

ORIGINAL ARTICLE

## The effects of different oral care protocols on mucosal change in orally intubated patients from an intensive care unit

Shu-Pen Hsu, Chao-Sheng Liao, Chung-Yi Li and Ai-Fu Chiou

**Aim.** To compare the effectiveness of three different oral care protocols in intubated patients.

**Background.** Although oral care is important to improve the oral mucosa integrity in intubated patients, there are few evidence-based nursing protocols to deal with this problem in critical care units.

**Design.** A quasi-experimental design was employed for this study.

**Methods.** Eighty-one orally intubated patients recruited from the intensive care unit of a medical centre in northern Taiwan were employed in this study. Patients were divided into three treatment groups: a control group ( $n = 27$ ), green tea group ( $n = 29$ ) and boiled water group ( $n = 25$ ). Oral mucosal status was monitored using a rating scale for 14 days. All data were analysed by the SAS software (version 8.2; SAS Institute, Cary, NC, USA) using descriptive statistics, the Kruskal–Wallis H test and generalised estimating equation regression models.

**Results.** Severity of mucosal change was significantly less on six subscales (labial mucosa, tongue mucosa, gingival colour, gingivitis, salivary status and amount of dental plaque) in the boiled water group than the control group ( $p < 0.05$ ). In addition, severity was significantly less on two subscales (salivary status and amount of dental plaque) in the green tea group than the control group ( $p < 0.05$ ).

**Conclusions.** Both boiled water and green tea oral care protocols may improve mucosal status of orally intubated patients. Mucosal status was significantly more improved by oral care with boiled water than by oral care with green tea.

**Relevance to clinical practice.** Because oral care plays an important role in improving mucosal status, nurses are urged to find new effective oral care methods to further reduce the occurrence of oropharyngeal colonisation and ventilator-associated pneumonia in intubated patients.

**Key words:** intensive care unit, intubated patients, mucosal change, oral care

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### Introduction

Any mucosal disruption may facilitate bacterial adherence, colonisation and infection. Thus, it is critical for nurses to maintain oral mucosa integrity and thereby prevent further infection. Oral flora and dental plaque may be introduced into the lower respiratory tract during intubation. In addition,

severity of disease, impaired immunological defences, use of antibiotics and poor nutrition of the intubated patients may also increase the risk of infection (Schleder *et al.* 2002) and ventilator-associated pneumonia (VAP) leading to death (Berry *et al.* 2007). The incidence rate of VAP is as high as 78% for intubated patients (Pugin *et al.* 1991). Recent reports suggest that head of bed elevation and improved oral

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care may contribute to a 34–46% decrease in VAP rate (Augustyn 2007, Alexiou *et al.* 2009, Sona *et al.* 2009). A randomised controlled trial by Fields (2008) even reported that a simple oral care intervention of toothbrushing dropped the VAP rate to zero in mechanically ventilated patients. Oropharyngeal colonisation (a causative factor for VAP) may occur within 48–72 hours after admission to critical care settings (Treloar & Stechmiller 1995). Nearly all intubated patients have potential pathogens in the mouth, and 67% have positive sputum cultures for pathogens (Sole *et al.* 2002). Munro *et al.* (2006) found an increase over time in dental plaque and oral organisms in 66 ICU patients with endotracheal intubation. In addition, higher dental plaque scores were correlated with greater risk of VAP. Therefore, appropriate oral assessment and oral care of intubated patients can prevent VAP.

Comprehensive oral assessment should include examination of the lips, saliva, soft tissues, dental plaque and gingival and mucosal surfaces (Anderson *et al.* 1999). An earlier study by Treloar and Stechmiller (1995) used an oral assessment tool to evaluate oral status of 16 ICU patients who were orally intubated for 24 hours or longer. Microbiological data were also obtained by cultures of the oropharynx and sputum. Nearly 44% of orally intubated patients had severe xerostomia and radiographic evidence of pulmonary infiltration consistent with pneumonia (Treloar & Stechmiller 1995). Totally, 26 oropharyngeal lesions were identified on the lips, tongue and mucosa of 16 patients; half had lesions in at least two areas (Treloar & Stechmiller 1995). Any mucosal disruption could provide a portal for bacterial adherence, colonisation and infection. It was, therefore, suggested that oral care should be focused on improving xerostomia, removing dental plaque and debris and preventing oral lesions.

