IMPLEMENTATION OF VENTILATOR BUNDLE FOR PREVENTION OF VENTILATOR ASSOCIATED PNEUMONIA IN PEDIATRIC INTENSIVE CARE UNIT

By

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ABSTRACT

***Background**: Ventilator-associated pneumonia (VAP) is associated with increased morbidity and mortality in PICU patients.*

***Objectives**: to examine the impact of adherence to VAP prevention bundle on the incidence of VAP in our pediatric intensive care unit (PICU).*

***Patients and Methods:** A prospective comparative study was conducted in Al_hussein university Hospital to all patients admitted and ventilated in PICU through a year (from September 2017 till September 2018). Divided into two groups; 1st group: Patients admitted to PICU after implementation of the study and they are forty-three patients as a cases; 2nd group: Patients admitted to PICU before implementation of the study and they are twenty-two patients as a control. All included ventilated childrens were subjected to the following:*

1- Diagnosis on admission and indication of MV.
2- Full physical examination including the assessment of:
    a) Anthropometric measures that was plotted on percentiles.
    b) Vital signs: oxygen saturation and heart rate were continuously recorded.
    c) Systemic examination and clinical evidence of sepsis and pneumonia.
3- Ventilation mode and duration.
4- Type of feeding whether TPN or enteral feeding.
5- Laboratory investigations including:
    1) Complete blood count.
    2) Quantitative C-reactive protein.
    3) Blood chemistry and renal functions.
    4) Arterial blood gases
6-Chest radiographs.
7- Microbiological studies.

***Results:** The VAP rate decreased with compliance to ventilator bundle from 50 % to 14 %(P= 0.002). Initiation of VAP bundle is associated with a significant reduced*

incidence of VAP. VAP bundle is effective in VAP reduction when compliance is maintained.

Conclusion: *Ventilator associated pneumonia is one of the serious complications of MV that significantly increases the length of PICU stay and mortality. Bundle implementation was found effective in decreasing the VAP rate in the PICU patients.*

Key words: *Pediatric intensive care unit- Ventilator-associated pneumonia-ventilator bundle.*

INTRODUCTION

Ventilator acquired pneumonia (VAP) is defined as a hospital-acquired pneumonia that develops in patients who have been treated with mechanical ventilation for 48 hours or longer who had no signs or symptoms of lower respiratory infection before they were intubated and treatment with mechanical ventilation began **(Centers for Disease Control and Prevention, 2012)**.

Many published reports demonstrated that the frequency of VAP is 6-10% of ventilated patients in pediatric intensive care unit (PICU) and the incidence density of 6-13 episodes per 1000Ventilator days **(Tullu MS. Study of ventilator associated pneumonia in a pediatric intensive care Unit. et al., 2014)**.

VAP is a marked health risk for hospitalized infants and children.1 It is one of the top causes of hospital acquired infections (HAIs) in the PICU, accounting for 18% to 26% of all HAIs in the unit and resulting in a mortality rate of about 10% to 20%.VAP is associated with increased mortality and morbidity, increased length of hospital stay, and high healthcare costs **(Casado RJ et al., 2011)**.

Care bundle is defined as implementation of a small set of evidence based interventions together for a defined patient population that when each one of all executed individually, improve patient's recovery process and outcomes; when executed all together providing better outcomes than implemented individually **(Okgün Alcan et al., 2015)**.

The ventilator bundle implementation was associated with significant reduction in VAP rates, duration of mechanical ventilation, antibiotic administration, length of PICU stay and hospital costs. In conclusion, implementation pediatric ventilator bundle seems to be an effective approach achieving better patient and clinic

outcomes with evidence based safe and multidisciplinary approach **(Alcan AO. et al., 2017)**.

AIM OF THE WORK

The aim of this work is to study the prevalence and risk factors of Ventilator acquired pneumonia (VAP) in ventilated patients admitted in (PICU) and to determine the importance of ventilator bundle as a protocol for prevention of VAP when applied to all patients on mechanical ventilation.

PATIENT AND METHODS

Our study is a prospective comparative study, the populations included in the study are the patients admitted to PICU in Al_hussein university Hospital and are mechanically ventilated (from September 2017 till September 2018).

Inclusion criteria:

- **Sixty-five Patients were included in this study and were divided into:**

- 1st group: Patients admitted to PICU after implementation of the study and they are forty-three patients.
- 2nd group: Patients admitted to PICU before implementation of the study and they are twenty-two patients: As a control.

Exclusion criteria:

1. Patients with pneumonia before ventilation.
2. High-risk patients such as immunocompromised patients.
3. All neonates, children >18 years.
4. Children received mechanical ventilation for less than 48 hours.

- **The ventilator bundle has four key components:**

- **Elevation of the head of the bed to between 30 and 45 degrees.**
- Daily "sedation vacation" and daily assessment of readiness for extubation.
- Peptic ulcer disease prophylaxis using sucralfate or ranitidine.
- Deep vein thrombosis prophylaxis: Since deep venous thrombosis is not recorded in our PICU except as complications of femoral vein sampling or cannulation, prophylaxis of DVT will not be implemented.

Compliance to this intervention will be assessed using a check list.

