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Impact of Education on Nurses' Knowledge of Ventilator-Associated Pneumonia in Neonatal Settings at Southern West Bank Hospitals: An Intervention Study

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Impact of Education on Nurses' Knowledge of Ventilator-Associated Pneumonia in Neonatal Settings at Southern West Bank Hospitals: An Intervention Study

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Jerusalem- Palestine

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Declaration

I hereby certify that this thesis, submitted for the degree of Masters, is the outcome of my own research, except where otherwise acknowledged, and that this thesis (or any part of the same) has not been submitted for a higher degree to any other university or institution.

Signed:______________

Kamil Mohammad Ahmed Hussien

Date: 3/5/2017

Acknowledgement

First and last, all thanks to (God) for his support me completed this

Thesis,

This work has been seen through to completion with the support and encouragement of numerous people including my teachers, friends, colleagues and family. It is a pleasant task, and I find it fit to express my thanks to all those who contributed in many ways to the success of this study and made it an unforgettable experience for me.

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Thank you all for making the past few years a rich and rewarding experience.

Abstract

Background: Ventilator-associated pneumonia (VAP) is a serious complication that can lead to a significant morbidity and mortality in critically ill patients in the neonatal intensive care units. These complications could range from prolonging the intubation period to an increase intensive care unit and hospital length of stay and costs.

Aim of the Study: The purpose of this study was to determine the impact of evidence-based educational program on knowledge of neonatal intensive care nurses of VAP prevention at Bethlehem and Hebron Hospitals in Palestine.

Design: A prospective educational intervention, using a pre-test and a post-test experimental design with the experimental and the control groups.

Setting: This study was conducted in the neonatal intensive care units at four governmental and private hospitals in cities of Bethlehem and Hebron.

Subjects: A total of 87 participants were randomly assigned to the control group (n= 38) and the intervention group (n = 49).

Tools: A 30-items VAP prevention bundle knowledge test was completed at baseline and post-test (3 months later). Nurses in the intervention group received education lessons for 12 consecutive weeks. A post-intervention survey that assessed knowledge changes was completed by participants after being exposed to the intervention. A mixed, between-within ANOVA was used to compare the nurses' knowledge changes over time (repeated measures).

Results: Findings from this study show the following results: (1) neonatal intensive care units nurses at Southern Palestinian Hospitals in both the intervention and control groups have poor knowledge at baseline regarding VAP (2) on post-test, NICU nurses' knowledge of VAP prevention bundle have improved after an educational intervention program (pre-intervention 65.7% versus post-intervention 86.7%) for the intervention group. Whereas, the general mean scores for the nurses in the control group didn't change over the same time frame. Moreover, no significant differences have been found for general knowledge scores by years of experience, previous training, gender & education level, while significant difference has been found for knowledge scores by place of work (p= 0.011).

Conclusion and Recommendations: The current study shows that nurses were having unsatisfactory total knowledge at the pre-program implementation, however, the score of total knowledge increased after the program. Therefore, further studies with different and

large sample populations are recommended to add to these findings. Therefore, Hospital administrations in collaboration with continuous education committee should focus on establishing educational programs and protocols to prevent and reduce the incidence of VAP and to enhance nurses' knowledge on preventions of Ventilator-Associated Pneumonia.

معرفة الممرضين والممرضات حول الالتهاب الرئوي المرتبط بالتنفس الاصطناعي في وحدات العناية المركزة لحديثي الولادة في مستشفيات جنوب الضفة الغربية بفلسطين: دراسة تدخليه.

إعداد: كامل محمد حسين

إشراف: د. فريد اغريب – د. سلام الخطيب

الملخص

الخلفية: إن الالتهاب الرئوي هو من المضاعفات الخطيرة الناتجة عن أجهزة التنفس الاصطناعي في وحدات العناية المركزة لحديثي الولادة، مما يؤدي إلى ارتفاع معدلات الأمراض والوفيات بينهم ومما يؤدي إلى مكوثه على التنفس الاصطناعي لفترة أطول وإلى زيادة الفترة الزمنية لمكوثه بالمستشفى وزيادة التكاليف المادية.

الهدف من الدراسة: الهدف من هذه الدراسة هو معرفة أثر البرنامج التعليمي ألقائم على الأدلة على معرفة ممرضين و ممرضات وحدات العناية المركزة لحديثي الولادة للوقاية من الالتهاب الرئوي المرتبط بجهاز التنفس الاصطناعي في مستشفيات بيت لحم والخليل في فلسطين.

تصميم الدراسة: تم استخدام الاختبار التجريبي قبل وبعد البرنامج التعليمي مع مجموعة التدخل ومجموعة الضبط لمقارنة أثر البرنامج التعليمي .

الإعداد: أجريت هذه الدراسة في وحدات العناية المركزة لحديثي الولادة في أربع مستشفيات حكومية وخاصة في مدينتي بيت لحم والخليل في فلسطين.

الموضوعات: تم توزيع ما مجموعه 87 مشاركا عشوائيا إلى مجموعتين: مجموعة الضبط (العدد = 38) ومجموعة التدخل (العدد = 49).

الأدوات: وقد تم استخدام 30 سؤال حول معرفة الممرضين والممرضات بخصوص الالتهاب الرئوي المرتبط بالتنفس الاصطناعي وتم عمل الاختبار قبل البرنامج التعليمي بثلاث أشهر وبعد البرنامج التعليمي بثلاث أشهر. وتلقى الممرضين والممرضات في مجموعة التدخل دروسا تعليمية لمدة 12

أسبوعا متتالية. وتم استخدام الفحص الإحصائي المسمى ب repeated measures ANOVA لمقارنة تغير معرفة الممرضين والممرضات مع مرور الوقت.

النتائج: أظهرت نتائج الدراسة أن النتائج التالية: (1) ممرضي وحدات العناية المركزة لحديثي الولادة في مستشفيات جنوب الضفة الغربية بفلسطين في كل من مجموعات التدخل والمجموعة الضابطة كان لديها معرفة ضعيفة قبل البرنامج التعليمي فيما يتعلق بالالتهاب الرئوي المرتبط بالتنفس الاصطناعي (2 درجة المعرفة الكلية تحسنت بعد برنامج التدخل التعليمي (قبل التدخل 65.7٪ مقابل ما بعد التدخل 86.7٪) لمجموعة التدخل، في حين لم تتغير درجة المعرفة الكلية للممرضين والممرضات في المجموعة الضابطة خلال نفس الإطار الزمني. وعلاوة على ذلك، لم يتم العثور على فروق ذات دلالة إحصائية لدرجات المعرفة العامة حسب سنوات الخبرة والتدريب السابق ونوع الجنس ومستوى التعليم، بينما وجد فرق ذات دلالة إحصائية لدرجات المعرفة حسب مكان العمل ($p = 0.011$).

الخلاصة والتوصية: تظهر الدراسة الحالية أن الممرضين والممرضات العاملين في وحدات العناية المركزة لحديثي الولادة كان لديهم معرفة كلية غير مرضية في مرحلة ما قبل تنفيذ البرنامج، وقد زادت النتيجة من إجمالي المعرفة بعد البرنامج لمجموعة التدخل. لذلك على إدارة المستشفيات العمل على دراسات أخرى مع عينات مختلفة وكبيرة الحجم لتضيف على هذه النتائج. لذلك، يجب على إدارة المستشفيات بالتعاون مع مركز التعليم المستمر أن تركز على وضع برامج وبروتوكولات تعليمية لمنع وتقليل حدوث الالتهاب الرئوي وتعزيز معرفة الممرضين والممرضات بشأن الوقاية من الالتهاب الرئوي المرتبط بأجهزة التنفس الاصطناعي.

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List of abbreviation

ATS	The American Thoracic Society
CBH	Caritas Baby Hospital
CDC	Center for Disease Control and Prevention
C.I.	Confidence Interval
DF	Degree of Freedom
ETT	Endotracheal Tube
HAI	Hospital acquired infection
HFH	Holy Family Hospital
HOB	Head-of-bed
ICM	Infection Control Measures
IDSA	Infectious Diseases Society of America
IgG	Immunoglobulin G
MV	Mechanical Ventilator
NHSN	National Hospital Safety Network
NICU	Neonatal Intensive Care Unit
NNIS	National Nosocomial Infection Surveillance System
PICU	Pediatric Intensive Care Unit
PIDAC	Provincial Infectious Diseases Advisory Committee
SD	Standard Deviation
SPSS	Statistical Package for Social Sciences
VAP	Ventilator-Associated Pneumonia
VCB	Ventilator Care Bundle

Chapter One

1.1 Introduction

The role of mechanical ventilation in the neonatal intensive care unit has been evolving (Melissa and DiBlasi, 2011). The survival rate of extremely preterm infants in the last decades has dramatically improved (Fanaroff et al., 2007; Cernada et al., 2013). Advances in mechanical ventilator (MV) have enabled the provision of respiratory support to extremely preterm infants within the limits of viability. However, barotrauma derived from MV caused abnormal remodeling of the lung structure contributing to the development of chronic pulmonary disease. Additional complications secondary to mechanical ventilator (MV) include air leaks, interstitial emphysema, subglottic stenosis, and ventilator-associated pneumonia (VAP) (Miller and Carlo, 2008; Cernada et al., 2013).

The Center for Disease Control and Prevention (2015) and National Healthcare Safety Network defined VAP as new and persistent radiographic infiltrates and worsening gas exchange in infants who are ventilated for at least 48 hrs, and those who exhibit at least three of the following criteria: temperature instability with no other recognized cause, leukopenia, change in the characteristic of respiratory secretions and respiratory distress and bradycardia or tachycardia. VAP is associated with increased duration of hospital stay resulting in high morbidity and mortality, and costs among neonatal intensive care unit (NICU) patients, with an estimated incidence of 6% – 32% (Afjeh et al., 2012). In United States, each episode of VAP is associated with 4.3 to 13 days increase in hospital stay and 4000-12000 dollars rise in therapeutic costs for each patient (Nesami and Amiri, 2013).

There are a series of risk factors that predispose to VAP, among them; prematurity and days of MV are the most relevant factors. Neonates have unique characteristics predisposing them to nosocomial infections. These patients' immature immune systems place them at increased risk for infection (Foglia et al., 2007), as skin and mucous membranes are more permeable and less effective barriers to infection (Harpin and Rutter, 1983; Foglia et al., 2007). Abnormal granulocyte migration and bacterial digestion in these patients have been demonstrated. Additionally, decreased activity of complement, particularly complement opsonization, occurs in newborn (Forman and Stiehm, 1969; Foglia et al., 2007). Lastly, hypogammaglobulinemia occurs in premature newborns. Maternal immunoglobulin G (IgG) is transported to the fetus in the second and last trimesters of pregnancy, and fetal IgG levels reach maternal levels by term Levels of IgG are lower in premature newborns, as maternal levels have not yet been attained (Foglia et al., 2007).

Moreover severe underlying disease, prolonged duration of mechanical ventilation, use of wide spectrum antibiotics, prolonged hospital stay and extensive use of invasive devices and procedures, stand as risk factors for developing VAP (Afjeh et al., 2012).

VAP arises from aspiration of secretions, colonization of the digestive tract, the use of contaminated equipment, or medications (Garland, 2010; Afjeh et al., 2012). The etiologic agent of VAP may differ according to length of hospital stay, co-morbid conditions and exposition of anti-microbial (Torres and Ewing, 2004; Badr et al., 2011). Aerobic gram negative bacilli account more than 60% of VAP cases. However, some investigators have reported that gram positive bacteria have become increasingly more common with *S. aureus* being the predominant isolate. (Shaw, 2005; Badr et al., 2011).

The clinical criteria for diagnosis of VAP have been established by the National Nosocomial Infection Surveillance System (NNIS) and the Center for Disease Control and Prevention (CDC). The criteria used to diagnose VAP in neonates include mechanical ventilation within 48 hours of onset of suspected VAP; worsening gas exchange with an increase in oxygen or ventilator requirements; 2 or more chest radiographs that show new infiltrates, consolidation, cavitation, or pneumatoceles; and at least 3 signs and symptoms. Signs and symptoms may include temperature instability, wheezing, tachypnea, cough, abnormal heart rate, change in secretions, or an abnormal leukocyte count. However, the criteria have not been validated in neonates, and they are often open to subjective interpretation because they overlap with other diseases (Garland, 2010; Badr et al., 2011).

Prevention of VAP is thus of utmost importance in critical care. Steps to reduce the incidence of VAP have been identified based on clinical best practice guidelines worldwide (Subramanian et al., 2013). The CDC has published guidelines for the prevention of health care-associated pneumonia. Several studies have shown a reduction in VAP after the guidelines were implemented into a bundle of interventions that were implemented as a single intervention. The power of the bundle is that it brings together several evidence-based practices that individually improve care but when applied together, may result in an even greater improvement in the desired outcome (Garland, 2010). Azab et al. (2015) mentioned that the implementation of interventional measures in ICU leads to reduction the incidence of VAP. Prevention of VAP bundle protocol includes: Head-of-bed elevation 30-45 degree; re-enforcement of hand hygiene practice; sterile suction and handling of respiratory equipment; Intubation, re-intubation and endotracheal tube (ETT) suction as strictly indicated by unit protocol (document); change ventilator circuit if visibly soiled or mechanically malfunctioning (document) weekly; proper timed mouth care with normal saline and oral care and daily evaluation for readiness for extubation**.**

The following figure illustrates relationship between pathogenesis and strategies to prevent VAP.

Prevention strategies | **Pathogenesis VAP**

- Routine mouth care
- Appropriates hand washing.
- Wear gloves when handling secretion

→ Bacterial colonization(oropharynx, stomach)

↓

- Avoid intubation.
- Strict reintubation
- Shortening duration of MV
- Limit ventilator circuit changes.
- Drain ventilator circuit condensation
- Avoid over-sedation and minimize opiate use.
- Elevate head of bed.

