Effect of Clinical Guidelines on Nurses' performance Concerning Ventilator Associated Pneumonia Prevention among High-risk Neonates

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Abstract

Background: Ventilator-associated pneumonia (VAP) is a leading cause of morbidity and mortality among high-risk neonates in neonatal intensive care units (NICUs). These infants, often premature or suffering from critical illnesses, require mechanical ventilation, which inherently increases their risk of developing VAP. **Aim:** to evaluate the effect of clinical guidelines on nurses' performance concerning ventilator associated pneumonia prevention among high-risk neonates. **Subject and Method:** Quasi-experimental research design (pre – post program) was utilized in current study. The study was conducted at the neonatal intensive care unit at Misr-El-Hora General Hospital which is associated with the Ministry of health. A convenient sample was utilized in this study; it was include all nurses on duty during the study (45) with various educational categories. **Two tools** were used in study, tool (I): Self-administered questionnaire and tool (II): Nurses practices about ventilator associated pneumonia. The program was carried out within about seven months from June 2024 to December 2024. **Results:** More than half of the studied nurses their age were 25< 30 years old. Before program, near than three quarters of nurses had poor knowledge level and after one month of program, the majority of them had good knowledge level and the majority of the studied nurses were incompetent level before program and almost all of them were competent levels according to their total practices level regarding ventilator associated pneumonia prevention among high-risk neonates. **Conclusion:** there was positive statistically significant correlation between total knowledge scores and total practices scores before and after one month of program. **Recommendations:** Implement Continuous Educational Program and workshop about the evidence based guidelines to prevent ventilator-associated pneumonia.

Keywords: clinical Guidelines, High-risk neonates, Prevention, Ventilator Associated Pneumonia.

Introduction:

The survival rates of preterm neonates have increased in the past decades due to the advances in intensive care treatment. This achievement is the result of the use of antenatal steroids, exogenous surfactant supplementation, improved nutrition, and mechanical ventilation (MV). Unfortunately, mechanical ventilation is associated with a substantial risk of ventilator-associated pneumonia (VAP**) (Rangelova et al., 2024)**.

Ventilator-associated pneumonia (VAP) is the second most common hospital acquired infection in the neonatal intensive care unit. According to the Centers for Disease Control and Prevention and National Nosocomial Infections Surveillance (NNIS), VAP is defined as pneumonia in a patient receiving mechanical ventilation that was absent at the time of admission to the hospital or that occurs 48 hours after intubation and initiation of mechanical ventilation **(Centers for Disease Control and Prevention, 2025).**

The incidence of VAP varies widely, with rates ranging from 5 to 40 cases per 1,000 ventilator days, depending on the population studied and the criteria used for diagnosis. The National Nosocomial Infections Surveillance System reported that 20 to 25% of pediatric patients undergoing mechanical ventilation in the United States developed VAP (**Davoudi& Vahedi, 2024).** VAP prolongs the duration of mechanical ventilation hence increasing the duration of hospital stay and health care costs as well as the risk of

morbidity and mortality in critically ill patients **(Jeengar et al., 2024)**.

The known risk factors for VAP include reintubation, aspirations of secretions, colonization of the respiratory tract, and the contamination of devices, medications used for the treatment of the hospitalized neonate, provision of enteral feedings, presence of thoracotomy tubes and poor bedside oral care are also important contributing factors leading to the development of VAP **(Opriș, 2024).** Traditional signs and symptoms of VAP among ventilated patients are typically fever,leukocytosis, changes in a respiratory parameter such as worsening hypoxemia and purulent secretions, and chest X-ray showing new or progressive diffuse infiltrate **(Papazian et al., 2020 &World Health Organization, 2021).**

For the diagnosis of ventilator-associated pneumonia, the most common clinical criteria that are used are a pulmonary infection accompanied by fever, purulent secretions, leukocytosis, bacteriologic evidence of pulmonary disease, and radiologic suggestions of pulmonary infection. There was 69% sensitivity in diagnosing and 75% specificity of VAP when the combination of radiologic infiltrates and 2 clinical criteria were observed in patients hooked in mechanical ventilators (**Abad et al., 2021; Al Aswad & Bayoumi, 2022; Dipanjali et al., 2020; Getahun et al., 2022; Jakhar et al., 2023)**.

Concomitantly, diagnosing VAP requires high clinical precision through microbiologic analysis of respiratory secretions, radiologic examination and focused physical examination. In addition, performing semi-quantitative cultures of endotracheal aspirates and gram stains is recommended for guiding treatment among patients who develop VAP **(Centers for Disease Control and Prevention, 2025).**

VAP prevention begins during intubation and must be continued until the extubation of critical patients. Thus, nurses need an extensive understanding of the strategies to develop VAP among ventilated patients. For this reason, critical care nurses play an essential role in VAP prevention. Nurses need to recognize the earliest signs and symptoms reduce the risk factors, and assist in diagnosing VAP in patients hooked to a mechanical ventilator. Also, critical care nurses must adhere to evidence-based guidelines to prevent VAP and consistently translate evidence-based findings care to ventilated patients **(Sanat et al., 2024**).

