

Effect of Care Bundle Strategies on Nurses' Performance Regarding Prevention of Ventilator Associated Pneumonia at Neonatal Intensive Care Units

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Abstract

Background: Ventilator-Associated Pneumonia is considered a severe health care-associated infection that results in severe morbidity and increase mortality rate. Moreover, it also lengthens hospital staying and increase hospital expenses. The study aims to evaluate the effect of care bundle strategies on nurses' performance regarding prevention of ventilator associated pneumonia at neonatal intensive care Units. **Design:** Quasi-experimental, pre- and post- intervention study. **Subjects:** All nurses (65) in neonatal intensive care units at 10th of Ramadan Charity Hospital and Aga Central Hospital. **Tools:** Two tools were used; 1st tool; sociodemographic data and predesigned questionnaire for nurses' knowledge and 2nd tool; observational checklist to assess nurses' performance regarding ventilator-associated pneumonia. **Results:** shows a significant improvement of nurses' knowledge regarding ventilator-associated pneumonia care bundle immediately after and at follow up in relation to neonates' positioning, oral care and ventilator care measures and the majority of them had a competent level of performance regarding observed ventilator-associated pneumonia care bundle before, immediately after and three months after program application. **Conclusion:** The application of care bundle strategies for the nurses had improved their level of knowledge and performance regarding prevention of ventilator-associated pneumonia with highly significant difference between mean score of total nurses' knowledge and performance. **Recommendations:** Continuous up to date guided protocols should focus on enhancing nurses' performance regarding ventilator-associated pneumonia care bundle.

Key words: Care bundle, Neonatal ventilator associated pneumonia, Nurses' performance.

Introduction

Ventilator-associated pneumonia (VAP), a hospital acquired pneumonia that occurs more than 48 hours after mechanical ventilation, is a common problem of mechanical ventilation with a higher communal infectious disorders in critical care units with increasing mortality rate⁽¹⁾. Extended intubation duration on mechanical ventilation was the common predisposing factor⁽²⁾. VAP is a serious complication in neonates set on mechanical ventilator and it takes a percentage from 6.8% to 32.2% of health-care associated infections among neonates. Also, it takes from 9% to 13% of the total neonatal deaths with mechanically ventilated devices. Furthermore, the problem of VAP in neonatal intensive care units (NICUs) is significantly serious in developing countries than in developed countries with great influence on neonatal morbidity, survival, hospital costs and long duration of NICU stay⁽³⁾.

Factors that predispose the neonates for acquiring VAP include pre-existing diseases of respiratory system such as chronic obstructive pulmonary disease, coma, head trauma and multi-organ system failure⁽⁴⁾. Other risk factors include previous taken antibiotic drugs, conditions that increase the risk of aspiration, and

disorders that impair defence mechanisms, such as malnutrition and diabetes.

Premature infants, with low birth weight (LBW) and extremely low birth weight (ELBW) are further predisposed to the development of VAP⁽⁵⁾.

Ventilator Associated Pneumonia is a dangerous complication for infants at present in acutely and critically condition and can results in lung tissue damage, increase oxygen demand, and more liable to complications such as lung abscess, empyema, due to bacteremia & sepsis, and bronchopulmonary dysplasia⁽⁶⁾. Seriously ill neonate has increased the vulnerability and mortality from VAP. Also, immaturity of the preterm immune system brings them at high potential for hospital associated infections (HAIs)⁽⁵⁾.

Evidence-based guidelines to prevent VAP and improve the quality of care are mainly implemented by the care bundle, which consists of simultaneous application of evidence-based preventive approaches which, applied together to attain a better infant outcomes⁽⁷⁻⁹⁾. In Egypt and developing countries, researchers reports few successfully VAP intervention strategies, mainly among premature infants. Furthermore, the bundle involved approaches to reduce microbial infection of the oropharynx, stomach & sinuses and

ways to avoid aspiration of infected secretions. Ventilator-associated pneumonia rate decreased from 5.6 to 0.3 infections per 1,000 ventilator days one time the bundle have applied during they ear progress⁽¹⁰⁻¹²⁾.

Nowadays, Neonatal nurses are in a key position as a main caregiver and one of interprofessional health care team to identify neonatal problems and apply preventive interventions to avoid VAP through "VAP Care bundle approach"⁽¹³⁾. These several interventions include oral care using chlorhexidine gluconate oral rinse; maintaining the head-of-bed at 15-30 degrees and promoting the correct position; daily sedation interruption and assessment of readiness for weaning; Ventilator management; Suction care, pressure ulcer prophylaxis; use of orogastric tubes; avoid over distending of the stomach and avoid unnecessary tracheal suctioning⁽¹⁴⁾.

Decline in nurses' knowledge and performance is an obstacle to accomplish evidenced-based strategies for prevention of VAP; these nurses must be aware of the problem and its threat as well as knowledge on preventive measures to be compliant with its performance to improve the quality of health care for the neonates. Skilful and knowledgeable nurses are really needed to create proper decisions in

neonatal care and reduce the threat to their life⁽¹⁵⁾.

