Effect of Implementing Educational Program about Safety Measures for Mechanically Ventilated Patients on Nurses' Performance

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Abstract

Background: - The critical care nurse plays a key part in putting safety precautions in place for critically ill patient on: mechanical ventilator. Aim: Evaluate the effect of implementing educational program about safety measures for mechanically ventilated patients on nurses' performance. **Design:** Quasi-experimental research design. **Setting**: Anesthesia Intensive Care Unit and Traumatology Medicine Intensive Care Unit in Tanta Emergency Hospital affiliated to Tanta University hospital. **Subjects**: All nurses (80) working in the previously mentioned settings who are caring for mechanical ventilated patients. 50 nurses at Anesthesia Intensive Care Unit and 30 nurses at traumatology medicine intensive care unit. **Tools:** Two tools were used in this study, Tool I: Nurses' knowledge of Safety Measures Questionnaire; it includes the following parts **:- Part (1):** Socio-demographic data of nurses . **Part (2):-** Nurses' knowledge about safety measures for mechanically ventilated patient. **Tool II**: Nurse's Observational Checklist. **Results:** A highly significant differences were found among all studied nurses regarding their total level of knowledge and practice pre, immediately and post 3 months of educational program, where $P<0.05$. **Conclusion:** implementing educational program about safety measures for mechanically ventilated patients is extremely effective in promoting the achievement of nurses' knowledge level and enhancement of nurses' practice level. **Recommendation**: Implementing educational program about safety measures for mechanically ventilated patients that should be obligatory for newly oppointed nurses critical care nurses in ICU.

Key words: Educational program, Mechanically ventilated patients, Nurses' performance, Safety measures.

I. Introduction

Mechanical ventilation (MV) is a necessary intervention for patients struggling to breathe due to issues with their airway or gas exchange. The objectives of mechanical ventilation include enhancing pulmonary gas exchange, alleviating respiratory distress, decreasing the effort required for breathing by the patient, supporting lung recovery, reversing fatigue in respiratory muscles, and preventing infection. Safety precautions for patients on mechanical ventilation help avoid medical errors that can result in negative health outcomes. **(Chiumello, et al., 2017).** The World Health Organization describes patient safety as the decrease and prevention of risky behaviors within healthcare, as well as by implementing proven methods that result in the best possible patient results. **(Jha, 2019).** Patient safety is fundamental to hospital operations and enhancing the performance of critical care nurses continues to be a goal that all organizations aim to accomplish. **(Guinea, et al., 2019).**

Ensure that the nurses are equipped with effective training methods to enhance the quality of their work, reduce the likelihood of errors, and safeguard ICU patients from medical mistakes made by colleagues. Several countries have released research indicating that a considerable amount of patients experience harm while receiving medical treatment, leading to either permanent damage, longer stays in healthcare institutions, or fatalities. **(Guinea, et al., 2019).**

Mechanical ventilators are complex and necessitate training to guarantee favorable results. The pre-use check of the ventilator is strongly advised by all ventilator manufacturers. This assessment is created to evaluate the performance of the parts, condition of the ventilator setup, the tubes, and the humidification system. Failure to follow proper settings, neglecting to adjust alarms, and not informing the medical team of changes can lead to negative impacts on patient health. This task aims to supervise healthcare workers to guarantee that all staff are knowledgeable in setting up, installing, and making necessary adjustments to mechanical ventilation. **(Botros, Mohamed, & Ahamed, 2019).**

Endotracheal intubations are required for patient connected to MV. It is an advanced airway procedure which is associated with complications following its placement throughout days to weeks of ICU admission. Pre-oxygenation, rapid sequence intubation, regularly checking the airway, ensuring cuff pressure is correct, repositioning the tube carefully, and monitoring for problems while using capnography can help make intubation safer and reduce complications. **(Sahoo, Tripathy & Mishra, 2021).**

Suctioning is required in order to clear out respiratory secretions and ensure an open airway for patients who have been intubated. Failure to perform endotracheal suction correctly can result in numerous complications. Nosocomial infections occur when suctioning is performed without applying aseptic technique. Furthermore, complications such as hypoxemia, hypoxia, atelectasis, cardiac arrhythmias, increased intracranial pressure, and potentially cardiac arrest may arise when an incorrect catheter size is used, insufficient oxygen is provided before and after suctioning, negative pressure exceeds 120 mmHg, and the procedure is administered for over 10 seconds **(Blakeman, Scott, Yoder, Capellari & Strickland, 2022).**

Performing an arterial puncture for analysis of arterial blood gases is an invasive procedure that comes with potential risks including

artery blockage, lack of blood supply, sepsis, infection at the site, and bleeding. Hence, safety precautions must be adhered to **(Weimar et al., 2024).**

Ventilated patients, particularly those under sedation, are susceptible to pressure ulcers due to the presence of pressure areas. It is crucial for immobilized patients to turn and reposition in bed as part of safety measures to improve comfort, preserve skin integrity, and promote healing**(Alshahrani, Sim, & Middleton, 2021).**

Having knowledge of weaning criteria is crucial for nurses when helping critically ill patients on mechanical ventilation successfully transition off the ventilator. In order to provide safe and high-quality patient-centered care, nurses should be knowledgeable about ventilator modes, functions, and limitations, as well as the causes of respiratory distress and dysynchrony with the ventilator, and appropriate management strategies. **(Abousallah, 2018).**

A lot of negative incidents faced by patients on mechanical ventilation are linked to inadequate nursing care. Critical care nurses need to utilize different approaches in order to guarantee the safety of patients. Furthermore, providing additional training for nursing staff on using intricate ICU equipment can enhance patient safety by avoiding improper use and ensuring the intended outcomes are achieved. **(Albalawi, Kidd, & Cowey, 2020).**