The Centers for Disease Control and Prevention (2021) provides the healthcare community with guidelines and tools, such as the bundle checklist for nurses to help eradicate VAP cases. Clinical guidelines are instrumental in the standardization of care, providing evidence-based practices to healthcare professionals. These guidelines encompass various strategies such as proper hand hygiene, appropriate endotracheal suctioning techniques, maintenance of ventilator circuits, and the positioning of neonates to minimize the risk of aspiration. The implementation of these guidelines is critical in NICUs where the complexity of care and the fragility of patients necessitate meticulous and consistent practices **(Klompas et al., 2022).**

Despite the availability of these guidelines, adherence is often suboptimal. Barriers include a lack of awareness, limited training, high workloads, and inadequate organizational support. Addressing these gaps through targeted educational interventions is crucial for improving nurse compliance with VAP prevention protocols **(Al-Harthi et al., 2025).** A study by **Górka-Kostrubiec et al. (2022)** highlights that while clinical guidelines are crucial; their successful implementation depends largely on the healthcare providers' understanding and acceptance of these guidelines. This underscores the importance of ongoing education, auditing, and feedback mechanisms to ensure compliance.

Nurses play a pivotal role in the prevention of VAP, as they are the primary caregivers responsible for the day-to-day management of ventilated neonates. Their adherence to clinical guidelines directly influences patient outcomes. Studies have shown that proper education and training of nursing staff on VAP prevention protocols significantly reduce the incidence of this infection. For instance, a recent study found that the introduction of a VAP prevention bundle in NICUs, coupled with continuous staff education, led to a substantial decrease in VAP rates **(Aly et al., 2023 &Abu-Elenen & Mehany, 2024).**

Furthermore, the dynamic and high-pressure environment of NICUs presents unique challenges for nurses. The high patient-to-nurse ratio, the severity of cases, and the technological demands of mechanical ventilation can lead to lapses in adherence to clinical guidelines. Therefore, institutional support in terms of adequate staffing, provision of necessary resources, and creating a culture of safety and quality care is essential **(Han et al., 2024).**

Lack of nurses' knowledge and performance may be a barrier to achieve evidenced based guidelines for preventing ventilator associated pneumonia and transforming evidence based outcomes into regular delivering care is a challenge. Nevertheless, many studies have revealed that, educational programs and implementing nursing guidelines for prevention of ventilator associated pneumonia leading to a significant decrease rates of ventilator associated pneumonia **(Abou Zed & Mohammed, 2019).**

Significance of the study:

Ventilator-associated pneumonia (VAP) is a significant concern in neonatal intensive care units (NICUs), particularly among high-risk neonates. The incidence of VAP among these vulnerable populations varies widely, depending on geographical location and the specific NICU practices. In developed countries, the incidence ranges from 1.4 to 7 episodes per 1000 ventilator days, whereas in developing countries, it can be much higher, ranging from 16.1 to 89 episodes per 1000 ventilator days **(Cantey & Marmer, 2022).**

The prevalence of VAP Varies widely but remains unacceptably high. Pediatric studies across the globe report VAP prevalence of 2-35% among mechanically ventilated patients in (NICU) **(Antalová et al., 2022)**. many studies as **Jones et al., (2023)** have reported an incidence of 32%, the diagnosis of VAP being established by the CDC. **Tetaj et al., (2022)** reported a VAP prevalence rate of 18.3 events per 1000 ventilator days. **Rangelova et al., (2024)** documented a prevalence rate of VAP 41 episodes per 1000 ventilator days. **Patil, (2020)** established the incidence rate of VAP in NICUS to 22.9%. According to the reported VAP incidence, it remains the most prevalent healthcare- associated infection in different intensive care settings Including neonatal, pediatric and adult units with significant costs, morbidity and mortality worldwide **(Alshammari et al., 2023).**

Clinical guidelines are vital in the prevention of VAP among high-risk neonates. The role of nurses in adhering to these guidelines cannot be overstated, as their performance directly impacts patient outcomes. Continuous education, institutional support, and a collaborative approach are essential in ensuring the successful implementation of these guidelines. Further research is needed to explore innovative strategies to enhance adherence and overcome implementation challenges, ultimately improving the quality of care for vulnerable neonatal populations. The implementation of clinical guidelines is crucial in mitigating these risks by standardizing preventive measures. Recent research has shown that adherence to clinical guidelines by nursing staff can dramatically reduce the incidence of VAP **(CDC, 2023).**

Aim of the study:

This study was aimed to evaluate the effect of clinical guidelines on nurses' performance concerning ventilator associated pneumonia prevention among high-risk neonates.

Research hypotheses:

To fulfill the aim of the current study the following research hypotheses were tested:

- **H1:** Nurses who receive the clinical guidelines program will have higher level of knowledge in post-program than pre-program concerning ventilator associated pneumonia prevention among high-risk neonates.
- **H2:** Nurses who receive the clinical guidelines program will have higher level of practices in post-program than preprogram concerning ventilator associated pneumonia prevention among high-risk neonates.

Research Design

Quasi-experimental research design (one group pre-post) was utilized to achieve the aim of the current study.

Setting

The study was conducted in the neonatal intensive care unit at Misr-El-Hora General Hospital which is associated with the Ministry of health and population. It receives high-risk neonates from all over Minia governorate who complained of different diseases, provides levels of care up to the 3rd level. Number of incubators is 18 incubators and there were 3 functioning mechanical ventilators and one CPAP machine.

Sample

This study employed a convenience sample of all nurses on duty during a six-month period (n=45), representing varied educational backgrounds, with participation being voluntary.

