah et al. [13], emphasizing the tongue as a potential reservoir for VAP-related pathogens.

The significant correlation (r value 0.372) between oral and endotracheal bacterial isolates substantiates the migration hypothesis. Reinforces the preventability of VAP, urging proactive measures like regular aspiration, stringent oral hygiene, and attentive nursing care [15][16]. Stresses the significance of robust infection control practices in reducing VAP incidence and improving patient safety

Statistical analysis of our data indicated a significant correlation (r =0.372) between bacterial isolates from oral secretions and endotracheal secretions. This finding strengthens the hypothesis that microorganisms from the oral cavity can indeed migrate to the lower respiratory tract through the endotracheal tube, initiating infection. This study contributes valuable insights into the microbial profile of VAP in our hospital setting. It supports the concept that in a majority of VAP cases, organisms present in the oral cavity traverse the endotracheal tube to cause lower respiratory tract infections. This phenomenon underscores the importance of preventive measures, including regular aspiration of oral secretions, stringent oral hygiene practices, and vigilant nursing care for intubated patients. By addressing the potential sources of microbial colonization and translocation, we can take significant steps toward reducing the incidence of ventilator-associated pneumonia and improving patient outcomes in intensive care units. Previously perceived as an unavoidable consequence of mechanical ventilation, this study strongly suggests that VAP is preventable, highlighting the significance of implementing robust infection control measures [16] Implementing proactive measures, including stringent infection control, attentive nursing care, and oral hygiene protocols, can significantly reduce VAP incidence and improve patient safety in ICU settings. [17]

Future Perspectives:

Effectiveness Evaluation: Suggests the need for future research to evaluate the effectiveness of preventive strategies over extended periods. This study contributes valuable insights into VAP microbial profiles, emphasizing the consistency with previous Indian studies and highlighting preventive measures' importance. The comparative analysis enhances the study's context, offering a comprehensive understanding of VAP etiology.

Limitations of the study: The study does not have addressed the long-term sustainability of the preventive measures proposed or the effectiveness of these strategies over extended period.

CONCLUSION

This study strongly supports a significant association between oral microorganisms and Ventilator-Associated Pneumonia (VAP), as indicated by a statistically significant r-value of 0.372. Recognizing the preventable nature of VAP, the study emphasizes the pivotal role of oral microflora in its pathogenesis. The findings underscore the need for stringent infection control in the ICU to minimize VAP risk. The study highlights VAP as a result of interconnected factors, including secretions' inadvertent leakage, compromised swallowing reflexes, and supine positioning in ICU care. This creates an environment conducive to aspirating oropharyngeal secretions and pathogens into the lower respiratory tract, initiating VAP. In conclusion, the study illuminates the preventable aspect of VAP, stressing the central role of the oral cavity. Implementation of rigorous infection control, meticulous oral hygiene, and attentive nursing care can significantly reduce VAP

incidence, enhancing patient safety in the ICU. The study's findings advocate for proactive strategies to prevent VAP and enhance overall care for mechanically ventilated critically ill patients.

Declaration by Authors

Ethical Approval: Ethical Approval was taken from the Institutional Ethics Committee of MGM Medical College, Navi Mumbai. Approval Number: N-EC/2019/SC/07/91.

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Conflict of Interest: The authors declare no conflict of interest.

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