



## Mouth Care in Patients Receiving Mechanical Ventilation: A Systematic Review

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### ABSTRACT

**Context:** Studies show that despite the role of mouth care in preventing ventilator-associated pneumonia, there is no high quality evidences for it. This study reviewed the literature related to mouth care in patients receiving mechanical ventilation.

**Evidence Acquisition:** PubMed, Ovide, Elsevier, ProQuest, IranMedex, SID, and Magiran databases were searched using key terms such as oral care, mouth care, critical care, and intensive care. Fifty-seven full-text articles in total were retrieved and included in the study.

**Results:** Totally, 15 review articles and 42 research articles were reviewed. Only 13 articles introduced or evaluated the validity of instruments or caring guidelines in the area of mouth care. Only one study discussed about designing and validating the psychometric properties of a mouth assessment scale. Most of the articles emphasized on brushing the teeth as the best method for mouth care, but there was no consensus on the frequency of washing and the best washing solution.

**Conclusions:** Despite the importance of mouth care, few original studies are conducted in this area and there is no approved clinical guideline for this procedure.

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### ► Implication for health policy/practice/research/medical education:

Nurses should try to keep with up-to-date and evidence-based protocols to afford oral care. Nurse investigators also should conduct high quality researches to provide evidences the nurses need to.

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## 1. Context

Many studies have reported the association between inappropriate mouth care and pneumonia in patients receiving mechanical ventilation (1-3). The prevalence of ventilator-associated pneumonia (VAP) is 9-68% and the mortality rate is at least twice of those for other types of the disease (4-6). Studies showed that mouth care might be an effective intervention to reduce the occurrence of VAP (7-9); however, it was reported that neither patients receiving mechanical ventilation received appropri-

ate mouth care nor this type of care was documented correctly (8, 10-15). The main reasons for inappropriate mouth care in patients receiving mechanical ventilations consisted of the lack of standard guidelines (1, 8, 16, 17), equipment and staff shortage (10, 18-20), and nurses' lack of knowledge (2, 4, 6, 21-23). A recent study in Kerman, Iran, revealed that the nurses did not pay much attention to mouth care and considered it as a hard and unpleasant nursing care (13). Another study conducted in ICUs of three Iranian cities showed that in

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comparison with other caring measures, nurses ranked the mouth care as the seventh importance level. This study reported that only 29% of nurses were trained for mouth care (10). In another study, nurses reported that nursing training courses were ineffective in increasing their ability to provide appropriate mouth care (18). This study was conducted according to the importance of mouth care among patients receiving mechanical ventilation, its association with VAP, the importance of updating healthcare providers' knowledge in this caring area, and for providing most recent evidences for mouth care among such patients. The aim of study was to review the most recent studies conducted in the area of mouth care among patients receiving mechanical ventilation hope to help nurses to make more effective decisions about mouth care in these patients.

## 2. Evidence Acquisition

We performed an internet-based literature review published between 2001 and 2012 to retrieve studies in the area of mouth care among patients under mechanical ventilation. English and Persian databases such as PubMed, Ovid, Elsevier, ProQuest, IranMedex, SID, and Magiran were searched using the following key terms: oral care, mouth care, critical care, and intensive care. All studies conducted on human subjects were included. We also searched the reference sections of retrieved articles to find other related studies. Excluding criteria included articles published in languages other than English or Persian, those studies that their complete contents were not retrievable, articles published in criticizing other studies, articles published as Letter-to-Editor, and studies conducted on healthy individuals or on patients not receiving mechanical ventilation. Totally, 93 papers were retrieved from which 57 papers were not repetitive (Figure 1).

## 3. Results

Among 57 articles, 15 articles were review studies and 42 articles original research papers. In most of the review studies, the importance of mouth care and its association with VAP as well as advantages and disadvantages of materials and equipment used for routine mouth care were discussed (Table 1). Original research papers were provided in three areas:

- 1) studies evaluating validity of instruments used for assessing mouth care,
- 2) descriptive studies investigating nurses' performance for mouth care, and
- 3) studies investigating advantages and disadvantages of equipment and solutions used for providing mouth care (Table 2). Below, findings of the study were explained in five subsections including dental plaque and VAP, instruments designed for assessing mouth care, assessment of nurses' routine practice in terms of pa-

tients' mouth care, equipment used for mouth care, and materials and solutions used for mouth care.

