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Research paper

Impact of an education program on the performance of nurses in providing oral care for mechanically ventilated children

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ABSTRACT

Background: Mechanically ventilated children are prone to pneumonia due to immobilization and lack of laryngeal (cough) reflex and swallowing. Nurses are directly responsible for many clinical approaches used to prevent ventilator-associated pneumonia.
Objective: The research objective is to determine the effectiveness of the nurse education program on the performance of nurses in providing oral care for mechanically ventilated children.
Methods: This quasi-experimental pretest-posttest design was conducted on 100 nurses (50 in each of the control and intervention groups) in pediatric intensive care units (PICU) in Tehran, 2015. The research tools included a demographic form and three checklists for evaluation of performance according to the clinical practice guidelines for the oral health status of children in PICU. Before intervention, the performance of nurses in both groups was observed at three stages and three different shifts, using an observational checklist. After one month, their performance was observed again with the same checklist at three stages and three different shifts in the PICU. The training was done in four 40-50 minute sessions in a workshop with a 4-week follow-up. The Chi-square test, Fisher's exact test, paired t-test, independent t-test, and regression analysis comprised the tools used to analyze the data.
Findings: The mean performance scores of nurses before the education program in the intervention and control groups were 42.8 (±18.5) and 48.7 (±15.7), respectively. These scores improved to 68.6 (±31.4) and 48.6 (±15.4) four weeks after the intervention ($p < 0.001$).
Conclusion: The performance of nurses in providing oral care for mechanically ventilated children improved after the intervention. It is recommended to implement this program for all nurses, regardless of their ward or specialty, based on the clinical practice guidelines. The periodic refreshing in-service training program should be provided to nurses in PICU in order to enhance their performance in providing oral care.

1. Introduction

Oral hygiene has been known to improve children's wellbeing. It is an important part of intensive and critical care nursing because intubated and ventilated children in the paediatric intensive care unit (PICU) are reliant on the healthcare team to realise their everyday basic needs. In the PICU, poor oral hygiene has been related to increased dental plaque accumulation, bacterial colonisation of the oropharynx, and higher nosocomial infection rates, particularly ventilator-associated pneumonia (VAP).[1,2] VAP is the second most frequently occurring nosocomial infection in PICU and common complication in paediatrics and adults.[3–7] Studies have reported the VAP prevalence of 5–32% in PICU.[4,5] Moreover, age is a factor in immunity, thus VAP is a noticeable health risk for hospitalised infants and ventilated children.[8] In Iran, the prevalence of this complication is 21.6% or 9.96 per 1000 days of ventilation.[9] There has been no pertinent study on children in Iran.

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Disease-associated changes in hospitalised children upset the normal balance of oral flora because of changes in oropharyngeal flora from gram-positive to gram-negative microorganisms, which are more pathogenic within the first 48 h after hospitalisation.[10] In mechanically ventilated children, factors such as immobility, lack of laryngeal (cough) reflex and swallowing, nothing by mouth, a naso/orogastric tube, and intake of medications such as antibiotics, inotropes, diuretics, anticonvulsants, anticholinergics, and sedatives lead to VAP in children.[11,12]

The clinical practice guideline for VAP prevention recommends some measures to critical care nurses and physicians, such as nurse-administered oral care.[13] In a study on 34 adult patients under mechanical ventilation, a relationship was reported between the incidence of VAP and oral health status.[2] In another study, the application of oral care in mechanically ventilated patients decreased the prevalence of VAP from 10.4 to 3.9 per 1000 days of ventilation.[14] A study by Behesht Aeen et al. in Iran indicates that 66.5% of critical care nurses in VAP prevention performed poorly in this regard.[15] Elsewhere in the literature, a descriptive study conducted to compare the opinions and performance of critical care nurses regarding oral care in mechanically ventilated adults reported that they ranked oral care seventh among the 10 care priorities, and 20% of them did not perform oral care practices.[16] Therefore, overall, when critical care nurses are overworked and their time is limited, the first practice to be postponed is oral care.[17]

According to previous studies, improvement of knowledge and skills is among the outcomes of nurse education programs.[18,19] Ongoing staffing issues and resource limitations require nurses and healthcare managers to explore creative and innovate care processes and models.[20]

