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Original Article

Effectiveness of In-Service Training Module on Intensive Care Nurses' Performance Regarding Mechanical Ventilator Patients' Skillful Handling

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ABSTRACT

Background: Mechanical ventilation is life-saving handling to the maintenance of patients throughout oxygenation and ventilation. Critical care nurses have the most crucial role among health care workers in the skillful handling of mechanically ventilated patients. So, nurses must have the awareness, skills, and capabilities to handle a patient receiving mechanical ventilation adequately. **Aim**: to assess the effectiveness of the in-service training module on intensive care nurses' performance regarding mechanical ventilator patients' skillful handling. **Design**: A quasi-experimental design was used. **Setting**: The study was conducted at intensive care units affiliated with 3 Public Hospitals related to the Ministry of Health. **Subjects:** A purposive sample of 60 nurses who worked in the previously mentioned setting. **Data collection tools:** Nurses' structured self-administered questionnaire and nurses' practical skill competency checklist. **Results:** The study shows that (85% & 80%) of the studied nurses gained a higher retained level of knowledge and practice in the follow-up phase compared with (31.7% & 35%) in the pre-test phase. **Conclusion:** The majority of studied nurses get promoting the achievement of nurses' knowledge level and enhancement of nurses' practice level with a highly statistically significant positive correlation between cumulative total knowledge and practice regarding care of mechanically ventilated patients during pre, post & three months follow-up phases at (r= 0.987 and P= 0.000). **Recommendations:** Develop ongoing in-service training courses on mechanically ventilated patient care which should be mandatory for newly employed nurses. Emerging a regular rating determines nurses' training requirements for updating nurses' knowledge and practice.

Keywords: The in-service training module, Mechanical Ventilator, Skilful handling, Nurses' performance

Introduction:

In recent years, mechanical ventilation (MV) has become a life-saving procedure for maintaining patients' breathing and oxygenation while effectively removing metabolically produced carbon dioxide over an extended period (**Mahfoz et al., 2022**). Critical care nurses must possess the necessary knowledge, skills, and proficiency to effectively manage patients receiving MV. Educators, students, and nurse practitioners are making efforts to improve the information required for handling patients who require ventilator support (**Hassen et al., 2023).**

Furthermore, nurses' education can lead to the advancement of nursing care if it is performed and intended based on nurses' requirements and appropriate fundamental principles (**Hassen et al., 2023).**

There are numerous circumstances where MV is essential. These may involve oxygenating the blood and relaxing the respiratory muscles when the patient is undergoing surgery or receiving therapy for a severe traumatic brain injury. Along with the effects of numerous illnesses or injury processes, such as drug overdose, COPD, asthma, pneumonia, neuromuscular diseases, shock or trauma, and multiple organ failure ***(Al-Gunaid, 2020; Attia, 2022)*.**

Commonly, nurses are the first to handle critically ill patients and are familiar with the recognition and understanding of how to address issues and apply MV settings that frequently change and affect patient physiological status and management in response to disease circumstances ***(Hickey & Giwa, 2022)*.** Therefore, nurses' expertise and experience in handling the required care of patients with ventilatory support are essential, including reviewing indications, contraindications, ventilator management, potential complications, troubleshooting invasive mechanical ventilation problems, and emphasizing the significance of managing patient care ***(Andres & Jorge, 2022)*.**

In order to offer high-standard patient-focused intervention, the intensive care nurse who provides care for ventilated patients must be skilled in handling the ventilator modes, function, and weaning restrictions, as well as appropriate management ***(Attia et al., 2022)*.** Healthcare professionals, notably newly graduated critical care nurses who have little experience with the precise capabilities of the ventilator in use, frequently make changes to mechanical ventilator settings. To ascertain positive consequences and minimize injury, mechanical ventilators require specialized training due to their sophistication ***(Hadfield et al., 2020)*.**

Therefore inappropriate setting customization without appropriate orders, deficiency alarm handling, and inappropriate reporting of patient's prognosis may worsen as a result of changes to the medical staff. The purpose of this activity is to assist intensive care nurses in making sure that all personnel trained are trained to skilfully set up, install, and make appropriate adjustments to MV ***(Williams & Sharma, 2022)*.**

In addition to a competent practice level personalized to the needs of these patients which refers to mastering the information base, complex decision-making skills, and high-quality technological care. The nurse must study current developments in ventilator technology and receive instruction on how to apply various approaches and conditions to patients with various lung disorders who require MV ***(Palmore & Bloom, 2020 and Mehany et al., 2021).***

All nursing professionals who directly handle an invasively ventilated patient should undergo periodical competency exams, according to almost all respiratory and pulmonary boards ***(Brackett & Sanghavi, 2022).***

All employees who provide care for ventilated patients must have expert knowledge and skill regarding all mechanical ventilators' technical components as well as direct patient management ***(Brackett et al., 2022).***

In reality, best practices for performing various tasks and duties are developed through in-service training as well as to bring up-to-date the nurses' staff job-related knowledge and proficient abilities. Applicability is one of the key characteristics of in-service training modules. Another crucial aspect of the nursing staff's in-service training is nurses' active engagement, which promotes efficient learning and professional growth ***(Ahamed & Mesbah, 2019).***

Additionally, the development of nurses' performance and skilled handling of mechanical ventilator patient care came naturally as a result of computer-aided presentation with virtual reality. The importance of inpatient standard-of-care education is demonstrated in a nursing in-service training program. A crucial requirement is the need to increase the effectiveness of nurses' in-service training. A novel, ideal module for nursing staff's in-service training was planned in this study ***(Chaghari et al., 2017; Elfaki, 2022).***

This suggests that, in addition to relevant theoretical training, the intensive care nurses' knowledge has to be reinforced through the use of visual learning techniques and simulated application methods. Patients in intensive care units who are undergoing treatment on ventilators are totally reliant on nurses for all aspects of care. In order to guarantee the complete care of patients, reduce physiological demands, and prevent consequences brought on by inadequate care, all systems should be thoroughly assessed every hour ***(Kara & Temiz, 2022).***

Performance competencies required of critical care staff with praise to MV comprises whole the mechanical feature of the mechanical ventilator. Future complications will be avoided as a result of nurses' expert patient care by taking into consideration skillful customary practice, which will result in a comfortable ventilator weaning and shorter duration of MV ***(Alsharari et al., 2020 and Williams & Sharma, 2022).***

Significance

In the United States, from 20 to 40 percent of all patients admitted to intensive care units each year were using MV which costs an estimated $27 billion ***(Halpern, 2022)***. About 90% of all patients in intensive care units who are critically ill require ventilator-based supporting interventions. A considerable death rate affects about 30% of patients with mechanical breathing, and more or less 45% of those patients struggle to wean off of support ***(Cumpstey et al., 2022).*** The most frequent infection among hospitalized patients is ventilator-associated pneumonia, which has 4–13 days and lengthens hospital stays with fatality rates between 20% and 70% ***(AL-Mugheed et al., 2022).***

In Egypt there are no clear data about the medical error and mortality rate related to mechanical ventilators, also the mortality rate of mechanically ventilated patients in public hospitals ***(Ahmed et al., 2019 and Eweas et al., 2020).***

Most studies highlighted the significance of intensive care nurses' need for in-service training programs to upgrade nurses' knowledge and practice in connection with the care of patients on ventilators. This acquaintance knowledge needs to be integrated into exact and effective decision-making about the best skilled practice for avoiding ventilator-related risks ***(Mohamed et al., 2019 and Attia et al., 2022).***

Aim of the study:

This study was performed to assess the effectiveness of in-service training module on intensive care nurses' performance regarding mechanical ventilator patients' skillful handling, through the following:

- Confirmed the achievable knowledge of nurses regarding mechanical ventilator patients' skilful handling.
- Confirmed the achievable practice of nurses regarding mechanical ventilator patients' skillful handling.
- Conceiving and implementing an in-service training module on intensive care nurses' performance regarding mechanical ventilator patients' skillful handling.
- Evaluate the effectiveness of an in-service training module on intensive care nurses' performance regarding mechanical ventilator patients' skillful handling.