### 3.1. Dental Plaque and VAP

Plaque formation and its association with VAP was a prevalent topic in most of the retrieved review studies and few original research papers (4, 16, 20). It was reported that 48 hours after hospitalization, normal bacterial flora of oral cavity changed to opportunistic and pathogenic organisms (24). Moreover, dental plaques and caries grew secondary to fibronectin reduction at dental surface (4, 19, 24-26).

### 3.2. Instruments Designed for Assessing Mouth Care

Thirteen studies in total introduced or evaluated the validity of instruments or caring guidelines in the area of mouth care (1, 8, 9, 11, 21, 27-34). Although primary mouth assessment should be considered as an important part of ICU baseline assessment, among retrieved studies, only one article discussed about designing and validating the psychometric properties of mouth assessment scale (35). Additionally, the BRUSHED Assessment Model was discussed in five review studies (1, 20, 21, 27) while the Jenkins scale was referred to in two (27, 36). On the other hand, four studies noted that most of mouth assessment instruments are not valid and applicable for nurses (21, 27, 35, 36). These studies also emphasized on the importance of continuous mouth assessment and documentation at least every 12 hours (20, 21, 27, 28). Among retrieved studies, six studies investigated the effects of mouth care guidelines and reported a reduction of 61% to 100% in VAP incidence after implementation of the guidelines (8, 9, 28, 31-33). These guidelines consisted of procedures such as hand washing; preparing equipment and suction machine; brushing the teeth, gums, and tongue; mouth washing and suctioning (several times a day); application of humidity pre-