Oral care is difficult for orally intubated patients. Development of an appropriate oral care protocol is needed to improve the oral mucosa integrity and to prevent infection. The US Centers for Disease Control and Prevention (CDC) guidelines (Tablan *et al.* 2004) recommend the development and implementation of a comprehensive oral-hygiene programme to prevent oropharyngeal colonisation in patients in acute-care settings. Fitch *et al.* (1999) found that implementation of a well-developed oral care protocol by bedside nurses could reduce plaque and inflammation and improve oral health of patients in ICUs. They used a paediatric toothbrush and rinsed with antibacterial alcohol-free mouthwash. Petroleum jelly was also applied to the lips. A retrospective study also suggested that a comprehensive oral care protocol may reduce the VAP rate from 5.6–2.2 VAPs per 1000 ventilator days for mechanically ventilated patients

in ICUs (Schleder *et al.* 2002). A similar result was reported in a study by Sona *et al.* (2009), the implementation of an oral care protocol led to a 46% reduction in risk of acquiring VAP in 24 mechanically ventilated patients in ICUs. Halm and Armola (2009) reviewed seven randomised controlled trials and one meta-analysis to examine the effect of oral care on bacterial colonisation and VAP. They found that most studies reported the positive effects of chlorhexidine (0.12% to 2%) on reducing dental plaque colonisation and VAP rates. Toothbrushing significantly decreased dental plaque colonisation, but such intervention may be used less frequently in ICUs. Fields (2008) also proposed that oral care, including timed toothbrushing, combined with the VAP bundle such as elevating the head of the bed of ventilated patients to 30° can mitigate and prevent the occurrence of VAP. A meta-analysis by Alexiou *et al.* (2009) also reported that patients positioned semirecumbently 45° have significantly lower incidence of clinically diagnosed VAP compared with patients positioned supinely. The following recommendations for comprehensive oral care in ventilated patients in the ICU have been previously reported (Schleder *et al.* 2002, Abidia 2007): (1) oral assessment daily; (2) teeth brushed every 12 hours; (3) alcohol-free antiseptic oral rinse used at least every two hours; (4) oral secretions suctioned; (5) water-based mouth moisturiser applied.

Although oral care is essential to prevent pneumonia, evidence-based nursing protocols to deal with this problem in critical care units are limited (Berry *et al.* 2007). Besides, little is known about the effects of oral care interventions in intubated patients (Munro & Grap 2004). Moreover, implementation of oral care protocols in clinical practice is still controversial (Berry *et al.* 2007). Routine oral care is limited to only once a day for patients in the study ICU. In addition, solutions and types of equipment used for oral care by nurses are still inadequate (Abidia 2007). This study examined the effects of three different oral protocols on mucosal change in intubated patients. We chose green tea as mouthwash solution because it is alcohol-free and has been found to have anti-oxidative, anti-inflammatory and antibacterial effects (Koo & Cho 2004, Cabrera *et al.* 2006). In addition, green tea is commonly consumed in Asia. Compared with other teas, green tea has the highest content of catechins (Cabrera *et al.* 2006), which damage bacterial membranes (Ikigai *et al.* 1993). Cabrera *et al.* (2006) reviewed previous studies and suggested that green tea may contribute to the promotion of oral health such as reducing dental caries, periodontal breakdown and inhibiting dental plaque bacteria. Sakanaka *et al.* (1989) also found that an extract of Japanese green tea was an inhibitor of the growth of *Streptococcus mutans*, a bacterium responsible for causing dental caries.

Rinsing with 0.2% Chinese green tea while brushing has also been found to reduce plaque and gingival index significantly (Wu & Wei 2002). However, Lauten *et al.* (2005) tested the effects of a mouthrinse containing extracts from four plants including green tea. They found no significant reduction in mean gingival and plaque indices scores when comparing results of the test rinse with the placebo control rinse. Therefore, further studies are necessary to fully understand the contributions of green tea to human oral health.

## Aims

The aim of this study was to compare three different oral care protocols in orally intubated patients in one ICU of a medical centre in northern Taiwan. The following hypotheses were tested in this study:

- 1 Oral mucosal change will be less severe after green tea or boiled water oral care interventions than after routine oral care.
- 2 Improvement in mucosal status will increase with observational time.

## Methods

### Study design

In this quasi-experimental design study, assignment of individual patients was non-random because (1) it was extremely difficult, if impossible, to obtain consent from patients or their care givers for random assignment and (2) an exposure contamination bias was possible when nurses performed different oral care protocols during the same time period. Instead, patients who came to the hospital during the same period were assigned to the same group and oral care protocol.