Evidence-based practice is an approach to patient care that involves considering the best evidence from well-designed studies and evidence-based theories with a clinician's expertise and a patient's desires and values in making the best clinical decisions.[21] Guidelines are vital tools in evidence-based practice that help maintain consistency in clinical practice, focus on appropriate usage of resources, and attempt to integrate evidence and clinical judgement and to provide a concentration for continuing education.[22] Clinical practice guidelines are recommendations for critical care nurses regarding the care of patients with specific conditions. Using evidence-based practice tools and guidelines is associated with enhanced care and potentially enhanced outcomes of patients.[23] However, critical care nurses do not always implement these guidelines, and this may result in unsafe practice.[24] Overall, the inability to use guidelines is observed in most areas, which simply indicates that merely providing guidelines does not ensure their usage. This is why individual, organisational, and environmental factors affect implementation.[25] However, only a few research studies have shown that effective intervention improves critical care nurses' performance. The aim of the current study was to determine the effectiveness of an education program on the performance of critical care nurses in providing oral care for mechanically ventilated children.

2. Design

This quasi-experimental pretest–posttest design was conducted on 100 critical care nurses working in PICUs of Tehran teaching hospitals. In this study, all hospitals (n = 5) with PICU in Tehran were selected. Two of them were randomly chosen to be in the intervention group, and the others were in the control group. Among the eligible critical care nurses in the selected hospitals, 50 were placed in the intervention group and 50 in the control group. The control group received usual services, including access to resources and in-service education, while the intervention group underwent a formal and structured education program in addition to the usual service. The inclusion criteria were Bachelor's degree or higher, at least 3 months of work experience in PICU, and clinical experience caring for mechanically ventilated children. Critical care nurses who did not participate in all educational sessions in the intervention group were not included in the analysis.

The demographic questions and checklist to evaluate the performance of critical care nurses in providing oral care for mechanically ventilated children were used for both groups before participation in the study to analyse the baseline data (Time 1; T1) and four weeks after the intervention (Time 2; T2) to measure the performance of the intervention and control groups in terms of care provision that were evaluated again using the checklist administered.

3. Setting and sample

Participants were recruited in Tehran from September 2015 to January 2016. Tehran has five teaching hospitals with PICU (Paediatric Medical Center, Rasool Akram Hospital, Bahrami Hospital, Ali Asghar Hospital, and Mofid Hospital). Each hospital is supervised by one of the city's medical universities and each hospital has one PICU except for the Paediatric Medical Center which has four. Two hospitals have nine beds in each ward, while the other hospitals have seven, 11, and 14 beds (n = 77). Furthermore, all the units have similar nurse–patient ratios (1–2) for ventilated patients as well as non-ventilated patients. In each hospital, an invitation letter was circulated to these critical care nurses and was also posted on the walls of the PICUs, together with the inclusion criteria listed below the invitation letter.

In the PICUs, two of five teaching hospitals with 89 critical care nurses (47 beds) were randomly chosen to be in the intervention group, and the other with 61 critical care nurses (30 beds) were the control group. The researchers chose volunteers in their own workplace to be included in the study. Proportions of staff enrolled in intervention and control groups were 56.2% and 81.9%, respectively. Each PICU had similar organisational and staffing structures that comprised rotating paediatric residents, paediatric critical care fellows, and critical care nurses. The sample size was determined at a confidence level of 95%, power of 80%, and moderate effect size. A sample size of 50 for each group was deemed adequate.

4. Intervention

Participants' performance during the provision of oral care in children receiving mechanical ventilation was evaluated in three stages at different shifts (morning, evening, and night) for 15–35 min. This observation was repeated three times for the pretest and posttest. Three trained critical care nurses completed the checklist in three stages at different shifts (morning, evening, and night) in the PICU. This is while participants of the study were aware of being observed.

The selection was based on the age and teeth developmental stage of mechanically ventilated children (less than 1 year with no teeth, less than 1 year with teeth, and above 1 year). In each stage, the critical care nurses were assessed using the same checklist employed in the first evaluation stage. Yes/No responses were given to items on the checklist. In each stage, scores “1” and “0” were given to the respondents if they were able or unable to perform the given item, respectively. If conducting an item was not required, “not necessary” was selected, and the item was not given any score.

The intervention comprised of a workshop, simulation, and follow-up programs, designed to help improve the education of critical care nurses. The workshop was repeated in three 5-h workshops (one workshop was repeated 3 times), to cover all

Table 1
A summary of intervention content and subjects.