VENTILATOR BUNDLE CHECKLIST
(Individual Patient)

- Hospital name:

- ICU name:
- Bed number:
- Hospital admission number:
- Patient name:
- Date of start of ventilation:
- Date of end of ventilation:

PICU Day	1	2	3	4	5	6	7	8	9	10
1. Head of the Bed (30-45°)	□	□	□	□	□	□	□	□	□	□
2. Daily Oral Care with Chlorhexidine.	□	□	□	□	□	□	□	□	□	□
3. Daily sedative interruption and daily assessment of readiness to extubate.	□	□	□	□	□	□	□	□	□	□
4. Peptic ulcer Prophylaxis	□	□	□	□	□	□	□	□	□	□
5. Deep vein thrombosis prophylaxis .	□	□	□	□	□	□	□	□	□	□

Adapted with permission from a tool created by Dominican Hospital (2005). Santa Cruz, California, USA.

All included ventilated childrens were subjected to the following:

1- Diagnosis on admission and indication of MV.

2- Full physical examination including the assessment of:

a) Anthropometric measures that was plotted on percentiles.

b) Vital signs: oxygen saturation and heart rate were continuously recorded.

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b) Quantitative C-reactive protein.

c) Blood chemistry and renal functions.

d) Arterial blood gases

6- Chest radiographs.

7- Microbiological studies.

ETHICAL ASPECT

• The ethical committee of faculty of medicine Al-Azhar University approved this study.

• Approval of the patients and the parents was obtained by a written consent.

RESULTS

In this study, males were 50.77% and females were 49.23% of the patients. The mean age of the patients was 22.4 months (m), SD=29.05 (median age: 10 m). The mean age of VAP +ve patients was 13.24 m, SD=16.13 (median age: 8 m). The mean age of VAP –ve patients was 23.47 m, SD=32.14 (median age: 11 m). CNS diseases (26.15%), pulmonary diseases (60%), neuromuscular diseases (3%) and other causes (10.77%). Ninety percent of patients were reintubated. Supine position was used in 43.07% of the patients, prior use of antibiotics was in 100% of the patients, urinary catheter (6.15%), central venous catheter (26.15%), immunodeficiency diseases (7.69%), and immunosuppressant drugs (4.61%). The main reason for ventilation was lung failure (66.15%). Overall mortality was (46.15%), VAP mortality rate patients was higher (83.3%) than non-VAP patients (35.1%). The overall mean ventilation duration was 10.89 days (d). The overall mean length of stay was 12.77 days.

Table (1): Demographic criteria of PICU patient's

Item	N	%	Mean - (SD)	Median - Range
Demographics				
Age (Month)			20.79 - 29.055	10.00 - (2-144)
Male	33	50.77		
Female	32	49.23		
Possible risk Factors				
Reintubation	58	90.0		
Prior use of Antibiotics	65	100		
Central line insertion	17	26.15		
Urinary catheter insertion	4	6.15		
Immunodeficiency disease	6	7.69		
Immunosuppressive drugs	3	4.61		
Organ failure	17	26.15		

Underlying illness				
CNS disease	17	26.15		
Pulmonary disease	39	60		
Neuromuscular disease	2	3		
Other diseases	7	10.77		
Outcome				
PICU length of stay (LOS) (days)			12.77 - 9.384	9.00 - (2 - 37)
Overall Mortality rate	30	46.1		
VAP	14	83.3		
Non VAP	16	35		
Duration of Ventilation (days)			10.89 - 8.798	7.00 - (2 - 37)

Patient's demographics, possible risk Factors, underlying diseases, Duration of Ventilation are summarized in Table 1.