Data collection tools

Two tools were used for data collection:

Tool (I): Self-administered knowledge questionnaire about ventilator associated pneumonia:

This tool was developed by **El.Sayed et al., (2023)** and was modified by the researcher based on pertinent literature **(CDC 2016 & Akl et al., 2020) and** was filled by nurses, It composed of the following parts:

Part (1): Socio-Demographic characteristics for nurses which included; nurses' age, qualifications, experience years, and attendance of previous training programs about prevention of Ventilator Associated Pneumonia (VAP) in neonates.

Part (2): Nurses' knowledge: It was consisted of 27 multiple choice questions which covered definition & causes of Ventilator Associated Pneumonia (VAP), risk factors & outcomes of VAP, clinical picture, indication of MV, and complications, it also included questions related to nursing care of neonates on MV, and questions covered VAP prevention guidelines pre/post nursing implementation.

Scoring system

Total number of questions was 27, each question score ranged from 0 to 2 (0=do not know answer, 1=incomplete correct answer, 2=complete correct answer). These scores was summed and converted into a percent score. The total score of questionnaire was 74 grades (equal 100%), the levels of nurses' knowledge were classified into Poor level of knowledge if total score was <75% which equal <(56 grades) , fair level of knowledge if score was ranged from 75<85% which was rom 56 <62.9 grades and finally good knowledge if score was ≥ 85% which was ≥ 62.9 grade **(Hendy et al., 2020)**

Tool (II): Nurses practices about ventilator associated pneumonia:-

An observational checklist was used to assess nurses' practices related to ventilator associated pneumonia (VAP)which adopted from**; Bowden & Greenberg (2016); Jerithea &Brennan (2017) and CDC (2016)** pre /post-test evaluation.It included practices which cover (6) practices of hand washing and gloving (15items), endotracheal tube suctioning (25items), gavage feeding (21) ,mouth care (13items), chest physiotherapy (12 items), and neonates' positioning (^items). It was tested for its content validity and reliability.

Scoring system

Total numbers of practices were (94 items), the nurses' practices checklist was classified into either done or not done. It was take score (one) for done and score (zero) for not done. The total score of practices was (94) grades (equal 100%), the levels of nurses practices was classified into competent if the score was ≥ 85% (≥79.9 grade) and incompetent if the score was < 85%(<79.9 grade) (**Abou Zed & Mohammed, 2019)**.

Validity and reliability

Five experts in pediatric nursing from Minia and Assuit University assessed the content validity of the data collection tool. Modifications for the tools were done according to the expert's judgment on the clarity of sentences, appropriateness of content, and sequence of items. Reliability of the tools was performed to confirm the consistency of the tools. The internal consistency was measured to identify the extent to which the items of the tools measured the same concept and correlated with each other by Cronbach's alpha test**.**

Tools	Cronbach's alpha
Tool (I): Self-administered knowledge questionnaire	**0.77**
Tool (II): Nurses practices about ventilator associated pneumonia	**0.89**

Ethical considerations

The study was conducted after obtaining official permission from Minia University, including approval from the Faculty of Nursing Dean, and the faculty's ethical committee with approval No. (REC2023620A). The pilot study as well as the study was approved from the directors of Misr-El-Hora General Hospital. Oral consent informed was taken from each nurse included in the study sample and that participation is voluntary. At the initial interview a sufficient explanation about the study was done. All information provided was kept confidential. The participants were informed that there were no known risks or hazards known associated with the participation. Study subject has the right to refuse to participate or withdraw from the study without any rational any time

Pilot study

The pilot study was conducted for 10% about (5) from the total nurses to ensure the clarity of questions, applicability of the tools and the time needed to complete them and perform the required modification according to the available resources. Following the pilot study, it was determined that there was no modifications were necessary for the data collection tools. Therefore, nurses who participated in the pilot study were included in the actual study sample. This process ensured that the data collection tools were appropriate for collecting the required information and that the study could proceed as planned.

Procedure of data collection:

The researcher reviewed current and previous, local and international related literature and theoretical knowledge of various aspects of the study using books, articles, journals, and internet to prepare the tools of data collection, then determine suitable time to collect the data and confirm days and times suitable to conduct the study. After that, the researcher met the study subjects and arranged with them for completing the study tools.

The clinical guidelines program:

The proposed program was conducted through the following phases:

1- Assessment phase

This assessment aimed to evaluate nurses' baseline knowledge, clinical competencies, and educational gaps about the topics to be covered in the program. The researcher was visited the previously mentioned study settings, three days/week, introduce herself and provided an explanation regarding the aim of the study and the expected outcomes was explained for the studied sample, each nurse was interviewed individually after taken their oral consent to contribute in the study. All participants were served as single studied group, constituted 45 nurses. The researcher collected the socio-demographic data after that assessed nurses' knowledge's regarding prevention of VAP in neonates a pre-test was distributed for the recruited sample. At this time, the researcher was observed the nurses during their work and completed the follow up observational checklist.

2-Planning:

The planning phase included the program strategy time, number of sessions, teaching methods, media that was used. In addition, the teaching place and the program facilities were checked for appropriateness. Number of sessions was 7 sessions, three sessions every week; the duration of each session was (30-45 minutes for each) including 10 minutes for open discussion and take feedback from nurses.

Program teaching methods:

The researcher used different teaching methods during implementation of the clinical guidelines program it included; lectures, group discussion, demonstration and re-demonstration and various teaching media such as watching videos, posters, power point presentation and hand-out for prevention of VAP in neonates.