Research hypothesis:

H_1. The mean scores of the intensive care nurses' knowledge regarding mechanical ventilator patients' skillful handling will be significantly improved at the follow-up test up from the pre-test.

H_2. The mean scores of the intensive care nurses' practice regarding mechanical ventilator patients' skillful handling will be significantly higher at the follow-up test than at the pre-test.

H_3. There is a positive statistically significant correlation between nurses' knowledge and practice regarding mechanical ventilator patients' skillful handling.

Operational definitions:

The in-service training module: Establish pre-scheduled goals (the knowledge and practice) for a specific task (the skilled handling of mechanical ventilator patients) and target nurses, which include a pre-planned pre-test, the acquisition of content, and learning occupation to improve nurses' knowledge and practice, and measurement which prevents the occurrence of mechanical ventilator health-related complications, then post-test and follow-up.

Research design:

The quasi-experimental study design has been utilized. Quasi-experimental is a study in which the researcher activates the level of some independent variable and then measures the result which is an effective technique for measuring cause-and-effect relations **(Gopalan et al., 2021)**.

Technical Design:

The technical design includes the research setting, subjects, and tools for data collection.

Setting:

The study was performed at 3 Public Hospitals related to the Ministry of Health through an agreement between the Ministry of Health, Amira Fatma Academy, and the Faculty of Nursing – at Helwan University to provide in-service training modules to intensive care nurses with the primary goal to improve nurses' competency level of skillful handling of mechanical ventilator patients.

The first Hospital was Shopra Public Hospital, consisting of one building that contains two main intensive care units; the general intensive care unit (10 nurses) is located on the second floor and the cardiac intensive care unit (10 nurses) is located on the third floor. The second Hospital was Imbaba Public Hospital which contains two buildings connected by a bridge. The hospital had three main intensive care units; the isolated intensive care unit (5 nurses) located on the ground floor and the general intensive care unit (10 nurses) located on the first floor which were related to the new building and the burn intensive care unit (5 nurses) at the third floor which was associated with the old building. The third Hospital was Om-Elmasreen Hospital which consists of one building that contains two main intensive care units; a critical intensive care unit (13 nurses) and an emergency intensive care unit (7 nurses) located on located first floor.

Subjects:

The sample consisted of 60 staff nurses who were willing to engage in the study, available for the entire length of the study, and employed by previously recommended hospitals associated with the Ministry of Health ***(McCombes, 2023).***

Tools for Data Collection:

Data for this study were gathered according to the subsequent tools:

A- Nurses' structured self-administered questionnaire: It involved 2 subsequent parts:

Part I: Nurses' d**emographic characteristics** correspond to age, gender, level of education, position, experience years, and attending previous training courses for mechanical ventilator patients' skillful handling.

Part II: Nurses' Knowledge Questionnaire: To evaluate nurses' knowledge (pre/post) and retention during follow-up, the researchers created this questionnaire in Arabic, taking into account the pertinent documentation and data**.** The items in this sheet were adapted from ***(Saseedharan, 2017; Wiegand, 2017; Krishna, 2022)***, to assess nurses' competency in handling mechanical ventilator patients skillfully during the pre/post and follow-up stages of implementing an in-service training module, it included 9 main items: To measure nurses' knowledge regarding mechanical ventilator related needs assessment (2 questions), mechanical ventilator modes and parameter manipulation (3 questions), mechanical ventilator bundle (3 questions), alarm handling according to its cause (3 questions), mechanical ventilator weaning (3 questions), mechanical ventilator and connected artificial airway care (3 questions), mechanical ventilator mode changes and ABG interpretation(3 questions), mechanical ventilator and VAP prevention (3 questions), and mechanical ventilator

connected devices and comprehensive nursing intervention (7 questions).

Scoring system: The total score for nurses' knowledge was 30 questions with 60 grades, with two points awarded for each correct answer and one for each incorrect one. The aggregated score was measured based on ***(Saseedharan, 2017; Wiegand, 2017; Krishna, 2022)*** as the subsequent:

- ≥ 80% was considered satisfactory level of knowledge.
- < 80% was considered unsatisfactory knowledge.

B- Nurses' practical skill competency checklist: It was adapted by the researcher and written in the Arabic language based on ***(Balderrama & Pravikoff, 2022)*** to appraise the nurse competency practice regarding mechanical ventilator patients' skillful handling practice during pre/post and follow-up phases of in-service training module implementation**.** The observational checklists were composed of 11 main aspects: To measure nurses' skill competency regarding the nurse-patient preparation (3 items), patient assessment (2 items), patient medication administration (1 item), use of PPE precaution (1 item), suction (3 items), early prevention of ventilator-associated pneumonia (VAP) (5 items), mechanical ventilator setting and patient parameter analyses (4 items), To measure nurses' skill competency regarding patients prognosis monitoring and evaluation (4 items), prevention of mechanical ventilator related health complication (6 items), manipulate equipment and supplies (5 items), and the nurse-update plan of care and documentation (1 item).

Scoring system: The total score on the observational practice checklists for nurses was (35point with a total grade of 105) points. three grade was assigned to the step that was completed correctly, and two was assigned to the step that was correct and incomplete and one grade to the step that was incomplete or incorrect. The aggregated score was measured based on ***(Balderrama & Pravikoff, 2022)*** as the subsequent:

- ≥ 80% was considered competent level of practice.
- < 80% was considered an incompetent level of practice.

C- Development of in-service training module: Based on the analysis of the staff nurses' knowledge and practice scores from the pre-program assessment, the development of a checklist standard, the preparation of the first module draft, the application of the in-service training module's content validity, and the preparation of the final draught were all used to create the in-service training module.

Operational Design:

It includes the preparatory phase, pilot study, and fieldwork.

Preparatory Phase:

In order to design the data collection tools, the researchers conducted a comprehensive study of previously available material and utilized information from various sources, including books, journals, the internet, periodicals, and

magazines to theorize about various aspects of the study.

Content validity:

Five specialists from the medical-surgical nursing staff at the faculty of nursing at Helwan University judged the study instrument for relevance, importance, adjustment, and permission as part of the content validity process. Professors and assistant professors made up the jury, which represented several academic categories.

Testing reliability:

The reliability scores of study tools, including the Arabic versions of tools I and II for nurses' practical observational checklists and self-administered knowledge questionnaires, were examined in accordance with the Cronbach alpha (0.879 & 0.912), respectively.

Ethical Considerations:

After the purpose of the study has been clearly defined prior to data collection, informed consent was obtained from the hospital director, the director of the intensive care unit, and the staff nurses who engage in the study procedure. They received guarantees that they would remain anonymous, that the study's confidentiality would be upheld, and that they would have the freedom to leave at any moment without providing a reason. Beliefs, values, and culture would all be upheld.

