MECHANICAL VENTILATION: THE BENEFITS OF INCORPORATING DENTAL PERSONNEL AND ORAL HYGIENE PROTOCOLS

An Undergraduate Research Scholars Thesis

by

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This project did not require approval from the Texas A&M University Research Compliance & Biosafety office.

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Mechanical Ventilation: The Benefits of Incorporating Dental Personnel and Oral Hygiene Protocols

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The oral cavity is a portal of entry for pathogenic organisms to circulate throughout the body. Without proper oral hygiene care and maintenance, patients under respiratory distress are left susceptible to potentially harmful diseases. Mechanical ventilation is a fundamental component of modern treatment facilitated in managing intubated patients due to upper respiratory diseases. Although ventilation therapy is essential, it bypasses the filtration mechanisms and salivary clearance necessary to prevent infection of the respiratory system. A combination of immunosuppression and poor oral hygiene increases the risk for potential virulent organisms to develop within the oral cavity. Appropriate measures to combat this

increased risk, include routine mechanical removal of plaque, use of antiseptic mouth rinse, saliva substitutes, and assessment of oral diseases. Unfortunately, implementation of care for the oral cavity is lacking due to the insufficient education and training for non-oral health care providers. The recent coronavirus disease 2019 (Covid-19) pandemic has exacerbated the use of mechanical ventilators, increasing the cases of ventilation-associated pneumonia (VAP). Promoting interprofessional relationships could establish improved oral health protocols for mechanically ventilated patients. Additionally, incorporation of dental personnel to a multidisciplinary team would benefit other medical providers in the care of ventilated patients. This new discipline has potential to eliminate disparity between health of the oral cavity and systemic health. Although there is significant research indicating positive outcomes, further investigation is needed on effective standard of care for ventilated patients by inclusion of dental personnel in healthcare facilities.

DEDICATION

To the family members who inspired this research, and to my family, instructors, peers and friends who have been a constant source of support throughout the research process.

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INTRODUCTION

Breathe in, breathe out. While this may seem like a simple concept for most people, difficulty breathing due to upper respiratory diseases has become somewhat of a pandemic. Due to the rise in communicable diseases such as coronavirus disease 2019 (Covid-19), the use of ventilators has become an essential component of treatment.[1] Covid-19 is caused by an acute upper respiratory virus, severe acute respiratory syndrome coronavirus 2 (SARS-Cov-2).[1] The use of ventilators has become the mainstay in the intervention used in the management of Covid-19 due to concerns of aerosol generation from noninvasive oxygenation therapies facilitating nosocomial viral transmission.[1] However, Covid-19 is just one of many upper respiratory diseases that requires the use of mechanical ventilation. While patients are undergoing assisted mechanical ventilation, they usually are under the care of non-oral healthcare professionals, such as nurses, doctors, and respiratory therapists. Unfortunately, these professionals are not explicitly educated in the proper maintenance of the oral cavity.[2]

Oral health is an integral part of overall health.[2] Suboptimal oral health can substantially and negatively affect a person's quality of life, leading to major health burdens.[2] Currently non-dental health professionals, have reported a lack of education regarding oral hygiene and proper maintenance, despite playing a crucial role in the prevention and management of oral diseases.[2] This may lead to inadequate care for patients who are on assisted mechanical ventilators.[2] Absence of proper training could lead to multiplication of bacterial accumulation in the oral cavity,[3] whereas additional instruction may diminish the sequelae of oral health diseases produced by harmful bacteria accumulating in these mechanical ventilators.

There is also an impression that oral diseases are circumscribed to the field of dentistry.[2] However, the high cost of dental treatments discourage patients, leading them to see general practitioners, who are considered to be primary contacts for patients.[2] Non-oral healthcare providers, such as general practitioners, can enhance their holistic approach to care by incorporating a dental professional on their care team. These dental professionals will not only assist and provide guidance in identifying oral diseases, but will also aid in the care of these patients.

