Effect of Implementing Educational Program about Preventive Nursing Measures of Medical devices related Pressure Injuries on Nurses' Performance and Patients' Clinical Outcome

Safaa Eid Sayed [1] , Hamdya Ahmed Ali [2], Sameh Kamel El maraghi[3], Shereen M. Diab [4]

[1,4]Assistant Professor of Critical Care Nursing, Faculty of Nursing, Tanta University

[2] Assistant Lecture of medical surgical-critical care nursing at Beni suief University

[3]Professor of Critical Care medicine Faculty of Medicine at Beni suief University

Abstract

Background: Medical Device-Related Pressure injury are skin breakdowns related to certain medical devices**. Aim:** Evaluate the effect of implementing educational program about preventive nursing measures of medical devices related pressure injuries on nurses' performance and patients' clinical outcome. **Design:** Quasi-experimental research design. **Setting:** Surgical Intensive Care Unit of Emergency hospital at Tanta University. **Subjects:** two samples included all nurses (70 nurses) and Purposive sampling of 60 adult critically ill patients who admitted to the previous mention settings and divided into two groups 30 in each. **Tools:** Three tools were used for data collection. Tool (I) demographic characteristics of nurses and nurses 'knowledge about MDRPI. Tool (II) Nurses' observational checklist. Tool (III): Patient' clinical outcome Assessment. **Results**: A highly significant improvement of total mean score of studied nurses' knowledge and practice immediately and post 3 weeks of educational program implementation compared to pre-program with P= 0.00. Also 30.0% of patients of control group had oral mucositis in lips compared to only 3.3% of study group on 2nd week of program implementation. **Conclusion:** Significant improvement of the total means score of nurse's knowledge and practices were observed at immediate phase. However this improvement was reduced by time. Oral mucositis and stages of pressure injury were decreased significantly among intervention group. **Recommendation:** Encouraging nurses to participate in seminars, conferences and workshops about MDRPI. Replication of study on large sample .

Key Words: Preventive nursing measures, Medical devices related Pressure Injuries, Nurses performance.

Introduction

Medical devices in Intensive Care Units provide therapeutic care for critically ill patients. However, these devices have the potential to harm their users by applying prolonged pressure for an extended period of time to any part of the body including mucosal cavities. Pressure injuries that occur as a result of medical device differ from the immobilization-related pressure injuries. It occurs around or under the medical devices and typically takes the shape of these devices. These Pressure injuries can progress to full-thickness ulcers due to the absence or reduction of adipose tissue in the ulceration sites [(1)].

Pressure injuries (PIs) caused by medical devices are serious health problems for severely ill patients. It is estimated that more than 30% of pressure injuries is caused by medical devices. They are more common than other pressure injuries [(2)]. A study conducted in Egypt, found that the incidence of endotracheal tube (ETT) related PIs was 90% and the prevalence of PIs associated to nasogastric tube (NGT) was 77.8% [(3)].

The neck and face are the area's most frequently affected by medical device related pressure injuries (MDRPI). It may be caused by improper devices securement, poor visualization of the

underlying tissue, nurses' workload and lack of practice guidelines. The majority of these pressure injuries are caused by endotracheal and nasogastric tubes [4]. Previous research studies have shown that, medical device pressure injuries affect 24% to 34.5% of patients admitted into intensive care unit(ICUs), and 30% to 70% of them were caused by respiratory-related medical devices in intensive care units [5].

Furthermore, critically ill patients are at higher risk to experience MDRPI for a variety of reasons, such as malnutrition, severe neuropathy, decreased tissue perfusion, immobility, sedative medications and increased use of supportive medical devices in the ICUs [6]. The pressure, heat and humidity produced by medical device itself alter the skin's microenvironment. These devices frequently need to be secured firmly to ensure a good seal which leads to pressure being created in unexpected places rather than bony prominences. It could be challenging to evaluate the underlying skin beneath the device due to the materials used to secure it, such as tape or straps [7].

The appropriate preventive measures of pressure injuries related medical devices present a special challenge for critical care nurses. They should had knowledge and practice about examination of the skin around and underneath the device, stage of pressure injuries, techniques of device securement to prevent dislodgment, and following the manufacturer's instructions for applying and removing this device [8].

The preventive nursing measures should be designed in accordance with the evidence based practice. The preventive measures of PI related to endotracheal tube include; applying the proper technique of securement as avoiding tying the tape of the endotracheal tube fixation under the head and fixing it away from the angle of the mouth, repositioning of the endotracheal tube every two hours, avoiding over tightening the tube knot, using regular saline solution to care for the patient's mouth, and using the endotracheal tube for no longer than three weeks before considering tracheostomy [3,9] .

Additionally, preventive measures of nasogastric tube PI including using fine pores nasogastric tube particularly for feeding, appropriate nasogastric tube taping techniques, offering nasal care with warm distilled water, wetting the adhesive tape with warm water before removing, changing tapping daily, and performing a thorough inspection and assessment of the nares of the nose [3,10].

Finally, the educational program to conduct this study consists of planned educational activities and coordination of various teaching and learning activities to give nurses comprehensive knowledge, more effective training and new information for nurses that they can use to enhance care and patient outcomes. Therefore this study's aim to evaluate the effect of educational program about preventive nursing measures of medical devices related pressure injuries on nurses' performance and patients' clinical outcome[11].

Significance of the study

Based on clinical observations at Tanta University Hospital, it was noticed that pressure injuries caused by medical devices are serious issue among critically ill patients that are neglected by health and nursing staff. Pre-existing illness associated with pressure injuries have the potential to worsen health and effect on patients' outcomes.The Previous study has

been indicated that medical device pressure injuries affect more than one third of patients, and 70% of them were caused by medical devices in ICU [5]. Therefore nurse's educational program about preventive measures of medical devices related pressure injuries is very important to decrease these complications and improve patients' clinical outcome [12].

Aim of the study:

To evaluate the effect of implementing of educational program about preventive nursing measures of medical devices related pressure injuries on nurses' performance and patients' clinical outcome.

Hypotheses

H1: Mean score of nurses' knowledge and practice are expected to be increased after implementation of the educational program about preventive nursing measures of medical devices related pressure injuries.