→ Aspiration or inhalation of contaminated secretions

↓

Ventilator associated pneumonia

Fig. 1. Relationship between pathogenesis and strategies to prevent VAP.

Lack of knowledge was indicated as a barrier for adherence to evidence-based practice (Pravikoff et al., 2005; Labaeu et al., 2007). Although knowledge does not ensure adherence, misconceptions about effective prevention strategies could be important in decision making. In other words, staff that does have knowledge about infection prevention protocols may not adhere to them, so knowledge does not guarantee adherence.

Even so, the reductions in the rates of hospital-acquired infection that occurred after educational programs on strategies to prevent infection provide indirect evidence for the value of knowledge. (Berenholtz et al., 2004; Labaeu et al., 2007).

Among the ICU staff, nurses have the most critical role in implementing most of the VAP preventive measures, thus their knowledge about the subject is of great importance (Ricart et al., 2003; Nesami and Amiri, 2013). It is necessary for nurses to be aware about factors that influence the development of VAP in vulnerable populations, such as critically ill neonates (Bockheim, 2011). Using educational programs for nurses about the effective measures for preventing VAP is only as useful as the proper implementation of these measures in the clinical setting (Foglia et al., 2007).

Many studies have shown a reduction in rates of VAP from applying a focused education intervention which can positively decrease the incidence of infection. Educational programs should be widely applied about infection control measures and the most used protocols to prevent the development of VAP in the intensive care unit setting. This can lead to substantial decreases in cost and patient morbidity attributed to hospital acquired infections (Zack et al., 2002).

Zack (2002), described how educational programs could improve nursing practices. Even though, some researches provide a contradictory idea that knowledge would not affect practice because some nurses prefer to go with the routine rather than using their knowledge to improve patient care. One of these researches was conducted by El-khatib et al. (2010), titled with critical care clinicians' knowledge of evidence-based guidelines for preventing VAP. In the research, they concluded that knowledge of recommended guidelines does not necessarily reflect appropriate practice, but knowledge remains the first step toward the implementation of evidence- based guidelines for the prevention of VAP. The researcher believes if nurses were educated about the effects resulted from VAP, they would be able to apply the required measures to prevent VAP. This will help in decreasing the incidence of VAP. So, the aim of this study is to assess the effectiveness of a structured educational program for prevention of ventilator associated pneumonia (VAP) on nurses' knowledge at neonatal intensive care units at Southern West Bank Hospitals.

1.2 Problem statement:

Pneumonia is a serious complication of mechanical ventilation in neonatal intensive care units (NICU), resulting in high morbidity and mortality with an estimated incidence of 6% – 32% (Afjeh et al., 2012). From my experience in the NICU department, it has been witnessed that babies with VAP suffer from its complications during their hospitalization period. It is also realized how the psychosocial and the economic status of the family were disrupted. Not only the parents suffering, but the hospital spends more money on these babies; needs more equipment, supplies, time and staff power. Some staff left their jobs because they were stressed and burned out due to the workload resulting from having a baby with VAP who needs more attention and effort.

In Palestine, there is no statistics for the percentage of VAP cases and there are no educational intervention programs to increase knowledge about VAP bundle prevention protocol. Prevention of VAP is primarily the responsibility of the bedside nurse whose knowledge, beliefs, and practices influence the health outcome of ICU patients. Nurses must be educated about the effects resulted from VAP and how they could implement recommended strategies to prevent VAP. So the main purpose of this study is to assess the effectiveness of a structured educational program for prevention of ventilator associated pneumonia (VAP) on nurses' knowledge at neonatal intensive care units at Southern West Bank Hospitals.

1.3 Significance of the study:

VAP results in increasing morbidity, mortality, hospitalization period, and high hospital costs for mechanically intubated patients. Therefore, the reduction of this preventable nosocomial infection is one of the major concerns in clinical practice in order to improve patient outcomes and conserve scarce healthcare resources.

Babies who suffer from VAP may have physical permanent problems. On the other hand, families might get affected in both economic and psychosocial status. Newly emerged cases of VAP worldwide stimulate hospitals to be more cautious about this problem and try to solve or reduce it.

Also what makes this study important is the lack of research in Palestine about VAP prevention protocols. So in order to improve nurses' knowledge about this problem, an educational intervention program about the prevention of VAP using bundle protocol should be applied.

1.4 General objective of the study:

To assess the effectiveness of a structured educational program for prevention of ventilator associated pneumonia (VAP) on nurses' knowledge at neonatal intensive care units at Southern West Bank Hospitals.

1.5 Specific objectives of the study:

1) To assess the mean knowledge scores on prevention of VAP among the intensive care nurses pre-intervention as base line measure.

2) To assess the mean knowledge scores on prevention of VAP within and between the intensive care nurses based on demographic variables pre-intervention.

3) To compare the mean knowledge scores on prevention of VAP three months post-intervention within-between the intensive care nurses for the intervention and the control groups.

4) To compare the mean knowledge scores on prevention of VAP three months post-intervention within and between the intensive care nurses based on demographic variables for the intervention and the control groups.

1.6 Hypothesis:

1. There is no significant difference at a level of (≥ 0.05) for the mean knowledge scores on prevention of VAP within and between the intervention and the control groups.

2. There is no significant difference at a level of (≥ 0.05) for the mean scores of the knowledge on prevention of VAP within and between the intervention and the control groups based on demographic variables at pre-intervention.

3. There is no significant difference at a level of (≥ 0.05) for the mean scores of the knowledge on prevention of VAP 3 months later within, and between the intervention and the control groups as result of education intervention program.

4. There is no significant difference at a level of (≥ 0.05) for the mean scores of the knowledge on prevention of VAP 3 months post-intervention within, between, and within-between the study groups based on demographic variables at pre-intervention.

1.7 Research questions:

1) What are the levels of the mean scores knowledge on prevention of VAP within and between the intervention and control groups at pre-intervention?

2) Are there any significant interactions present in knowledge on prevention of VAP among the study groups based on demographic variables at pre-intervention?

3) Is there significant difference between the pre-intervention and 3-months post-intervention mean scores of knowledge on prevention of VAP within and between the study groups?

4) Are there a significant interactions present between the mean scores of the knowledge on prevention of VAP 3-months post-intervention within-between the study groups based on demographic variables?

1.8 The following were the assumptions of this study:

1. VAP is a preventable disease when recommendations and protocols are implemented to assist nurses in improving patient outcomes.

2. The health team shows their interest in the study and their readiness to attend educational sessions and facilitate data collection.

3. Nurses will follow the protocol that they are learning through educational programs.

4. Increase knowledge of the health team working in the neonatal care setting through educational programs will lead to positive change in dealing with neonates and providing care properly, which reduces VAP.

5. Educational program about VAP and how important it is would prevent the incidence of VAP among patients, decrease hospital stay and medical costs.

1.9 Feasibility of the study:

Since the researcher is a nurse at NICU, this means that the experience he has enables him to teach the nurses educational programs effectively. Also the researcher lives in the city of the sample hospitals. This is supposed to make it accessible and easy to reach.

1.10 Summary:

In this chapter, an overview of the proposed study has been presented including the background of the study, the statement of the problem, the aim and objectives as well as the importance of the study. In addition, the research assumptions were defined.

Chapter Two

Literature review

2.1 Introduction

This chapter discusses ventilator-associated pneumonia as a major threat to patient’s safety. Therefore, it becomes extremely important that intensive care nurses have knowledge of strategies that aids in the prevention of this nosocomial infection and are able to implement evidence based nursing in the intensive care units, aiming to achieve a high quality of care as well as optimal outcomes for their patients.

In this literature review, the researcher describes the epidemiology and pathogenesis of VAP, risk factors, and discusses effective prevention measures in neonatal ICUs. Also, the researcher summarizes main studies related to nurses' knowledge of ventilator-associated pneumonia bundle protocol in the neonatal setting in a systematic way.
So our main objective of this literature review was to assess the effectiveness of a structured educational program for prevention of ventilator associated pneumonia (VAP) on nurses' knowledge at neonatal intensive care units at Southern West Bank Hospitals.

2.2 Ventilator associated pneumonia

Ventilator-associated pneumonia (VAP) is defined by the Center for Disease Control and Prevention as new and persistent radiographic infiltrates and worsening gas exchange in infants who are ventilated for at least 48 hrs and who exhibit at least three of the following criteria: temperature instability with no other recognized cause, leukopenia, change in the characteristic of respiratory secretions and respiratory distress and bradycardia or tachycardia (CDC, 2015). Health care-associated infections have a large impact on neonatal morbidity, survival, hospital costs, and length of stay.VAP is a common cause and accounts for 6.8% to 32.2% of health care-acquired infections among neonates (Garland, 2010).

2.2.1 Epidemiology

The exact rate of neonatal VAP is difficult to establish, because radiographic identification of pneumonia is difficult, especially among neonates with significant underlying lung disease, and diagnostic procedures commonly used in adults are rarely used in the neonatal intensive care unit (Garland, 2010). According CDC (2009), VAP is the second most frequent cause of nosocomial infection in NICU, and the incidence is highly influenced by gestational age and regional economic development. Hence, while in developed countries the incidence oscillates between 2.7 to 10.9 episodes per 1,000 ventilator days, in developing countries it may reach up to 37.2 cases per 1,000 ventilator days (Cernada et al., 2013).

VAP is common in the NICU and proportions between 6.8% and 57.0% of hospital acquired infection have been reported (Tekin et al., 2013; Aelami et al., 2014). A Spanish study identified VAP in 9.1% of 198 neonates on mechanical ventilation (Cernada et al., 2013; Aelami et al., 2014). VAP incidence densities in an Iranian and Turkish NICU were 13.8/1000 and 11.6/1000 ventilator-days, respectively (Aelami et al., 2014). Garland (2010) stated that low birth weight and mechanical ventilation increased pneumonia risk. Prolonged length of stay was the main driver of attributable costs of up to US$ 1040 in Iran and US$ 51,157 in the USA (Moradi et al., 2013; Aelami et al., 2014). Pneumonia is less common in neonates treated with nasal continuous positive airway pressure (NCPAP) when compared with those intubated on mechanical ventilation (12.5/ 1000 ventilator days vs 1.9/1000 NCPAP days, P 5 .04) (Hentschel et al., 2005; Garland, 2010). There are no data on the attributable mortality of VAP in NICU (Aelami et al., 2014). NICU design and staffing may affect VAP rates. Neonatal VAP decreased significantly when a NICU was moved from a crowded space to a larger unit with 50% more staffing (Goldmann et al., 1983; Garland, 2010).

2.2.2 Pathogenesis

VAP occurs when bacterial, fungal, or viral pathogens enter the normally sterile lower respiratory tract and lung parenchyma. Under normal circumstances, anatomic barriers, cough reflexes, tracheobronchial secretions, mucociliary lining, cellmediated and humoral immunity, and the phagocytic system of the alveolar macrophages and neutrophils protect the lung parenchyma from infection. If these defenses are impaired, absent, or overcome by a high inoculum of organisms or those of unusual virulence, pneumonitis ensues through microorganisms invading the respiratory airways and infecting the lung parenchyma may cause VAP. Microorganisms responsible for VAP can originate from endogenous or exogenous sources (Garland, 2010). The most common pathogens isolated in the neonatal population are Pseudomonas aeruginosa and Staphylococcus aureus. However, isolation of other microorganisms such as Klebsiella pneumoniae and Escherichia coli has also been reported (Cernada et al., 2013). Oropharyngeal or tracheobronchial colonization with pathogenic bacteria begins with the adherence of microorganisms to the epithelial cells of the respiratory tract (Fig. 1). Organisms causing VAP are often noted in the posterior pharynx. Neonates are likely at greater risk for such aspiration of contaminated oral secretions, because endotracheal tubes used to ventilate neonates are not cuffed. Gram-positive organisms in the mouth colonize the trachea and endotracheal tubes within the first 48 hours of mechanical ventilation (Feldman et al., 1999; Garland, 2010). Gram-negative bacilli begin colonizing the endotracheal tube and trachea after 48 hours of respiratory support. VAP early after intubation tends to be more benign when compared with episodes that occur later in the hospital stay when gram-negative organisms begin to colonize the endotracheal tube (Feldman et al., 1999; Garland, 2010).

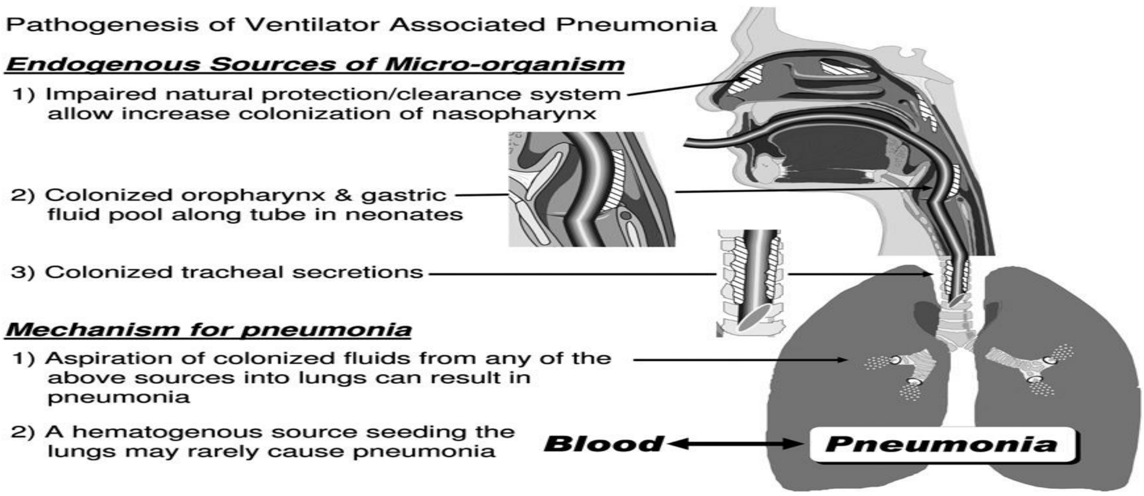

Fig. 1. Endogenous sources of organisms responsible for VAP.