Research on this topic aligns with the American Dental Hygiene Association (ADHA) research agenda, specifically in the area of health promotion and disease prevention. Despite being largely preventable, oral diseases affect approximately 3.5 billion people worldwide and remains mostly neglected within general health policy.[2] This neglect could be due to oral health education being absent from post-operative instructions used by non-oral healthcare professionals.[2] Non-oral healthcare providers should be able to understand and interpret the important significance of the oral manifestations that arise from patients undergoing mechanical ventilation. Fortunately, this understanding may be facilitated in various ways, such as heightened awareness, additional education and collaboration with dental professionals. These factors can bring forth a new progressive practice to improve the quality of care for patients undergoing assisted mechanical ventilation. This research will not only demonstrate how those objectives may be accomplished but will also show the advantages of them. This will contribute to the ADHA research focus area of Health Promotion/Disease Prevention by explaining how the prevention of upper respiratory diseases, such as Covid-19, may be better controlled.

1. IDENTIFY THE SIGNIFICANCE OF ORAL BIOFILM ON MECHANICAL VENTILATORS AMONG PATIENTS WITH RESPIRATORY INFECTIONS

The human body is a host to billions of microbial cells that accumulate every day. Many of these microbes enter through the oral cavity, where, if not being maintained through proper oral care, bacterial aggregation can rise.[3] Individuals with healthier immune systems and adequate dexterity have a greater chance to efficiently control the dental plaque accumulation with the use of proper mechanical removal or antimicrobial agents. Conversely, hospitalized ventilated patients who do not have the adequate immune mechanisms or dexterity are more susceptible to bacterial colonization in the oral cavity of more virulent organisms.[3] There are a variety of risk factors that can cause ventilated patients to be more susceptible to opportunistic biofilm. A reduction of the oral immunity can develop due to the increased susceptibility of xerostomia from prolonged mouth opening and side effects of the antibiotic medications.[4] Among healthy individuals, saliva contains lubricating, antibacterial and buffering activities.[4] With a decrease in saliva, the buffering and cleansing effects are reduced.[4] Patients undergoing mechanical ventilation are administered antibiotics in order to prevent ventilator-associated pneumonia (VAP). [4] VAP is a respiratory infection that occurs when bacteria colonize in the oral cavity and dental plaque then make their way down the oropharynx and upper airways. [3] Conversely, an overuse of antibiotics can lead to the development of multidrug resistant pathogens.[4] These factors can contribute to an increase in biofilm accumulation leading to a greater probability of opportunistic pathogens to colonize in the oral cavity.[4] Another factor could be that ventilated patients are not physically capable of following an oral care routine,

since most of them are unconscious or have limited dexterity.[4] This makes them dependent on hospital staff to perform the mechanical removal of biofilm.

Patients who are unable to perform self-respiration are put under ventilators or artificial breathing machines.[4] Patients are normally placed under mechanical ventilation after experiencing a critical health occurrence such as a heart attack, stroke, or after undergoing an extensive surgery. The purpose of ventilators is to reduce the strenuous respiratory muscle activity, decrease oxygen consumption, and to maintain gas exchanges.[2] Hospitalized patients who are under mechanical ventilation are more prone to developing a higher rate of bacterial biofilm accumulation.[3] This is due to a reduction of salivary secretion, lower levels of salivary local immunity factors, and absence of self-cleaning by chewing.[3] With inadequate saliva flow, patients are more prone to higher biofilm accumulations, therefore increasing the development of virulent pathogens.[3] Ventilated patients generally undergo critical conditions which makes them unable to meet their oral hygiene and nutritional needs.[4] Therefore, the dependence on their oral hygiene and nutrition is on the management of the hospital caretakers.[4] If the ventilated patients' oral health deteriorates, the patients will be at a high risk for developing VAP.[3]