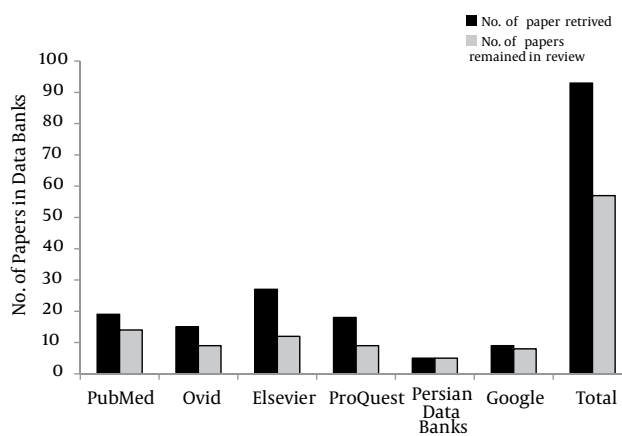


Figure 1. Number of Papers Retrieved in Each Data Bank

**Table 1.** The list of Review Studies Included in the Study

Authors, y	Study Design	Aim	Main Findings
<b>Blot et al. (2008)</b>	Review	Reviewing new perspectives on mouth care, consequences of inappropriate mouth care, and the current mouth care procedures for patients receiving mechanical ventilation.	Pathologic assessment of dental plaque, effects of the tracheal tube on bacterial flora of the oral cavity, conducted studies in the area of nurses' knowledge and performance regarding mouth care, equipment's, materials and solutions used for mouth care, introducing a BRUSHED assessment model, and presenting a brief guideline for mouth care in patients receiving mechanical ventilation.
<b>Munro et al. (2004)</b>	Review	Reviewing recent literature in the area of mouth care and investigating its association with VAP.	Investigating the formation process of the dental plaque, factors compromising the immunity of the oral cavity in intubated patients, and routine mechanical and chemical methods of mouth care
<b>Berry and Davidson (2006)</b>	Review	Determining barriers to mouth care in ICU and the most effective caring strategy	The most important barriers were mechanical obstacles around and in the oral cavity, nurses' perception of the importance and priority of mouth care, patients' disturbed sensory perception and their inability to communicate. The most effective method for mouth care remained unknown.
<b>Mehta and Niederman (2002)</b>	Review	Reviewing factors inducing nosocomial pneumonia	Assessment of nosocomial pneumonia and VAP, and highlighting the role of mouth decontamination and treatment with antibiotics
<b>Scannapieco et al. (2001)</b>	Review	Investigating the similarity between oral and pulmonary bacteria	Pathogens extracted from dental plaque (Gram-negative bacteria, methicillin-resistant <i>S. aureus</i> and <i>Pseudomonas</i> ) were responsible for VAP.
<b>Jelic et al. (2008)</b>	Review	Investigating the effects of mechanical and pharmacologic mouth care strategies on outcomes in ICU patients	Mouth care and mouthwash with pharmacologic agents decrease the VAP incidence rate in patients receiving mechanical ventilation.
<b>Abidia (2007)</b>	Review	Investigating the difficulties of mouth care in intubated patients and providing a guideline for practice.	Introducing materials and equipment routinely used for mouth care; Introducing a BRUSHED assessment model; Presenting a guideline for providing mouth care to patients receiving mechanical ventilation
<b>Schwartz and Powell (2009)</b>	Review	Introducing an appropriate method for assessment of and care for mouth in patients receiving mechanical ventilation	Introducing a BRUSHED assessment model; A brief review of the importance, barriers, and equipment of mouth care in patients receiving mechanical ventilation and providing several important tips
<b>Berry et al. (2007)</b>	Systematic review (55 studies published between 1985 to 2006)	Reviewing published research for improving the quality of care	Despite the importance of mouth care in patients receiving mechanical ventilation, there is a lack of well-designed clinical trials in this area. There is no consensus on the best method and most effective equipment of mouth care.
<b>Stonecypher (2010)</b>	Review	Reviewing the importance of and factors affecting VAP and the role of mouth care in VAP prevention	Reviewing the importance of VAP and its prevention; Reviewing the importance of mouth suction and hand-wash, and the effect of gastric secretions and dental plaque on VAP
<b>Bouza and Burillo (2009)</b>	Review	Investigating the recent advancements in the prevention, diagnosis and treatment of VAP	There is no consensus on the best diagnostic method for VAP. Mouth care using chlorhexidine has an important role in the prevention of VAP.
<b>Tablan et al. (2004)</b>	Review	Updating and extending the CDC guideline for the prevention of nosocomial pneumonia	Oral hygiene is very important in the prevention of VAP. Based on the current evidence, chlorhexidine and topical antibiotics are not recommended for routine use in mouth care.
<b>Oreilly et al. (2003)</b>	Review	Reviewing published studies to determine best practice method for mouth wash	Reviewing factors affecting oral health and the outcomes of inadequate mouth care. Advantages and disadvantages of different materials and methods without eliminating current controversies

<b>Jones and Munro (2008)</b>	Review of nine article	Investigating the association of mouth care and development of bacteremia in patients receiving mechanical ventilation	Three common microorganisms responsible for nosocomial bacteremia are <i>S. aureus</i> , coagulase-negative staphylococci, and <i>Enterobacter</i> ; however, there were controversies about their origins.
<b>Adib-Hajbaghery et al. (2011)</b>	Review of 45 article	Developing a protocol for mouth care in ICU	The incidence of VAP was indirectly associated with oral hygiene. A protocol was recommended for mouth care.

