Effect of Implementing The Protective Nursing Care Bundle of Ventilator Associated Pneumonia on Its Incidence among Critically Ill Children

Mona El-sayed Mohammed Shaheen, Assistant Lecturer
Pediatric Nursing department, Faculty of Nursing, Damanhour University

Yousr Abd El-salam Gaafar, Professor Emeritus
Pediatric Nursing department, Faculty of Nursing, Alexandria University

Manal Abdel Malik Antonios, Assistant Professor
Pediatrics Department, Faculty of Medicine, Alexandria University

Eman Arafa Badr, Lecturer
Pediatric Nursing department, Faculty of Nursing, Alexandria University

Abstract

Background: *Ventilator-associated pneumonia is the most common hospital-acquired infection and associated with an increased mortality rate among critically ill children. So, the protection of mechanically ventilated critically ill children from ventilator-associated pneumonia is the primary responsibility of pediatric critical care nurses.* ***Objective:*** *To determine the effect of implementing the protective nursing care bundle of ventilator associated pneumonia on its incidence among critically ill children.* ***Settings:*** *This study was conducted at two pediatric intensive care units of Smouha Children's University Hospital in Alexandria and Beheira Specialized Children's Hospital in Markaz Abu Humus, El Beheira Governorate.* ***Subjects:*** *Thirty critically ill children on invasive mechanical ventilation for more than 72 hours, ranged from one to 12 years old, recently admitted and free from any infection and immune-compromised diseases.* ***Method:*** *Two tools were used to collect the necessary data; "Characteristics and medical data of critically ill children record", as well as "The Centers for Disease Control and "Prevention PNU-1 criteria for diagnosis of ventilator-associated pneumonia checklist". Critically ill children received the protective nursing ventilator-associated pneumonia bundle care daily for seven consecutive days. Every critically ill child was assessed daily for seven consecutive days for incidence of ventilator-associated pneumonia.* ***Results:*** *The main study findings showed that early onset of ventilator-associated pneumonia was noticed among 33.3% of critically ill children, while none of them developed late onset of ventilator-associated pneumonia across the studied days.* ***Conclusion:*** *the implementation of protective nursing ventilator-associated pneumonia bundle care potentially had a positive impact on its incidence among mechanically ventilated critically ill children.* ***Recommendations:*** *pediatric critical care nurses should apply protective nursing care ventilator-associated pneumonia bundle based on recent evidence-based guidelines for all mechanically ventilated critically ill children.*

Key words: Protective Bundle, Nursing Care, Ventilator Associated Pneumonia, Critically Ill Children.

Introduction

Mechanical Ventilation (MV) is used as mainstay critical care and lifesaving therapy for critically ill children in PICU (Elkolalya et al., 2019). Although its lifesaving benefits, MV can result in serious complications including Ventilator Associated Pneumonia (VAP) (Meliyanti, 2021).

Centers for Disease Control and Prevention (CDC), (2022) defined VAP as a pneumonia where the child is on MV for more than two consecutive days on the date of event, with day of ventilator placement being first day. Ventilator associated pneumonia is the second most common nosocomial infection about 20% of all nosocomial infections in the PICUs (Galal et al., 2016). In Egypt, VAP incidence was

ranged between 16% - 75% of mechanically ventilated critically ill children in PICUs (Attia et al., 2018).

Ventilator associated pneumonia can be categorized into early onset of VAP which occurs more than 48 hours to 96 hours post intubation. While late onset occurs more than 96 hours after initiation of MV (Yostina et al., 2022). The (CDC) PNU-1 is a more recently diagnostic tool, used in diagnosing critically ill children with a VAP episode based on a combination of radiological and clinical criteria for children from 1- 12 years old and more (CDC, 2022).

Fortunately, VAP is a preventable complication of MV. So, The CDC and the Institute for Healthcare Improvement (IHI) have developed several evidence-based guidelines and protective nursing care bundle for VAP (Osmana, 2020). The recommended protective nursing bundle of VAP care include firstly, following infection control and preventive measures. The head of the bed elevation 30◦ –45◦ known as semi-recumbent position (de Kraker et al., 2022).

Additionally, endotracheal suctioning care, maintaining the ETT cuff pressure between 20-25 cm H2O and oral hygiene. Moreover, ventilator circuits should be kept clean and dry and changing them when contaminated or malfunctioned (Klompas et al., 2022). Finally, Gastric residual volume (GRV) should be measured regularly (Tume et al., 2020).

