

Nurses' Application of Evidence-Based Guidelines on Prevention of Ventilator Associated Pneumonia in Neonates

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Abstract: Implementation of evidence-based guidelines of Ventilator Associated Pneumonia prevention affirmed a significant reduction in the incidence and prevalence of Ventilator Associated Pneumonia.

Objective: This study aims to assess nurses' application of evidence-based guidelines on prevention of ventilator associated pneumonia in neonates.

Settings: The study was carried out in NICUs at El-Raml Pediatric Hospital in Alexandria and Kafrelsheikh General Hospital in Kafrelsheikh.

Subjects: All nurses who are responsible for providing care for mechanically ventilated neonates in previously mentioned settings comprised the subjects (n= 100 nurses).

Tool: Nurses' Application of Evidence Based Guidelines on Prevention of Ventilator Associated Pneumonia Observational Checklist was used in the study. It included aseptic practices, aspiration prevention, oral care, endotracheal tube suctioning and respiratory equipment care guidelines.

Results: The main results revealed that 39% and 38% of the nurses had "Good" and "Satisfactory" practices scores respectively compared to only 23% of those who had "Unsatisfactory" scores regarding application of evidence-based guidelines of VAP prevention.

Conclusion: It can be concluded that more than two thirds of the nurses had either "Good" or "Satisfactory" total scores of practices in their application of evidenced based guidelines of VAP prevention.

Recommendation: The findings of the study recommended that proper in-service training programs should be provided for nurses about the most recent VAP preventive guidelines to update their knowledge and improve their practices about VAP prevention.

Keywords: Evidence-Based Guidelines, Ventilator Associated Pneumonia, Neonates.

1. INTRODUCTION

Mechanically ventilated neonates are at a very high risk of developing Ventilator associated pneumonia (VAP) because of their immature immune system, their skin and mucous membranes are more permeable to microbial invasion. Moreover, using the invasive procedures and devices, suctioning as well as frequent exposure to broad spectrum antibiotic makes them more vulnerable to acquire VAP. Tracheal intubation is associated with 6-20 fold risk of developing pneumonia. In addition, poor nutritional state and hypoalbuminemia of neonates also contribute to the development of VAP ⁽¹⁾.

Ventilator associated pneumonia is defined by Centers for Disease Control and Prevention (CDC) (2003) ⁽²⁾ and Scientific Committee on Infection Control (2010) ⁽³⁾ as an episode of pneumonia in a patient who requires a device to assist or control respiration through a tracheostomy or endotracheal tube within 48 hours before the onset of infection. Also, National Health Care Safety Network (2015) ⁽⁴⁾ defined VAP as new and persistent radiographic infiltrates and worsening gas exchange in neonates exhibit at least three of the following criteria: temperature instability with no other recognized cause, leukopenia, change in the characteristic of respiratory secretions, respiratory distress and bradycardia or tachycardia ⁽⁵⁾.

Ventilator associated pneumonia is the second most frequent type of Healthcare Associated Infections and accounts about 6.8% - 32.2% among mechanically ventilated neonates. It is also associated with considerable morbidity, including prolonged Neonatal Intensive Care Units (NICUs) stay, prolonged mechanical ventilation days and increased costs of hospitalization⁽⁶⁻⁸⁾. According to Dudeck et al. (2012)⁽⁹⁾, National Health Care Safety Network reported the estimated incidence of VAP was ranging from 0 - 4.4 per 1000 ventilator days.

Centers for Disease Control and Prevention (2003)⁽²⁾ have published guidelines for the prevention of health care associated pneumonia. Several studies have shown a reduction in VAP after application of such evidence-based guidelines in a form of bundle of interventions rather than a single one. Ventilator associated pneumonia bundle interventions include three main categories namely: aseptic practices, aspiration prevention and ventilator circuit maintenance guidelines. Initially, aseptic practices emphasizes on hand washing and gloving, while aspiration prevention emphasizes on elevate neonates' head of bed. Moreover, oral care, suctioning and maintenance of ventilator circuit integrity also incorporated in VAP bundle interventions^(2,10,11).

Currently, the occurrence of VAP is directly related to nursing malpractices, such as improper hand decontamination, oral care and suctioning. Unfortunately, lack of knowledge and compliance regarding evidence-based guidelines of VAP prevention is considered as the major cause of VAP among neonates. So, skilled nurses are extremely important to make appropriate decisions in practices and minimize risks to neonates⁽¹²⁾. Therefore, prevention of VAP is a high nursing priority for infection control in NICU⁽⁸⁾. Neonatal intensive care unit nurses are in the best position to put evidence-based guidelines into practice.

Aim of study:

This study aims to assess nurses' application of evidence-based guidelines on prevention of ventilator associated pneumonia in neonates.

Research Question:

To what extent do nurses apply evidence-based guidelines on prevention of ventilator associated pneumonia in neonates?

2. MATERIALS AND METHOD

Materials:

Research Design:

A descriptive design was used to accomplish the study.

Settings:

The study was conducted at Neonatal Intensive Care Unit at El-Raml Pediatric Hospital in Alexandria and Neonatal Intensive Care Unit at Kafrelsheikh General Hospital in Kafrelsheikh.

Subjects:

All nurses who are responsible for providing care for mechanically ventilated neonates from the previously mentioned settings within a period of three months comprised the subjects (n= 100 nurses; 50 nurses from each setting).

Tool:

Nurses' Application of Evidence Based Guidelines on Prevention of Ventilator Associated Pneumonia Observational Checklist.

The tool was developed by the researcher guided by Centers for Disease Control and Prevention evidence-based guidelines (2003)⁽²⁾ to assess nurses' application of evidence-based guidelines on prevention of VAP in neonates covered the 5 main areas. It included the following:

1. Aseptic Practices Guidelines such as hand washing and gloving.
2. Aspiration Prevention Guidelines such as head of bed elevation.