**Table 2.** The List of Original Research Articles Included in the Study

Authors, y	Study Design	Aim	Main Findings
<b>Rello et al. (2007)</b>	Descriptive (59 ICU nurses)	Investigating the knowledge, attitude, and performance of ICU nurses regarding mouth care	Two third of nurses received trainings regarding mouth care; however, 93% reported that they needed more training. One third of nurses considered this care as unpleasant, 20% of nurses reported that they provided mouth care to patients once a day and 30% reported that they provided the care twice a day.
<b>Grap et al. (2003)</b>	Descriptive (77 ICU nurses)	Investigating the frequency and documentation of mouth care	The documented frequency was less than the self-reported frequency. Only one third of nurses reported the use of toothbrush for mouth care.
<b>Ganz et al. (2009)</b>	Descriptive (218 ICU nurses)	Describing nurses' performance in terms of mouth care and comparing it with evidence	84% of nurses reported the use of gauze pieces and 34% reported the use of toothbrush for mouth care. Chlorhexidine was used in 75% of cases. Only 57% of mouth care procedures were documented.
<b>Cason et al. (2007)</b>	Descriptive (1200 nurses)	Investigating nurses' practice regarding the implementation of mouth care guidelines	Guidelines were not followed appropriately. One-half of nurses reported that they did not have any mouth care guideline at their workplace.
<b>Mori et al. (2006)</b>	Non-randomized clinical trial (1666 ICU nurses)	Investigating the effects of Betadine versus routine mouth care on the occurrence of VAP	Mouth care once in a working shift decreased the occurrence of VIP (3.9 cases versus 10.4 cases per 1000 ventilator-day). Betadine was also effective in decreasing the occurrence of VIP.
<b>Cutler and Davis (2005)</b>	Interventional-observational (observation of care provided to 253 patients)	Investigating nurses' adherence to a mouth care guideline	Before intervention, the most prevalent caring method was simple suctioning of the mouth. No case of toothbrush and moisturizing was observed. After intervention, tooth-brushing was reported in 33% of cases.
<b>Adib-Hajbaghery and Ansari (2012)</b>	Cross-sectional (90 ICU nurses)	Comparing nurses opinion with their practice in terms of mouth care	Nurses considered mouth care as non-important. 20% of them did not perform mouth care. Mouth care was documented in only 20% of cases.
<b>Ranjbar et al. (2011)</b>	Cross-sectional (131 nurses)	Investigating the factors affecting the frequency and quality of mouth care in ICUs	The most prevalent mouth caring method and solution were mouthwash and chlorhexidine, respectively. Nurses' attitude towards mouth care was effective on the quality of mouth care practice.
<b>VanNieuwenhoven et al. (2004)</b>	Analytic-correlational (181 ICU patients)	Investigating the cost-effectiveness of mouth care and decontamination	Through the prevention of VAP, oral decontamination saved 16,000 dollars for the hospital and 18,000 dollars for patients

<b>Hanneman et al. (2005)</b>	Descriptive (181 ICU nurses)	Investigating the frequency of mouth care in ICU	In most cases, mouth care was not documented. There was a significant difference between nurses' self-reported and the documented times of performing mouth care.
<b>Schleder et al. (2002)</b>	Retrospective	Investigating the effects of a comprehensive mouth care program on the risk of VAP	The program decreased the occurrence of VAP by 60%.
<b>Sole et al. (2003)</b>	Descriptive-comparative	Investigating the frequency of mouth care and closed tracheal suctioning in 27 ICUs	Nurses performed mouth care and suctioning better than other healthcare providers.
<b>Johnstone et al. (2010)</b>	Descriptive	Reporting the primary results of the implementation of a mouth care guideline	Nurses valued mouth care; however, they needed re-training courses. Designing a mouth care guideline
<b>Binkley et al. (2004)</b>	Descriptive (102 ICU nurses)	Investigating the knowledge, attitude, and performance of nurses for mouth care	92% of nurses considered mouth care as an important caring component. The main mouth caring method was using swab and performing mouthwash. Toothbrush was used rarely.
<b>Allen Furr et al. (2004)</b>	Descriptive-analytic (556 ICU nurses)	Investigating the knowledge and performance of nurses for mouth care and its affecting factors	The most important factors affecting the mouth care practice were having enough time, prioritizing the mouth care, and not considering the performance of mouth care as unpleasant.
<b>Pedreira et al. (2009)</b>	Randomized controlled trial (56 patients receiving mechanical ventilation)	Comparing the effects of two mouthwash solutions and tooth-brushing (with and without chlorhexidine) on oral bacterial flora, duration of dependence to mechanical ventilation, and duration of hospitalization	After intervention, groups did not differ significantly in terms of the study variables.
<b>Feider et al. (2010)</b>	Descriptive—cross-sectional (347 ICU nurses)	Investigating nurses' performance in terms of mouth care in patients receiving mechanical ventilation	42% of nurses reported the implementation of mouth care once every 4 hours. The most common method for mouth cleaning was the use of swab. In wards with caring guidelines, the use of toothbrush was more common.
<b>Munro et al. (2009)</b>	Randomized clinical trial (four 44 to 51-person groups)	Comparing the effects of tooth-brushing, mouthwash with chlorhexidine, and the routine mouth care on the occurrence of VAP	The occurrence of VAP was lower in patients with pneumonia-risk-score greater than 6 who received mouth care using chlorhexidine.
<b>Ranjbar et al. (2010)</b>	Clinical trial (80 ICU patients)	Comparing the effects of mouthwash with chlorhexidine and normal saline on the occurrence of VAP	22.5% of patients in the chlorhexidine group and 32.5% of patients in the normal saline group developed VAP; this difference was not statistically significant.
<b>Feider and Mitchell (2009)</b>	Descriptive	Testing the validity of an instrument used for the assessment of mouth care in patients receiving mechanical ventilation	Reporting the results of the validity testing process
<b>Panchabhai et al. (2009)</b>	Clinical trial	Comparing the effects of mouthwash with chlorhexidine and potassium permanganate on the occurrence of VAP	After the intervention, the incidence of VAP in both groups decreased significantly; however, the frequency of VAP in both groups did not differ significantly.

