Brushing Teeth With Purified Water to Reduce Ventilator-Associated Pneumonia

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ABSTRACT

Background: Oral care may decrease the development of ventilator-associated pneumonia (VAP) and improve oral hygiene. However, little evidence is available to guide the development of oral care protocols. The practical effect of toothbrushing on VAP development and oral health and hygiene improvement is inconclusive.

Purpose: This study evaluated the effects in postneurosurgical, intensive care unit patients of brushing teeth twice daily with purified water on VAP rates and oral health or hygiene.

Methods: This study conducted a randomized controlled pilot trial. Patients consecutively admitted to the surgical intensive care unit at a suburban hospital in 2007 were invited to participate if they met two inclusion criteria: (a) under ventilator support for at least 48 to 72 hours and (b) no current pneumonia. Upon obtaining informed consent, subjects were randomized into experimental and control groups. Both groups received usual hospital care, that is, daily oral care using cotton swabs. The experimental group additionally received a twice-daily oral care protocol of toothbrushing with purified water, elevating the head of the bed, and before-and-after hypopharyngeal suctioning. The control group also received twice-daily mock oral care (elevating the head of the bed, moisturizing the lips, and before-and-after hypopharyngeal suctioning). VAP was defined by a clinical pulmonary infection score of ≥ 6. Oral hygiene and health was assessed after conclusion of the intervention.

Results: Patients (N = 53) were predominantly male (64.2%), mean age was 60.6 years old, and most had received emergency surgery (75.5%). After 7 days of toothbrushing with purified water, cumulative VAP rates were significantly lower in the experimental (17%) than in the control (71%; p <.05) group. The experimental group also had significantly better scores for oral health (p <.05) and plaque index (p <.01).

Conclusion/Implication for Practice: Findings suggest that, as an inexpensive alternative to existing protocols, toothbrushing twice daily with purified water reduces VAP and improves oral health and hygiene.

KEY WORDS: ventilator-associated pneumonia, oral care, toothbrushing, oral health, oral hygiene.

Introduction

Ventilator-associated pneumonia (VAP) is a common and potentially fatal complication in patients receiving mechanical ventilation in the intensive care unit (ICU). Indeed, VAP has been associated with high mortality rates, ranging from 20% to 33% in the United States to 44% in Taiwan (Huang, Wang, Hsieh, Chung, & Wang, 2004; Rello et al. 2002). Moreover, for every additional day a patient remains on a ventilator, VAP risk increases by 1% to 3% (Stonecypher, 2010). As the oral cavity is a potential reservoir for organisms, patients with poor oral hygiene have been shown 1.3 times more likely to develop respiratory diseases than healthy controls (Scannapieco, Papandonatos, & Dunford, 1998).

Preventing VAP is thus a priority in ICU care, with evidence-based guidelines issued by the Centers for Disease Control and Prevention in 2004 and the American Thoracic Society and Infectious Diseases Society of America in 2005. These guidelines include general strategies to reduce the ability of pathogens to invade the lower respiratory tract, for example, by avoiding intubation whenever possible, preventing gastric reflux, disinfecting and maintaining respiratory equipment, preventing cross contamination, and oral care (American Thoracic Society and the Infectious Diseases Society of America Guideline Committee, 2005; Centers for Disease Control and

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Prevention, 2004). However, limited evidence is available from well-controlled randomized experimental studies on the effects of oral care.

Oral care may decrease the development of VAP and improve oral hygiene, but little evidence suggests what to include in oral care protocols. In fact, oral care of ICU patients using chlorhexidine (CHX; oral decontamination; Fourrier et al., 2000), using a mouthwash of green tea or boiled water (Hsu, Liao, Li, & Chiou, 2011), and mechanically brushing the oral cavity (toothbrushing; Mori et al., 2006) to dislodge plaque all achieved mixed results in terms of improving mucosal status and reducing organism populations. One recent Taiwanese study that examined the effect of washing the mouth with water and green tea found boiled water as more effective than green tea in improving the mucosal status of orally intubated patients (Hsu et al., 2011). Most of other studies (Pobo et al., 2009; Scannapieco et al., 2009) have focused and compared the effect of 0.12% CHX gluconate by oral swab and toothbrushing with antiseptic agents (including CHX and 1.5% hydrogen peroxide; peroxamint solution) and achieved mixed results. For example, one randomized controlled trial (RCT) found CHX achieved the same effect on a mixed ICU patient population as the placebo gel, with a VAP rate of 11% in each group (Fourrier et al., 2005). Other studies on mixed ICU patient populations have shown CHX to reduce pathogens effectively (Scannapieco et al., 2009) and that adding toothbrushing to the antiseptic agent regimen did not further reduce VAP incidence significantly (Mori et al., 2006; Pobo et al., 2009).