3-Implementation phase

The implementation of the clinical guidelines program will be premeditated based on the actual nurses' needed assessment of the studied nurses through reviewing the related literature. The implementation of the clinical guidelines program covered the theoretical and practical skills regarding prevention of VAP in neonates. It aimed to improve the nurses 'knowledge and practices regarding ventilator-associated pneumonia prevention in neonates. Nurses were divided into small groups each group contains (5-6) nurses and sessions were done in the unit and sometimes in the nursing station, the same guidelines program was implemented for each group of nurses. The program was carried out within about seven months from June 2024 to December 2024.

The program content was as follows:

Through 7 sessions, theoretical and practical sessions, the researcher was started every session with summary related previous sessions and the objectives of the new session.

1st session: about definition & causes, risk factors, clinical picture, of Ventilator Associated Pneumonia (VAP)

2nd session: outcomes of VAP**,** indication of MV, and complications.

3rd session: VAP prevention guidelines about (hand hygiene, oral care, ventilator care measures).

4th session: (gavage feeding, E.T.T suctioning, chest physiotherapy and positioning).

5th session: practical demonstration about infection control measures, and gavage feeding.

6th session: practical demonstration about suctioning from the ETT/and chest physiotherapy.

7th session: practical demonstration includes; frequency of neonates positioning and oral care.

4-Evaluation phase one month after the completion of the clinical guidelines program, nurses' knowledge and practices were evaluated using the same study tools of pre-test, for the post-test to evaluate the program effectiveness.

Data analysis:

The collected data were tabulated & statistically analyzed using a software program and statistical package for social science (SPSS 25.0). The statistical analysis included percentage (%), mean, and stander deviation (SD). Fisher's exact test is used to detect differences between more than two variables, and the sample size is small. Graphs were done for data visualization using Microsoft Excel. A correlation test and P - value of ≤ 0.05 indicates a significant result, while a P value > 0.05 indicates a non-significant result.

Results

Table (1) Socio-demographic characteristics of the studied nurses (n=45):

Socio-demographic characteristics	Studied Nurses (n=45)	
	N	%
Nurse's age/years:		
20 < 25 years	11	24.5
25< 30 years	**24**	**53.3**
30-35 years	9	20
>35 years	1	2.2
Age **(mean ±SD)**	**27.06±3.80**	
Nurse's education:		
Diploma in nursing (secondary school)	2	4.4
Technical institute of nursing	16	35.6
Bachelor in nursing	**26**	**57.3**
Postgraduate studies in nursing	1	2.2
Years of experience of nurses in NICU		
< 3 years	13	28.9
3 < 5 years	**16**	**35.6**
5 < 7 years	5	11.1
7-10 years	6	13.3
>10 years	5	11.1
Attendance of previous training courses about ventilator associated pneumonia prevention		
No	**35**	**77.8**
Yes	10	22.2
How many courses		
One	**8**	**80**
Two	2	20
Year of last training course		
2011	1	10
2020	2	20
2021	1	10
2022	**4**	**40**
2023	2	20

Table (1) shows the demographic characteristics of the studied nurses and it was observed that, 53.3% of the studied nurses their age were 25< 30 years old, with the mean of their age 27.06 ± 3.80. Meanwhile, 57.3 % of them had a Bachelor degree in nursing, and 35.6% had 3 < 5 years of experience in the neonatal intensive care unit. On the other hand, only 10% of them attended training courses regarding the care of high-risk neonates with ventilator associated pneumonia and 80% of these nurses attended one course and 40%of them attended training courses in 2022.

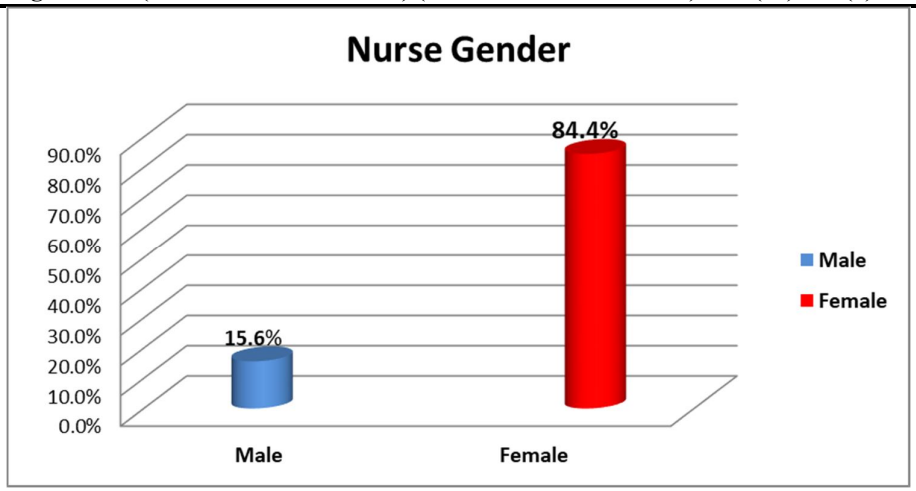


Figure (1) percentage distribution of the studied nurses according to their gender (n=45):
Figure (1) illustrates that 84.4% of studied nurses were female while 15.6% were male.

