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Effectiveness of Ventilator Associated Pneumonia Care Bundle on the Pediatric Critical Care Nurses Knowledge, Practice and Critically ill Neonates Outcome

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Abstract
Background: *Ventilator-associated pneumonia (VAP) is a serious complication in critically ill infant and it is a major cause of hospital morbidity, mortality, and increased health care costs. A multi-strategy approach is required to prevent such infections. VAP care bundle implementation with education prepared according to the evidence-based care bundle has been shown to decrease VAP rates.* ***Aim:*** *To evaluate the effectiveness of ventilator-associated pneumonia care bundle on the pediatric critical care nurses' knowledge, practice and critically ill neonate's outcome at a neonatal intensive care unit in Aswan university hospital. Quasi-experimental research design was utilized in this study The sample of the study was consisted of two subjects (infants and nurses) on a convenient sample of (36) critical care nurses and (50) infants critically neonatal ICU connected to mechanical ventilation more than 24 hours, infants divided into two equal groups: study group for ventilator-associated pneumonia care bundle and control group for routine neonatal ICU care.* ***Tools:*** *Three tools were used for data collection, tool (I): Pre / Post-test questionnaire sheet for nurses consists of two parts; part (1): socio-demographic characteristics of nurses, part (2): assess nurses knowledge, Tool (II): pre/post observational checklist sheet for nurses, to assess ventilator-associated pneumonia care bundle practice on nurses providing care for critically ventilated ill neonate. Tool (III): Neonatal clinical outcome sheet: consists of two parts, socio-demographic characteristics of infants, and Clinical pulmonary infection score (CPIS).****Results:*** *The main results revealed that: there was a significant difference between total CPIS score pre and post-application of VAP care bundle, it means that when the studied nurses followed the ventilator care bundle correctly, it decreased ventilator-associated pneumonia frequency at P-value (<0.01).* ***Conclusion:*** *After implementing a ventilator-associated pneumonia care bundle the nurses' knowledge and practices was improved that led to a decreased VAP rate among mechanically ventilated patients.* ***Recommendation:*** *the training workshops and courses for pediatric critical nurses to control VAP must be reduplication in a large probability sample in the different setting area.*

Keywords: *Bundle care bundle, Ventilator Associated Pneumonia, pediatric critical units.*

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I. Introduction:

Ventilator-associated pneumonia (VAP) is defined by the National Health Care Safety Network (NHSN) of the Centers for Disease Control and Prevention [1]. as an episode of pneumonia where the infant is intubated and connected to a ventilator for more than two calendar-days [2].VAP is a severe complication for infants at present in acutely and critically condition and can subsequently increase lung tissue damage, increase oxygen demand, and more risk of complications such as lung abscess, empyema, secondary to bacteremia and sepsis, and bronchopulmonary dysplasia [3].

VAP is also linked with prolonged hospital and ICU stays, increased period of ventilation and deaths. VAP is the second most hospitalized infection among critical care children in neonatal intensive care units[4].Implementing care bundles in clinical practice has been widely advocated in mechanically ventilated patients admitted to an intensive-care unit (ICU) and is associated with a reduced risk of ventilator-associated pneumonia (VAP). A care bundle identifies a set of key interventions deriving from evidence-based guidelines that, when implemented, are expected to improve patients' health outcomes [5].

Airway infection that progresses more than 48 hours next to intubation, the biologic causes of the transitions from largely gram-positive organisms in the first 48 to 72 hours to gram-negative organisms the state more problematic to effectually treat by antibiotics [6].

The furthermost common microbes cultured in VAP personal belongings are Streptococcus pneumonia, Staphylococcus aureus, and Haemophilus influenza. But culture of airways secretions confirms the diagnosis of VAP, the Centers for Disease Control reports that the detection and management of VAP may be designated with the expansion of any combination of the subsequent: fever, pus-filled sputum, leukopenia, increase respiratory rate, using accessory respiratory muscle manifested by chest wall retractions with flaring nose, cough, and wheezes, rhonchi [7].

Ventilator-associated pneumonia (VAP) in neonates can be decreased by applying preventive care practices. Application of a bundle, of evidence-guidelines practices that improve manners of care, has been publicized to be economical and to have enhanced outcomes than the implementation of separate single practices. Neonatal ET tubes are uncuffed to avoid tracheal mucosal ischemia or ulcer occurred by cuff pressure, creating intubated neonates vulnerable to microorganisms leaking into the airway [8].