Pediatric critical care nurses have a pivotal role in those children's prevention and management of VAP. So, critical care nurses should apply protective nursing VAP bundle care for all mechanically ventilated children as preventable measures for incidence of VAP (Akl et al., 2020).

Aim of the Study

The aim of this study was to determine the effect of implementing the protective nursing care bundle of ventilator associated pneumonia on its incidence among critically ill children.

Research Hypothesis:

The hypothesis of this study was:

Critically ill children who receive protective nursing care bundle of ventilator associated pneumonia exhibit low incidence of ventilator-associated pneumonia.

Materials and Method

Materials

Design: A quasi experimental research design was used to conduct this study.

Settings: This study was conducted at the Pediatric Intensive Care Units (PICUs) at Smouha Children's University Hospital (SCUH) in Alexandria and Beheira Specialized Children's Hospital (BSCH) in Markaz Abu Humus, El Behera Governorate.

Subjects: A convenient sample of 30 critically ill children on invasive mechanical ventilation with the following inclusion criteria; age ranged from 1- 12 years old, newly admitted, intubated (endotracheal tube) for more than 72 hours and free from any infection and immune-compromised diseases. All critically ill children who were enrolled in the current study (study group) received a protective nursing care bundle of ventilator-associated pneumonia.

Tools: Two tools were used in order to collect the necessary data for the study.

Tool one: Characteristics and Medical Data of Critically Ill Children Record:

This tool was developed by the researcher to assess characteristics of critically ill children and their medical data. It included three parts:

Part 1: Characteristics of critically ill children included age, gender and residence.

Part 2: Medical Data of Critically Ill Children included diagnosis, date of admission, length of PICU stay, time and duration of intubation, method of intubation (cuffed or uncuffed ETT), attached devices, as well as received medications.

Part 3: Mechanical Ventilation Data comprised ventilator mode, FIO_2, PEEP, and respiratory rate.

Tool II: ''The Centers for Disease Control and Prevention PNU-1 (CDC PNU-1)'' Criteria for Diagnosis of Ventilator-Associated Pneumonia Checklist.

This tool was adopted. The original tool was developed in 2009, by the Centers for Disease Control and Prevention, and then updated in 2021 by CDC's National Healthcare Safety Network (NHSN) (CDC, 2021). It aimed to assess the incidence of VAP for children aged 1 - 12 years old. This tool "CDC PNU-1" included two parts, clinical and radiological parts to diagnose every critically ill child on mechanical ventilation to have VAP or NO VAP.

Part 1: Clinical Criteria: critically ill children should have at least three signs from the following clinical criteria: fever (> 38. 0°C or > 100. 4°F), hypothermia (< 36. 0°C or < 96.8°F), leukopenia (≤ 4000 WBC/mm3), leukocytosis (≥ 15,000 WBC/mm3), new onset of purulent sputum or changes in sputum character, increased respiratory secretions, increased suctioning requirements, new onset of worsening cough, dyspnea, apnea, tachypnea, rales, bronchial breath sounds, worsening gas exchange (O_2 desaturations < 94%), increased oxygen requirements, or increased ventilator demand) (CDC, 2022; Papakyritsi et al., 2022).

Part 2: Radiological criteria: critically ill child should have two or more serial chest imaging test results with at least one of the following: New and persistent or progressive and persistent (Infiltrate, Consolidation, Cavitation). Critically ill children without underlying pulmonary or cardiac disease, one definitive imaging test result is acceptable (CDC, 2022)

Method

1- Approval from Research Ethics Committee, Faculty of Nursing, Alexandria University was obtained before carrying out this study.
2- An official letter was sent from the Faculty of Nursing to the directors of the study settings to facilitate research implementation after explanation the aim of the study.
3- Tool I was developed by the researcher**.**
4- A pilot study was conducted on 10% of mechanically ventilated critically ill children (three of critically ill children) to test the feasibility, applicability, and clarity of the tools. The necessary modifications were done. Those children were excluded from the total study subjects.
5- At the initial contact, characteristics of critically ill children and their medical data were assessed by using tool I.
6- At the initial assessment, the researcher assessed every mechanically ventilated critically ill child for VAP using tool II (CDC PNU-1) to confirm absence of pneumonia for any study subject on admission. If any child had VAP, the researcher excluded him/her from the study.