H2: incidence of medical device-related pressure injuries are expected to be decreased among intervention group who received preventive measures of medical devices related pressure injuries.

Subjects and Method

Study design: - A quasi- experimental research design.

Study Setting

This study was carried out in Anesthesia Intensive Care Unit of Emergency Hospital at Tanta University which included 4 wards with 20 beds.

Subjects

The study's sample included the following:

1. All of the (70) critical care nurses who are working in the previously mentioned settings.

2. Purposive sampling of 60 critically ill patients. The sample size was calculated based on Epi-info program according to the total population admitted to Intensive Care Units yearly (200 patients admitted per year). They were divided into two equal groups; 30 patients in each. Control group received hospital routine of endotracheal and nasogastric tube care and study group received preventive nursing measures of medical devices related pressure injuries. The Inclusion criteria as the following:

The inclusion criteria

- Adult patients aged from 21-60 years old of both sexes
- Newly admitted critically ill patients with endotracheal or nasogastric tube.
- Patients with ulcer or trauma in (lips, nose and mouth) from any causes rather than medical devices will be excluded.

Tools of data Collection

Three tools were utilized to collect pertinent data.

Tool I: Nurses ' knowledge about Preventive Measures of Medical Devices related Pressure Injuries: It was developed by the researcher based on reviewing recent relevant literature[8,11,12], it included two parts:

Part (1): Demographic Characteristics of the Studied Nurses: it was used to assess nurses' demographic data as age, sex, educational level, experience in years and previous educational sessions about medical devices related pressure injuries.

Part (2): Nurses ' knowledge about Medical Devices related Pressure Injuries: This part covered items geared towards eliciting critical care nurses' knowledge regarding preventive measures of ETT and NGT related pressure injury and are distributed into seven main domains including the following:

-Skin anatomy and definition of PIRMD (4 questions), risk factors (9 questions), signs, symptoms and complication of medical devices related pressure injury (7 questions), the most affected site and most common device cause PIs (2 questions), ETT insertion(6 questions), preventive measures of ETT related pressure injuries (10 questions) and preventive measures of NGT related pressure injuries (12questions).

Scoring system included the following: Two points were given for each complete and correct answer, complete response was given one point and incorrect answer was given zero. The total score more than 80% was considered high level of knowledge, score 80% - ≥ 60% was considered moderate level of knowledge and less than 60% were considered low knowledge level.

Tool (II): Nurses' Observational Checklist about Preventive nursing measures of Medical Devices related Pressure Injuries [3,4,9] . The researcher created this tool after reviewing pertinent literature to assess nurses' practice regarding preventive measures of endotracheal and nasogastric tube related pressure injury. This tool was distributed into 5 domains related to ETT and 5 domains for NGT including the following:

-Appropriate techniques for skin assessment around the ETT 5 items, reposition the endotracheal tube every shift (4 items), ETT related skin care (8 items), technique of ETT securement (9 items), Mouth care (4 items), appropriate techniques for skin assessment around the NGT (5 items), Skin Care and fixation of NGT (7 items), re-insertion of new NGT (9 items), hydration and nutrition (5 items) and post care and documentation (4 items).

-Each item in checklist was scored as the following: correctly and fully completed step was received score (2), correctly and partially completed step received scored (1) and incorrectly step was scored (0). The nurses' practice total scoring system was calculated and categorized as follows: less than 80% deemed unsatisfactory, while between 80% and 100% deemed satisfactory.

Tool (III): Patients' Outcome Assessment Tool: It included 3 parts:-

Part (I): Patients' Bio-demographic Characteristics: It included patient 'age, gender, diagnosis, past medical history and level of consciousness.

Part (2): Pressure Injury Staging System Checklist (PISS): This tool was developed by the National Pressure ulcer Advisory Panel (NPUAP, 2016) [13] and it was used to assess skin condition and detect if any endotracheal and nasogastric tube related pressure injury occurred in any patients, and, if so, to what degree. It consisted of six items and each item was checked for presence: yes (1) or no (0). The scale ranged from 0–6: The scoring system as the following:

- Score (0): indicated free from pressure ulcers.
- Score (1) indicated stage one: non-blanchable erythema of intact skin.
- Score (2) indicated stage two: partial-thickness skin loss with exposed dermis.
- Scores (3) indicated stage three: full-thickness skin loss.
- Score (4) indicated stage four: full-thickness skin and tissue loss.
- Score (5) indicated unstageable pressure ulcer: obscured full-thickness skin and tissue loss.

- Score (6) indicated deep tissue pressure ulcer: persistent non blanchable deep red, maroon or purple discoloration.

Part (3): Oral Assessment Guide (OAG) scale: This tool was adapted from **Al Sebaee & Elhadary (2017)** [14] to suit study aim. It was used to measure changes of oral condition as regards lips and tongue mucosa.

Scoring system

- Score (1) indicated normal findings of healthy oral mucosa. Score (2) indicated moderate oral mucositis. Score (3) indicated severe abnormality with compromise of either mucosal integrity or loss of function (severe oral mucositis).

Method

The following steps were taken to complete the study

1-Administrative process

The director of Tanta Emergency had been informed of the study's official approval, which was received from the appropriate authorities at Tanta University's Faculty of Nursing.

2- Informed consent

- A written informed consent was obtained from each conscious adult patient or from responsible person who is the first relative and the medical attorney (if unconscious patient) after explaining the purpose of the study and confidentiality was preserved.

- Nurse's informed consent to participate in the study was obtained after explanation of the objective of the study and confidentiality was preserved.

3-Ethical considerations

- Using code number rather of participant's name and allowing him to leave at any time of the study maintain the privacy and confidentiality. Nature of the study didn't cause any harm or pain.

-The researcher assuring anonymity and confidentiality of subjects' data.

-The ethical committee consent was obtained from the Faculty of Nursing, Tanta University with code (97-9-2022).

4- Tools development

Three tools were used in this study, two tools were developed by the researcher after reviewing related literature; Tool (I), Nurses' knowledge about Preventive Measures of Medical Devices related Pressure Injuries. and was divided into two parts: Part (1): demographic characteristics of the studied nurses, Part (2): Nurses' knowledge about Preventive Measures of Medical Devices related Pressure Injuries. Tool (II) included Nurses' observational checklist about preventive nursing measures of medical devices related Pressure Injuries.