<b>Fields (2008)</b>	Randomized controlled trial	Investigating the effects of a mouth caring guideline on the occurrence of VAP	In the experimental group (receiving tooth brushing once every eight hours) the incidence of VAP decreased to zero after one week.
<b>Jones et al. (2004)</b>	Descriptive (103 nurses)	Investigating knowledge of the nurses regarding mouth care and their adherence to the guideline for practice	23% of nurses did not receive trainings regarding mouth care and 58% asked to receive more training. Only 26% of nurses used a written assessment tool. Provided care was consistent with the available guidelines.
<b>Hutchins et al. (2009)</b>	Interventional	Investigating the effects of a mouth care program on the incidence of VAP	The 4-year program decreased the prevalence of VAP by 89.7%.
<b>Koeman et al. (2006)</b>	Double-blind randomized controlled trial (380 patients)	Comparing the effects of mouthwash with chlorhexidine gel, chlorhexidine plus colistin, and placebo on the occurrence of VAP	The VAP incidence decreased in patients receiving chlorhexidine. The decrease of microbial colonization was greater in patients receiving chlorhexidine-colistin.
<b>Garcia et al. (2006)</b>	Interventional	Investigating the effects of a 48-month mouth care program on the incidence of VAP	80% adherence to the program decreased the VAP incidence from 12 to 8 cases per 1000 ventilator-day.
<b>Tolentino et al. (2007)</b>	Interventional (before-after); (61 nurses)	Investigating the effects of a training program on nurses' adherence to mouth care guideline	Nurses' compliance to guideline in areas such as documentation and hand-wash improved after intervention.
<b>Pobo et al. (2009)</b>	Single-blind randomized controlled trial (147 patients)	Comparing the effects of using toothbrush versus mouthwash with chlorhexidine on the occurrence of VAP	After intervention, the difference between the groups in terms of the incidence of VAP was not statistically significant.
<b>Powers et al. (2007)</b>	Interventional	Reporting the results of an intervention for improving the quality of care and preventing VAP	Thirteen weeks after intervention, the incidence of VAP decreased to zero.
<b>Houston (2002)</b>	Randomized controlled trial (561 patients)	Investigating the effects of mouthwash with chlorhexidine on the occurrence of nosocomial pneumonia after cardiac surgery	The incidence of pneumonia in chlorhexidine group, patients having tracheal tube for more than 24 hours, and patients at greater risk for pneumonia decreased by 52%, 58%, and 71%, respectively.
<b>Segers et al. (2006)</b>	Randomized controlled trial (954 patients)	Investigating the effects of mouthwash with chlorhexidine on the occurrence of nosocomial infection after cardiac surgery	The incidence of infection in the experimental and control group was 19.8% and 26.2%, respectively.
<b>Grap et al. (2004)</b>	Randomized controlled trial (34 patients)	Investigating the effects of mouthwash with chlorhexidine on the oral bacterial flora and risk of VAP	Bacterial flora and the risk of VAP decreased in the chlorhexidine group and increased in the control group.
<b>Mirian et al. (2004)</b>	Quasi-experimental (60 ICU patients)	Investigating the effects of the sodium bicarbonate solution and honey solution on the prevention of oral lesions in ICU patients	At the seventh day of intervention, none of the patients in the groups had oral lesions. The color and status of tongue and mouth was better in patients receiving honey solution.
<b>Sona et al. (2009)</b>	Interventional (4158 ventilator-day)	Determining the effects of a caring guideline on the occurrence of VAP	Implementing the guideline in a several-month period decreased the incidence rate of VAP by 46%.