7- For Study Group:

The researcher applied the protective nursing care bundle of VAP for seven consecutive days for each critically ill child consisting of the following evidence based guidelines:

I. Infection Control Measures:

The researcher's hands were washed with soap and water for 40-60 seconds when hands were visibly soiled. Alcohol based hand rub for 20-30 seconds when hands were visibly clean. The researcher used the gloves when there was a risk of contamination of the hands with blood or body fluids (Pinilla-González, 2021). Personal Protective Equipment (PPE) was used appropriately and disposed correctly (UNICEF &WHO, 2021).

II. Critically Ill Children Positioning:

The head of the bed was elevated 25°-45° for infants and older children, unless medically contraindicated (Osti et al., 2017).

III. Oral Hygiene:

According to AACN recommendation oral hygiene guideline/ protocol as follows

For infants and young children with teeth (1-6 years): every 12 hours, the researcher brushed the teeth with toothpaste, no mouth rinsing according to the American Dental Association (ADA) recommendations (Klompas et al., 2022).

For children aged 6 years and more: every 12 hours, teeth were brushed with toothpaste, no rinsing with water. After at

least 30 minutes, mouth was rinsed with 0.1% chlorhexidine; according to ADA.

Every 2 hours, mouth was moistened with swabs soaked in clean water or physiological saline and lips were coated with petroleum jelly as needed for all age groups (Klompas et al., 2022).

IV. Ventilator circuit Care Measures:

The researcher drained any water from the ventilator circuit away from the critically ill child. Ventilator circuit changes were limited only when visible soiling or mechanically malfunctioning (Klompas et al., 2022). Sterile humidifiers were filled with sterile water and adjusted for level of water and temperature (zaiton & Elhanafy, 2015).

V. Endotracheal Tube Suctioning Care:

- **Before procedure**

Respiratory status was assessed. The researcher selected suction catheter size according to internal lumen diameter of the ETT. Hyper-oxygenation for critically ill children for 30– 60 seconds. The suction negative pressure level was adjusted for each critically ill child (Schults et al., 2021).

- **During Procedure:**

The researcher followed an opened and shallow suctioning system. Suction catheter passes did not exceed three passes. The recovery time was 30 seconds between each suction pass to permit re-oxygenation (Schults et al., 2021)

After Procedure:

The researcher closely monitored critically ill children before, during, and after ET suctioning (Schults et al., 2021).

VI. Monitoring Endotracheal Tube Cuff Pressure:

The researcher measured ETT cuff pressure and recorded it on a regular basis to maintain it between 20-25 cm H_2O (Ahmed & Boyer, 2022).

VII. Monitoring Gastric Residual Volume:

The researcher measured GRV every 4 hours before each enteral bolus feedings (Tume et al., 2020). Every critically ill child was assessed daily for seven consecutive days for incidence of VAP by using Tool II to evaluate the condition of the studied critically ill children and follow up VAP rates after implementation of the protective nursing care bundle of VAP.

8. The radiological criteria were confirmed after consultation of the resident physician about chest x-ray findings or radiologist reported its findings.
9. The researcher applied daily the protective nursing care bundle for every critically ill child in this study morning and evening shift. In addition to that, the researcher trained the assigned bedside nurse who was responsible for this critically ill child about every evidence-based guideline of VAP bundle care to continue application of the protective nursing care bundle during night shift.
10. The one-group pretest -posttest was done to determine the effect of implementing the protective nursing care bundle of ventilator associated pneumonia on its incidence among critically ill children.
11. Data was collected over a period of one year starting from the first of March 2022 to the end of April 2023.
12. **Ethical Considerations**:

Written informed consent was obtained from every critically ill child's parent after explaining the aim of the study and voluntary participation in the study as well as the right to withdraw from the study at any time. Parents were ascertained about confidentiality of data. The privacy of critically ill children was ascertained.

Statistical Analysis of the data:

The collected data were fed to the computer and analyzed using the statistical package for social science IBM SPSS (version 23). Qualitative data were described using numbers and percentages. The Kolmogrov-Smirnov test was used to verify the normality of distribution. Quantitative data were described using range (minimum and maximum), mean, and standard deviation. Significance of the obtained results was judged at the 5 levels.

The tests for statistical analysis were:

McNemar and Marginal Homogeneity Test, used to analyze the significance between each successive day.
Friedman Test, used to analyze the significance for ordinal data between the different days.
Cochran's Test, used to analyze the significance for binary nominal data between the different days.
ANONA with repeated measures, for quantitative data for multiple comparisons between the different days.
Paired t test, for quantitative data to analyze the significance between each successive day.

