Oral Chlorhexidine Use to Prevent Ventilator-Associated Pneumonia in Adults
Review of the Current Literature

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Ventilator-associated pneumonia (VAP) describes pneumonia in patients requiring mechanical ventilation that was not present prior to intubation. Ventilator-associated pneumonia concurrently increases patient mortality, hospital length of stay, and health care costs. Ventilator-associated pneumonia also contributes to patient morbidity, which is challenging the progression of patient care in intensive care units throughout the United States. Through critique of current literature, suitable interventions for intensive care unit implementation to prevent VAP are clearly identified. Oral health was shown in this literature to greatly contribute to the development or prevention of VAP; it can be compromised by critical illness and mechanical ventilation while being influenced by nursing care. Oral health is managed by proper oral care using oral chlorhexidine in order to decrease oral bacteria and potential oropharynx colonization. The previously mentioned literature review demonstrates a decrease in VAP rates with the use of such oral interventions as chlorhexidine. These research results will support and influence patient care practices considering nursing and medicine are driven by evidence rather than experience to prevent avoidable patient harm.

Keywords: Adult, Chlorhexidine, Efficacy, Intensive care unit, Oral care, Prevention, Ventilator-associated pneumonia

intubation for their infection to be considered VAP, and it is early onset if the infection presents in the first 4 days of mechanical ventilation (MV). Of all the factors relating to VAP occurrence, colonization in the oropharynx is the most critical risk factor and can be combated with proper oral care and chlorhexidine (CHX) use. All of this considered, VAP contributes to added cost, duration of MV, intensive care unit (ICU) length of stay (LOS), hospital LOS, and mortality. These factors make VAP an important HAI to control, requiring all medical and advanced practice nursing professionals to be working toward a common goal of VAP reduction for fulfillment of hospital goals and patient advocacy.

Similar to pneumonia, VAP also involves pathogens, but in an intubated and mechanically ventilated patient of at least 48 hours. Any patient who is mechanically ventilated is at risk of developing VAP because of the loss of airway defense mechanisms. Ventilator-associated pneumonia involves bacterial aspiration from the oropharynx down into the lungs, with subsequent failure of patient defenses to clear said bacteria, resulting in an infection of the lungs. The risk of VAP increases the longer a patient is intubated. Once this occurs, it progresses quickly and easily. The microorganisms found to cause VAP are most commonly located in the oropharynx and the stomach and find their way to the lungs past the endotracheal cuff via aspiration. The most common potential respiratory bacterial pathogens (PRPs) for a ventilated patient are Staphylococcus aureus, Pseudomonas aeruginosa, Acinetobacter species, and enteric species.

Ventilator-associated pneumonia is not only a great contributor to morbidity and mortality, but is also the leading cause of death among HAIs. It is crucial to consider VAP when discussing institution, ICU, and patient outcomes. Ventilator-associated pneumonia prevention is best. Health care providers need to focus on early extubation as appropriate to minimize risk. In addition, oral interventions aimed at reducing flora that are known as PRPs can be another method for preventing VAP occurrence. Reduction in VAP rates prevents an increase in patient LOS, hospital costs, and resource utilization, while improving outcomes.