### Sample and setting

The study sample consisted of a total of 81 ICU patients with an oral endotracheal tube at a medical centre in Taipei, Taiwan, recruited between June 2005–March 2006. Inclusion criteria were age 40 years or older, oral intubation for less than 48 hours and written informed consent to participate by the patients themselves or their family members. We only included patients older than 40 years because most patients in the study ICU were aged 40 years or older. Exclusion criteria were as follows: oral bleeding or other difficulties prohibiting use of a toothbrush or oral assessment; surgery, general anaesthesia, cancer or chemotherapy; oral candidiasis; immunosuppressive, anticholinergic or morphine therapy; immune system impairment. In total, 99 patients met the

inclusion criteria. However, we excluded 18 patients because of oral bleeding ( $n = 7$ ), oral candidiasis ( $n = 2$ ), extubation ( $n = 4$ ) or death within two days ( $n = 5$ ) of analysis. We assigned 29, 25 and 27 patients to the green tea, boiled water and control groups, respectively. Based on mucosal status data acquired from previous studies, the sample size needed to show group differences was estimated to be approximately 25–30 patients. With this sample size, a power of 0.92–0.96 to detect true difference in mucosal status would achieve using an alpha of 0.05.

### Data collection

The Institutional Review Board of our hospital approved our study protocol. Once recruited, the patients were given the purpose and procedure of this study and all provided written informed consent. A trained senior registered nurse then obtained demographic data and completed a structured checklist. All information was kept confidential and all data were presented as group data to preserve anonymity.

Data on demographics, clinical status (obtained from medical charts) and treatment were obtained at the time of study entry. These included age, gender, diagnosis, acute physiology and chronic health evaluation II (APACHE II) score, use of medications (sedatives, antibiotics, steroids, diuretics and bronchodilators) and use of bite blocks.

A senior registered nurse rated the patients' oral mucosa status at the time of study entry as baseline data and before oral care in the evening everyday at the same time for 14 consecutive days. The senior nurse was blinded to the intervention. An oral mucosa assessment scale modified from that of Hoo and Kao (1990) was used to rate the patients' oral mucosa status. This scale consisted of nine subscales: labial mucosa; buccal mucosa; tongue mucosa; palatal, uvular and parotid gland mucosa; gingival colour; gingival bleeding; gingivitis; salivary status; and amount of dental plaque (Table 1). Each subscale score ranged from 1–4 points. Thus, the total score could range from 9–36 points, a higher score indicating greater severity of mucosal change. In Hoo and Kao's study, the inter-rater reliability of this oral assessment scale was 0.87. Content validity was also obtained from the suggestions of six oral care experts including dental physicians, physicians and experienced nurses. In our study, the level of reliability was supported by Cronbach alpha coefficient of 0.81, based on the patient's responses at baseline.

### Oral care protocols

Green tea oral care or boiled water oral care were given every four hours, in addition to routine oral care once a day, which

Table 1 Oral mucosa assessment scale

Subscale	Descriptive rating			
	1	2	3	4
Labial mucosa	Pink or white, moist, soft	oedema, dry	Blister	Cracked
Tongue mucosa	Pink, moist, soft	Mild dryness	Atrophy, smooth, red	Ulceration
Buccal mucosa	Pink or white	Erythema	Ecchymosis or bleeding	Ulceration
Palatal, uvular, parotid gland	Pink or white	Erythema	Ecchymosis or bleeding	Ulceration
Gingival colour	Pink or white	Redness	Blue	Ulceration
Gingival bleeding	None	Localised (controllable)	Generalised (controllable)	Continue, spontaneous
Gingivitis	None	Mild: slight change	Moderate: redness, oedema	Severe: marked redness, oedema, ulceration
Salivary status	Clear, watery	Slight decrease	Dryness, few amount	Viscosity
Amount of dental plaque	None	Adhering to teeth and gingival margins	Adhering to gingival	Adhering to teeth surface

included cleaning the mouth in the morning and brushing using the Bass technique with a paediatric toothbrush and fluoride toothpaste. Patients in the control group received routine oral care once a day in the morning. Details of the oral care protocols are shown in Table 2. The green tea protocol consisted of oral care plus mouthwash every four hours with green tea extract (2 g of green tea powder immersed in 100 ml boiling water for one hour). The boiled water protocol consisted of routine oral care plus mouthwash with boiled water. Fifteen registered nurses were trained to implement these interventions. Furthermore, these nurses were periodically evaluated for their adherence to the oral care protocols.

### Data analysis

All data were analysed using SAS software (version 8.2; SAS Institute). The Kruskal–Wallis H test was used to compare between-protocol differences in continuous variables (i.e. demographic characteristics, clinical status, treatment data and mucosal status) at baseline. The Chi-square test was used for comparing between-protocol differences in categorical variables. The generalised estimating equation (GEE) model was used to compare differences in mucosal status repeatedly measured over a 14-day period between the control group and two experimental groups. The use of GEE model allowed inter-correlation among repeated measurements of mucosal status over the 14 days (Burton *et al.* 1998). An interaction term of experimental/control groups and time (in days) was further fitted in the regression model to assess whether the mean differences in mucosal status between groups varied significantly with time. All hypothesis tests were two-sided and were considered statistically significant at  $p < 0.05$ .

