

Effect of an Educational Program on Nurses' Performance Regarding Care of Mechanically Ventilated Children and Their Clinical Outcomes in Pediatric Intensive Care Units

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Abstract: Background: Even though mechanical ventilation has drawbacks, it is a crucial supportive technique in intensive care units. Therefore, nurses' mechanical ventilator knowledge and practices are essential to enhancing both the efficacy of mechanical ventilation and outcomes for child. Aim of the study was to evaluate the effect of an educational program on nurses' performance regarding care of mechanically ventilated children and their clinical outcomes in pediatric intensive care units. Research design: A quasi -experimental design was utilized to conduct this study. Settings: The study was conducted in pediatric intensive care units in Suez Canal University Hospitals, Ismailia Medical Complex, Pediatric Hospital at Zagazig University Hospitals and Al Ahrar Hospital in Zagazig city. Sample: A purposive sample of 74 nurses and 74 children. Tools of data collection: Tool I: A structured interview questionnaire sheet consisted of 3 parts, Part I: Personal characteristics of the studied nurses, Part II: Characteristics of studied children and Part III: Nurses' knowledge regarding mechanical ventilator and nursing care of children on mechanical ventilator, Tool II: An observational checklist for nurses' practice, Tool III: Likert Type Rating Scale and Tool IV: Child outcome assessment sheet Results: There were, a highly statistically significant difference existed between the total mean score of nurses' knowledge and practice (pre/post) and (pre/follow up), less than three quarters of the studied nurses had positive attitude regarding care of mechanically ventilated children and the studied children clinical outcomes were improved Conclusion: the implementation of an educational program had a positive effect on nurses' performance and child clinical outcomes. Recommendation: Nurses will be able to update their knowledge and enhance their practice with the support of in-service training programs and continuing nursing education for the management of children on mechanical ventilation.

Keywords: Clinical Outcomes, Educational Program, Mechanically Ventilated Children, Nurses Performance, Pediatric Intensive Care Units.

I. INTRODUCTION

The primary supportive treatment utilized in critical care is mechanical ventilatory support. Simply put, a mechanical ventilator is a device that augments or replaces the body's natural breathing mechanism. Usually, it is a stopgap solution until the infant is able to breathe on their own ⁽¹⁾.

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The term "mechanical ventilation" describes the use of life support equipment to help youngsters who are unable of efficiently oxygenating or ventilating themselves ⁽²⁾. However, in order to maintain proper pulmonary gas exchange and lessen the effort required to breathe, mechanical ventilation (MV) is an automated device that does all or part of the breathing for children who are unable to breathe adequately on their own ⁽³⁾.

One of the most frequent treatments carried out in intensive care units (icus) worldwide is mechanical ventilation, which is also one of the primary reasons why children require an ICU bed. It is anticipated that the incidence of this procedure will rise over the course of the next ten years. A life-saving procedure, mechanical ventilation reduces children's respiratory effort and reverses acute, potentially fatal respiratory acidosis and hypoxemia. It is recommended in cases of sepsis, acute respiratory failure, heart failure, and drug overdose, sluggish anesthetic agent reversal, and neuromuscular problems in children who are unable to protect their airway ⁽⁴⁾.

Mechanical ventilation is used to either assist the child with chronic ventilatory issues or to keep them supported until the underlying issue is resolved. These objectives can be met by increasing lung volume, decreasing labor of breathing, or improving arterial oxygenation and alveolar ventilation ⁽⁵⁾.

Positive pressure and negative pressure ventilators are currently the two primary types of ventilators on the market. Externally attached to the infant, negative pressure ventilators lower the air pressure around the thorax to start inspiration; they are typically not utilized in critical care settings. Positive pressure ventilators pump air into the child's lungs via a tracheostomy tube or endotracheal tube (ETT) using a mechanical driving mechanism ⁽⁶⁾.

In contrast to spontaneous natural breathing, which involves negative pressure breathing (air passively flowing into the lungs), mechanical ventilation is a non-physiological procedure since the Gas is forced into the lungs under positive pressure. As a result, difficulties are likely to arise. Therefore, in addition to being aware of these issues, health care professionals should be able to detect, foresee, identify, and avoid them as soon as possible ⁽⁷⁾

Ventilator-associated lung damage (VALI) and nosocomial infections, including ventilator-associated pneumonia (VAP), are the physiological consequences linked to MV. Increased permeability, pulmonary edema, cell contraction, cytokine production, diffuse alveolar damage, and alveolar over distention are all consequences of ventilator-associated lung injury. Inappropriate use of mechanical ventilation can lead to additional difficulties, such as alveolar stretch and edema formation from a large tidal volume, and excess alveolar gas that can cause pneumothorax or subcutaneous emphysema due to high peak inspiratory pressures ⁽⁸⁾.

As a result, critical care nurses are essential to enhancing the efficiency of mechanical breathing, avoiding injury, and improving the outcomes for children. Additionally, health teams can adjust ventilator settings to optimize ventilator support advantages and minimize issues by using their knowledge and expertise in the care of a kid on a mechanical ventilator and the child's clinical status ⁽⁹⁾.

Any changes in physical assessment results or noteworthy blood gas trends that indicate the onset of a major issue (such as pulmonary embolus, tube displacement, or pneumothorax) or early indications of ventilator-related infections are frequently noted by the nurse first ⁽¹⁰⁾.

Therefore, it is crucial to make sure that nurses who care for children on mechanical ventilation have the necessary training and experience to monitor, identify, and prevent any potential negative effects because these children require specialized knowledge and skills ⁽¹¹⁾.

Because they are the primary source of information for children, family members, and other members of the interdisciplinary team, nurses must possess the pertinent knowledge and abilities needed for their Position. Nurses who possess the necessary knowledge and abilities can enhance child outcomes, shorten hospital stays, and lower the risk of complications ⁽¹²⁾.

SIGNIFICANCE OF THE STUDY:

Many youngsters with breathing problems find that mechanical ventilation (MV), a technical development that reduces the stress of breathing, is their life support. It is one of the most frequent causes of pediatric intensive care unit admissions; the percentage of infants and children on mechanical ventilation varies from 30% to 64% over time ⁽¹³⁾. The percentage of children in Egypt who used mechanical ventilation was 32.8% ⁽¹⁴⁾.