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3. Oral Care Guidelines such as time of oral care, oral and nasal suctioning.
4. Endotracheal Tube Suctioning Guidelines such as indication of suctioning, hyperoxygenation and normal saline instillation.
5. Respiratory Equipment Care Guidelines such as oxygen therapy equipment, nebulizers and ventilator circuit care.

Nurses' socio-demographic data such as age, level of education, years of experiences and attendance of training programs about VAP were attached to this tool.

Method:

1. An official letter was directed from the Faculty of Nursing in Alexandria University to responsible administrative personnel in the previously mention settings to collect the necessary data after explaining the aim of the study.
2. Tool was developed and tested for its content validity by five experts in the pediatric nursing field, and its value was 91.0%.
3. Reliability of the tool was asserted by using Cronbach's Coefficient Alpha Test and its value was 0.83.
4. A pilot study was carried out on 10 nurses to ascertain the feasibility and applicability of the tool. No modifications were done. Those nurses were excluded from the study subjects.
5. Every nurse was asked about her socio-demographic characteristics in her office during the break time.
6. Every nurse was observed for three times while providing care for mechanically ventilated neonates (twice at morning and once at afternoon shifts) . The total observations are 300; 150 observations for each hospital.
7. Data were collected from May to July 2016.

Ethical Considerations:

- Witness informed consent was obtained from head nurses after explanation of the study aim.
- Confidentiality of data was guaranteed.
- **Data Analysis**
 - Collected raw data were revised, coded and transferred into specially designed format to be suitable for computer feeding and entered into SPSS system files (SPSS package version 23). Following data entry, checking and verification processes were carried out to avoid any error during data entry.
 - The data were coded. Analysis and interpretation of data were conducted.

Scoring system for nurses' practices was done as follow:

Each item performed completely and correctly was given one mark and each item that was not performed or performed incorrectly was given zero.

The total scores of nurses' practices were 73 marks distributed as follows:

- | | |
|--|-----------|
| 1. Aseptic practices guidelines | 18 marks. |
| 2. Aspiration prevention guidelines | 7 marks. |
| 3. Oral care guidelines | 11marks. |
| 4. Endotracheal suctioning guidelines | 14 marks. |
| 5. Respiratory care equipment guidelines | 23 marks. |

The total scores of nurses' practices were categorized as follow:

- Good = 70% and more.
- Satisfactory = 60% to less than 70%.
- Unsatisfactory = less than 60%.

The following statistical measures were used:

- Descriptive statistics including frequency, distribution, mean and standard deviation were used to describe different characteristics.
- Kolmogorov – Smirnov test was used to examine the normality of data distribution.
- Univariate analyses including: Mann Whitney test and Kruskal Wallis test were used to test the significance of results of quantitative variables.
- The significance of the results was at the 5% level of significance.

3. RESULTS

Table (1) shows the characteristics of nurses. It is clear from the table that 43% of the nurses were in the age from 25 to less than 30 years old (54% and 32% for El-Raml and Kafrelsheikh nurses respectively) with mean age 29.72±6.17 for El-Raml and 25.40±3.91 for Kafrelsheikh hospital. About two-thirds of the nurses had Nursing Bachelor Degree (63% for all nurses; 54% for El- Raml and 72% for Kafrelsheikh nurses) and only 10% of the nurses had Secondary Nursing School Diploma (mainly 20% for El-Raml nurses). About one-third of the nurses had 1-5 years of experience (31% for all nurses; 30% for El-Raml and 32% for Kafrelsheikh nurses). In addition, 30% of the nurses had 6 to less than 10 years of experience (36% for El-Raml and 24% for Kafrelsheikh nurses). Moreover, 45% of the nurses attended workshops about VAP prevention for neonates (62% and 28% for El-Raml and Kafrelsheikh nurses respectively).

Table (1): Characteristics of Nurses

Characteristics	El-Raml Nurses		Kafrelsheikh Nurses		Total	
	No (n=50)	%	No (n=50)	%	No (n=100)	%
Age/Years						
• <20	7	14	29	58	36	36
• 25-	27	54	16	32	43	43
• 30&more	16	32	5	10	21	21
Mean±SD	29.72±6.17		25.40±3.91		27.5600±5.58193	
Level of Education						
• Secondary Nursing School Diploma	10	20	0	0	10	10
• Technical Nursing Institute	13	26	14	28	27	27
• Nursing Bachelor Degree	27	54	36	72	63	63
Years of experience/Years						
• <1	5	10	19	38	24	24
• 1-	15	30	16	32	31	31
• 6-	18	36	12	24	30	30
• 10 &more	12	24	3	6	15	15
Mean±SD	8.80±5.89		4.14±3.52		6.4700±5.36817	
Attendance of training workshops						
• Attended	31	62	14	28	45	45
• Did not attend	19	38	36	72	55	55

Nurses' application of hand washing according to evidence-based guidelines of VAP prevention is presented in **Table (2)**. It is apparent from the table that in 93% of the observations, the nurses washed their hands before wearing sterile gloves for performing aseptic procedure (90% for El-Raml hospital and 96% for Kafrelsheikh hospital). Only in 31% of the observations, the nurses washed their hands before contact with inanimate surfaces and objects (18% for El-Raml hospital compared to 44% of Kafrelsheikh hospital and the difference was statistically significant, where P =0.003). Moreover, it was found that the majority of the nurses washed their hands between contacts with mechanically ventilated neonate and others (94% for all the nurses' observations; 90 and 98% for El-Raml and Kafrelsheikh hospitals, respectively). In addition, in 71% of the observations, the nurses washed their hands between contacts with contaminated body site of the same mechanically ventilated neonates (56% for El-Raml compared to 86% for Kafrelsheikh nurses and the difference was statistically significant, where P =0.042).