<b>Seguin</b>	Clinical trial (98 patients)	Comparing the effects of mouthwash with diluted Betadine and normal saline versus simple suctioning of mouth and throat on the occurrence of VAP	The incidence of VAP in patients receiving Betadine decreased.
<b>Bergmans et al. (2001)</b>	Clinical trial (98 patients)	Decreasing VAP by decontamination of mouth and throat (comparing the effects of Gentamicin and placebo)	The incidence of VAP in the experimental group was lower than the control group (10% versus 31% and 23%).
<b>Jones et al. (2010)</b>	Interventional (before-after)	Investigating the association between tooth-brushing and bacteremia in patients receiving mechanical ventilation	Bacterial growth on the mouth culture was observed in 17% of patients; however, none of the patients showed evidence of bacteremia on the blood culture.
<b>Prendergast et al. (2009)</b>	Descriptive (45 patients)	Investigating the association of oral health with VAP and intra-cranial pressure	Oral health was disturbed after endotracheal intubation and returned to the normal status 48 hours after the removal of the tube. Mouth care did not change the intra-cranial pressure.
<b>McCaughan et al. (2002)</b>	A mixed (quantitative and qualitative) method study	To assess the barriers that nurses feel prevent them from using research in the decisions they make	Nurses had problems in interpreting and using research products, they also perceived a lack of organizational support as a significant barrier. Many nurses felt that research products lack clinical credibility; some nurses lacked the skills needed and the motivation to use research finding.
<b>Pearson and Hutton (2002)</b>	A controlled trial	To measure how effective foam swabs are at removing dental plaque when compared with using a toothbrush	Toothbrushes performed substantially better than foam swabs to remove dental plaque.
<b>Soh et al. (2012)</b>	A cross-sectional survey (124 ICU nurses)	Determining the methods used, frequency, and attitude of nurses toward oral care in patients under mechanical ventilation	Methods for oral care varied between nurses. Cotton swab was the most method used. Nurses had positive attitude toward providing oral care.
<b>Khalifehzadeh et al.</b>	A clinical trial (54 patients)	Assessment of the effects of chlorhexidine swab on the incidence of VAP in ICU	Using chlorhexidine with swab could not significantly reduce VAP in patients admitted in ICUs.

serving materials; swabbing the teeth and mouth mucus membranes; and suctioning of the pharynx. Some of the guidelines were more extended and consisted of methods and frequencies of mouth assessment and ways of using the suctioning catheter (1, 21) while other guidelines were simple with merely the frequency of tooth-brushing (33). Most of the studies recommended tooth-brushing two to three times daily and moisturizing the lips and mouth mucus membranes every two to four hours (8, 21, 27).

### 3.3. Assessment of Nurses' Routine Practice in Terms of Patients' Mouth Care

Most studies highlighted nurses' role in mouth care and 24 papers addressed this area directly. Four studies

assessed the factors influencing on implementation of mouth care (18, 13, 10, 4) and nine studies investigated knowledge, attitude, and performance of nurses in regard to the implementation of this type of care (2, 3, 8, 12, 14, 17, 27, 35, 36). In nine studies, nurse-mediated health promotion strategies or effects of designing and implementing care guidelines on nurses' performance were investigated (9, 13, 15, 21, 23, 29, 32, 34, 37). Several studies reported that nurses did not perceive the importance of mouth care (2, 10, 12, 22). Other studies noted that there were barriers in providing mouth care (3, 17). These barriers included nurses' time limitation, staff shortage, heavy workload, poor supervision, poor teamwork, ineffective training, lack of standard guidelines, and unpleasant nature of the procedure (3, 18, 20). A study reported that the quality of mouth care was associated

with receiving continuous education, nurses' attitude toward the care, managers' supervision, and having enough time, and it was not associated with the years of working experience and available equipment (18). Some studies reported that nurses did not document all aspects of the care [3, 5, 10]. Two studies from America (25) and Europe (3) conducted respectively in 102 and 57 ICUs reported that although nurses valued mouth care, their practice did not support their attitude.