Significance of the study

Nurses' staff in critical care units had various problems related to patient safety which considered being a great challenge for critical care nurses. Statistics indicated that patients in ICUs experience an average of 1.7 errors per day and almost all of them suffer from a potentially life-threatening error at some point during their stay in the ICU. Nurses have a critical function in enhancing patient safety. They spend more time with the patients and are highly involved in providing ongoing care to them. A relationship like that could increase the likelihood of nurses making mistakes. **(Peyrovi, Nikbakht Nasrabadi & Valiee, 2016).**

Worldwide, the documented occurrence of negative health occurrences varies from 4% to 17%. It was interestingly discovered that roughly half of all reported adverse events that jeopardized patient safety could have been prevented. **(Killam et al., 2017).** Approximately half of new nurses with less than one year of experience attribute adverse patient events to their formal educational training. (**Saintsing, Gibson & Pennington, 2016).**

Aim of the study was to evaluate the effect of implementing educational program about safety measures for mechanically ventilated patients on nurses' performance**.**

Research hypothesis:

Nurses' performance is expected to be improved after implementation of an educational program about safety measures for mechanically ventilated patient.

Subjects and Methods

Study design: A quasi-experimental design was utilized in this study.

Study Setting: This study was conducted at:-

- The study was conducted at Anesthesia Intensive Care Unit in Tanta Emergency Hospital. It is prepared with 5 wards each ward equipped with 4 beds; the total number of beds is 20. Traumatology and Emergency Medicine Intensive Care Unit in Tanta Emergency Hospital. It is prepared with 3

wards each ward equipped with 4 beds; the total number of beds is 12.

Subjects:

All nurses (80) working in the previously mentioned settings who are caring for mechanical ventilated patients. 50 nurses at Anesthesia Intensive Care Unit and 30 nurses at traumatology medicine intensive care unit.

Tools of data collection

- Two tools were used in this study:

Tool (I): Nurses' knowledge of Safety Measures Questionnaire

This tool was developed by the researcher after reviewing relevant literature to collect data pertinent to the current study. It consisted of two parts:

Part (a): Socio-demographic data of nurses, to assess nurses' age, sex, marital status, years of experience, level of education and previous training program about safety measures.

Part (b): Nurses' knowledge about safety measures for mechanically ventilated patient (Richard B, 2016, Alvarado and Panakos, 2024, Abbasinia et al., 2014, Kelly and Klim, 2013, Zuo and Meng, 2015). This part was used to assess nurse's level of knowledge related to:

Definition and purpose of Safety measures (4 question)

Definition and purpose of Mechanical ventilator (5 question)

Safety weaning from mechanical ventilator (5 question)

Safety measures related endotracheal tube insertion and suction (3 question)

Safety measures related arterial blood gases (4 question)

Safety measures related safe handling and moving patient (3 question)

Scoring system

Three level of scoring for questions was utilized as follows:

-Correct and complete answer scored (2)

-Correct and incomplete answer scored (1)

-Incorrect answer will scored (0)

The total scoring system of nurses' knowledge was calculated and classified as the following:

-More than 80% was considered high level of knowledge.

-More than or equal 60% - 80% was considered moderate level of knowledge.

-Less than 60% was considered low level of knowledge.

Tool (II):- Nurse's Observational Check Lists. It was developed by the researcher to assess nurses' practice about implementing safety measures of mechanical ventilated patient **(Alvarado and Panakos, 2024, Abousallah, 2018, Dubois et al., 2013, Walston et al., 2010, Peyrovi et al., 2016, Shaheen et al., 2016, Divatia et al., 2011)**. It included safety measures regarding:

-Preparation of mechanical ventilator.(14 steps)

-Preparation for endotracheal tube insertion. (17 steps)

-Endotracheal suction appropriately. (28 steps)

-Preparation for weaning from mechanical ventilation. (13 steps)

-Obtaining arterial blood specimen for blood gas analysis. (23 steps)

-Assisting patient with turning and moving in bed. (23 steps)

Scoring system

Each item in check list was scored as following:

-Done scored (1)

-Not done scored (0)

The total scoring system of nurses' practices was calculated and classified as the following:

-Equal or more than 80 % was considered satisfactory.

-Less than 80 % was considered unsatisfactory.

Method

1. Obtaining approval:

An official permission for data collection was obtained from the Faculty of Nursing and was submitted to the director of Tanta Emergency Hospital affiliated to Tanta University and critical care unit for permission to carry out the study.

2-Ethical and legal consideration:

-Ethical committee approval was obtained from the Faculty of Nursing Ethical Research committee with code No (22/1/2022).

-Nature of the study was not causing any harm or pain to the entire subjects.

-Confidentiality and privacy was taken into consideration regarding data collection.

-Nurses' consent to participate in this study was obtained after explaining the aim of the study with the right to withdrawal at any time.

3 -Tools development:

Two tools were used in this study:

Tool (I): Nurses' knowledge of Safety Measures Questionnaire was developed by the researcher **(Richard B, 2016, Alvarado and Panakos, 2024, Abbasinia** et al., 2014, Kelly and Klim, 2013, Zuo and Meng, 2015)**. Tool(II):-** Nurse's Observational Check Lists was developed by the researcher to assess nurses' practice about implementing safety measures of mechanical ventilated patient **(Alvarado and Panakos, 2024, Abousallah, 2018, Dubois et al., 2013, Walston et al., 2010, Peyrovi et al., 2016, Shaheen et al., 2016, Divatia et al., 2011)**

4- Content validity of the tools:

The content validity of the developed tools was tested for clarity and applicability by five experts in critical care nursing and biostatistics to ensure their validity and modification was done.