It is also observed from the same table that in 87% of the nurses' observations, they washed their hands after exposure to body fluids (84% and 90% for El-Raml and Kafrelsheikh, respectively). Only in 34% of the observations, the nurses washed their hands after contact with inanimate surfaces and objects (20% for El-Raml compared to 48% for Kafrelsheikh nurses). It is also revealed that in 82% of the observations, the nurses rubbed their hands with alcohol if hands are not visibly contaminated with blood (86% for El-Raml and 78% for Kafrelsheikh nurses). While, in more than three-quarters of the observations, the nurses rubbed their hands with alcohol if hands are not visibly contaminated with body fluids (77% for all nurses' observations; 68% and 86% for El-Raml and Kafrelsheikh hospitals respectively).

Table (2): Nurses' Application of Hand Washing According to Evidence Based Guidelines of VAP Prevention

Hand Washing	El-Raml Nurses (n=150)*				Kafrelsheikh Nurses (n=150)*				Total (n=300)				Test of Significance
	Done		Not Done		Done		Not Done		Done		Not Done		
	No	%	No	%	No	%	No	%	No	%	No	%	
Wash hands before:	93	62	57	38	117	78	33	22	210	70	90	30	MWP=0.003*
• Contact with mechanically ventilated neonate	57	38	93	62	99	66	51	34	156	52	144	48	
• Wearing clean gloves for performing a clean procedure	135	90	15	10	144	96	6	4	279	93	21	7	
• Wearing sterile gloves for performing aseptic procedure	27	18	123	82	66	44	84	56	93	31	207	69	
Wash hands between contacts with:	84	56	66	44	129	86	21	14	213	71	87	29	MWP=0.042*
• Contaminated body site of the same mechanically ventilated neonates	135	90	15	10	147	98	3	2	282	94	18	6	
Wash hands after:	126	84	24	16	135	90	15	10	261	87	39	13	MWP=0.295
• Exposure to body fluids	129	86	21	14	126	84	24	16	255	85	45	15	
• Exposure to Blood	30	20	120	80	72	48	78	52	102	34	198	66	
• Contact with inanimate surfaces and objects	81	54	69	46	114	76	36	24	195	65	105	35	
Touching mechanically ventilated neonate's surrounding environment													
Rub hands with alcohol if hands not visibly contaminated with:	129	86	21	14	117	78	33	22	246	82	54	18	MWP=0.166
• Blood	102	68	48	32	129	86	21	14	100	77	69	23	
• Body fluids													

* (n = No of observations, where 50 nurses were observed 3 times) MW= Mann Whitney test *Significant at Sig.≤0.05

Table (3) shows nurses' application of gloving according to evidence-based guidelines of VAP prevention. It is clear from the table that in 89% of the observations, the nurses wore sterile gloves for aseptic procedure (94% and 84% for El-Raml and Kafrelsheikh nurses, respectively). Moreover, in more than three-quarters of the observations, the nurses wore gloves before exposure to blood (76% for all nurses' observations; 74% for El-Raml and 78% for Kafrelsheikh nurses). In addition, in 72% of the nurses' observations, the nurses wore gloves before handling objects contaminated with respiratory secretions of any mechanically ventilated neonate. Only during 47% of the observations, the nurses wore clean gloves for a clean procedure (26% for El-Raml compared to 68% for Kafrelsheikh nurses). It was also found that all nurses changed gloves between different neonates (100% of the observations). There was no statistical significant difference between El-Raml and Kafrelsheikh hospitals regarding gloving practices.

Table (3): Nurses' Application of Gloving According to Evidence Based Guidelines of VAP Prevention

Gloving	El-Raml Nurses (n=150)				Kafrelsheikh Nurses (n=150)				Total (n=300)				Test of Significance
	Done		Not Done		Done		Not Done		Done		Not Done		
	No	%	No	%	No	%	No	%	No	%	No	%	
Wear gloves before:	78	52	72	48	105	70	45	30	183	61	117	39	MWP=0.363
• Exposure to body fluids	111	74	39	26	117	78	33	22	228	76	72	24	
• Exposure to blood	108	72	42	28	108	72	42	28	216	72	84	28	
• Handling objects contaminated with respiratory secretions of any mechanically ventilated neonate	141	94	9	6	126	84	24	16	267	89	33	11	
• Wear sterile gloves for aseptic procedure	39	26	111	74	102	68	48	32	141	47	159	53	
• Wear clean gloves for a clean procedure	150	100	0	0	150	100	0	0	300	100	0	0	
• Change gloves between different neonates													MWP=1.000

MW= Mann Whitney test

*Significant at Sig.≤0.05

Table (4) illustrates nurses' application of aspiration prevention practices according to evidence-based guidelines of VAP prevention. Concerning head of bed elevation, it is clear from the table that in 90% of the observations, the nurses elevated head of bed for neonates' 15 - 30° (80% for El-Raml and 100% for Kafrelsheikh hospitals and the difference was statistically significant between both hospitals, where $P = 0.001$). In slightly more than one third of the observations, the nurses inserted feeding tube orally (32% for all nurses' observations; 38% and 26% for El-Raml and Kafrelsheikh nurses' observations respectively) and in 32% of the observations, the nurses checked endotracheal tube placement every 3-4 hours (22% and 42% for El-Raml and Kafrelsheikh nurses' observations respectively).

It is also revealed from the same table that checking appropriate placement of feeding tube was performed in 81% of the nurses' observations (74% and 88% for El-Raml hospital and Kafrelsheikh hospital respectively). In addition, placing endotracheal tube and the ventilator circuit in horizontal position was performed in 91% of the nurses' observations (92% from El-Raml hospital and 90% from Kafrelsheikh hospital). Statistical significant difference was found between both hospital regarding application of ETT care guidelines, where $P = 0.033$.