#### 3.4. Equipment Used for Mouth Care

Equipment used for mechanical washing of mouth included toothbrush, swab, and suction machine. A study reported that most ICU nurses limited their routine mouth care to a simple mouth and throat suctioning. In this study, the most prevalent procedure used for mouth care was simple mouth suctioning while tooth-brushing was implemented only in 16% of cases (10). Toothbrush is the most effective tool for removing bacterial colonies and dental plaques (4, 17, 21, 38) and is contraindicated only in patients with coagulation disorders (21). Compared with adult-sized toothbrushes, children-sized ones with a flexible stick are easier to use for providing mouth care in intubated patients (36). Eleven studies investigated the effects of tooth-brushing with a pharmacologic agent (4, 19, 28, 29, 31, 32, 37, 39-42). Moreover, four studies introduced or reported the results of using mouth care protocols and emphasized on the importance of using toothbrush (1, 8, 31, 33, 38). In four other studies, a list of necessary equipment for providing mouth care in patients receiving mechanical ventilation, and the importance of tooth brushing were discussed (4, 16, 21, 23). In seven studies the nurses' mouth caring practice and its frequency were investigated (2, 3, 5, 10, 12, 13, 36). In a clinical trial, the fields compared routine mouth care practice with a once-every-eight-hour tooth-brushing practice method in patients hospitalized in ICU. After a six month period, the number of VAP episodes occurred in intervention and control groups was 0 and 4, respectively (28). However, Munro et al. reported that the occurrence of VAP in patients receiving only tooth-brushing care did not decrease significantly (24). Toothpaste was not used in any of the retrieved studies; instead, tooth brushing was performed using chlorhexidine or other mouth-washing solutions. Oral swab with cotton-like applicator is not a powerful device for removing dental plaques; however, it is useful for moisturizing oral cavity (4, 38). Several studies reported the use of swab for providing mouth care (38, 43-45). An Iranian study reported that oral swab with cotton-like applicator soaked in normal saline was used in more than 69% of cases to provide mouth care (10). Compared to swabbing, brushing for at least two times a day was more effective to prevent pneumonia occurrence (17).