Significance of the study:

Ventilator associated pneumonia is one of the most common disorders which could be greatly affected the nurses' outcome caring for critically ill neonates. All neonates on mechanical ventilation have the potential to develop VAP because the placement of the endotracheal tube (ETT) prevents the natural defence against respiratory infections and increases the risk of microorganisms in the lower airway⁽¹⁶⁾. Ventilator associated pneumonia has been associated with greater morbidity, mortality, increase duration at NICU and increased the hospital financial cost. The developing countries reported a higher VAP rates than developed countries. Moreover, the studies that monitoring VAP rates and success of implemented techniques in Egyptian NICUs are few^(17,18). Hence, it was emergent to apply care bundle program for improving nurses' performance regarding prevention of ventilator associated pneumonia at neonatal intensive care units.

Aim of the study:

This study aims to evaluate the effect of care bundle strategies on nurses' performance regarding prevention of

ventilator associated pneumonia at neonatal intensive care unit.

Research hypothesis:

Application of care bundle strategies for nurses may improve their performance include knowledge and practice regarding prevention of VAP.

Subjects and Method

Research design:

A quasi-experimental (pre/post- test) research design.

Setting:

This study was carried out at Neonatal Intensive Care Units at 10th of Ramadan Charity Hospital (17 nurses) and Aga Central Hospital (48 nurses).

Subjects:all nurses (65) working at the above mentioned study setting.

Tools of data collection:

Tool I:A structured questionnaire sheet (pre/post & follow up -test) was developed by researchers after reviewing the related literature⁽¹⁹⁾⁽⁷⁾. It included two parts as the following:

- 1) **Demographic data for nurses include** age, education level, years of experience and previous attendance of VAP Bundle training program.
- 2) **A predesigned questionnaire** (pre, post and follow up) was used to assess nurses' knowledge about bundle care for ventilator associated pneumonia in NICUs. It consisted of 29 multiple

choice questions. It involved; 7 questions about (definition of VAP, risk factors related to intubated neonates & causes of VAP, signs & symptoms of VAP), knowledge questions regarding VAP care bundle covered VAP prevention guidelines pre/post and after follow-up as (positioning 2 questions, 2 questions for hand hygiene, 1 question for oral care, 4 questions for ventilator care measures, 10 questions for suctioning from the ETT, 1 question for peptic ulcer prophylaxis and 2 questions for extubation and weaning trials).

Scoring system of nurses' knowledge :a correct answer give one score while, incorrect answer give zero score. The nurses' knowledge level was categorized as follows: good knowledge if the score was ≥ 80 , average knowledge from $60 - < 80\%$ and poor if the score was $< 60\%$ ⁽²⁰⁾.

Tool II: Ventilator associated pneumonia observational checklist. It was adapted from CDC, (2016)⁽⁷⁾. The tool was used to assess the nurses' performance in areas (infection control measures, patient positioning, ventilator care measures, suctioning from the ETT/tracheotomy, oral care, peptic ulcer prophylaxis, extubation and weaning trials, frequency of oral swabbing, frequency of coat lips with petroleum jelly).

The scoring system for the observational checklist was developed; each correct step of the procedure scored on the bases of "done", scored (1) and "Not done", scored (0). The scoring system for these observation checklists sheets were classified into: Competent who gets 85% and Incompetent who gets less than 85%⁽²¹⁾.

Method

Validity and reliability:

Content validity was assessed by five experts in pediatric nursing field who revised the tools for clarity, relevance, applicability and comprehensiveness. Regarding reliability of internal consistency by using coefficient Cronbach's alpha was as follow; for tool I (Knowledge sheet: 0.752), for tool II (Performance sheet: 0.96), Total reliability for two tools was assessed by using coefficient alpha was 0.946.

Ethical considerations:

Ethical approval to conduct this research study was obtained from the Research Ethical Committee at Faculty of Nursing, Mansoura University. An official permission was obtained from the director of 10th of Ramadan Charity Hospital, Aga Central Hospital and the head of the NICUs. Oral consent was obtained from the nurses after explaining of the aim, tools, duration and the benefits of this

study. The researchers confirmed them that participation in the study is voluntary, the secrecy and the confidentiality of their responses were assured.

Pilot study:

It was conducted on 6 subjects representing 10% of the sample size to ascertain the viability, clarity, replication of questions. It also helped to approximate time needed to complete interview prior to data collection. Required modifications were done by exclusion of some items consequently; so excluded from main study.

Field of work:

Data collection extended over a period over six months from the beginning of September 2019 to the end of February 2020. The researchers were available in the study settings 3 days per week from 9 A.m. to 12 p.m. Each nurse was individually interviewed using the previously mentioned study tools. The questionnaire and the answers were marked by the nurses after the researchers were explained how they were answered it; 20 minutes was needed to complete the questionnaire. The study nurses were divided into small groups; (11 in each group).

Data collection was carried out in 3 stages at the NICUs in the above mentioned settings; first stage assessment was done before starting VAP care strategies "pre-

test". Second stage: implementation of VAP care bundle, and third stage; evaluation immediate and three months follow up after implementation of VAP care bundle to evaluate intervention outcomes' post-test'. The reasons for selecting these intervals were to assess the point of maximum benefits from intervention immediately after, the nurses were assumed to follow the learning process by observation stages (attention, retention, and motivation). Also, the second assessment post intervention (three months later) aimed to assess nurses' ability to retain the acquired learning knowledge and performance over a short period of time and assess the effect of VAP care bundle at follow up.