Table (4): Nurses' Application of Aspiration Prevention Practices According to Evidence Based Guidelines of VAP Prevention

Aspiration Prevention Practices	El-Raml Nurses (n=150)				Kafrelsheikh Nurses (n=150)				Total (n=300)				Test of Significance
	Done		Not Done		Done		Not Done		Done		Not Done		
	No	%	No	%	No	%	No	%	No	%	No	%	
Head of bed • Elevate head of bed 15 - 30°.	120	80	30	20	150	100	0	0	270	90	30	10	$MWP = 0.001^*$
Feeding tube Insert feeding tube: • Orally. • Nasally. Check: • Appropriate placement of feeding tube. • Gastric residual volume / 4hrs.	57 93 111 105	38 62 74 70	93 57 39 45	62 38 26 30	39 114 132 129	26 76 88 86	111 76 18 21	74 36 12 14	96 207 243 234	32 69 81 78	204 93 57 66	68 31 19 22	$MWP = 0.116$
Endotracheal tube • Check its placement / 3 to 4 hrs. • Place ETT and ventilator circuit in horizontal position.	33 138	22 92	117 12	78 8	63 135	42 90	87 15	58 10	96 273	32 91	204 27	68 9	$MWP = 0.033^*$

ETT= Endotracheal Tube

MW= Mann Whitney test

*Significant at $Sig. \leq 0.05$

Table (5) presents nurses' application of oral care according to evidence based guidelines of VAP prevention. It is revealed from the table that small proportion of the nurses performed oral care before repositioning neonates (in 26% of the observations), moving or re- taping neonates' endotracheal tube (in 27% of the observations) and performing nasal care to neonates (in 14% of the observations). In addition, during slightly more than three-quarters of the nurses' observations, the nurses performed oral care before changing the dressing of feeding tube (in 77% of the observations; 92% and 62% for El-Raml and Kafrelsheikh hospitals, respectively). Moreover, it was observed that only in 16% of the observations, the nurses performed oral care every 2-4 hours (24% for El-Raml hospital compared to 8% for Kafrelsheikh hospital).

It is also found from the same table that in 94% of the observations, the nurses performed oral care as needed. In addition, during 94% of the nurses' observations, they suctioned neonates' mouth and subglottic prior to oral care, (88% and 100% for El-Raml and Kafrelsheikh hospitals respectively). Only in 38% of the observations, the nurses swapped exterior surface of endotracheal tube that reside in oral cavity of the neonates (48% for El-Raml hospital compared to 28% for Kafrelsheikh hospital). There were statistical significant differences between both hospitals regarding timing and application of oral care guidelines, where $P = 0.014$ and 0.040 respectively, as nurses at Kafrelsheikh hospital practiced oral care more than those at El-Raml hospital.

Table (5): Nurses' Application of Oral Care According to Evidence Based Guidelines of VAP Prevention

Oral Care	El-Raml Nurses (n=150)				Kafrelsheikh Nurses (n=150)				Total (n=300)				Test of Significance
	Done		Not Done		Done		Not Done		Done		Not Done		
	No	%	No	%	No	%	No	%	No	%	No	%	
Perform oral care before: • Repositioning neonate • Moving or re-taping endotracheal tube • Changing dressing of feeding tube • Performing nasal care	42 57 138 15	28 38 92 10	108 93 12 135	72 62 8 90	36 24 93 27	24 16 62 18	114 126 57 123	76 84 38 82	78 81 231 42	26 27 77 14	222 219 69 258	74 73 23 86	$MWP = 0.014^*$
Perform oral care: • 2 - 4 hours • As needed	36 141	24 94	114 9	76 6	12 141	8 94	138 9	92 6	48 282	16 94	252 18	84 6	$MWP = 1.000$
• Suction mouth prior to oral care. • Suction subglottic prior to oral care. • Perform oral hygiene with sterile water. • Swap exterior surface of endotracheal tube that reside in oral cavity. • Moisturize lips and oral mucosa after oral care by sterile water.	132 132 141 72 132	88 88 94 48 88	18 18 9 78 18	12 12 6 52 12	150 150 135 42 120	100 100 90 28 80	0 0 15 108 30	0 0 10 72 20	282 282 276 114 252	94 94 92 38 84	18 18 24 186 48	6 6 8 62 16	$MWP = 0.040^*$

MW= Mann Whitney test

*Significant at $Sig. \leq 0.05$

Nurses' application of endotracheal suctioning according to evidence-based guidelines of VAP prevention is presented in **Table (6)**. It was found that in 65% of the observations, the nurses performed chest physiotherapy for neonates before suctioning (32% for El-Raml hospital compared to 98% for Kafrelsheikh hospital). During more than half of the nurses' observations, they performed suctioning as needed and used sterile suction equipment before suctioning (54% of the observations for each hospital). In addition, in half of the observations, the nurses hyperoxygenated neonates by increasing FIO₂ from 10% to 20% above baseline data on mechanical ventilator prior to suctioning (50% in all the observations; 90% for El-Raml hospital compared to only 10% for Kafrelsheikh hospital). Unfortunately, in one-quarter of the nurses' observations, the nurses adjusted suction pressure for neonates (60 – 80 mmHg) (26% in all nurses' observations; 26% for both El-Raml and Kafrelsheikh hospitals).

It is also revealed that almost all of the nurses applied suction during withdrawal of catheter only (99% in all nurses' observations; 100% and 98% in El-Raml and Kafrelsheikh hospitals respectively). In about two-thirds of the observations, the nurses used normal saline for installation prior to suctioning (58% for all the observations; 20% for El-Raml compared to 96% for Kafrelsheikh hospitals). Concerning nurses' practice after suctioning, in more than half of nurses' observations, they discarded the used suction tube (57% for all nurses' observations; 34% for El-Raml hospital compared to 80% for Kafrelsheikh hospital). In addition, in 48% of the observations, the nurses used new sterile catheter if the procedure needs to be repeated (38% and 58% for El-Raml and Kafrelsheikh nurses respectively). There were statistical significant differences between both hospitals regarding application of guidelines followed before and after ETT suctioning (P =0.046 and 0.017 respectively).