Pilot Study:

A pilot research was conducted on a group of 6 nurses (or 10% of the sample) in order to assess the usefulness of the data-collecting tools, clarify the desired questionnaire, and determine the time needed to complete the tools. Because the instruments weren't changed, nurses included in the pilot study were also mixed in with the primary study subject.

Field Work:

- This study was performed through three phases: Assessment phase, in-service training module implementation phase including both theoretical and practical stages, and evaluation phase:

I- Assessment phase:

- The study was carried out as part of an agreement between the Ministry of Health, Amira Fatma Academy, and the Faculty of Nursing at Helwan University to offer intensive care nurses an in-service training module with the main objective of raising the nurses' competency level in terms of knowledge and practice.

- Before the in-service training module implementation, nurses who were available at the time of the study were chosen, and formal consent to participate in the collection of study pre-data was obtained. This step also involved describing the purpose and advantages of the study to the nurses.

- In this phase, the researchers were gathering information from nurses, starting with the demographic details, using practical observational checklists to observe and interview nurses in order to assess nursing staff members' skill proficiency. It took 20 to 30 minutes for each nurse to record what they saw and what the nurses stated for the researchers. Then the nurses' self-administered

knowledge surveys, which had taken each nurse about 20 minutes to complete

Proposed in-service training module:

It was designed to improve nurses' knowledge and practical level regarding mechanical ventilator patients' skillful handling. Based on nurses' knowledge pre-requisites, the researchers formulated the in-service training module in the Arabic language in particular the subsequent contents; knowledge regarding (Mechanical ventilator related needs assessment, mechanical ventilator modes and parameter manipulation, bundle, alarm handling according to its cause, weaning, connected artificial airway care, mechanical ventilator mode changes and ABG interpretation, VAP prevention, and mechanical ventilator connected devices and comprehensive nursing intervention). The practical part was designed to improve nurses' skill competency regarding (nurse-patient preparation, patient assessment, use of PPE precaution, suction, early prevention of ventilator-associated pneumonia (VAP), mechanical ventilator setting and patient parameter analyses, patients prognosis monitoring and evaluation, prevention of mechanical ventilator related health complication, manipulate equipment and supplies, and the nurse-update plan of care and documentation). Then Apply validity for the in-service training module content, thus the PowerPoint and audio-visual methods were prepared using related bibliography, research, and web citation.

II- Implementation phase

The in-service training module was repeated in the same manner at each hospital in the previously mentioned places respectively over 6 weeks.

- Nurses were divided into two groups, each group consisting of ten nurses, and the theoretical portion of the in-service training module was primarily explained to nurses through group discussion in the education room using PowerPoint presentations and audio-visual methods. This was done with the consent of various ICUs, the theoretical portion was broken up into three sections, each lasting two hours. In the event of a misunderstanding, nurses were permitted to ask questions while listening and demonstrating interest in nurses.

- With the assistance of an education team, the nurses were divided into 4 groups, with each group consisting of 5 nurses, and received practical in-service training one at a time in a sequential format through demonstration, re-demonstration, and role play applied in the intensive care unit within the hospital. Each group received the practical portion in a single session lasting no longer than two hours.

- The in-service training module was administered on the same day with the following instructions; applying the pre-test before it and then completing the post-test, nurses had given a soft audio-visual method and a Powerpoint presentation were sending to nurses on their phones to read and the source was given to the hospital education team.

II- Evaluation phase:

The effect of the in-service training module on the intensive care nurses' performance regarding mechanical ventilator patients' skillful handling was evaluated by comparing the results of pre, post, and post 3 months of the follow-up tests applied using the same data collection tools.

- Data collection and teaching sessions for the study group took about 5 months and were carried out in morning shifts starting from the beginning of November 2022 until the end of March 2023.

Administrative Design:

The existing study was approved after taking official permission from the ethics committee of the Faculty of Nursing, Helwan University by (N0.31) by date 19 October 2022.

Informed consent has been obtained from the recruiting hospitals to carry out the study and from the studied nurses.

Statistical Design:

Through the use of SPSS version 24, the collected statistics were examined. Chi-square and paired sample t-tests were used to show qualitative and quantitative data as frequency, mean, and standard deviation. A correlation coefficient (also known as person correlation) was used to examine relationships between various variables. Probability as p-value: less than 0.05 was considered significant, and more than 0.05 was considered extremely significant **(Salcedo & McCormick, 2021)**.

Results

Table (I) the demographic characteristics percentage distribution of the studied nurses illustrated that the majority of the studied nurses were females with a male-to-female ratio was 1:9. As well as, 73.3% of the studied nurses were between 20 < and 30 years with a mean age (25.95 ± 6.02) years. As well, 50% of the studied nurses had secondary school nursing education with 45% of the studied nurses had experience (6 ≥ 10) years, 35% of them had less than 5 years, and twentieth of them had more than 10 years with the mean experience years were (9.63 ± 5.34) years. Finally, 95% of the studied nurses didn't attend training courses related to the skillful handling of mechanically ventilated patients.

Table (2) Comparison between the level of knowledge regarding care of mechanically ventilated patients throughout pre/post and follow-up phases denoted that during the post-test phase, the majority of the studied nurses gained a higher satisfactory level (90%) followed by the follow-up phase test (85%) up from the phase of pre-test (31.7%). Moreover, a 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 nurses post-implementation with P = 0.000.

Table (3) Comparison between the total mean score of the studied nurses' knowledge regarding care of mechanically ventilated patient skillful handling represented that the studied nurses

achieved a higher mean score of knowledge 55.2+6.7 at the post-test phase, followed by follow-up phase test 53.1+7.6 up from the pre-test phase 38.9+8.5. Moreover, a highly statistically significant difference existed between the total mean score of knowledge regarding the care of mechanically ventilated patients throughout implementation phases with P = 0.000. Additionally, throughout implementation phases; Shubra Hospital increased higher mean score of knowledge (41.75+9.1, 56.9+5.1&54.8+6.6), followed by Embaba Hospital (38.75+8.1, 55.5+6.3 & 53.6+7.0) as compared to Om-Elmasreen Hospital (36.2+8.0, 53.4+8.2 & 51.1+9.0), respectively.

Figure (1) Percentage distribution of the total level of knowledge regarding care of mechanically ventilated patient skillful handling throughout implementation phases among the studied nurses displayed that, the studied nurses gained a higher satisfaction level of knowledge (90%) with the post-test phase then by the follow-up phase test (85%) up from the pre-test phase (31.7%). Additionally, throughout the implementation phases; Shubra Hospital attracted a higher satisfaction level of knowledge (40%, 95% &90), then Embaba Hospital (35%, 90% & 85%) compared to Om-Elmasreen Hospital (20%, 85% & 80%), respectively.

Table (4) Comparison between levels of practice regarding care of mechanically ventilated patient skillful handling throughout implementation phases among the studied nurses signified that during the post-test phase, the studied nurses gained a higher competent level (85%) followed by the follow-up phase test (80%) up from the pre-test phase (36.7%). Moreover, A highly statistically significant difference existed between the total mean score of practice for the care of mechanically ventilated patients during (pre & post) and (pre & follow-up) among the studied nurses was also found, with P = 0.000.