-Tool (III): Patients ' clinical outcome assessment tool. It was divided in to three parts: Part (1): Bio-demographic Characteristics of the studied patients part (2) Pressure Injury Staging System Checklist (PISS) and part (3) Oral Assessment Guide (OAG) scale**.**

5-Pilot study: It was conducted on 10% of the study participants (six patients and seven nurses) to test the tool's relevance, clarity, and organization, as well as to determine how long it would take to collect data from each patient and nurse. The pilot study sample was included in the actual study science a minor modification was done.

6- Content Validity of the tools

- The developed tools (I and II) were translated into Arabic, was tested for clarity and applicability and tested by seven experts from the Faculty of Nursing

and three from the Faculty of Medicine of University of Tanta to ensure their validity

- A concesus approach with experts in critical care was used to confirm the validity of the modified questionnaire.

7- Reliability of the tools

- The Cronbach Alpha was used to find out internal consistency developed tools both knowledge tool reliability was (0.85), practice (0.75) to confirm the reliability of the questionnaire by test-retest on two occasions of the pilot of the instrument on the same population, and the cronbach alpha were greater than the recommended value of 0.7.
- Tool (III) part 2: Pressure Injury Staging System Checklist (PISS), its reliability (15) was in between 72.1 and 77.1. Part 3: Oral assessment guide scale was tested by Cronbach Alpha; its reliability was in between 0.79 and 0.84.

8- Data collection

Data were gathered from the beginning of June to the end of December 2021 across a six-month period. The researcher stared the interview by introducing herself after providing an explanation for the purpose and the nature of the study. To avoid data contamination, the researcher began with the control group before moving on to the study group. Each nurse was interviewed individually to fulfill the sheet questions. Each interview for the nurse lasted for about 20-30 minutes to complete the tools and 15-20 minutes for each patient. The study was conducted at four phases.

9- Phases of the study

1- Assessment phase: -

- Through meetings with ICU nurses, data collected by the aforementioned tools to evaluate nurses' knowledge and practice about MDRPI preventive nursing measures. The researcher gave each nurse the knowledge questionnaire sheet to answer it. Also, the researcher observed each nurse individually during their work in morning and afternoon shift to assess their practice.
- Regarding patients, an initial assessment of endotracheal and nasogastric tube carried out on the first day after intubation for studied patients by using tool III before implementing the educational program. Filling the patient assessment tool from the patients' medical record and assessment of skin was done by the researcher from the first day of intubation and continue every day for two weeks.

2. Planning phase. Setting the specific objectives of the educational program about preventive nursing measures of medical devices related pressure injuries. The content was prepared to meet the aim of the study. An illustrated booklet prepared and written in simple Arabic language. The booklet was revised by experts in critical care nursing field and was distributed to all nurses of the study. Different teaching methods were used as booklet, video, group discussion and PowerPoint, demonstration and re-demonstration. The control group received hospital routine care which included only change adhesive tape of ET|T and NGT.

Expected outcome

1. Improve of mean scores of nurses' knowledge and practice about preventive nursing measures of medical devices related pressure injuries after implementation of the educational program
2. Decrease incidence of medical device-related pressure injury among intervention group who recieved preventive measures of medical devices related pressure injuries

3. **Implementation phase:** The educational program was conducted in five sessions to nurses who divided into seven subgroups, ten nurses in each group and sometimes to three nurses according their endorsement shifts distribution to maintain nurse patient ratio 1 to 1 and according to patient critical condition, four days per week.. The researcher was attended the sessions that was scheduled in the morning. The time for each session will be about 20- 30 minutes. The researcher implemented the educational program for all study subjects as the following:-

   The first part: theoretical part; three sessions was used for three consecutive days and 30 minutes for each one.

- **Session one:** Focused on explaining the aim of the study, definition of pressure injury related to medical devices, risk factors contributing to pressure injury and risk assessment.
- **Session two:** Focused on signs and symptoms of pressure injuries, Pressure injury staging system and representation of most common disorder and complications associated with pressure injury.
- **Session three:** Focused on preventive measures of device related pressure injuries. Each nurse was given with the knowledge booklet and printed materials with guidelines after each session. During the classes, nurses were encouraged to ask questions and provide feedback. Communication kept open between the researchers and the nurses.
- **For the practical part:** Two sessions were used for two consecutive days and 30 minutes for each one.
- **Session four**: Focused on preventive nursing measures of endotracheal tube (ETT) related pressure injury which includes; appropriate techniques for skin assessment and inspection around the endotracheal, reposition the endotracheal tube every shift (right, middle, left), provide mouth care, applying and removing transparent adhesive tape, technique of Twill fixation of endotracheal tube and confirmation of tube position for endotracheal).

4. **Evaluation phase:** the evaluation was done by using Tool I, II for nurses three times pretest, immediate after program implementation and follow up 3 weeks and Tool III for patients and compared them with control group who received routine care every day for two weeks.

Results

Results are presented in the following order: The first section is devoted to the description of distribution of the studied nurses according to their demographic data, their knowledge and practice about preventive measures of endotracheal and nasogastric tube related pressure injury. (Table 1- 4). The second part covered correlations between total nurses' knowledge and their practice (Table 5). The third section covered distribution of the studied Patients according to socio demographic and clinical data, oral assessment guide scale and Pressure injury staging system checklist related to endotracheal and nasogastric tube (Table 8-10).

Table (1): illustrates the distribution of the studied nurses according to their socio–demographic characteristics.

Regarding age, It was found that 77.1% of studied nurses were between the age of 21-<30 years and the mean age for them were 27.61±5.572. It can also be noted that that more than half of the studied nurses (54.3%) were female. Moreover, it was found that the majority of the studied nurse

(80%) had technical institute of nursing and the mean years of experience inside ICU were 4.01±6.579 year. Concerning nurses' previous training program, the present result concluded that all participant (100%) nurse not attend any training program about medical devices related pressure injury

Table (2): shows mean score and standard deviation of the studied nurses' knowledge in relation to seven main domains about medical devices related pressure injury throughout phases of study.