As part of the 5 Million Lives campaign, efforts were made to improve the rate of VAP occurrence in adult ICU patients. Since the literature was unclear as to the exact interventions to implement in order to prevent VAP, in 2004, a basic bundle was created by the Institute for Healthcare Improvement (IHI) as a guide to treatment. The IHI bundle included 4 key components: head of bed (HOB) elevated to greater than 30 degrees, peptic ulcer disease prophylaxis, deep vein thrombosis prophylaxis, and daily sedation-vacations. These 4 interventions would work in conjunction to optimize patient health and prevent complications such as VAP by approaching the potential problem from multiple angles. While these interventions on their own may not greatly impact VAP rates, the IHI believed that as a bundle they could be effective at decreasing pneumonia rates. By controlling gastrointestinal composition and optimizing patient mechanics through positioning and awakenings, IHI believed VAP would decrease in ICU patients. This initiative was evaluated by the majority of early research studies on VAP prevention, and from that guidance, alternative VAP bundle protocols were developed. Some noted differences between the initial bundle, and those that followed included oral care using CHX every 6 or 12 hours, the use of continuous or intermittent aspiration of subglottic secretions (oral interventions decrease oral colonization), change from a heated moisture exchanger to a heated-wire ventilator circuit with humidifier (to prevent contamination), red blood cell transfusion only if hemoglobin is less than 7 g/dL (reduce risk of VAP through modulation of the immune system), and ventilator tubing management and scheduled replacement to prevent airway contamination. These additional interventions are designed to work in coordination with the initial VAP bundle set forth by the IHI in order to create an inclusive bundle to prevent VAP.

Of all the possible interventions to be considered in the prevention of ICU VAP, the 1 method utilized in all of the research reviewed was the use of CHX solution for oral care every 6 or 12 hours. The CHX liquid is applied using an oral swab with 0.12% to 0.2% CHX solution soaked on a sponge. The sponge is then swabbed inside the ventilated patient’s mouth and tongue 4 times per day. This application works to improve oral hygiene and decrease the prevalence of oropharyngeal colonization by PRPs known to cause pneumonia and therefore decrease the incidence of VAP. The National Institute for Health and Clinical Excellence has recently advocated for this intervention in the National Health Service in the United Kingdom as a low-risk intervention for the prevention of VAP. In order to further evaluate the role of CHX use in practice, this research analysis focused on the use of CHX to prevent VAP.

**LITERATURE SEARCH**

In order to conduct a comprehensive literature review surrounding the use of CHX to prevent VAP, 4 databases were searched. Using broad inclusion criteria and various research study designs, the articles were chosen based on title presentation, abstract read, and full-text relation to the research topic and desired outcome examination. A standardized search strategy was used to search CINAHL, PubMed Plus, Scopus, and EMBASE. All 4 advanced searches included the keywords of chlorhexidine, ventilator-associated pneumonia, prevention, ventilator-associated pneumonia,
and adult. A keyword search was utilized in order to yield a more comprehensive result pool from which to draw for the literature review. Articles were included in the literature review if they were primary human research studies examining CHX effect on VAP in ICU adult patients 18 years or older, published between 2009 and 2015, and presented in the English language. Articles were excluded from the review if they were in any language other than English, involved pediatric patients younger than 18 years, or included nonhuman subjects.

The database search yielded 47 articles, which were retrieved for preliminary title review. CINAHL produced 17 articles; PubMed Plus, 10 articles; Scopus, 13 articles; and finally EMBASE, 7 articles, to examine. The preliminary screening of these 47 articles related to the relevancy of their title to the research topic. Through this process, 16 were excluded for being a duplicate article among the 4 databases, and 7 were excluded because of lack of relevance in the title. The remaining 24 articles were examined based on their abstract presentation, and 11 were excluded for lack of relation to the topic question, resulting in 13 articles suitable for secondary screening of the full text. Finally, 9 more articles were eliminated after the full-text review for not meeting the already established inclusion criteria. Through the use of the decision tree for article inclusion, 4 articles remained that assessed CHX use in the prevention of VAP in the adult ICU patient population. The included articles are authored by Sharma and Kaur, Özçaka et al, Grap et al, and Munro et al and are summarized in detail in the Table.

**RESEARCH EVALUATION**

All 4 studies reviewed had the primary objective of evaluating whether the use of oral CHX reduced the rate of VAP in their respective ICU populations. Each study design was a randomized controlled trial in a single center. Although they had similarities in patient demographics and selection, timing of the intervention, and determination of VAP status, there were some differences in study methodology. All will be discussed after each of the studies is reviewed.