Recently, there are evidence-based guidelines in the neonatal intensive care unit that establishes that prevention of VAP is achievable through the application of certain multiple interventions at the same time. This approach, identified as "a VAP bundle the implementation of these procedures as a bundle has been demonstrated to decrease the occurrence of VAP in infants and children [9].Pediatric nurses are in the ultimate position as the primary caregiver and member of the interprofessional team to identify infant's stressors and implement primary and secondary preventions and interventions to avoid VAP [7].These include oral care using chlorhexidinegluconate oral rinse; maintaining the head-of-bed at 15-30 degrees and promoting the correct position; daily sedation vacation and daily assessment of readiness to exudate; Ventilator management; Suction care; Assessment of extubation readiness (The Institute for Healthcare Improvement [10].

Significant of the study

Several studies recommended application in infants VAP has strong evidence in reduction of infections, especially in pediatric critical units. Persistent education of health caregivers will increase their awareness about the disease and their compliance in the application the approved guidelines and protocols in their units so that there is a vital need for trials to recognize reliable tests that confirm the diagnosis of VAP at all pediatric critical units in order to prevent it and reduce the infection.

Aim of this study

To evaluate the effectiveness of ventilator-associated pneumonia care bundle on the pediatric critical care nurses' knowledge, practice and critically ill neonate's outcome at neonate critical units in Aswan university hospital.

Hypothesis of the study:

1. The post mean knowledge score of nurses will be higher than the pre mean knowledge score.
2. The post mean practice scores of nurses will be higher than pre mean practice scores.
3. The frequency of ventilator-associated pneumonia in critically ill neonates cared by nurses after ventilators associated pneumonia (VAP) care bundle implementation will be lesser than pre VAP care bundle implementation.
4. A positive relationship will exist between knowledge and practice score obtained by nurses receiving the ventilator associated pneumonia care bundle.

II. Material and Methods

Study Design:

Quasi-experimental research designs were used in this study.

Setting:

Subjects were recruited from a 20-advanced incubator three of whom are equipped with light therapy, children with jaundice level III neonatal intensive care unit at Aswan University hospital.

Subjects:

1. All available nurses that dealing with ventilated infants in a neonatal intensive care unit (36 nurses), according to the following inclusion criteria include all nurses both sex (male and female), and all nurses dealing with mechanically ventilated patients and nurses with all level of education.
2. All ventilated infants in the neonatal intensive care unit (25 patient) from January to April 2018 (control group) and all ventilated patients (25 patient) in the previous setting after applying ventilator associated pneumonia care bundle, from June through September 2018 (the experimental group), according to the following inclusion criteria: infants from1day to 12 months from both sex (male and female), newly admitted and 24-48 hours of intubation, needs mechanical ventilator for more than 72 hours, using invasive mechanical-

ventilation via artificial airway either endotracheal or tracheostomy tube, hemodynamically stable i.e. parameters within normal levels such as pulse, blood pressure, blood gases analysis, & central venous pressure and free from infection as evidenced by clinical manifestation or microbiological analysis and chest X-ray.

Tools:

Three tools were used for data collection

***Tool (I):*Pre / Post-test questionnaire sheet for nurses**

1. It was used prior to the implementation of a ventilator-associated pneumonia care bundle to measure the exact knowledge level of nurses regarding VAP care bundle. The same tool was used post-implementation of a ventilator-associated pneumonia care bundle (post-test). It was designed and utilized by the researchers: It consists of two main parts

2. Part 1: Socio-demographic characteristics of nurses included data related to subjects' characteristics such as name; age, sex, years of experience, and educational level.

3. Part 2:assess nurse's level of knowledge as regards ventilator-associated pneumonia care bundle: was developed by the researcher based on the Centers for Disease Control and Prevention (CDC) guideline adopted from**Bockheim,**[11] In addition to some items were adopted from a reliable questionnaire developed by **El-Khatib,** [12]

Included 27 items of multiple-choice questions that covered pathophysiology, risk factors of ventilator-associated pneumonia and VAP bundle care related to preventive measures, then provided nursing care components to enhance their knowledge to improve neonate's clinical outcome.

The Scoring system for the questionnaire was as follows; the correct answer was given the score of "ONE" and the wrong answer was given the score of "ZERO. Based upon the scoring system utilized, the knowledge level was categorized as follows: satisfactory level is ≥ 75% and unsatisfactory level was < 75%.