Table (6): Nurses' application of endotracheal suctioning according to evidence-based guidelines of VAP prevention

Suctioning	El-Raml Nurses (n=150)				Kafrelsheikh Nurses (n=150)				Total (n=300)				Test of Significance	
	Done		Not Done		Done		Not Done		Done		Not Done			
	No	%	No	%	No	%	No	%	No	%	No	%		
Before Suctioning:														MWp =0.017*
• Perform suctioning as needed	102	68	48	32	100	40	90	60	162	54	138	46		
• Perform chest physiotherapy.	48	32	102	68	147	98	3	2	195	65	105	35		
• Use sterile suction equipment.	63	42	87	58	99	66	51	34	162	54	138	46		
• Adjust suction pressure for neonates: 60 – 80 mmHg.	39	26	111	74	39	26	111	74	78	26	222	74		
• Hyperoxygenate neonates by increasing FIO ₂ from 10% to 20% above baseline data on mechanical ventilator prior to suctioning.	135	90	15	10	15	10	135	90	150	50	150	50		
During Suctioning:														MWp =0.185
• Use normal saline for installation prior to suctioning.	30	20	120	80	144	96	6	4	174	58	126	42		
• Use distilled water for installation prior to suctioning.	9	6	141	94	45	30	105	70	54	18	246	82		
• Use sterile technique when applying tracheal suctioning.	36	24	114	76	51	34	99	66	87	29	213	71		
• Introduce suction catheter only 3 passes during suction technique.	117	78	33	22	132	88	18	12	249	83	51	17		
• Apply suctioning in a period of 30 seconds.	129	86	21	14	120	80	30	20	249	83	51	17		
• Apply suction during withdrawal of catheter only	150	100	0	0	147	98	3	2	297	99	3	1		
After Suctioning:														MWp =0.046*
• Discard used suction tube.	51	34	99	66	120	80	30	20	171	57	129	43		
• Use new sterile catheter if procedure needs repeating.	57	38	93	62	87	58	63	42	144	48	156	52		
• Use new sterile glove if procedure needs repeating.	66	44	84	56	93	62	57	38	159	53	141	47		

MW= Mann Whitney test

*Significant at Sig.≤0.05

Table (7) presents nurses' application of oxygen therapy equipment care according to evidence based guidelines of VAP prevention. It is revealed from the table that all nurses changed oxygen therapy equipment based on mechanical malfunctioning (100% of the observations). In slightly more than two-thirds of the observations, the nurses changed oxygen therapy equipment based on visibly soiled with secretions (69% for all nurses' observations; 42% for El-Raml compared to 96% for Kafrelsheikh hospitals and the difference was statistically significant, where P =0.035). In addition, during 60% of the observations, the nurses disinfected oxygen therapy equipment with alcohol after its usage (46% for El-Raml hospital compared to 74% for Kafrelsheikh hospital). It is also revealed from the same table that none of the nurses in both hospitals rinsed oxygen therapy equipment with sterile water after use (0.0% of the observations for each hospital). Moreover, drying oxygen therapy equipment with forced air was not applicable in both hospitals (0.0% of the observations).

Table (7): Nurses' Application of Oxygen Therapy Equipment Care According to Evidence Based Guidelines of VAP Prevention

Oxygen Therapy Equipment Care	El-Raml Nurses (n=150)				Kafrelsheikh Nurses (n=150)				Total (n=300)				Test of Significance
	Done		Not Done		Done		Not Done		Done		Not Done		
	No	%	No	%	No	%	No	%	No	%	No	%	
Change oxygen therapy equipment based on:													MWP =0.035 *
• mechanical malfunctioning.	150	100	0	0	150	100	0	0	300	100	0	0	
• visibly soiled with secretions.	63	42	87	58	144	96	6	4	207	69	93	31	
Between treatments on the same patient:													MWP =0.425
• Clean used oxygen therapy equipment after every use.	75	50	75	50	63	42	87	58	138	46	162	54	
• Disinfect oxygen therapy equipment with alcohol.	69	46	81	54	111	74	39	26	180	60	120	40	
• Rinse oxygen therapy equipment with sterile water.	0	0	150	100	0	0	150	100	0	0	300	100	
• Dry oxygen therapy equipment with forced air.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	

MW= Mann Whitney test

*Significant at Sig.≤0.05

Table (8) Nurses' application of nebulizers care according to evidence based guidelines of VAP prevention is illustrated in table (8). It was observed that in 86% of the observations, the nurses used the same nebulizers for one neonate every time (100% and 72% for El-Raml and Kafrelsheikh hospitals respectively and the difference was statistically significant, where P =0.000). While, 70% of nurses' observations revealed that they disinfected the used nebulizers with alcohol (58% from El-Raml hospital compared to 82% from Kafrelsheikh hospital).

It is also revealed from the same table that almost all nurses did not rinse used nebulizers with sterile water after their use (in 99% of all nurses' observations; 98% and 100% for El-Raml and Kafrelsheikh hospitals respectively).None of the nurses in both hospital dried used nebulizers with forced air (0.0% in all observations). On the other hand, the nurses used only sterile water for nebulization in 97% of the observations (94% and 100% for El-Raml and Kafrelsheikh hospitals respectively).