Stage 1. Assessment of the nurses' knowledge about bundle care strategies for ventilator associated pneumonia in NICU pre/post and at follow-up after program implementation includes definition of VAP, risk factors for VAP related to intubated neonates & causes, signs & symptoms of VAP; knowledge questions about VAP care bundle using the above tools. A brief introduction about the questionnaire was given by the researchers to help the nurses understand how to complete the questionnaire.

Stage 2. The application of VAP care bundle program was aimed to improve the

nurses' performance regarding prevention of ventilator associated pneumonia at NICUs through six sessions; three theoretical and three practical sessions (around 45-60 minutes for each) including ten minutes for open discussion and take feedback from nurses.

Three theoretical sessions about VAP care bundle include (1st session about definition of VAP, risk factors, causes, signs & symptoms of VAP; 2nd & 3rd session about VAP care bundle guidelines about positioning, hand hygiene, oral care, ventilator care measures, suctioning from the ETT, extubation and weaning trials). The other three practical sessions include; first practical demonstration session about infection control measures, neonatal positioning, ventilator care measures; second practical session about suctioning from the ETT/tracheotomy, oral care, peptic ulcer prophylaxis; third one includes; extubation and weaning trials, frequency of oral swabbing, frequency of coat lips with petroleum jelly. The researchers started every session with summary related previous sessions and the objectives of new session, reinforcement of teaching were accomplished related to nurses' needs to confirm their understanding. Many teaching methods were used such as group discussion, lectures, practical demonstration and re-

demonstration, also teaching media in the form of power point, educational handout about VAP care bundle elements and videos were used.

Stage3. Performance of the nurses were evaluated pre / immediate post and at follow-up later 3 months after application of VAP care bundle program using the previously mentioned study tools. Comparison between pre/post and at follow-up results was done to evaluate the effect of application of VAP care bundle intervention on nurses' performance.

Statistical analysis:

Data was sorted, coded, organized, categorized and then transferred into especially designed formats. Analysis performed using SPSS (Stands for Statistical Product and Service Solutions) version 21. Data were described using number and percent or mean \pm SD. Repeated measured analysis of variance (RM-ANOVA) was used to compare means of three times (pre, immediately post and at follow up). A statistical test with a p value \leq 0.05 was considered statistically significant and highly significant if <0.01 .

Results:

Table (1) revealed that, mean age of studied nurses was 29.58 ± 11.80 and 41.5% of them had nursing diploma. According to experience, near half of them

(49.2%) were having from one year experience to less than five years, with mean score 6.81 ± 7.34 years.

Figure (1) showed that three quarters of participants (75%) were not previously attended (VAP) training program, while one quarter of them attended previous training program.

Table (2) revealed that there were a highly significant differences between mean score for meaning of VAP pre, immediate post training and follow up (1.50 ± 0.61 , 1.7 ± 0.55 and 1.6 ± 0.60) respectively, with significant difference at p value <0.05 . Also, there were increase in mean knowledge score about signs & symptoms of VAP (0.15 ± 0.36 , 0.93 ± 0.24 & 0.93 ± 0.24) respectively pre, immediate post and follow up with highly significant difference at p value <0.01 .

Table (3) revealed that there was an improvement in mean score of ventilator care measures pre training, immediate post and follow up (1.83 ± 1.03 , 2.53 ± 0.96 & 2.83 ± 1.02) respectively with highly significant difference with p value <0.01 . Furthermore, there was an improvement in mean score of extubation and weaning trials pre training, immediate post and follow up (0.58 ± 0.74 , 1.52 ± 0.70 & 1.49 ± 0.73) respectively with highly significant difference with p value <0.01 .

Table (4) showed that there was improvement in mean values of infection control measures pre, immediately post and at follow up (3.09 ± 2.70 , 7.07 ± 1.24 & 5.69 ± 1.75) respectively with highly significant difference at p value <0.01 . Also, there was improvement in mean values of suctioning from the ETT/tracheostomy pre, immediate post and at follow up (9.55 ± 5.38 , 19.16 ± 1.05 & 16.73 ± 2.74) respectively with highly statistically significant difference at p value <0.01 .

Figure (2) showed that 80% of nurses had poor knowledge pre training program compared to only (12.3%) of them immediately post the training program and (18.5%) of them at follow up. In the contrary more than three quarters of them (76.9%) have good knowledge immediately post the training program compared to only (10.8%) of them pre training program.

Figure (3) revealed that about 81.5% of nurses were incompetent pre the training program compared to only 3.1% of them

immediately post the training program. While, 18.5% of them were competent before the training program compared to (96.9%), immediately post the training program.

Table (5) detected that there was a highly significant difference between mean score of total nurses' knowledge regarding VAP (2.84 ± 1.32 , 5.09 ± 1.07 & 4.75 ± 1.25) respectively at p value <0.01 . Moreover, there were improvement in total mean score of nurses' total practice regarding VAP care bundle pre, immediately post and at follow up at p value <0.01 .