Results

Table 1 clarifies characteristics and medical data of the studied critically ill children. It was found that more than half of the studied critically ill children (56.7%) were under five years old. Moreover, more than half of these critically ill children (56.7%) were admitted with neurological disorders. Furthermore, seventy percent of them were intubated for more than seven days with the mean duration 10.67 ± 4.62 days. It can be also observed that all the studied children (100%) were attached to central venous catheter, nasogastric tube and urinary catheter. Finally, it was clear that all of them (100%) received sedatives and antibiotics medications.

Table (2) shows comparison of the studied critically ill children according to the diagnostic criteria of ventilator associated pneumonia across study days. It was noticed that nearly one third of critically ill children exhibited leukocytosis on the sixth and seventh days of the study. A statistically significant difference was found across the study days (P=0.001). It was found that more than one third of them (36.7%) showed increase in respiratory secretions on 3rd and 4th days of the study. Finally, theses respiratory secretions showed more decline on the 7th day to reach 15.4% of them only. A statistically significant difference was noticed also between seventh days of the study (P <**0.001***).

Oxygen desaturation was noticed among twenty percent of critically ill children on the 4th and 5th days of the study. On the 7th day of the study, all of them (100%) had normal oxygen saturation. Statistically significant difference was found across the study days (P=0.004). Consequently, the same findings were observed for increased ventilator demand criteria. The pulmonary consolidation was observed among one third of critically ill children (33.3%) on the 4^{th,} 5th, 6th and 7th days of the study.

Table 3 reveals incidence of ventilator associated pneumonia among critically ill children across the study days. It was found that none of the studied critically ill children had VAP on the first and second days of the study. Moreover, VAP was presented among one third of critically ill children (33.3%) on 4th and 5th days of the study. In addition to that, VAP was confirmed among slightly more than one third of critically ill children on the 6th and 7th days of the study (35.7% and 34.6% respectively). There was statistically significant difference across the study days (p <0.001).

Figure 1 reflects that early onset of VAP was confirmed among one third of critically ill children (33.3%). No late onset VAP case among the studied critically ill children was found across the study days.

Discussion

Ventilator-Associated Pneumonia remained a significant origin of morbidity and mortality in PICUs. So, the urgent need for protection of those children from the VAP is a practical approach. This could be achieved through the application of certain nursing interventions together at the same time (Sood et al., 2023). Thus, this study was conducted to determine the effect of protective nursing VAP bundle care on its incidence among critically ill children.

The present study results revealed that nearly one third of critically ill children exhibited leukocytosis on the 6th and 7th days of the study (table 2). This could be justified by the PICU is a uniquely stressful environment and admission to the PICU is not an isolated stressor, but rather a series of traumas. They could include illness, multiple treatments/interventions that heighten the risk of immunological alterations (Nelson et al., 2021). So, leukocytosis is a normal immunological reaction of the body for any inflammatory disorders (Abdelbadeea et al., 2022). This finding is consistent with Khademi et al., (2018) findings.

The present study findings reflected that slightly more than one third of the critically ill children experienced increase in respiratory secretions on the third and fourth days of the study. Consequently, suction requirements for those critically ill children increased (table 2). These results could be due to the fact that all critically ill children under invasive mechanical ventilation through ETT could be affected due to interference with normal mucociliary clearance and impaired cough reflex (Shkurka etal., 2023). These findings were supported by Gohr et al., (2021**)** results which revealed that only one third of critically ill children had increased respiratory secretions.

It is remarkable that the current study findings recorded that most of critically ill children did not experience oxygen desaturation across study days. As an exception merely 20% of the studied critically ill children experienced oxygen desaturation on the fourth and fifth days of the study. Consequently, the same findings were needed for increased ventilator demand criteria (table 2). These findings may be justified by the fact that the mechanically ventilated critically ill children are at risk of airway leakage due to the conical shape of the airway in infants and children which increases the chance of oxygen deterioration (Sood et al., 2023). These findings came contradicting to Khademi et al., (2018) reported that most of critically ill children experienced oxygen desaturation. Moreover, Ghor et al., (2021) mentioned that there were significant changes in the ventilator settings with the VAP participants with an increase in ventilation demands.