Pathogens may also originate from exogenous sources (Fig. 2). The endotracheal tube can serve as a reservoir for infecting microorganisms that adhere to the surface. Ventilator circuits, airway suctioning equipment, humidifiers, and nebulizers can become contaminated with pathogens that subsequently cause VAP (Sole et al., 2002; Garland, 2010). Perhaps the most important source of exogenous contamination is from the caregivers' hands (Alcon et al., 2003; Garland, 2010). Gram-negative organisms, which begin colonizing the endotracheal tube later than gram-positive organisms, are frequently carried on the hands of caregivers (Garland, 2010).

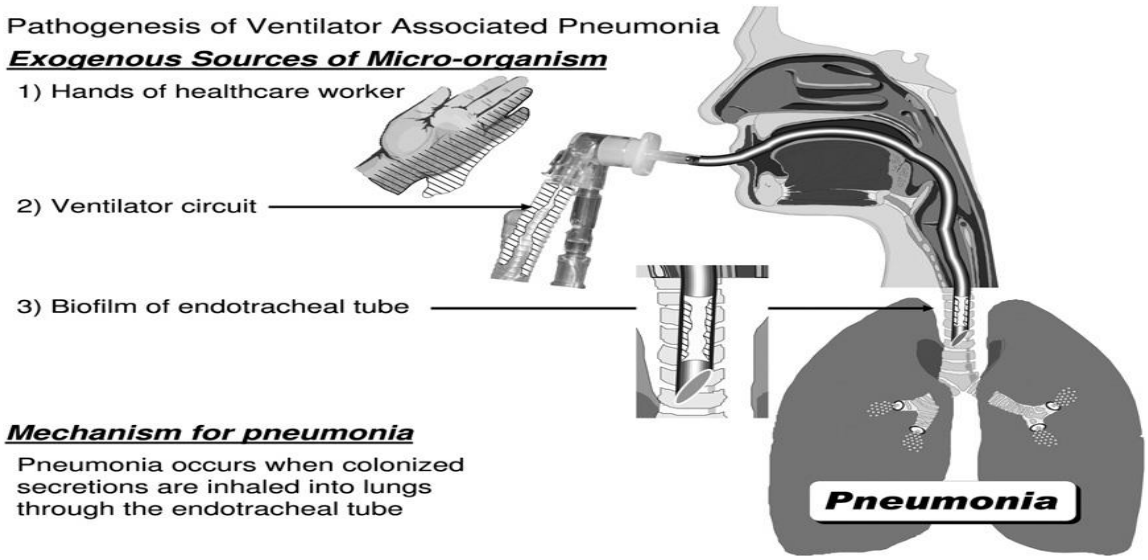

Fig. 2. Exogenous sources of organisms responsible for VAP.

2.2.3 Diagnostic Criteria of VAP

The major controversy regarding VAP in neonates is the criteria used to establish the diagnosis (Baltimore, 2003; Garland, 2010). Stringent clinical criteria to define VAP have been developed by the CDC and the National Hospital Safety Network (NHSN). Criteria include mechanical ventilation within 48 hours of onset of suspected VAP; worsening gas exchange with an increase in oxygen or ventilatory requirements; 2 or more chest radiographs that show new infiltrates, consolidation, cavitation, or pneumatoceles; and at least 3 signs and symptoms. Signs and symptoms may include temperature instability, wheezing, tachypnea, cough, abnormal heart rate, change in secretions, or an abnormal leukocyte Count (Garland, 2010). The problem with the criteria is the lack of a gold standard—microbiological identification of a pathogen from the lower respiratory tract, and thus the diagnostic value of the CDC surveillance recommendations is unknown (Baltimore, 2003; Garland, 2010). The criteria have not been validated in neonates, and they are often open to subjective interpretation because they overlap with other diseases (Garland, 2010).

2.3 Bundle protocol for prevention of VAP

The most current guidelines for VAP prevention focus on the components of the "ventilator bundle," a group of interventions supported by research to decrease the rates of VAP and other complications common in ventilated patients (Institute for Healthcare Improvement, 2012; Cal, 2015). Several studies that were conducted by Kollef (2004), Resar et al. (2005), and Garland (2010), have shown a reduction in VAP after the guidelines were implemented into a bundle of interventions that were implemented as a single intervention. The power of the bundle is that it brings together several evidence-based practices that individually improve care but when applied together, may result in an even greater improvement in the desired outcome (Garland, 2010). The use of the VAP prevention bundle aimed to address numerous risks that result from mechanical ventilation (Bockheim, 2011). According Centers for Disease Control and Prevention (2003) provided recommendations for nursing actions to prevent VAP. These recommendations include head of the bed elevation, oral care, hand washing and changing the ventilator circuit when it is visibly soiled.

2.3.1 Infection control measures

2.3.1.1 Hand washing

Hand washing is one of the most important strategies to reduce nosocomial infections (Pittet et al., 1999; Cernada et al., 2013). Improper hand washing techniques, which result in the cross-contamination of patients, have been identified as the biggest nurse-related risk factor for VAP (Augustyn, 2007; Musvosvi, 2013). Hand decontamination before and after patient contact, is one of the important measures to reduce the spread of germs. Hand hygiene includes one of the following: washing hands with soap and water if there is visible dirt or soiling with body fluids or using an alcohol-based antiseptic for in the absence of soiling (Musvosvi, 2013). In a 2-year-long surveillance intervention with NICU patients, increased hand hygiene compliance (from 43 to 80%) significantly reduced the incidence of respiratory infections from 3.35 to 1.06 infections per 1,000 patient days. (Won et al., 2004; Cernada et al., 2013). The importance of hand hygiene in preventing horizontal transmission of pathogens among mechanically ventilated patients was highlighted by a study performed by Sole et al. (2002) evaluated the proportion of suctioning devices colonized with pathogenic bacteria and to correlate the bacteria found on respiratory equipment with those found in patients' mouths and sputum. Those investigators found that within 24 hours of changing to new suctioning equipment, 94% of tonsil suction tubing, 83% of in-line suction tubing, and 61% of distal suction connectors were colonized with pathogenic bacteria similar to those found in the patients' oropharynx and sputum (Sole et al., 2002, Foglia et al., 2007;).

2.3.1.2 Frequency of ventilator circuit changes

The frequency of ventilator circuit changes does not influence the incidence of VAP. Cost considerations favour less frequent changes. Therefore new circuits for each patient and changes if the circuit becomes soiled or damaged is recommended (Muscedere, et al., 2008). Many studies that were conducted by Zhou et al. (2013) and Garland (2010) have shown the ventilator circuits do not need routine changing unless they become visibly soiled or malfunction. Breathing circuit condensate contamination can also serve as a mechanism for pathogenesis of VAP. The condensate that collects in the tubing should be drained away to prevent aspiration.

2.3.1.3 Airway humidification: frequency of humidifier changes

Frequent humidifiers changes may be associated with a slightly decreased incidence of VAP. Reduction in the frequency of humidifier changes might be considered as a cost reduction measure. Therefore changes of humidifiers every 5 to 7 days are recommended (Muscedere, et al., 2008). Many studies that were conducted by Labeau et al. (2007), Ahmed and Abosamra (2015) and El-Khatib et al. (2010) identified frequency of humidifier changes every 7 days.

2.3.2 Head of bed elevation

Head of the bed elevation is a simple and cost-free intervention, which has been proven to reduce the risks of VAP. Benefits of elevating the head of the bed are well documented (Musvosvi, 2013). Most adult VAP prevention bundles recommend elevating the head of a ventilated patient's bed to between 30_ and 45_ to reduce the risk of aspiration of contaminated oropharyngeal and gastrointestinal contents (Garland, 2010). The efficacy of semirecumbent positioning in preventing VAP in children has not been established (Foglia et al., 2007). On the other hand, Aly et al. (2008) said that tracheal aspirates are less likely to become colonized when ventilated infants are positioned on their sides kept laterally positioned rather than supine. Also, infants placed on their sides are less likely to selfextubate.

2.3.3 Oral care

Pathogens responsible for VAP are often located in the oral mucosa. Oral hygiene plays a significant role in preventing nosocomial infections (Musvosvi, 2013). If performed in a timely and consistent manner, good oral care practices can reduce the number of bacteria in the oral cavity thereby reducing risks of lung colonization and ultimately the development of VAP (Musvosvi, 2013). The CDC recommended a comprehensive oral hygiene program in patients at high risk for health care-associated pneumonia (Garland, 2010). Oral care is recommended in both adult and infant patient groups to inhibit bacteria from colonizing the mouth, which can be transported to the lower airways. Techniques specific to oral care in neonates additionally consider developmentally appropriate practices. Oral care should be provided every three to four hours with single use supplies (Bockheim, 2011). Endotracheal suctioning is used for eliminating bronchopulmonary secretions from the airway (Foglia et al., 2007). A meta-analysis by Pineda and colleagues, (2006) showed a reduction in VAP among adult patients treated by decontamination with oral chlorhexidine, although the reduction in VAP did not reach statistical significance. A meta-analysis by Chlebicki and Safdar, (2007) revealed a similar protective effect with chlorhexidine rinse. However, the CDC makes no recommendation for the use of an oral chlorhexidine rinse for the prevention of VAP in ill patients. Chlorhexidine gluconate is not approved for neonates younger than 2 months (CDC, 2004; Garland, 2010).

2.4 Risk factors for VAP

There are a series of risk factors that predispose to VAP. Among them, prematurity and days of MV are may be the most relevant ones (Donowitz, 1989; Foglia et al., 2007). Moreover severe underlying disease, use of wide spectrum antibiotics, prolonged hospital stay and extensive use of invasive devices and procedures, stands as risk factors for developing VAP (Afjeh et al., 2012). Developmental abnormalities in the neonate's immune system including greater permeability of the skin and mucous membranes, decreased complement activity, and lower levels of immunoglobulins increase the susceptibility to health care-acquired infections (CDC, 2004; Garland, 2010). Duration of ventilation has been acknowledged in studies performed with different sampling methods. Hence, Cernada et al. (2013), Afjeh et al. (2012), and Tripathi et al. (2010) identified duration of MV as the most common risk factor**.**

2.5 Summary of a literature review of main studies relating nurses' knowledge of ventilator-associated pneumonia bundle protocol in the NICU.

2.5.1 Studies about educational intervention to increase nurses' knowledge of ventilator-associated pneumonia bundle protocol.

Many studies that were conducted by Azab et al. (2015), Zhou et al. (2013), Subramanian et al. (2013), Rello et al. (2012), Babcock et al. (2004), and Zack et al. (2002), found similar results, and emphasized that educational interventions can be associated with decreased rates of ventilator associated pneumonia in the ICU setting. Intervention prospective study was conducted by Azab et al. (2015), aimed to evaluate the effectiveness of a comprehensive VAP prevention bundle on the rate of ventilator-associated pneumonias in the neonatal intensive care unit (NICU). The study was conducted in the NICU of Children Hospital of Zagazig University. The study conducted through three periods from January 2013- March 2014. The study population included all neonates (admitted to NICU during phase-I and II periods) mechanically ventilated ICU patients who had been intubated and mechanically ventilated for at least 48 hrs. The results showed 143 mechanically ventilated neonates admitted to NICU, 73 patients developed VAP (51 %) throughout the study period. The rate of VAP was significantly reduced from 67.8 % (42/62) corresponding to 36.4 VAP episodes/1000 mechanical ventilation days (MV days) in phase-I to 38.2 % (31/81) corresponding to 23 VAP/1000 MV days (RR 0.565, 95 % confidence interval 0.408-0.782, p = 0.0006) after VAP prevention bundle implementation (phase-II). Parallel significant reduction in MV days/case were documented in post-intervention period (21.50 ± 7.6 days in phase-I versus 10.36 ± 5.2 days in phase-II, p =

0.000). The study concluded that the implementation a bundle of infection control practices can effectively reduce the occurrence of VAP during neonatal ventilation. The study was limited by the small sample size. Also the study faced a limited setting so the results would not be representative, which will affect the generalization of the results. Also they mentioned the causes of MV initiation pre and post the intervention but if they assessed the most causes of VAP, this will enriches the data since they have already assessed the causes for MV. Another intervention prospective study was conducted by Zhou et al. (2013), aimed to evaluates the efficacy of an infection control program in reducing VAP in a neonatal intensive care unit (NICU) in China at Children's Hospital of Fudan University (FUCH) from February 2006 to December 2010 through three phases. The study population was all neonates who received mechanical ventilation for at least 48 hours and were hospitalized in the NICU for 5 days (during phase-I and II periods). A bundle of comprehensive preventive measures against VAP were gradually implemented using the evidence-based practice for improving quality method for NICU team then trained NICU staff in quality improvement before introduction of interventions. The results showed 491 patients receiving mechanical ventilation, 92 (18.7%) developed VAP corresponding to 27.33 per 1,000 ventilator-days. The incidence rate of VAP decreased from 48.84 per 1,000 ventilator-days in phase 1 to 25.73 per 1,000 ventilator-days in phase 2 and further diminished to 18.50 per 1,000 ventilator-days in phase 3 ($P < .001$). Overall mortality rate of admitted neonates significantly decreased from 14.0% in phase 1 to 2.9% in phase 2 and 2.7% in phase 3 (P ¼ .000). Gram-negative bacteria (95.5%) were the predominant organisms in VAP and Acinetobacterbaumannii (65.2%) was the most frequently isolated microorganism. The study concluded that a bundle of infection control practices can effectively reduce the occurrence of VAP among neonatal patients in China. One of the confounding variables is reactivity of the people within the study with and the external stimulus which might affect their knowledge about VAP prevention protocols. The study took a long time and that might affect their memories about the intervention provided. The reviewers implemented this intervention in a large tertiary care center, but did not monitor staff compliance on an ongoing basis.