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So, pediatric critical care nurses must have a specialized skills and knowledge to practice efficiently in critical situations. Also, they should have a competent level of care for children on the MV. Therefore, this study was conducted to evaluate the effect of an educational program on nurses' performance regarding care of mechanically ventilated children and their clinical outcomes in PICUs.

II. BODY OF ARTICLE**AIM OF THE STUDY:**

The aim of this study was to evaluate the effect of an educational program on nurses' performance regarding care of mechanically ventilated children and their clinical outcomes in pediatric intensive care units.

RESEARCH HYPOTHESIS:

- Nurses' performance regarding care of mechanically ventilated children in pediatric intensive care units will be improved after implementation of an educational program.
- Clinical outcomes of mechanically ventilated children will be improved after implementation of an educational program.

Subjects and Methods:**Research design**

A quasi experimental study design (pre, post and follow up) was utilized to conduct this study.

Research Settings:

The study was conducted in pediatric intensive care units in Suez Canal University Hospitals, Ismailia Medical Complex, Pediatric Hospital at Zagazig University Hospitals and Al Ahrar Hospital in Zagazig city.

Subjects:

- A purposive sample of (74 nurse) who were working in the previous mentioned settings, who were responsible for providing care for children on mechanical ventilator at the time of this study from the above mentioned setting were included in the study regardless their personal characteristics and willing to participate in the study.
- A purposive sample: A sample made up of (74 child) attending the previously mentioned setting were included in the study. Children were assigned into two groups: the first (37 children) were considered as control group received the hospital routine care and the second (37 children) were considered as study group who were subjected to the program intervention. All children were selected according to the following:

Inclusion criteria:

- Both sex children aged between 1 month to 12 years
- Children should be intubated for more than 12 hours
- Children should have the same diagnosis

Exclusion criteria:

- New born (<28 days old).
- Post-operative cardiothoracic children were excluded from the study.

Tools of data collection:

There are four tools were used to collect the required data.

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These tools as the following:-

Tool I: A structured interview questionnaire sheet

It was designed by the researcher in Arabic language after review of different literature to assess nurses' knowledge regarding mechanical ventilator and nursing care of children on mechanical ventilator and consists of three parts:

Part 1: Personal characteristics of the studied nurses such as age, gender, educational level, years of experiences, attendance of any training program regarding care of children on mechanical ventilation.

Part 2: Characteristics of studied children according to their personal and clinical data such as age, gender, diagnosis, underlying disease and reasons for the initiation of mechanical ventilation, duration on mechanical ventilator, and modes of mechanical ventilation.

Part 3: Nurses' knowledge regarding mechanical ventilator and nursing care of children on mechanical ventilator.

Scoring system for knowledge

The scoring system was developed by the researcher; each correct answer was scored (1) point and (0) for wrong answer or don't know. The total nurses' knowledge level were ranged from

(0 – 67) marks which classified as the following:-

- Good $\geq 80\%$ (53.6 – 67 marks).
- Fair 60-80% (40.2 – < 53.6 marks).
- Poor < 60% (< 40.2 marks).

Tool II: An observational checklist for nurses' practice It was adopted from ⁽¹⁵⁾ & ⁽¹⁶⁾ to evaluate nurses' practice about all aspect of care provided to children on mechanical ventilator.

Scoring system of nurses' practice

The scoring system was developed by the researcher, each correct step done

adequately will take two points, done in adequately will take one point and zero point for not done. The total level of nurses' practice was ranged from (0- 424) marks which classified as the following:

- Competent $\geq 85\%$ (360.4 – 424 marks)
- Incompetent <85% (< 360.4 marks)

Tool III: Likert Type Rating Scale

Modified Likert scale adopted from ⁽¹⁷⁾ was used to assess attitude of PICUs nurses regarding care of children on mechanical ventilator and consists of (13) statements. The scale was measured on five point's Likert Scales ranging from strongly agree, agree, neutral, disagree, and strongly disagree respectively.

Scoring System of Nurses' Attitude:-

The total number of items (13) was measured on five points Likert scale ranging from 5,4,3,2 and 1 for responses: strongly agree, agree, neutral, disagree, and strongly disagree respectively for the positive statements number (3,5 and 8) and this scoring will be reversed from 1 to 5 for negative statements number (1,2,4,6,7,9,10,11,12, and 13). Score of items was summed up with total score (25) divided by number of items giving mean score for the attitude of nurses regarding care of children under mechanical ventilator. Total score was converted in to a percent score, and means and standard deviations was computed. The attitude considered **"Positive"** if percent score **60%** or more (15 or more than) and **"Negative"** if less than **60%**(less than 15).

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Tool IV: Child outcome assessment sheet:

Was developed by the researcher after review of different literature to assess clinical outcomes of mechanically ventilated children. This tool was used to assess the effect of nurses' practice on clinical outcomes of children after program implementation, it covered: length of stay, type of discharge, weaning outcomes (as successful weaning or weaning failure), duration on mechanical ventilator, mortality rate, Clinical parameters and occurrence of other morbidities (Complications) e.g. ventilator associated pneumonia VAP, atelectasis, pneumothorax, pulmonary edema, laryngeal edema and oxygen toxicity.

Tools validity and reliability:

Tools of data collection were translated and investigated for their content validity by panel of three experts in pediatric nursing specialty (one assistant professor from faculty of nursing, Suez Canal University and two assistant professor from faculty of nursing, Benha university) to test content validity of the tools and to judge its clarity, relevance, comprehensiveness, understanding and applicability. The opinion was elicited regarding the layout, format and sequence of the questions and all of their remarks were taken into consideration and the tools were regarded as a valid from the experts' point of view.

Reliability of the tools was examined by using Cronbach's alpha coefficient test in SPSS program, version 26 to measure the internal consistency for all tools. The results were as the following: internal consistency reliability Cronbach's alpha for nurses' knowledge regarding care of mechanically ventilated children is good reliable emerged as (0.781). Nurses' practice (0.796), nurses' attitude (0.704). Studied children outcomes (0.711) and control children outcomes (0.549).