5- Pilot study:

It was carried out on 10% of the nurses to test clarity and applicability of the study tools then the necessary modification was done. Pilot study was excluded from the study sample

6- Reliability of the tools

All tools were tested for reliability and Cronbach alpha was used based on standardized items is 0.761 and 0.837 respectively for a tool I and II

7 -Data collection

Data were collected over a period of 6 months starting from the beginning of July 2022 until the end of December 2022.

The researcher starts the interview by introducing herself after providing an explanation for the purpose and the nature of the study. Each nurse individually was interviewed to fulfill the sheet question. Each

interview for the nurse lasted for about 20_30 minutes to complete the tool.

Phases of the study

The present study was conducted at four phases including assessment, planning, implementation and evaluation:

1-Assessment phase:

Data was collected by the previously mentioned tools through meeting with nurses in ICU to assess nurses' knowledge and practice regarding safety measure of mechanical ventilation. The researcher gave each nurse the knowledge questionnaire sheet to answer it, using tool I. Also, the researcher observed each nurse individually during their work in morning and afternoon shift to assess their practice using tool II.

2-Planning phase:

-Educational program was planned according to nurses ' educational needs assessment and based on literature review, goals and expected outcome criteria will be taken into consideration when planning patient care.

-Illustrated booklet was prepared and written in simple Arabic language. The booklet was revised by experts in critical care nursing field. Different teaching methods were used as booklet, video, group discussion and PowerPoint, demonstration and re-demonstration. The educational program was conducted in four sessions for theoretical and four session for practice, nurses was divided into eight subgroups, ten nurses in each group, four days per week until all subgroups finished program and time of each session was about 30 minutes.

3-Implementation phase:

The educational program was conducted in eight sessions to nurses as the following:

Theoretical part; four sessions was used for four consecutive days 30 minutes for each session.

-First session: focused on explaining the aim of the study, definition of safety, indication, complication and preparation for connecting patient with mechanical ventilation, ventilator alarm and criteria for weaning from ventilator.

-Second session focused on indication, purpose, complication and safety preparation for arterial blood gas sampling, endotracheal intubation and suctioning.

-Third session focused on indication, purpose, complication and safety preparation for endotracheal intubation and suctioning.

-Fourth session focused on principles of safe patient handling and movement, barriers to using moving and handling equipment, the risks associated with patient-handling tasks, ways of reducing risks and the benefits of bed rails. During the classes, nurses will be encouraged to ask questions and provide feedback. Communication was kept open between the researchers and the nurses.

-For the practical part: four sessions was used for four consecutive days 30 minutes for each session.

-First session: focused on technique and preparation for mechanical ventilator, safety weaning from mechanical ventilation which includes assessment of pulmonary function parameters, ABG, Patient communication before starting weaning, and documentation before, during and after weaning,

- Second session: focused on preparation for endotracheal intubation and suctioning

-Third session: focused on technique of safe arterial blood gas sampling, which include Patient preparation, blood collection device of

sample integrity and operator safety, sample collection, sample handling on sample transport**. -Fourth session:** focused on safety preparation for moving, handling and turning patients in beds which includes proper use of patient handling equipment, safety techniques for moving, transferring, lifting and repositioning a patient in bed**.**

4-Evaluation phase: Each nurse was evaluated by the researcher pre, immediate and three months later post implementation of educational program by using (Tool I part 2 and II).

II. Results

Table (1): illustrates distribution of the studied nurses according to their Socio demographic characteristics. This table showed that about two third (61.25%) of the studied nurses had age ranged from (21-<30) years old, more than half (56.25%) of them were females, near two third (60%) of them were married, and it was found that more than half (52.50%) of the studied nurses had technical institute. Also this result showed that more than two third (78.75 %) of the studied nurses had (1-<5) years of experience, and more than one quarter (46.25%) of them didn't attend training about safety measures**.**

Table(2) :Shows distribution of the studied nurses related to mean scores of knowledge domains about safety measures for mechanically ventilated patient throughout period of study. This table represented that there were statistically significant differences regarding all items of mean score of nurses knowledge domain about safety measures; related mechanical ventilator, safety weaning from mechanical ventilator, endotracheal tube insertion and suction, arterial blood gases, and safe handling and moving of patient) where (P=0.000, P=0.000, P=0.000, P=0.000, P=0.000 and P= 0.000) respectively in pre, immediate and 3 month post program implementation. Moreover, there was a significant decreased of total mean score (13.06±17.84) of nurses knowledge related domain of safety measures for mechanically ventilated pre implementation phase. However, significant improvement of total mean score (31.86±15.81) was observed at immediate phase of program and relatively reduced to (24.50±16.14) post 3 months of program implementation with p= 0.000.

Figure (1): shows distribution of the studied nurse regarding their total knowledge level about safety measures for mechanically ventilated patient throughout period of study. This figure revealed that the majority of the studied nurses (75%) had low level of knowledge preprogram implementation compared to 80% and 68.75% of them had moderate level of knowledge score immediately and post 3 weeks of program implementation respectively.

Table (3): Illustrates mean scores of nurses practice domains about safety measures for mechanically ventilated patient throughout period of study. This table shows a significant decreased of total mean score of nurses' practice (59.50±59.875) pre implementation phase of program related to domain of (preparation for mechanical ventilation, Preparation for endotracheal tube insertion, Preparation for endotracheal suction appropriately, Preparation for weaning from mechanical ventilation, Preparation for obtaining arterial blood specimen for blood gas analysis, assisting patient with turning and moving in bed). On the other hand, a significant improvement of mean score (95.20±47.900) of the same domain was observed at immediate phase of program implementation, however there was a relative reduction in mean score (83.30±54.877) post

3 month of program implementation with P=0.000.