According to Dagnew et al, amongst industrialized countries such as the United States (U.S.), VAP is a common nosocomial infection with a high mortality rate of 36-60%.[4] If the oral cavity has not been properly cleaned, this infection can occur at least 48 hours after intubation.[3] The combination of poor oral hygiene and low salivary immune mechanisms amongst ventilated patients due to prolonged mouth opening, a transition between low virulent gram-positive bacteria to higher virulent gram-negative bacteria develops.[3] With the maturation of dental biofilm, respiratory pathogens such as *Staphylococcus (S.) aureus*, *Pseudomonas aeruginosa* and *Streptococcus pneumoniae*, begin to colonize in the oral cavity, worsening the overall health of

the patient.[3] With the constant mouth exposure, the bacterial flora begins traveling down the endotracheal tube, obstructing the physiological cleansing of the upper respiratory tract. This eventually reaches the lungs and the development a pneumonia infection ensues.[3] Having poor oral hygiene is a significant risk factor in the health of ventilated patients.[3] Therefore, increasing oral hygiene care can reduce the incidence of VAP.[3]

According to Dagnew et al, oral care is often overlooked and not prioritized in the daily activity plan of many nurses.[5] In hospital institutions, medical providers mostly tend to prioritize other health concerns over oral hygiene.[3] This could be due to the insufficient training the staff receives on performing oral care, knowledge on the importance of it, or the lack of updated protocols.[5] Based on the study conducted by Dagnew et al, 73 nurses participated in face to face interviews at the medical-surgical department in Orotta Hospital in Eritrea to determine their level of professional oral care training.[5] 94.5% (n=73) nurses reported that they have not received adequate training in providing quality oral care for their patients.[5] Additionally, the majority of the nurses (76.7%) did not perform routine oral health assessments.[5] It was concluded that although the majority of the nurses had a poor level of experience in oral care practice, they had a positive attitude towards learning proper oral care.[5] Incorporating an interprofessional collaboration among dental and medical providers can improve the competency of non-oral healthcare workers performing proper oral care. Increasing the management of oral hygiene on ventilated patients can minimize the risk and development of VAP.[3]

2. PROPER EDUCATION AND TRAINING FOR NON-ORAL HEALTHCARE PROVIDERS TO POTENTIALLY IMPROVE THEIR KNOWLEDGE ON ORAL HEALTH AND ITS LINK TO PREVENTABLE SYSTEMIC DISEASES, SUCH AS VENTILATION ASSOCIATED PNEUMONIA

VAP is a prevalent infection associated with mechanically ventilated patients, where the risk increases by 1-3% per day as a result of intubation.[6] Exposure susceptibility contributes to the length of stay in an intensive care unit (ICU) by an additional seven to nine days, risking progression in severity for VAP.[6] Use of the endotracheal tube for intubation bypasses normal oropharyngeal filtration mechanisms and salivary clearance, impairing the body's defense system against pneumonia.[6] A diminished salivary clearance mechanism creates a favorable environment for microorganisms to thrive and wreak havoc within the oral cavity, leading to diseases such as caries, gingivitis, or periodontitis. Unfortunately, not all healthcare workers receive proper training and education to be effective in providing adequate oral care. Due to insufficient regulations, the Centers for Disease Control and Prevention (CDC) established oral hygiene care protocols, reducing the risk for mechanically ventilated patients to aspirate oral microbiota and potentiating the contraction of VAP.[6] Appropriate oral hygiene care for at-risk patients composes of regular removal of plaque, use of an antiseptic mouth rinse such as 0.12% Chlorhexidine, moisturizing of the mouth, and assessment of the patient for oral diseases that could worsen their status.[6] Evidence suggests that proper oral hygiene care for critically ill

patients, such as those on mechanical ventilation, can prevent pneumonia by approximately 60%.[6]

A report by Coker, et al. in 2020 examined the extent to which nurses provide oral hygiene care to older patients in post-acute hospital settings (n=25) by observation of their practices during evening shifts.[7] Results revealed that nurses provided basic routine care only if patients consented.[7] Furthermore, nurses varied in their knowledge of hospital protocols and measures in preventative oral care, admitting to inadequate training to provide oral hygiene care for patients.[7] Many of the nurses believed that enforcing oral hygiene care is connected to patient autonomy; when interviewed, some nurses admitted to never learning how to brush a patient's teeth, because they were only taught identification of oral findings and what it could bring about from a one-day course in their nursing program.[7] The report highlighted the limited oral health care knowledge and skills among nurses has led to the neglect of oral hygiene and its importance for those recovering from an impaired health state.[7]