Table (5): Comparison between the studied nurses' total mean score of practice regarding care of mechanically ventilated patient skillful handling throughout implementation phases denotes that, the studied nurses gained a higher mean score of practice 91.5 $\pm$ 10.9 regarding the care of the mechanically ventilated patient at the post-test which slightly lessened by the follow-up test to 89.43 $\pm$14.2 up from the pre-test score 74.8 $\pm$ 13.3. Moreover, a highly statistically significant difference existed between the total mean score of knowledge regarding the care of mechanically ventilated patients throughout implementation phases with P = 0.000. As well, implementation phases indicated that Shubra Hospital gained a higher mean score of practice (77.3 $\pm$ 12.6, 94.0 $\pm$ 8.7, and 92.0 $\pm$ 12.3), followed by Embaba Hospital (76.6 $\pm$ 12.7, 90.8 $\pm$ 11.5 and 89.2 $\pm$ 14.3 up from Om-Elmasreen Hospital (70.4 $\pm$ 14.1, 89.8 $\pm$ 12.1 and 87.0 $\pm$ 16.0), respectively

Figure (2) Percentage distribution of total level of practice regarding care of mechanically ventilated patient skillful handling throughout implementation phases among the studied nurses showed that during the post-test phase, the studied nurses gained a higher competent level of practice

(85%) followed by the follow-up test (80%) up from with the phase of pre-test (35%). Additionally, implementation phases showed that Shubra Hospital gained a higher competent level of practice (40%, 90% &85), followed by Embaba Hospital (35%, 85% & 80%) up from Om-Elmaseen Hospital (30%, 80% & 75%), respectively.

Figure (3) Scatter dot 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 at (r= 0.987 and P= 0.000).

Table (1): Percentage distribution of the studied nurses' demographic characteristics (n= 60)

Items	Shubra Hospital (20)		Embaba Hospital (20)		Om – Elmasreen (20)		Total		χ^2	P Value
	N	%	N	%	N	%	N	%		
Age (year)										
≤30	14	70.0	15	75.0	15	75.0	44	**73.3**		
31 < 40	6	30.0	5	25.0	5	25.0	16	26.7		
Mean ± SD	**27.80 ± 6.16**		**26.20 ± 6.63**		**23.85 ± 4.74**		**25.95 ± 6.02**		0.17	0.918
Gender										
Male	4	20.0	2	10.0	0	0.0	6	10.0		
Female	16	80.0	18	90.0	20	100.0	54	90.0		
Male to female ratio	**1:4**		**1:9**		**0:1**		**1:9**		4.44	0.108
Educational level										
Secondary school	9	45.0	10	50.0	11	55.0	30	**50.0**		
Technical institute	7	35.0	7	35.0	8	40.0	22	36.7		
Bachelor	4	20.0	3	15.0	1	5.0	8	13.3	2.04	0.728
Experience										
1 ≥ 5 years	6	30.0	7	35.0	8	40.0	21	35.0		
6 ≥ 10 years	9	45.0	9	45.0	9	45.0	27	**45.0**		
> 10 years	5	25.0	4	20.0	3	15.0	12	20.0		
Mean ± SD	**10.80 ± 6.24**		**10.0 ± 5.76**		**8.10 ± 3.53**		**9.63 ± 5.34**		0.78	0.940
Attending training course										
No	2	10.0	1	5.0	0	0.0	57	**95.0**		
Yes	18	90.0	19	95.0	20	100.0	3	5.0	2.10	0.349

***Significant p < 0.05** ****Highly significant p < 0.01**

Table (2): Comparison between the level of knowledge regarding care of mechanically ventilated patient skillful handling during pre, post, and follow-up phases among the studied nurses (n=60)

Items	Pre-test				Post-test				3 months follow up				Pre× Post		Pre× Follow-up	
	Satisfactory		Un-satisfactory		Satisfactory		Un-satisfactory		Satisfactory		Un-satisfactory		T-test	P-Value	T-test	P-Value
	F	%	F	%	F	%	F	%	F	%	F	%				
▪ M.V. assessment	18	30.0	42	70.0	56	93.3	4	6.7	53	88.3	7	11.7	13.0	0.000**	11.9	0.000**
▪ Modes and parameter	20	33.3	40	66.7	55	91.7	5	8.3	52	86.7	8	13.3	14.8	0.000**	14.2	0.000**
▪ Ventilator bundle	23	38.3	37	61.7	54	90.0	6	10.0	51	85.0	9	15.0	19.1	0.000**	18.9	0.000**
▪ Ventilator alarm handling	21	35.0	39	65.0	57	95.0	3	5.0	54	90.0	6	10.0	19.9	0.000**	17.1	0.000**
▪ Ventilator weaning	25	41.7	35	58.3	58	96.7	2	3.3	55	91.7	5	8.3	14.7	0.000**	14.9	0.000**
▪ Connected artificial airway care	20	33.3	40	66.7	54	90.0	6	10.0	51	85.0	9	15.0	13.6	0.000**	14.6	0.000**
▪ ABG Interpretation	12	20.0	48	80.0	51	85.0	9	15.0	48	80.0	12	20.0	17.3	0.000**	16.3	0.000**
▪ VAP prevention	14	23.3	46	76.7	53	88.3	7	11.7	50	83.3	10	16.7	14.9	0.000**	15.4	0.000**
▪ Comprehensive nursing intervention	17	28.3	43	71.7	57	95.0	3	5.0	54	90.0	6	10.0	18.1	0.000**	16.3	0.000**
Total	**19**	**31.7**	**41**	**68.3**	**54**	**90.0**	**6**	**10.0**	**51**	**85.0**	**9**	**15.0**	**19.9**	**0.000****	**20.5**	**0.000****

***Significant p ≤ 0.05** ****Highly significant p ≤ 0.01** **T: T paired Test**

Table (3): Comparison between the total mean score of knowledge regarding care of mechanically ventilated patient skillful handling during pre, post, and follow-up phases among the studied nurses (n=60)

Items		Pre-test	Post-test	3 months follow up	F- test	P-Value
		$\bar{x} \pm$ SD	$\bar{x} \pm$ SD	$\bar{x} \pm$ SD		
▪ Shubra Hospital	Satisfactory	51.38±4.3	57.74±3.4	56.4± 4.6	26.6	0.000**
	Un-satisfactory	35.33±4.2	41.0±0.0	40.5±0.70		
	Total	**41.75±9.1**	**56.9±5.1**	**54.8+6.6**		
▪ Embaba Hospital	Satisfactory	48.57±2.2	57.11±1.0	55.88+4.5	32.5	0.000**
	Un-satisfactory	33.46+3.7	41.0±4.2	40.6+3.0		
	Total	**38.75±8.1**	**55.5±6.3**	**53.6±7.0**		
▪ Om-Elmasreen Hospital	Satisfactory	50.0±3.3	56.24±4.5	54.8±4.7	24.3	0.000**
	Un-satisfactory	32.8±4.0	37.67±6.1	36.2±6.1		
	Total	**36.2±8.0**	**53.4±8.2**	**51.1±9.0**		
Total	Satisfactory	50.0±3.5	57.0±4.0	55.75±4.6	80.4	**0.000****
	Un-satisfactory	33.76±4.1	39.33±4.6	38.6±4.6		
	Total	**38.9±8.5**	**55.2±6.7**	**53.1±7.6**		