Table (1): Characteristic of the studied nurses (n=65)

Variables	No.	%
Age in years		
<20ys	19	29.2
20-<30ys	21	32.4
30-<40ys	9	13.8
≥40ys	16	24.6
Mean ± SD	29.58 ± 11.80	
Educational level		
Nursing Diploma	27	41.5
Nursing Institutes	22	33.9
Bachelor of nursing science	16	24.6
Years of experience		
1- < 5 yrs	32	49.2
5- < 10 yrs	14	21.5
≥ 10 yrs	19	29.3
Mean ± SD	6.81 ± 7.34	

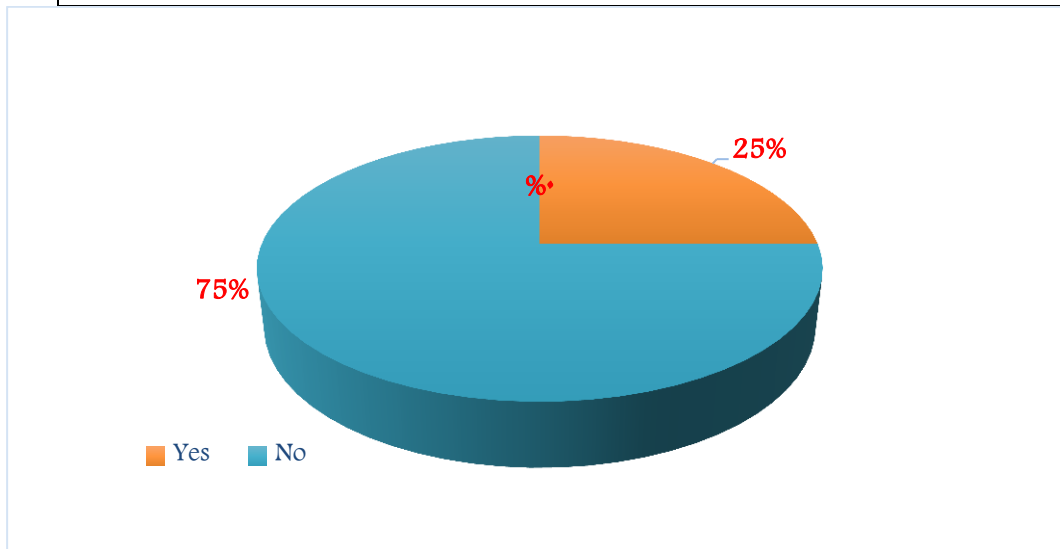


Figure 1. Distribution of nurses about previous attendance of training program about VAP bundle (No.=65)

Table (2): Mean values of nurses' knowledge concerning VAP pre, immediately post and at follow up of the program implementation(n= 65)

Nurses' Knowledge	Pre	Immediate Post	Follow up	F	P. value
	Mean ±SD	Mean ±SD	Mean ±SD		
- Meaning of VAP	1.50±0.61	1.7±0.55	1.6±0.60	3.607	0.03*
- Risk factors for VAP related to intubated neonates	1.18±1.02	1.92±0.98	1.87±0.99	21.65	0.000**
- Signs and symptoms of VAP	0.15±0.36	0.93±0.24	0.93±0.24	197.23	0.000**

Highly significant at P<0.001

Table (3): Mean values of nurses' knowledge regarding VAP care bundle pre, immediately post and at follow up of the program implementation (n =65)

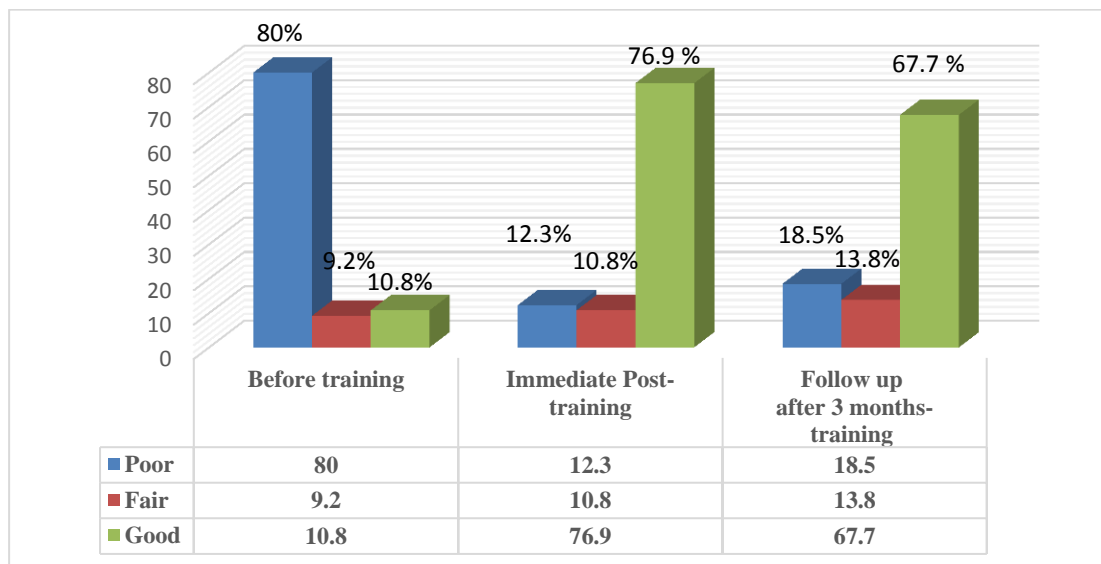
Nurses' Knowledge	Pre Mean ±SD	Immediately Post- Mean ±SD	Follow up Mean ±SD	F	P. value
- Positioning	1.00±0.93	1.87±0.48	1.81±0.52	45.11	0.000**
- Hand Hygiene	1.26±0.75	1.66±0.71	1.58±0.74	8.24	0.000**
- Oral Care	0.35±0.48	0.75±0.43	0.72±0.45	20.38	0.000**
- Ventilator care measures	1.83±1.03	2.53±0.96	2.83±1.02	12.00	0.000**
- Suctioning from the ETT	3.83±1.50	6.96±2.1	6.76±2.17	85.63	0.000**
-Extubation and Weaning trials	0.58±0.74	1.52±0.70	1.49±0.73	48.22	0.000**