## Results

### Sample characteristics and oral mucosa status at baseline

There was no significant difference in demographic, clinical or treatment characteristics among the three groups ( $p > 0.05$ ; Table 3). The mean age and standard deviation (SD) were 65.8 (SD 11.7), 68.0 (SD 17.1) and 62.1 (SD 14.0) years in the green tea, boiled water and control groups, respectively. The mean APACHE II score was 25.8. The average length of hospital stay was 7.6 days. The mean level of albumin and C-reactive protein (CRP) was 2.9 g/dl and 9.1 mg/dl, respectively. Of the 81 patients in our sample, one-third had a history of diabetes or renal disease and 32 (39.5%) used a bite block. During the study period, 79 (97.5%), 57 (70.4%), 39 (48.1%), 35 (43.2%) and 23 (28.4%) received antibiotics, diuretics, bronchodilators, sedatives and steroids, respectively. Because sedatives are not commonly used for all patients in the study ICU, a bite block is used to prevent the patients from biting their endotracheal tube.

Table 4 compares the mean scores of the oral mucosa assessment scale at baseline among the three groups. There were significant among-group differences in the lip, tongue, buccal and palatal mucosa subscales and amount of dental plaque subscale but not in the gingival colour, gingival bleeding, gingivitis and salivary status subscales ( $p > 0.05$ ).

### Mucosa status

Table 5 shows the results of the GEE multiple regression analysis. Analysis after adjustment for age, gender and APACHE II score was carried out because of possible associations with mucosal status. It was also because there

**Table 2** Equipment and implementation of oral care protocols

Protocol	Frequency	Equipment	Procedure
Routine oral care	Once a day	Paediatric soft-bristled toothbrush Fluoridated toothpaste 20 ml syringe Suction equipment Vaseline or lip balm Oral airway if needed	Explain the purpose and procedure to the patient Position patient in semi-fowlers Remove and clean bite block if needed Perform Bass tooth brushing technique: Brush teeth using toothbrush with toothpaste on the following order: chewing surface of tooth, inside tooth, outside tooth, top of oral cavity, right & left cheeks, tongue Brush for at least five minutes Use 20 ml syringe with water to wash oral cavity and remove secretions with suction equipment Use foam swab with water to clean tongue and oral cavity Apply Vaseline or lip balm to lips
Routine oral care plus green tea oral care	Every four hours	Paediatric soft-bristled toothbrush Fluoridated toothpaste 20 ml syringe Suction equipment Vaseline or lip balm Oral airway if needed Green tea solution	Perform routine oral care once a day Perform green tea oral care every four hours with the following steps: Explain the purpose and procedure to the patient Position patient in semi-fowlers Remove and clear bite block if needed Use syringe with green tea solution 100 ml to wash oral cavity for 3–5 minutes and remove secretions with suction equipment Use foam swab with green tea to clean tongue and oral cavity Apply Vaseline or lip balm to lips
Routine oral care plus boiled water oral care	Every four hours	Paediatric soft-bristled toothbrush Fluoridated toothpaste 20 ml syringe Suction equipment Vaseline or lip balm Oral airway if needed Boiled water	Perform routine oral care once a day Perform boiled water oral care every four hours with the following steps: Explain the purpose and procedure to the patient Position patient in semi-fowlers Remove and clear bite block if needed Use syringe with boiled water 100 ml to wash oral cavity for 3–5 minutes and remove secretions with suction equipment Use foam swab with water to clean tongue and oral cavity Apply Vaseline or lip balm to lips

were among-group differences in these variables, though the differences were not significant. During the 14-day observational period, mean score of mucosa status was significantly lower in the boiled water group than the control group on six subscales: labial mucosa ( $\beta = -0.48$ ,  $p < 0.05$ ), tongue mucosa ( $\beta = -0.48$ ,  $p < 0.05$ ), gingival colour ( $\beta = -0.15$ ,  $p < 0.05$ ), gingivitis ( $\beta = -0.15$ ,  $p < 0.05$ ), salivary status ( $\beta = -0.94$ ,  $p < 0.001$ ) and amount of dental plaque ( $\beta = -0.32$ ,  $p < 0.05$ ). Mean score of mucosa status was significantly lower in the green tea group than in the control group on two subscales: salivary status ( $\beta = -0.54$ ,  $p < 0.05$ ) and amount of dental plaque ( $\beta = -0.25$ ,  $p < 0.05$ ). However, buccal mucosa scores were significantly higher in the boiled water group than the control group ( $\beta = 0.24$ ,  $p < 0.01$ ). Overall, the boiled water protocol proved to be more efficacious.