	Goals	Brief description of intervention	Lecturer	Duration (minutes)
Part 1	Assessing the educational needs of nursing Motivating critical care nurses to participate in the study Improving communication within the participations	Assessing and evaluating the critical care nurse's knowledge on oral care for mechanical ventilated children and VAP, stage of oral care and nursing strategies for prevention of VAP in PICU. Group discussion, sharing experiences	A paediatric nurse	20–30
Part 2	Providing information about physiology & anatomy of the mouth and teeth in children Expanding the importance of oral health in children hospitalised in PICU	A brief discussion of the physiology and anatomy of the tooth Explanation of tooth development stages: primary and permanent teeth Expressed general practices, dental care for children A brief discussion about common oral disease in children hospitalised in PICU View images common oral and dental disorders in hospitalised children by PowerPoint	A paediatric dentist & a paediatric critical care Medicine	60–70
Part 3	Providing information about the assessment of the oral cavity Oral assessment tool Practical exercise	Reviewing previous parts and answering questions Holding discussions among participants about previous part Expanding the importance of assessing oral cavity before performing oral care, The introduction of tools to assess children's oral cavity and explain the scoring method Practical training by reviewing pictures Group discussion, sharing experiences Exercise I: To practice oral cavity assessment by tools and on the basis of related images	A paediatric critical care Medicine & a paediatric nurse	60–70
Part 4	Presenting the principles of oral care Providing information about performing oral care in mechanically ventilated children based on the guideline Practical exercise	Reviewing previous parts and answering questions Holding discussions among participants about previous sessions Explaining stage of oral care in three group age: neonates and infants aged less than 1yr with no teeth, infants and children aged less than 1yr with teeth, & children with teeth aged over 1 yr Practicing oral care Exercise I: To practice oral care for mechanically ventilated children Distributing a booklet on oral care	Two expert critical care nurses	60–70
Part 5	Expressed the importance of oral care in the prevention of ventilator-associated pneumonia According to research	The definition of VAP Expression of the prevalence and significance of the mortality in PICU Explaining the diagnosis and treatment methods and costs associated with hospitalisation due to this nursing care for prevention	A paediatric critical care medicine & a paediatric nurse	20–30

PICU = paediatric intensive care unit; VAP = ventilator-associated pneumonia.

staff. Twenty critical care nurses participated in the first workshop, 21 in the second, and 16 critical care nurses in the third. The education program was held in the form of lecture, group discussion, question and answer, practice with moulage, educational film, and finally practical performance by the participants. The same educators were responsible for running the educational program. The education program included the importance of oral and teeth health in children with regards to teeth growth physiology, methods for examination, and evaluation of oral cavities in hospitalised children using standard instruments.[26–29] Furthermore, importance of oral care in mechanically ventilated children, specifically for VAP, and the stages of oral care for mechanically ventilated children also included (Table 1). Two educational packages were given to the critical care nurses in the intervention group at the end of the educational sessions, including (1) educational and (2) oral care equipments.

The contents included a booklet along with visual files, as well as a video clip for the educational program. Subsequently, at the end of the workshop for the intervention group, researcher has created a 50 × 70 cm poster to be displayed in rest areas. The aim was to encourage consistent training and remind critical care nurses of educational points. A nurse was then selected from each ward to act as a link between the researcher and the rest of the critical care nurses in the intervention group to inform the researcher if they needed more oral care supplies.

The second package included the minimum oral care supplies needed for providing children with 1-month-long oral care including 20 toothbrushes (Size 0 and Size 1), one toothpaste, one lip-lubricating ointment, and one chlorhexidine gluconate 0.2%. The participants were provided with more oral care supplies, if needed, until completion of the intervention. The quality and type of oral care supplies were approved by the workshop lecturers before making a purchase. To homogenise the conditions in the intervention and control group, the second package, excluding the educational materials, was distributed among the control group to avert poor oral care provision due to lack of oral care supplies.

Four weeks after the last training session, all participants' performances during the provision of oral care in children receiving mechanical ventilation were evaluated once more via checklist in three stages at different shifts (morning, evening, and night) by the same researchers. The control group only received a package but no training during the same period of time and underwent exactly the same tests. Therefore, each item of measuring the critical care nurses' performance was scored by three yes/no items, and each item was given a score of 0 (No) or 1 (Yes) in the pretest and posttest. During those 4 weeks after intervention, the researcher

also called all participants once a week to remind them to practice according to the procedure and to answer any potential questions regarding the content of the educational package. The intervention components are described in detail in Table 1.

5. Data collection

Sociodemographic information questionnaire: Participants completed the questionnaire, including critical care nurses' information such as age, sex, education level, and years in practice at the time of enrolment.