Highly significant at P<0.001

Table (4): Mean values of nurses' performance about VAP care bundle pre, immediately post and at follow up of the program implementation (n =65)

Nurses' Performance	Pre Mean \pm SD	Immediately Post Mean \pm SD	Follow up Mean \pm SD	F	P. value
- Infection control measures	09 \pm 2.70	07 \pm 1.24	69 \pm 1.75	63.28	0.000**
- Neonate position	0.35 \pm 0.48	0.92 \pm 0.26	1.00 \pm 0.00	83.1	0.000**
- Ventilator care measures	3.35 \pm 2.25	6.64 \pm 0.54	6.13 \pm 0.68	101.75	0.000**
- Suctioning from the ETT/tracheostomy	9.55 \pm 5.38	19.16 \pm 1.05	16.73 \pm 2.74	129.52	0.000**
- Oral care	0.61 \pm 1.16	2.90 \pm 0.29	1.96 \pm 1.01	99.22	0.000**
- Peptic ulcer prophylaxis	1.76 \pm 1.04	2.98 \pm 0.12	2.21 \pm 0.97	35.93	0.000**
- Extubation and Weaning trials	1.16 \pm 0.62	1.93 \pm 0.30	1.86 \pm 0.34	58.94	0.000**

Highly significant at $P < 0.001$

**Figure 2: Distribution of nurses regarding their total knowledge about VAP care bundle pre, immediately post and at follow up of the program implementation (n=65)**

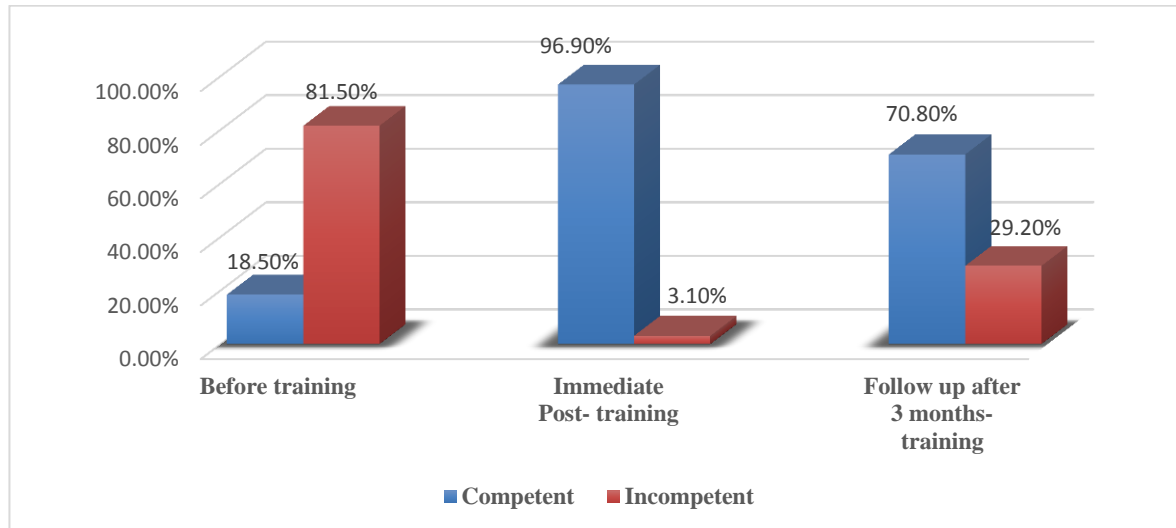


Figure 3: Distribution of nurses related to their total performance about observed VAP care bundle pre, immediately post and at follow up of the program implementation (n=65).

Table (5): Mean score of total nurses' knowledge and practice regarding VAP care bundle pre, immediately post and at follow up of the program implementation (n=65).

Items	Pre	Immediately post	at follow up	F	P. value
- Nurses' Knowledge regarding VAP	2.84±1.32	5.09±1.07	4.75±1.25	67.77	0.000**
- Nurses' Knowledge regarding VAP care bundle	9.50±3.56	14.38±3.43	12.93±3.31	48.53	0.000**
- Nurses' total practice regarding VAP care bundle	20.04 ±12.40	43.3 ± 1.98	37.15 ± 4.7	149.16	0.000**

Highly significant at P<0.001

Discussion

Ventilator Associated Pneumonia is the second most major serious complications of mechanical ventilation and the primary cause of morbidity and mortality. Incidence of VAP in NICU vary significantly around the world (between 1 to 63 episodes per 1000 ventilator days) reflecting different burden of disease but also differences in diagnostic process ⁽²²⁾. The implementation of educational measures to increase adherence of health professionals to VAP prevention measures, which will reverberate in the improvement of neonate-related outcomes and quality of nursing care provided to them ^(23,24). So, this study aims to evaluate the effect of care bundle strategies on nurses' performance regarding prevention of VAP at neonatal intensive care unit.