### Interactions between groups and observational time

Interactions between groups and day of observation were significant on only two subscales: labial mucosa and gingival colour. Figure 1 showed that the mean labial mucosa score for patients in the boiled water group decreased gradually with time, whereas that for patients in the control group increased with time. Additionally, the gingival colour score increased gradually in the green tea group but remained essentially unchanged in the control group (Fig. 2).

### Discussion

The findings of this study suggest that both boiled water and green tea oral care protocols could improve the oral mucosal status of intubated patients in ICUs.

Table 3 Characteristics of patients

Characteristics	Green tea ( <i>n</i> = 29)		Boiled water ( <i>n</i> = 25)		Control ( <i>n</i> = 27)		K-W $\chi^2$	<i>p</i>
	Mean $\pm$ SD		Mean $\pm$ SD		Mean $\pm$ SD			
Mean age	65.8 $\pm$ 11.7		68.0 $\pm$ 17.1		62.1 $\pm$ 14.0		2.25	0.33
Length of stay	10.6 $\pm$ 13.8		5.7 $\pm$ 14.2		6.2 $\pm$ 14.8		1.61	0.45
APACH II	25.5 $\pm$ 8.2		27.4 $\pm$ 6.2		24.7 $\pm$ 8.9		2.58	0.26
Albumin	2.8 $\pm$ 0.5		2.8 $\pm$ 0.5		2.9 $\pm$ 0.5		1.25	0.54
CRP	10.1 $\pm$ 7.0		10.2 $\pm$ 6.7		7.1 $\pm$ 5.8		4.22	0.12
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%		
Gender								
Male	16	55.2	8	32.0	14	51.9	3.29	0.19
Female	13	44.8	17	68.0	13	48.1		
Diabetes								
Yes	10	34.5	9	36.0	8	29.6	0.26	0.88
No	19	65.5	16	64.0	19	70.4		
Renal disease								
Yes	11	37.9	8	32.0	7	25.9	0.93	0.63
No	18	62.1	17	68.0	20	74.1		
Sedations								
Yes	14	48.3	12	48.0	9	33.3	1.61	0.45
No	15	51.7	13	52.0	18	66.7		
Antibiotics								
Yes	29	100.0	24	96.0	26	96.3	1.15	0.56
No	0	0.0	1	4.0	1	3.7		
Steroids								
Yes	6	20.7	10	40.0	7	25.9	2.58	0.28
No	23	79.3	15	60.0	20	74.1		
Diuretics								
Yes	21	72.4	17	68.0	19	70.4	0.13	0.94
No	8	27.6	8	32.0	8	29.6		
Bronchodilators								
Yes	18	62.1	12	48.0	9	33.3	4.63	0.10
No	11	37.9	13	52.0	18	66.7		
Use of bite								
Yes	12	41.4	8	32.0	12	44.4	0.91	0.64
No	17	58.6	17	68.0	15	55.6		

K-W, Kruskal-Wallis H test.

### The effect of the solutions

The present findings are consistent with previous findings that green tea improves oral health (Wu & Wei 2002, Okamoto *et al.* 2004, Cabrera *et al.* 2006). Nevertheless, it was surprising to note that boiled water was even more effective than green tea. The time of green tea oral care, time of green tea extraction and the method of preparing the green tea extract may account for this difference. Further investigation is needed to address these possible explanations.

### The effect of oral care frequency

In the present study, the frequency of oral care was increased from once a day to six times per day. Consistent

with the findings of others (Yang *et al.* 1996, Stiefel 2000), this study demonstrated that oral care every four hours significantly improved salivary status and reduced the amount of dental plaque. Because saliva has both an antiplaque and antibacterial role, decreasing saliva may cause gingivitis and mucositis (Stiefel 2000). A prospective study reported the near absence in intubated patients of salivary flow, which might contribute to the development of mucositis and oropharyngeal colonisation with Gram-negative bacteria (Dennessen *et al.* 2003). Salivary flow may be affected by severity of disease, lack of normal oral intake, fluid balance disturbance and use of medications such as morphine and diuretics. In our study, the mean APACHE II score was 25.8, which was relatively higher than previously reported (Treloar & Stechmiller