Figure (1): Demonstrating the sex of the patients

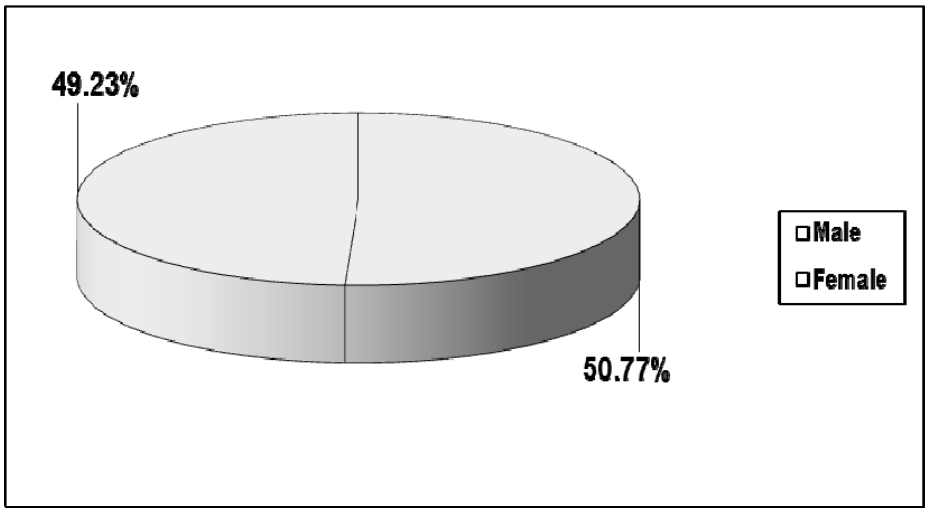


Figure (2): Demonstrating the underlying diseases of the patients

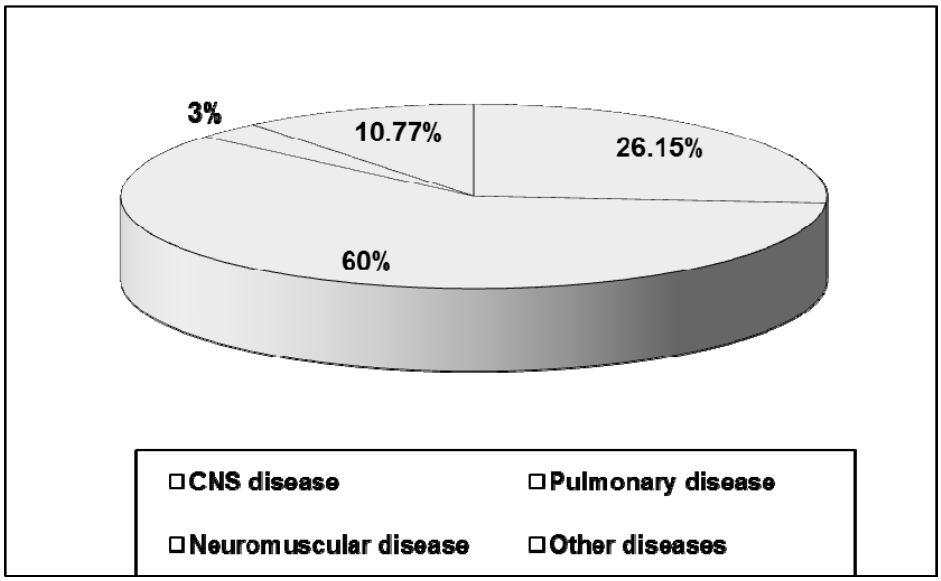


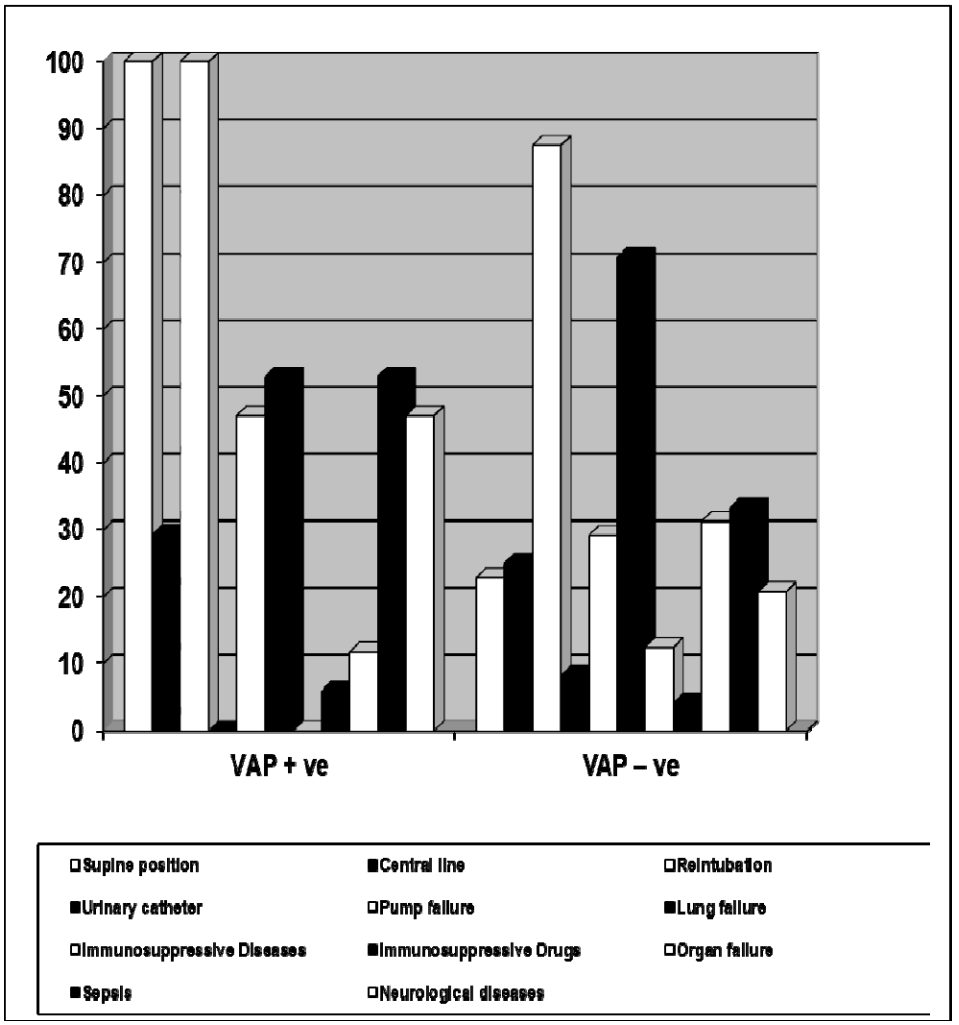
Table (2): Risk factors predisposing to VAP