Related nurses' characteristics the current study findings illustrated that 61.6% of studied nurses' age ranged from 20-< 30years which represents the highest percentage of study sample. This result comes in agreement with **Abou Zed & Mohammed (2019)**⁽²¹⁾, who reported that, 74.3% of studied sample, their age ranged between 20 to less than 30 years with mean age of 26.63 ± 4.25 . Regarding to

educational level, the current results showed that, 41.5% of studied nurses had diploma degree this congruent with

Elbilgahy et al.,(2015)⁽¹⁵⁾ who reported that more than one third of studied nurses had a diploma certificate. Regarding the nurses' experience, the present study showed that 49.2% of nurses were have 1-< 5 years. Three quarters (75%) of nurses did not attend any previous training program related to VAP care bundle, this finding is consistence with **Abou Zed & Mohammed (2019)**⁽²¹⁾ who reported that less than half of studied nurses had less than 5 years of experience and less than two thirds(65%) of the study subjects didn't attended preceding training programs concerning preventive measures about neonatal VAP.

The current study revealed that nurses' mean knowledge score regarding VAP were improved at post and at follow up in relation to meaning, risk factors and signs and symptoms of VAP related to intubated neonates. These results were at same line with **Abou Zed & Mohammed (2019)**⁽²¹⁾ who found that there were

highly significant differences between the mean scores of nurses' knowledge before and after the intervention. Also, congruent with **Sanders-Thompson (2020)**⁽²²⁾ who represented that the nurses had a high level of knowledge following teaching (11.43 ± 0.775) compared to nurses prior to teaching ($9.55, \pm 0.976$), $p < .001$. These results explained as the majority of the studied nurses were diploma and nursing institutes. That reflected that nursing VAP care bundle training program had backbone in improvement the nurses' knowledge about preventive measures about neonatal VAP.

The current study revealed a significant improvement of nurses' knowledge regarding VAP care bundle immediately post and at follow up in relation to neonates' positioning, oral care and ventilator care measures. This improvement due to effect of teaching program on nurses' knowledge related to the care of critically ill neonates. These results are consistent with the study conducted by **Hussien(2017)**⁽²⁵⁾ who stated that there were significant improvement in mean knowledge score between pre and post training program regarding VAP prevention bundle. This study accordance with **Madhuvuet**

al.,(2020)⁽²⁶⁾ who reported that most of the study participants had poor knowledge about evidence-based guidelines for the prevention of VAP. They mentioned that nurse's lack of knowledge about VAP preventive care bundle and appropriate intervention may become barrier to prevent VAP. Nevertheless, numerous studies have shown that, training programs and applying nursing strategies for bundle care for VAP result in significant decline incidence of VAP⁽²⁷⁾.

In relation to total nurses' knowledge about neonatal VAP care bundle, this study represented that more than three quarter of nurses had a poor score of knowledge pre-program, which improved to good level of knowledge immediately post and at follow up of the program. This finding is in the same line with **Chithra&Raju (2017)**⁽²⁸⁾ who revealed that more than half of nurses had poor knowledge pre-program intervention. Meanwhile, in post educational program, the majority of studied nurses have a good knowledge level. Thus the designed training sessions was efficient in enhancing the knowledge of critical care nurses regarding prevention of VAP. This finding is congruent with **Aklet al.,(2020)**⁽¹⁹⁾ who showed that

there was marked improvement regarding the subject total knowledge level to prevent ventilator-associated pneumonia (VAP) post-application of VAP care bundle. In contrary the current results are inconsistent with previous findings by **Musvosvi (2013)⁽²⁹⁾** who reported that both the experimental group and the control group possessed very good baseline knowledge.

The results of the present study pointed out that the mean score of nurses' performance about neonatal VAP care bundle in the current study was significantly improved immediately post program implementation while this improvement decreased at follow up as revealed in this drop of performance may be due to unavailability of resources, lack of continuous education and absence of written VAP care bundle protocol in NICU which in turn affect nurses' performance. This improvement in our study is similar to study conducted by **John (2017)⁽¹⁷⁾** who found that the mean value of nurse's practice with modified neonatal VAP preventive care bundle was to be high on the third day of the program in comparison with the first day and second day. This finding was in contrary to the finding

of **Aloush (2017)⁽¹²⁾** who found that teaching in VAP-preventive guidelines was not advance nurses' skills without other perplexing influences, as their workload are controlled. In addition **Gomes et al.,(2020)⁽²⁴⁾** found that the adherence to some VAP care bundle measures was not different between groups of patients (with or without VAP) and showed low values of adherence .Also, **Álvarez-Lerma&García (2018)⁽³⁰⁾** reported that the reasons for non-compliance in performance of nurses to the proposed approaches were; that they were not in the unit protocols, lack of necessary resources, disagreement with the proposed strategy, cost, the possibility of causing patient discomfort and side effects on the patient.