Drafting the checklist: This study required drafting of a checklist to evaluate the performance of critical care nurses in providing oral care in mechanically ventilated children based on the clinical practice guidelines.[26] Some researchers have acknowledged that tools such as checklists can increase adherence to evidence-based practice guidelines.[30] The effectiveness of using clinical practice guidelines in the reduction of ventilator-associated infections has been suggested in a study on adults.[19] The checklist was developed for three age groups and according to the teeth development chart of the children: (i) infants aged less than 1 year with no teeth; (ii) infants aged less than 1 year with teeth; and (iii) children aged above 1 year with teeth. The checklist used in this study was developed by the research team according to the clinical practice guideline.[26] The checklist is composed of two parts; the first part consisted of the general procedure with five items (e.g., explain the procedure, tilt the head of bed, wash hands, don disposable gloves, and inspect child's mouth). The second part consisted of three sections; the first section was to assess wiping of the gums and mucosa in newborns and infants with one item. The second section contained eight items (e.g., frequency of brushing teeth, use of suction, use sterile water, rinse toothbrush, apply lubricant, etc.). The third section contained 10 items (e.g., prepare solutions/mouthwash required, at 45° angle; use and frequency of swabbing; storage, rinsing, and replacement of suction devices, etc). The total score of this tool is between 0 and 24, while a higher score indicates good performance, and a lower score indicates failure to comply with clinical guidelines.

A panel of experts was recruited to validate the content and face validity of the checklists.[31] The panel comprised of 16 specialists including faculty members of the nursing and midwifery universities in paediatric (n = 4), intensive care (n = 1), and paediatric intensive care (n = 1); critical care nurses with master's degrees in nursing and more than 10 years of work experience in PICU (n = 4); and physicians with fellowships in PICU (n = 6). The panel of experts was selected based on their knowledge and experience in the field of PICU. The scientific, feasibility, rationality, and simplicity aspects of the educational booklet were checked and confirmed by the members of the expert panel. A few changes were made in the sentence structure and wording of the items in the instrument

To measure the tool's reliability, the evaluation of agreement between observers was used. In this way, the performance of 15 critical care nurses was evaluated simultaneously by the researcher and the assistant researcher. Cohen's Kappa score was additionally used to analyse the homogeneity of each checklist variable. The obtained correlation coefficient (0.78) indicated the interobserver reliability. Values above 0.70 indicate a sufficient consistency of the data. Based on Cohen, the value of 0.60 is minimally acceptable, and values of 0.75 or higher are very good.[31]