The research approval was obtained from the Scientific Research Ethical Committee at the faculty of nursing Suez Canal University before starting the study. The inclusion of subjects in the study was totally voluntary. A verbal consent was obtained from the nurses to accept to participate in the study and confidentiality of any obtained information was ensured and each nurse has the right to withdraw at any time of the study without incurring any consequences.

Pilot Study:

A pilot study was carried out on 10% of the study subjects (7 for nurses and 7 for children) to test applicability, feasibility, practicability of the study tools and time required to fill in each tool. The result of the obtained data helped in modifications of the study tools by adding arterial blood gases instead of capillary blood gases, and weaning child from mechanical ventilator was added to the observational checklist. Nurses' and children who participated in the pilot study were excluded from the study sample.

Field Work:

The educational program was implemented achieve the aim of the current study through four sequential phases; assessment, planning, implementation and evaluation phase. These phases were conveyed from the beginning 1st of July, 2023 and ending March 2024 covering 9 months.

1- Assessment phase:

This period took 3 months (from the beginning of July, 2023 to the end of September 2023). This phase was performed before the implementation of educational program by interviewing each nurse individually to assess their knowledge, practice and attitude (pretest) by using tool I, tool II and tool III after explaining the aim of the study and had their approval to participate in the study.

2- Planning phase:

This phase includes analysis for the pretest to detect the nurses' needs about care of mechanically ventilated children through the finding of a pretest. Based on the results obtained from the interview sheet, observational checklist and Likert Type Rating Scale (from pilot and assessment phase) as well as reviewing the related literature the educational program was developed by the researcher. Detected needs, requirements and deficiencies were translated into aim and objectives of the educational program. The contents of the educational program were selected on the basis of identified needs.

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Teaching methods were selected to suit teaching in small groups in a form of lectures, group discussion and demonstration. Teaching materials were prepared as videotapes, manikin and real equipment, colored poster and handout that covered theoretical and practical information.

3- Implementation phase:

This phase took 3 months from the beginning of October 2023 to the end of December 2023. The educational program of this study was implemented through eight sessions for each group. Each group have 5 nurses and each session started by a summary of the previous session and objective of new one. The researcher interviewed the nurses' individually according to their availability (after providing nursing activities of the unit), the time of each session differed according to its content and nurses response and ranged between 30-45 minutes. Teaching session was conducted one day per week for each group setting, Saturday for nurses in Suez Canal University Hospitals, Monday for nurses in Ismailia Medical Complex, Tuesday for nurses in Pediatric Hospital at Zagazig University Hospitals and Thursday for nurses in Al Ahrar Hospital in Zagazig city.

Theoretical part as the following; first session of program included introduction about educational program and basic knowledge about function and anatomy of respiratory system, **second session** included mechanical ventilator; definition, purpose, indications, types of mechanical ventilation, signs indicate that the child needs for mechanical ventilator and complications of mechanical ventilator, **third session** included modes of mechanical ventilation, component of mechanical ventilator, ventilator settings and ventilator alarms.

Practical part concerned with application of care related to; fourth session included endotracheal tube care and application of suctioning for mechanically ventilated children, **fifth session** included arterial blood gases sampling and application of Glasgow coma scale for mechanically ventilated children, **sixth session** included preparation of mechanical ventilator and nursing care for mechanically ventilated children, **seventh session** included weaning child from mechanical ventilator, **eighth session** included application of chest physiotherapy, auscultation of breathing sounds and range of motion exercise for mechanically ventilated children. At the end of each session, the researcher summarizes the key topics and verifies that the nurses understand the information presented.

Evaluation phase:

This phase took 3 months from the beginning of January to the end of March 2024. After conducting educational program studied nurses' knowledge and practice as well as clinical outcomes of studied children was evaluated using tools (I), (II)&(IV) (by the end of the sessions as a posttest and after three months later as follow up).

Statistical Design:

The data were collected, coded, tabulated and subjected to statistical analysis. Statistical analysis was performed by Statistical Package for Social Science (SPSS) version 26; also Microsoft Office Excel is used for data handling and graphical presentation. Descriptive statistics were applied in the form of mean and standard deviation for quantitative variables and frequency and percentage for qualitative variables. Qualitative categorical variables were compared using the Chi-square test (X^2) and Pearson's correlation coefficient was calculated between variables. Highly statistical significance was considered at P-value ≤ 0.001 , Statistical significance was considered at P-value ≤ 0.05 , Non significance P-value > 0.05

III. RESULTS

Table (1) found that, less than half of the studied nurses' age 45.9 % ranged between 25 -<30 years old with mean age of 28.33 ± 5.67 years, most of them 83.8 % were females and less than half 47.3 % and more than one third of them 36.5 % were graduated from technical institute and Bachelor degree of nursing respectively. Also, this table reflects that, less than one third of the studied nurses 31.1 % had 1-3 years of experience with mean of 2.74 ± 8.51 years of experience.

Table (2) demonstrates that, less than half 43.2% and more than one third 37.8% of both study and control groups were in the age group of 1-3 years old, with a mean age of 2.41 ± 1.24 years and 2.21 ± 1.11 years respectively. Also, it was found that, less than two third 64.9% and less than half 48.6% of the studied children in both study and control groups were male respectively, moreover there is no statistical significant difference between both study and control group in relation to their

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age and gender ($P > 0.05$). The majority 94.5% and 89.2% of studied children in both study and control groups were medical admitted children respectively. Additionally respiratory causes were found to be major cause of medical admission in mechanically ventilated children contributing for less than half 40.0% and 42.4% in both study and control groups respectively.

Figure (1) illustrates that less than half of the studied nurses 43.2% had poor total level of knowledge pre-educational program intervention. While, most of them 79.7% had a good total level of knowledge post program followed by follow up phase more than three quarter of them 75.7 % had good total level of knowledge than pre educational program intervention.

Figure (2) reveals that, more than two third of the studied nurses 68.9% had an incompetent total percentage score of practice level pre educational intervention, meanwhile most of them 87.8% & 83.8% had a competent total percentage score of practice level post & follow up educational program respectively.

Figure (3) shows the percentage distribution of studied nurses regarding their total attitude level regarding care of mechanically ventilated children. It was revealed that less than three quarters of the studied nurses (70.3 %) had positive attitude, Meanwhile less than one third (29.3 %) of them had negative attitude.