The existing study illustrated that the majority of studied nurses had a competent skills concerning observed VAP care bundle pre, immediately post and at follow up of program implementation. This reflect positive effect of implementation of bundle and nurses were enthusiastic to learn more about how care about neonatal VAP. These results is aligning with **Metwally et al., (2015)⁽³¹⁾** who reported that the more than three quarters of nurses had an

unsatisfactory practice level pre-program intervention and post program intervention more than two third of nurses had a satisfactory practice level. Also, congruent with **John (2017)**⁽¹⁷⁾ who reported that all nurses had partial compliance in applying developed neonatal VAP preventive care bundle in the first and second day while on the third, less than quarter of them were complaint about the performance and more than three quarter were partially complaint.

According to the present study findings, improvement in the nurses' knowledge and performance regarding VAP care bundle with a highly significant difference before, immediately after and after three months of program application. The researchers found this finding could be due to the effectiveness of the study intervention. This finding is compatible with **Aklet al.,(2020)**⁽¹⁹⁾ who found that there was a positive association between nurse's knowledge and their practice post intervention. Moreover, the majority of critical care nurses practice was the greatest skillfully related to all VAP care bundle items. This study was incongruent with **Madhuvuet al.,(2020)**⁽²⁶⁾ who reported that there

was no relationship between participants' knowledge and compliance to evidence-based guidelines regarding VAP. While most study participants understood the evidence-based guidelines, they did not necessarily follow it in practice. The differences in compliance practices might be due to specific organization policies, which do not support the practice and the availability of resources.

Conclusion

The application of care bundle strategies for the nurses had improved their level of performance regarding prevention of ventilator associated pneumonia in the neonatal intensive care units.

Recommendations

1. Continuous up to date guided protocols should focus on enhancing nurses' performance regarding VAP care bundle.
2. Ongoing in-service training must be introduced into hospitals and NICUs using the updated bundle strategy.
3. Orientation of new NICU nurses should include education on VAP preventive care bundle.
4. Manuals, information booklets and self-instruction module regarding

VAP preventive care bundle should be present in every intensive care unit.

Limitation

The small sample size was the most common limitation in this study; we propose that several hospitals may be needed to get higher sample sizes and to evaluate feasibility/cost-effectiveness.

References:

1. Wu D, Wu C, Zhang S, Zhong Y. Risk factors of ventilator-associated pneumonia in critically ill patients. *Frontiers in pharmacology*. 2019 May 9;10:482.
2. Awany M, El-Gamasy A, Elsadek E, Alenany E. Ventilator associated pneumonia in Egyptian critically ill preterm and full term neonates. *Trauma Crit Care*. 2017;(2):4-17.
3. Terjesen CL, Kovaleva J, Ehlers L. Early assessment of the likely cost effectiveness of single-use flexible video bronchoscopes. *Pharmacoeconomics-open*. 2017 Jun;1(2):133-41.
4. Weber D, Ikuta L, Zukowsky K. Applying adult ventilator-associated pneumonia bundle evidence to the ventilated neonate. *Advances in Neonatal Care*, 2016;16(3): 178-190.
5. Sahlo NY, Madkour LA, Soliman YM. Ventilator associated pneumonia in a tertiary care hospital: incidence, risk factors and etiological agents. *Microbiology Research Journal International*. 2016 Feb 14:1-0.
6. De Neef M, Bakker L, Dijkstra S, Raymakers-Janssen P., Vileito A, Ista, E. Effectiveness of a Ventilator care Bundle to prevent Ventilator-Associated Pneumonia at the PICU: A systematic review and Meta-Analysis. *Pediatric Critical Care Medicine*. 2019; 20(5): 474-480.
7. Centers for Disease Control and Prevention (CDC). Pneumonia ventilator-associated (VAP) and non-ventilator associated pneumonia (PNEU) event. CDC. 2016. Available from: <http://www.cdc.gov/nhsn/PDFs/pscManual/6pscVAPcurrent>. [Accessed January 2017].
8. Centers for Disease Control and Prevention (CDC). Pneumonia (Ventilator-associated [VAP] and non-ventilator-associated Pneumonia [PNEU]) Event. 2021. <https://www.cdc.gov/nhsn/pdfs/pscmanual/6pscVAPcurrent>.
9. Obeid A, Kamel R, Naous A, Merhi A, Rajab M. Preventing