Routine use of CHX during oral care procedures has been reported to contribute to discoloration of the teeth and tongue, alterations in taste perception, and, most importantly, anaphylaxis (Lim & Kam, 2008). In fact, the Japanese Ministry of Welfare has recommended since 1989 that CHX not be used on mucous membranes to reduce anaphylaxis risk (Okano et al., 1989). Furthermore, when 2% CHX was rubbed on patient oropharyngeal mucosa, 9.8% reported mucosal irritation (Tantipong, Morkchareonpong, Jaiyindee, & Thamlikitkul, 2008). Working to find a more suitable alternative, several studies have suggested the use of a mouthwash of potable water or green tea to improve oral health (Hsu et al., 2011; Wu, & Wei, 2002). Before making credible recommendations for alternatives to CHX for ICU patients (Berry, Davidson, Masters, & Rolls, 2007; Chan, Ruest, Meade, & Cook, 2007; Paju & Scannapieco, 2007), alternatives must be tested using a rigorous RCT design.

No RCT studies have been reported related to the effects of brushing teeth with purified water. Where clean water is available, toothbrushing using purified water instead of CHX may be a less costly and less irritating alternative. Thus, the purpose of this pilot RCT was to examine the effects of an oral care protocol—toothbrushing with purified water twice daily—on VAP incidence and oral health and hygiene in postoperative ICU patients.

Methods

Study Design and Patients

This single blind pilot RCT was approved by the institutional ethics board of the study hospital in northern Taiwan (Clinical Trial NCT00604916). Intubated and ventilated postoperative patients consecutively admitted to a surgical ICU at the study site from March to November 2007 were screened for the following inclusion criteria: (a) expected length of ICU stay over 2 days and (b) expected to receive mechanical ventilation for at least 48 to 72 hours with oral–nasal–tracheal intubation. Patients already presented with pneumonia were excluded. Eligible patients or their family who agreed to participate in the study were asked to sign written informed consent. As the level of consciousness of some patients was not optimal, written consent from all family members was obtained in addition to patient verbal consent.

A dental hygienist blinded to group assignment and study hypothesis assessed subjects immediately after enrollment. Subjects were then randomized using a computer-generated randomization table into either the experimental group (EG) or control group (CG). After enrollment, subjects were tracked for 9 days or until their transfer to another unit.

Oral Care Intervention

All patients in the study received usual care, which involved daily oral care with Toothette oral swabs or cotton swabs by ICU nurses. In addition to usual care, participants in the EG received a standardized 7-day oral care protocol twice daily from a trained intervention nurse. This 15- to 20-minute oral care was performed as follows: (a) patients were kept in a head-up position by elevating the head of their bed 30° to 45°, and hypopharyngeal suctioning was conducted; (b) the oral cavity was moisturized with 5 to 10 ml purified water (reverse osmosis water obtained from a dialysis unit), teeth facial sides were cleansed with an electric toothbrush (Braun Oral-B Vitality Precision Clean, Kronberg, Germany), and lingual sides were cleansed with a soft pediatric toothbrush; (c) tongue, gums, and mucosa were massaged using a soft pediatric toothbrush; (d) the oral cavity was cleaned using a Toothette swab connected to a suction tube and rinsed with 50 ml purified water; and (e) the procedure was finished with hypopharyngeal suctioning. This oral care protocol was developed based on literature references and was designed using components considered most feasible and effective in the context of current hospital practice. For example, toothbrushing at least twice daily is recommended for most patients receiving mechanical ventilation (Simmons-Trau, Cenek, Counterman, Hockenbury, & Litwiller, 2004). Both pediatric and electric toothbrushes have been shown to enhance plaque removal, and we used purified water instead of toothpaste or other mouthwash/antiseptic agents to enhance ease of protocol application, minimize costs, reduce mouth-rinsing-related problems (as
compared with toothpaste), and reduce irritations (Berry et al., 2007; Garcia, 2005).