#### 3.5. Materials and Solutions Used for Mouth Care

Normal saline solution: incidence of VAP after application of normal saline in conjunction with chlorhexidine was investigated in only one study; the results showed no significant difference between the intervention and control groups (17, 45). Moreover, in seven studies the usability of normal saline solution or its application by nurses was addressed. However, normal saline solution bears drying effects and, therefore, is not recommended for mouth washing (1, 5, 16, 21, 27, 36). Tap and sterile water: only one study addressed the use of tap or sterile water in mouth care (11). Also, in seven papers tap water was referred to as an appropriate solution for moisturizing and cleaning the mouth, gums and teeth of patients receiving mechanical ventilation (4, 6, 16, 21, 36, 39, 46). Some studies noted that tap water was an appropriate environment for *Pseudomonas* growth; therefore, tap water containers should be small, sterile, and impenetrable with tightly-closed openings which the date of the first use should be written on containers (4, 16). Topical antibiotics: few studies addressed the use and efficacy of topical antibiotics in decontamination of oral cavity (4, 16, 24, 47). However, the use of topical antibiotics may increase the likelihood of bacterial resistance to antibiotics (24). Chlorhexidine: the effects of chlorhexidine in the prevention of bacterial colonization and VAP were addressed in 14 studies among which eight studies reported positive effects of the solution in the prevention of VAP (32, 34, 41, 48-52). However, six remaining studies reported that chlorhexidine, compared to placebo, did not produce significant difference in the incidence of VAP or bacterial colonization (19, 25, 31, 43, 46, 53). On the other hand, some studies confirmed the effectiveness of chlorhexidine in the reduction of respiratory infection in patients undergoing selective cardiac surgery (50, 52); however, the Center for Disease Control and Prevention (CDC) does not recommend routine use of the solution (19). Sodium bicarbonate solution: only one study investigated effects of sodium bicarbonate versus honey solution and reported that oral lesions were more prevalent in sodium bicarbonate group (54). Six studies referred to sodium bicarbonate as a mouth-wash solution; however, inappropriate concentrations of the solution may lead to irritation and destruction of oral mucus membranes (4, 12, 16, 21, 24, 36). Hydrogen peroxide solution: we could retrieve only two original research papers in which diluted hydrogen peroxide for mouth care was discussed (11, 29). In addition, five studies referred to the diluted hydrogen peroxide as a traditional mouthwash solution (4, 16, 21, 23, 24). About 27% of nurses participated in one study also reported the use of the solution for mouth care (6). However, most of the retrieved studies warned about irritation and destruction of oral mucus membranes secondary to multiple use of hydrogen peroxide solution (2, 4, 8, 21). Povidone-iodine (Betadine): long-term use of Betadine was not rec-



ommended because of its absorption to blood through oral mucus membrane, change in normal bacterial flora of mouth, and likelihood of bacterial resistance (4, 16). Only three original studies investigated effects of the solution administration on mouth care (9, 30, 55). Moreover, three studies referred to Betadine as a mouthwash solution (1, 4, 16). Lemon juice and Glycerin: the use of lemon juice and glycerin and also their drying and irritating effects on mucus membranes and teeth were addressed in eight studies (2, 4, 6, 10, 21, 23, 28, 56). In one study (36) 2% and in another (6)19% of nurses reported the use of these solutions to provide mouth care.

#### 4. Conclusion

Despite the importance of mouth care, enough evidence is not available about this care and its implementation method and frequency. There is a consensus among researchers on the association between inadequate mouth care and increased prevalence of VAP (4, 9, 24, 25, 47, 51, 57). However, there is no consensus on the manner, frequency, and appropriate solutions for mouth care in patients under mechanical ventilation. Lack of consensus may be resulted from the lack of well-designed studies. In our study, more than one fourth of the articles were review studies and one third of the research papers were descriptive studies according to knowledge, attitude, and performance of nurses. Several studies reported that tracheal tube, nasogastric tube, and tube-fixating tapes made oral cavity hard-to-access (4, 20, 36). Moreover, nurses were reluctant to perform mouth care worrying about tracheal tube displacement and/or aspiration (20, 36). Several European studies also reported the lack of a standard protocol for mouth care (5, 14, 35). On the other hand, studies showed that developing a caring protocol in conjunction with implementation of continuous education programs could improve quality of mouth care and decrease prevalence of VAP (31, 32, 37, 53). Adequate evidences for best practice protocols were partially provided in only 46% of retrieved studies. However, these studies not only failed to provide an agreed strategy to reach to a consensus on a caring guideline but also highlighted the lack of a standard improving protocol for mouth care of patients receiving mechanical ventilation. Also, lack of reliable evidence resulted in bewildering of nurses and affected their mouth care practices (17). Moreover, different findings reported by different clinical trials may be the result of practical biases, lack of precise monitoring and measuring of outcome variables, and inconsistent treatment methods (25). Therefore, to determine best practice protocols, still there is a need to conduct well-designed large-scale clinical trials. Despite the great importance of mouth care in patients receiving mechanical ventilation, there is no consensus on caring methods, , materials, and equipment . Therefore, investigators should consider mouth care in patients receiving

mechanical ventilation as an important research area and attempt to provide high quality evidences for best practices. Finally, it is noteworthy that the number of studies with including criteria of this study was far beyond the number of retrieved studies; however, complete contents of those articles were not available to the authors.

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#### Authors' Contribution

All authors have participated equally in conception of the study, search of literature, and preparing the manuscript.

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