Table (3) shows that the length of stay of studied children on invasive ventilation was less than half 43.2% of study group stay less than one week while more than half 54.1% of control group stay two weeks and more with mean length of stay 10.11 ± 8.727 and 16.57 ± 9.371 respectively. Also it was found that less than half 40.5% of study group compared to less than two third 62.2% of control group stay two weeks and more in pediatric intensive care unit PICU with mean length of stay 13.27 ± 9.291 and 19.08 ± 9.532 respectively. Furthermore total hospital length of stay of both groups was more than half 56.8% of study group and most 89.2% of control group stay two weeks and more with mean length of stay 17.14 ± 9.007 and 23.41 ± 9.441 respectively. With statistical significant difference between length of stay of both study and control groups ($P < 0.05$). The same table showed that less than two third 62.2% of study group were alive and weaned compared to only 13.5% of control group with high statistical significant difference in relation to type of discharge of both study and control groups ($P = .000$).

Table (4) reveals that, there is a positive correlation between total score of nurses' knowledge and total score of nurses' practice and attitude post & follow up educational program intervention ($p < 0.05$).

Table (5) reflects that, there is no statistical significant correlation between total score of nurses' knowledge and their age, educational level and attendance of training courses pre educational program intervention ($P > 0.05$). However, there is a highly statistically significant correlation between total score of nurses' knowledge and their educational level post/ follow up educational program intervention ($P = 0.000$). Moreover, this table shows that, there is a statistically significant correlation between total score of nurses' knowledge and their years of experience pre, post and follow up-educational program intervention ($P < 0.05$).

Table (6) reveals that, there is statistically significant correlation between total nurses' practice level and their educational level, years of experience and attendance of training courses pre, post and follow up-educational program intervention ($P < 0.05$).

Table (7) shows that, there is statistically significant correlation between total nurses' attitude and their age, educational level, years of experience and attendance of training courses ($P < 0.05$).

IV. DISCUSSION

One of the most important medical advances that can save lives is mechanical ventilation; nurses who care for children on mechanical ventilators need to be able to effectively offer nursing care for this patient group. The quality of nursing care will also be improved by an efficient training program for nursing personnel⁽¹⁸⁾.

This study was conducted to evaluate the effect of an educational program on nurses' performance regarding care of mechanically ventilated children and their clinical outcomes in pediatric intensive care units.

As regard to nurses' characteristics, the result of the present study revealed that slightly less than half of the studied nurses were in age group of 25 - <30 years old and the minority of them in the age group of 30-35+ years old with Mean age

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28.33±5.67 years. This finding goes in line with ⁽¹⁹⁾ who conducted a study about "Impact of nursing guidelines on nurses' knowledge and performance regarding to prevention of ventilator associated pneumonia in neonates" and found that, less than half of the studied nurses were in the age group of 25 - <30 years while the minority of them in the age group of 30-35 + years.

⁽²⁰⁾ who conducted his study in **Tanta** City to provide information about "Effect of Educational Intervention Program on Nurses' Performance Regarding Tracheoesophageal Fistula among Mechanically Ventilated Patients" and mentioned that most of the studied nurses were females. This result agrees with the current study that showed that most of nurses in the study sample were females.

The present study revealed that less than half and more than one third of the studied nurses were graduated from technical institute and faculty of nursing respectively. This finding might be due to in Egypt nursing education showed noticeable enhancement of academic degrees and replacement of technical secondary school of nursing by technical institute of nursing this make bridging to allow carriers of secondary school diploma degree to increase their qualification and therefore, to be recruited in the critical care units believing that these cadres could have better knowledge and skills of caring for high risk children.

Concerning years of experience, the results of the present study showed that less than one third of the studied nurses had 1 to less than 3 years of experience while the minority of them had more than 6 years of experience. These findings were consistent with ⁽²¹⁾ who carried out study about "Knowledge and Practice of Intensive Care Unit Nurses toward Prevention of Ventilator Associated Pneumonia at Public Hospitals in Sana'a City Yemen" and found that more than half of the studied nurses had 1 to 3 years of experience and the minority of them had 7 to 9 years of experience.

Concerning personal data of studied children ,the current study revealed that, less than one half and more than one third of both study and control groups were in the age group of 1-3 years old, with a mean age of (2.41±1.24) years and (2.21±1.11) years respectively. These results agrees with ⁽²²⁾ who studied "A case study to assess the effect of bundle care on respiratory hygiene among the children on mechanical ventilator in the Pediatric Intensive Care Unit" and revealed that , less than one half (40%) of participants ages were 1-3 years

These findings were contradicted with ⁽²³⁾ who conducted a study about "Clinical Profile and Outcomes of Mechanically Ventilated Children in Pediatric Intensive Care Units - A Single Centre Prospective Study" and found that only (11.67%) of children were in age group 1-3 years.

Concerning the gender of the studied children, finding of the current study proved that, less than two third and less than one half of the studied children in both study and control groups were male respectively. This may be contributed to the respiratory distress is commonly seen in male gender than female associated with connection to mechanical ventilator ⁽²⁴⁾. This result parallels with ⁽²⁵⁾ who studied "The Expected Outcomes of Nursing Care Provided to Children on Mechanical Ventilation" and found that less than three quarter of children were male.

On the same scope, the results of the current study are compatible with ⁽²⁶⁾ in a study entitled "Complications Of Mechanical Ventilation in Children Up To 12 Y of Age" who found that, less than two third (64.24%) of children were male .

The current study showed that, the Majority of studied children in both study and control groups were medical admitted children respectively. Additionally respiratory causes were found to be major cause of medical admission in mechanically ventilated children contributing for less than one half for each study and control groups respectively. This result was in harmony with ⁽²⁷⁾ who studied "Clinical Profile and Outcome of Mechanically Ventilated Children in Pediatric Intensive Care Unit of a Tertiary Hospital: Retrospective Analysis and found that the majority (95.7%) of participants were medical patients and respiratory failures were found to be major types of organ failures in mechanically ventilated children contributing for less than one half (41.7%) of patients.