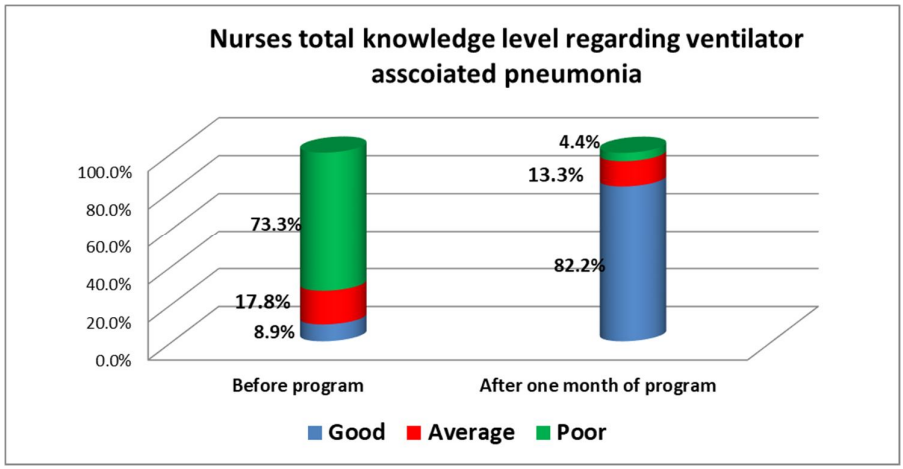
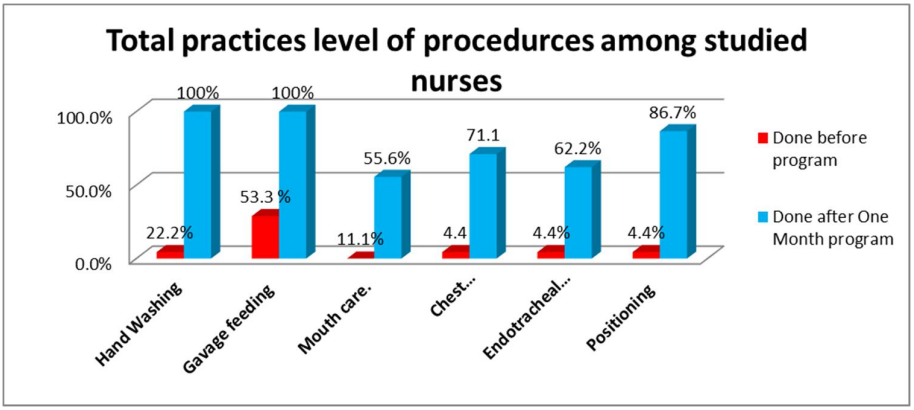


Figure (2): Distribution of nurses' total knowledge level regarding ventilator associated pneumonia prevention among high-risk neonates (before and after the program).

Figure (2): illustrates that 73.3% of studied nurses had poor knowledge level before the program regarding ventilator associated pneumonia prevention among high-risk neonates and increased to 82.2% after one month of program with highly statistically significant difference between the pre- and post-program knowledge levels, with a p-value < 0.001.



Figure(3): Percentage distribution of the studied nurses according to their total practices level regarding hand washing ,gavage feeding , mouth care, chest physiotherapy, endotracheal suction and positioning among high-risk neonates with ventilator associated pneumonia (n = 45).

Figure(3) : clarifies that there is marked improvement in all procedures especially hand washing and positioning showing a jump from 22.2% and.4.4% respectively to 100% and 86.7 after one month of program, with highly statistical significant relation between before program and after one month of program.

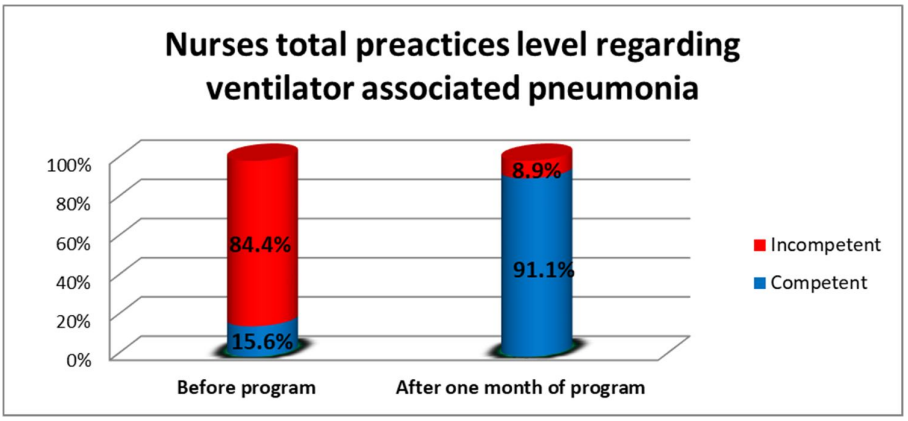


Figure (4): Percentage distribution of the studied nurses according to their total practices level regarding ventilator associated pneumonia prevention among high-risk neonates (n = 45).

Figure (4): reveals that 84.4% of the studied nurses were incompetent level before program and 91.1% of them were competent level according to their total practices level regarding ventilator associated pneumonia prevention among high-risk neonates with highly significant differences between before program and after one month of program at P value ≥0.0001.

Table (2): Relation between total knowledge level of the studied nurses and their demographic data the program (n= 45).