Figure (2) Shows of the studied nurse regarding their practice level about implementing safety measures of mechanical ventilated patient throughout period of study. This figure presented that about half of nurses (50%) had unsatisfactory level of practice preprogram implementation compared to (80% and 70 %) of them had satisfactory practice immediately and after 3 months of program implementation respectively with a significant difference was observed where p =0.000.

Table (4): Correlation between total knowledge score of the studied nurses and their practice about implementing safety measures of mechanical ventilated patient throughout period of study. This table illustrates a highly statistical significant correlation between the studied nurses' overall knowledge score and their practice score throughout the intervention periods (pre, immediately and post 3month) where P= 0.000, in addition the majority of studied nurses (80%) had high knowledge &satisfactory practice immediately following program implementation and this percentage decreased to 1.25 % post 3 month of program implementations.

Table (5): Relation between socio-demographic characteristics of the studied nurses and their total knowledge score about implementing safety measures of mechanical ventilated patient throughout period of study. This table revealed that, there was no significant relation between total knowledge and their socio demographic data. Also, This table shows that the highest mean ±SD of total knowledge was(33.42±1.924)immediately program implementation compared to (12.35±1.978) preprogram and decreased to (24.84±1.150) post 3 months program among age of (30-<40) years . It shows also an increase of mean score (34.26±1.889) immediately following program implementation and decreased gradually (25.00±1.042) post 3months among female nurses. Also, the highest mean ±SD of total knowledge score (34.94±1.122) immediately following program implementation and decreased gradually (24.79±1.077) post 3months among married group of marital status. The highest mean ±SD of total knowledge score(33.24±1.814) among technical institute nurses immediately following program but slightly decreased (25.83±1.575) post 3 months program implementation. Also, the highest mean ±SD of total knowledge score of the studied nurses with 1-<5 years of experience in ICU was (32.24±1.462) immediately following program implementation but mean score decreased (23.89±1.423) post 3 months of program implementations.

Table (6) Relation between socio-demographic characteristics of the studied nurses and their total practice score about implementing safety measures of mechanical ventilated patient throughout period of study. Concerning relation between age ,gender, marital status, level of education and years' experience in ICU and their total practice score, no significance differences were observed among studied nurses in pre ,immediately and post 3month periods with p.> 0.05 .On the other hand, significance differences were observed among the studied nurses regarding to their gender and their total practice at immediately periods with p=0.000 . However it was found that increased mean score (99.81±4.492) of nurses immediately program among nurses in groups (30-<40) years but decreased gradually (84.45±5.908) post 3month of program implementations. Also, the highest mean ±SD of total practice of the studied nurse's female

(102.00±4.249) immediately program compared to (61.20±6.344) preprogram implementations and decreased gradually (85.00±4.544) post 3month of program implementing. Also, the highest mean ±SD of total practice score (104.13±3.772) immediately following program implementation and decreased gradually (84.29±5.661) post 3month among married group of marital status. But the highest mean ±SD (99.17±4.886) was observed in technical institute nurses immediately following program. Also ,it shows that the highest mean ±SD of total practice of studied nurses 1-<5years experience in ICU was (96.33±4.104)immediately program and (81.22±5.838)post 3month of program compared to (64.22±5.789) preprogram implementations.

Table (1): Percentage distribution of the studied nurses according to their Sociodemographic characteristics.

Characteristics	The studied nurses (n=80)	
	N	%
Age (in years)		
(21-<30)	49	61.25
(30-<40)	31	38.75
Range	(22-36)	
Mean ± SD	28.91±3.057	
Gender		
Male	35	43.75
Female	45	56.25
Marital status		
Married	48	60.00
Single	28	35.00
Divorced	4	5.00
Education level		
Technical institute	42	52.50
Bachelor	34	42.50
Post studies	4	5.00
Years of experience		
(1-<5)	63	78.75
(5-<10)	17	21.25
Range	(1-7)	
Mean ± SD	3.50±1.369	
Attend training about safety measures (in weeks)		
None	37	46.25
(< 1)	15	18.75
(1-2)	21	26.25
(>2)	7	8.75

Table (2): Distribution of the studied nurses related to mean scores of knowledge domains about safety measures for mechanically ventilated patient throughout period of study.

Knowledge domains	The studied nurses (n=80) Range Mean ± SD			F P
	Pre	**Immediately**	**Post 3 months**	
Definition and purpose of safety measures	(0-8) 2.44±2.97	(0-7) 5.25±2.55	(0-5) 3.50±2.31	23.25 0.000*
Definition and purpose of mechanical ventilator	(0-10) 2.81±3.72	(0-8) 6.40±3.22	(0-7) 4.90±3.23	22.51 0.000*
Safety weaning from mechanical ventilator	(0-10) 2.50±3.73	(0-10) 7.19±3.68	(0-8) 5.60±3.69	33.21 0.000*
Safety measure related endotracheal tube insertion and suction	(0-6) 1.75±2.24	(0-4) 3.20±1.61	(0-4) 2.80±1.85	12.24 0.000*
Safety measure related arterial blood gases	(0-8) 1.81±3.02	(0-8) 6.05±3.08	(0-7) 4.90±3.23	39.70 0.000*
Safety measure related safe handling and moving patient	(0-6) 1.75±2.24	(0-5) 3.78±1.94	(0-4) 2.80±1.85	20.22 0.000*
Total knowledge score	**(0-48) 13.06±17.84**	**(0-41) 31.86±15.81**	**(0-35) 24.50±16.14**	26.98 0.000*