The present study revealed that less than half of the studied nurses had poor total level of knowledge pre-educational program intervention, this might be due to the wide base of nurses' education were technical institute, lack of motivation, ICU nurses had not enough time to frequent attend conferences and workshops to enrich and update their knowledge, ICU workload and shortage of the staff number, While most of them had good total percentage score of knowledge post program

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followed by follow up phase slightly more than three quarter of them had a good total score up from pre educational program intervention this indicating the improvement of nurses' knowledge based on educational program which might rehabilitate to provide optimal care.

This finding was congruent with ⁽²⁸⁾ who conducted study to investigate "Influence of Training Program Implementation on Nurses' Performance Regarding Neonates Invasive Mechanical Ventilation noted that less than half of nurses had a good level of knowledge at the pre- test, while at the post- test, after implementing the training program, more than three quarters of them had a good level of knowledge with significant difference ($P = 0.0001$).

In the same line with the results, ⁽²⁹⁾ conducted a study at Port Said governorate to analyze "Effect of an Educational Program for Nurses about Prevention of Ventilator Associated Pneumonia in Neonatal Intensive Care Units" and found that two fifths (40%) of the nursing staff had good level of knowledge preprogram implementation and the percentage increased to all nurses' (100 %) immediate post program, while level of knowledge slightly declined to majority (90.7%) of them had good knowledge in follow up phase. With statistical significant differences were found between nurses' knowledge pre & immediate post and pre& follow up ($P \leq 0.001$).

In addition, ⁽³⁰⁾ conducted a study to determine "The effect of Educational Program On Nurses' Knowledge and Practice Caring for Patients on Mechanical Ventilation Working in Assuit University Hospital" agreed with findings of the current study, who found that the majority of studied nurses knowledge were improved after the educational program compared to 44% before the educational program, with statically significant differences ($p < 0.05$).

Concerning total practice level of the studied nurses, the results of the present study illustrated that there was a significant improvement of nurses' practice throughout program phases. Before implementation of the program, more than two third of the studied nurses had an incompetent total percentage score. This might be due to the highest percentage of studied nurses had technical institute, their experience years in PICU only 1-3 years additionally in bachelor degree nurses usually worked as a head nurses not bedside when they worked in governmental hospital, moreover this could be due to shortage of staff nurses which lead to workload in these units, poor management of nurses' time. All these adversely affected the nurses' practice and consequently lead to poor children outcome. While after implementation, most of them had a competent total percentage score post & follow up educational program respectively.

This could be due to the success of educational program in improving nurses' practice about care of mechanically ventilated children, also nurses' were interested and had internal motivation to acquire skills about care of mechanically ventilated children. On the other hand, their practice slightly declined at the follow up phase of program due to lack of reinforcement, continuity of the training and their in ability to remember the exact sequences of the procedure.

This finding was matched with ⁽³¹⁾, who conducted a study about "Effectiveness of In-Service Training Module on Intensive Care Nurses' Performance Regarding Mechanical Ventilator Patients' Skillful Handling" and reported that, during the post-test phase, most of the studied nurses gained a higher competent level of practice (85%) followed by the follow-up test (80%) up from more than one third of them in the phase of pre-test (35%). And concluded that the success of program on improving nurses' knowledge had a great role in raising and improving their practice

In the same line with the results, ⁽³²⁾ who conducted a study to develop "nursing care protocol regarding the care of child on mechanical ventilator and assess its effectiveness in terms of knowledge and practice among the staff nurses working in the intensive care unit in selected hospital of New Delhi" found that less than three quarter of studied subjects had incompetent practice regarding care of child on Mechanical ventilator before administration of nursing care protocol while after administration of nursing care protocol their practice improved to all nurses had competent practice regarding care of child on mechanical ventilator after administration of nursing care protocol.

Concerning nurses total attitude level regarding care of mechanically ventilated children. The present study revealed that less than three quarter of the studied nurses had positive attitude regarding care of mechanically ventilated children. This might be due to nurses sympathized with mechanically ventilated children because of their critical and crucial condition that requires more attention in order to improve child clinical outcomes.

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This finding was supported by ⁽¹⁰⁾ who conducted a study about "Assessment of Nursing Performance toward Infection Control Measures for Mechanically Ventilated Patients" and concluded that less than two third (65%) of nurses had positive attitude toward Infection control measures for mechanically ventilated patients while more than one third (35%) of them had negative attitude.

On the other hand this finding contradicted with ⁽³³⁾ who carried out study about "Undergraduate Nursing Students' Knowledge and Attitude: Care of Patients Of Mechanical Ventilators" and reported that most (88%) of nurses had poor attitude regarding patients on mechanical ventilator care and only 12% had average attitude while no one had good attitude regarding care of patients on mechanical ventilator.

The current study revealed that after implementation of educational program, less than half of study group stay less than one week on mechanical ventilator compared to more than one half of control group stay two weeks and more with mean score 10.11 ± 8.727 and 16.57 ± 9.371 respectively. This emphasized that studied children length of stay is positively impacted by the application of an educational program which potentially could boost nurses' performance and this would improve their clinical outcome on mechanical ventilator. Additionally the implementation of an educational program may reduce the incidence of such complication, improve the quality of child care, improve the prognosis of child condition and this in turn would decrease the average length of ventilation support and hospital length of stays.

This study was supported by ⁽³⁴⁾ who conducted a study about "The effect of preventive nursing on the duration of mechanical ventilation and the incidence of complications in neonates with respiratory distress syndrome" and pointed that compared with the control group, the time of mechanical ventilation in the experimental group were decreased with high statistical significant difference (**P= 0.000**). Similarly ⁽²²⁾ who found that less than two third (60%) of children stay less than one week and explained that the children on mechanical ventilator improved remarkably after bundle of care.

On the other hand this result contradicted with ⁽³⁵⁾ who carried out study about "Application of Modified Ventilator Bundle and Its Effect on Weaning and Ventilation Days among Critical Ill Patients" and found that more than two third (68.0%) of the study group, compared with only less than one half (40.0%) of the control group, had a shorter duration of mechanical ventilation support between 4-6 days with mean \pm SD of (6.1 ± 1.6) and (7.3 ± 1.9) respectively after modified bundle implementation.