**Patient Demographics**

In examining the patient populations across the 4 studies, it was found that all included patients were older than 18 years and both male and female patients. Sharma and Kaur had 260 total patients with their ages ranging from 18 to older than 60 years. Of this, the majority of patients were in the older-than-60-years category for both experimental and control groups, with that group accounting for 108 of the total patients studied. Özçaka et al had a clinical variable of age for both the CHX and control groups. All patients included were 56 years or older. They included 29 patients in the CHX group and 32 in the control group. Grap et al evaluated 60 patients with 48 to 72 hours of data and displayed their age results based on a mean (SD) starting at age 42 years. Finally, Munro et al had a total mean age of the enrolled sample as 47.9 years old. They included 547 patients in the study.

The presence or absence of comorbidities or environmental factors at the time of the study was addressed in all studies examined. All 4 studies compared the medical backgrounds of their included subjects. This provides more information about the subjects, allowing the reader to determine what else may have contributed to VAP development based on patient history. Each study also divulged the general location of their research and unit type, giving even more subject information and allowing for transparency. Sharma and Kaur evaluated patients in a tertiary care hospital. The population consisted of medical and surgical ICU patients. Özçaka et al performed research at a university hospital respiratory ICU. They examined comorbidities based on Acute Physiology and Chronic Health Evaluation (APACHE) scores. Grap et al completed their research at a university health system trauma center. They also examined the presence of comorbidities based on an APACHE score. Finally, Munro et al conducted their research at a university medical center urban hospital, and they too assessed their comorbid conditions using APACHE.

**Patient Selection and Study Design**

Patient selection and methodology reveal dissimilarities. While all 4 studies included some inclusion and exclusion criteria, little detail was included regarding the patient populations. All 4 studies were already discussed in terms of demographics, and any further distinctions in population will be addressed here.

In examining inclusion criteria for each study, it was noted that only 2 studies broke down any specific criterion beyond those patients excluded. Sharma and Kaur narrowed their patient population to those admitted to the ICU, who were to be intubated and ventilated within 48 hours of admission. They also required a medical or surgical diagnosis and an age older than 18 years. Grap et al included those intubated in the emergency department or in route to the emergency department if they were enrolled within 12 hours of intubation. The other 2 studies relied on the exclusion criteria to build their populations.