Tool II: pre/post observational checklist sheet for nurses

This tool was developed by the researcher based on the current international literature VAP care bundle checklist, was initiated by **CDC,** [13]& adapted **by Institute for Healthcare Improvement** [14]**&(Stokowski.,** [15] to assess ventilator associated pneumonia care bundle practice on nurses providing care for a critically ill ventilated neonate. This tool was used before and after the implementation of the ventilator associated pneumonia care bundle to assess the nurses` practice.

The checklist sheet covered 9 main areas including infection control measures (5 items), positioning strategies(2 items), Bedside maintenance (2 items), ventilator care measures (4 items), End tracheal tube and gastric tube (2 items), Suctioning care (4 items), Oral care (4 items), Assessment of extubation readiness (2 items), Documentation (1 item). Each area has sub-items.

The Scoring systemfor the developed observational checklist had two responses, ' done ' response was given the score of "ONE" and 'not done ' response was given the score of "ZERO". Based upon the scoring system utilized, the performance level was categorized as follows: satisfactory level is ≥ 75% and the unsatisfactory level was <75%.

Tool III: Neonatal clinical outcome sheet: consists of two parts:

Part 1:Socio-demographic characteristics of neonates included data related to subjects' characteristics such as name; age, sex, ICU admission date, and ICU discharge date.

Part 2: Clinical pulmonary infection score (CPIS)**(Zilberbergi.,** [16]is assessed six variables, vital signs (temperature), blood leukocyte count, amount of tracheal secretions, radiographic finding on chest radiography, culture result and oxygen saturation.

Scoring system which is ranging from 0 – 12 points that were categorized as follows, a score > 6 at baseline or at 72 h is considered suggestive of pneumonia. If <= 6 at 72 hours patient probably doesn't have pneumonia and antibiotics probably can be stopped.

Content validity:

Face, content and concurrent validity for the previously mentioned tools were revised and ensured by seven experts in infection control, pediatric care nursing and critical care nursing. Based on the experts' opinions responses, the researchers developed the final validated form of the tools.

Pilot study:

A pilot study was carried out on 10% of the study sample to obtain information regarding clarity of the wording and presentation of the questionnaire, and time needed for completing the revised tools. No further alterations were needed according to participants' responses in the pilot study. The neonate shared in the pilot study were included in the study sample.

Reliability assessment:

The developed and validated tool for the knowledge questionnaire was tested for reliability on 10% of the study sample. Test-retest results using Alpha Cronbach revealed that all items are significantly differed and have a

correlation coefficient above the threshold of significance (r=0.87). On the other hand, the alpha value for the performance checklist in the sample was (r=0.85).which indicating the strong reliability of both tools.

Procedure:

Once permission was granted to proceed with the current study from responsible and authoritative parties at Aswan university hospital, the researchers initiated data collection and contacted each potential nurse to explain the purpose and nature of the study and ask nurses to fill out the questionnaire sheet (tool I) to assess nurses` knowledge before application of the VAP care bundle and the researcher fill out the observation checklist to assess nurses` performance prior to application of the VAP care bundle (tool II).

To facilitate the implementation of ventilator-associated pneumonia, researchers prepared the training places, teaching aids and media (pictures, handouts). This was followed by arranging for the teaching schedule based on the contents of VAP bundle care, a number of nursing staff involved, time availability, shifts as well as the resources available.

Also scheduled with them the teaching sessions for both theoretical, practical and the nurses were divided into small groups, each group contains 2 to 4 nurses. Each group of nurses chooses the optimal time for receiving the teaching sessions whenever they have minimal workload.

Teaching has been implemented for nurses in sessions and teaching on the spot during their official working hours. There were a total of 9 sessions. The number of nurses in each session ranged from 2- 4 nurses. The duration of each session was 30 – 45 minutes, including 10 minutes for discussion and feedback. Each session usually started with a summary of what has been taught during the previous sessions and the objectives of the new topics. Feedback and reinforcement of teaching were performed according to the nurses` needs to ensure their understanding.

Researchers established VAP rate in the NICU before the implementation of the nursing care guidelines, then re-determination the VAP rate after implementation of the nursing care guidelines.

The study consisted of a voluntary questionnaire distributed to the nursing staff to assess their knowledge of VAP before a series of educational sessions. A ventilator care bundle with several different modes of information delivery was used: information posted on a PowerPoint presentation, and an information brochure.