To ensure staff blindness and control for attention effects, patients in the CG received a mock 7-day, twice-a-day care protocol provided by the same intervention nurse in addition to usual care. The mock procedure was as follows: (a) patients were kept in a head-up position by elevating the head of their bed 30° to 45°, and hypopharyngeal suctioning was conducted; (b) their lips were moisturized using a Toothette swab with purified water; and (c) the procedure was finished with hypopharyngeal suctioning. The mock care procedure lasted approximately 10 to 15 minutes.

Baseline and Covariate Measures
These measures included subject personal and clinical characteristics. Age, gender, type of surgery received (neurosurgery/other), intubation route (oral/nasal), and scores from the Glasgow Coma Scale (GCS) and Acute Physiology and Chronic Health Evaluation II (APACHE II) were obtained from medical records as proxies of disease severity. Validity and reliability of GCS and APACHE II are well established (Bastos, Sun, Wagner, Wu, & Knaus, 1993). Baseline oral health and hygiene were measured using an oral assessment guide (OAG; Eilers, Berger, & Petersen, 1988) and a dental plaque index, both evaluated by two professional dental hygienists blind to the study hypothesis. Researchers also recorded durations of mechanical ventilation and length of ICU stay.

Outcome Measures of Oral Health and Hygiene
Oral health and hygiene, measured using the OAG and plaque index, were evaluated three times: preintervention (T0), 3 to 4 days after the start of the intervention (T1), and 7 to 8 days after the start of the intervention (T2). Two trained hygienists blind to the group assignment and study hypothesis conducted all evaluations. The OAG is a standardized measure with indicated reliability and validity (Eilers et al., 1988) that has been recommended for routine oral health assessment (Ministry of Health, Singapore, 2004). It has eight items that assess voice, swallowing, lips, tongue, saliva, membranes, gums, and teeth, with summed scores ranging from 8 to 24 and higher scores indicating worse oral health.

The plaque index was based on the Turesky–Gilmore–Glickman Modification of Quigley–Hein Plaque Index after rinsing teeth with an erythrosine-disclosing solution (Turesky, Gilmore, & Glickman, 1970). Index validity and reliability have been reported and used widely in longitudinal studies and clinical trials (Reddy, 2008). This index includes six descriptors used to score the facial and lingual surface of each tooth from 0 (no plaque) to 5 (plaque covering two-thirds or more of the tooth crown). We assessed the plaque index by picking one tooth from each quadrant and assessing premolars and incisors as the priority (Fourrier et al., 2000; Fourrier et al., 2005; Scannapieco et al., 2009). Summed scores represent average dental plaque, with higher scores indicating worse oral hygiene. Researchers compared OAG and dental plaque scores. Changes relative to baseline were also compared between groups.

Outcome Measure of VAP Incidence
Clinical onset of VAP has been defined as a Clinical Pulmonary Infection Score (CPIS) >6 (Singh, Rogers, Atwood, Wagener, & Yu, 2000), and the modified version of CPIS has been recommended in the detection and management of VAP (American Thoracic Society and the Infectious Diseases Society of America Guideline Committee, 2005). The modified CPIS is based on seven medical record items, including temperature (°C), blood leukocytes, tracheal secretions, blood oxygenation, chest radiography results (no infiltration/diffused infiltration/localized infiltration, interpreted by a board-certified pulmonologist, blinded to group assignment), progression of pulmonary infiltrate (yes/no, interpreted by the same pulmonologist), and tracheal aspirate culture. Total CPIS scores have a potential range from 0 to 14. Using CPIS>6 as a cutoff, sensitivity and specificity achieved 89% and 47%, respectively (Luyt, Chastre, & Fagon, 2004). The CPIS was evaluated daily from the start of the intervention until 2 days after the intervention ended, giving a maximum of nine consecutive CPIS values. VAP rate was estimated by survival analysis as a cumulative rate (based on patient cases) within the maximum nine observation days.