***Significant p ≤ 0.05** ****Highly significant p ≤ 0.01** **F: ANOVA Test**

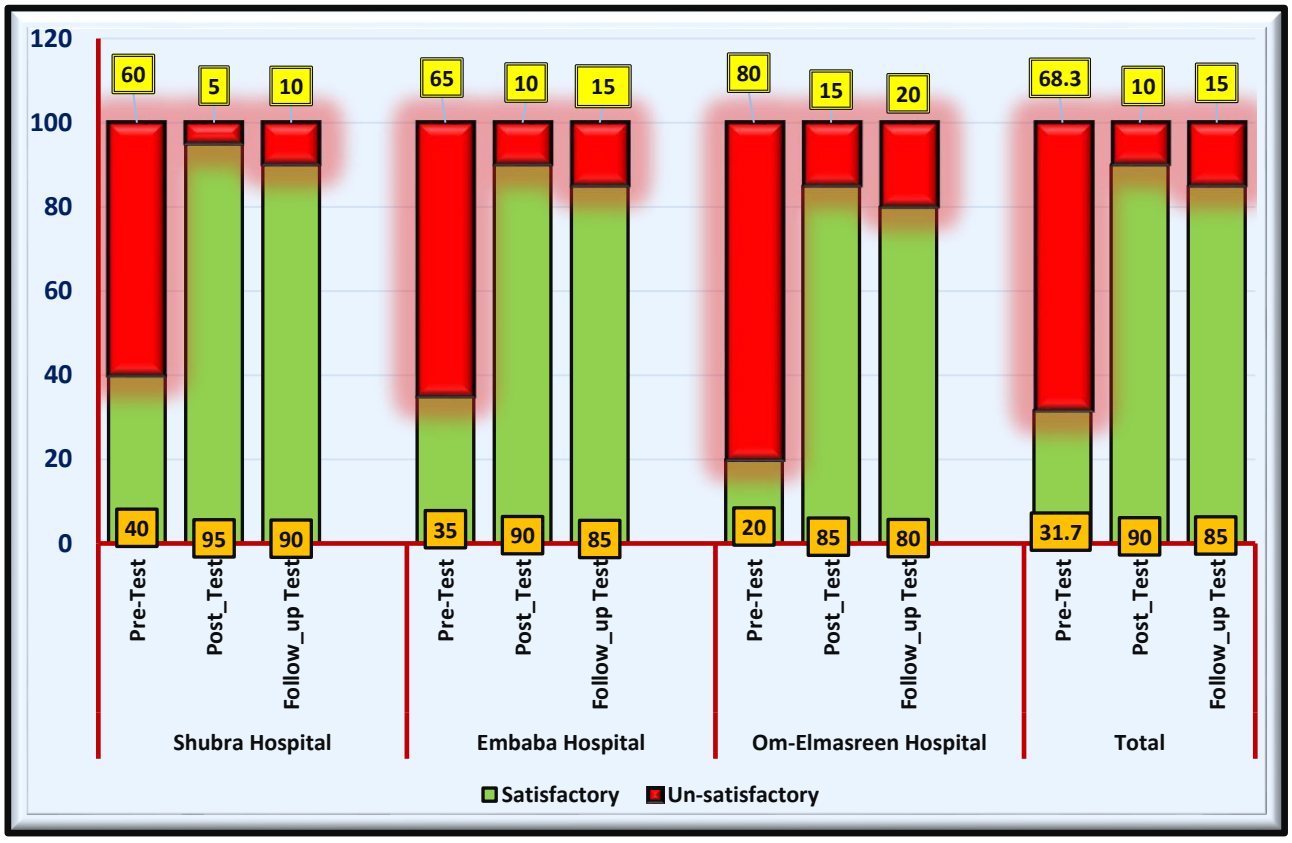

Figure (1): Percentage distribution of the total level of knowledge regarding care of mechanically ventilated patient skillful handling during pre, post, and follow-up phases among the studied nurses (n=60).

Table (4): Comparison between the level of practice regarding care of mechanically ventilated patient skillful handling during pre, post, and follow-up phases among the studied nurses (n=60)

Items	Pre-test				Post-test				3 months follow up				Pre× Post		Pre× Follow-up	
	Competent		Incompetent		Competent		Incompetent		Competent		Incompetent		T-test	P- Value	T-test	P- Value
	F	%	F	%	F	%	F	%	F	%	F	%				
▪ Preparation aspect	22	36.7	38	63.3	54	90.0	6	10.0	51	85.0	9	15.0	12.8	0.000**	11.0	0.000**
Patient assessment aspect	18	30.0	42	70.0	51	85.0	9	15.0	48	80.0	12	20.0	10.5	0.000**	10.7	0.000**
▪ Pre-ventilatory patient medication administration	24	40.0	36	60.0	54	90.0	6	10.0	51	85.0	9	15.0	8.8	0.000**	9.1	0.000**
▪ Use PPE precaution	21	35.0	39	65.0	54	90.0	6	10.0	48	80.0	12	20.0	9.8	0.000**	9.1	0.000**
▪ Suction	17	28.3	43	71.7	51	85.0	9	15.0	48	80.0	12	20.0	14.5	0.000**	12.1	0.000**
▪ Early prevention of (VAP)	20	33.3	40	66.7	55	91.7	5	8.3	51	85.0	9	15.0	16.5	0.000**	12.5	0.000**
▪ Mechanical ventilator setting and parameter	25	41.7	35	58.3	49	81.7	11	18.3	46	76.7	14	23.3	10.7	0.000**	7.4	0.000**
▪ Monitoring and evaluation aspect	19	31.7	41	68.3	46	76.7	14	23.3	44	73.3	16	26.7	10.7	0.000**	8.0	0.000**
▪ Health complication aspect	26	43.3	34	56.7	52	86.7	8	13.3	50	83.3	10	16.7	14.3	0.000**	10.1	0.000**
▪ Manipulate equipment and supplies aspect	14	23.3	46	76.7	48	80.0	12	20.0	45	75.0	15	25.0	13.6	0.000**	7.1	0.000**
▪ Update plan of care documentation aspect	21	35.0	39	65.0	51	85.0	9	15.0	50	83.3	10	16.7	9.5	0.000**	9.7	0.000**
▪ Total	**22**	**36.7**	**38**	**63.3**	**51**	**85.0**	**9**	**15.0**	**48**	**80.0**	**12**	**20.0**	**16.9**	**0.000****	**12.6**	**0.000****

***Significant p ≤ 0.05** ****Highly significant p ≤ 0.01** **T: T paired Test**

Table (5): Comparison between the total mean score of practice regarding care of mechanically ventilated patient skillful handling during pre, post, and follow-up phases among the studied nurses (n=60)