All 4 study authors provided a similar list of patient exclusions. This shared list includes a witnessed aspiration, a confirmed diagnosis of post-obstructive pneumonia, a known hypersensitivity to CHX, absence of consent, a diagnosed thrombocytopenia, a do-not-intubate order, being younger than 18 years, pregnant, legal incarceration, oral mucositis, immunosuppression, and readmission to the ICU. Additional exclusions distinct to each study can be seen in the Table.
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<td>Sharma and Kaur, 2012</td>
<td>To assess the efficacy of CHX mouth care in prevention of VAP</td>
<td>MICU, SICU, NICU patients at a 1200-bed tertiary care center in Ludhiana, who were mechanically ventilated</td>
<td>Randomized controlled trial; randomly assigned to either control arm (twice daily [AM and PM] oral care with placebo normal saline) or experimental arm (twice daily oral care with 0.12% CHX)</td>
<td>Significance of effect or difference was established at the level of .05. Baseline comparisons between groups were performed using the χ² test.</td>
<td>Development of VAP Hours of MV and incidence of VAP</td>
<td>Significantly more subjects developed VAP in control group (46; 35.4%) as compared with experimental group (7; 5.7%) which is statistically significant being P &lt; .05. Duration of MV significantly affects the occurrence of VAP. More than half of cases developed VAP after &gt;120h of MV. However, the effect of duration of MV on incidence of VAP did not differ in experimental and control groups (P &gt; .05); 48-72 h: Experimental group had 14.4% (1/7 patients) with VAP, and control group with 17.4% (8/46 patients) with VAP; 71-120 h: experimental group 28.6% (2 patients) with VAP and 21.7% (10 patients) of control group with VAP; &gt;120 h MV experimental group was 57.1% (4 patients) with VAP and the control group 60.9% (28 patients) with VAP. Therefore, CHX use to prevent VAP was the same for early and late periods of MV.</td>
<td>Majority of patients male (97 compared with 33 females in the experimental group; 94 compared with 36 females in control group) Single-center study</td>
<td>While there were more males than females included in this study, the experimental and control groups were found to be statistically identical in their sociodemographic characteristics (P &gt; .05). No adverse events (mucosal irritation, tooth staining) were noted during the intervention period with CHX use. Study strengths: randomization intervention provided by staff nurses.</td>
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260 Patients enrolled from August 2010 to December 2010. Age: <20 y old: 12 patients (9.2%), experimental group; 9 patients (6.9%), control group; 21-40 y: 24 (18.5%) experimental and 27 (20.8%) control; 41-60: 37 (28.5%) experimental and 43 (33.1%) control; and >60: 57 (43.8%) experimental and 51 (39.2%) control.
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<td>Ozcka et al., 2012</td>
<td>The aim was to evaluate whether oral swabbing with 0.2% CHX decreases the risk of VAP in ICU patients</td>
<td>Dentate patients with MV for at least 48 h with 29 being in the experimental group and 32 in the control group</td>
<td>Randomized, double-blind, controlled study</td>
<td>Clinical periodontal status, age, gender, diagnosis on admission, and comorbid disease explanatory or confounder variables</td>
<td>Primary outcomes: incidence of VAP, mortality</td>
<td>Patients (68.8%) in control group and 12 (41.4%) in the CHX group were diagnosed with VAP. VAP rate in the control group was significantly higher than in the CHX group with an odds ratio of 3.12, P = .03. Most cases of VAP (27 of 34) were defined as late onset</td>
<td>Single-center study Relatively small sample size All study interventions were performed by experienced (&gt;5 y) ICU staff nurses who were trained by the study nurses</td>
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### Chlorhexidine Use in the Prevention of Ventilator Associated Pneumonia: A Review of Primary Sources, Continued

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<td>Age: CHX group: 60.5 ± 14.7 y; control group: 56.0 ± 18.2 y</td>