Subscale	Green tea (n = 29)	Boiled water (n = 25)	Control (n = 27)	K-W	p
	Mean ± SD	Mean ± SD	Mean ± SD		
Labial mucosa	2.34 ± 1.11	1.48 ± 0.87	2.52 ± 1.12	14.7	0.001**
Tongue mucosa	1.79 ± 0.68	1.60 ± 0.91	2.33 ± 0.92	12.4	0.002**
Buccal mucosa	1.62 ± 0.90	1.36 ± 0.76	2.48 ± 1.40	11.5	0.003**
Palatal, uvular, parotid gland	1.97 ± 1.18	1.32 ± 0.75	1.78 ± 0.97	6.8	0.033*
Gingival colour	1.21 ± 0.41	1.20 ± 0.71	1.11 ± 0.32	1.7	0.429
Gingival bleeding	1.17 ± 0.66	1.12 ± 0.33	1.15 ± 0.36	0.7	0.709
Gingivitis	1.17 ± 0.54	1.12 ± 0.33	1.15 ± 0.46	0.0	0.995
Salivary status	1.62 ± 0.78	1.24 ± 0.44	1.78 ± 1.01	5.2	0.074
Amount of dental plaque	1.66 ± 0.67	1.24 ± 0.52	1.85 ± 0.99	8.6	0.013*
Total score	14.55 ± 4.14	11.68 ± 3.91	16.15 ± 3.68	20.4	0.000***

K-W, Kruskal-Wallis H test.

\*p < 0.05, \*\*p < 0.01, \*\*\*p < 0.001.

Table 4 Comparisons of oral mucosa assessment score at baseline among the three groups of patients

Table 5 Comparisons of oral mucosa scores between control group and two experimental groups over the 14-day study period

Subscale	Experimental groups	Adjusted estimate*	
		Regression coefficient (β)	95% CI
Labial mucosa	Green tea	0.19	-0.16-0.54
	Boiled water	-0.48	-0.09 to -0.87
Tongue mucosa	Green tea	0.19	0.16-0.54
	Boiled water	-0.48	-0.09 to -0.87
Buccal mucosa	Green tea	0.23	-0.24-0.68
	Boiled water	0.24	-0.23-0.71
Palatal, uvular, parotid gland	Green tea	0.45	0.0-0.9
	Boiled water	-0.48	-0.97 to 0.01
Gingival colour	Green tea	0.07	-0.13-0.27
	Boiled water	-0.15	-0.31-0.01
Gingival bleeding	Green tea	-0.05	-0.25-0.15
	Boiled water	-0.03	-0.21-0.15
Gingivitis	Green tea	0.00	-0.16-0.16
	Boiled water	-0.15	-0.01 to -0.29
Saliva status	Green tea	-0.54	-0.19 to -0.89
	Boiled water	-0.94	-0.61 to -1.27
Amount of dental plaque	Green tea	-0.25	-0.01 to -0.49
	Boiled water	-0.32	-0.1 to -0.54

\*Estimated from multivariate generalised estimation equation model controlling for study participants' age, gender, APACH II score and baseline score.

1995). In addition, 70.4% of our patients received diuretics.

The effects over time

The present study found that interaction of the protocol with elapsed time had effects on labial mucosa and gingival

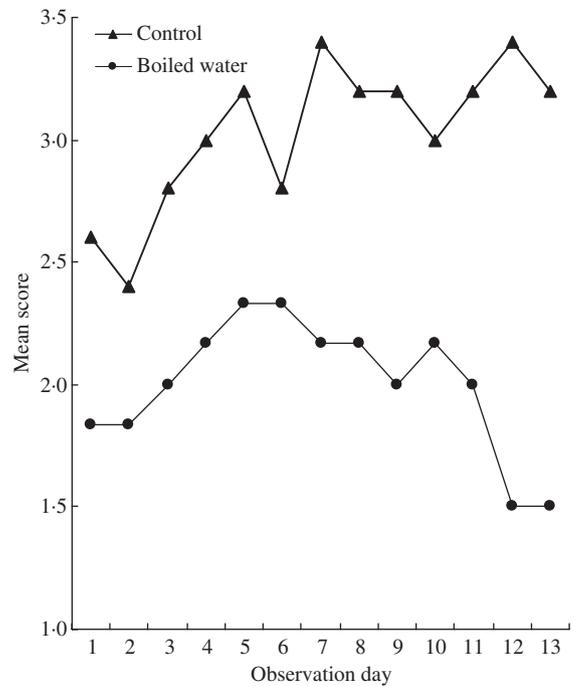
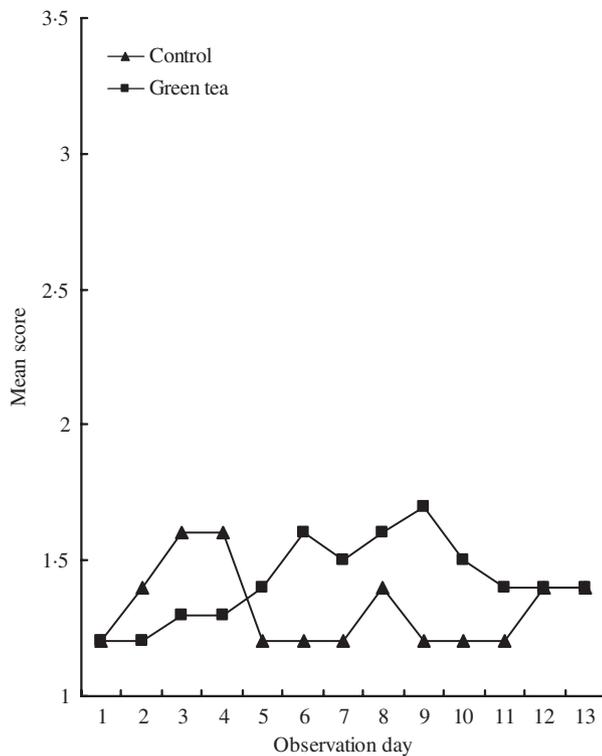