A significant decreased of total mean score of nurses knowledge (29.31±6.779) was found pre implementation phase related domain of (skin anatomy and definition of pressure injury related to medical devices, risk factors, signs, symptoms and complication of pressure injuries, the most affected site and most common device cause PIs, ETT insertion, preventive measures of ETT and NGT related pressure injuries. However, significant improvement of total mean score (44.90±4.115) was observed at immediate phase of program and relatively reduced in mean score (43.33±4.204) post 3 weeks of program with p= 0.000

Figure I: displays the nurse's distribution in accordance to their total knowledge level about medical devices related pressure injury throughout phases of study.

This figure revealed that the majority of the studied nurses (74.3%) had low level of knowledge preprogram implementation compared to 64.3% and 72.9% of them had moderate level of knowledge score immediately and post 3 weeks of program implementation respectively. Moreover, A highly significant differences were found among all studied nurses regarding their total level of knowledge pre, immediately and post 3 weeks of education program with P= 0.00.

Table (3): illustrates mean score and standard deviation of the studied nurses' practice of domains about medical devices related pressure injury throughout phases of study.

A significant decreased of total mean score of nurses' practice was noted pre implementation phase related to domain of appropriate techniques for skin assessment around the ETT, reposition the endotracheal tube, ETT related skin care, technique of ETT securement, mouth care, appropriate techniques for skin assessment around the NGT, skin care and fixation of NGT, re-insertion of new NGT, hydration and nutrition and post care and documentation. On the other hand, this table revealed a significant improvement of mean score of the same domain at immediate phase of program , however there was a relative reduction in mean score post 3 weeks of program with P=0.000.

Table (4): Shows distribution of the studied nurses according to their total level of practice about medical devices related pressure injury throughout phases of study. it was noted that, the vast majority of nurses (94.3%) had unsatisfactory level of practice preprogram implementation compared to more than half of them (57.1% and 51.4%) had satisfactory practice immediately and after 3 weeks of program implementation respectively with a significant difference was observed where p =0.000**.**

Table (5): illustrates a highly statistical significant correlation between the study nurses' overall knowledge score and their

practice score throughout the intervention periods (pre, immediately and post 3 weeks) where P= 0.000

Table (6): demonstrates the demographic characteristics of the studied patients.

It was noticed that 40% of the control and study groups were in between the ages of (50-60) years with the mean age of 45.07±12.27 and 43.87±12.43 respectively, more than half of them (60%, 53.3%) were male and only 20% of patients in both groups were smokers with no statistical differences was observed at P >0.0

Table (7): shows distribution of the studied patients according to their clinical data

Concerning diagnosis, it was found that more than one third of control group (43.3%) and near one third of the studied groups (30%) had neurological disorders. In relation to past medical history of previous disease, more than one quarter of control and study groups had respiratory disease respectively (26.7%) followed by renal disease for study groups (20%). Regarding level of consciousness, it was observed that, more than one third (33.3%, 36.7%) control and study group respectively was semiconscious.

Table (8): reveals distribution of the studied patients according to their Oral Assessment Guide (OAG) scale throughout periods of study.

It was found that near to one third of control group (30.0% and 26.7%) had severe oral mucositis of lips and tongue respectively compared to only 3.3% of the study group on second week post program implementation. Conversely, 36.7% and 50.7% of study group had healthy mucosa of lips and tongue compared to only 3.3% and 23.3% of the control group on second week post program implementation respectively with a highly significant difference was observed between control and study group regarding to oral assessment scale with P= 0.00

Table (9): illustrates distribution of the studied patients according to the endotracheal tube related to Pressure injury staging system (PISS) checklist throughout periods of study.

This table revealed that, all studied patients had normal ETT related PISS scale on admission, the most frequent stage that had been occurred was 1st stage Pressure injury post one week from admission where more than half of control groups had Pressure injury at back of neck (53.3%), Cheek (60.0%), Ear loop (50.0%) and Helix (56.7%) compared to 43.3%, 50.0, 53.3% respectively in the study group. Additionally, the most sites affected by1st stage Pressure injury in control group post 2 week were ear loop (50%), and Helix (63.3%) compared to ear loop, back of neck, cheek and angle of mouth (66.7%) for study group post 2 week from admission, also a significant differences were observed among control and study group regarding to ETT related PISS scale for which P= 0.000

Table (10): shows distribution of the studied patients according to Nasogastric tube related Pressure injury staging system checklist throughout periods of study.

Regarding nairs**,** this table revealed that, more than half (66.7%) of the control group had 1st stage of pressure injury post one week compared to 46.7% of the study group. On the other hand, 67.0% of study group had normal nairs compared to only 3.3% in control group post 2weeks.

Significant differences were observed among the study and control group about nairs related pressure injury in which P < 0.000.

Concerning to nose tip, this table showed that more than half (60 %) of the control group compared to 53.3% of study group had 1st stage of pressure injury at nose tip post one week. while 53.3 % of the control group had 2nd stage pressure injury compared to no patient in the study group. Also this table illustrated that significant differences were observed among the studied and control group pressure injury respectively in which = P 0.000

Table (1) Percent distribution of the studied nurses according to their socio–demographic characteristics (n=70).

Characteristics	The studied nurses (n=70)	
	N	%
Age (in years)		
▪ (21-<30)	54	77.14
▪ (30-<40)	12	17.14
▪ ≥40	4	5.72
Range	**(21-42)**	
Mean ± SD	**27.61±5.572**	
Gender		
▪ Male	32	45.7
▪ Female	38	54.3
Educational level		
▪ Technical Institute of nursing	56	80.0
▪ Bachelor degree in nursing.	14	20.0
Experience inside ICU (in years)		
▪ < 5	40	57.14
▪ (5- < 10)	18	25.71
▪ ≥10	12	17.14
Range	**(1-26)**	
Mean ± SD	**4.01±6.579**	
Previous educational sessions		
▪ No	70	100.0

Table (2): Mean score and standard deviation of the studied nurses' knowledge in relation to seven main domains about medical devices related pressure injury throughout phases of study.