The present study finding displayed that pulmonary consolidation was reported among slightly more than one third of critically ill children on the 4th, 5th, 6th and 7th days of the study (table 2). These findings could be interpreted by the fact that microorganisms damage the alveoli leading to an increase in secretion of fluid into the alveoli to involve the entire segment or lobe (Garg et al., 2017). These findings are parallel with Manjhi et al., (2018) results that specified the consolidation lesion was observed in critically ill children with VAP.

The results of the current study showed that the incidence of VAP was reported among 33.3% of critically ill children in the PICU (table 3).These findings parallel with Vijay et al., (2018) who revealed that the incidence of VAP was found among 38.3% of critically ill children by CDC criteria.

It is amazing that the current study findings revealed that only one third of critically ill children exhibited early onset of VAP on the third and fourth days of the study. On the other hand, no late onset of VAP among studied critically ill children was found (figure 1). More than half of children in the study were less than five years old, diagnosed with neurological disorders and all children were receiving sedation therapy (table 1). So, this is explained the fact of the immune system and respiratory system of young children still under process of ongoing maturation (Lu, 2021). Amanati et al., (2017) findings supported the current study findings that acquainted that early onset of VAP was diagnosed among one quarter of critically ill children, while little percentage of late onset of VAP was observed among them.

The findings of the present study revealed that critically ill children who received protective nursing care bundle of VAP exhibit low incidence of VAP throughout the study period (Table 4.22 & 4.23). These findings could be explained by the fact that the multidimensional VAP bundle is a set of evidence-based nursing interventions implemented together at the same time. This was done from the beginning of intubation, mechanical ventilation and continued until critically ill children were extubated (Muhammad et al., 2016; Ali, 2013).

These findings are consistent with Niedzwiecka et al., (2019) and Alsoda et al., (2019) who emphasized that ventilator bundles were effective approach and impact positively on the incidence of VAP among critically ill children. On the contrary, Osman et al., (2020) study found that the VAP bundle care did not significantly reduce VAP incidence among critically ill children in the PICU.

Conclusion

The current study findings proved that critically ill children who received protective nursing VAP bundle care exhibited low incidence of VAP.

Recommendations

Based on the current study findings, the following recommendations are suggested:

Protective nursing bundle of VAP care needs to be merged in the care of critically ill children in the PICU and unit policy. Periodical educational programs and training courses should be provided for all pediatric critical care nurses as regards recent evidence-based guidelines VAP bundle care

Table (1): Characteristics and medical data of the Studied Critically Ill Children:

Characteristics and medical data of the Studied Critically Ill Children		Total (n=30)	
		No.	%
Age (years)	<5	17	56.7
	5-	11	36.6
	≥10	2	6.7
	Min –Max (Mean ± SD)	1.0 - 12.0 4.617±2.962	
Diagnosis	Cardiac disorders	5	16.7
	Neurological disorders	17	56.7
	Diabetic ketoacidosis	1	3.3
	In born error of metabolism (MUSD)	1	3.3
	Rickets	1	3.3
	Road traffic accidents	3	10.0
	Disseminated intravascular coagulopathy	2	6.7
Duration of intubation (days)	5-7 days	9	30
	>7 days	21	70
	Min – Max	5.0 – 20.0	
	Mean ± S.D	10.67 ± 4.62	
Length of PICU stay (days)	7-10 days	6	20
	>10 days	24	80
	Min – Max	7.0 – 30.0	
	Mean ± S.D	14.93 ± 4.60	
Attached invasive devices#	Central venous catheter	30	100.0
	Nasogastric tube	30	100.0
	Urinary catheter	30	100.0
Received medications #	Sedatives	30	100.0
	Antibiotics	30	100.0

Table (2): Comparison of the studied critically ill children according to the diagnostic criteria of ventilator associated pneumonia across study days:

Criteria		Days														Test of Significance
		1st day (n=30)		2nd day (n=30)		3rd day (n=30)		4th day (n=30)		5th day (n=30)		6th day (n=28)		7th day (n=26)		
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Temperature/°c	Normal	29	96.7	25	83.3	20	66.7	19	63.3	19	63.3	18	64.3	20	76.9	**p =0.014***
	Hyperthermia	1	3.3	5	16.7	10	33.3	9	30.0	10	33.3	8	28.6	6	23.1	
	Hypothermia	0	0.0	0	0.0	0	0.0	2	6.7	1	3.3	2	7.1	0	0.0	
White blood cells count (10^3/mm^3)	Normal	28	93.3	28	93.3	25	83.3	20	66.7	20	66.7	18	64.3	17	65.4	**p = 0.001***
	Leukopenia	0	0.0	0	0.0	0	0.0	1	3.3	1	3.3	1	3.6	0	0.0	
	Leukocytosis	2	6.7	2	6.7	5	16.7	9	30.0	9	30.0	9	32.1	9	34.6	
Secretions characteristics																
New onset of purulent sputum	Yes	0	0.0	0	0.0	3	10.0	6	20.0	6	20.0	4	14.3	3	11.5	**p** = 0.250
	No	30	100.0	30	100.0	27	90.0	24	80.0	24	80.0	24	85.7	23	88.5	
Change in characteristics of sputum																
• Color	Off-white	0	0.0	0.0	0.0	2	66.7	4	66.7	5	83.3	4	100.0	3	11.5	
	Yellow	0	0.0	0.0	0.0	1	33.3	2	33.3	1	16.7	0	00	0	0.0	
	Green	0	0.0	0.0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	
• Quantity	Large	0	0.0	0.0	0.0	2	66.7	2	33.3	0	0.0	0	0.0	0	0.0	
	Moderate	0	0.0	0.0	0.0	1	33.3	2	33.3	3	50.0	3	75.0	3	11.5	
	Small	0	0.0	0.0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	
• Odor	No	30	100.0	30	100.0	27	90	26	86.7	28	93.3	28	100.0	26	100.0	
	Yes	0	0.0	0.0	0.0	3	10	4	13.3	2	6.7	0	0.0	0	0.0	
• Consistency	Sticky	0	0.0	0.0	0.0	2	66.7	2	33.3	1	16.7	0	0.0	0	0.0	
	Bloody	0	0.0	0.0	0.0	1	33.3	2	33.3	1	16.7	0	0.0	0	0.0	
	Mixed	0	0.0	0.0	0.0	0	0.0	2	33.3	2	33.3	1	25.0	0	0.0	
	P value across the study days															**p = 0.001***
Increase of respiratory secretions	No	30	100	30	100	19	63.3	19	63.3	20	66.7	21	75.0	22	84.6	**p <0.001***
	Yes	0	0.0	0	0.0	11	36.7	11	36.7	10	33.3	7	25.0	4	15.4	
Increased suction requirements	No	30	100.0	30	100.0	19	63.3	19	63.3	20	66.7	21	75.0	22	84.6	**p <0.001***
	Yes	0	0.0	0	0.0	11	36.7	11	36.7	10	33.3	7	25.0	4	15.4	
	Mean ± SD	0.33 ± 0.61										3.35 ± 1.91		2.53 ± 1.58		

McN: McNemar Test between each successive day **Q: Cochran's Test to compare the change between the study days** ***: Statistically significant at p ≤ 0.05**

N.B. On the sixth day 2 children extubated, on the 7th day one child died and one child extubated (Sixth day n = 28 and at seventh day n = 26)