Risk factors	VAP + ve		VAP – ve		P value	Relative risk
	n	%	n	%		
Supine position	17	100	11	22.9	0.001	
Duration of ventilation (days)	Mean 19.35		Mean 7.9		0.001	
Central line	5	29.4	12	25.0	0.754	1.176
Reintubation	17	100	42	87.5	0.327	
Urinary catheter	0	0.0	4	8.3	0.566	
Pump failure	8	47.1	14	29.2	0.236	1.737
Lung failure	9	52.9	34	70.8	0.236	0.576
Immunodeficiency Diseases	0	0.0	6	12.5	0.327	
Immunosuppressive Drugs	1	5.9	2	4.2	1.000	1.292
Organ failure	2	11.8	15	31.3	0.198	0.376
Sepsis	9	52.9	16	33.33	0.683	
Neurological diseases	8	47.1	10	20.8	0.042	

The table shows that the most significant risk factor for (VAP) were supine position (100%) in vap +ve cases, (22.9%) in vap – ve cases, reintubation (100%) in vap +ve cases, (87.5%) in vap - ve cases, pump failure (47.1%) in vap +ve cases, (29.2%) in vap

- ve cases, lung failure (52.9%) in vap +ve cases, (70.8%) in vap - ve cases, neurological disease (47.1%) in vap +ve cases, (20.8%) in vap - ve cases.

Figure (3): Risk factors predisposing to VAP



The table shows that the most significant risk factor for (VAP) were supine position (100%) in vap +ve cases, (22.9%) in vap –

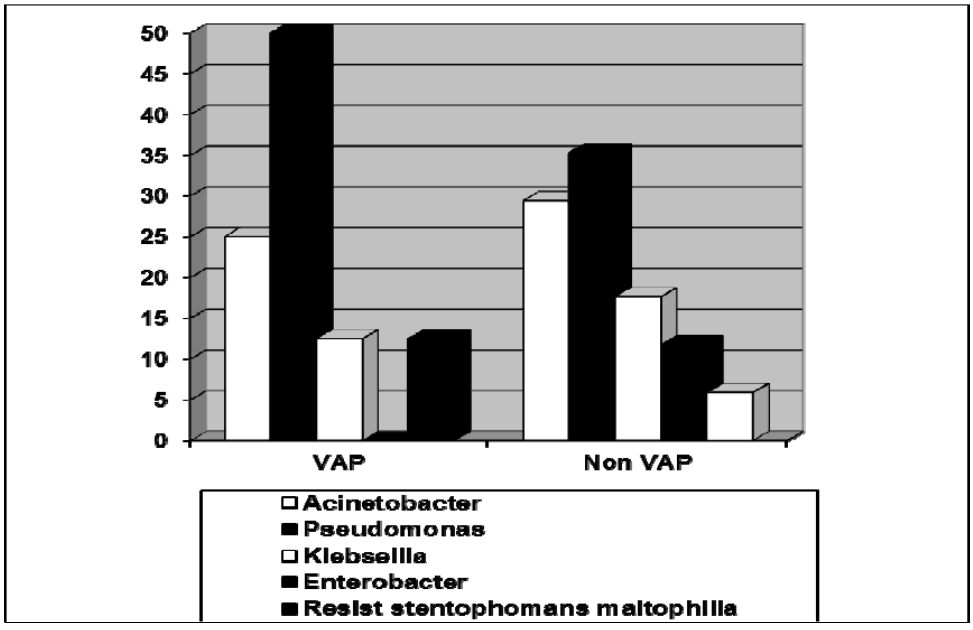
ve cases, reintubation (100%) in vap +ve cases, (87.5%) in vap - ve cases, pump failure (47.1%) in vap +ve cases, (29.2%) in vap - ve cases, lung failure (52.9%) in vap +ve cases, (70.8%) in vap - ve cases, neurological disease (47.1%) in vap +ve cases, (20.8%) in vap - ve cases.

Table (3): Comparison of endotracheal micro-biological cultures between VAP and non VAP patients among studied cases

Organisms	VAP		Non VAP		P value
	N	%	N	%	
Acinetobacter	5	29.41	2	25.0	0.736
Pseudomonas	6	35.29	4	50.0	
Klebseilla	3	17.64	1	12.5	
Enterobacter	2	11.76	0	0.00	
Resist stentophomans maltophilia	1	5.88	1	12.5	
Total	17	100.0	8	100.0	

This table shows that the most common cause of vap were Pseudomonas (35.29%), Acinetobacter (29.41%), Klebsiella (17.64%).

Figure (4): Comparison of endotracheal micro-biological cultures between VAP and non VAP patients.