*** Statistically significant at level P<0.05**

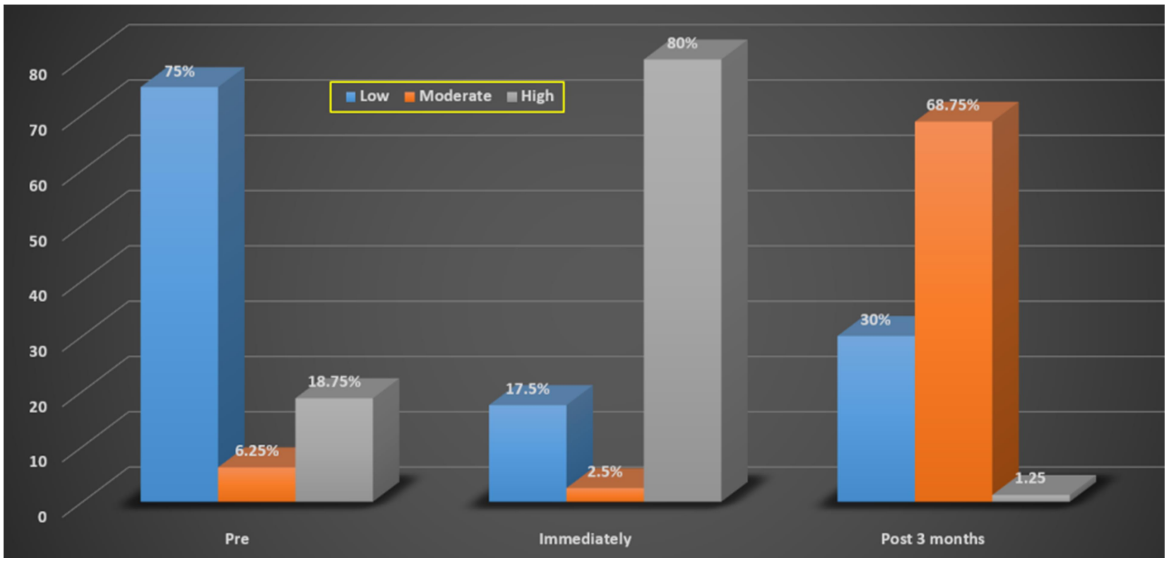
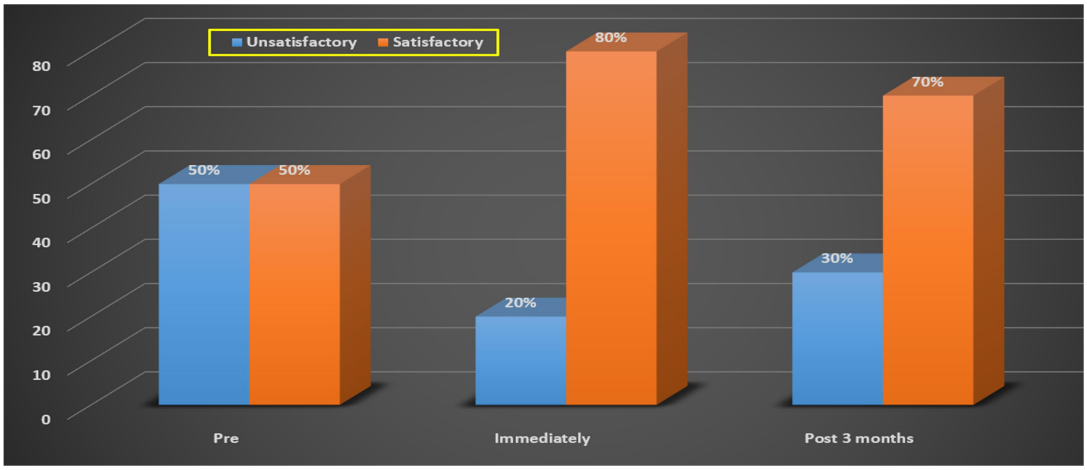


Figure (1): Distribution of the studied nurse regarding their total knowledge level about safety measures for mechanically ventilated patient throughout period of study

Table (3): Mean scores of Nurses' practice domains about safety measures for mechanically ventilated patient throughout period of study

Practice domains	The studied nurses (n=80) Range Mean ± SD			F P
	Pre	**Immediately**	**Post 3 months**	
Preparation for mechanical ventilation	(0-14) 7.00±7.044	(0-14) 11.20±5.635	(0-14) 9.80±6.456	8.919 0.000
Preparation for endotracheal tube insertion	(0-18) 9.00±9.057	(0-18) 14.40±7.245	(0-18) 12.60±8.301	8.919 0.000
Preparation for endotracheal suction appropriately	(0-28) 14.00±14.088	(0-28) 22.40±11.271	(0-28) 19.60±12.912	8.919 0.000
Preparation for weaning from mechanical ventilation	(0-13) 6.50±6.541	(0-13) 10.40±5.233	(0-13) 9.10±5.995	8.919 0.000
Preparation for obtaining arterial blood specimen for blood gas analysis	(0-23) 11.50±11.573	(0-23) 18.40±9.258	(0-23) 16.10±10.606	8.919 0.000
Assisting patient with turning and moving in bed	(0-23) 11.50±11.573	(0-23) 18.40±9.258	(0-23) 16.10±10.606	8.919 0.000
Total practice score	**(0-119) 59.50±59.875**	**(0-119) 95.20±47.900**	**(0-119) 83.30±54.877**	8.919 0.000*



Figure(2):Distribution of the studied nurse regarding their total practice level about implementing safety measures of mechanical ventilated patient throughout period of study

Table (4): Correlation between total knowledge score of the studied nurses and their practice about implementing safety measures of mechanical ventilated patient throughout period of study

Total Practice score	The studied nurses (n=80) Total knowledge score						χ^2 P
	Low		**Moderate**		**High**		
	N	**%**	**N**	**%**	**N**	**%**	
Pre							
Unsatisfactory	40	50.00	0	0.00	0	0.00	26.667
Satisfactory	20	25.00	5	6.25	15	18.75	0.000*
r , P	0.737 , 0.000**						
Immediately							
Unsatisfactory	14	17.50	2	2.50	0	0.00	80.064
Satisfactory	0	0.00	0	0.00	64	80.00	0.000*
r , P	0.998 , 0.000**						
Post 3 months							
Unsatisfactory	24	30.00	0	0.00	0	0.00	74.780
Satisfactory	0	0.00	55	68.75	1	1.25	0.000*
r , P	1.00 , 0.000**						

r: Pearson' correlation coefficient * Statistically significant at level P<0.05

Table (5): Relation between socio-demographic characteristics of the studied nurses and their total knowledge score about implementing safety measures of mechanical ventilated patient throughout period of study.