The study began by reviewing the charts of critically ill neonates on ventilators in the neonatal intensive care unit from January through April 2018 to determine the VAP rate before the implementation of the ventilator-associated pneumonia care bundle (the control group). The education component was then completed and the VAP care bundle was implemented. The nursing staff was allowed to become comfortable using the nursing care in practice, and then the VAP rate was examined over a period of one month from June through September 2018 (the experimental group).

The time for collecting data through this tool lasted 2 weeks. After that, VAP care bundle checklist was utilized to observe each nurse who is caring infants undergoing mechanically ventilation throughout shift (morning and afternoon) for three consecutive times, one week a part.

Ethical consideration:

Permission to conduct the study was obtained from the administrative authorities. The researchers emphasized that participation in the study is entirely voluntary, the anonymity and the confidentiality of their responses were assured. Nurse participants were asked to sign a consent form.

Written informed consent from parents of the studied infants was obtained. The researchers was confirmed on research data confidentiality.

Statistical analysis:

All collected data were organized, categorized, tabulated, entered, and analyzed by using computer SPSS, (Statistical Package for Social Sciences), soft-ware program version 24, which was applied to frequency tables, statistical significance and associations were assessed using chi-square test, McNemar test, Marginal Homogeneity, Monte Carlo for Chi square test, Fisher Exact for Chi square test, Student t-test, mean, and standard deviation were also used.

The observed differences and associations were considered as the following:

Significant (S) $p \leq 0.05$

Non significant (NS) $p > 0 > 0.05$

III. Result

Table (1): revealed distribution of the studied subject according to socio-demographic data, In relation to subject' gender, more than half (52.8%) were females, while the highest percentage (41.7%) were in the age group of less than 25 years with mean ± SD=30.33 ± 10.25. Regarding qualification (63.9%) had a Bacaloric degree. Concerning working experience, more than two-fifth of them (44.4%) had 1 – 5 years of working experience, and all of them did not have training VAP bundle within ICU.

Table (2): showed Distribution of the studied subject according to their knowledge score during pre and post-application, the table showed marked improvement in knowledge in post-test than pre from 36.1% to 91.67% with statistical significant differences in all items regarding to subject' knowledge score to prevent ventilator-associated pneumonia (VAP) when compared pre with post-application of VAP care bundle, at p-value (0.001).

Table (3): showed Distribution of the studied subject according to their practices score during pre and post-application, the table showed marked improvement in total practices in post-test than pre from 30.6% to 83.33% with statistical significant differences all items regarding to subject' practice score to prevent ventilator-associated pneumonia (VAP) when compared pre with post-application of VAP care bundle, at p-value (.001).

Table (4): Revealed that there was statistically significant difference between nurse's knowledge and ICU training when compared pre with post-application of VAP care Bundle , at p-value (< 0.01).

Table (5): Showed that there was statistically significant difference when compared pre with post-application of VAP care Bundle between nurse's practice and subject socio-demographic related to sex, experience and ICU training with p-value (>0.003, 0.01) respectively.

Table (6): Showed that there was a highly statistically significant relation between total nurse's knowledge score and total nurse's practice score when compared pre with post-application of VAP care Bundle to prevent ventilator-associated pneumonia, at p-value (< 0.001).

Table (7): Revealed Clinical pulmonary infection score (CPIS) for ventilated neonates which showed that there were statistically significant differences of CPIS parameters related to body temperature, tracheal secretion, radiographic finding and oxygenation status for the studied neonates' pre and post-application VAP care bundle with p-value (< 0.001, 0.006, 0.001,0.003) respectively.

Table (8): Showed that there was a significant difference between Total CPIS score pre and post-application of VAP care bundle, P-value (<0.001).

Figure (1): Showed that there was marked improvement regarding the subject' total knowledge level to prevent ventilator-associated pneumonia (VAP) from 36.1% in pre to 91.67% post-application of VAP care bundle.