Criteria		Days														Test of Significance
		1st day (n=30)		2nd day (n=30)		3rd day (n=30)		4th day (n=30)		5th day (n=30)		6th day (n=28)		7th day (n=26)		
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
New onset or worsening																
• New onset of cough	No	30	100.0	28	93.3	28	93.3	30	100.0	30	100.0	28	100.0	26	100.0	**p =0.151**
	Yes	0	0.0	2	6.7	2	6.7	0	0.0	0	0.0	0	0.0	0	0.0	
• Worsen cough	No	30	100.0	30	100.0	28	93.3	28	93.3	29	96.7	27	96.4	25	96.2	**p = 0.210**
	Yes	0	0.0	0	0.0	2	6.7	2	6.7	1	3.3	1	3.6	1	3.8	
• Presence of dyspnea	No	30	100.0	29	96.7	25	83.3	26	86.7	27	90.0	24	85.7	26	100.0	**p = 0.010***
	Yes	0	0.0	1	3.3	5	16.7	4	13.3	3	10.0	4	14.3	0	0.0	
• Presence of apnea	No	30	100.0	30	100.0	25	83.3	22	73.3	22	73.3	24	85.7	26	100.0	**p =0.001***
	Yes	0	0.0	0	0.0	5	16.7	8	26.7	8	26.7	4	14.3	0	0.0	
• Presence of tachypnea	No	30	100.0	30	100.0	27	90.0	27	90.0	26	86.7	26	92.9	25	96.2	p = 0.035*
	Yes	0	0.0	0	0.0	3	10.0	3	10.0	4	13.3	2	7.1	1	3.8	
Presence of rales	No	30	100.0	30	100.0	22	73.3	22	73.3	20	66.7	21	75.0	21	80.8	p <0.001*
	Yes	0	0.0	0	0.0	8	26.7	8	26.7	10	33.3	7	25.0	5	19.2	
Presence of Bronchial Breath Sounds	No	30	100.0	30	100.0	28	93.3	26	86.7	24	80.0	24	85.7	22	84.6	p <0.001*
	Yes	0	0.0	0	0.0	2	6.7	4	13.3	6	20.0	4	14.3	4	15.4	
Worsening gas exchange																
Presence of Oxygen desaturation	No	29	96.7	29	96.7	27	90	24	80.0	24	80.0	26	92.9	26	100.0	**p = 0.004***
	Yes	1	3.3	1	3.3	3	10.0	6	20.0	6	20.0	2	7.1	0	0.0	
Increased ventilator demand	No	29	96.7	29	96.7	27	90	24	80.0	24	80.0	26	92.9	26	100.0	p = 0.004*
	Yes	1	3.3	1	3.3	3	10.0	6	20.0	6	20.0	2	7.1	0	0.0	
Radiological criteria																
Infiltration	No	30	100.0	30	100.0	30	100.0	30	100.0	30	100.0	28	100.0	26	100.0	-
	Yes	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	
Consolidation	No	30	100.0	30	100.0	26	86.7	20	66.7	20	66.7	18	64.3	17	65.4	p <0.001*
	Yes	0	0.0	0	0.0	4	13.3	10	33.3	10	33.3	10	35.7	9	34.6	
Cavitation	No	30	100.0	30	100.0	30	100.0	30	100.0	30	100.0	28	100.0	26	100.0	-
	Yes	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	
Mean score of diagnostic criteria of VAP	Min – Max	0.0 – 2.0		0.0 – 2.0		0.0 – 9.0		0.0 – 12.0		0.0 – 12.0		0.0 – 7.0		0.0 – 6.0		**P<0.001***
	Mean ± SD	0.33 ± 0.61		0.53± 0.68		3.06 ± 2.3		4.97 ± 2.74		4.93 ± 3.04		3.35 ± 1.91		2.53 ± 1.58		

McN: McNemar Test between each successive day Q: Cochran's Test to compare the change between the study days *: Statistically significant at p ≤ 0.05

N.B. On the sixth day 2 children extubated, on the 7th day one child died and one child extubated (Sixth day n = 28 and at seventh day n = 26)

Table (3): Ventilator Associated Pneumonia among Critically Ill Children across the Study Days.

VAP		No.	%	McN p
1st day	No VAP	30 0	100.0 0.0	
2nd day	No VAP	30 0	100.0 0.0	-
3rd day	No VAP	26 4	86.7 13.3	0.125
4th day	No VAP	20 10	66.7 33.3	0.031*
5th day	No VAP	20 10	66.7 33.3	1.000
6th day	No VAP	18 10	64.3 35.7	1.000
7th day	No VAP	17 9	65.4 34.6	1.000
P value across the study days		Q =49.821* , p <0.001*		

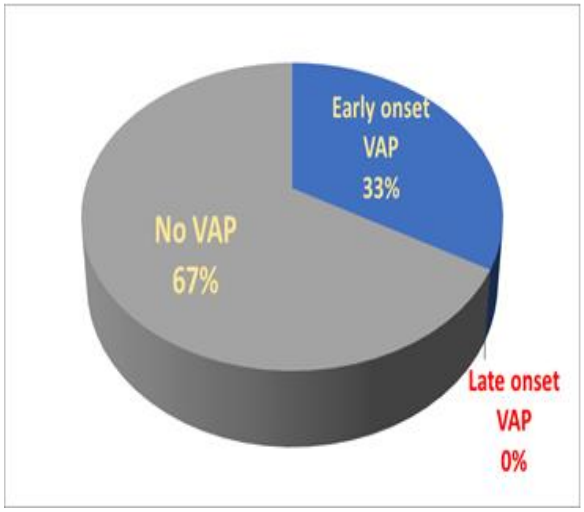

Figure (1): Classification of Critically Ill Children According to the Onset of Ventilator Associated Pneumonia.

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