Characteristics	The studied nurses (n=80) Total knowledge score Range Mean ± SD		
	Pre	Immediately	Post 3 months
Age (in years) (21-<30)	13.51±1.519	30.88±1.412	24.29±1.298
(30-<40)	12.35±1.978	33.42±1.924	24.84±1.150
t , P	0.079 , 0.780	0.488 , 0.487	0.022 , 0.882
Gender Male	11.80±1.786	30.00±1.068	24.11±1.386
Female	14.69±1.230	34.26±1.889	25.00±1.042
t , P	0.512 , 0.476	1.436 , 0.234	0.059 , 0.809
Marital status Married	12.33±1.157	34.94±1.122	24.79±1.077
Single	14.46±1.745	29.68±1.131	23.75±1.646
Divorced	12.00±2.001	10.25±2.501	26.25±1.500
F , P	0.131 , 0.878	5.472 , 0.006	0.060 , 0.942
Education level Technical institute	14.31±1.697	33.24±1.814	25.83±1.575
Bachelor	12.29±1.731	30.47±1.898	21.62±1.264
Post studies	6.50±2.506	29.25±1.500	35.00±2.01
F , P	0.399 , 0.673	0.340 , 0.713	1.553 , 0.218
Years of experience (1-<5)	14.79±1.772	32.24±1.462	23.89±1.423
(5-<10)	6.65±1.242	30.47±1.443	26.76±1.303
t , P	2.858 , 0.095	0.166 , 0.685	0.422 , 0.518

* Statistically significant at level P<0.05

Table(6): Relation between socio-demographic characteristics of the studied nurses and their total practice score about implementing safety measures of mechanical ventilated patient throughout period of study

Characteristics	The studied nurses (n=80) Total practice score Range Mean ± SD		
	Pre	**Immediately**	**Post 3 months**
Age (in years)			
(21-<30)	58.29±6.104	92.29±5.167	82.57±5.413
(30-<40)	61.42±6.452	99.81±4.492	84.45±5.908
t , P	0.051 , 0.821	0.465 , 0.497	0.022 , 0.882
Gender			
Male	58.18±6.157	89.91±5.719	81.98±5.713
Female	61.20±6.344	102.00±4.249	85.00±4.544
t , P	0.050 , 0.824	1.258 , 0.265	0.059 , 0.809
Marital status			
Married	59.50±6.130	104.13±3.772	84.29±5.661
Single	63.75±6.437	89.25±5.474	80.75±5.596
Divorced	29.75±5.500	29.75±5.500	89.25±5.500
F , P	0.558 , 0.575	5.304 , 0.007*	0.060 , 0.942
Education level			
Technical institute	62.33±6.153	99.17±4.886	87.83±5.955
Bachelor			
Post studies	56.00±6.290	91.00±5.237	73.50±5.699
	59.50±8.705	89.25±5.500	119.00±6.01
F , P	0.103 , 0.902	0.300 , 0.742	1.553 , 0.218
Years of experience			
(1-<5)	64.22±5.789	96.33±4.104	81.22±5.838
(5-<10)	42.00±5.618	91.00±5.031	91.00±5.031
t , P	1.864 , 0.176	0.164 , 0.686	0.422 , 0.518

* Statistically significant at level P<0.05

Discussion

Mechanical ventilation is a supportive therapy to help patients who are unable to maintain adequate gas exchange. The main challenge of nurses in critical care units is mechanically ventilated patients and the failure to wean them from machine support. This is related to the high occupancy rate of ventilated patients, which is one-fourth to one-half of critically ill patients who require MV **(Sheta & Mohamed Tantaewy, 2022)**. Therefore, educational program have been formulated to ensure the effectiveness of safety measures for patients of mechanical ventilators.

Regarding **Socio demographic data of the studied nurses,** the results of the present study found that that about two third of the studied nurses had age ranged from (21<30) years old. This finding is justified by that nursing can offer flexible work schedules and the ability to balance work with family responsibilities, Besides the accessibility of nursing education and the variety of pathways to enter the profession, such as associate and bachelors degree programs, have made it an appealing choice for younger individuals, including those in the (21-30) age range.

This finding was in line with **(Ali & Ahmed, 2023)** conducted a quasi-experimental design a purposive sample of 60 nurses were included in the study showed that the majority of the studied nurses were between 20 < and 30 years with a mean age (25.95 ± 6.02) year This study also was congruent with the research result directed at public hospitals in Sana'a City-Yemen by **(Al-Gunaid, 2020)** who enrolled thesis entitled knowledge and practice of intensive care nurses towards weaning criteria from MV at public hospitals in Sana'a City Yemen, revealed that more than two-thirds of ICU nurses age alternated from 20-30 years with a mean age ± SD, 29.7± 4 .

Additionally it was found that more than half of them were females, this could be explained considering the known fact that nursing job in Egypt was exclusive to females only till a few years ago and the number of nurses who graduated from the secondary school of nursing was higher than technical institute and bachelor's degree. Also, this result was supported by **(Ali & Ahmed , 2023)** who concluded that most of the studied nurses were females with a male-to-female ratio was 1:9. Moreover, **(Abd Al Fadeel, Abd El Megeed& Etway, 2023)** displayed that the most studied nurse were female. Also, **(Ebrahim, El-Dakhakhny& AbdElnabi, 2023),** discovered that most of the nurses under study were female**.** Also, it was showed that two third of them were married, this result was in accordance with **(Anggraini& Ilhamda, 2020)** who found in his study that most of the sample were married.