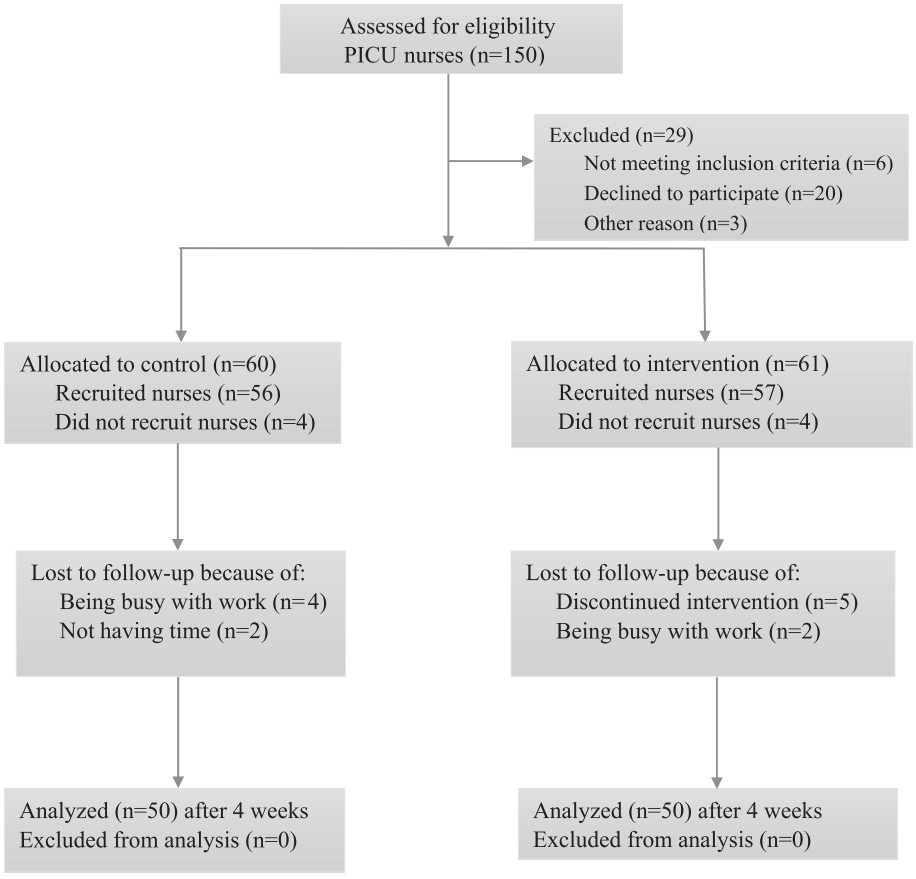

Fig. 1. Diagram of the participants' enrolment in the study.

Table 2
Critical care nurses characteristics in the intervention (n = 50) and control (n = 50) groups.

Individual characteristics	Intervention	Control	*p*-value
Age (y), mean (SD)	31.20 (5.50)	34.91 (5.50)	p < 0.001
Gender, n (%)			0.500
Male	2 (4)	3 (6)	
Female	48 (96)	47 (94)	
Level of education, n (%)			0.372
Bachelor's degree	45 (90)	42 (84)	
Master's degree	5 (10)	8 (16)	
Shifts worked, n (%)			0.488
Fixed	9 (18)	8 (16)	
Rotating	41 (82)	42 (84)	
Nurse experience (y), mean (SD)	6.50 (4.51)	9.50 (6.60)	0.010
Nurse experience (y) in PICU, mean (SD)	4.94 (4.24)	6.18 (5.13)	0.191
Oral health education prior to the study, n (%)			0.008
Yes	22 (44.9)	10 (20)	
No	27 (55.1)	40 (80)	
Use of oral care protocol, n (%)			p < 0.001
Yes	40 (80)	21 (42)	
No	10 (20)	29 (58)	
Interval oral care, n (%)			p < 0.001
1–2 hourly	1 (2)	1 (2.4)	
3–4 hourly	40 (81.6)	2 (4.9)	
>5 hourly	8 (16.4)	38 (92.7)	

PICU = paediatric intensive care unit; SD = standard deviation.

6. Data analysis

All statistical analyses were performed using the Statistical Package for Social Sciences, version 18 (SPSS Inc., Chicago, IL, USA). The chi-square test was performed when comparing independent groups for nominal data and student paired and unpaired *t* tests on continuous data and multiple regression analysis at the significance level of $p < 0.05$.

7. Ethics

This study was approved by the ethics committee of Iran University of Medical Sciences, and the researchers abided by the Helsinki Declaration. The critical care nurses provided informed verbal and written consent. The information letter contained the purpose of the study and stressed confidentiality of the collected data, the voluntary nature of the study and the possibility of withdrawal at any point during the trial (the right to quit the study). All educational contents were given to the control group by the end of the study. This study was registered in the Clinical Trial Registration Center under code no. IRCT2015070423054N1.2.3.4

8. Results

The flow chart of participants is displayed in Fig. 1. The demographic information of participants is summarised in Table 2.

Table 3
Comparisons of means and SDs of critical care nurse's oral care performance score in the intervention (n = 50) and control (n = 50) groups at preintervention and postintervention.

Intervention	Intervention Mean (SD)	Control Mean (SD)	*p*-value
Preintervention	42.8 (18.45)	48.6 (15.73)	0.090
Postintervention	68.6 (32.43)	48.6 (15.41)	p < 0.001
p-value	p < 0.001	0.961	

PICU = paediatric intensive care unit; SD = standard deviation.

The participants' age ranged from 25.7 to 36.7 years in the intervention and 29.4–40.4 years in the control group, respectively.

The results showed that the research samples were homogeneous in terms of gender, educational level, nursing experience, and work shift; however, this was the opposite in terms of age, use of oral care protocol, and interval oral care. Among all participating critical care nurses, approximately 95% were female, more than 84% had a bachelor's degree, all had more than 5 years of work experience in PICU, and 83% had a rotating shift schedule (Table 2).

According to the results from the application of regression analysis on inhomogeneous variables, as well as preintervention and postintervention performance scores of critical care nurses, there was no significant difference between the two groups.

According to the paired *t* test, there was a statistically significant difference between the mean performance scores of the intervention group before and after the implementation of the education program ($p < 0.05$); however, there was no statistically significant difference between the mean performance scores of the control group before and after the implementation of the education program ($p > 0.05$; Table 3).