Knowledge domains	The studied nurses (n=70) Range Mean±SD			F P
	Pre	Immediately	Post 3 weeks	
A. Skin anatomy and definition of medical devices related pressure injury throughout	(0-4) 2.01±1.097	(1-4) 3.17±0.868	(0-4) 3.00±0.978	**28.125 0.000***
B. Causes and risk factors of medical devices related pressure injury throughout	(1-10) 5.46±2.172	(5-11) 8.20±1.682	(4-11) 7.63±1.729	**41.744 0.000***
C. Signs, symptoms of pressure injuries and complication of medical devices related pressure injury throughout	(0-7) 3.14±1.696	(2-7) 5.29±1.144	(1-7) 4.83±1.372	**44.07 0.000***
D. Most affected site and most common device cause pressure injury	(0-2) 0.96±0.550	(0-2) 1.40±0.549	(0-2) 1.39±0.597	**13.851 0.000***
Preventive measures of ETT and NGT related pressure injury E. ETT Related pressure injury	(2-8) 4.80±1.893	(3-10) 7.64±1.455	(4-10) 7.53±1.511	**68.146 0.000***
F. Preventive measures of ETT related pressure injury	(1-8) 4.79±1.777	(2-9) 7.19±1.354	(4-9) 7.21±1.250	**62.27 0.000***
G. Preventive nursing measures related NGT related pressure injury	(5-13) 8.16±1.983	(7-15) 12.01±1.698	(8-15) 11.74±1.783	**97.382 0.000***
Total knowledge score	**(19-42) 29.31±6.779**	**(34-53) 44.90±4.115**	**(34-53) 43.33±4.204**	**191.93 0.000***

(*) Significant at level P < 0.05.

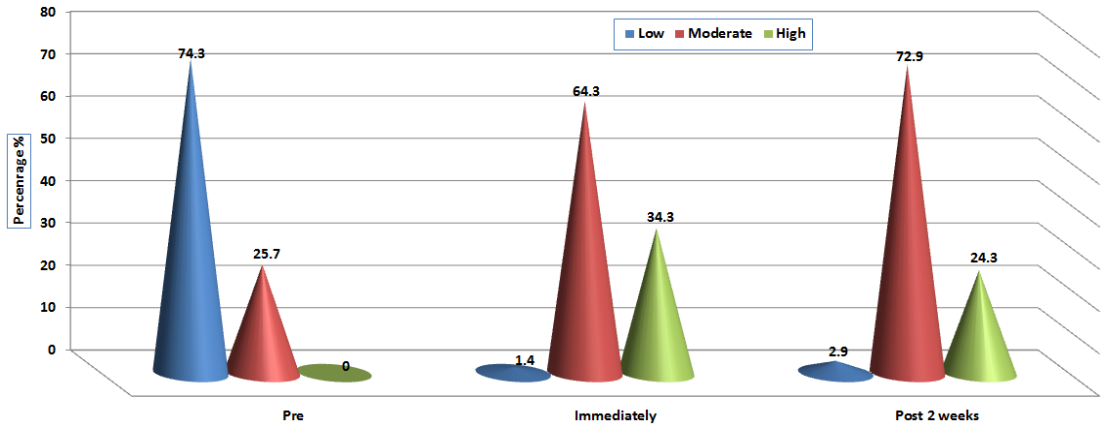

Figure I: Nurse's distribution in accordance to their total knowledge level about medical devices related pressure injury throughout phases of study

Table (3): Mean score and standard deviation of the studied nurses' practice of domains about medical devices related pressure injury throughout periods of intervention

Practice domains	Range Mean ± SD			F P
	Pre	Immediately	Post 3 weeks	
A. preventive measures to minimize pressure injuries associated with ETT				
1. Skin assessment around ETT	(2-8) 5.34±1.61	(4-10) 6.79±1.52	(2-10) 6.30±1.81	**13.841 0.000***
2. Reposition of ETT	(0-6) 1.11±2.28	(0-6) 3.99±2.02	(0-6) 3.70±2.05	**39.036 0.000***
3. ETT related skin Care	(8-18) 12.46±2.24	(11-21) 16.70±2.58	(11-20) 16.21±2.55	**62.315 0.000***
4. ETT securement	(3-18) 10.10±3.69	(7-27) 19.50±4.29	(7-25) 18.83±4.04	**119.599 0.000***
5. Mouth care	(0-4) 1.66±1.17	(0-4) 2.86±1.24	(0-4) 2.74±1.24	**20.790 0.000***
B. Preventive measures to minimize the pressure injuries associated with NGT				
1. Skin assessment related NGT	(1-8) 3.80±1.54	(3-10) 6.39±1.88	(1-10) 5.96±2.29	**36.297 0.000***
2. Skin Care and fixation of NGT	(1-12) 4.56±2.24	(6-12) 9.39±1.81	(4-12) 9.27±1.93	**132.590 0.000***
3. Re-insertion of New NGT	(2-10) 4.77±1.87	(6-12) 8.40±2.03	(6-12) 8.40±2.03	**78.324 0.000***
4. Hydration and nutrition	(0-3) 1.20±0.94	(0-4) 1.73±0.99	(0-4) 1.61±0.98	**5.729 0.004***
5. Post Care and Documentation	(0-4) 1.76±1.01	(0-4) 2.49±1.16	(0-4) 2.40±1.18	**8.798 0.000***
Range Mean ± SD	**(76-147) 102.09±22.453**	**(120-174) 148.30±16.716**	**(118-170) 146.19±16.301**	**F=112.81 P=0.000***

(*) Significant at level P < 0.05.

Table (4): Distribution of the studied nurses according to their total level of practice about medical devices related pressure injury throughout phases of study (n=70).

Total practice level	The studied nurses (n=70)						χ^2 P
	Pre		Immediately		Post 3 weeks		
	N	%	N	%	N	%	
▪ Unsatisfactory	66	94.3	30	42.9	34	48.6	**47.169**
▪ Satisfactory	4	5.7	40	57.1	36	51.4	**0.000***

<80% Unsatisfactory ≥80% Satisfactory (*) Significant at level P < 0.05.