Regarding the educational level, it was found that more than half of the studied nurses were technical institute, this result was in accordance with **(Mohamed et al.,2020)** found that nearly half of the study sample had technical nursing diploma. This result in contrast with **(Abd Al Fadeel, Abd El Megeed& Etway, 2023)** showed that about three-quarters of nurse managers had baccalaureate degrees. **Concerning Years of experience,** the finding of the present study revealed that about more than two third of the studied nurses had (1<5) years of experience. In line with current results, **Caldas, Ostermeier & Cooper, 2021** revealed that nearly half of

the staff nurses' years of experience ranged from five to ten years.

Also**,** These results were in line with **(AbdElbaky, Mohamed& Nagib, 2018)** found that the majority of them were newly graduated and had less than 5 years of experience. **((Ebrahim, El-Dakhakhny& AbdElnabi, 2023)** highlighted that more than two-thirds had less than 10 years of experience and had not previously training course in mechanical ventilation. From the investigator's point of view, the studied nurses' years of experience were matched with their educational qualifications, age, and hiring date. Moreover, the study result illustrated that most of the studied nurses did not attend training courses regarding mechanical ventilation.

As regard nurses 'knowledge about mechanically ventilated safety measures, it was found that there was a significant decrease of total mean score of nurse's knowledge related domain of safety measures for mechanically ventilated pre implementation phase. However, significant improvement of total mean score was observed at immediate phase of program and relatively reduced post 3 months of program implementation. The possible explanation for the present difference between pre-post scored reflects the effectiveness of the educational program for intensive care nurses' regarding safety measures of mechanical ventilator patients. Additionally, the presence of a difference between pre and follow up tests reflects knowledge retention. Meanwhile, the explanation for nurses' lack of understanding regarding mechanically ventilated safety measures may be due to a lack of post-graduate continuing education courses or programs on the subject and regular testing of nurses' expertise.

Also, the decline of the mean score of knowledge in the pre-test phase may be due to a lack of concern from of hospital and responsible persons for training the nurses about safety measures as well as the shortage of time and increase workload. While the improvement of the mean score of knowledge in the post-test phase may be due to studied nurses gaining new knowledge by completing the in-service training module within the nurses' workplace regarding mechanical ventilator patients' skillful handling this is essential for reinforcing and retaining theoretical learning.

These results were in line with **(Ali &Ahmed, 2023)** who found highly statistically significant difference existed between the total mean score of knowledge regarding care of mechanically ventilated patients throughout (pre/ post) and (pre/ follow-up) phases among the studied nurse's post-implementation.

On the same line, the study was consistent with descriptive research performed by **(Ahmed Abdelsttar, et al. 2022).**who confirmed that more than half of the nurses in the study had inadequate knowledge of mechanical ventilator devices and cared for mechanically ventilated patients poorly. This is because most nurses focused on general knowledge and infection control strategies for MV and patients. In the same line, the study were congruent with the study result accomplished by **(Al-Gunaid, 2020) who** reported an unsatisfactory degree of knowledge about the readiness for weaning from MV, the modes of weaning intervention from MV, the recommendation parameters for

weaning intervention, the tolerance criterion for weaning criteria, and the weaning criteria from MV among more than half of the studied nurses.

Also, **(Botros, Mohamed & Ahamed, 2019),** reviewed and assess nursing practice regarding safety measures on mechanically ventilated patients and summarized that none of the study's nurses paid attention to alarm noises or examined patients for potential reasons of mechanical ventilator alarms. Additionally, (**Mahmoud, EL-shafie & Abdel-Aziz, 2020).** highlighted that there was a very good improvement in nursing performance after the educational program in all steps.

Also this study showed that statistically significant differences regarding mean score of nurse's knowledge domain about safety measures, regarding arterial blood gases. In the same direction, **(Mauliandari, Sumarwati & Setyo Upoyo, 2020)** who evaluated effective teaching-learning method for improving ability of taking arterial blood gases sample and interpretation, showed a marked increase in the score on interpreting ABGs before and after the intervention of the two groups. As well the study statistics were in the same line with quantifiable study statistics carried out by **(Kumari, Choudhary& Sharma, 2020).** who summarized that more than three-quarters of the participants in the study had good knowledge about ABG analysis and interpretation at the posttest, up from more than two-thirds at the pre-test.

In the present study, it was found that there were statistically significant differences regarding mean score of nurse's knowledge domain about safety weaning from mechanical ventilator. This data was supported by a quasi-experimental design conducted at Suez Canal University Hospital and Ismailia Medical Center, Egypt by **(Mahfoz, El Sayed & Ahmed, 2022),** who found the existence of statistically significant differences between the mean scores of the pre-post-test of nurses' knowledge regarding mechanical ventilator in relation to mechanical ventilator definition, risk factors, indications, problems, weaning and management. This section supported the first hypothesis which stated that the mean follow-up test knowledge scores of the intensive care nurses regarding the expert handling of mechanical ventilator patients would be significantly higher than the mean pretest knowledge scores.

Also this study showed that there was statistically significant differences regarding mean score of nurse's knowledge domain about regarding endotracheal tube insertion and suction. This result was supported by **(Afenigus et al., (2021),** who studied "The skill of suctioning adult patients with an artificial airway and associated factors among nurses working in intensive care units and found that three-fifths of the nurses maintain sterility during endotracheal suctioning procedures to lower the risk of pneumonia in mechanically ventilated patients.