Table (8): Nurses' Application of Nebulizers Care According to Evidence Based Guidelines of VAP Prevention

Nebulizers Care	El-Raml Nurses (n=150)				Kafrelsheikh Nurses (n=150)				Total (n=300)				Test of Significance
	Done		Not Done		Done		Not Done		Done		Not Done		
	No	%	No	%	No	%	No	%	No	%	No	%	
• Use the same nebulizer for one neonate every time.	150	100	0	0	108	72	42	28	258	86	42	14	MWP =0.000 *
• Clean used nebulizers after every use.	69	46	81	54	42	28	108	72	111	37	189	63	MWP =0.064
• Disinfected used nebulizers with alcohol.	87	58	63	42	123	82	27	18	210	70	90	30	
• Rinse used nebulizers with sterile water.	3	2	147	98	0	0	150	100	3	1	297	99	
• Dry used nebulizers with forced air.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
• Use only sterile water for nebulization.	141	94	9	6	150	100	0	0	291	97	9	3	MWP =0.015 *
• Dispense sterile water into nebulizer aseptically.	126	84	24	16	147	98	3	2	273	91	27	9	

MW= Mann Whitney test

*Significant at Sig.≤0.05

Table (9) delineates nurses' application of ventilator circuit care according to evidence based guidelines of VAP prevention. It was found that 35% of nurses' observation revealed that they drained ventilator circuit before re positioning of neonate in both hospitals. One the other hand, It was observed that all nurses changed the circuit only when the tubing has a malfunctioning, drained condensate away from the neonate and replaced humidifiers with sterile one (100% of the observations for each hospital). In addition, almost all the nurses used closed condensation traps in ventilator circuit (99% for all nurses' observations; 100% and 98% for El-Raml and Kafrelsheikh hospitals, respectively). Also, during 97% of the nurses' observations, the nurses used sterile water to fill humidifiers (96% and 98% for El-Raml and Kafrelsheikh hospitals respectively).

It is also revealed from the same table that in 93% of the observations, the nurses changed the used heat moisture exchanger humidifiers when malfunctioning (86% from El- Raml hospital and 100% from Kafrelsheikh hospital). During more than one-third of the observations, the nurses drained ventilator circuit before repositioning neonate (35% for all nurses; 42% and 28% for El-Raml and Kafrelsheikh hospitals respectively). Furthermore, in 56% of the nurses' observations, they drained any condensate collected in mechanical ventilator tube every four hours (32% for El-Raml hospital compared to 80% for Kafrelsheikh hospital).

Table (9): Nurses' Application of Ventilator Circuit Care According to Evidence Based Guidelines of VAP Prevention

Ventilator Circuit Care	El-Raml Nurses (n=150)				Kafrelsheikh Nurses (n=150)				Total (n=300)				Test of Significance
	Done		Not Done		Done		Not Done		Done		Not Done		
	No	%	No	%	No	%	No	%	No	%	No	%	
• Drain ventilator circuit before repositioning neonate.	63	42	87	58	42	28	108	72	105	35	195	65	MWP =0.560
• Change circuit only when tubing: • Visibly internally soiled with secretion. • Malfunctioning.	99	66	51	34	129	86	21	14	228	76	72	24	
• Drain any condensate that collected in mechanical ventilator tube / 4 hrs.	48	32	102	68	120	80	30	20	168	56	132	44	
• Drain condensate away from neonate.	150	100	0	0	150	100	0	0	300	100	0	0	
• Use closed condensation traps.	150	100	0	0	147	98	3	2	297	99	3	1	
• Change used heat moisture exchanger humidifier when: • Visibly soiled with secretion. • Malfunctioning	90	60	60	40	123	82	27	18	213	71	87	29	
• Replace humidifier with sterile one.	150	100	0	0	150	100	0	0	300	100	0	0	
• Use sterile water to fill humidifiers.	144	96	6	4	147	98	3	2	291	97	9	3	

MW= Mann Whitney test

*Significant at Sig.≤0.05

Figure (1) shows nurses' total practices scores regarding application of evidence-based guidelines of VAP prevention. It was found that 39% and 38% of the nurses had "Good" and "Satisfactory" practices scores respectively compared to only 23% of those who had "Unsatisfactory" scores.

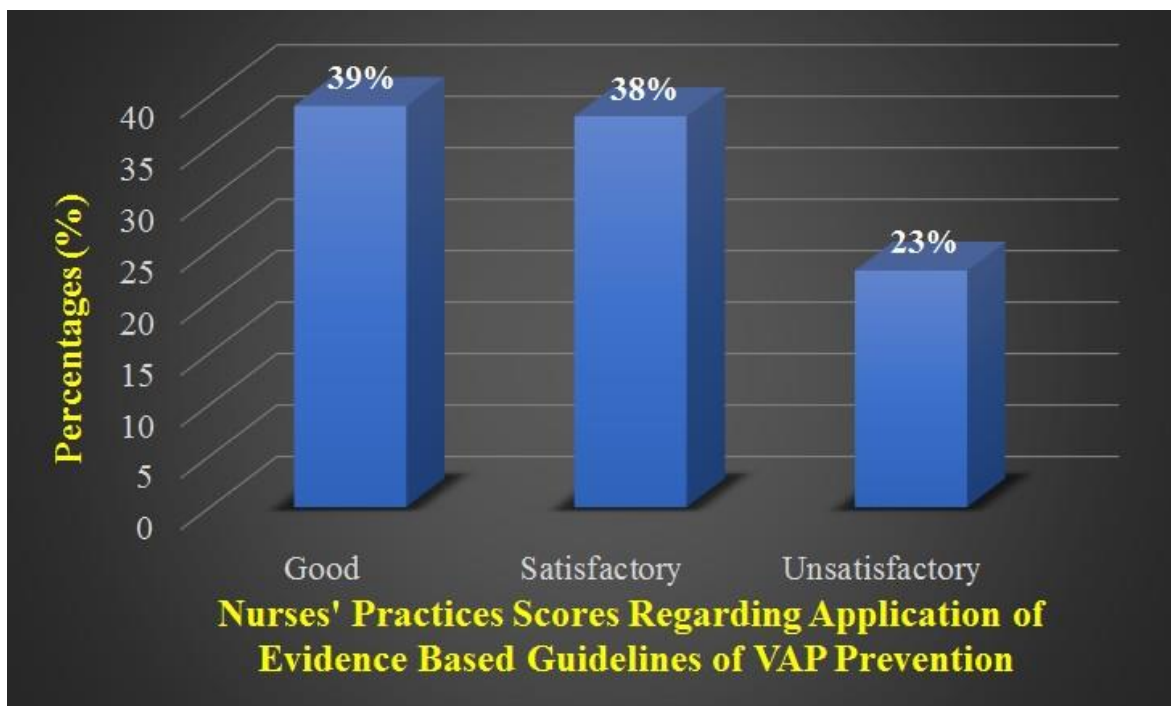


Fig. (1): Nurses' Total Practices Scores Regarding Application of Evidence Based Guidelines of VAP Prevention.