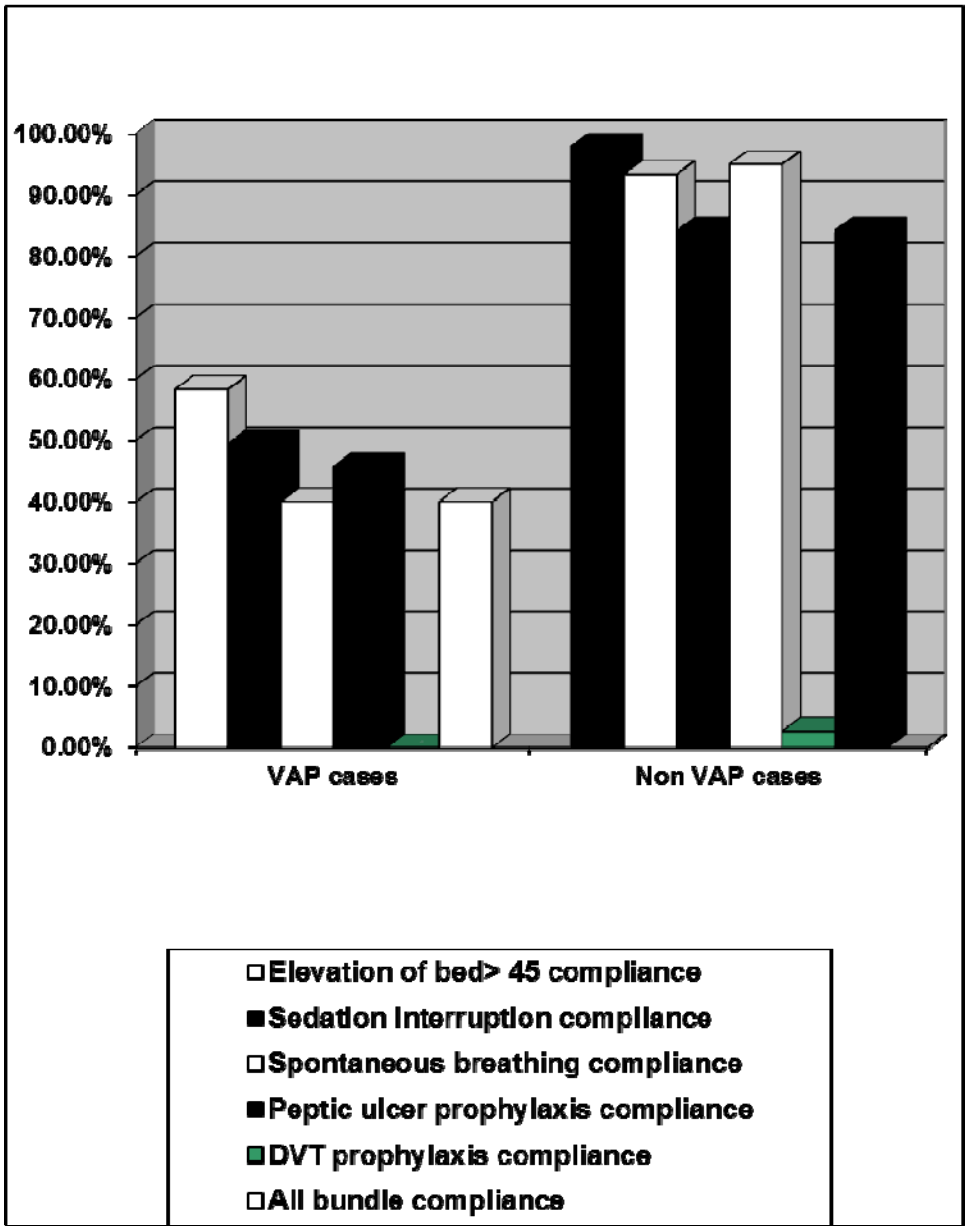
This table shows that the most common cause of vap were Pseudomonas (35.29%), Acinetobacter (29.41%), Klebsiella (17.64%).

Table (4): Comparison between VAP + ve cases and VAP – ve cases according to compliance to ventilator bundle

Items	VAP cases		Non VAP cases		P value
	Mean-SD %	Median-Range %	Mean-SD %	Median-Range %	
Elevation of bed > 45 compliance	58.39% - 3.850	58.12 - (54.1-64)	97.80% - 8.095	100.0% - (60-111)	0.001
Sedation interruption compliance	49.56 - 5.250	50.0 - (43.2-55)	93.35 - 12.16	100.0 - (50 - 105)	0.001
Spontaneous breathing compliance	40.07 - 4.48	40.27 - (32.3-45)	84.10 - 24.29	91.66 - (0.0 - 100)	0.001
Peptic ulcer prophylaxis compliance	45.80 - 2.74	44.72 - (43.2-50)	94.96 - 8.365	100.0 - (71.4 - 100)	0.001
DVT prophylaxis compliance	0.00 - 0.00	0.00 - (0.0-0.0)	2.70 - 16.43	0.00 - (0.0 - 100)	0.687
All bundle compliance	40.07 - 4.48	40.27 - (32.3-45)	84.10 - 24.29	100.0 - (0.0 - 100)	0.001

There was statistical significant difference between VAP +ve and VAP –ve groups regarding all bundle compliance.