<td>Severity of illness score determined using the APACHE II system</td>
<td>Secondary outcomes: length of MV; LOS in the ICU; presence of potential respiratory pathogens determined by quantifying colonies using standard culture</td>
<td>ICU stay (12.17 ± 11.3d in the CHX group and 15.44 ± 13.5d in control) and number of days of MV (9.00 ± 8.3 d in the CHX group and 12.28 ± 11.9 d in control) were similar in the CHX and control groups</td>
<td>Another strength is that all patients were followed for up to 14 d, or until discharge from the ICU, extubation or death</td>
<td>No significant differences were found for demographic, clinical, and laboratory characteristics between the CHX and control groups</td>
<td>Study completed in a respiratory ICU—study strength</td>
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<td>Between November 2007 and November 2009 in Ege University, School of Medicine, Department of Chest Diseases, Respiratory ICU (Izmir, Turkey).</td>
<td>VAP diagnosed: pathogens identified by quantifying colonies using standard cultures</td>
<td>Acinetobacter baumannii was the most common (64.7%) pathogen isolated in the 34 cases of VAP in the 2 groups. The APACHE score was not significantly different between the VAP (+) and VAP (−) control groups (P = .14). The APACHE score of the VAP (−) CHX group was significantly lower than that of the VAP (+) CHX patients (P = .039)</td>
<td>No significant difference in the time of VAP development between the CHX and control groups</td>
<td>Crude logistic regression analysis indicated that the odds ratio of VAP development in the control group was 3.12. Age itself increased this odds ratio of VAP development to 5.05 with adjusted logistic regression analysis</td>
<td>No intraoral adverse events were noted during the study</td>
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<td>Exclusion criteria: a witnessed aspiration; confirmed diagnosis of postobstructive pneumonia; known hypersensitivity to CHX; absence of consent; a diagnosed thrombocytopenia; a &quot;do not intubate&quot; order; age &lt;18 y; pregnancy; presence of oral mucositis; and readmission to the same ICU</td>
<td>Statistical tests: χ² test; Mann-Whitney U test; Logistic regression analysis; odds ratio. All tests were performed at a significance level of P = .05</td>
<td>No significant differences were found for demographic, clinical, and laboratory characteristics between the CHX and control groups on admission</td>
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<td>Secondary exclusion criteria: survival expectation &lt;1 wk and edentulism</td>
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<td>3. Grap et al, 2011</td>
<td>This clinical trial tested an early (within 12 h of intubation) application of a 1-time 5 mL; 12% CHX solution by swab vs control (no swab) on oral microbial flora and the development of VAP</td>
<td>Virginia Commonwealth University Health System, in Richmond, Virginia, 983-bed medical center</td>
<td>Randomized, controlled clinical trial with 2 groups being the intervention and control groups</td>
<td>Comparison of baseline variables in the study groups was done to assess group equivalence</td>
<td>CHX effect on VAP</td>
<td>No significant differences between groups at study admission for any clinical characteristic except a greater number of male patients in the intervention group and higher CPIS scores; 5.36 ± 2.53 for intervention vs 3.95 ± 1.83 for control, P = .023</td>
<td>70% of the patients in the intervention group were male Higher CPIS scores for intervention vs control group Single-center study Relatively small sample size for analysis after all the exclusions Focused on only the trauma patient population</td>
<td>Replication may be warranted because it is difficult to distinguish pulmonary inflammation of sepsis from VAP, and it may also be difficult to attribute all the differences in CPIS to the development of VAP alone</td>
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When assessed together with the APACHE score, the odds ratio was 7.98 in the control group.