Items	Poor		Average		Good		P value (X^2) Fisher test)
	No	%	No	%	No	%	
Nurse's age/years:							
20 < 25 years	1	9.1	1	9.1	9	81.8	0.952 (NS) 1.61
25- < 30 years	1	4.2	4	16.7	19	79.2	
30-35 years	0	0.0	1	11.1	8	88.9	
>35 years	0	0.0	0	0.0	9	100	
Nurse's gender							
Male	0	0.0	0	0.0	7	100	0.408 (NS) 1.79
Female	2	5.3	6	15.8	37	78.9	
Nurse's education:							
Diploma in nursing (secondary school)	0	0.0	0	0.0	2	100	0.306 (NS) 7.16
Technical institute of nursing	1	6.3	1	12.5	13	81.2	
Bachelor in nursing	1	3.9	3	11.5	22	84.6	
Postgraduate studies in nursing	2	4.5	6	13.3	37	82.2	
Years of experience of nurses in NICU							
< 3 years	2	15.4	1	7.7	10	76.9	0.40 (NS) 8.34
3 < 5 years	0	0.0	2	12.5	14	87.5	
5 < 7 years	0	0.0	1	20	4	80	
7-10 years	0	0.0	2	33.3	4	66.7	
>10 years	0	0.0	0	0.0	5	100	
Attendance of previous training courses about ventilator associated pneumonia prevention							
No	1	2.9	5	14.3	29	82.9	0.60 (NS) 1.008
Yes	1	10	1	10	8	80	

NS= Non statistical significant * =Statistical significant difference ** =A highly statistically significant

Table (2): illustrates that there were no statistical significant relation between total knowledge level of the studied nurses and their demographic data at p-value >0.05.

Table (3): Relation between total practices level of the studied nurses and their demographic data after the program (n= 45).

Items	Total practices level after the program				
	Incompetent		Competent		P value (X^2 or Fisher test)
	No	%	No.	%	
Nurse's age/years:					
20 < 25 years	0	0.0	11	100	0.006** 12.58
25- < 30 years	3	12.5	21	87.5	
30-35 years	0	0.0	9	100	
>35 years	1	100	0	0.0	
Nurse's gender					
Male	0	0.0	7	100	0.368(NS) 8.09
Female	4	10.5	34	89.5	
Nurse's education:					
Diploma in nursing (secondary school)	1	50	1	50	0.2169 (NS) 4.45
Technical institute of nursing	1	6.2	15	93.8	
Bachelor in nursing	2	7.7	24	92.3	
Postgraduate studies in nursing	0	0.0	1	100	
Years of experience of nurses in NICU					
< 3 years	1	7.7	12	92.3	0.714(NS) 2.11
3 < 5 years	2	12.5	14	87.5	
5 < 7 years	0	0.0	5	100	
7-10 years	0	0.0	6	100	
>10 years	1	20	4	80	
Attendance of previous training courses about ventilator associated pneumonia prevention					
No	4	11.4	31	88.6	0.26 1.25
Yes	0	0.0	10	100	

NS= Non statistical significant * =Statistical significant difference ** =A highly statistically significant

Table (3): indicates that there was a highly statistical significant relation between total practices level of the studied nurses and their age at p-value >0.05, other parameters had no significant relation.

Table (4): Correlation between total knowledge and practices scores of the studied nurses before and after one month of program

Items		Before the program		After one month of the program	
		Total Knowledge Scores	Total practices Scores	Total Knowledge Scores	Total practices Scores
	r		0.359*		
Total Knowledge Scores (Before)	P		0.015		
Total Knowledge scores (After one month)	r				**0.384****
	P				**0.009**

**. Correlation is significant at the 0.01 level *. Correlation is significant at the 0.05 level

Table (4): shows that there was positive statistically correlation between total knowledge scores and total practices scores before program at p- value 0.015 and there was highly positive statistically correlation between total knowledge scores and total practices scores after one month of program at p- value 0.009.

Discussion:

Regarding socio-demographic characteristics of the studied nurses the current study results showed that more than half of the studied nurses their age ranged from 25< 30 years old, with the mean of their age 27.06 ± 3.80. **From the researcher point of view**, this may be due to that, newly graduated and young age nurses usually assigned to work in ICUs and emergency departments. This finding is in agreement with previous Egyptian study held by **Kunswa & Mohamed, (2021)** who revealed that four fifths of studied nurses their age was ranging from 20 to less than 30 years, with mean age 28.66 ± 3.474 year. On the other side, this finding were incongruent with the findings of **Mahfoz et al. (2022)** in Egypt, who conducted that; over than half of the nurses were between the ages of 30 and 35 years. Furthermore, concerning nursing education, the present study results illustrated that more than half

of the studied nurses had a Bachelor degree in nursing, **from the researcher's point of view**, this result may be due to the opening of a large number of nursing faculties and the fact that the faculties of Nursing provides the health sector with a large number of nursing bachelor's degree graduates compared to nursing schools and technical nursing institutes. And this result may be due to nurses working in emergency department and ICU should be high qualifications. This finding was consistent with **Mohamed et al. (2025)** in Egypt, who reported that more than one third of nurses had Bachelor degree of nursing. In reinforcement with **Ebrahim et al., (2023)** in Egypt, who studied that; over two fifth of the participating nurses had obtained their nursing education from a technical institute.

Concerning years of experience, the present study revealed that around one third of the studied nurses had 3 < 5 years of experience in the neonatal intensive care unit. This in the agreement with **Al-jaradi, (2018)** in Yamen, who revealed that less than two third of nurses had 1-5 years of experience with mean of 2.74±8.51 years of experience. **From the researcher point of view,** this difference may be due to the difference of study settings.