Data Analysis
Continuous variables were described using means and standard deviations, the Mann–Whitney U test analyzed group differences in these variables (OAG, plaque index, GCS, and APACHE II scores), categorical variables were described by percentages, the chi-square test analyzed group differences in frequency distributions of these variables, and cumulative rates of VAP-free patients in the two groups were examined using the Kaplan–Meier method and compared using the log-rank test. An important advantage of the Kaplan–Meier method is that it can account for certain types of censored data, for example, patient withdrawal or loss from a study prior to completion. Therefore, analysis employed an intention-to-treat approach. In all tests, statistical significance was defined as p < .05. All statistics were calculated using the SAS version 9.2 software package (SAS Institute Inc., Cary, NC, USA).

Results
Sample and Baseline Characteristics
Of the 84 eligible patients screened on admission, 31 declined to participate (based on family member(s) feelings of being overwhelmed by patient care responsibilities, concern, etc.). The remaining 53 patients (63%) were enrolled
in the study and randomized to the EG ($n = 28$) or CG ($n = 25$). All patients were followed for 9 consecutive days after enrollment, unless they were discharged from the ICU ($n = 12$), had died ($n = 3$), or withdrew consent ($n = 2$). Figure 1 presents the patient flowchart.

Subject mean age was 60.6 years, with men accounting for two thirds (64.2%) of the sample. Most received emergency surgery (75.5%), underwent neurosurgery (81.1%), and were intubated orally (92.5%). Mean length of ICU stay was 12.9 days, with average mechanical ventilator support lasting 12.8 days. Table 1 illustrates the significant similarities between the two groups in terms of demographics, preintervention oral health and hygiene status, comorbidities, intubation route, GCS, and APACHE II scores. The two groups also did not differ significantly in terms of other potential confounding factors such as duration of ventilation (days) and ICU stay (days).

**Oral Health and Hygiene**

The OAG scores and the plaque index for EG and CG at three time points are illustrated in Figure 2. Mean OAG

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**Figure 1.** Study flowchart ($N = 53$).
scores for the CG remained stable over the 9-day intervention (Figure 2a). In contrast, the baseline mean OAG score of the EG declined from 16.3 ± 2.0 to 14.8 ± 2.7 at T1 and had leveled off to 15.1 ± 2.6 by T2. Subjects in the CG had significantly higher OAG scores than those in the EG at T1 (p = .03) and T2 (p = .03), suggesting significantly worse oral hygiene. Mean OAG scores for the EG also improved more than those for the CG (p < .01; Figure 2a).

A similar trend was observed for the plaque index. As shown in Figure 2b, the two groups did not differ at baseline (3.8 ± 0.6 for CG and 3.9 ± 0.6 for EG). For the CG, the plaque index remained high, whereas that of the EG had decreased significantly at T1 (2.6 ± 0.6, p < .001) and remained low at T2 (2.5 ± 0.9). Compared with baseline (T0), the EG had improved significantly over the CG at both T1 (p < .001) and T2 (p < .001).

### TABLE 1.

**Baseline Characteristics of Patients by Group (N = 53)**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Experimental (n = 28)</th>
<th>Control (n = 25)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>n</td>
</tr>
<tr>
<td>Age (years)</td>
<td>60.7</td>
<td>16.0</td>
<td>60.5</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>17</td>
<td>60.7</td>
<td>17</td>
</tr>
<tr>
<td>Female</td>
<td>11</td>
<td>39.3</td>
<td>8</td>
</tr>
<tr>
<td>Surgery received</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neurosurgery</td>
<td>21</td>
<td>75.0</td>
<td>22</td>
</tr>
<tr>
<td>Other</td>
<td>7</td>
<td>25.0</td>
<td>3</td>
</tr>
<tr>
<td>Antibiotics at admission</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1</td>
<td>3.6</td>
<td>1</td>
</tr>
<tr>
<td>Yes</td>
<td>27</td>
<td>96.4</td>
<td>24</td>
</tr>
<tr>
<td>Intubation route</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oral</td>
<td>26</td>
<td>92.9</td>
<td>23</td>
</tr>
<tr>
<td>Nasal</td>
<td>2</td>
<td>7.1</td>
<td>2</td>
</tr>
<tr>
<td>GCS score</td>
<td>7.5</td>
<td>3.4</td>
<td>6.9</td>
</tr>
<tr>
<td>APACHE II score</td>
<td>19.6</td>
<td>5.2</td>
<td>19.4</td>
</tr>
<tr>
<td>OAG score</td>
<td>16.3</td>
<td>2.0</td>
<td>16.4</td>
</tr>
<tr>
<td>Plaque index</td>
<td>3.9</td>
<td>0.6</td>
<td>3.8</td>
</tr>
<tr>
<td>MV support (days)</td>
<td>12.0</td>
<td>11.0</td>
<td>13.6</td>
</tr>
<tr>
<td>Length of ICU stay (days)</td>
<td>12.5</td>
<td>6.1</td>
<td>13.5</td>
</tr>
</tbody>
</table>

Note. GCS = Glasgow Coma Scale; APACHE II = Acute Physiology and Chronic Health Evaluation II; OAG = oral assessment guide; MV = mechanical ventilation; ICU = intensive care unit.