Pre and post intervention, non- randomized observation study conducted by Zack et al. (2002), aimed to evaluate the effectiveness of education initiative program in decreasing the hospital rate of ventilator-associated pneumonia. The study was conducted in five intensive care units in Barnes-Jewish Hospital, an urban teaching hospital. Non-randomized selection of 114 respiratory care practitioners and 225 intensive care unit nurses then an education program directed toward respiratory care practitioners and intensive care unit nurses was developed by a multidisciplinary task force to highlight correct practices for the prevention of ventilator-associated pneumonia. The intervention consisted of two1-hr lectures on the pathogenesis and prevention of ventilator-associated pneumonia. Measurements were collected one week prior to the intervention and at 1, 3, and 6 weeks post-intervention. The results showed that the average percentage correct on the pre-intervention test was 79.6 _ 10.3%. These scores increased on the post intervention test to 90.9 _ 6.1%. The education module was also completed by 146 of the 225 (64.9%) nurses working in the five intensive care units. The average percentage correct on the pre-intervention test was 81.0 _ 10.3%. These scores increased on the post intervention test to 91.0 _ 6.1%. Following implementation, the rate of VAP decreased to 81 episodes in 14,171 ventilator days (5.7 per 1,000 ventilator days), a decrease of 57.6%. They concluded that education intervention can dramatically decrease the incidence of ventilator-associated pneumonia. The above study was well structured with good references. Pre-post intervention studies provide good evidence and this study was one of them. Sample was enough but if it was limited in setting as it was conducted in one hospital which affects generalizability of the findings. Randomized observational study may be biased by nurses because of social desirability which might change their behavior. Eight respiratory care practitioners (7.0%) had a decrease in the percentage correct on their post intervention tests, even if the overall results showed improvement post intervention. A similar study conducted by Babcock et al. (2004), using method of quantitative pre posttest design, aimed to determine whether an educational initiative could decrease rates of ventilator-associated pneumonia in a regional health-care system. The intervention was performed at four hospitals in a single health system in the Midwestern United States, 635 of 792 ICU nurses (80.1%) and 215 of 239 respiratory therapists (89.9%) completed the module. The overall ventilator-associated pneumonia rate for all four hospitals combined was 8.75/1,000 ventilator days. In the 18 months after the intervention was completed (January 1, 2001, through June 30, 2002), the overall rate dropped to 4.74/1,000 ventilator days (p _ 0.001). There were no statistically significant differences in the ventilator-associated pneumonia rates during the first 6 months or 12 months after the intervention was completed compared to the last 12 months or 6 months after the intervention was completed. The results also suggest respiratory therapists may be important targets for educational interventions about ventilator-associated pneumonia. They concluded that educational interventions can be associated with decreased rates of ventilator associated pneumonia in the ICU setting. The study was well structured with good references. Pre-post intervention studies provide good evidence and this study was one of them. The sample was enough but if it was limited in setting as it was conducted in one hospital which affects generalization of the findings. The achievement of a similar effect in multiple settings suggests that the intervention may be generalized to other facilities.

Another quasi-experimental, pretest - posttest study conducted by Subramanian et al. (2013), investigated the effects of nurse-led education on: (a) knowledge of and compliance with ventilator care bundle (VCB) practices among intensive care unit (ICU) nurses; and (b) reduction in the rates of VAP post intervention. The study was conducted among 71 nurses, and the intervention involved structured education on VAP and its prevention using VCB in an ICU setting. Data were collected using a 20-item structured questionnaire (regarding the knowledge of VAP and its prevention via VCB practices) to test the pre-intervention knowledge levels of the group. These 20 multiple-choice questions pertaining to the definition and diagnosis of VAP, its pathophysiology, risk factors, causative factors and disease burden, as well as questions on VCB. Furthermore, to determine the current practice patterns regarding ventilated patients, observation was carried out with a checklist one month before educational intervention. The observation checklist revolved around five important elements based on the adapted VCB. All the 71 participants the questionnaire with 100% response rates for pre- and posttest evaluations, educational intervention and pre-intervention observation of VCB practices among the nurses. However, the response rate for observation of VCB practices post intervention was only 93%. The results revealed that the nurse-led educational intervention had a significant effect ($p < 0.001$) on the nurses' knowledge of VAP and VCB and on the nurses' compliance ($p < 0.001$), as reflected in their test scores (pre-intervention 63.17; post-intervention 95.99) and (pre-intervention 60.00; post-intervention 96.06), respectively. The findings indicate that education on VAP and VCB significantly increased ICU nurses' knowledge of VAP and compliance with VCB practices, thereby reducing the post-intervention incidence of VAP among intubated and mechanically ventilated patients. The sample size was small and not representative, which will affect the generalizability of the results and convenience sampling method could be biased with the part when they did observation pre and post the educational program that the nurses may change their behavior when they are observed.

A cohort study was conducted by Rello et al. (2012), aimed to determine the impact of implementing a care bundle package for VAP prevention on VAP rates and duration of mechanical ventilation. The data collection period was conducted using designated questionnaire and lasted from March 2007 to December 2008. The results showed a total of 3845 ventilator-days, 149 patients in the baseline period and 885 patients after the intervention were included in the study. During the baseline period, there was a VAP incidence of 12.9/1000 ventilator-days (a rate of 16 cases per 100 patients), which decreased to 9.28/1000 ventilator-days (a rate of 11 cases per 100 patients) after the intervention period ($p < 0.05$). The highest compliance of bundle care was achieved regarding not changing ventilator circuits unless necessary (34%; 301/885) and performing sedation control (27%; 239/885) (p 0.20). On the other hand, intracuff pressure control was consistently performed only in 18% (159/885) of opportunities, followed by oral care (21%; 186/885) and hand hygiene (19%; 188/885), which revealed the lowest levels of compliance. In the intervention period, the risk of developing VAP was significantly reduced, when hand hygiene was performed and the same association was found with intra-cuff pressure control and oral hygiene. They concluded that significant improvements in outcomes can be achieved with high compliance in implementing a care bundle package for VAP prevention. The researcher thinks that a major strength of the study is that its design has allowed the assessment of individual measures over a long follow-up period and the overall results shows the need for continuous education of healthcare workers to maintain high levels of compliance.

2.5.2 Studies about Intensive care nurses' knowledge level on prevention of VAP.

Many studies that were conducted by Ahmed and Abosamra, (2015), Nesami and Amiri, (2013), Gatell et al. (2012), and Meherali et al. (2011), pointed out the importance of an educational intervention program to increase nurse's knowledge of ventilator-associated pneumonia bundle protocol in the ICU to prevent the incidence of VAP among patients and decrease hospital stay and medical costs. A pre- and post intervention study was conducted by Meherali et al. (2011), aimed to identify the critical care nurses knowledge of evidence based guidelines for the prevention of VAP at a tertiary care teaching hospital. Eleven bedded mixed medical-surgical intensive care unit (ICU), which also includes 3 beds for Paediatric Intensive care unit and 9-bedded Cardiac intensive care unit (CCU) at Karachi Pakistan. The sample of study included 40 nurses. To identify the existing level of knowledge of nurses regarding evidence based guidelines for the prevention of VAP, a pre-test was conducted. Post-test 1 conducted immediately after the teaching module, whereas Post-test 2 was conducted four weeks after the intervention to assess if there was a positive effect on the nurses' knowledge for evidence based practice guidelines for the prevention of VAP. The sample size included 40 nurses, who were receiving a 5-hour module conducted as a workshop, focusing on assessment and nursing management based on CDC evidence based guidelines for the prevention of VAP. The results of the pre-test highlighted that majority of the nurses had a significantly low level of knowledge regarding evidence based guidelines for the prevention of VAP. Nurses scored quite low in some very important areas, like risk factors associated with the development of Ventilator Associated Pneumonia, patient positioning, lack of knowledge regarding CDC recommendation for all ventilated patients for the prevention of VAP. On post-test, the educational intervention significantly improved the knowledge level of the participants regarding evidence based guidelines for VAP prevention; however, there was a decline in the score in post-test 2. This study had a limited time and setting. The sample size was small, and the intervention that offered to nurses was weak because in this study was that the team did not have the resources to increase the frequency of their education sessions. The participants should have at least one year experience in order to be included and that's not enough. It might be the cause for having a variance in the knowledge scores. The majority the participants had a diploma level of education which might affected the mean scores. Another quantitative study was conducted by Ahmed and Abosamra, (2015), aimed to assess knowledge of pediatric critical care nurses regarding evidence based guidelines for prevention of VAP in both pediatric and neonatal intensive care unit at children's University Hospital in Mansoura, Egypt. The sample of study included 28 nurses from Pediatric Intensive Care Unit (PICU) and 21 nurses from Neonatal Intensive Care Unit (NICU). The results showed this study revealed inadequate knowledge of pediatric critical care nurses regarding evidence based guidelines for prevention of ventilator associated, where the highest percentage of studied sample reported the correct answer regarding oral intubation, changing humidifiers, kinetic beds, appropriate routine oral care and positioning as evidence by (83.6%,51%, 73.5, 65.3, 67.3%) respectively. Also, the highest percent of studied sample reported incorrect answers regarding frequency of ventilator circuit changes, condensation in the ventilator circuit, ventilator and bed side maintenance, type of air way humidifier, type of suction system, frequency of change in suction systems, type of endotracheal tubes, head of the bed and hand hygiene and gloving. Moreover, there is strong correlation between years of experiences, previous training on guidelines of prevention of VAP and knowledge of nurses on the evidence based guidelines for prevention of VAP. Moreover, there is no correlation between age and knowledge of nurses on evidence based guidelines for prevention of VAP. The researcher made some mistakes in interpretation of some of the data, the researcher stated that there is no correlation between age and knowledge but the p- value was 0.00 which means there is a strong correlation. Also stated that there is significance between level of education and knowledge but p- value was .173, which means there is no correlation. Therefore, analysis of the results is not accurate. Also the study faced a limited setting so the results would not be representative, which will affect the generalization of the results. Also, the researcher failed to provide the conceptual framework of the study which added to the contribution of making the study weaker.

Another descriptive study was conducted by Nesami and Amiri, (2013), to evaluate the knowledge of nurses in the intensive care unit in University hospitals of Sari, Iran. The study population included the nurses working in three ICUs of a university hospital in Sari, a total of 54 ICU nursing staff. Nurses' knowledge was assessed using a questionnaire completed by 52 ICU nurses chosen through availability sampling. The results showed 34.6% of them answered correctly about oral route for endotracheal intubation; 78.8% answered correctly about the type of humidifier; and 80.8% chose the closed suction system as the correct answer. Using kinetic beds, endotracheal tubes with extra lumens for the drainage of subglottic secretions and semi-recumbent positioning were the correct options chosen by 90.4%, 65.4% and 82.2% of the participants. Respondents had the least knowledge about the frequency of ventilator circuit changes (17.3%), the frequency of humidifier changes (3.8%) and the frequency of changes in the suction system (13.5%). According to this questionnaire nurses' knowledge mean level on VAP preventive measures was determined 51.92%. This study provided researchers with highly valid questionnaire in assessing nurses' knowledge about VAP and will inform practice in preventing VAP. The study was limited by the small sample size. Also the study faced a limited setting so the results would not be representative, which will affect the generalizability of the results. The researcher used convenience sampling method which is one of the non-probability sampling and this could bias the results. The researcher did not take measures to control the confounding variables of the study like age, gender; years of experience which might affect the inference of study. Trying to get a homogenous sample would help the researcher to have over control over the study variables. Another prospective, quasi experimental, pre-and post-study conducted by Gatell et al, (2012), aimed to assess the impact of training session on nurses' knowledge regarding VAP, compliance with VAP preventive measures, VAP incidence and determining whether nursing workload affects compliance. The study population included all the ICU nursing staff (n = 58) in a 16-bed medical-surgical ICU in the study. The study conducted through three phases: pre-intervention phase: a questionnaire to assess nurses' knowledge of VAP prevention measures, direct observation and review of clinical records to assess compliance. Intervention phase: eight training sessions for nurses. The post-intervention phase mirrored there-intervention phase. The results showed that the nurses answered more questions correctly on the post-intervention questionnaire than on the pre-intervention (17.87 ± 2.69 versus 15.91 ±2.68, $p = 0.002$). Compliance with the following measures was better during the post-intervention period ($p = 0.001$): use of the smallest possible nasogastric tube, controlled aspiration of subglottic secretions and endotracheal tube cuff pressure, use of oral chlorhexidine and recording the endotracheal tube fixation number. VAP incidence remained unchanged throughout the study. However, a trend towards lower incidence of late (>4 days after intubation) VAP was observed (4.6 versus 3.1 episodes/1000 ventilation days, $p = 0.37$). The study concluded that the programme improved both knowledge of and compliance with VAP preventive measures, although improved knowledge did not always result in improved compliance. The study was limited by the small sample size. Also the study faced a limited setting so the results would not be representative, which will affect the generalization of the results. One of the limitations was that some that participants who were aware that they are being observed may change their behavior and biased the results. Another limitation of this study is that the questionnaire used to evaluate nurses' knowledge was not validated.