The current study showed that less than two third of study group were alive and weaned compared to the minority of control group with high statistical significant difference in relation to type of discharge of both study and control groups. This might be due to the implementation of an educational program reduce the incidence of complications, improve the quality of child care, improve the prognosis of child condition and this in turn would improve the weaning process

This finding goes in the same line with ⁽³⁶⁾ who carried out study to investigate " Outcomes of mechanical ventilation according to WIND classification in pediatric patients" and pointed that less than two third (64.3%) of participant were alive and weaned. Additionally ⁽³⁷⁾ who conducted a study about Mechanical Ventilation in Pediatric Intensive Care Unit at Minia University Hospital and supported this study and found that more than one half (50.2%) weaned and discharged to in ward patient.

Concerning the correlation between total score of nurses' knowledge and total score of nurses' practice and attitude, this study finding detected a positive correlation between total score of nurses' knowledge and total score of nurses' practice and attitude post & follow up educational program intervention ($p < 0.05$). This finding might be due to that gaining knowledge affects nurses' practices; the nurses with requisite knowledge regarding care of mechanically ventilated children do the better professional practice to improve the care of these children and whenever an increased in nurses' level of knowledge there was an increase in their level of practices which increase nurses enthusiastic to work with these children. This finding congruent with ⁽³⁸⁾ who conducted a study about "Effect of Educational Program on Critical Care Nurses' Performance of Cuffed Endotracheal Tube Care Using Blended Method" and stated that there was a positive statistically significant correlation between nurse's knowledge level and practice level of cuffed endotracheal tube care at post 2 weeks and post 3 months of an educational program.

Also these results were supported by ⁽³⁹⁾ entitled "Effect of an Educational Program Regarding Cardiac Arrhythmias on Nurses' Knowledge and Practices in Critical Care Units" who found that there was a statistically significant positive correlation between total nurses' knowledge and practice scores post-educational program implementation and follow-up.

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On the other hand these results was not supported by ⁽⁴⁰⁾ who conducted a study about "Prevention of Ventilator-associated Pneumonia: Knowledge and Practice of Ventilator Care Bundle among ICU Nurses of Tertiary Care Hospitals of Jodhpur, Rajasthan" and found that there was a negative correlation between total score of nurses' knowledge and total score of nurses' practice.

Concerning correlation between nurses' personal characteristics and their total knowledge score through the program phases, the current study showed that, there is no statistical significant correlation between total score of nurses' knowledge and their age, educational level and attendance of training courses pre educational program intervention ($P > 0.05$). However, there is a highly statistically significant correlation between total score of nurses' knowledge and their educational level post/ follow up educational program intervention ($P= 0.000$). Moreover, there is a statistically significant correlation between total score of nurses' knowledge and their years of experience pre, post and follow up-educational program intervention ($P < 0.05$).

This result agrees with ⁽⁴¹⁾ who conducted a study about "Nurses' Knowledge and Practices Regarding Care of High-Risk Neonates Connected with Mechanical Ventilator" and found that there was no statistically significant correlation between nurse's knowledge and their age. Furthermore, this result agrees with ⁽⁴²⁾ who conducted a study about "Effect of Evidence Based Practice Training Program on Professional Nurses' Decision Making Abilities" and found that and displayed that there were statistically significant correlation between nurses' total knowledge score preprogram and immediate post-program and their years of experience.

On the other hand this finding was contradicted with ⁽⁴³⁾ who reported that there is a statistical significant positive correlation between knowledge and selected characteristics of the studied sample age and education

As regard to correlation between nurses' personal characteristics and their total practice level through the program phases, the current study revealed that there was statistically significant correlation between total nurses' practice level and their educational level, years of experience and attendance of training courses pre, post and follow up-educational program intervention ($P < 0.05$). This means that, the nurses who spend long experience years in nursing field especially in PICU and attended of training courses had better practice. Indeed, this result goes in the same line with ⁽⁴⁴⁾ entitled " the Effect of Using Mobile Applications on Facilitating Nursing Intervention in Critical Care Units " who concluded that, there was a statistically significant correlation between total practices of the studied nurses of using mobile applications and their qualification at ($P < 0.05$).

While ⁽⁴⁵⁾ who carried out study about Socio demographic determinants of knowledge, attitude and practices of Ghanaian nurses towards persons living with HIV and AIDS in Kumasi, was contradicted with these results, as he reported that there was negative correlation with practice and training.

The current study portrayed that, there is statistically significant correlation between total nurses' attitude and their age, educational level, years of experience and attendance of training courses ($P < .05$). This result attributed with ⁽⁴¹⁾ who concluded that there was highly statistically significant correlation between professional nurses' total attitude score and their years of experience ($p = 0.021$).

V. CONCLUSION

Based on the findings of the present study, it can be concluded that; the research hypothesis was ascertained by showing that the implementation of educational program had a positive effect on nurses' performance and child clinical outcomes where, knowledge and practice of studied nurses regarding care of mechanically ventilated children were improved. Also, the studied children who were cared for by apply educational program content exhibited better outcomes compared to the control group who received routine hospital nursing care.

VI. RECOMMENDATIONS

On the light of the current study findings the following recommendations are suggested:

1. Continued nursing education and in service training programs about care of mechanically ventilated children will help nurses to update their knowledge and improve their practice.

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2. Adequate guidance, supervision and continuous monitoring should be engaged in routine work of head nurse to improve nurses' performance
3. Implement a periodic evaluation to determine the nurses' proficiency for evaluating nurses' knowledge and improving nurses' practice.
4. Further studies is required to apply the educational program with a larger sample size and estimate its effect on nurses' performance in caring for critically ill children under mechanical ventilation and child clinical outcomes.