Furthermore, the current study revealed that the minority of nurses attended training courses regarding the care of high-risk neonates with ventilator associated pneumonia, **from a researcher's perception**; it is possible that, this outcome can be attributed to a lack of ongoing training and education provided by hospitals to their nursing staff, as well as an increase in nurses' workload. This finding was consistent with a study conducted by **El-Garhy et al. (2020)** who studied that; more than two-thirds of the studied nurses had not participated in any training courses. Similarly, the same findings were reported by **Abou Zed & Mohammed, (2019)** in Egypt, and who conduct that; a significant proportion of nurses, specifically less than two-thirds did not receive instruction on the care of neonates with invasive mechanical ventilation.

Regarding attending of training courses in 2022, the present study results reported that the most of nurses attended one course and two fifths of them attended training courses in 2022. This may be attributed to a lack of training. **These results may be attributed** to the non-continuous education and preparation prior to work or training concerning to care of children, in addition to the lack of their need to update their knowledge. This finding was compatible with **Abu-Odah et al. (2022)** in Palestine, who revealed that in past 2 years, the majority of health team attended to learning courses.

Concerning percentage distribution of the studied nurses according to their gender, the current study illustrated that the majority of studied nurses were female. This finding agreed with **Alhamad & Elsayed, (2024)** in KSA, who reported that around three quarters of the nurses were females.

As regards total knowledge level regarding ventilator associated pneumonia prevention among high-risk neonates, the current study results illustrated that before program near than three quarters of nurses had poor knowledge level regarding ventilator associated pneumonia prevention among high-risk neonates. And after one month of program the present study revealed that the majority of them had good knowledge level regarding ventilator associated pneumonia prevention among high-risk neonates. In the same line with **Mohamed et al., (2025)** who illustrates that less than half of the studied nurses had poor total level of knowledge pre-educational program intervention. While, more than three quarters of them had a good total level of knowledge post program. And not in the same line with **Terho et al. (2025)** they showed that near than one quarter nurses and physicians had good knowledge regarding ventilator-associated pneumonia prevention.

The current study results illustrated that there was highly statistically significant difference between total knowledge levels regarding ventilator associated pneumonia prevention among high-risk neonates before and after month of program. in accordance with **ALaswad & Bayoumi, (2022)** who reported that regarding the overall knowledge score indicated improvement in the general knowledge about VAP and knowledge about VAP bundle in pre and post improvement. And in agreement with study done by **Dipanjali et al. (2021**), they reported that significant difference in the knowledge of nurses after the intervention regarding Hand washing & gloving before and after one month of the program**.**

As regards total practices level regarding ventilator associated pneumonia prevention among high-risk neonates**,** the present study revealed that the majority of the studied nurses were incompetent level before program and almost all of them were competent level according to their total practices level regarding ventilator associated

pneumonia prevention among high-risk neonates. The study finding in the same line with **El-Sayed et al. (2023)** who indicated that regarding nurses' total practice, the smallest number of the nursing staff had adequate practice compared to largest number of them had inadequate total practice score. Also, these findings are in line with **Amin et al. (2021),** who discovered that the majority of nursing staff were incompetent prior to the training program as opposed to the minority following it. **From the researcher point of view**, this may be due to no supervision and no role models which may lead to absence of adherence to VAP prevention guidelines. Additionally, lack of training that is appreciated by the fact that a high percentage of the studied nurses did not participate in any training courses regarding VAP prevention.

The current study showed that there were highly significant differences between before program and after one month of program in total practices level regarding ventilator associated pneumonia prevention among high-risk neonates at P value ≥0.0001. The study finding was in the same line with **Mohamed et al. (2025)** who showed that there was a significant improvement of nurses' practice regarding ventilator associated pneumonia prevention throughout program phases. This finding was matched with **Ali & Ahmed, (2023)** who conducted that pre-test and the post- test phase, there was significant association in total practices level regarding ventilator associated pneumonia prevention And concluded that the success of program on improving nurses' knowledge had a great role in raising and improving their practice. **From the researcher point of view**, This could be due to the success of educational program in improving nurses' practice regarding ventilator associated pneumonia prevention among high-risk neonates, also nurses' were interested and had internal motivation to acquire skills about care of mechanically ventilated among high-risk neonates.

Concerning to relation between total knowledge level of the studied nurses and their demographic data before and after one month of the program, the present study results illustrated that there were no statistical significant relation between total knowledge level of the studied nurses and their demographic data the program. The study finding in the same line with **Trivedi et al. (2023)** in India, they reported that there was no significant association between total knowledge level regarding ventilator associated pneumonia prevention of the studied nurses and their sociodemographic data before and after teaching programme. And in agreement with **Rani et al., (2023)** who discovered that there was no significant association between post-test knowledge scores towards VAP and demographic variables. The study results not in the same line with **Al-jaradi, (2018)** who indicated that there was a significant association between the total knowledge toward prevention VAP and demographic variables as level of education.

As regards relation between total practices level of the studied nurses and their demographic data before and after one month of the program, the present study results indicated that there was a highly statistical significant relation between total practices level of the studied nurses and their age. From the researcher point of view, this age affinity to create a common understanding language, positive work relationship that facilitate exchange of information between them as well as encourage them to ask questions.