Table (1): Distribution of the studied subjects (nurses) according to socio demographic data (n = 36)

Items	No	%
Gender Male Female	 17 19	 47.2 52.8
Age Less than 25 25-less than30 30	 15 12 9	 41.7 33.3 25.0
Min. – Max. 22.0 – 50.0	Mean ± SD. 30.33 ± 10.25	
Academic qualification diploma associated degree bacaloric degree	 8 5 23	 22.2 13.9 63.9
Experience less than 1 1-5 6-10	 13 16 7	 36.1 44.4 19.4
Training Yes No	 0 36	 0 100

Table (2): Distribution of the studied subject according to their knowledge score during pre and post application (n=36)

Knowledge items	Pre				Post				Chi-squared	p-value
	Unsatisfactory		Satisfactory		Unsatisfactory		Satisfactory			
	No	%	No	%	No	%	No	%		
Frequency of ventilator Circuit	28	77.8	8	22.2	5	13.88	31	86.11	**31.958**	**.001****
Suction care	25	69.4	11	30.6	4	11.11	32	88.88	23.095	**.001***
Patient positioning	26	72.2	10	27.8	1	2.8	35	97.2	**34.133**	**.001***
Head of the bed	33	91.7	3	8.3	0	0	36	100	57.287	**.001***
Condensation in the ventilator circuit	23	63.9	13	36.1	3	8.33	33	91.67	**21.732**	**.001****
Oral care	22	61.1	14	38.9	1	2.8	35	97.2	**25.555**	**.001***
Hand hygiene and gloving	22	61.1	14	38.9	1	2.8	35	97.2	**25.555**	**.001***
Current VAP prevention practice	23	63.9	13	36.1	3	8.33	33	91.67	**21.732**	**.001***
Belief about ability to affect VAP outcomes in the NICU.	23	63.9	13	36.1	1	2.8	35	97.2	**27.562**	**.001***
Total knowledge	23	63.9	13	36.1	3	8.33	33	91.67	**21.732**	**.001***

Chi-squared test-

Table (3): Distribution of the studied subject practice score of VAP care bundle checklist (n=36)

Practice items	Pre				Post				Chi-squared	p-value
	Unsatisfactory		Satisfactory		Unsatisfactory		Satisfactory			
	No	%			No	%	No	%		
Infection control measures	26	72.2	10	27.8	5	13.88	31	86.11	22.65	0.001**
HOB and Infant positioning	26	72.2	10	27.8	8	22.22	28	77.77	16.10	0.001**
Bedside maintenance	30	83.3	6	16.7	7	19.44	29	80.55	26.91	0.001**
Ventilator management	23	63.9	13	36.1	5	13.88	31	86.11	16.89	0.001**
End tracheal and gastric tube placement	22	61.1	14	38.9	6	16.67	30	83.33	13.14	0.001**
Oral care practice	24	66.7	12	33.3	7	19.44	29	80.55	14.50	0.001**
Suction care	26	72.2	10	27.8	3	8.33	33	91.67	27.94	0.001**
Assessment of extubation readiness	23	63.9	13	36.1	6	16.67	30	83.33	14.78	0.001*
Documentation	26	72.2	10	27.8	8	22.22	28	77.77	16.10	0.001**
Total practices	25	69.4	11	30.6	6	16.67	30	83.33	18.35	0.001*

Table (4): Relation between nurse's knowledge with socio demographic data pre and post application of VAP care Bundle.

Variables	Nurse's knowledge						p-value
	Pre		Post				
	Unsatisfactory (n = 23)		Satisfactory (n = 33)		Unsatisfactory (n = 3)		
	No.	%	No.	%	No.	%	
Sex							
Male	6	24.0	6	17.6	0	0.0	P=0. 51 n.s
Female	17	76.0	27	81.81	3	100.0	
Age (in years)							
<25y		43.5					
25 - <30	10	17.4	14	41.2	1	33.33	P= 0.50 n.s
>30	4	39.1	10	29.4	0	0.0	
	9		9	27.27	2	66.67	
Qualification							
Diploma degree	9	39.1	9	26.5	1	33.33	P= 0.69 n.s
Associated degree	10	43.5	15	45.45	2	66.67	
Bacaloric degree	4	17.4	9	26.5	0	0	
Experience							
Less than1 – 5 y	22	95.7	29	96.96	3	100.0	P=0.50 n.s
6-10 years	1	4.3	4	3.03	0	0.0	
ICU training							
Yes	0	0.0	33	100.0	0	0	P<0.01*
No	23	100.0	0	0	3	100	

Table (5): Relation between nurse's practice with socio demographic data pre and post application of VAP care Bundle.