TABLE: I Distribution of studied nurses regarding to their personal characteristics (n=74)

Characteristics	No	%
Age/years		
20- 25	25	33.8
25 - <30	34	45.9
30-35 +	15	20.3
Mean ±SD 28.33±5.67		
Gender		
Male	12	16.2
Female	62	83.8
Academic Qualification (Education)		
Diploma	9	12.2
Technical institute of nursing	35	47.3
Bachelor degree of nursing	27	36.5
Postgraduate	3	4.1
Years of experience		
<1	19	25.7
1-3	23	31.1
3-6	19	25.7
6+	13	17.6
Mean ±SD 2.74±8.51		
Attendance of training courses		
Yes	43	58.1
No	31	41.9

TABLE: II Distribution of studied children regarding to their personal and clinical data (n=74)

Characteristics	Study (n=37)		Control (n=37)		X ²	p-value
	No	%	No	%		
A-Child Personal Data						
1- Age						
From month - <1 year	8	21.6	8	21.6	.356	.949
1-3 year	16	43.2	14	37.8		
3-6 year	8	21.6	10	27.0		
6-12 year	5	13.5	5	13.5		
Mean ± SD						
		2.41±1.24	2.21±1.11			
2-Gender						
Male	24	64.9	18	48.6	1.982	.159
Female	13	35.1	19	51.4		

B- Child Clinical Data						
1-Diagnosis						
A- Postoperative	2	5.4	4	10.8		
B- Medical diagnosis	35	94.5	33	89.2	.725	.394
Causes of medical diagnosis:	N= 35		N= 33			
Respiratory	14	40.0	14	42.4		
Cardiovascular	9	25.7	9	27.4		
Neurologic	6	17.1	6	18.2		
Other:	6	17.1	4	12.1		
Dehydration	1	2.9	1	3.0		
Hypoglycemia	1	2.9	1	3.0	.341	.952
Renal failure	2	5.7	1	3.0		
Leukemia	1	2.9	0	0.0		
Thalassemia	1	2.9	1	3.0		
2-Underlying diseases and reason for the initiation of mechanical ventilation.						
Neurologic	6	16.2	8	21.6		
respiratory	23	62.2	23	62.2		
Cardiologic	6	16.2	6	16.2	.952	.917
Infectious	4	10.8	2	5.4		
♣ Other	4	10.8	4	10.8		
3-Duration on MV						
1day to 1 week	14	37.8	4	10.8		
1week to 2 weeks	14	37.8	13	35.1	10.704	.013*
2weeks to 1 month	5	13.5	15	40.5		
1month to 6 months	4	10.8	5	13.5		
4-Modes of MV						
CPAP	1	2.7	2	5.4		
IMV	22	59.5	18	48.6		
SIMV	13	35.1	15	40.5	1.210	.751
CMV	1	2.7	2	5.4		

♣Sidro plastic anemia ♣Immune deficiency N.B. highly statistically significanc

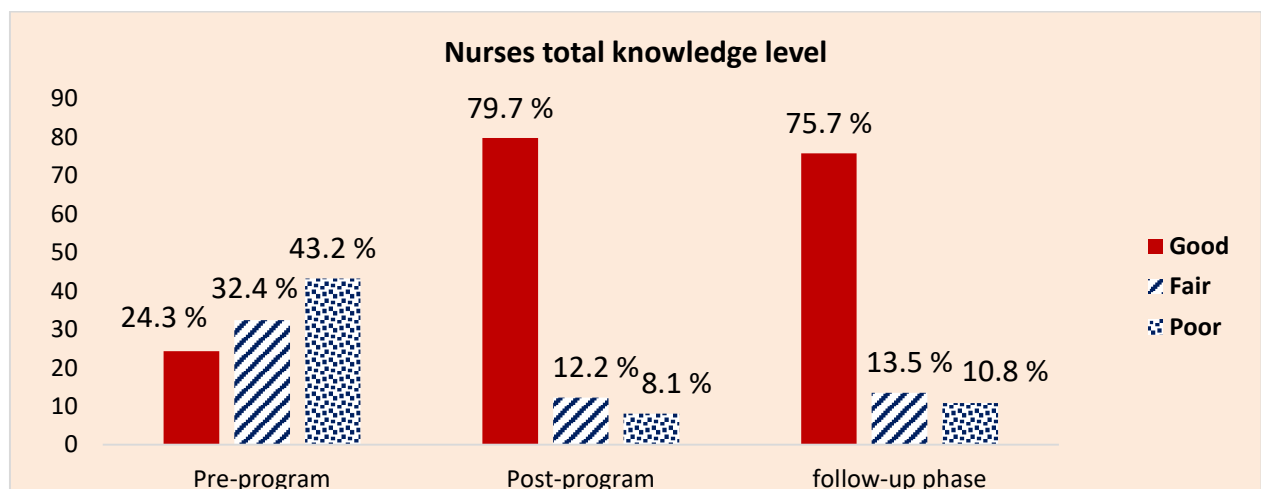


Fig. 1: Percentage distribution of studied nurses regarding to their total knowledge level through the program phases (n=74)

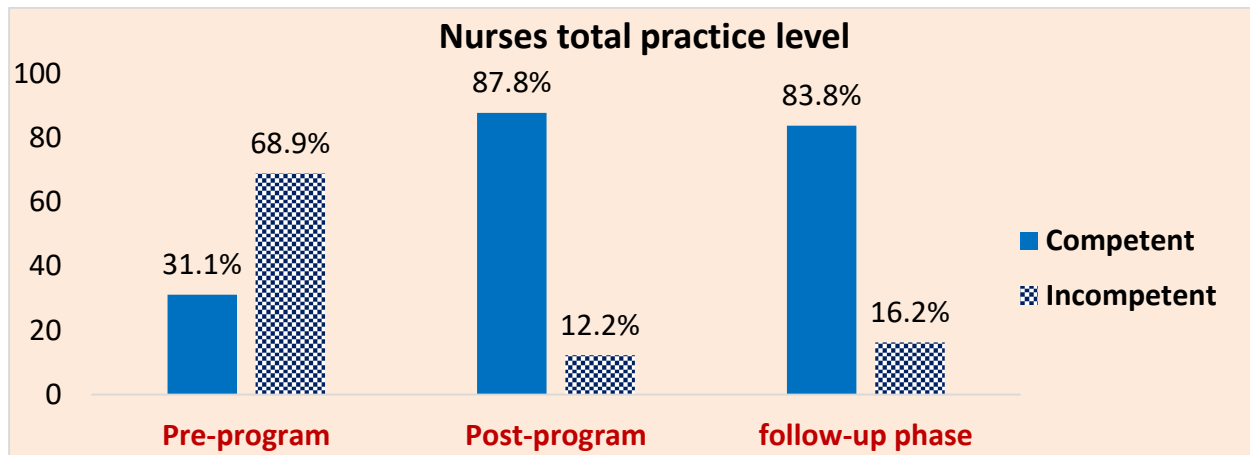


Fig. 2: Percentage distribution of studied nurses regarding their total practice level through the program phases (n=74)