2.5.3 Studies about the guidelines for the prevention of VAP

The prevention and control of VAP in intensive care units are dependent on the education and sensitisation of ICU staff members towards the problem and on the application of measures to prevent its occurrence (Gomes, 2010). The guidelines can improve outcomes and costs of critical care to patients and institutions. A quantitative study conducted by El-Khatib et al. (2010), aimed to evaluate knowledge of critical care providers (physicians, nurses, and respiratory therapists in the intensive care unit) about evidence-based guidelines for preventing ventilator-associated pneumonia. The study population included ten physicians, 41 nurses, and 18 respiratory therapists working in the intensive care unit of a major tertiary care university hospital center completed a questionnaire on 9 non pharmacological guidelines for prevention of ventilator-associated pneumonia. The results showed that mean (SD) total scores of physicians, nurses, and respiratory therapists were 80.2% (11.4%), 78.1% (10.6%), and 80.5% (6%), respectively, with no significant differences between them. Furthermore, within each category of health care professionals, the scores of professionals with less than 5 years of intensive care experience did not differ significantly from the scores of professionals with more than 5 years of intensive care experience. The sample size was small and data cannot be generalized. They did not use randomization in their selection of the sample which might help in reducing selection biases that a preexisting differences between the groups so their comparison would not be equivalent. A similar quantitative study was conducted by Labeau et al. (2007), aimed to develop a reliable and valid questionnaire for evaluating critical care nurses’ knowledge of evidence-based guidelines for preventing ventilator associated pneumonia. They develop a questionnaire with selected interventions from previous recently published review of evidence-based guidelines for relevant randomized, controlled trials and systematic reviews. A questionnaire was distributed to 855 nurses during the annual congress of the Flemish Society for Critical Care Nurses. Of the 855 registered participants, 638 completed the questionnaire (response rate 74.6%). Most of the 638 respondents were women (n =472, 74%). A total of 274 respondents (43%) had more than 10 years of ICU experience, and 274 worked in units with more than 15 beds. A degree in emergency and critical care was held by 68% (n = 437) of respondents. As a result of the face and content validity, the original 10-item questionnaire was adapted and reduced to 9 items. Also the results showed that the quality of the response alternatives led to the detection of widespread misconceptions among critical care nurses which was that respondents are convinced that an intervention without evidence-based preventive value is preferred over the evidence-based 6nurses' knowledge of evidence based interventions for preventing VAP and could be used after educational programs. This study provides researchers with highly valid questionnaire in assessing nurses' knowledge about VAP and will inform practice in preventing VAP that the study had two limitations including the limited sample size and settings.

A cross-sectional descriptive study conducted by Kiyoshi-Teo et al. (2014), aimed to identify factors that influence adherence to guidelines for prevention of ventilator-associated pneumonia, with a focus on oral hygiene, head-of-bed elevation, and spontaneous breathing trials. The study conducted at 8 hospitals in Northern California. The results showed a total of 576 critical care nurses participated in the survey. Nurses had positive attitudes and reported adhering to the guidelines always or most of the time. The score on the user attitude scale was the strongest and most consistent predictor of adherence across interventions (odds ratio, 3.49-4.75). Time availability (odds ratio, 1.54) and the level of prioritization (odds ratio, 1.86) were also significant predictors. They concluded that the most consistent facilitator of adherence to guidelines for prevention of ventilator-associated pneumonia was nurses' positive attitude toward the guidelines. As a researcher I think that one of the limitation of the study lacking a random sampling which may have introduced the study selection bias. Also, the response rate was low (44.6%) and that's suggests possible ignorance and poor follow up with the contacts. The researcher thinks design like mixed one would work better than the chosen one (descriptive, cross sectional).
Management of ventilator-associated pneumonia in intensive care units: a mixed methods study assessing barriers and facilitators to guideline adherence conducted by Safdar et al. (2016), aimed to understand barriers and facilitators to the adoption of the Infectious Diseases Society of America/The American Thoracic Society (IDSA/ATS) guidelines. The study was conducted in medical-surgical ICUs at the University of Wisconsin Hospital, a tertiary academic hospital. The researchers conducted surveys and focus group discussions of different health care providers involved in the management of VAP. The results found that 55 % of participants indicated that they were aware of the IDSA/ATS guideline. The most barriers to VAP management included: 1) having multiple physician groups

managing VAP, 2) variation in VAP management by differing ICU services, 3) physicians and level of training, and 4) renal failure complicating doses of antibiotics. Facilitators to VAP management included presence of multidisciplinary rounds that include nurses, pharmacist and respiratory therapists, and awareness of the IDSA/ATS guideline. This awareness was associated with receiving effective training on management of VAP. As a researcher I do think that this study provided a good evidence since it is one of the few studies that used mixed design. They used Focus group methods and development of survey to identify barriers and facilitators of managing VAP in ICUs from the providers' perspective. They included physicians, nurses, respiratory therapist and pharmacist. One of the new views was avoiding unnecessary antibiotic administration, increasing the effectiveness of prescribed antibiotics, and reducing antimicrobial resistance as well by creating antibiotic protocols. One of the possible drawbacks that the study was limited for two settings. Also to make this study better they should have used an international guideline because the one used were not validated and tested.

Non experimental, longitudinal, descriptive study was conducted by Grap et al. (2005), aimed to describe the relationship between backrest elevation and development of ventilator associated pneumonia. The study was conducted in the medical respiratory ICU at Virginia Commonwealth University Health Systems. Data were obtained from laboratory results and medical records from the start of mechanical ventilation up to 7 days. The results showed Sixty-six subjects were monitored (276 patient days). Mean backrest elevation for the entire study period was 21.7º. Backrest elevations were less than 30º 72% of the time and less than 10º 39% of the time. The mean Clinical Pulmonary Infection Score increased but not significantly, and backrest elevation had no direct effect on mean scores. They concluded that only the combination of early, low backrest elevation and severity of illness affected the incidence of ventilator associated pneumonia. The researcher thinks that the time period of the data collection was short and the study was limited by the small sample size. Also the lack of bronchoscopic evaluation for diagnosis of pneumonia which might indorse a bias in the inference because there are no specific, valid criteria used to diagnose pneumonia.

Another prospective, randomized, controlled study was conducted by Aly et al. (2008), aimed to test the hypothesis that intubated infants positioned on their sides would be less likely to contract bacterial colonization in their tracheae, compared with those positioned supine. The study was conducted in the neonatal unit at Cairo University Children's Hospital. A total of 79 infants were initially enrolled in the trial; 19 infants dropped out of the study because of death (n # 15) or early extubation (n # 4). Therefore, 60 infants completed the study, 30 infants in the supine group and 30 infants in the lateral group. The 2 groups were similar in demographic and clinical characteristics. Eligible subjects were identified and assigned to 1 of 2 groups according to a predetermined randomization sequence. The investigators did not have control regarding the randomization sequence when recruiting a new subject. The results showed after 2 days, the numbers of positive tracheal cultures in the supine group (67%) and in the lateral group (47%) showed no statistical difference. After 5 days of mechanical ventilation, tracheal cultures differed significantly between groups. Cultures were positive for 26 infants (87%) in the supine group and 9 infants (30%) in the lateral group. Compared with the lateral group, more infants in the supine group experienced increased colony counts or had new organisms in their tracheal aspirates over time (21 vs. 8 infants). The most common organisms isolated from tracheal aspirates in both groups were Gram-negative rods. The study concluded that lateral positioning of infants in the NICU had a positive effect on decreasing the incidence of VAP. Also, infants placed on their sides are less likely to self-extubate. One of the limitations of this study is that the sample size was small. Also the study faced a limited setting so the results would not be representative, which will affect the generalization of the results. Another limitation was that the sample size in the beginning of the study 79 and at the end, it became 60. The attrition rate was 19 case. The risk of attrition is especially great when the length of time between times of data collection is long, in this study the drop out was because of death or extubation. An intention to treat analysis might help in getting outcomes from those who dropped out but even though it holds some difficulty.

2.5.4 Studies about the VAP incidence

The studies that were conducted by Fallahi et al. (2014) and Badr et al. (2011), found similar results, the most important risk factors for developing VAP in NICU include prematurity, low birth weight, prolonged duration of mechanical ventilation, enteral feeding and invasive devices. A prospective cross-sectional study conducted by Fallahi et al. (2014), aimed to determine the rate, microbiological characteristics and outcome of VAP in neonates admitted in the NICU of Shohada-e-Tajrish Hospital. Clinical and paraclinical data were documented and tracheal secretions were collected by nonbronchoscopicbronchoalveolar lavage. The results found From 103 patients admitted In the NICU, a total of 66 patients were intubated for 48h or more. VAP occurred in 33.3% of the mechanically ventilated neonates. Microorganisms associated with VAP included: Klebsiella species in 68.1%, Acinetobacter spp. And Enterococcus spp. in 13.6%, and Candida spp. in 4.5%. Lower gestational age and birth weight, longer duration of hospital stay and prolonged ventilator need had a significant relationship with VAP. Mortality rate was 6.8% in the ventilated infants without VAP, while 22.7% of the neonates who developed VAP, died. The study had a small sample size in the current study may be a limiting factor to determine the risk factors of VAP & the study faced a limited setting. Also one of their limitations was that the BACTEC media was not utilized for culturing, which could have increased the yield of the microorganisms and this could bias the results. Another prospective observational study was conducted by Badr et al. (2011), aimed to determine characteristics and risk factors of VAP in critically ill newborn infants admitted to NICU, Zagazig University Hospitals. The sample size included 56 neonates who received mechanical ventilation by orotracheal tube for a period of >48 hrs because of different illnesses. Patients were classified into 2 groups: **Group I (VAP-group):** included 32 neonates (18 males and 14 females) of ages ranged from 6 to 18 days who were clinically diagnosed with VAP according to CPIS. **Group II (non-VAP group):** included 24 neonates of ages ranging from 6 to 11 days `who did not develop VAP. The results showed the VAP and non-VAP groups differ significantly regarding gestational age and weight. Duration on mechanical ventilation was highly significantly longer in VAP patients than in non VAP. Meanwhile, there were non-significant differences regarding gender, mode of delivery and indication to new admission. The most prevalent organism isolated from Non-bronchoscopic bronchoalveolar Lavage fluid in VAP patients was *Klebsiella* (34.3%) while *Pneumococci* were the least ones. The study concluded that the most important risk factors for developing VAP in their unit include prematurity, low birth weight, prolonged duration of mechanical ventilation, enteral feeding and invasive devices such as umbilical catheters. The study was limited by the small sample size. Also the study faced a limited setting so the results would not be representative, which will affect the generalizability of the results. also the exclusion criteria was limited on neonates who required mechanical ventilation for less than 48 hours and those who had pneumonia at the time of initiation of mechanical ventilation but the researcher thinks that mothers who had

GBS infection or recent UTI infections in the pregnancy or any infection in the late stage of pregnancy should be excluded because babies might not show signs of infection till period of time. They should have explained more details about the observation technique since the results of observational studies maybe biased by selection bias resulting from the way study subjects are recruited or from differing rates of study participation depending on the subjects' cultural background, age, or socioeconomic status, information bias, measurement error, confounders, and further factors. So the researcher should have explained methods used to have more control over the study design. The literature review part of the study was limited and needed to point more views about the current knowledge about the study.

Another prospective, observational study was conducted by Blot et al. (2011), aimed to determine how the patient to nurse ratio affects risk for ventilator-associated pneumonia. This study conducted in 27 ICUs in 9 European countries: Belgium, France, Germany, Greece, Italy, Ireland, Portugal, Spain, and Turkey. Using structured survey all patients who were admitted to the ICU for treatment of pneumonia or received invasive mechanical ventilation for more than 48 hours, irrespective of the admission diagnosis, were included in the initial cohort. Ventilator-associated pneumonia developed in 393 of the 1658 patients (23.7%) in the secondary cohort. In units with patient to nurse ratios of 1 to 1, 2 to 1, 2.5 to 1, and 3 to 1, rates were 9.3%, 25.7%, 18.7%, and 24.2%, respectively (P = .003). Rates were significantly lower (P = .002) in units with a ratio of 1 to 1 (9.3%) than in units with a ratio of more than 1 patient to 1 nurse (24.4%). After adjustments for confounding covariates, ratios of more than 1 patient to 1 nurse were no longer associated with increased risk for ventilator-associated pneumonia. They concluded that ICUs with a patient to nurse ratio of 1 to 1 have less ventilator days and inferred a subsequent decrease risk of VAP since length of ventilator days is a risk factor for VAP development. As a researcher I do think that this study provided good evidence was since it is one of the few studies that brought the attention to new subject. One of the limitations is that quality of care is not fully reflected by degree of staffing. Quality of care at the level of individual patients strongly depends on nurses' competencies.

Another quasi-experimental study conducted by Bénet et al. (2012), aimed to investigate the effect of HAI (Hospital acquired infection) surveillance disruption on ventilator-associated pneumonia (VAP) incidence. This study was done between 1 January 2004 and 31 December 2010 in two intensive care units (ICUs) of Edouard Herriot Hospital in Lyon, France. Pre-test period comprised patients hospitalized during 2004 to 2006, and post-test period involved patients hospitalized during 2008 to 2010. Patients hospitalized ≥48 hours and intubated during their stay were included. The results showed a total of 2,771 patients, accounting for 19,848 intubation-days at risk, were studied; 307 had VAP. The VAP attack rate increased in unit A from 7.8% during period 1 to 17.1% during period 2 (P = 0.17), no change in mortality was observed (P = 0.22), while length of stay decreased between periods 1 and 2 (P = 0.002). They concluded that VAP incidence, length of stay and all-cause mortality rose after HAI surveillance disruption in ICU, which suggests a specific effect of HAI surveillance on VAP prevention and reinforces the role of data feedback and counseling as a mechanism to facilitate performance improvement. As a researcher I think that this was a good article that pointed the effect of having surveillance in ICU departments and its effect on VAP. One of the limitations was the lack of randomization of the intervention, therefore it quasi-experimental design which implies that the intervention and control groups are not equivalent.

Another prospective cohort study was conducted by Ruzieh et al. (2013), aimed to determine the incidence and risk factors of ventilator-associated pneumonia (VAP) in Palestine. The study was conducted in six different multidisciplinary ICUs and one CCU in 6 hospitals in Tulkarm, Jenin, Nablus and Ramallah, which represent VAP patients in Palestine referral hospitals. The sample size included all patients who required mechanical ventilation for more than 48 hours. The results showed 134 patients were involved in the study. VAP was present in 29 patients (21.6%). No significant difference between the VAP and non-VAP patients in relation to age, enteral feeding days or H2 blocker use days was found. However, number of ventilation days were significantly higher in patients with VAP (P value=0.04). Patients with VAP were more likely to have sepsis, neuromuscular disorders and chronic pulmonary obstructive disease (COPD), (P value: <0.001, 0.009 and 0.01), respectively. The study was limited by the small sample size. One of the limitation was that some ventilated patients did not have a CBC results and body temperature was not measured which could make a bias in the results, that the incidence of VAP could be more than the calculated one. Also they followed the CDC criteria in diagnosing VAP and CBC tests one of the investigations needed according to CDC.