The independent *t* test did not show any statistically significant difference between the performance scores of critical care nurses in the intervention and control groups ($p > 0.05$); however, results from this test 1 month after the implementation of the education program showed a statistically significant difference between groups in the mean performance scores ($p < 0.05$; Table 3). In the intervention group, 82% of participants scored lower than 50% prior to the implementation of the program. Fifty percent of participants scored higher than 75% after the implementation of the program ($p < 0.05$). According to the checklist of children over 1 year, only 17% of critical care nurses used chlorhexidine correctly and uses a medical flashlight, whereas this rate increased to 70% after the education program.

9. Discussion

These results demonstrate that the intervention appeared to be effective because the increased score of critical care nurses' performance was statistically significant after 1 month of participating in the education program. This finding is consistent with the findings of other studies.[18,29,32–34] Implementation of the oral care education program improved evidence-based oral care practices by critical care nurses and by extension the patients' oral health status.[19]

Among the significant results of the present study, there was a considerable increase in the frequency of applying a toothbrush as an oral care practice for mechanically ventilated children. Before implementation of the program, critical care nurses did not use a toothbrush, whereas this rate increased to almost 65% in the intervention group after implementation of the program. However, we did not find this result in the control group; whereas, we provided homogenised conditions in both the intervention and control group. In this study, basic oral care equipment was bought and given to the critical care nurses in both groups. A study conducted in 2014 in Australia showed that 38% of critical care nurses used a toothbrush when performing oral care on ventilated patients.[34] Another study conducted in Iran showed that only 16% of critical care nurses used a toothbrush for their patients.[35] Result of a study showed the effect of using a toothbrush in reducing the incidence of dental plaque and VAP.[36]

In this study, increased number of the critical care nurses used a medical flashlight in the intervention group after the education program. According to the clinical practice guidelines, oral examination with a medical flashlight should be carried out to examine the chance of bleeding before providing oral cavity care. Some

previous studies highlighted the importance of regular oral examination.[11] In addition, the clinical practice guideline recommends oral examinations before providing care services to select suitable instruments and determine the frequency of oral care.[25]

Although the majority of critical care nurses performed lip lubrication on children, it increased in number after the implementation of the education program. This improvement reflects the simplicity of its practicality and the critical care nurses' genuine concern for providing children with a sense of comfort. According to the clinical practice guidelines, children aged above 1 year with teeth should receive chlorhexidine gluconate, which was applied correctly by few critical care nurses.

The findings of this study showed that the availability of sufficient equipment (toothbrush, chlorhexidine gluconate 0.2%, lip-lubricating ointment) in PICU could improve the provision of oral care by critical care nurses. However, this improvement depends on the knowledge and positive attitude of the staff. Despite providing both groups with oral care supplies, no change was observed in the technique and type of equipment used by critical care nurses in the control group.

Among the limitations of this study was the need for direct observation of the critical care nurses' performance: most importantly, the effect of the "observer" on the "observed". Critical care nurses who are aware they are being observed may alter their performance, introducing the Hawthorne effect bias.[31] To address this limitation, the observer attended the wards in different shifts and stayed there for 2 to 3 h. This measure made the observer's presence normal and reduced its effect, allowing the observer to observe the actual performance of the critical care nurses. Among other limitations of this study was the few number of critical care nurses who provided oral care for ventilated children aged below 1 year with no teeth; therefore, further studies with a larger sample size are recommended. The short duration of the study was another limitation, as institutionalisation of fundamental changes in people cannot be achieved in a short period of 1 month. Therefore, it is better to offer education and feedback continuously and periodically. In this study, we used a convenience sampling method, and representation of the general population was limited. We recommend an educational program that reinforces the role of oral hygiene in the prevention of nosocomial infections among mechanically ventilated premature neonates, one that teaches strategies for delivering the best care. Moreover, the periodic refreshing in-service training program, multifaceted educational interventions, and follow-up programs are necessary to foster change from initiation to outcome.

To the best of our knowledge, this is the first study on oral care practices in paediatric critical care. The results of this study suggest that it is necessary to educate PICU professionals. The educational program based on the clinical practice guidelines demonstrated an improvement in the quality of oral care provided for ventilated children as indicated by the performance scores. In addition, providing critical care nurses with sufficient supplies can improve their performance in care provision.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.aucc.2018.06.007.

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