Variables	Nurse's practice						p-value
	Pre		Post				
	Unsatisfactory (n = 25)		Satisfactory (n = 30)		Unsatisfactory (n = 6)		
	No.	%	No.	%	No.	%	
Sex							P<0.003**
Male	8	32	6	20.0	0	0.0	
Female	17	68	24	80.0	6	100.0	
Age (in years)							
<25y	10	40	10	33.3	4	66.67	P=0.45 n.s
25 - <30	6	24	10	33.3	0	0.0	
>30	9	36	10	33.3	2	33.33	
Qualification							
Diploma degree	8	32.0	7	23.33	1	16.67	P<0.94 ns
Associated degree	5	20.0	5	16.67	1	16.67	
Bacaloric degree	12	48.0	13	43.33	4	66.67	
Experience							P=0.001**
Less than1 – 5 y	22	88	29	96.67	2	100.0	
6-10 years	3	12	1	3.33	4	0.0	
ICU training							
Yes	0	0.0	30	100.0	0	0.0	P<0.001**
No	25	100.0	0	0	6	100.0	

χ^2, p: χ^2 and p values for **Chi square test**

Table (6): Relation between nurse's total practice score with their total knowledge score**:**

Total score nurse's knowledge	Total score nurse's practice				χ^2	p
	Satisfactory (n = 30)		Unsatisfactory (n = 6)			
	No.	%	No.	%		
Satisfactory	30	100.0	3	50.0	10.473	0.001^{**}
Unsatisfactory	0	0.0	3	50.0		

χ^2, p: χ^2 and p values for **Chi square test**

Table (7): Distribution of the studied cases according to Clinical pulmonary infection Score (CPIS) (n= 50)

Practice items		Pre=25		Post=25		Test(f)	p-value
		No	%	No	%		
Temperature	36.5 – 38.4	4	16.0	22	88.0	$\chi^2=$	P<0.001**
	38.5 – 38.9	11	44.0	3	12.0	27.03^{*}	
	more 39	10	40.0	0	.0		

Leukocytes in blood	6,200 to 17,000 <6,200 >17.000	15 10 0	60.0 40.0 0	16 9 0	64.0 36.0 0	χ^2= 0.373*	P=0.54 n.s
Tracheal secretion	None Mild / non purulent Purulent	10 7 8	40.0 28.0 32.0	12 13 0	48.0 52.0 0	χ^2= 9.98	P<0.006**
Radiographic finding	No infiltrate Diffuse/ patchy infiltrate	1 24	4.0 96.0	18 7	72.0 28.0	χ^2= 21.73	P<0.001**
Culture finding	No or mild growth Moderate or florid growth Moderate or florid growth and pathogen consistent	9 7 9	36.0 28.0 36.0	17 3 5	68.0 12.0 20.0	χ^2= 5.204*	P<0.07 ns
Oxygenation status	>75-100 mmHg = 75-100 mmHg more 75-100 mmHg	8 8 9	32.0 32.0 36.0	10 15 0	40.0 60.0 0	χ^2= 11.353*	P<0.003**