4. DISCUSSION

To ensure high standards of nursing care provided for mechanically ventilated neonates, nursing practice must be based on a strong body of scientific knowledge and adherence to the VAP evidence-based guidelines.⁽¹³⁾ Neonatal intensive care nurses have an important role in preventing VAP by decreasing risk factors, recognizing early symptoms, assisting in diagnosis and integrate evidence-based guidelines of VAP prevention into their practices^(14,15). Basically, hand hygiene is considered a cornerstone of all infection control practices⁽¹⁶⁾. The CDC strongly recommended hand washing before and after direct contact with mechanically ventilated neonates or when handling articles that could be contaminated with respiratory secretions⁽¹⁷⁾. The findings of the present study showed that the majority of the studied nurses washed their hands between direct contact with mechanically ventilated neonates and others. This could be justified by nurses' accountability for their adherence to infection control measures and the continuity of in-service training courses and workshops about infection control, where almost half of the nurses attended such training. The findings of the current study are congruent with Gatell et.al. (2012)⁽¹⁸⁾ who did a study about assessment of a training program for the prevention of VAP and found that the majority of the nurses washed their hands before and after contact with mechanically ventilated neonates. On the contrary, Kandeel and Tantawy (2012)⁽¹⁹⁾ found that only less than half of the nurses in their study washed their hands frequently between contact with patients in ICU.

Centers for Disease Control and Prevention (2012)⁽²⁾ and Institute for Health Improvement (2012)⁽²⁰⁾ recommended rubbing hands with alcohol if hands are not visibly soiled with secretions, body fluids and blood. The results of the current study revealed that large percentage of the nurses performed hand rubbing when their hands were not visibly soiled with blood. This result could be attributed to the availability of hand rubbing facilities or to the availability of hand rubbing posters which remind nurses by hand rubbing. This finding is incongruent with Said (2012)⁽²¹⁾ who mentioned that the minority of the nurses used alcohol-based hand rub.

One of the most important guidelines of VAP prevention is gloving. Centers for Disease Control and Prevention (2012)⁽²⁾ and Mehta et al. (2014)⁽²²⁾ emphasized changing of gloves between neonates which reduces the risk of health care associated infections. The findings of the present study reflected that more than two-quarter of nurses wore gloves before exposure to blood. In addition, all nurses changed gloves between contact with different neonates. These findings could be interpreted in the light of the fact that nurses may be aware of the transmission ways of contagious diseases, the in services training program or presence of infection control team. These findings are supported by Bagheri et.al. (2015)⁽²³⁾ who found that nurses used gloves before contact with patient as preventive measure for VAP in ICUs. On the contrary, Ali (2013)⁽²⁴⁾ who carried out a study about knowledge and compliance of critical care nurses with VAP bundle at Cairo University hospitals that half of the nurses were not compliant with changing gloves between patients.

Head of the bed elevation at angle of 15 to 35 reduces the risk of aspiration of contaminated oropharyngeal and gastrointestinal contents in neonates according to CDC guidelines if there are no contraindications⁽²⁾. The findings of the present study showed that the majority of the nurses elevated neonates' head of bed 15 - 30°. This could be related to nurses' awareness about the importance of head of bed elevation for neonates' safety or they might be afraid from neonates' aspiration that may occur if such simple practice is ignored or not done. This finding is in agreement with Alcan et.al. (2016)⁽²⁵⁾ who carried out a study about prevention of VAP, where they found that two-thirds of the nurses elevated patient's head of bed.

Checking the gastric residual volume every 4 - 6 hours is also a recommended care for prophylaxis VAP prevention by CDC (2003)⁽²⁾ and Garland (2014)⁽²⁶⁾ to avoid gastric distension and reduce the risk of aspiration. The results of the present study revealed that more than three-quarters of the nurses checked gastric residual volume every 4 - 6 hours. This could be related to nurses' verification of neonates' digestion before their feeding. This result is incongruence with Oliveira et al. (2010)⁽²⁷⁾ who reported that verification of residual volume amount done by less than half of their nurses.

Ventilator associated pneumonia is largely related to instrumentation of the airway with Endotracheal tube (ETT) followed by microaspiration of contaminated secretions⁽²⁸⁾. Therefore, checking endotracheal tube placement is one of the most important measures of daily care which must be performed by nurses to avoid complications associated with ETTs. Unfortunately, only one- third of nurses in the current study were committed with checking ETT placement every 3-4 hours. This may be interpreted by nurses' fear from dislodging of ETT. In addition, lack of nurses' awareness about the importance of periodical checking of ETT placement. Similarly, Gatell et al. (2012)⁽¹⁸⁾ mentioned that the majority of the nurses in their study did not perform periodical checking of neonates' ETT placement.