2.6 Gaps in literature

From this review it can be concluded that some studies talked about knowledge as a major factor in decreasing rate of VAP and increased the emphasis on having educational programs, united guidelines and protocols, monitor performance and adherence. Other studies talked about the role of having surveillance and monitoring. Most of the studies used quantitative design and others mixed. Quasi-experimental design, observational descriptive, prospective designs also were used. In this study the researcher will focus on doing an educational program that will help increasing nursing knowledge and ultimately decreasing VAP rates.

Despite the importance of the effectiveness of education programs about the prevention of VAP using bundle protocol on nurses' knowledge in neonatal setting, no recent studies have addressed this issue in Palestinian hospitals or given the paucity in information about the effectiveness of an education intervention program about the prevention of VAP in Palestine, this study will assess the effectiveness of an education intervention program about the prevention of VAP using bundle protocol on nurse's knowledge in neonatal setting at Southern West Bank Hospitals.

2.7 Summary

This chapter provided to the readers a literature review of the studies that have been done about ventilator associated pneumonia prevention, incidence, nursing adherence to protocols, nursing knowledge about it and how to promote interventions in order to improve nurses' knowledge and aid to the evidence based practices. Also, the studies highlighted the effectiveness of ventilator care bundle protocols in the prevention of ventilator associated pneumonia.

Chapter three

Conceptual framework

3.1 Introduction

This chapter provides the framework of this study to explore the nurses' knowledge about the prevention of VAP using bundle protocol in neonatal intensive care units. The conceptual framework of the study is built based on the results of the literature reviews regarding nurses' knowledge about the prevention of VAP that indicate relationships between the independent variables (Socio demographic data and background data) such as gender, age, previous training on guidelines of prevention of VAP, educational level, years of experience and place of work on nurses' knowledge about VAP and educational program as well as the dependent variables indicating nurses' knowledge of VAP that have an impact on the prevention of VAP.

3.2 Dependent variables

3.2.1 Nurses' knowledge of VAP

Knowledge is the awareness or familiarity gained by experience; a theoretical or practical understanding of a subject (The Concise Oxford Dictionary, 1990). Knowledge remains the first step toward the implementation of evidence- based guidelines for the prevention of VAP (El-khatib et al., 2010). Lack of knowledge was indicated as a barrier for adherence to evidence-based practice (Pravikoff et al., 2005; Labaeu et al., 2007). It is necessary for nurses to be aware about factors that influence the development of VAP in vulnerable populations, such as critically ill neonates (Bockheim, 2011). Prevention of VAP is primarily the responsibility of the bedside nurse whose knowledge and practices influence the health outcome of ICU patients. Nurses must be educated about the effects resulted from VAP and how to implement recommended strategies to prevent VAP (Pravikoff et al., 2005; Labaeu et al., 2007). In order to improve nurse's knowledge about this problem an educational intervention program about the prevention of VAP using bundle protocol to be applied to increase nurses' knowledge in the targeted sessions.

3.3 Study independent variables

This study has displayed the effects of independent variables (Socio demographic data and background data) such as gender, age, previous training on guidelines of prevention of VAP, educational level, years of experience and place of work on nurses' knowledge about VAP. Also educational programs indicate a material used for teaching nurses prevention strategies of ventilator associated pneumonia such as lectures about the prevention of VAP, Pamphlet and Posters.

Regarding the relationship between nurses' characteristics and their level of knowledge according to evidence based guidelines for preventing ventilator associated pneumonia, the results of many studies shows that, there was strong correlation between years of experiences, previous training on guidelines of prevention of VAP and knowledge of nurses on the evidence based guidelines for prevention of VAP (Jansson et al., 2013; Ahmed and Abosamra, 2015), show that the nurses with more experience performed significantly better than less experienced colleagues, while incongruent with a previous study by Said (2012) and Musvosvi (2013), show that the knowledge did not differ among groups depending on ICU experience. Moreover, there is no correlation between age and nurses' level of knowledge regarding evidence based guidelines for preventing ventilator associated pneumonia. This result is congruent with Gomes, (2010) who found that, there is no correlation between age and knowledge of nurses on the evidence based guidelines for prevention of VAP. Also, previous trained nurses were more knowledgeable and skilled in their work to prevent VAP. One of the studies conducted by Ahmed and Abosamra, (2015), found that strong correlation between previous training on guidelines of prevention of VAP and knowledge of nurses on the evidence based guidelines for prevention of VAP. The higher educational level for nurses increase positively the knowledge in giving the accurate care for the patients in trying to limit the risk of infections (Al-Sayaghi, 2014; Yaseen and Salameh, 2015). These studies showed that there is significant relationship between the total knowledge score of VAP and level of education.

3.3.1 Socio demographic data and background data

Gender: This refers to male and female respondents.

Age: This refers to the age of the respondent: It was categorized into five groups: 20 – 24 years old, 25 -29 years old, 30 – 34 years old, 35 – 39 years old & 40 years old and above.

Level of education: This refers to the level of nursing education obtained by respondents. It was categorized into five groups: Diploma, Bachelor Degree, High diploma, MSN & PhD.

Years of experience in NICU: This refers to the years of work spent in the NICU. It was categorized into the following: Less than 1 year, 1-5 years, 6-10 years & more than 10 years.

Previous training: This refers to the training received by the respondents that was relevant to guidelines of prevention of VAP. It was categorized into two groups: The group received training (Yes) & group did not receive training (No).

Place of work: This refers to the employee's place of work in the NICU. It was categorized into four groups: Holy Family Hospital, Caritas Hospital, Hebron Governmental Hospital and Red Crescent Hospital.

3.3.2 The education intervention program

In this study the researcher used education to expand nursing knowledge through the intervention. The educational program aimed at increasing knowledge among nurses and this made a positive effect in improving knowledge level for intervention groups. A structured training program for prevention of ventilator associated pneumonia (VAP) on knowledge of neonatal intensive care would improve the care provided and reduce rate of VAP. Using educational program for nurses about the effective measures for preventing VAP is only as useful as the proper implementation of these measures in the clinical setting (Foglia et al., 2007). Nurses play a vital role in infection control practices especially in the NICU. This role is linked to the amount of time nurses spend at the bedside caring for the critically ill patient as well as the numerous hands on procedures performed for the patients who are so sick that in some cases they can barely breathe on their own. The ventilated patient is at an increased risk for acquiring ventilator-associated pneumonia especially if the bedside nurse lacks the knowledge or neglects infection control practices and established guidelines for preventing VAP (Musvosvi, 2013). According to Tolentino et al. (2007), educational reinforcements can help to ensure improvements in knowledge and nursing practices in a sustained manner. Educational programs indicated to lectures about the prevention of VAP, Pamphlet & Posters.

Lectures about the prevention of VAP: This lectures provided to the nurses by slides via a power point presentation in NICU at Holy Family Hospital & Red Crescent Hospital, which focused the content on topics specific to VAP in the NICU setting. The lectures summarizes general information about VAP, risk factors, epidemiology, causes of VAP, diagnosis and treatment of VAP, and strategies to prevent VAP in neonates.

Pamphlet: It consists of a single sheet of paper that is printed on both sides and contain information about VAP, risk factors, epidemiology, and strategies to prevent VAP in neonates briefly.

Poster: It a way to attract attention and communicate basic information about strategies to prevent VAP in neonates and put posters in front of neonatal setting at Holy Family Hospital & Red Crescent Hospital.

3.4 Operational definition

This section provides the main concepts that were used in the study and their operational definitions.

Neonatal intensive care unit: A special area in a hospital, where critically ill or premature newborn infant, who need close and frequent observation, can be cared for by qualified nurse.

Intensive care nurse: Any nurse working in NICU at South Palestine Hospitals and who is able to work in NICU.

Pneumonia: An acute inflammation of the lung parenchyma that is caused by an infectious agent leading to alveolar consolidation (Urden et al., 2009)**.**

Ventilator-associated pneumonia: A nosocomial pneumonia that develops in a patient on mechanical ventilatory support (either via an endotracheal tube or a tracheostomy) for more than 48 hours or later after intubation (Bonten et al., 2004).

Premature infant: A premature infant is a baby born before 37 weeks gestation.

Intubated patient: Who are unconscious or unable to maintain their airway patent.

Endotracheal tube: A flexible plastic tube is placed into the trachea (windpipe) through the mouth or sometimes the nose to help the patient with breathing.

Knowledge: A theoretical understanding of measures to prevent ventilator associated pneumonia**.**

Nurses' knowledge of VAP: The number of items scored correctly on selected items on the survey questionnaire for this study. It was categorized into five groups: 90% and above is excellent, 80-89% is very good, 70-79% is good, 60-69% is poor & less than 60% is failed.

VAP bundle protocol: A group of interventions related to a disease process that, when executed together, result in better outcomes than when implemented individually (Musvosvi, 2013).

Structured teaching program: Indicate to a material used for teaching nurses on prevention strategies of ventilator associated pneumonia such as lectures about the prevention of VAP, pamphlet & posters, which is prepared by researcher and content validated by experts.

VAP rate: The rate refers to the number of diagnosed cases of VAP per 1,000 ventilator days in the Intensive Care Unit.

3.5 Conceptual definition

Nurses' knowledge of VAP: Information and facts that nurses possess related to VAP.

Knowledge: Awareness or familiarity gained by experience; a theoretical or practical understanding of a subject (The Concise Oxford Dictionary, 1990).

VAP rate: A type of hospital-associated infection characterized as an episode of pneumonia that occurs in a patient who was intubated and ventilated at the time of or within 48 hours before the onset of pneumonia (CDC, 2010).

Pneumonia: An acute inflammation of the lung parenchyma that is caused by an infectious agent leading to alveolar consolidation (Urden et al., 2009)**.**

Endotracheal tube: A flexible plastic tube is placed into the trachea (windpipe) through the mouth or sometimes the nose to help the patient with breathing.

3.6 The conceptual framework of the study is presented in Figure 3.4

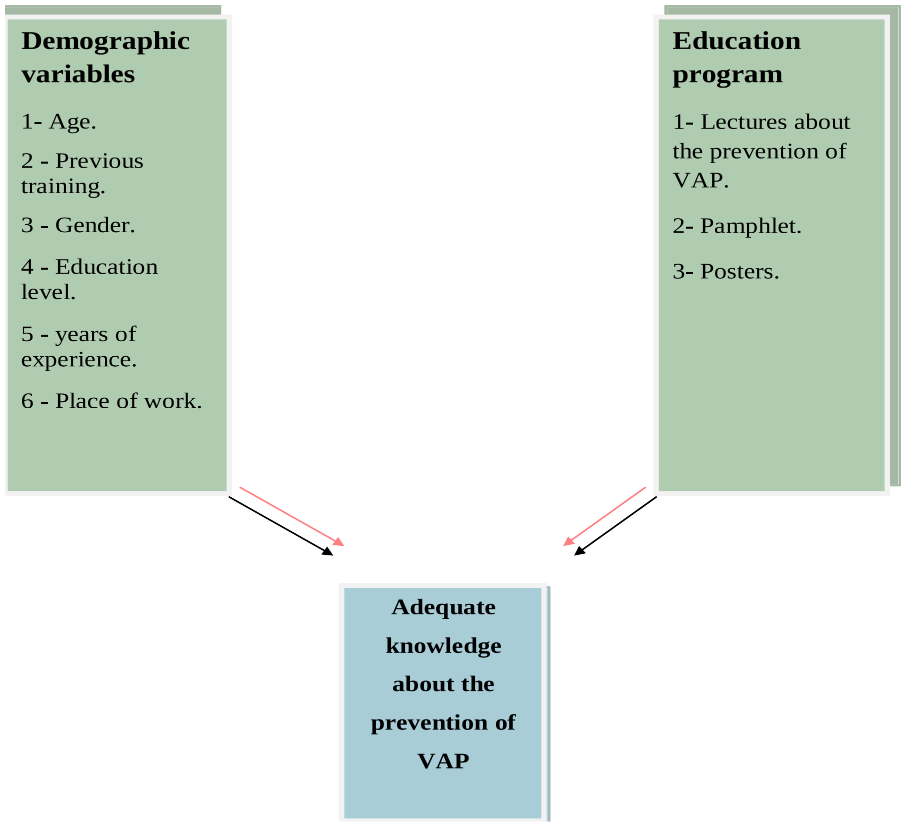

Figure 3.1: Conceptual framework model of the study

Chapter four

Methodology

4.1 Introduction

This chapter describes the research methodology used to assess the effectiveness of an education intervention program about the prevention of VAP using bundle protocol on nurses' knowledge in neonatal intensive care unit. It displays the study design, the study setting, study population, sampling frame, sample criteria, sampling process and data collection procedures as well as the development and validation process of the research instrument used for data collection and ethical considerations are discussed thoroughly.

4.2 Study design

True experimental design was utilized, because the research involves performing and measuring an intervention that demonstrates randomization of nurses to either intervention or control groups. All nurses who meet eligible criteria were involved in the study. At the beginning, four hospitals at two sites (Hebron and Bethlehem) were randomized. Two hospitals at each site were randomized as either experimental hospitals or controls using simple random sampling. The names of the two hospitals in each site were put in two separate bags. The bags were marked group 1 or group 2. Then, two cards, labeled as group 1 and group 2, were put in a third bag. Whichever group number (1 or 2) was picked started the intervention and the other would be the control group. One label was randomly selected and it was group 1. Thus, group 1 was selected as the intervention group and group 2 as the control group. The same thing was applied with the other two hospitals from the second site. "Experimental design is powerful in establishing causal connections between interventions and outcomes" (Polit and Beck, 2011).