Higher CPIS scores for intervention vs control group

The CPIS data were compared using a random-effects, repeated-measures analysis of covariance model. TRISS and illness severity APACHE and a random effect for patient

By controlling for the difference in CPIS on admission to the study, a significant treatment effect on CPIS both from admission to 48 h (P = .020) and to 72 h (P = .027) was found

60 Subjects left for final analysis. CHX: 29; control: 32

Age: control group: 41.92 ± 19.77; CHX group: 44.17 ± 16.77

Block randomization scheme

Inclusion criteria: intubated in the ED, in the field, or in route to the ED or in the prehospital setting were eligible for enrollment if enrolled within 12 h of intubation

Exclusion criteria: previous endotracheal tube placement in the last 48 h, a clinical diagnosis of pneumonia at the time of intubation, or burn injuries, edentulous patients

APACHE and a random effect for patient
4. Munro et al. 2009  To examine the effects of mechanical (tooth brushing), pharmacological (topical oral CHX), and combination (tooth brushing plus CHX) oral care on the development of VAP in critically ill patients receiving MV  Critically ill adults in 3 ICUs in Richmond, Virginia, at Virginia Commonwealth University Medical Center were enrolled within 24 h of intubation in this clinical trial after obtaining informed consent. Inclusion criteria: >18 y old, in medical, surgical/trauma, and neuroscience ICUs  Randomized controlled clinical trial with a 2 x 2 factorial design  Descriptive statistics were used to summarize the characteristics of the study population. Analysis of covariance was used to compare CPIS values by treatment group. Development of VAP was quantified by using the CPIS. At day 3 analysis, 249 patients remained in the study. Among patients without pneumonia at baseline, pneumonia developed in 24% (CPIS > 6) by day 3 in those treated with CHX. When data on all patients were analyzed together, mixed-models analysis indicated no effect of either CHX (P = .29) or tooth brushing (P = .99). After all of the exclusions, the analyzed sample sizes were rather small, limiting the collected data. The smaller sample sizes on days 5 and 7 did not allow conclusions about the effect of the CHX on late-onset VAP. Clinical characteristics did not differ significantly among the 4 groups. Sample was diverse in race and included men and women with 60% being men, with appropriate severity of illness proving in line with other published works and speaking to the strengths of the study.
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<td>Exclusion criteria: patients with a clinical diagnosis of pneumonia at the time of intubation; edentulous patients; previous intubation during the current hospital admission</td>
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<td>The final models included terms for the main effects of tooth brushing and CHX along with the covariates ICU (a stratification variable) and baseline CPIS score</td>
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<td>However, CHX significantly reduced the incidence of pneumonia on day 3 (CPIS &lt;6) among patients who had CPIS &lt;6 at baseline (P = .006)</td>
<td>Tooth brushing had no effect on CPIS and did not enhance the effect of CHX</td>
<td>Overall, CHX but not tooth brushing reduced early VAP in patients without pneumonia at baseline</td>
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<td>Age: toothbrush only: 47.1, CHX only: 46.1, both CHX and toothbrush: 47.3, control: 46.8 y old</td>
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<td>Logistic regression was used to compare proportions of patients in each group with pneumonia (CPIS score ≥6) in a similar manner, again with controls for ICU and baseline CPIS score</td>
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<td>Analysis was performed on data of all patients in the analysis sample, as well as data of the subset of patients who had a CPIS &lt;6 at baseline</td>
<td>Thus, a comparison was statistically significant when P &lt; .025</td>
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<td>547 Patients were randomly assigned to 1 of 4 treatments: 0.12% solution CHX oral swab twice daily (119 patients), tooth brushing 3 times daily (113), both tooth brushing and CHX (116), or control (123) (usual care). Staff who performed the interventions had no knowledge of patients’ CPIS</td>
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<td>Patients were in the study for a maximum of 7 d unless extubated, whereby the study ended at the time of extubation</td>
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<td>VAP was determined by using the CPIS on day 3, which consisted of 192 patients for analysis. CPIS showed 116 patients on day 5 and 76 on day 7</td>
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Abbreviations: APACHE, Acute Physiology and Chronic Health Evaluation; CHX, chlorhexidine; CPIS, clinical pulmonary infection score; ED, emergency department; ICU, intensive care unit; LOS, length of stay; MICU, medical intensive care unit; MV, mechanical ventilation; NICU, neurological intensive care unit; RCT, randomized controlled trial; SICU, surgical intensive care unit; TRISS, Trauma-Injury Severity Score; VAP, ventilator-associated pneumonia.
Beyond their inclusion and exclusion criteria, the 4 examined articles had relatively small sample sizes. Sharma and Kaur3 examined 260 patients, Özçaka et al6 study had 61 subjects, Grap et al7 utilized 60 patients, and Munro et al8 had the largest population at 547 patients.

Outcome Analysis

The selection and utilization of patient population information are of significant consideration when analyzing the outcomes of the 4 studies3,6-8 discussed. While all 4 studies3,6-8 examined the primary outcome of CHX use for VAP prevention, Sharma and Kaur3 and Özçaka et al6 also focused on the hours of MV related to the incidence of VAP. Beyond this, Özçaka et al6 also developed a secondary outcome of LOS in the ICU.

All 4 articles demonstrated a decrease in VAP rates with the use of oral CHX as an intervention. Sharma and Kaur3 as well as Özçaka et al6 showed a statistically significant decrease in VAP rates from the control groups to the experimental (CHX) groups. Grap et al7 also demonstrated a significant decrease in VAP rates between the control and CHX groups. Finally, Munro et al8 compared control and intervention groups of patients and found that those without pneumonia at baseline had a significant reduction in VAP rates. This study also demonstrated that tooth brushing alone had no effect on VAP rates and did not enhance the effect of oral CHX. Therefore, the CHX-alone group had the most effective intervention noted in this study.6 Overall, these 4 studies all found that with the use of CHX there is a significant decrease in VAP rates.