Figure 1 Mean score of labial mucosa change within 14 days for the boiled water group and the control group.

colour. During the 14-day period, labial mucosal change was more severe after routine care than after boiled water. Although we controlled statistically for the difference between the two groups, the time of wound healing may still have contributed to this result. On the other hand, gingival colour status deteriorated with time in the green tea group compared with the control group. This result did not support our hypothesis of temporal improvement in mucosal status. A previous report showed improvement in



**Figure 2** Mean score of gingival colour within 14 days for the green tea group and the control group.

gingivitis after oral care for one month (Hoo & Kao 1990). Short-term observational period and pre-existing gingival bleeding or ulcers in the green tea group may account for our result.

Several limitations of this study should be noted. The findings are based on a sample recruited from a single hospital and their generalisability should be interpreted with caution. Replication of the study using a larger, multicentre-based sample of intubated patients is therefore recommended. In addition, the training of the 15 registered nurses to perform the oral care protocols might have varied because of differences in perception between nurses. Reducing the number of nurses to reduce inter-rater differences is suggested. Several potential confounding factors including frequency of water intake, frequency of lip care, the way the endotracheal tube was stabilised and frequency of suction may have interfered with protocol assessment and should be taken into consideration in future studies. Limitation of study resources prevented examination of the incidence of oropharyngeal colonisation and VAP. Oropharyngeal colonisation and VAP should

also be a focus in future studies. However, the development of VAP can be multifaceted including host-related factors such as patients' pre-existing conditions, body position, medications, device-related and personnel-related factors such as improper hand washing (Augustyn 2007). In addition, diagnosis of VAP remains difficult and controversial. Therefore, further studies on oral care interventions using VAP as outcome variables may require enormous resources and need to consider these confounding factors.

## Conclusion

Because the number of intubated patients in critical care settings is growing, development of appropriate oral care protocols is essential. This study demonstrated that oral care with boiled water and green tea may improve mucosal status of orally intubated patients. Because oral care plays an important role in improving mucosal status, nurses and other healthcare professionals are urged to find new effective oral care methods to further reduce the occurrence of oropharyngeal colonisation and VAP in intubated patients.

## Relevance to clinical practice

Because oral care plays an important role in improving mucosal status, nurses are urged to find new effective oral care methods to further reduce the occurrence of oropharyngeal colonisation and VAP in intubated patients.

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## Contributions

Study design: SPH, AFC; data collection and analysis: SPH, CSL, CYL, AFC and manuscript preparation: SPH, CYL, AFC.

## Conflict of interest

There is no any conflict of interest for this study.