Items		Pre-test	Post-test	3 months follow up	F- test	P- Value
		$\bar{x} \pm$ SD	$\bar{x} \pm$ SD	$\bar{x} \pm$ SD		
▪ Shubra Hospital	Competent	91.2 ± 6.7	96.1± 6.4	96.3± 6.6	12.7	0.000**
	In-competent	68.1 ± 3.5	75.5± 0.71	67.3± 3.1		
	Total	**77.3 ± 12.6**	**94.0 ± 8.7**	**92.0 ± 12.3**		
▪ Embaba Hospital	Competent	92.0 ± 5.4	94.8 ± 6.6	95.5 ± 6.3	7.2	0.002**
	In-competent	68.3 ± 5.6	68.3 ± 4.9	64.2 ± 7.3		
	Total	**76.6 ± 12.7**	**90.8 ± 11.5**	**89.2 ± 14.3**		
▪ Om-Elmasreen Hospital	Competent	89.1 ± 7.1	95.1 ± 5.6	95.4 ± 5.9	11.5	0.000**
	In-competent	62.4 ± 6.4	68.7 ± 5.6	62.0 ± 7.1		
	Total	**70.4 ± 14.1**	**89.8 ± 12.1**	**87.0 ± 16.0**		
Total	Competent	90.90 ± 6.2	95.3 ± 6.1	95.7 ± 6.2	**30.0**	**0.000****
	In-competent	66.1 ± 6.0	70.0 ± 5.2	64.1 ± 6.2		
	Total	**74.8 ± 13.3**	**91.5 ± 10.9**	**89.43 ±14.2**		

***Significant p ≤ 0.05** ****Highly significant p ≤ 0.01** **F: ANOVA Test**

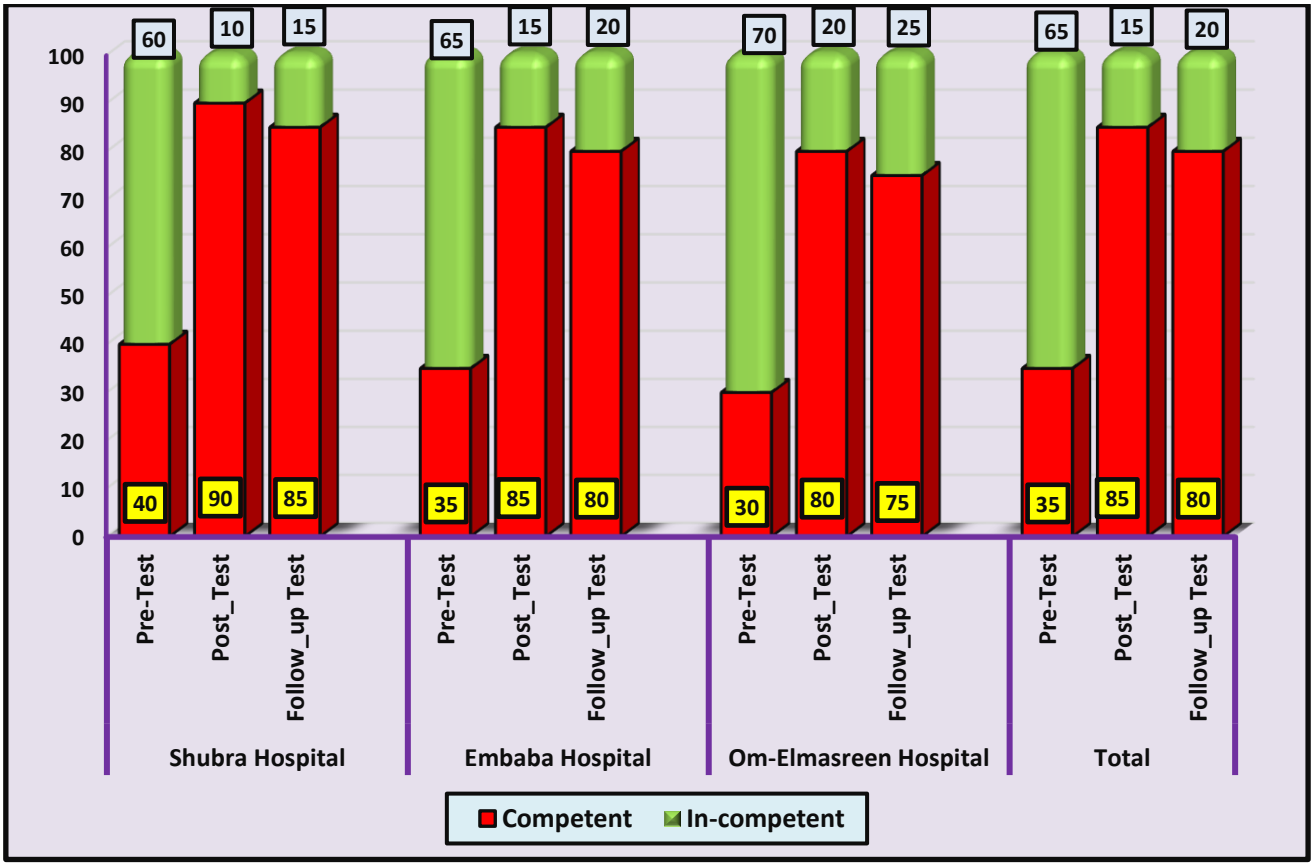

Figure (2): Percentage distribution of total level of practice regarding care of mechanically ventilated patient skillful handling during pre, post, and follow-up phases among the studied nurses (n=60)