4.3 Study setting

The setting for this study was in the neonatal intensive care units (NICU) at four government and private hospitals in two cities of Bethlehem and Hebron in Palestine. These hospitals include: Holy Family Hospital, Caritas Hospital in Bethlehem city, Red Crescent Hospital and Hebron Governmental Hospital in Hebron city. Intervention group from the neonatal intensive care unit of Holy Family Hospital and Red Crescent Hospital, while a control group from the neonatal intensive care unit of Hebron Governmental Hospital and Caritas Hospital.

Table (4.1): Characteristics of the study setting in 2015.

Name of hospital	Number of staff	Number of beds	Annual admission
Holy Family Hospital	3 critical care attending physicians and 4 resident doctors, 27 nurses (12 RN, & 15 LPN) at the NICU.	21-bed unit.	300 baby
Red Crescent Hospital	4 critical care attending physicians and 5 resident doctors, 26 nurses (15 RN, & 11 LPN) at the NICU.	18-bed unit.	350 baby
Caritas Hospital	4 critical care attending physicians and 9 resident doctors, 27 nurses (20 RN, & 7 LPN) at the NICU.	15-bed unit.	400 baby
Hebron Governmental Hospital	3 critical care attending physicians and 4 resident doctors, 20 nurses (10 RN, & 10 LPN) at the NICU.	20 bed unit.	600 baby

4.4 Study population

The population included all nurses (N=53) working in NICU at Holy Family Hospital, and Red Crescent Hospital for the intervention group, whereas the control group from the neonatal intensive care unit of Hebron Governmental Hospital and Caritas Hospital (N=47), which include 100 nurses. Response level was 87% in pre test (the number of nurses whom participated in the research divided by the number of nurses in the sample) and response level was 86% in post test.

Table (4.2): Distribution of the sample

The population of the study	Intervention group	Control group
Nurses	49 nurses	38 nurses

4.5 Sampling frame

Inclusion criteria:

1) The study included, nurses working in the neonatal intensive care units regardless of their educational level and experience. There are a lot of studies who did the intervention period without concern of years of experience, one of them a study conducted by Zaiton and Elhanafy, (2015) about Impact of Implementation Nursing Guidelines on Minimizing Ventilator Associated Pneumonia among Intensive Care Patients.

Exclusion criteria:

1) Nurses who had already attended formal teaching program on VAP.

2) Nurses who refuse or are not willing to participate in the study.

4.6 Sample and Sampling method

The non-probability sample (purposive sample) of all nurses working in neonatal intensive care units in four separate Southern West Bank Hospitals. The nurses participated in the study through completion of a questionnaire. The sample was randomized to either intervention or control group before distributing the questionnaire on pre-test.

4.7 Tools for data collection

Self administered questionnaire sheet developed by the study investigator and based on VAP protocol: it was designed and utilized by the researcher. It included two parts:

Part 1: Socio demographic and background data: it included data related to subjects' characteristics namely; age, gender, previous training, years of experience, place of work and educational level.

Part 2: 30- items knowledge questionnaire related to VAP and prevention strategies are divided to the following areas:

- Area-A: 10 questions ask about infection control measures.
- Area-B: 10 questions ask about oral care in care of ventilated patients.
- Area-C: 10 questions ask about NICU Providers' knowledge of Head of Bed (HOB) and positioning in care of ventilated patients.

The answers of the questionnaire were ranked as; 1 for correct answer and 0 for wrong answer.

4. 8 Validity and Reliability

Reliability

The researcher was checked the reliability through two ways. First: Pilot testing an instrument (questionnaires) of the study was done. The researcher was taken a purposive sample of 20 nurses working in neonatal intensive care unit in Al-ahli Hospital. Results of the analysis were positive because the questions were clear and understandable.

Second: to evaluate the reliability of the knowledge questionnaire, cronbach's alpha coefficient was used. Stability and consistency of the tool: reliability coefficient was calculated for the ICM tool, the Oral Care tool, the HOB tool, and the whole tool, results are shown in Table (4.3).

Table (4.3): Reliability Statistics of the tool

Tool	Cronbach's Alpha	Number of Items
ICM	.775	10
Oral Care	0.692	10
HOB	0.824	10
Total	0.819	30

Cronbach's alpha of the internal consistency for the scale in the whole tool was 0.819 and for the units of the tool were 0.775, 0.692 and 0. 824 respectively, which indicates high reliability and consistency for the tool of the study.

Validity of the study

The researcher was used content validity by giving the pre/post test to four qualified experts in neonatology and in research beside the advisors comments who were asked to advise on the accuracy and comprehensiveness of the knowledge questions, readability of the questions and to see if the questions are related to the purpose of the study.

4.9 Data collection methods and Procedure:

Initially, permissions from selected hospitals administration (directors of nursing) were obtained to introduce their total approval to conduct this study. The researcher distributed the questionnaires by himself. The questionnaire sheet was filled individually and completed by the study participants while they were on duty. The data were collected pre and post intervention of multimodal intervention, starting from February and March 2016 (pre Intervention phase), April, May and June, (Intervention phase), October and November, (post Intervention phase).

The pre-intervention phase consisted of gathering VAP knowledge prior to the implementation of the intervention in order to assess nurses' current knowledge regarding

VAP. A structured questionnaire on knowledge on VAP prevention strategies. Then, a structured teaching program was conducted for three months.

Educational program indicates the material used for teaching nurses on prevention strategies of ventilator associated pneumonia such as lectures about the prevention of VAP, pamphlet & posters. The lectures were implemented three times weekly for a period of twelve consecutive weeks in NICU at Holy Family Hospital and Red Crescent Hospital.

Post test was conducted with same tool for both intervention and control group nurses in order to assess knowledge on VAP prevention. Whereas the post intervention was conducted in October 2016 three months after the structured teaching program ended. Therefore, knowledge questionnaires were circulated to nurses and collected immediately.

4.10 Intervention program

Based on the preceding assessment performed by the researcher, and the results obtained from baseline assessment of nurse's knowledge, a structured teaching program was implemented. This occurred for 12 weeks starting from April, May and June, 2016. Whereas the post intervention assessment was conducted in October 2016 three months after the structured teaching program ended.

The general goal of the educational program was to improve nurse's knowledge about the prevention of VAP using bundle protocol in neonatal intensive care units at Bethlehem and Hebron Hospitals in Palestine.

Educational program indicates the material used for teaching nurses on prevention strategies of ventilator associated pneumonia such as lectures about the prevention of VAP, pamphlet & posters, which is prepared by researcher and content validated by experts. The lectures were developed by the researcher and were reviewed by two qualified personnel who are experts and specialists in neonatology. Finally the program was reviewed by the academic supervisors before being presented to the nurses. These lectures were designed and presented to nurses in their work at hospitals within a period of 60 minutes. The lectures were implemented three times weekly for a period of twelve consecutive weeks in NICU at Holy Family Hospital and Red Crescent Hospital. The intervention consisted of different teaching techniques that were used successfully such as lectures through Power Point presentation to deliver the lessons. In addition, pamphlet was distributed to help increase memory retention. It contained information about VAP, risk factors, epidemiology, and strategies to prevent VAP in neonates briefly. Also, posters were used to draw the attention of nurses. It contained basic information about strategies to prevent VAP in neonates and put posters in front of neonatal setting at Holy Family Hospital & Red Crescent Hospital. Discussions were held at certain key areas throughout the presentations, and at the end of each presentation in order to address any comments or questions.

Educational modules:

Module one

It was designed to increase nurses' knowledge regarding general information about ventilator associated pneumonia. Nurses were given the opportunity to talk briefly about their experience. The nurses were informed about the ventilator associated pneumonia to reinforce general information such as: definition of pneumonia, risk factors for VAP in NICU, causes of VAP, microbiology, diagnosis of VAP and treatment.

Module two

It was designed to increase knowledge concerning ventilator associated pneumonia prevention. Nurses were given the opportunity to talk briefly about their experience to avoid the problem. The discussion and Power Point slides were designed to increase knowledge and skills necessary to prevent the ventilator associated pneumonia in NICU.

Module three

It was designed to increase knowledge concerning mechanical ventilator. The discussion and Power Point slides were designed to increase knowledge regarding neonates on mechanical ventilator and how to deal with it.

Module four

It was designed to increase knowledge concerning hand washing to prevent the ventilator associated pneumonia in NICU. Nurses were given the opportunity to talk briefly about their experience to avoid the problem. Power Point slides were designed to increase knowledge and skills necessary to prevent the ventilator associated pneumonia. The nurses were informed about the definition of hand washing, improving of hand washing, hand washing techniques and preparation of the hands prior to decontamination. The researcher put posters about hand washing techniques beside every sink, and beside the doors of the neonatal wards at Holy Family Hospital & Red Crescent Hospital.

Module five

It was designed to increase knowledge regarding positioning and head of bed. Power Point slides were designed to increase knowledge to prevent the ventilator associated pneumonia in ventilated neonates is the head of the bed kept up (semi recumbent positioning) or a horizontal left or right lateral position. The final activity in this module was designed to reinforce information about positioning and head of bed.

Module six

It was designed to increase knowledge regarding oral care. Power Point slides were designed to increase knowledge to prevent the ventilator associated pneumonia in ventilated neonates. The nurses were informed about the ventilator associated pneumonia to reinforce information about oral care, oral colostrums care and endotracheal tube suction guidelines.

Module seven

It was designed to increase knowledge concerning equipment care to prevent the ventilator associated pneumonia in NICU. The nurses were informed about the equipment care to reinforce information about ventilator circuit, endotracheal tube care, ambubag, laryngoscope, suctioning machine and blades.

4. 11 Data analysis

Data analyses were performed by using version 22 of the Statistical Package for Social Sciences (SPSS). The purpose of this analysis was to answer the research questions. Descriptive statistics were computed to answer the first question, "what are the levels of the mean scores knowledge on prevention of VAP among nurses in both the intervention and control groups at pre-intervention in south West Bank Hospitals?" Percentages of correct and incorrect answers were computed to determine participants' level of knowledge regarding VAP prevention. Mean and standard deviation (SD) scores of NICU knowledge as related to their gender, place of work, and years of experience were calculated. Multifactorial ANOVA was utilized to answer the second question, "Are there any significant interactions present in knowledge on prevention of VAP among the study groups based on demographic variables at pre-intervention in south West Bank Hospitals? Post-intervention analysis was done by utilizing the Repeated Measures ANOVA to answer the third and fourth research questions.

4.12 Ethical considerations

Ethical considerations of the study have been addressed by implementing the following measures:

1. Ethical approval was obtained from ethical committee in Al-Quds University.
2. Ethical approval was obtained from hospitals administration to do this study.
3. Ethical approval was obtained from the Ethics & Research Committee at the CBH to check the questionnaires and to do this study.
4. Informed consent of participants have been obtained before involving them in the study, Informed consent is intended to protect the participants' autonomy, integrity, and prevent any harm.
5. Each participant was informed about the purpose, and the nature of the study.
6. The participants' were informed that their participation is totally voluntarily and they can withdraw from the study at anytime, and confidentiality and anonymity of the subjects was assured.
7. Texts belonging to other authors that have been used in any part of this study have been fully referenced with Harvard Referencing System.

4.13 Summary

This chapter provides an overview of the methodology which was used in this assessment, describing study design, population and sampling method, the instrument that used and the validity and reliability to it, data collection, and ethical consideration.

Chapter five

Results

5.1 Introduction

This chapter presents the analyses of the data collected in this study. This study involved determining the effectiveness of the educational modules about VAP prevention by focusing on nurses' retention of knowledge in the experimental group. It looks at the change of nurse's knowledge 3 months after they finished the VAP prevention course from their knowledge at baseline.

This chapter begins with a description of the sample, including number of participants, age, gender, education level, previous training, place of work and years of experience in NICU. Following are the findings related to the research questions, and change of knowledge over time.

5.2 Descriptive statistic of the demographic variables in the study sample (at baseline).

Table 1 presents the descriptive statistics for the characteristics of nurses participants after they were assigned to either intervention or control groups.

The Results showed that the sample consisted of 87 registered nurses working in the intensive care units of four separate hospitals from two sites (Hebron and Bethlehem, including 38 (43.7%) of the sample were in the control group of which 10.5% were males and 89.5% were females, and 49 (56.3%) of the sample were in intervention group of which 22 (44.9%) were males and 27 (55.1%) were females. More than the half of the nurses 30 (61.2%) in the intervention group was between the ages of 25 – 34 years old, whereas, in control group their age were evenly distributed between the age-groups. For the previous training variable, the majority of nurses in both groups didn't expose to previous training about the prevention of VAP with a percent of 69.4% and 68.4%, respectively. A total percent of 71.4%(35 nurse) in intervention group had less than 5 years of experience in the neonatal intensive care units; whereas the percentages of nurses in the control group whose experience was 5 years and more was 57.9% . More than the half of the nurses with a percent of (55.1%) had bachelor degree in nursing in the intervention group, for the control group their level of education were divided on all categories.

Table1: Socio-demographic characteristics of the respondents (n = 87)

Characteristics	**Intervention group (n=49)**		**Control group (n = 38)**	
	No. of nurses (n)	**(%)**	**No. of nurses (n)**	**(%)**
Age-group (years)				
20-24	13	26.5	5	13.2
25-29	20	40.8	8	21.1
30-34	10	20.4	9	23.7
35-39	1	2	6	15.8
40 years and more	5	10.2	10	26.3
Gender				
Male	22	44.9	4	10.5
Female	27	55.1	34	89.5
Previous Training				
Yes	15	30.6	12	31.6
No	34	69.4	36	68.4
Level of education				
Diploma	10	20.4	15	39.5
BSN	27	55.1	13	34.2
High Diploma	11	22.4	10	26.3
MSN	1	2	0	0.00
Years of experience in NICU				
Less than 1 year	11	22.4	6	15.8
1-5 years	24	49.0	10	26.3
6-10 years	10	20.4	7	18.4
More than 10 years	4	8.2	15	39.5

5.2.1 Baseline knowledge comparison between groups

Table 2 illustrates the levels of general and specific knowledge regarding VAP among the intervention and control groups at south West Bank hospitals at baseline, correct and incorrect answers for each of the 3 areas were computed to determine nurses' levels of general and specific knowledge regarding VAP. The researcher consulted a panel of experts to determine the categories of knowledge levels (i.e., excellent, very good, good and poor). The results indicated that the percentages of correct answers in all areas for both groups were quite homogeneous, and almost the same for each specific area for both groups. The lowest percentage of correct answers for all nurses in the intervention group was 59.2% for HOB and the highest percentages was 69.6% for oral care. The level of nurses' general knowledge regarding VAP in the intervention group was 65.7%, as well as their knowledge on each VAP area were weak. For the control group, the highest percentages of correct answers for all nurses were 71.9% for ICM and the lowest was 62.9% for HOB. The level of nurses' general knowledge regarding VAP in the control group was 68.7%, as well as their knowledge on each VAP area were also poor.