Figure (5): Comparison between VAP + ve cases and VAP – ve cases according to compliance to ventilator bundle



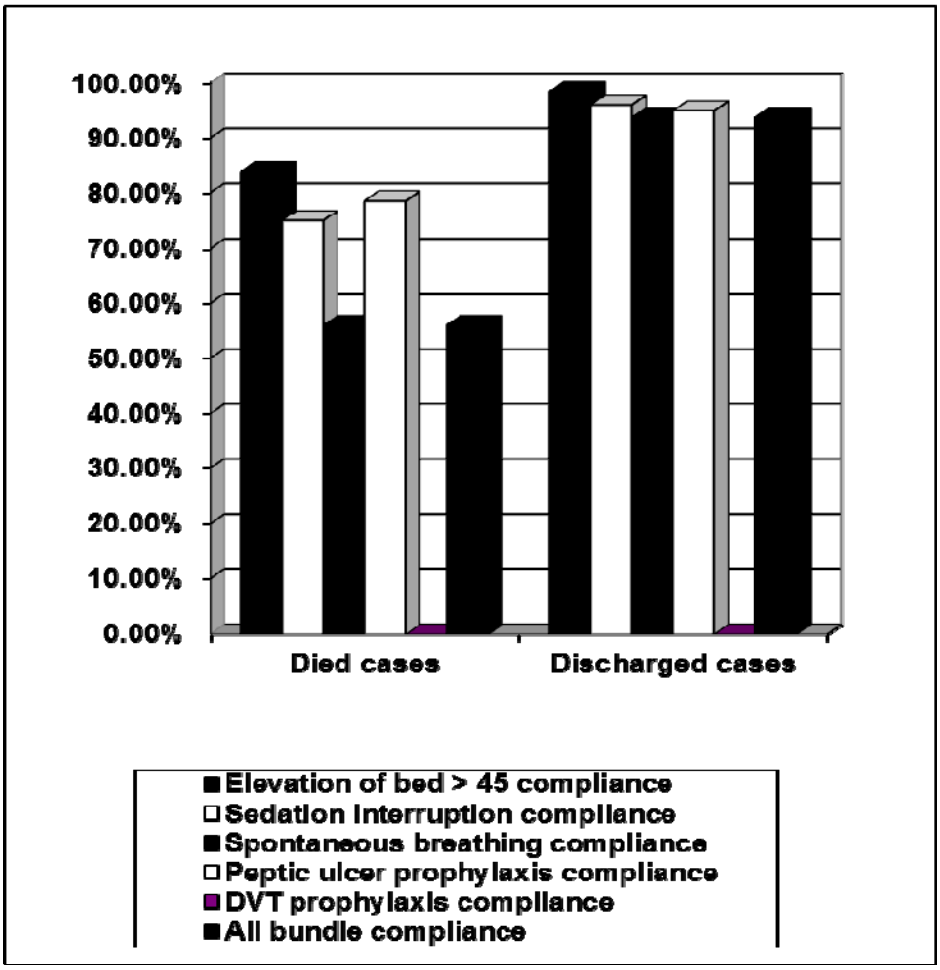
There was statistical significant difference between VAP +ve and VAP –ve groups regarding all bundle compliance.

Table (5): The effect of ventilator bundle compliance on the outcome of cases

Items	Died cases		Discharged cases		P value
	Mean %-SD	Median%-Range	Mean %-SD	Median%-Range	
Elevation of bed > 45° compliance	83.88%-19.44	96.87%-(54.1-100)	98.37%-8.72	100.0%-(60.0-111)	0.001
Sedation interruption compliance	75.03-21.85	75.71-(43.2-100)	96.03-10.45	100.0-(50.0-106)	0.001
Spontaneous breathing compliance	56.01-27.63	60.00- (0.0-100.0)	93.76-11.98	100.0-(45.0-100)	0.001
Peptic ulcer prophylaxis compliance	78.58-22.69	82.85-(43.2-100)	94.96-12.02	100.0-(45.0-100)	0.001
DVT prophylaxis compliance	0.000-0.00	0.000-(0.00-0.00)	0.000-20.00	0.000-(0.00-100)	0.396
All bundle compliance	56.01-27.63	60.00-(0.0-100.0)	93.76-11.98	100.0-(45.0-100)	0.001

This table shows the relation between ventilator bundle compliance and outcome among cases and it was statistically significant, P = 0.001.

Figure (6): The effect of ventilator bundle compliance on the outcome of cases



The relation between ventilator bundle compliance and outcome among cases was statistically significant, P = 0.001.

DISCUSSION

Ventilator acquired pneumonia (VAP) is defined as a hospital-acquired pneumonia that develops in patients who have been treated with mechanical ventilation for 48 hours or longer who had no signs or symptoms of lower respiratory infection before they were intubated and treatment with mechanical ventilation began. **(Centers for Disease Control and Prevention, 2012)**.

VAP is described as the most common nosocomial infection of intensive care and is often fatal, although attributed mortality varies **(Klompas, 2007)**.

The epidemiology and outcomes of VAP are well described in adults, but few data exist for pediatric patients particularly with respect to risk factors, morbidity, mortality, and cost **(Niaudet, et al., 2000)**.

A prospective comparative study of VAP was performed in PICU of Al_hussein university Hospital (from September 2017 till September 2018), detecting the incidence of VAP, the risk factors and outcomes including the ventilation duration, PICU length of stay and mortality rate. We determined also the efficacy of ventilator bundle in decreasing the incidence of VAP and detecting the compliance to this bundle.