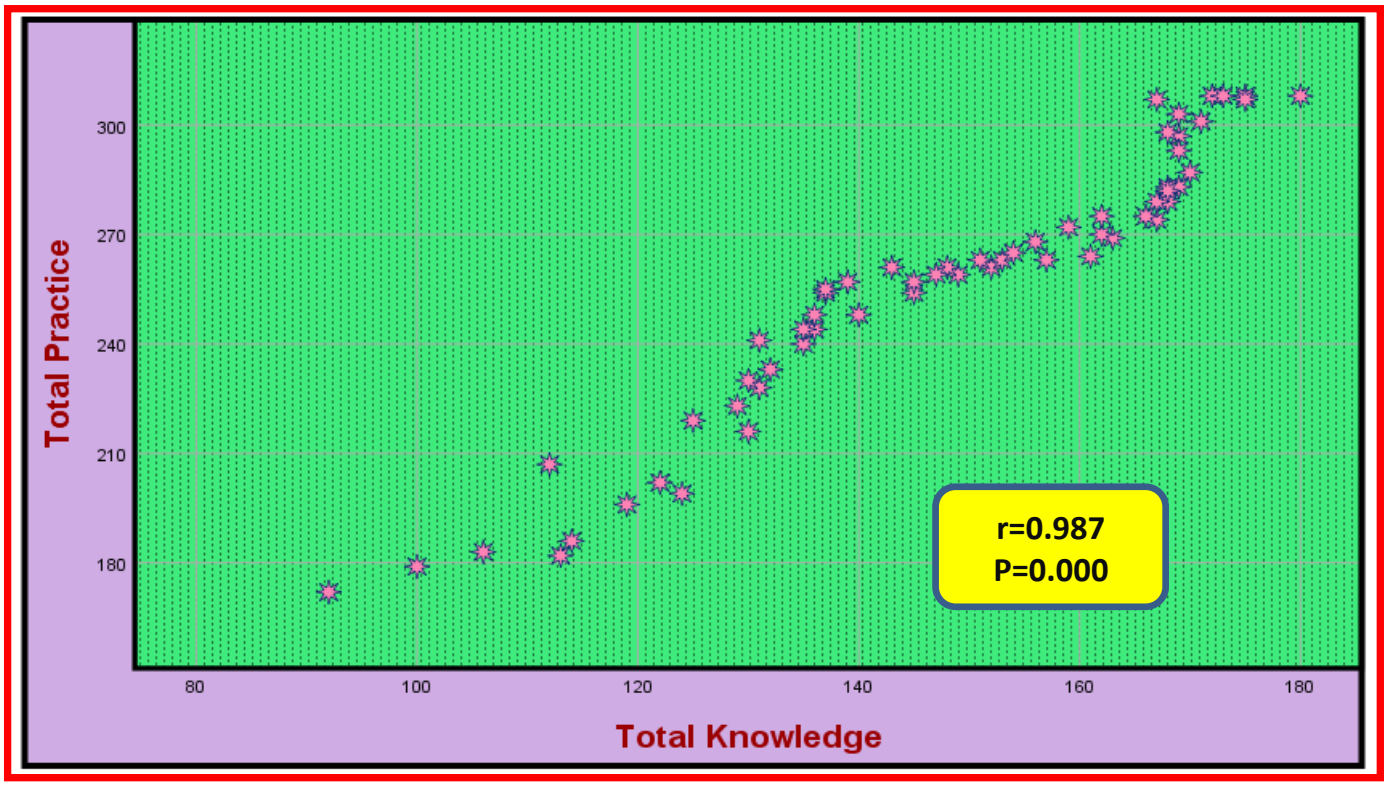

Figure (3): Scatter dot correlation between cumulative total knowledge and practices regarding the care of mechanically ventilated patient skillful handling throughout implementation phases among the studied nurses (n=60)

Discussion

Mechanical ventilation is one of the most significant life-saving advancements in medicine; nurses caring for patients on ventilators must be able to provide efficient nursing care for this patient population. Additionally, an effective training program for nursing staff will raise the standard of nursing care ***(Stawicki et al., 2020).*** So, the aim of this study is to, assess the effectiveness of the in-service training module on intensive care nurses' performance regarding mechanical ventilator patients' skillful handling.

Concerning critical care nurses' personal characteristics; regarding age among the studied nurses. The study results illustrated that around three-quarters of the age of studied nurses were between twenty and less than thirty years old with a mean age of 25.95 ± 6.02. From the researcher's point of view, this may be due to most of the nurses being newly graduated and most of the young, aged nurses able to provide direct care in the ICU for patients effectively, while the higher age groups of nurses have managerial roles.

In the same vein, the study 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± 4.5.

As well, these statistics were in the same line with ***Abd Elkader et al. (2020),*** in the study entitled 'Effect of Applying Program based learning on Nurse's Performance and self-efficacy regarding arterial blood puncture,' which examined 70 nurses working at four Ministry of Health-affiliated hospitals—in Port Said General Hospital, Elzohor, Elnaser, and Port Fouad Hospitals—and found that the average age of the sample under study was between 25 and 30 years old.

The bulk of the subjects who were studied were female, with a male-to-female ratio of 1:9. According to the researcher, this study's discoveries may be explained by the fact that nursing is a universally feminine profession and that men have just recently begun to enter this field. In the same vein, the study result was supported by a quasi-experimental design conducted at Suez Canal University Hospital and Ismailia Medical Center, Egypt by ***Mahfoz et al. (2022),*** which addressed the thesis entitled "The effect of design nursing instruction on mechanically ventilated children in paediatric intensive care units", and reported that majority of the studied participants were female.

Concerning educational level, about one-half of the studied nurses held a secondary school degree that is followed by was held a technical institute degree while the minority of them held a bachelor's degree. This could be explained in light of 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. In the same vein, the study was congruent with the study result achieved at Public hospitals in Sana'a City-Yemen by ***Al-Gunaid (2020),*** which revealed that more than two third of ICU nurses had a diploma in nursing and nearly three-quarters were working in ICU for 1-5 years.

Considering years of experience, more than two-fifths of the studied nurses had a year of experience ranging from sex to equal or less than ten years with a mean of 9.63 ± 5.34. 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 well, the study statistics were supported by a quasi-experimental study result applied at Benha Specialized Hospital by ***Mohamed et al. (2022),*** which analyzed the effect of a competency-based training program on nurses' performance regarding endotracheal tube suction, and found that The average age of the nurses who were the subject of the study was 30.26 4.74 years, and most of the nurses were female. Furthermore, more than one-third of nurses had experience ranging from five to eight years. A small percentage of them also skipped MV training sessions.

Additionally, the study statistics were in accordance with the study published in the Journal of Pharmaceutical Negative Results by ***Ebrahim et al. (2023),*** who reviewed the expected outcomes of

nursing care provided to children on mechanical ventilation, and discovered that the majority of the nurses under study were female and that roughly half of them were in the 20–30 age range. Additionally, more than two-thirds had less than 10 years of experience and had not previously taken a training course in mechanical ventilation.

With reference to the total level of knowledge about the care of mechanically ventilated patients, the present study denoted that during the pre-test, more than two-thirds of the research's nurses scored poorly on the pre-test when it came to the knowledge level of how to care for mechanically ventilated patients. According to the investigator, the explanation for nurses' lack of understanding regarding mechanically ventilated patients may be due to a lack of post-graduate continuing education courses or programs on the subject, supervision, and regular testing of nurses' expertise.

On the same line, the study statistic was consistent with descriptive research performed by **Abdelsttar *et al. (2022),*** which enrolled thesis entitled "Assessment of nursing performance toward infection control measures for mechanically ventilated patients", 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 the majority of nurses focused on general knowledge and infection control strategies for MV and patients.

In the same vein, the study statistics were congruent with the study result accomplished at Public hospitals in Sana'a City-Yemen by ***Al-Gunaid (2020),*** who uncovered 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.

On the contrary, the study statistics were discordant with the study result conducted by ***Mohammed et al., (2020)*** who assessed nurses' knowledge regarding the prevention of ventilator-associated pneumonia and found that more than half of the nurses had the necessary information regarding the ideal patient posture to lower the risk of aspiration.

Considering the total mean score of knowledge regarding care of mechanically ventilated patients throughout the study, the present study reported that the studied nurses gained a higher satisfaction level at the post-test phase followed by the phase of the follow-up test. Moreover, a highly statistically significant difference existed between the total mean score of knowledge regarding care of mechanically ventilated patients during pre-post and pre and follow-up tests among the studied nurses at P = 0.000. According to the researcher's explanation, the present difference between pre-post reflects the effectiveness of the in-service training module on intensive care nurses' performance regarding mechanical ventilator patients. Additionally, the presence of a difference between pre and follow-up tests reflects knowledge retention.

In the same direction, the study found was in harmony with ***Mauliandari et al. (2020),*** who evaluated effective teaching-learning method for improving ability in arterial blood gases 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 et al. (2020),*** which assessed a pre-experimental study entitled "The effectiveness of structured teaching program on knowledge regarding arterial blood gas analysis and interpretation among staff nurses working in selected hospitals of district Mohali, Punjab", summarised that more than three-quarters of the participants in the study had good knowledge about ABG analysis and interpretation at the post-test, up from more than two-thirds at the pre-test.

Additionally, the study statistics is congruent with the study result conducted in the trauma ICU and emergency ICU at Assiut University Hospital by ***Mahmoud et al. (2020),*** which studied "the effect of an educational program on nurses' performance regarding infection control precautions, toward patient on mechanical ventilation", and summarized that nurses 'knowledge regarding all knowledge component infection control in relation to hand washing, personal protective equipment PPE, ventilator bundle care, and ventilator-associated pneumonia showed statistically significant difference before and after application of infection control precautions.