χ^2, p: χ^2 and p values for **Chi square test**

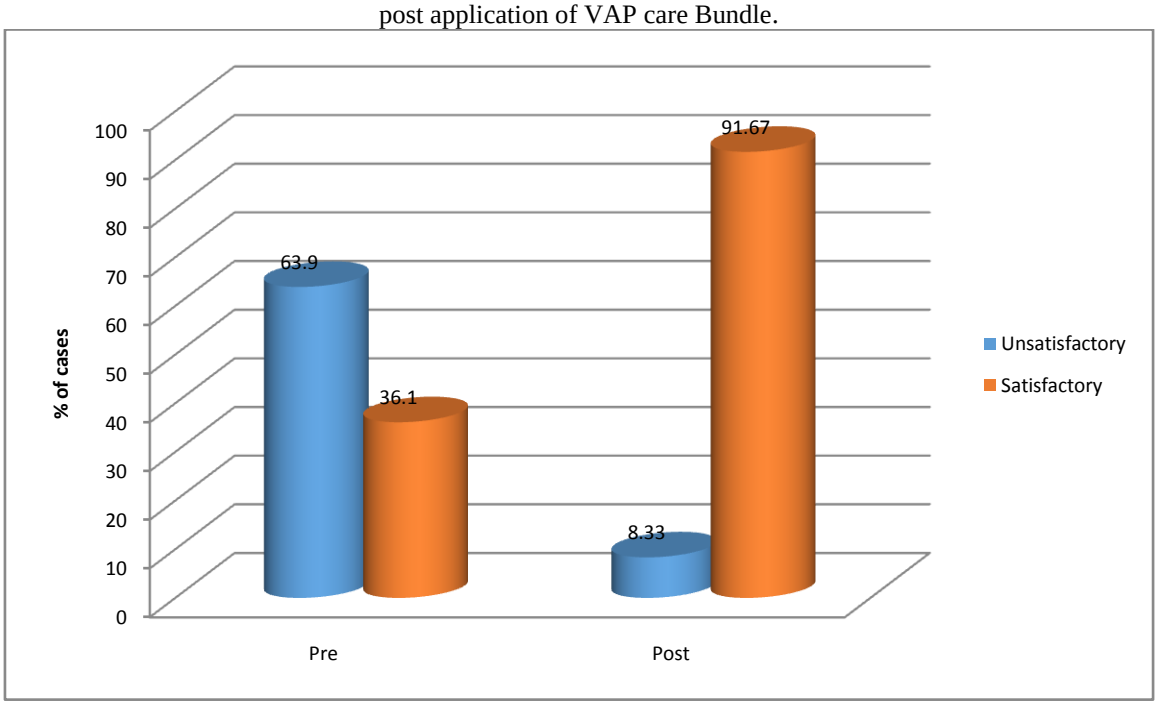
Table (8): Descriptive analysis of the studied cases according to total score of CPIS (n = 50)

items	Pre (n = 25)	Post (n = 25)	t	p
Total score of CPIS Min. – Max. Mean ± SD.	4.0 – 10.0 7.08 ± 1.56	0.0 – 7.0 3.51± 1.53	9.005	0.001**

t, p: t and p values for **Student t-test**

*: moderate statistically significant at $p \leq 0.05$

Figure (1): total knowledge level of studied nurses to prevent the ventilator associated pneumonia (VAP) pre & post application of VAP care Bundle.



IV. Discussion

Ventilator-associated pneumonia (VAP) is a common nosocomial infection in critically ill patients that is associated with poor clinical outcomes and economic, including longer duration of intubation, longer ICU and hospital stay, high rate of mortality, and increased hospital charges **Ahmed etal.,**[17].

This study has major consequences for nursing knowledge and practice. Ventilator associated pneumonia is an inevitable to prevention nosocomial infection. Critical care nurses play a vital role in control of Ventilation-associated pneumonia by protecting the neonate from risk Factors, reporting early indicator signs of VAP in patients and assisting in Diagnosis. So, a lack of knowledge and insufficient experienced nurses may convert an obstacle to prevent VAP in PICU **Zeb**[18].

Little studies have focused on neonates, particularly those with low or very low birth weight. The incidence of neonatal VAP is difficult to be correctly determined, because it is difficult to differentiate between new or progressive radiographic infiltrates due to neonatal pneumonia or due to exacerbation of bronchopulmonary dysplasia and frequent episodes of atelectasis. So the aim of the present study was to evaluate effectiveness of VAP care bundle on the pediatric critical care nurse's knowledge practice and critically ill neonate outcome.

Regarding age, the present study revealed that less than half (41.7%) of the studied subjects their age less than 25 years old with mean age of 30.33 ± 10.25. This result agreed with **Metwally,** [19], whose study about (Critical Care Nurses' Knowledge and Compliance with Ventilator Associated Pneumonia Bundle at Banha Specialized Pediatric Hospital) who reported that, 52.9% of studied sample, their age ranged between 25 to more than 30 years with mean age of 25.12 ± 2.42.

As regard to qualification, the present study showed that most of studied nurses (63.9%) have bacaloric degree and more than two fifth of them (44.4%) had 1-5 years of experience. This result agreed with **Yaseen and Salameh,** [20], the result of study by entitled (Saudi Critical Care Nurses' Knowledge Of and Barriers toward Adherence to Prevention of Ventilator Associated Pneumonia Guidelines)) who mentioned that, 48.4% of all participants had a Bachelor of Nursing degree, More than half of nurses (53.4%) had 1- 5 years of experience in ICU.

In relation to differences of nurses knowledge and practice among the study phases VAP care bundle application; regarding pre-intervention phase, the findings of the current study portrayed that the majority of nurses had significantly shown lower scores in knowledge and practice scores regarding the VAP care bundle; and both total knowledge and practice levels were unsatisfactory.