In 2020, Blaylock, et al. emphasized the importance of educating general practitioners concerning the link between oral and overall health and its impact on patient well-being.[2] The Directorate of Multi-Disciplinary Dental Education (DMDE) established oral health training courses for general practitioners to enhance understanding.[2] Evaluation forms of participant feedback and reflection concluded that training had an 100% outcome with impacting their knowledge.[2] Results highlight the significance of interprofessional, team-oriented, efforts in educating healthcare workers on the connection between oral and overall health.[2] With adequate oral health and preventative care training, healthcare workers demonstrated confidence with incorporating discussions on the importance of good oral hygiene and answering specific questions regarding oral health relating to overall well-being with their patients.[2] The study's

implementation of dental knowledge for all non-dental health care providers supports the need for development of necessary measures to prevent oral diseases that worsen systemic health.

In 2019, Warren C., et al. contributed to an evidence-based study comparing nurses (n=1,131) providing oral hygiene care and education in an in-patient care setting at a level 1 trauma hospital, between a baseline and intervention group.[8] The intention of the study was to help understand the need for oral hygiene protocol interventions to reduce the number of VAP and non-ventilator hospital-acquired pneumonia (NV-HAP) events. A protocol was developed and implemented after educational sessions were held, providing oral hygiene care for short-term care, at-risk, or mechanically ventilated patients as well as education for these patients and their caregivers.[8] Depending on the patient status, kits equipped with high-quality bristled toothbrushes, alcohol-free antiseptic mouthwash, baking soda toothpaste, mouth moisturizers, and oral care swabs were used; additionally, if the patient was at a higher risk as a result of intubation, a suction would also be included.[8] Though results showed a variation of nurses adhering to the protocol based upon their department, approximately 76% of nurses began implementing oral hygiene care into their routine.[8] Furthermore, a statistically significant difference in the baseline and intervention VAP and NV-HAP patients revealed there was a decrease in the number of incidences in infection and death cases.[8] Evidence suggests that with the necessary training, implementation, and adherence of oral hygiene care protocols, nursing staff are capable of reducing the rate of patients becoming infected with pneumonia.

3. INCORPORATING A DENTAL HEALTHCARE PROVIDER WITH A STRICT PROTOCOL TO ENSURE APPROPRIATE CARE NEEDS ARE MET AND ALLOW FOR CORRECT IDENTIFICATION OF ORAL MANIFESTATIONS

The addition of a dental healthcare provider for patients undergoing mechanical ventilation could decrease oral manifestations that lead to pneumonia and other upper respiratory infections.[9] Each healthcare system has different policies on which healthcare worker is responsible for the inpatient's oral health; therefore, oral healthcare professionals need to identify who these healthcare workers are so that meaningful interprofessional collaboration can occur.[9] Ideally, oral healthcare professionals can become a permanent part of the healthcare system; however, this may not be an available option in all contexts.[9] Thus, oral healthcare professionals need to partner with healthcare systems in various capacities to help assure their patients' oral health is an integral part of patient care, particularly for those patients under mechanical ventilation.