Regarding the total mean score of knowledge regarding care of mechanically ventilated patients, the study result discusses that, during the post-test phase, the studied nurses gained a higher mean score of knowledge regarding care of mechanically ventilated patients followed by the follow-up phase as compared with the pre-test phase. Moreover, a highly statistically significant difference existed between the total mean score of knowledge regarding care of mechanically ventilated patients during the pre, post, and 3 months follow-up phase among the studied nurses at P = 0.000. Additionally, throughout the implementation phases; Shubra Hospital gained a higher mean score of knowledge, followed by Embaba Hospital as compared Om-Elmasreen Hospital, respectively.

As the researcher's Explanation, the decline of the mean score of knowledge in the pre-test phase may be due to a lack of concern from the authority and responsible persons for training the studied nurses before demonstrating the training contract with El-AMira Fatma, 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.

Moreover, there was a slight decline in the follow-up phase as compared with the post-test phase. These statistics may be due to the fact that studied nurses must be provided with opportunities to reflect and apply new knowledge to practice, as

this is essential for reinforcing and retaining theoretical learning. Additionally, the discrepancy in the mean score of knowledge between the three hospitals might be due to the differences in the availability of institutional policies and procedure guidelines, knowledge of nurses, continuing education, and equipment between the pre-mentioned hospitals.

Additionally, this data was supported by a quasi-experimental design conducted at Suez Canal University Hospital and Ismailia Medical Center, Egypt by ***Mahfoz et al. (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, and management. This section supported the 1st 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 pre-test knowledge scores.

According to the study apprehensive nurses' practice; more than two-thirds of the nurses demonstrated incompetence in the pre-test about patient care for those on mechanical ventilation. From the perspective of the researchers, the study's nurses were between the ages of 20 and 30; most of the nurses had just graduated or been hired; half of the studied nurses held a secondary school degree, while only a minority of the staff had bachelor's degrees.; most of the study's nurses had not attended training sessions on MV; and lack of nurses' ongoing evaluation with poor multidisciplinary healthcare team members (nurses–physicians) collaboration. All of these factors may have contributed to the lack of practice with respect to mechanically ventilated patients.

In a similar vein, the study's data matched those of a descriptive exploratory study completed by **Abdelsttar *et al. (2022),*** which revealed that about two-thirds of the study's participants performed infection control procedures for mechanically ventilated patients at an inadequate level. Additionally, the study statistics were consistent with a study by ***Ebrahim et al. (2023) that*** was published in the Pharmaceutical Negative Journal and found that nearly two-thirds of the nurses in the study had completely insufficient levels of experience in providing MV nursing care for children.

Additionally, the study supported by ***Botros et al., (2019),*** who 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.

In contrast, the study statistics disagreed with ***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, in the Amhara region, public hospitals, Ethiopia" and found that three-fifths of the nurses under investigation do chest physical therapy and maintain sterility during endotracheal

suctioning procedures to lower the risk of pneumonia in mechanically ventilated patients.

The current study also revealed that the examined nurses increased their level of competence from the pre-test to the post-test phase and subsequently to the follow-up phase. Additionally, the relationship between the pre-post and pre-follow-up phases revealed a highly statistically significant difference in the total mean score of practice on the treatment of mechanically ventilated patients at P = 0.000. As the researcher's explanation, 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 ***(Abou Zed & Mohammed, 2019).***

Moreover, the study statistics were in agreement with ***Sheta and Mohamed (2022),*** which evaluated "The effect of evidence-based programs on critical care nurses' performance related to care for intubated patients", published in the Egyptian Journal of Health Care and illustrated that ICU nurses who follow EBP 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 the program was implemented, 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.

Additionally, a high statistically significant difference regarding the overall practice existed between the relation of pre-post and pre-follow-up phases of the program implementation. While, there was no statistically significant difference in the total level of nurses' practice between post and three months follow-up of the program implementation.

Regarding the total mean score of practice regarding care of mechanically ventilated patients; the study result summarized that the studied nurses gained a higher mean score of practice regarding care of mechanically ventilated patients at the post-test phase which slightly decreased at the follow-up phase up from with the pre-test phase. Moreover, a highly statistically significant difference existed between the total mean score of knowledge regarding care of mechanically ventilated patients during pre, post, and 3 months follow-up among the studied nurses at P = 0.000. Additionally, implementation phases displayed that Shubra Hospital achieved a higher average practice score, followed by Embaba Hospital up from Om-Elmasreen Hospital, respectively.

As a result, the current study improved nurses' overall mechanical ventilation understanding and practice. maybe a result of outdated training and experience, which can occasionally result in medical errors, a staffing shortfall, a lack of equipment, inadequate close monitoring and reinforcement, and an overburden of the nurse's workload. 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).***

Additionally, the researchers interpreted the difference between hospitals may be reflected as the percentage of nurses with bachelor's degrees and the number of older nurses were higher in Shubra Hospital followed by Embaba Hospital as compared Om-Elmasreen. This section supported the 2nd hypothesis which stated that the mean follow-up test practice scores of the intensive care nurses regarding the skillful handling of mechanical ventilator patients would be significantly higher than the mean pre-test knowledge scores.

Concerned with the study correlation; the present study clarified that a highly statistically significant positive correlation existed between cumulative total knowledge and practice regarding care of mechanically ventilated patients throughout implementation phases among the studied nurses. It implies that the pre-test phase's nurses had inadequate information, which led to inadequate practice levels. On the other hand, during post and follow-up tests, the studied nurses gained higher knowledge and consequently higher practice levels Therefore, in order to deliver high-quality treatment, nurses must possess the necessary knowledge and practical experience.

The researchers' perspective view was in agreement with ***Yones et al. (2019),*** who stated that low knowledge among nurses can lead to medication errors. As well, the researchers noted that safe drug administration is dependent on knowledge, attitude, and solid clinical judgment.

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 and Bader (2023),*** who published in the Egyptian Journal of Health Care and illustrated that between nurses' procedural practice, understanding of the topic, and activities practiced prior to program implementation, immediately following it, and three months later, there was a highly significant statistically positive link about following EBP during the procedure implementation.

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 at P value > 0.05. This section supported the 3rd hypothesis that there is a positive correlation between nurses' knowledge and practice regarding mechanical ventilator patients' skillful handling.

Conclusion

Based on the statistics of the current study, it can be concluded that applying an in-service training module on intensive care nurses' performance regarding mechanical ventilator patients' skillful handling is extremely effective in

promoting the achievement of nurses' knowledge level and enhancement of nurses' practice level. As well, the majority of the studied nurses gained a higher retained level of knowledge and practice at the follow-up phase up from around one-third at the pre-test phase. Furthermore, a highly statistically significant positive correlation existed between cumulative total knowledge and practice regarding mechanically ventilated patient care during pre, post & three months follow-up phases of program implementation.

Recommendations

From the previous conclusion, the following recommendation is suggested:

- A further study is to be carried out in different settings on a larger sample for a wider utilization of the in-service training module, in order to attain higher gained performance in public hospitals.
- Implement a periodic evaluation to determine the nurses' proficiency for evaluating nurses' knowledge and improving nurses' practice.
- Reassure in-service training courses about mechanically ventilated patient care that should be obligatory for recently hired nurses.
- To achieve greater gained performance in public hospitals, a future study is to be conducted in various contexts on a larger sample for wider use of the in-service training program.

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