To further establish possible interventions relating to VAP prevention, hours of ventilation and LOS will be discussed. Sharma and Kaur3 examined the effect of hours of MV on the incidence of VAP. While the duration of MV is thought to significantly affect VAP occurrence, they found that the duration of MV on incidence of VAP did not differ between the experimental and control groups. With the duration of MV not having a significant effect on VAP decline, the use of CHX as a VAP reduction intervention remains relevant because of its demonstrated effectiveness. Özçaka et al6 also examined the length of MV and ICU stay. Lengths of both MV and ICU stays were found to be similar in the CHX and control groups, but a significantly shorter ICU stay was noted for VAP-negative patients. This again supports the importance of VAP prevention in all ICU patients. All of these outcomes will be considered with the main focus of this analysis in order to determine the effectiveness of CHX on VAP prevention.

Variables/Limitations

Before considering the evidence for use in future practice, it is important to note any variables or limitations within the study material. As previously mentioned, all 4 research studies3,6-8 had a relatively small sample size. A small sample size can limit the data collected and skew the results one way or the other, depending on the specific population tested. A larger sample size would allow for outliers to be discounted and provide a more broad evaluation of the intervention for accurate results. While the inclusion criteria for each study were broad, the exclusion criteria were specific, whereas deleting some exclusion criteria would increase sample size that may have skewed data results. Future studies should focus on institution-wide ICU patient inclusion and on multicenter design to increase the quantity of patients evaluated.

Another variable to consider for future research is the use of multiple ICUs and medical centers. All 4 research studies completed their research at single institutions. While the benefit and ease of this approach are understood, the evidence would be more effective with the use of multicenter methods to improve generalizability.

While it is not readily discussed in the research material, this study intervention could be affected by patient demographics such as age, gender, weight, comorbidities, and ethnicity. Of the studies that discussed patient gender, more men were evaluated than women. This could be seen as a variable in research participants and therefore research results. The way CHX is metabolized and utilized in the oropharynx is not discussed in detail throughout current literature, and it is therefore not understood how it differs from patient to patient. Also, patient comorbidities could be evaluated more in depth in future research to decrease study variations and limitations. Multiple comorbidities indicate a worse overall prognosis, increasing their overall risk of developing VAP regardless of prevention interventions, and this could skew research results.9 The effect of patient demographics on study results is probably minimal, but it is to be considered in the thorough evaluation of outcome analysis.

Also relating to the study population itself is the idea that the target population of critically ill adults is difficult to study. They often have underlying conditions and uncontrollable attrition due to death or extubation. It is also noted that it is difficult to obtain consent because of the stress of the situation in many cases. These things combined would limit the enrollment of adult patients into these studies.8

Finally, the results of these studies could have been varied by the provider individuality. It is assumed that each hospital, nurse, physician, advanced practice nurse, manager, respiratory therapist, and so on, all complete a task with some variability from one another. Two of the studies had experienced ICU nurses carry out the intervention. This could be seen as a strength in that it not only allowed for randomization of the intervention, but it also allowed for individual differences that could affect research results.10

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**USE OF CHLORHEXIDINE TO PREVENT VENTILATOR-ASSOCIATED PNEUMONIA IN PRACTICE**

This comprehensive outcome analysis demonstrates that there is sufficient evidence to support the use of oral CHX in practice for VAP prevention in adult ICU patients. Overall, it was described that through the use of CHX there is a statistically significant decrease in patient VAP rates. While there is much discussion about the implementation of VAP bundles, it is seen through this research analysis that oral CHX is a crucial part of the said bundle and should continue to be encouraged in ICUs nationally. Based on these results, CHX use should continue to be incorporated into patient management.

In order to utilize CHX as part of a VAP bundle, it is necessary to understand the correct use of the solution. Chlorhexidine should be administered orally, using a sponge swab as the delivery method. The sponge is swiped throughout the oral cavity, tongue, and teeth of all ventilated patients. The therapy should begin immediately after a patient is intubated and continue until they are extubated in order to work to prevent VAP. The CHX should be applied 4 times daily in order to have the most advantageous effect on VAP prevention.