Table (5): Correlation between total knowledge score of the studied nurses and their practice score throughout phases of study

Total Practice Score	Total knowledge score		
	Pre	Immediately	Post 3 weeks
r	0.617	0.465	0.454
P	0.000**	0.000**	0.000**

(*) Significant at level P < 0.05. (**) Highly significant at level P < 0.0

Table (6): Distribution the demographic characteristics of the studied patients.(n=60).

Characteristics	The studied patients (n=60)				χ^2 P
	Control group (n=30)		Study group (n=30)		
	N	%	N	%	
Age (in years)					
▪ (21-<30)	6	20.0	6	20.0	
▪ (30-<40)	4	13.3	5	16.7	0.178
▪ (40-<50)	8	26.7	7	23.3	0.981
▪ (50-60)	12	40.0	12	40.0	
Range	**(24-60)**		**(22-60)**		t=0.376
Mean ± SD	**45.07±12.27**		**43.87±12.43**		P=0.708
Gender					
▪ Male	18	60.0	14	53.3	FE
▪ Female	12	40.0	16	46.7	0.438
Smoking					
▪ Yes	6	20.0	6	20.0	FE
▪ No	24	80.0	24	80.0	01.00

FE: Fisher's Exact test

Table (7): Distribution of the studied patients according to their clinical data (n=60).

Clinical data	The studied patients (n=60)				χ^2 P
	Control group (n=30)		Study group (n=30)		
	N	%	N	%	
Diagnosis					
▪ Cardiovascular disorders	2	6.7	1	3.3	
▪ Respiratory disorders	8	26.7	8	26.7	
▪ Neurological disorders	13	43.3	9	30.0	
▪ Hematological disorders	2	6.7	2	6.7	1.071
▪ Endocrine and metabolic disorders	4	13.3	5	16.7	0.301
▪ Renal disorders	8	26.7	8	26.7	
▪ Gastrointestinal disorders	3	10.0	4	13.3	
▪ Others	1	3.3	2	6.7	
# more than one answer					

Past medical history					
▪ Cardiovascular disorders	4	13.3	5	16.78	
▪ Respiratory disorders	8	26.7	8	26.7	
▪ Hematological disorders	4	13.3	4	13.3	0.267
▪ Endocrine and metabolic disorders	4	13.3	4	13.3	0.606
▪ Infectious disorders	2	6.7	2	6.7	
▪ Renal disorders	4	13.3	6	20.0	
Level of consciousness (GCS)					
▪ Coma (3–7)	10	33.3	9	30.0	
▪ Semi-conscious (8–14)	10	33.3	11	36.7	0.100
▪ Fully conscious (15)	10	33.3	10	33.3	0.951

Table (8): Distribution of the studied patients according to their Oral Assessment Guide (OAG) scale throughout periods of study

OAG scale	The studied patients (n=60)													
	Control group (n=30)						χ^2 P	Study group (n=30)						χ^2 P
	On admission		Post a week		Post 2 weeks			On admission		Post a week		Post 2 weeks		
	N	%	N	%	N	%		N	%	N	%	N	%	
1. Lips														
-Healthy mucosa	30	100.0	16	53.3	1	3.3	**63.439**	30	100.0	22	73.3	11	36.7	**29.436**
-Moderate mucositis	0	0.0	14	46.7	20	66.7	**0.000***	0	0.0	8	26.7	18	60.0	**0.000***
-Sever mucositis	0	0.0	0	0.0	9	30.0		0	0.0	0	0.0	1	3.3	
2. Tongue														
-Healthy mucosa	30	100.0	17	56.7	7	23.3	**44.992**	30	100.0	19	63.3	15	50.0	**20.696**
-moderate oral mucositis	0	0.0	13	43.3	15	50.0	**0.000***	0	0.0	11	36.7	14	46.7	**0.000***
-Sever oral mucositis	0	0.0	0	0.0	8	26.7		0	0.0	0	0.0	1	3.3	

* Significant level at P<0.05

Table (9): Distribution of the studied patients according to the ETT related to Pressure injury staging system (PISS) checklist throughout periods of study(n=60)..

ISS scale	The studied patients (n=60)												
	Control group (n=30)						χ^2 P	Study group (n=30)						χ^2 P
	On admission		Post a week		Post 2 weeks			On admission		Post a week		Post 2 weeks		
	N	%	N	%	N	%		N	%	N	%	N	%	
ETT related PISS scale														
1. Back of neck														
- Normal	30	100.0	13	43.3	3	10.0		30	100.0	17	56.7	5	16.7	
- 1st stage	0	0.0	16	53.3	14	46.7	**62.004**	0	0.0	13	43.3	20	66.7	**46.766**
- 2nd stage	0	0.0	1	3.3	11	36.7	**0.000***	0	0.0	0	0.0	5	16.7	**0.000***
- 3rd stage	0	0.0	0	0.0	2	6.7		0	0.0	0	0.0	0	0.0	
2. Cheek														
- Normal	30	100.0	8	26.7	0	0.0		30	100.0	15	50.0	3	10.0	
- 1st stage	0	0.0	18	60.0	10	33.3		0	0.0	13	43.3	20	66.7	
- 2nd stage	0	0.0	3	10.0	16	53.3	**83.876**	0	0.0	2	6.7	7	23.3	**50.602**
- 3rd stage	0	0.0	1	3.3	3	10.0	**0.000***	0	0.0	0	0.0	0	0.0	**0.000***
- 4th stage	0	0.0	0	0.0	1	3.3		0	0.0	0	0.0	0	0.0	