*Excludes edentulous patients: experimental group, n = 3; control group, n = 1.

**Figure 2.** Changes of OAG scores (Figure 2a) and plaque index (Figure 2b) at three time points. Lower scores indicate better oral health and hygiene status. OAG = oral assessment guide; EG = experimental group; CG = control group. * and ** represent the between-group comparison between the change relative to baseline reached statistical significance at p < .05 and p < .01, respectively.
The overall incidence of VAP was 34% among the 53 patients enrolled for 4 to 9 days. This rate is much higher than the VAP incidence of 24% reported in a U.S. sample of neurological patients with a median ICU stay of 10.7 days (Prendergast, Hallberg, Jahnke, Kleiman, & Hagell, 2009). The higher rates of VAP incidence in our study may be due to our subjects being older (60.6 ± 16.0 years), having longer ICU stays (12.9 ± 6.3 days), most (75.5%) receiving emergency surgery, and most (81.1%) receiving neurosurgery. Despite the fact that 96% of subjects in both groups had received empirical antibiotics at hospital admission, mechanically ventilated patients in our neurologic surgical ICU still remained at increased VAP risk because of factors such as postoperative status for multiple trauma, decreased level of consciousness, dry mouth, and microaspiration of secretions. Furthermore, few ICUs in Taiwan have a written oral care protocol, and compliance with twice-daily oral care, including toothbrushing and oral rinsing, is less than optimal. These factors may explain the very high incidence of VAP, especially in our CG.

Despite this, patients receiving our oral care protocol had a significantly lower VAP rate than that of the CG. Our findings suggest these high rates can be effectively reduced and healthcare costs can be saved by an oral care protocol of twice-daily toothbrushing with purified water for the sickest, nonelective neurosurgical ICU patients.

In contrast, one previous RCT study found that toothbrushing alone did not reduce the incidence of VAP nor did toothbrushing with CHX achieve an incidence lower than using CHX alone (Munro, Grap, Jones, McClish, & Sessler, 2009). Of note, we used both a pediatric toothbrush and electric toothbrush in our study, which complicates direct comparison of our results to those of other studies (which used either one or the other, but not both). Although using both types of toothbrushes seems to complicate the intervention for bedside providers, we learned that an electric toothbrush speedily decreased buccal dental plaque and that a pediatric toothbrush could easily approach and clean the lingual and posterior aspects of patients’ teeth (Berry et al., 2007; Garcia, 2005). These toothbrush-specific advantages eliminated plaque buildup on dental surfaces and more effectively cleaned the whole oral cavity. Furthermore, we did not find that dislodging dental plaque organisms posed a risk to patients. Indeed, patients whose teeth were brushed twice daily with purified water had significantly lower CPIS scores (Figure 3) and plaque index than controls (Figure 2) at 9 days. Our findings also echo previous studies and indicate that water is beneficial not only in keeping the oral cavity moisturized but also in helping rinse out debris (Berry et al., 2007; Hsu et al., 2011).

Unlike other trials, our study did not include a CHX rinse because it was not a part of the routine oral care in the study unit or in many other similar units in Taiwan. If clean water is available, toothbrushing using purified water instead of CHX may be a less costly and less irritating alternative for neurosurgical ICU patients to maintain oral health and hygiene and reduce VAP incidence. Confirmation of our results will need a well-designed, prospective trial with a larger sample, greater diversity in surgical ICU patients, longer follow-up, and inclusion of CHX as a study arm.