These results could be contributed to that the majority of subject acquired their knowledge of care for neonates from their basic VAP care bundle as well as they have lack of the updated knowledge toward the prevention of VAP. Moreover, it may be due to lack of in-service education & training courses, high workload & time constrains for nurses, and inadequate agency supervision to ideal practices. All theseadversely affected the nurse's knowledge & practice and consequently lead to poor neonate's outcome.

This finding is consistent with **Tayel,** [21], who tested implementation of ventilator-associated pneumonia prevention bundle in the neonatal intensive care unit at Alexandria University Children's Hospital, Egypt, the results exhibited that all subject had unsatisfactory poor knowledge and practice scores during baseline phase before the implementation of VAP care guideline.

Regarding the post-intervention phase, the present study findings highlighted that the nurses had a sharply significant increase and enhancement of their knowledge and performance scores regarding the VAP care strategies. Moreover, the current findings revealed that there was a significant positive correlation between nurse's knowledge and their performance in after care applications. Furthermore, the majority of critical care nurses performance was the most proficiently regarding all VAP care bundle items. The possible attributed reasons for this phenomenon returned to the implementation of the educational program and nurse's demonstration and re-demonstration techniques of the VAP care bundle.

The present study is also consistent with published studies that reported evidence that implementing a VAP prevention bundle can result in significant and sustained reductions in VAP rates. A 9-month prospective study at the NICU of AUCH was launched to implement the VAP bundle and to estimate its effect on decreasing VAP rate. All staff education was provided by multiple presentations to discuss how to diagnose and prevent VAP. Also, multiple sessions during clinical rounds were carried out to stress on VAP bundle items, particularly hand hygiene, securing the ETT, sterile handling of respiratory equipment, and proper timed mouth care. A signed statement from each staff member acknowledging their understanding to ensure the connection between policy and practice was obtained**(Azab.** [22], Also, the present study finding is consistent with, **De Cristofano**[9], **Meherali**[23], they conducted a study about the impact of education on VAP in the intensive care unit. Their results revealed that overall knowledge results in the pretest phase were poor and Enhanced after education. On the other hand, the study findings were contradicting with **Tayel.,**[21], who revealed that no

difference was observed in hand hygiene behavior even after the implementation of unit-level interventions to reduce VAP.

The power of the bundle is that it brings together several evidence-based practices that individually improve care, but when applied together, it may result in an even greater improvement in the desired outcome **Garland, [24], Zilberberg, M. D., &Shorr, A. F. [15].** The incidence of VAP on the basis of clinical and radiological diagnosis during bundle implementation, so the present study showed marked improvement in the neonates' outcomes in post phase than pre. Thus may due to marked improvement in knowledge and practices of nurses after implementation of the VAP bundle.

Several studies have shown a reduction of VAP rate after VAP care bundle implementation, For example, **Weber, [8]** who revealed that decreased VAP rate in neonatal intensive care unit (NICU),**Azab, [22]**brought off that VAP rate in the NICU significantly reduced from 68% with 36 VAP per 1000 Mechanical Ventilator Day to 38% with 23 VAP per 1000 Mechanical Ventilator Day after Bundle application ($p = 0.0006$).

Finally showed that there were significant relation between total CPIS score pre and post application of VAP bundle, it means that when the studied subject followed the ventilator bundle correctly, it nearly prevent ventilator associated pneumonia at P- value (<0.001).

V. Conclusion

The finding of the present study, concluded that: VAP care bundle was effective and improving ICU nurses knowledge and practices in addition to decreased VAP rate and clinical outcome among mechanically ventilated neonates at Aswan University Hospital.

RECOMMENDATIONS

Based on the foregoing conclusions, it is recommended to:

– Provide ICU departments with Arabic and English versions of the VAP care bundle and be available for all health team personnel.

– Organize training workshops and courses for NICU subjects about nursing care guidelines to prevent VAP.

– Provision of institutional written policies and guidelines regarding the application of protocol of care in daily routine care for mechanically ventilated infants.

- Similar study is recommended to include large sample size in other hospitals which provide care for critically ill pediatric patients, further research on factors affecting implementation of VAP prevention strategies is recommended.

-A similar study is recommended to include the large sample size in other ICU that provide care for critically ill neonates, and further research on factors affecting the implementation of VAP prevention strategies is recommended.

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