A study was conducted by Silva et al. in Belo Horizonte, Brazil where the addition of dental personnel on staff was compared to medical staff alone.[9] Patients hospitalized in the ICU were treated by these two different types of staff. Silva et al. found the incorporation of a dental personnel was more effective than the typical medical staff.[9] The dental and medical collaboration designed a bundle showing a significant difference from the medical staff. This bundle included swabbing the mouth with 0.12% Chlorhexidine every 12 hours.[9] After this incorporation, pneumonia was no longer the main manifestation on the ICU floor.[9] Not only did the incorporation of 0.12% Chlorhexidine seem to influence the status of these ICU patients, but

the help of someone who specializes in the oral cavity impacted the health of these patients.[9] Silva et al. stated the Brazilian National Health Agency recommends 0.12% Chlorhexidine in addition with other biofilm removal measures to reduce the Pneumonia Associated Mechanical Ventilation (PAMV) cases.[9] The incorporation of an oral hygiene protocol could be very effective since there is no proven protocol for those undergoing mechanical ventilation.[10]

Another study was conducted in Pavia, Italy where the University of Pavia dental hygiene students assessed 160 patients in multiple hospital wards.[11] These patients gave their consent allowing the dental hygiene students to gather information through answering pre-made questionnaires, observing patients' current oral hygiene status, reviewing their medical history, assessing current oral home care, and any assistance needed by a caregiver.[11] These hospitalized patients had a range of medical conditions from cardiovascular, lung disease, diabetes, obstetric complications, pregnancy, and more.[11] When determining the hygiene status for each patient, there was one index that stood out from the remainder. The plaque index (PI) was extremely high across the board resulting in 52-90% generalized plaque in these patients' oral cavities.[11] Without proper daily oral biofilm removal, these numbers will remain high and could exacerbate their medical concerns.[11] There were other indices that accounted for gingival inflammation, caries, periodontal disease, etc., which were fairly high and could also aggravate these patients' medical conditions.[11] These dental hygiene students were well aware the longer these patients were hospitalized with minimal mouth care, the worse the pathogens would get.[11] Therefore, the dental hygiene students took advantage of this research opportunity and educated their patients, staff, and faculty.[11]

Our experts in this article concluded, specifically, dental hygienists could be the missing link in the medical field to help the overall health of each patient.[11] In order to prevent these oral

pathologies biofilm needs to be removed, daily, by a specialist who has been formally trained and is knowledgeable about the oral cavity.[11] Nurses, doctors, and therapists have countless responsibilities they must accomplish each day in order to do their job.[11] Patients who do not have family members or caregivers rely on these medical professionals to perform their daily functioning tasks that they cannot complete themselves.[11] The addition of dental personnel in the hospital setting, or increased didactic training on oral hygiene instruction and maintenance could alleviate the burden placed on medical professionals to protect their patients' oral health.[11] This collaboration of a dental personnel on the medical team would allow access to reverse or prevent oral diseases to patients who are not educated on the importance of going to the dentist or who have limited access.

CONCLUSION

Patients who are undergoing assisted mechanical ventilation are more susceptible to bacterial accumulation in the oral cavity.[3] However, lack of oral health and care knowledge often leaves the oral cavity being overlooked.[2] The oral cavity can be the portal of entry for bacterial pathogens to gain access to the rest of the body.[3] Thus, non-oral health care providers must have a general knowledge in how to adequately care for these patients.[2] The incorporation of dental personnel to multidisciplinary teams could aid in the care of patients relying on the help of other hospital healthcare providers.[9] Providing supplementary education and establishing a professional relationship between dental and non-dental medical providers could result in reducing the bioburden within the oral cavity and in mechanical ventilators.[2,9] Both interprofessional education and collaboration in the health profession can also lead to a potential decrease in the risk of oral complications from respiratory diseases. [2,9]

The inception of a partnership and/or discipline of dental personnel embedded in hospital settings, could lead to further research and establishment of new protocols for the improvement of the oral health of patients on mechanical ventilators.

In the future, comparing current to prospective oral health care training through longitudinal methods may demonstrate a more enhanced and holistic approach to reducing the likelihood of contracting respiratory infections. This approach can be conducted through augmented curricula and meaningful interprofessional partnerships. The implementation of these protocols will ensure the appropriate oral health care for patients on assisted mechanical ventilators, and thus produce a new standard of care. With proper execution, the oral induced health consequences of infections such as Covid-19, RSV, and VAP may one day be eradicated.

Achieving these objectives will potentially lead to a new and effective standard of care and will bridge the gap between oral health and physical health.

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