The prevalence of VAP in ICU patients places great importance on preventive strategies. For the adult gerontology acute care nurse practitioner (NP) and the adult gerontology clinical nurse specialist (CNS), this is a current and relevant topic to be considered for practice of patient management or nurse education. The adult gerontology acute care NP will often be managing patients who are intubated and sedated and therefore at great risk of developing VAP. Knowing this, it becomes crucial that NPs continue to utilize the VAP bundle in place at that institution in order to guide patient care to prevent avoidable patient harm. In order for this to become incorporated into patient care, the NP will need to ensure that such discussed VAP bundles are incorporated into an order set that is utilized to prevent VAP. This will allow for a previously established method of VAP prevention, with said interventions, to be easily implemented by the registered nurses (RNs), advanced practice RNs, and physicians caring for these ventilated patients.

Further responsibilities of the NP are to participate in daily patient rounding and patient assessments, work with the CNS for system-wide change implementation, and nurture nurse and physician collaboration. This will allow for the NP to function as the liaison between all disciplines and patients to ensure complete patient care and positive outcomes through VAP prevention.

The responsibility of the adult gerontology CNS will be to remain current on the literature surrounding VAP prevention and educate the staff on the most recent and effective methods for VAP prevention. Through the use of unit-based committees to evaluate the evidence and contribute to the work of the CNS, VAP bundles can continue to be perfected and implemented on a unit and hospital-wide level to all ventilated patients. The CNS needs to function as a patient advocate and implementation agent of the most current and proven methods of patient protection. Incorporating VAP bundles and VAP order sets into daily practice is a great example of the utilization of the CNS role in health care. This information will then need to be delivered to the physicians, NP staff, and RNs caring for these patients in order to complete full-circle, closed-loop communication and ensure VAP prevention. Knowing how important this intervention is to current and future advanced practice nursing care, the synthesis of this research is focusing specifically on the use of oral CHX to prevent VAP in adult ICU patients.

**FUTURE RESEARCH**

Considering the in-depth analysis of VAP prevention through CHX use alone, further research on other VAP prevention strategies and bundles would only help solidify the evidence. By combining CHX use with other evidence-based interventions, VAP rates will diminish further and take with it the rate of occurrence of preventable patient harm. One research question that could be considered to broaden the scope of knowledge on VAP prevention is: Does raising the head of the bed to greater than 30 degrees significantly decrease VAP occurrence? The beginning of this research question was examined by Azab et al, when they discussed results regarding a significant relationship between elevating the HOB 30 to 45 degrees and the decrease in VAP incidence. Further studies evaluating this individual intervention for VAP prevention will add to the science and expand current knowledge.

Another question that could be addressed in future research related to this topic is: Does oropharyngeal suctioning significantly reduce VAP rates? This has been included in some VAP bundles; however, the strength of the research is not yet supported. More in-depth research with this as the primary variable would yield great benefit to the support of its potential role in VAP prevention. The article by Zhang et al demonstrates the importance of suctioning the oropharynx to ensure bacteria are not harboring in the patient’s oral cavity working against efforts to prevent VAP. This study found a correlation between oropharyngeal suctioning and a decrease in VAP rates of intubated patients. This in conjunction with previously discussed methods could create a new bundle for VAP prevention and further the success of CHX use in these patients. These articles are some of many discussing these topics individually; however, bringing all statistically significant interventions together into 1
bundle would be the culminating step. The findings related to HOB elevation and oropharyngeal suctioning could then be applied to the established findings on CHX to further support or detract from the confidence to incorporate VAP bundles in personal patient care.

**CONCLUSION**

It is of the utmost importance to remain current on new evidence-based literature for interventions and patient care. This ensures the best staff education and patient assessment and management. Chlorhexidine use for VAP prevention is an example of a small step toward an encompassing goal of preventing avoidable patient harm.

**References**


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