2. Angle														
- Normal	30	100.0	5	16.7	0	0.0		30	100.0	11	36.7	1	3.3	
- 1st stage	0	0.0	12	40.0	4	13.3		0	0.0	15	50.0	20	66.7	
- 2nd stage	0	0.0	13	43.3	13	43.3	**97.286**	0	0.0	4	13.3	9	30.0	**58.956**
- 3rd stage	0	0.0	0	0.0	6	20.0	**0.000***	0	0.0	0	0.0	0	0.0	**0.000***
- 4th stage	0	0.0	0	0.0	6	20.0		0	0.0	0	0.0	0	0.0	
- 5th stage	0	0.0	0	0.0	1	3.3		0	0.0	0	0.0	0	0.0	
3. Ear loop														
- Normal	30	100.0	8	26.7	1	3.3		30	100.0	14	46.7	8	26.7	
- 1st stage	0	0.0	17	56.7	15	50.0	**68.242**	0	0.0	16	53.3	20	66.7	**37.590**
- 2nd stage	0	0.0	5	16.7	12	40.0	**0.000***	0	0.0	0	0.0	2	6.7	**0.000***
- 3rd stage	0	0.0	0	0.0	2	6.7		0	0.0	0	0.0	0	0.0	
4. Helix														
- Normal	30	100.0	8	26.7	2	6.7		30	100.0	16	53.3	9	30.0	
- 1st stage	0	0.0	17	56.7	19	63.3	**62.509**	0	0.0	13	43.3	19	63.3	**32.160**
- 2nd stage	0	0.0	5	16.6	8	26.7	**0.000***	0	0.0	1	3.3	2	6.7	**0.000***
- 3rd stage	0	0.0	0	0.0	1	3.3		0	0.0	0	0.0	0	0.0	

* Significant level at P<0.05

Table (10): Distribution of the studied patients according to the Nasogastric tube related Pressure injury staging system (PISS) checklist throughout periods of study(n=60).

NGT related PISS scale	The studied patients (n=60)												
	Control group (n=30)						χ^2 P	Study group (n=30)						χ^2 P
	On admission		Post a week		Post 2 weeks			On admission		Post a week		Post 2 weeks		
	N	%	N	%	N	%		N	%	N	%	N	%	
1. Nairs														
▪ Normal	30	100.0	8	26.7	1	3.3		30	100.0	15	50.0	21	67.0	
▪ 1st stage	0	0.0	20	66.7	11	36.7	**84.364**	0	0.0	14	46.7	9	26.7	**35.890**
▪ 2nd stage	0	0.0	2	6.7	12	40.0	**0.000***	0	0.0	1	3.3	0	0.0	**0.000***
▪ 3rd stage	0	0.0	0	0.0	6	20.0		0	0.0	0	0.0	0	0.0	
2. Nose Tip														
▪ Normal	30	100.0	9	30.0	0	0.0		30	100.0	14	46.7	24	80.0	
▪ 1st stage	0	0.0	18	60.0	12	40.0	**80.104**	0	0.0	16	53.3	6	20.0	**40.320**
▪ 2nd stage	0	0.0	3	10.0	16	53.3	**0.000***	0	0.0	0	0.0	0	0.0	**0.000***
▪ 3rd stage	0	0.0	0	0.0	2	6.7		0	0.0	0	0.0	0	0.0	

Discussion

Pressure injury caused by medical devices is a problem that has progressively gained more attention due to the fact that it lowers the quality of life for seriously ill patients. In addition, pressure injuries together with an existing disease, may cause deterioration of health, lead to further complications such as infection, prolonging hospital stays and increase in unnecessary medical expenditure. Moreover, if left untreated, it can increase the risk of death [16,17].

Nurses play a key role in identifying patients at risk of medical devices related pressure

injury as well as preventing it. The quality of health care provided is increasing in parallel with the increase in nurses' knowledge and practice. It is essential to provide more effective training, comprehensive knowledge and up to date information for nurses about preventive measures of medical devices related pressure injury [18]. Therefore the aim of this study was to evaluate the effect of educational program about preventive nursing measures of medical devices related pressure injuries on nurses' performance and patients' clinical outcome.

Regarding nurses' age and education level, the current result showed that the majority of participant nurses were in the age group of 21 < 30 years and had technical institute of nursing. This could be attributed to the fact that young nurse can tolerate the nature of ICU work as an area of specialty necessitates a young qualified nurse for better quality of nursing care. These findings are in line with **Sönmez (2022)**[19] reported that the majority of participants nurses were less than 30 years and also **Mohamed & Weheida (2019)**[20] found that the majority of nurses working in ICU had a secondary education and technical institute of nursing. On the other hands, these findings were disagreed with **Zhang et al (2021)** [21] and **Hu et al (2021)**[22] they concluded that most of the sample in their studies had aged more than 30 years and bachelor's level of education.

As regards to gender, years of experience and previous training program of the studied nurses, about more than half of nurses having years of experience less than five years. From the researcher's point of view this result may be due to their years of experience were consistent with their ages. In addition, most of nurses of studied group were female, this may be because that male nurse learnt nursing lately in recent years, and before that, most of the graduated nurses were female.

Additionally, the current findings showed that none of the participation nurses had taken a course on preventive measures of pressure injury caused by medical devices. This result could be explained by a lack of funding for training and shortage in nursing staff that didn't allow them to participate in training activities.

These findings are in agreement with **Yan (2022)** [23] who revealed that the majority of the study participants were female, had less than five years of experience and did not participate in any training programs. Moreover **Gaballah & Salah El-Deen (2021)** [24] showed that the majority of studied nurses had age ranged less than 30 years, were female, and were graduated from the institute of nursing and had 5 to less than 10 years' experience in nursing field. On contradiction, this result was disagreed with **Lotfi et al (2019)** [25] they mentioned that almost two third of the studied nurses had more than 14 years of experience.

Regarding nurses' knowledge about mean score of seven main domains of medical devices related pressure injury. The present finding revealed a significant decreased of total mean score of nurse's knowledge and they had low level of knowledge preprogram implementation. This might be because the majority of the nurses think that MDRPIs usually occurs in areas with bony prominences only. This finding was supported by **Karadağ et al (2017)** [26] who concluded that the majority of the nurses had no idea about what of MDRPIs and that they do not think that every medical device may cause MDRPI.

However, the total nurse's knowledge means score significantly improved at immediate phase. This result supported by **Zhang et al**

(2021)[21] who concluded that improvement of the mean scores of the nurses 'knowledge about medical devices related pressure injury after program implementation . This may be due to the effect of education program in Intensive Care Unit; the researcher had enough time, proper environment, suitable learning media and material for teaching.