Over one year, 65 patients were admitted to the PICU and matched the inclusion criteria in our study. Twenty-two patients in the 1st six months before implementation of the ventilator bundle, eleven patients of them developed VAP (50.0 %). Forty-three patients were admitted to the PICU in the next six months after implementation of the ventilator bundle approach, six patients of them developed VAP (14.0 %), as summarized in **table 1**.

In contrast to other studies not implementing ventilator bundle approach, the VAP rate ranges from 8% to 44% : **(Lopriore and colleagues, 2002)** reported a VAP rate of (8.4 %); **(Almuneef and colleagues, 2004)** reported in their PICU in Saudi Arabia a VAP rate of (10.3%); **(Yuan and colleagues, 2007)** reported in their NICU a VAP rate of (20.1 %); **(Cravan and colleagues, 2001)** studied about nosocomial pneumonia in 233 ICU patients requiring mechanical ventilation and reported that 21 % of the patients suffered from VAP%; **(Carvalho and colleagues, 2005)** reported a VAP rate of (23.5 %); **(Chastre and colleagues, 2002)** reported a VAP rate of 28%; **(Yidizdas and colleagues, 2002)** reported a VAP rate of (44%).

On other hand, the VAP rate in studies implementing the VAP bundle approach reported by **(Nolan and colleagues, 2006)** were 22.72% in PICU and 9.09% in surgical intensive care unit (SICU) in contrast to VAP rate before the intervention which were 34.78 % and 33.33% respectively.

This variation in the rates of VAP could have resulted from the type of patients admitted to each

unit. **(Epps and colleagues, 2002)** demonstrated that the rates of nosocomial infections including VAP differed by the type of patients in PICU that serve mainly cardiothoracic surgery patients have lower rates than do other PICU. The type of patients admitted to our PICU could have influenced the rate.

In our study, we found that supine position (p = 0.001), neurological ad neuromuscular diseases (p = 0.042), prolonged duration of ventilation (p = 0.001) were independent risk factors for VAP in our PICU, as summarized in **table 2**.

Supine position, which reflects aspiration, appears to be important in the pathogenesis of VAP as demonstrated in this study and other studies. **(Drakulovi and colleagues, 1999)** found in their PICU studies that supine position was one of the risk factors for VAP development, as their study demonstrated a threefold reduction in the incidence of ICU-acquired VAP in patients kept in a semi recumbent position vs. supine. **(Torres and colleagues, 2002)** found that supine position was one of their risk factors for VAP in PICU. **(Davis and colleagues, 2001)** found that significantly higher incidence of VAP in supine positioning as compared with the semi-recumbent positioning.

Neurological and neuromuscular diseases were found to be a significant risk factor in this study and other studies. **(Hina and colleagues, 2010)** found that comatosed patients had high incidence of VAP.

Prolonged duration of ventilation was found to be a significant risk factor in the present study and other studies. **(Richards and colleagues, 1999)** found that prolonged duration of ventilation is a risk factor for VAP. **(Ibrahim and colleagues, 2001)** found that the risk of VAP increases with the increase in the duration of mechanical ventilation.

Several risk factors for the development of VAP identified by other studies as genetic syndrome, reintubation, transport out of the ICU, use of invasive procedures as central venous lines and urinary catheter, immunosuppressive diseases, immunosuppressive drugs, sepsis and use of gastric stress ulcer prophylaxis were not found to be independently associated with VAP in our study.

On other hand, **(Elward and colleagues, 2002)**, **(fayon and colleagues, 2007)** found in their studies that genetic syndrome,

transport out of the PICU, immunosuppressive drugs and immunodeficiency diseases were all independent predictors of pediatric VAP.

In this study, there was significant relation between the compliance to each component of the VAP bundle and prevention of VAP, the most higher compliance was to elevation of the head of bed (HOB) more than 45 degree (97.8 % of the ventilation days, P = 0.001), then the compliance to peptic ulcer prophylaxis among non VAP cases which was 94.96% of the duration of ventilation (P = 0.001), then the compliance to daily sedation interruption which was 93.35 % (P = 0.001), the compliance to daily assessment of spontaneous breathing and trial of extubation which was 84.10 % (P = 0.001), DVT prophylaxis was not done due to nature of the patients admitted to the PICU were critical medical illness and susceptible to bleeding, the compliance to all bundle together without DVT prophylaxis was 84.10 % (P = 0.001)

(Dorothy and colleagues, 2010) found in their study in 2 (SICU) over 3 years that compliance with head of bed (HOB) elevation had the greatest impact on VAP reduction. Compliance with (HOB) elevation was initially very low in both ICUs but had the greatest improvement during the study period. Deep vein thrombolysis prophylaxis compliance, also initially poor, improved but does not contribute to VAP reduction. Other bundle elements had excellent compliance throughout the study period. Head-of-bed elevation was the single element associated with reducing VAP risk that improved during the stud period. **(Resar and colleagues, 2005)** described the IHI impact Network s experience implementing the IHI VAP bundle at 61 hospitals. The ICUs achieving greater than 95 % compliance saw a 59 % reduction in VAP rates. **(Resar and colleagues, 2005)** emphasized that while bundle use may improve clinical outcomes, its use would also improve process reliability. They speculated further that the multidisciplinary teams, daily goal-setting and increased attention to detail stimulated by bundle importantly contributed to improved clinical outcomes.