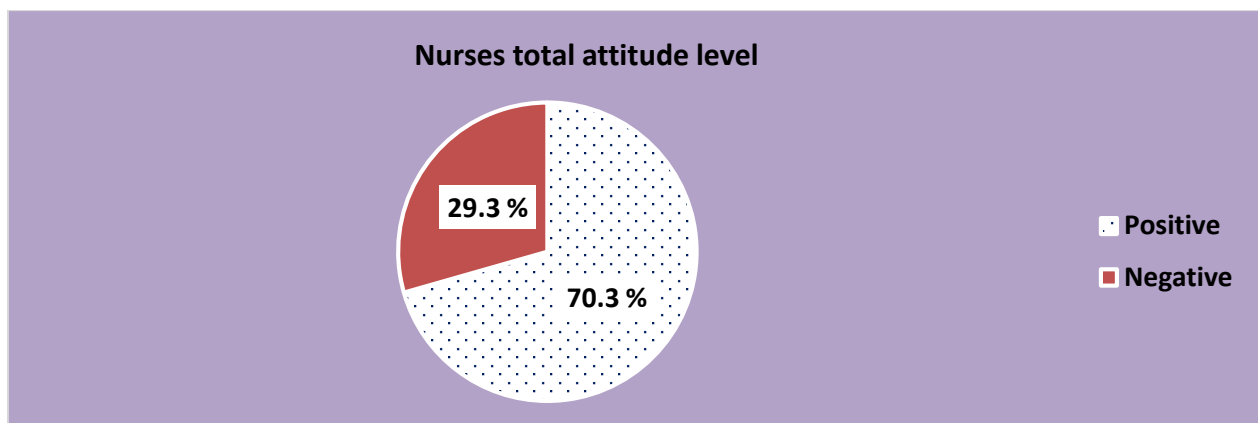


Fig. 3: Percentage distribution of studied nurses regarding their total attitude level regarding care of mechanically ventilated children (n=74)

TABLE: III Distribution of studied children regarding their clinical outcomes (n=74)

Clinical Outcomes	Study (n=37)		Control (n=37)		X ²	p-value
	No	%	No	%		
1-Length of stay						
A- Days on invasive ventilation						
▪ <week	16	43.2	4	10.8	12.343	.002*
▪ Week-< two weeks	13	35.1	13	35.1		
▪ Two weeks and more	8	21.6	20	54.1		
	Mean ± SD		16.57±9.371			
	10.11±8.727					
B- ICU stay						
▪ <week	11	29.7	2	5.4	7.958	.019*
▪ Week-< two weeks	11	29.7	12	32.4		
▪ Two weeks and more	15	40.5	23	62.2		
	Mean ± SD		19.08±9.532			
	13.27±9.291					
C- Total hospital stay						
▪ <week	3	8.1	2	5.4		
▪ Week-< two weeks	13	35.1	2	5.4		

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▪ Two weeks and more	21	56.8	33	89.2	10.933	.004*
	Mean ± SD					
	17.14±9.007		23.41±9.441			
2-Type of discharge						
▪ Dead	4	10.8	13	35.1		
▪ Alive and weaned	23	62.2	5	13.5	19.129	.000**
▪ Alive and not weaned	10	27.0	19	51.4		
3-Weaning outcomes						
	(n=33)			(n=24)		
-Successful weaning (successful extubation)	23	69.7	5	20.8		
-Weaning failure (reintubation)	10	30.3	19	79.2	13.27	.000**
4-Duration on MV						
▪ 1day to 1 week	14	37.8	4	10.8		
▪ 1week to 2 weeks	14	37.8	13	35.1		
▪ 2weeks to 1 month	5	13.5	15	40.5	10.704	.013*
▪ 1month to 6 months	4	10.8	5	13.5		
5-Mortality rate N						
yes	4	10.8	13	35.1	6.18	.013*
No	33	89.2	24	64.9		

N.B. highly statistically significance p<.001

TABLE: IV Correlation between total nurse' knowledge, practice and attitude through the program phases

Variables	Knowledge					
	Pre educational intervention		Post educational intervention		Follow-up educational intervention	
	r	P-value	r	P-value	r	P-value
Practice	.447	.090	.842	.024*	.755	.037*
Attitude	.545	.072	.851	.022*	.813	.028*

**highly statistically significance p<.001 * statistically significance p<.05

TABLE: V Correlation between nurses' personal characteristics and their total knowledge score through the program phases

Variables	Total knowledge score					
	Pre educational intervention		Post educational intervention		Follow-up educational intervention	
	r	p-value	r	p-value	r	p-value
Age	.160	.173	.110	.035*	.875	.019*
Gender	.822	.027*	.130	.271	.201	.086
Educational level	.098	.404	.855	.000**	.115	.000**
Years of experience	.741	.039*	.770	.014*	.717	.036*
Attendance of training courses	.107	.365	.600	.036*	.601	.012*

**highly statistically significance p<.001 * statistically significance p<.05

TABLE: VI Correlation between nurses' personal characteristics and their total practice level through the program phases

Variables	Total practice level					
	Pre educational intervention		Post educational intervention		Follow-up educational intervention	
	r	P-value	r	P-value	r	P-value
Age	.100	.396	.884	.017*	.810	.016*
Gender	.971	.064	.856	.021*	.865	.011*
Educational level	.605	.037*	.986	.000**	.432	.000**
Years of experience	.739	.039*	.767	.000**	.590	.022*
Attendance of training courses	.302	.031*	.508	.005*	.600	.039*

**highly statistically significance p<.001 * statistically significance p<.05

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TABLE: VII Correlation between nurses' personal characteristics and their attitude

variables	Attitude	
	r	P-value
Age	.886	.000**
Gender	.549	.071
Educational level	.329	.015*
Years of experience	.774	.009*
Attendance of training courses	.694	.046*

**highly statistically significance $p < .001$ * statistically significance $p < .05$

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