There is an association between VAP and oral cavity as it acts as a reservoir for bacteria⁽²⁹⁾. Consequently, Centers for Disease Control and Prevention (2003)⁽²⁾ suggested that a comprehensive oral hygiene regimen should be implemented for all neonates at risk for VAP. Unfortunately, the minority of the nurses in the current study performed oral care every 2-4 hours. The finding of the current study may be due to lack of nurses' knowledge regarding the importance of performing oral care every 2 - 4 hours and its association with occurrence of VAP. Moreover, these findings could be attributed to nurses' conception that oral care is a comfortable procedure rather than for VAP prevention or may be due to absence of written policy regarding oral care in NICU. The findings of the present study is similar to the findings of Kandeel and Tantawy (2012)⁽¹⁹⁾ who found that the oral care was performed as needed not on a regular base.

Suctioning of neonates' secretions prevents oral secretions from pooling within oropharynx and maintaining good oral hygiene, which reduces oropharyngeal colonization.⁽²⁶⁾ The findings of the present study showed that the majority of the nurses suctioned mouth and subglottic secretions before performing oral care of mechanically ventilated neonates. This could be explained in the light of the fact that oral suctioning is indicated to prevent aspiration of secretion during oral care and nurses should perform oral care as normal sequence of suctioning of neonates' mouth. These results are consistent with Stokowski (2010)⁽³⁰⁾ who mentioned that the prevention of VAP among infant with non-cuffed ETT is achieved by oropharyngeal and nasopharyngeal secretions removal.

Tracheal suctioning is mandatory for neonates to ensure good ventilation and oxygenation⁽²⁶⁾. But, repeated suctioning procedure increases the risk of colonization of the respiratory tract and potentially trauma that predisposes to infection⁽³¹⁾. Therefore, Centers for Disease Control and Prevention (2003)⁽²⁾ recommended that suctioning should be performed when indicated not as routine intervention after appropriate neonatal assessment. The findings of the current study revealed that only half of the nurses performed suctioning as needed. This may be due to nurses' ignorance about the complications of repeated suctioning or it may be due to nurses' fear of ETT occlusion by accumulation of secretion. This finding is supported by Gonçalves et al. (2012)⁽³²⁾ who found that tracheal suctioning occurred without prior assessment by half of the nurses.

Centers for Disease Control and Prevention (2003)⁽²⁾ and Ceballos et al. (2013)⁽³³⁾ guidelines for VAP prevention recommended the avoidance of normal saline instillation prior to ETT suctioning that leads to lower airway colonization and subsequently predisposing to VAP. Unfortunately, the findings of the current study found that about two-thirds of the nurses used normal saline for installation prior to suctioning. This result is supported by Ali (2013)⁽²⁴⁾. This finding could be attributed to lack of nurses' knowledge about normal saline instillation blouse and its association with VAP occurrence or it may be due to nurses' believe that normal saline instillation may dissolve respiratory secretion.

Centers for Disease Control and Prevention recommendations emphasized the importance of cleaning and disinfecting the respiratory equipment after use to prevent VAP as respiratory equipment can become colonized with pathogens that cause VAP⁽³¹⁾. It was found that two-thirds of the nurses in the present study disinfected used oxygen therapy equipment and nebulizer for the same neonate. These results may be attributed to good supervision of infection control team on nurses' practice in application of infection control measures or the availability of supplies for disinfecting used respiratory equipment. These findings are inconsistent with Naihar (2016)⁽³⁴⁾ who carried out a study to assess the knowledge and practice related to oxygen therapy among nurses and found that the majority of the nurses didn't disinfect respiratory equipment after use.

Gram-negative bacilli colonize ventilation equipment such as ventilator circuits and humidifiers. This consequently leads to delivering contaminated air directly into respiratory air way of neonates⁽³⁵⁾. Centers for Disease Control and Prevention (2003)⁽²⁾ and Ceballos et al. (2013)⁽³³⁾ recommended the change of ventilator circuits only when they are visibly soiled or malfunctioning rather than being changed according to their duration of use. It is revealed from the current study that all nurses changed ventilator circuits when they become malfunctioning and three-quarters of them changed ventilator circuits when they become soiled with secretions. This could be due to the fact that changing malfunctioning or soiled humidifiers is normal reaction by nurses to ensure effective care delivered to mechanically ventilated neonates. These findings are congruent with Kandeel and Tantawy (2012)⁽¹⁹⁾.

Concerning nurses' total practices scores of evidence-based guidelines of VAP prevention, the results of the present study revealed that more than two-third of the nurses had either "Good" or "Satisfactory" total score of evidence-based guidelines practices. On the contrary, Aferu (2016)⁽³⁶⁾ reported that more than half of the nurses had "Good" total score

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practices. Moreover, an Egyptian study done by Aysha (2016)⁽³⁷⁾ found that most of the nurses had “Good” scores in their total practices. The result of the present study could be explained by the fact that the majority of the nurses have more than one-year experience in NICU and a large percentage of them have Nursing Bachelor Degree and attended workshops about VAP prevention which reflected on their care delivery to mechanically ventilated neonates.

5. CONCLUSIONS

Based on the findings of the present study, it can be concluded that more than two thirds of the nurses had either “Good” or “Satisfactory” total scores of practices in their application of evidenced based guidelines of VAP prevention.

6. RECOMMENDATIONS

Based on the previous findings and conclusion of the present study, the following recommendations are suggested:

1. Procedure manual handbook or handout containing all evidence-based guidelines about nursing procedures related to VAP prevention of mechanically ventilated neonates should be available in NICUs.
2. Comprehensive updated evidence-based guidelines of VAP prevention must be strictly followed by NICU nurses.
3. Proper pre-service training for newly recruited nurses and in-service training programs for nurses about the most recent VAP preventive guidelines are mandatory to update their knowledge and improve their practices about VAP prevention.

Further Study:

- Study nurses’ attitude toward application of evidence- based guidelines on VAP prevention of neonates.
- Study barriers of nurses’ adherence to evidence- based guidelines of VAP prevention in NICUs.
- Study risk factors leading to VAP in NICUs.
- Effect of application of evidence-based guidelines of VAP prevention on VAP incidence among mechanically ventilated neonates.

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