(Cocanour and colleagues, 2005) described VAP bundle in their use in their Houston, Texas, TICU, on discovery of high VAP incidence, a bundle program that included elements of the IHI VAP bundle in addition to several other

precautions was initiated. The initial improvements in VAP incidence were modest and unsustained. When a computerized audit tool was implemented to calculate weekly bundle compliance data, the VAP rate decreased below the National Nosocomial Infections Surveillance System's 25th percentile and was sustained for the remaining months of the study. This reveals the importance of process quality evaluation and feedback in improving clinical outcome when using a bundle. **(Nola and Berwick, 2006)** found in their study that the use of ventilator bundle was successful in reducing the incidence of VAP.

In our study we found that there was clinical difference between the mortality in the VAP cases (83.3 %) and non VAP cases (35.1 %) although it was statistically insignificant (P = 0.067).

The mortality rate in our study was higher than several studies done in PICUs. In **(Grasso, et al., 2004)** study mortality rate was (27%) in VAP group. In **(Elward, et al., 2002)** study mortality rate was (20%) in VAP group. In **(Yidizdas, et al., 2002)** mortality rate was (22%). In **(Lopriore, et al., 2002)** study mortality rate was (7.7%) in VAP. This difference can be attributed to the illiterate parents in our hospital so patients admitted to our PICU come in bad and complicated conditions.

In the present study a statistically insignificant difference was found in microorganism's cultures of tracheal aspirate between VAP group and non –VAP group of patients (p =0.736), see **Table 3**. Bacterial micro-organisms responsible for nosocomial pneumonia in the PICU were most commonly aerobic gram-negative bacilli (AGNB) such as pseudomonas aeruginosa; acinetobacter; Klebsiella pneumonia and enterobacter. This predominance of AGNB in the PICU was found to be similar to that reported by other studies in PICU patients. **(Elward, et al., 2002; Yilidizdas, et al., 2002; Almuneef, et al., 2004** and **Mardganieva, et al., 2006)**. On the contrary, Carvalho and colleagues 2005, found a predominance of gram-positive organisms mainly staphylococcus.

Although viral and mycoplasma infections are thought to play an important role in causing VAP **(Yildizadas, et al., 2002)**, there is no sufficient data to justify routine culture for these microorganisms, moreover,

their isolation in our hospital cannot performed.

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تطبيق حزمة التهويه للوقاية من الالتهاب الرئوي المصاحب لجهاز التنفس الصناعي فى الرعايه المركزه للأطفال

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يعد الالتهاب الرئوى المصاحب لجهاز التنفس الصناعى فى الاطفال من الاسباب المؤدية لارتفاع نسبة الوفاة والاصابة بتبعيات المرض. ولذلك فالهدف من دراستنا معرفة نسبة حدوث الاصابة بالالتهاب الرئوى المصاحب لجهاز التنفس الصناعى و اختبار مدى تأثير الالتزام بالاجراءات الوقائية المتبعة بالدراسة على معدل حدوث ذلك.

تم عمل دراسة لمدة عام بالرعاية المركزة للاطفال، بمستشفى الحسين الجامعي ، على كل المرضى المستخدمين لجهاز التنفس الصناعى. وقد وجد انخفاض بمعدل الإصابة بهذه الالتهاب مع الالتزام بحزمة الاجراءات الوقائية .

وبعد تحليل هذه الدراسة وجد الآتى:

١- أهم أسباب الإلتهاب الرئوى المصاحب لجهاز التنفس الصناعى هى عدم رفع رأس سريرالمريض، الأمراض التى تسبب فقدان الوعى وطول المدة التى يخضع فيها المريض لجهاز التنفس الصناعى.

٢- الالتزام بحزمة من الإجراءات وهى(رفع رأس السرير 45ºووقف الأدوية المغيبة للوعى لمدة من الوقت يوميا و استخدام أدوية تقلل الحموضة وإختبار مدى قابلية الإستغناء عن جهاز التنفس الصناعى يوميا) أدى الى خفض نسبة الإصابة بالإلتهاب الرئوى المصاحب لجهاز التنفس الصناعى.

٣- نسبة الوفاة بين الحالات كانت أكثر بين الحالات المصابة بالإلتهاب الرئوى المصاحب لجهاز التنفس الصناعى.

وكانت التوصيات:

- نحتاج لمزيد من الدراسات لمعرفة الأسباب المؤدية للإلتهاب الرئوى المصاحب لجهاز التنفس الصناعى فى الأطفال فى نطاق أوسع من المرضى.
- نحتاج لمزيد من الدراسات لاتباع إجراءات جديدة لتجنب الإصابة بالإلتهاب الرئوى المصاحب لجهاز التنفس الصناعى
- اعادة تقييم الإجراءات الوقائية فى دراسات أخرى قبل الحكم على تقييمها.