**Strengths and Limitations**

A major strength of this study is that its design was a rigorous RCT. However, the study had important limitations. First, the sample was small, follow-up was only 9 days, and subjects were recruited from one center, limiting the
generalizability of findings. Second, we were not able to obtain VAP diagnoses based on culturing bronchoalveolar lavage samples, the gold standard suggested by the American Thoracic Society and Infectious Diseases Society of America in 2005. However, bronchoalveolar lavage samples cannot be assessed serially and prospectively, and CPIS has been used extensively with shown validity (Luyt et al., 2004). Third, attrition differed by group with three subjects in the EG and none in the CG dying, which might affect the internal validity of this study. Furthermore, we purposely included a group of patients with a high risk rate of VAP, which may have contributed to our highly significant decrease in cumulative VAP incidence for patients receiving toothbrushing with purified water. Nevertheless, this pilot study used a prospective RCT design to test the effect of an oral care protocol of toothbrushing with purified water. It is important to note that, although both groups received two treatments with proven efficacy (elevating the head of the bed and hypopharyngeal suctioning), subjects in the CG still had a very high VAP incidence. This finding highlights the benefit of toothbrushing using purified water and the limited benefits of bed elevation and hypopharyngeal suctioning. Our finding also emphasizes the necessity of prevention strategies based on a “care bundle.” As the whole bundle is more effective than the sum of its parts, basing a prevention strategy on a care bundle translates the best available evidence to clinical care and allows more uniform management of this highly vulnerable patient population. For example, our protocol provides a nursing care bundle of twice-daily toothbrushing with purified water, elevating the head of the bed, and hypopharyngeal suctioning before and after oral procedure. We argue that, rather than focusing on finding each single measure that contributes to VAP prevention, healthcare providers and researchers should develop and test effective, feasible nursing protocols for clinical use.

Conclusion

The biggest medical payer in the United States, the Center for Medicare and Medicaid Services, stopped reimbursing hospitals in late 2008 for care of eight “preventable complications,” including two that occur in ICUs, namely catheter-associated urinary tract infection and vascular-catheter-associated infection. Other ICU infections such as VAP may follow, underscoring the need to implement effective prevention strategies. Our study findings suggest that an oral care protocol of twice-daily toothbrushing with purified water can effectively reduce the incidence of VAP and improve oral health and hygiene in postoperative neurosurgical ICU patients. A larger and more diverse surgical ICU sample is needed to verify our findings.

Acknowledgments

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References


利用純水刷牙減少呼吸器相關肺炎之研究

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1國立臺灣大學醫學院護理學系暨研究所研究助教 2雙和醫院神經外科主治醫師暨台北醫學大學傷害防治學研究所教授 3國立臺東大學身心整合暨運動休閒產業學系教授 4國立臺灣大學公共衛生學院流行病學與預防醫學研究所博士研究生 5國立臺灣大學醫學院護理學系暨研究所副教授

背景 口腔護理可能有助於降低肺炎發生並增進口腔健康及衛生，然鮮少有臨床試驗探討刷牙是否可以減少呼吸器相關肺炎，並改善口腔健康及衛生。

目的 研究目的在於探討每日兩次純水刷牙，是否可以降低神經外科加護病房病患呼吸器相關肺炎的發生率，並改善口腔健康及衛生。

方法 本研究為隨機之臨床前驅試驗。將新北市某醫院中心神經外科加護病房新入住病患，依據(1)使用呼吸器至少48~72小時、且(2)未感染肺炎的條件，共收案53位並隨機分配至實驗與對照兩組。除病房常規外，實驗組接受一天兩次，包括搖高床頭、深部口咽抽吸、及以純水（逆滲透水）和牙刷清潔口腔的口腔護理。對照組也接受包括搖高床頭、深部口咽抽吸、及以純水潤濕口腔，一天兩次的仿實驗組類口腔護理。呼吸器相關肺炎發生，則依據肺部感染指標大於6分來判定；口腔健康及衛生則以相關量表評估。

結果 53位個案中，大多接受緊急手術（75.5%），平均年齡為60.6歲，其中有64.2%為男性。呼吸器相關肺炎發生率在實驗組（17%）顯著低於對照組的71%（p < .05）。實驗組的口腔健康及衛生狀態，不論在口腔健康量表（p < .05）或牙菌斑得分（p < .01）均顯著優於對照組。

結論/實務應用 研究結果顯示，每日兩次純水刷牙的口腔護理，可有效降低呼吸器相關肺炎的發生率，並改善口腔健康及衛生。

關鍵詞：呼吸器相關肺炎、口腔護理、刷牙、口腔健康、口腔衛生。