The study findings were in the same line with Mohammed et al. (2023) in Egypt, they demonstrated that regarding relation between total mean score of nurses' practices with their selected demographic characteristics, and this study indicated a strong statistical relation between the overall average score of nurses' practice and their marital status, age and qualifications. And the study findings of this study were consistent with the research conducted by El-Garhy et al. (2020) in Egypt, who demonstrated a significant positive relation between the overall practice of the nurses under investigation and their qualifications and their age. Furthermore, the research conducted by Ebrahim et al. (2023) who provided clarification regarding the existence of a significant statistical relation between the total practice score of nurses and their qualifications within the pediatric intensive care unit (PICU).

The findings of the present study were found to be not in accordance with the research conducted by Qasem (2022) in Iraq, they highlighted that; there was no statistically significant association between nurses' practice and their socio-demographic characteristics variables prior to and after the implementation of the program. In disagreement with Rani et al., (2023), they discovered that there was no significant association between post-test attitude scores towards VAP and demographic variables.

As Regarding correlation between total knowledge and practices scores of the studied nurses before and after one month of program**,** the current study results showed that there was positive statistically correlation between total knowledge

scores and total practices scores regarding ventilator associated pneumonia prevention among high-risk neonates before program and there was highly positive statistically correlation between total knowledge scores and total practices Scores after one month of program. The study finding in agreement with **El-Sayed et al. (2023)** who elaborated that there was a statistical positive correlation between total nurses' knowledge score and total nurses' practice scores regarding VAP prevention.

The findings of the present study were congruent with the results reported by **Mahfoz et al. (2022)** and **Thabet et al. (2021),** as they observed a statistically significant relationship between the total knowledge score and total practice score in the pre-test phase. In disagreement with **Madhuvu et al. (2020),** who illustrated that there was no relationship among nursing staff knowledge and compliance to evidence-based guidelines concerning VAP, while, most of the nursing staff understood the evidence-based guidelines and didn't follow in practice. **From the researcher point of view**, this explanation is expected because good theoretical knowledge regarding VAP prevention essentially reflected adequate practices and also, knowledge is still the first step toward implementation of VAP prevention practices.

Limitations of the Study

Despite the valuable insights gained from this research, certain limitations should be acknowledged. The study's sample was confined to only one sitting, which may limit the generalizability of the findings to other contexts. Additionally, the reliance on self-reported data for knowledge introduces the possibility of bias. Furthermore, the one-month follow-up period may not provide a comprehensive view of the long-term effects of the intervention. Further longitudinal studies are necessary to assess long-term efficacy. Lastly, not fully capture the influence of work environmental factors on ventilator associated pneumonia prevention practices.

Conclusion

Based on the findings of the current study, it can be concluded that, the findings of this study clearly demonstrate the significant positive impact of the educational program on nurses' knowledge and practices regarding ventilator-associated pneumonia (VAP) prevention among high-risk neonates , as well as positive statistically significant correlation between total knowledge scores and total practices scores before and after one month of program, which reflecting that when the nurses' knowledge increase and improve, the degree of nurses' application of the guidelines will increase and their performance will improve as well.

Recommendations

Based on the results and conclusion of the current study, the following recommendations were suggested:

1. New nursing staff in neonatal intensive care units (NICUs) should receive structured education on VAP prevention during their orientation period.
2. Implement Continuous Educational Program and workshop about the evidence based guidelines to prevent ventilator-associated pneumonia targeting all nurses in all intensive care units in other hospitals.
3. Develop Standardized VAP Prevention Protocol should be present and reviewed regularly and updates in the intensive care units about the evidence based guidelines for the prevention of ventilator-associated pneumonia and learned to all nurses in NICUs.
4. Periodical follow-up evaluation for the level of knowledge and practices of all nurses regarding the care of high risk neonates undergoing ventilator associated pneumonia.
5. The developed instructional pamphlets and illustrated booklets about ventilator associated pneumonia should be provided for all nurses working in all NICUs.
6. Incorporate simulation training to allow nurses to practice VAP prevention techniques in a risk-free environment, improving confidence and skill retention.
7. Ongoing research and quality improvement projects related to VAP, enhancing nurses' critical thinking and engagement with current best practices.
8. Hospital administration should support VAP-related education and policy enforcement through adequate staffing, resources, and recognition of best performers.

Study implications in nursing and clinical practices:

The implementation of clinical guidelines aimed at preventing Ventilator-Associated Pneumonia (VAP) in high-risk neonates has important implications for nursing practice. By

adhering to procedures that are supported by evidence, nurses can enhance their knowledge, skills, and confidence in infection control, which ultimately leads to treatment that is more consistent and of higher quality. This standardization enhances collaboration among healthcare providers, minimizes practice variability, and leads to improved neonatal outcomes, including reduced VAP incidence, shorter hospital stays, and increased neonatal survival rates. Practices that are based on guidelines have the potential to improve policy creation, encourage ongoing quality improvement, and result in cost savings by reducing the number of complications that occur and the amount of money spent on healthcare. In order to facilitate the incorporation of these standards into clinical settings, it is necessary to provide ongoing training to staff members, conduct regular audits, and establish checklists to guarantee compliance. The ability of nurses to participate in the formulation of policies and the implementation of quality assurance programs improves infection control measures. Through the promotion of evidence-based interventions, the improvement of safety, and the optimization of health outcomes for vulnerable neonates who are at a high risk of pneumonia associated to mechanical ventilation, the application of clinical guidelines effectively increases neonatal care.

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