- ventilator associated pneumonia (VAP) in a pediatric intensive care unit using a modified ventilator-associated pneumonia bundle: Pre-interventional and post-interventional trial. *Int. Med. Res J.* 2014; 2:14–19.
- 10.** Azab F, Sherbiny S, Saleh H, Elsaed F, Elshafiey M, Siam G, et al., Reducing ventilator-associated pneumonia in neonatal intensive care unit using “VAP prevention Bundle: A cohort study. *BMC Infectious Diseases.* 2015; 15(1): 1-7.
- 11.** Akdogan O, Ersoy Y, Kuzucu C, Gedik E, Tugal T, Yetkin F. Assessment of the effectiveness of a ventilator associated pneumonia prevention bundle that contains endotracheal tube with subglottic drainage and cuff pressure monitorization. *The Brazilian Journal of Infectious Diseases.* 2017; 21(3): 276–281.
- 12.** Aloush M. Nursing students' knowledge about ventilator-associated pneumonia prevention guidelines: Effectiveness of a teaching program. *American Journal of Infection Control.* 2017; 45(5): 544-546.
- 13.** Álvarez-Lerma F, Palomar-Martínez M, Sánchez-García M, Martínez-Alonso M, Álvarez-Rodríguez J, Lorente L, et al., Prevention of ventilator associated pneumonia: The multimodal approach of the Spanish ICU “Pneumonia Zero” Program. *Critical Care Medicine.* 2018; 46(2): 181.
- 14.** Leone M, Bouadma L, Bouhemad B, Brissaud O, Dauter S, Gibot S, et al., Hospital-acquired pneumonia in ICU. *Anesthesia Critical Care & Pain Medicine.* 2018; 37(1): 83-98.
- 15.** Elbilgahy A, Ouda W, Hashem S, Elasmym M. Effect of implementing training program for nurses on prevention of pediatric ventilator-associated pneumonia. *Mansoura Nursing Journal.* 2015; 2(2): 59-70.
- 16.** Malhotra P, Kumar N, Thapar K, Bagga K. Comparative study of incidence, risk factors, etiological agents and outcome of early and late ventilator associated pneumonia in paediatric intensive care unit at a tertiary care centre. *Int. J. Contemp. Paediatric.* 2018; 5(3): 708-13.

17. John, N. Nurses' compliance in using modified neonatal ventilator associated pneumonia (VAP) preventive care bundle for newborn, Master thesis of science in nursing, Chennai.2017.
18. Pinilla-González A, Solaz-García Á, Parra-Llorca A, Lara-Cantón I, Gimeno A, Izquierdo I, Vento M, Cernada M. Preventive bundle approach decreases the incidence of ventilator-associated pneumonia in newborn infants. *Journal of Perinatology*. 2021 May 25:1-7.
19. Akl B, Saadoon M, Sayed A. Effectiveness of ventilator associated pneumonia care bundle on the pediatric critical care nurses knowledge, practice and critically ill neonates outcome. *Journal of Nursing and Health Science*. 2020; 9(3): 57-68.
20. Taha AS. Impact of designed skin care bundle protocol on Nurses' knowledge and practice and patients outcomes at intensive care unit. *Journal of Natural Science Research*.2014; 4(4):1.
21. Abou Zed F, Mohammed A. Impact of nursing guidelines on nurses' knowledge and performance regarding to prevention of ventilator associated pneumonia in neonates. *Journal of Nursing Education and Practice*. 2019; 9(10): 1-14.
22. Sanders-Thompson D. Examining ICU Nurses' Knowledge of Ventilator-Associated Events and Ventilator-Associated Pneumonia (Doctoral dissertation, Walden University).
23. Iosifidis E, Pitsava G, Roilides E. Ventilator-associated pneumonia in neonates and children: A systematic analysis of diagnostic methods and prevention. *Future Microbiology*. 2018; 13(12):1431-1446.
24. Gomes A, De Brito Röder D, Cunha M, Cardoso Filho M, Mendes Rodrigues C, et al., Adherence to ventilator-associated pneumonia prevention measures in intensive care. *Rev. Pre. Infec. Saúde*. 2020; 6(9165):1-8.
25. Hussien M. Impact of education on nurses' knowledge of ventilator-associated pneumonia in neonatal settings at Southern West bank hospitals: An intervention study. Published Master thesis, AL-Quds University, Ghazasectore,2017.

26. Madhuvu A, Endacott R, Plummer V, Morphet J. Nurses' knowledge, experience and self-reported adherence to evidence-based guidelines for prevention of ventilator-associated events: A national online survey. *Intensive and Critical Care Nursing*. 2020; 59(102827):1-6.
27. Mogyoródi B, Dunai E, GalJ, Ivanyi Z. Ventilator-associated pneumonia and the importance of education of ICU nurses on prevention—Preliminary results. *Interventional Medicine and Applied Science*. 2016; 8(4): 147-151.
28. Chithra A, Raju J. Effect of structured teaching program on knowledge regarding prevention of ventilator associated pneumonia among critical care nurses. *International Journal of Health Sciences & Research*. 2017; 7(7): 165-163.
29. Musvosvi E. The impact of in-service education on ICU nurses knowledge and compliance with practice for preventing ventilator-associated pneumonia. A research report. Published Master thesis. California State University2013.
30. Álvarez-Lerma F, García S. The multimodal approach for ventilator associated pneumonia prevention”—requirements for nationwide implementation. *Annals of Translational Medicine*. 2018; 6(21): 1-11.
31. Metwally H, El-Sayed W, Shafik F, Bayoumi M. Effect of Preventive Bundle Guidelines on Nurses' Knowledge and Compliance towards Ventilator Associated Pneumonia in Pediatric Critical Care Units. In 4th annual and 1st International Scientific Conference of Faculty of Nursing Benha University in Collaboration of Psychological Intelligence Foundation (PIFCIC), Hertford, UK.2015.