In addition, the current result showed a relative reduction in the mean score post 3 weeks of program. This is interpreted by that most of nurses have no time to refresh and updates their knowledge about critical problems such as medical devices related pressure injury. This result was consistent with **Subramanian (2013)**[27] and **Aysha et al (2016)** [28] they showed that nurses' knowledge about ETT care improved significantly in the first post-test of educational program; however, the score decreased in the follow-up phase, but it was still higher than the pretest. On the other hand, the study conducted by **Zhang et al (2021)**[21] in China was contradicted to study findings, and stated that the knowledge level of nurses about MDRPIs was at an acceptable level without training program.

Concerning mean score of ten domains of nurses 'practice about medical devices related pressure injury**,** the present results revealed a significant decreased of total mean score of nurses' practice and majority of them had unsatisfactory level pre implementation program. This could be attributed to lack of experience of nurses to inspect skin under device and fear of accidental dislodgement of ETT or NGT.

However, the current study revealed marked an improvement of their total mean practice score immediately and after 3 weeks of program implementation compared to preprogram**.** These reflect the positive effect of the educational program on improving nurses' level of practice. This finding was supported by **Seo & Roh (2020)**[29] who reported that the Pressure injury prevention training is useful for enhancing nurses' practice regarding pressure injury prevention. On the other hand, these findings are not in harmony with a study carried out by **Yan et al (2021)**[23] who found that the nurse's total practice regarding medical devices related pressure injury was desirable and satisfactory without educational program.

The current result demonstrated a highly statistically significant relation between nurses' overall knowledge score and their practice score. This contributed that the integration between knowledge and practice improving learning process and facilitate application of clinical nursing skills to the critically ill patients.

This result was supported by the research done by **Nasreen et al (2017)**[30] who stated that the participant nurses had poor level of total practice and knowledge, and a significant link is established between knowledge and practice of the study participants. Moreover **Khojastehfar et al (2020)** [31] reported a highly significant association between nurses 'total knowledge and practice score regarding preventing pressure injury. However this finding was contradicted with **Mahmoud et al (2016)** [32] who indicated that no significant correlation found between nurses' practice scores and their total knowledge scores.

Part II: Distribution of the studied Patients according to demographic and clinical data, Oral assessment guide scale and Pressure injury staging system checklist related to endotracheal and nasogastric tube.

The current study reported that more than one third of both control and study groups were in the age between (50-60) years and

were male. In addition, it was found that more than one third of the studied patients had neurological disorders and more than one third of them were semi-conscious level with no significant differences was observed. The current findings were supported by **Zakaria et al (2019)**[3] and **Rashvand et al (2020)** [18] they stated that the most of studied patients were 50 years old, males and majority of them semi-conscious with no significant differences was observed. However this study was contradicted with **Gaballah & Salah El-Deen (2021)** [25] stated that about half of both the study and control groups had age more than 60 years, female and cardiac patients

In relation to oral assessment guide scale among the studied groups, one-third of the control group experienced severe oral mucositis of the lips and tongue, compared to a minority of patients in the study group. A higher rate of oral mucositis in control group may be due to the application of false technique of fixation for endotracheal tube that may damage oral cavity and lips of the patient, especially at the corners. Also the pressure on the lips created by the unsupported weight of ETT may compromise the microcirculation of the lips and lead to a pressure area on the oral mucosa [33].

This emphasized the importance of shift-by-shift assessment of oral cavity to identify lesions and using of new methods of fixation that decrease development of pressure injuries.

This finding was supported by **Ali etal (2022)**[34] they reported a decreased rate of oral mucositis in study group who received T- will fixation of ETT compared to control group that received the adhesive tape technique and a highly significant differences observed between two groups regarding oral assessment scale. Also **Silva and Fonseca (2012)**[35] clarified that old methods of endotracheal tube fixation increased the development of pressure areas within the mouth or on the lips.

Conversely, the present results were in opposition with **Landsperger (2019)** [36] who found reduction of oral mucosal and lip breakdown with usual tube securement method in control group and no association among study and control group. Also **Prendergast et al (2012)** [37] showed that there was a no significant increase in scores of intubated patients despite oral care intervention in the assessment before and after oral care.

Regarding the endotracheal and nasogastric tube related to Pressure injury staging system checklist among the studied groups. The present study illustrated that, the 1st stage pressure injury related endotracheal and nasogastric tube was occurred in most patients in control group compared to study group post 1st week. This could be attributed to that, poor assessment and fixation of ETT and NGT with adhesive tape that leads to neglected pressure ulcers in subcutaneous tissues. While appropriate assessment and use of ETT, NGT fastener with good quality reduced incidence of pressure injury among study group.

This finding was supported by **VanGilder et al (2018)**[38] who found that half of endotracheal and nasal pressure injury developed 1st stage pressure injury whereas further stages rarely occurred. Also **Black et al (2010)**[39] **and Lewis et al (2018)** [40] stated that medical devices related pressure injuries are commonly 1st or 2nd stage, however, it can easily worsen to further stages if not treated.

Additionally the current results showed that the most site affected for control group was cheek followed by helix

and ear loop compared to ear loop, back of neck, cheek and angle of mouth for study group post 2 week from admission. This could be due to the increasing number of critically ill patients that require medical device that are commonly located in the lip, mouth, nose, ear, and head region as endotracheal and nasogastric tube.

This study was in the same line with **Zakaria (2018)**[3] reported that the most common affected site for studied patients was angle of mouth, ear loop, back of neck, cheek, angle of mouth and nasal tips with significant differences was observed between the control and intervention groups, also **Kim and Lee (2019)**[41] **and Barakat et al (2019)**[6] found that the most common anatomical locations of medical devices related pressure injury development were the ears, nose, face, chin, lips, and mouth.

Limitation of the study

The sample size is small and this may decrease the generalizability of the study findings.

Conclusion:

- A significant improvement of the total mean score of nurse's knowledge and practice at immediate phase concerning important areas of preventive nursing measures of endotracheal and nasogastric tube related pressure injury, however this improvement was reduced by time.
- Clinical patients' outcomes including oral mucositis, and stages of oral ETT and NGT pressure injury) were decreased significantly after implementation of the educational program about preventive measures of medical devices related pressure injuries

Recommendation:

- In-service training programs should be conducted to maintain efficient nurses' performance
- Implementing medical devices related pressure injuries protocol in the ICU as a routine care

-For further research

- Replicate the study on a larger probability sample in different settings for generalizing the findings.

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