## References

- Abidia RF (2007) Oral care in the intensive care unit: a review. *The Journal of Contemporary Dental Practice* 8, 76–82.
- Alexiou VG, Ierodiakonou V, Dimopoulos G & Falagas ME (2009) Impact of patient position on the incidence of ventilator-associated pneumonia: a meta-analysis of randomized controlled trials. *Journal of Critical Care* 24, 515–522.
- Anderson P, Persson L, Hallberg IR & Renvert S (1999) Testing an oral assessment guide chemotherapy treatment in a Swedish care setting: a pilot study. *Journal of Clinical Nursing* 8, 150–158.
- Augustyn B (2007) Ventilator-Associated Pneumonia: risk factors and prevention. *Critical Care Nurse* 27, 32–39.
- Berry AM, Davidson PM, Masters J & Rolls K (2007) Systematic literature review of oral hygiene practices for intensive care patients receiving mechanical ventilation. *American Journal of Critical Care* 16, 552–562.
- Burton P, Gurrin L & Sly P (1998) Extending the simple linear regression model to account for correlated responses: an introduction to generalized estimating equations and multi-level mixed modelling. *Statistics in Medicine* 17, 1261–1291.
- Cabrera C, Artacho R & Giménez R (2006) Beneficial effects of green tea: a review. *Journal of the American College of Nutrition* 25, 79–99.
- Dennesen P, van der Ven A, Vlasveld M, Lokker L, Ramsay G, Kessels A, van den Keijbus P, van Nieuw Amerongen A & Veerman E (2003) Inadequate salivary flow and poor oral mucosal status in intubated intensive care unit patients. *Critical Care Medicine* 31, 781–786.
- Fields LB (2008) Oral care intervention to reduce incidence of ventilator-associated pneumonia in the neurologic intensive care unit. *Journal of Neuroscience Nursing* 40, 291–298.
- Fitch JA, Munro CL, Glass CA & Pellegrini JM (1999) Oral care in the adult intensive care unit. *American Journal of Critical Care* 8, 314–318.
- Halm MA & Armola R (2009) Effect of oral care on bacterial colonization and ventilator-associated pneumonia. *American Journal of Critical Care* 18, 275–278.
- Hoo YJ & Kao CH (1990) The study on the effectiveness of oral care protocol on the acute leukemic patients with alteration in oral mucous membrane. *The Journal of Nursing (in Chinese)* 37, 21–33.
- Ikigai H, Nakae T, Hara Y & Shimamura T (1993) Bactericidal catechins damage the lipid bilayer. *Biochimica et Biophysica Acta* 1147, 132–136.
- Koo MWL & Cho CH (2004) Pharmacological effects of green tea on the gastrointestinal system. *European Journal of Pharmacology* 500, 177–185.
- Lauten JD, Boyd L, Hanson MB, Lillie D, Gullion C & Madden TE (2005) A clinical study: Melaleuca, Manuka, Calendula and green tea mouth rinse. *Phytotherapy Research* 19, 951–957.
- Munro CL & Grap MJ (2004) Oral health and care in the intensive care unit: state of the science. *American Journal of Critical Care* 13, 25–34.
- Munro CL, Grap MJ, McKinney J, Sessler CN & Hummel RS III (2006) Oral health status and development of ventilator-associated pneumonia: a descriptive study. *American Journal of Critical Care* 15, 453–460.
- Okamoto M, Sugimoto A, Leung K-P, Nakayama K, Kamaguchi A & Maeda N (2004) Inhibitory effect of green tea catechins on cysteine proteinases in *Porphyromonas gingivalis*. *Oral Microbiology & Immunology* 19, 118–120.
- Pugin J, Auckenthaler R, Lew DP & Suter PM (1991) Oropharyngeal decontamination decreases incidence of ventilator-associated pneumonia. *The Journal of the American Medical Association* 265, 2704–2710.
- Sakanaka S, Kim M, Taniguchi M & Yamamoto T (1989) Antibacterial substances in Japanese green tea extract against *Streptococcus mutans*, a cariogenic bacterium. *Agricultural and Biological Chemistry* 53, 2307–2311.
- Schleder B, Stott K & Lloyd R (2002) The effect of a comprehensive oral care protocol on patients at risk for ventilator-associated pneumonia. *Journal of Advocate Health Care* 4, 27–30.
- Sole ML, Poalillo FE, Byers JF & Luday JE (2002) Bacterial growth in secretions and on suctioning equipment of orally intubated patients: a pilot study. *American Journal of Critical Care* 11, 141–149.
- Sona CS, Zack JE, Schallom ME, McSweeney M, McMullen K, Thomas J, Coopersmith CM, Boyle WA, Buchman TG, Mazuski JE & Schuerer DJE (2009) The impact of a simple, low-cost oral care protocol on ventilator-associated pneumonia rates in a surgical intensive care unit. *Journal of Intensive Care Medicine* 24, 54–62.
- Stiefel KA (2000) Improving oral hygiene for the seriously ill patient: implementing research-based practice. *MedSurg Nursing* 9, 40–46.
- Tablan OC, Anderson LJ, Besser R, Bridges C & Hajjeh R (2004) Guidelines for preventing health-care-associated pneumonia, 2003: recommendations of CDC and the Healthcare Infection Control Practices Advisory Committee. *MMWR. Recommendations and Reports* 53(RR-3), 1–36.
- Treloar DM & Stechmiller JK (1995) Use of clinical assessment tool for orally intubated patients. *American Journal of Critical Care* 4, 355–360.
- Wu CD & Wei GX (2002) Tea as a functional food for oral health. *Nutrition* 18, 443–444.
- Yang TY, Kao CH, Maa SH, Lai YL & Chen JK (1996) The effectiveness of oral care protocol on the cancer patients undergone head and neck radiotherapy. *Chang Gung Nursing (in Chinese)* 7, 15–29.

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