Concerning nurses practice, it was found a highly statistically significant difference in the total mean score of practice on the regarding safety measures for mechanically ventilated patients Besides, preparation for mechanical ventilation, endotracheal tube insertion, and endotracheal suction. This can be explained by the fact that the newly staff nurses were full of energy and

enthusiasm. Nursing continuing education seeks to advance practice and knowledge to promote high standards of care **(Abou Zed &Mohammed, 2019)**.

The study findings were in agreement with **(Sheta & Mohamed Tantaewy, 2022),** which evaluated the effect of evidence-based programs on critical care nurses' performance related to care for intubated patients, ICU nurses who follow evidence based practice steps in all practice items related to ETT care and suctioning including the intubated patient oral care, ETT securing or re-taping, and cuff pressure measuring were only observed in a quarter of the studied nurses, who have a competent level of practice. However, after implementation of program, all practices in the same items significantly improved to a competent level. While a small drop in practice competence was seen following a three-month follow-up.

Also, **(Abou Zed &Mohammed,2019)** found that there was a significant decrease of total means score of nurses' practice pre implementation phase of program while there was a significant improvement of mean score of the same domain was observed at immediate phase of program implementation, however there was a relative reduction in mean score post 3 months of program implementation. This can be explained by the newly hired staff nurses were full of energy and enthusiasm. Nursing continuing education seeks to advance practice and knowledge to promote high standards of care.

In the present study, it was found that about half of nurses had unsatisfactory level of practice preprogram implementation compared to most of them had satisfactory practice immediately and after 3 months of program implementation. In agreement with current results **(Ali &Ahmed). (2023)** showed that, the studied nurses gained a higher satisfaction level of knowledge with the post-test phase then by the follow-up phase test up from the pre-test phase. Lastly, programs for ongoing education are intended to enhance the standard of nursing care and close the gap between scientific knowledge and real nursing performance **(Mahfoz et al., 2022)**.

In the present study, it was found that there was a highly statistically significant correlation between the studied nurses' overall knowledge score and their practice score throughout the intervention periods (pre, immediately and post 3months) .**In agreement with current results, Ali and Ahmed. (2023)** found that there was a correlation clarified that there was a highly statistically significant positive correlation between cumulative total knowledge and practice regarding care of mechanically ventilated patients throughout implementation phases among the studied nurses.

In the same way, the quasi-experimental study conducted at Benha Specialized Hospital by **(Mohamed et al., 2022),** indicated that a positive correlation existed between the total knowledge score, total practice, and total attitude score pre and post-competency-based training program implementation . In addition to **(Mohammed &Bader 2023)** illustrated that there was highly statistically significant positive correlation among nurses' procedural practice, understanding of the topic, and activities practiced prior to program implementation, immediately following it, and three months later.

In contrast, the study statistics were incompatible with a descriptive exploratory research study conducted by **(Ibrahem et al., 2021),** which reviewed Arterial blood gases interpretation: critical care nurses' knowledge and practices at a university hospital, confirmed that no statistically significant difference existed between nurses' knowledge and practices regarding arterial blood gases interpretation

Regarding relation between nurse's total knowledge and their ages, it was found that there was no significant relation between total knowledge and their ages. **(Mahmoud etal., 2020**) found that there was a statistically significant relationship between this procedure about nurses' age and educational program before and after the implementation of the educational program. Also, it was found that there was no significant relation between total knowledge and educational level. Parallel to our results, **(Mahmoud etal., 2022),** showed that there was no significant relation between total knowledge and educational level .

Also, the current result showed that no significant relation between nurses 'total knowledge and years of experience. In line with present results, **(Ali, 2013)** stated that all CCNs, irrespective of years of experience or area of work had unexpectedly unsatisfactory knowledge level about ventilator associated pneumonia (VAP) EBP prevention. The researcher suggested that the majority of nurses in this part acquire their knowledge of taking care of critically ill patients from their basic educational programs, or from hospital policies and procedures .

Concerning relation between age ,gender, marital status, level of education and years' experience in ICU and their total practice score, no significance differences were observed among studied nurses in pre ,immediately and post 3month periods. However it was found that increased mean score of nurses immediately after program among nurses in groups (30-<40) years but decreased gradually post 3months of program implementations.

Also, the highest mean ±SD of total practice of the studied nurses were in female immediately after program compared to preprogram implementations and decreased gradually post 3months of program. Also, the highest mean ±SD of total practice score was among married group immediately following program and decreased gradually post 3month. In addition the highest mean ±SD was observed in technical institute nurses immediately following program. Also, it shows that the highest mean ±SD of total practice of studied nurses was 1-<5years experience in ICU immediately program and compared to preprogram implementations and 3month of program.

In line with current results, **(Kim and Shin et al., 2017)** who found that the highest mean of total knowledge and practice program score among technical institute nurses immediately following program but slightly decreased post 3-month program implementation. Also, the highest mean of total knowledge and practice score of the studied nurses with 1-<5 years of experience in ICU was immediately following program implementation but mean score decreased post 3 month of program implementations.

Conclusions

The findings of this study suggest that introducing an educational program on

safety measures for mechanically ventilated patients significantly improves the knowledge and practice levels of nurses. About implementing safety measures of mechanical ventilated patient in pre, immediate and 3 months post program implementation.

Recommendations: Based on the finding of the current study, the following recommendations are derived:

A.Recommendation for clinical practice

Reassure implementing educational program about safety measures for mechanically ventilated patients that should be obligatory for recently critical care nurses in ICU.

Developing a simplified and comprehensive booklet including safety measures for mechanically ventilated patients should be available at ICU.

B. Recommendations for further research studies:-

-The research needs to be repeated with a wide-ranging probability sampling in diverse environments in order to apply the findings broadly.

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