Table 2: Percentage of correct answers of the general and 3 specific knowledge areas about VAP prevention among the intervention and control groups at baseline (n = 87)

Health areas	**Intervention group (n = 49)**	**Control group (n = 38)**
	Correct answers (%)	**Correct answers (%)**
ICM (10)	68.0	71.9
Oral care (10)	69.6	71.6
HOB (10)	59.2	62.9
General knowledge regarding VAP (30)	65.7	68.7

Comparison of mean knowledge scores between the intervention and control groups at baseline.

Table 3 showed that, the general mean knowledge scores regarding VAP for nurses in the intervention group was lower than mean knowledge score of the control group. The mean scores of nurses' general knowledge regarding VAP in the control group (68.7) was 3 points higher than the nurses' general knowledge regarding VAP in the intervention group (65.7), the difference was not up to significant level. Moreover, although the mean score of the intervention group were lower than the mean scores of the control group in all three specific areas; the results indicated that there were no significant differences in all 3 areas between groups. Intervention group's mean scores in ICM; oral care; and HOB slightly lower than mean scores for control group, were (6.80, 7.19), (6.96, 7.16) and (5.92, 6.29) respectively.

To conclude, the results indicated that there are no significant differences in general mean knowledge scores regarding VAP between the intervention and control groups at baseline (p=0.343).

Table 3 Comparison of mean knowledge scores between the intervention and control groups at baseline.

Health area	**Mean knowledge (SD)**		**t statistic (df)**	**Mean difference**	***P* value**
	Intervention (n=49)	**Control (n=38)**			
ICM	6.80 (1.88)	7.18 (1.69)	-1.00 (85)	-0.39	0.321
Oral Care	6.96 (2.09)	7.16(1.50)	-0.50 (85)	-0.20	0.622
HOB	5.92 (2.35)	6.29 (1.81)	-0.80 (85)	-0.37	0.424
General Knowledge regarding VAP	19.77 (5.41)	20.63 (3.41)	-0.95 (85)	-0.96	0.343

Independent samples t-test.
SD = standard deviation
df = degree of freedom
Note: The maximum score for specific health knowledge area is 10

5.3.2 Baseline Knowledge comparison within groups

5.3.2.1 Comparison Based on Gender

Table 4 indicated that the mean scores of the females in the intervention group were higher in all 3 specific areas than the mean scores of males, and higher than general knowledge means scores of males. Although the mean scores of females' general knowledge regarding VAP (20.70) was 2.29 points higher than the males' mean score (18.41); there was no significant difference. Despite that the mean score of the females in all 3 areas of VAP prevention were higher than the mean scores of males; there were no significant differences between male and female nurses in the 3 areas.

To conclude, there are no significant differences in the mean knowledge scores among the intervention group according to gender at baseline. (p=0.142).

Table 4: Mean knowledge scores of the intervention group according to gender at baseline (n =49).

Health area	**Mean knowledge (SD)**		**t statistic (df)**	**Mean difference**	***P* value**
	Male (n=22)	**Female (n=27)**			
ICM	6.50 (2.06)	7.04 (1.72)	-0.99 (47)	-0.54	0.326
Oral Care	6.50 (2.50)	7.33 (1.64)	-1.40 (47)	-0.83	0.168
HOB	5.41 (2.54)	6.33 (1.15)	- 1.38 (47)	-0.92	0.174
General Knowledge regarding VAP	18.41 (6.28)	20.70 (4.45)	-1.50 (47)	-2.29	0.142

Independent samples t-test.
SD = standard deviation
df = degree of freedom
Note: The maximum score for specific health knowledge area is 10

Table 5 showed that female nurses in the control group possessed higher mean knowledge scores compared to male nurses. The female general mean knowledge scores (20.70) was 2.29 points higher than male general mean knowledge scores (18.41). The mean score of the females in all 3 specific areas of VAP prevention were higher than males. Males' mean knowledge scores in ICM, oral care, and HOB were lower than mean score females, were (6.50, 7.04), (6.50, 7.33), (5.41, 6.33), respectively.

To conclude, significant differences in mean knowledge scores between male and female nurses were detected in two specific areas. These areas were ICM (p = 0.033) and HOB (p = 0.035). But there was no significant differences between male and female nurses in the third specific (oral care, p = 0.411), as well as, there was no significant differences in the general mean knowledge scores (p=0.074) between male and female nurses (Table 5).

Table 5: Mean knowledge scores of the control group according to gender at baseline (n = 38).

Health area	Mean knowledge (SD)		*t* statistic (df)	Mean difference	*P* value
	Male (n=4)	Female (n=34)			
ICM	5.50 (1.73)	7.38 (1.60)	-2.22 (36)	-1.88	0.033
Oral Care	7.75 (2.63)	7.09 (1.36)	0.83 (36)	0.66	0.411
HOB	4.50 (1.73)	6.50 (1.73)	-2.19 (36)	-2.00	0.035
General Knowledge regarding VAP	17.75 (5.56)	20.97 (3.02)	-1.84 (36)	-3.22	0.074

Independent samples t-test.
SD = standard deviation
df = degree of freedom
Note: The maximum score for specific health knowledge area is 10

5.3.2.2 Comparison Based on Previous Training

For intervention group

Independent samples t-test was employed to test the mean knowledge scores of the intervention group according to previous training at baseline. The range of mean scores of trained and not trained nurses in the intervention group was from 5.31 for HOB to 7.92 for ICM, and from 6.00 for HOB to 7.17 for ICM, respectively (Table 6). Although the results indicated that, trained nurses' general mean knowledge scores (20.46), was (0.29) points higher than the non-trained mean score (20.17), but was not significant. Furthermore, there was no significant difference between trained and non-trained nurses in all 3 specific areas. Results showed that trained nurses possessed higher knowledge than non-trained in two areas including ICM and oral care, but not in HOB (5.31, 6.00).

To conclude, no significant differences were detected in mean knowledge scores in general and in 3 specific areas between nurses based on their previous training.

Table 6: Mean knowledge scores of the intervention group according to previous training at baseline (n = 49).

Health area	Mean knowledge (SD)		t statistic (df)	Mean difference	*P* value
	Yes (n=15)	No (n=34)			
ICM	7.92 (1.50)	7.00 (1.56)	1.74 (35)	0.92	0.090
Oral Care	7.23 (1.24)	7.17 (1.52)	0.13 (35)	0.06	0.897
HOB	5.31 (1.97)	6.00 (1.69)	-1.12 (35)	-0.69	0.270
General knowledge regarding VAP	20.46 (4.01)	20.17 (4.51)	0.23 (35)	0.29	0.818

Independent samples t-test.
SD = standard deviation
df = degree of freedom
Note: The maximum score for specific health knowledge area is 10

For control group

Independent samples *t* test was used to compare the mean knowledge scores between nurses in the control group based on their previous training at baseline (Table 7). Although the results revealed that nurses with no previous training had higher mean knowledge scores in the general and in the all 3 specific areas than trained nurses, these differences were not up to significant levels, (20.40, 18.93), (6.77, 6.53), (7.14, 6.47), (6.49, 5.93), respectively. Accordingly, no significant differences were detected.

Table 7: Mean knowledge scores of the control group according to previous training at baseline (n = 38).

Health area	Mean knowledge (SD)		t statistic (df)	Mean difference	*P* value
	Yes (n=12)	No (n=26)			
ICM	6.53 (1.30)	6.77 (2.14)	-0.40 (48)	-0.24	0.692
Oral Care	6.47 (1.96)	7.14 (2.18)	-1.03 (48)	-0.68	0.307
HOB	5.93 (2.52)	6.49 (2.27)	-0.76 (48)	-0.55	0.449
General Knowledge regarding VAP	18.93 (4.64)	20.40 (5.57)	-0.89 (48)	-1.47	0.376

Independent samples t-test.
SD = standard deviation
df = degree of freedom
Note: The maximum score for specific health knowledge area is 10

5.3.2.3 Comparison Based on Years of Experience

For Intervention Group

One-way ANOVA was employed to test the mean knowledge scores regarding VAP prevention among nurses in the intervention group according to their years of experience at baseline (Table 8). The results showed that there were no significant differences in the mean knowledge scores between nurses in the intervention group according to their years of experience at baseline.

Table 8: Mean knowledge scores of the intervention group according to years of experience at baseline (n = 49).

Health area	Years of experience	Mean (SD)	F statistics (df)	P value
ICM	Less than 1 year	6.91(1.4)	1.083	0.366
	1-5 years	6.46 (2.0)		
	6-10 years	6.90 (2.2)		
	More than 10 years	8.25 (1.0)		
Oral care	Less than 1 year	7.27 (1.3)	0.376	0.771
	1-5 years	6.71 (2.3)		
	6-10 years	6.90 (2.60)		
	More than 10 years	7.75 (.50)		
HOB	Less than 1 year	5.36 (2.0)	1.148	0.340
	1-5 years	6.33 (2.5)		
	6-10 years	5.10 (2.6)		
	More than 10 years	7.00 (1.6)		
General knowledge regarding VAP	Less than 1 year	19.55 (4.2)	0.566	0.640
	1-5 years	19.50 (5.9)		
	6-10 years	18.90 (6.5)		
	More than 10 years	23.00 (1.4)		

For Control Group

By using one-way ANOVA to test the mean knowledge scores of the control group according to years of experience at baseline, as can be seen from table 9, that there are no significant differences in the mean knowledge scores of VAP prevention among nurses in the control group according to their years of experience at baseline (Table 9).

Table 9: Mean knowledge scores of the control group according to years of experience at baseline (n = 38).

Health area	Years of experience	Mean (SD)	F statistics (df)	P value
ICM	**Less than 1 year**	6.33 (2.0)	1.981	0.135
	1-5 years	7.00 (1.7)		
	6-10 years	6.57 (1.8)		
	More than 10 years	7.93 (1.3)		
Oral care	**Less than 1 year**	7.50 (1.9)	0.699	0.559
	1-5 years	7.10 (1.8)		
	6-10 years	7.71 (0.5)		
	More than 10 years	6.80 (1.5)		
HOB	**Less than 1 year**	5.50 (1.2)	1.824	0.161
	1-5 years	6.80 (1.9)		
	6-10 years	7.29 (1.5)		
	More than 10 years	5.80 (1.9)		
General knowledge regarding VAP	**Less than 1 year**	19.33 (2.9)	0.470	0.705
	1-5 years	20.90 (3.8)		
	6-10 years	21.57 (2.2)		
	More than 10 years	20.53 (3.9)		

5.3.2.4 Comparison Based on Level of Education

For Intervention Group

Table 10 presents the results of using one-way ANOVA to test the mean knowledge scores of VAP prevention among nurses in the intervention group according to level of education at baseline. The results revealed that there are no significant differences in the mean knowledge scores among nurses in the intervention group according to level of education at baseline.

Table 10: Mean knowledge scores of the intervention group according to level of education at baseline (n = 49)

Health area	level of education	Mean (SD)	F statistics (df)	P value
ICM	Diploma	6.00 (2.2)	1.197	0.322
	BSN	6.77 (1.9)		
	High diploma	7.54 (1.2)		
	MSN	7.00		
Oral care	Diploma	6.50 (1.7)	0.656	0.583
	BSN	6.81 (2.4)		
	High diploma	7.63 (1.5)		
	MSN	8.00		
HOB	Diploma	5.40 (2.8)	0.954	0.423
	BSN	5.77 (2.0)		
	High diploma	6.45 (2.5)		
	MSN	9.00		
General knowledge regarding VAP	Diploma	17.90 (5.5)	1.087	0.364
	BSN	19.37 (5.6)		
	High diploma	21.63 (4.3)		
	MSN	24.00		

For Control Group

By using one-way ANOVA to test the mean knowledge scores of the control group according to level of education at baseline, as can be seen from table 11, that there are no significant differences in the mean knowledge scores of VAP prevention among nurses working in NICU in the control group according to level of education at baseline.

Table 11: Mean knowledge scores of the control group according to level of education at baseline (n = 38)

Health area	level of education	Mean (SD)	F statistics (df)	P value
ICM	Diploma	7.33 (1.7)	0.387	0.682
	BSN	6.84 (1.5)		
	High diploma	7.40 (1.8)		
	MSN			
Oral care	Diploma	7.20 (1.2)	0.426	0.656
	BSN	7.38 (1.9)		
	High diploma	6.80 (1.2)		
	MSN			
HOB	Diploma	6.13 (1.5)	0.182	0.835
	BSN	6.53 (2.1)		
	High diploma	6.20 (1.8)		
	MSN			
General knowledge regarding VAP	Diploma	20.66 (2.4)	0.033	0.968
	BSN	20.76 (4.0)		
	High diploma	20.40 (4.1)		
	MSN			

5.3.2.5 Comparison Based on Place of Work

For Intervention Group

Table 12 addresses the mean scores of nurses as related to their place of work in the intervention group at baseline. The results indicated that, nurses working in Holy family Hospital have higher mean knowledge scores in the general and in the 3 specific areas than their colleagues in the control group. Accordingly, significant differences were detected between nurses by place of work in all areas including: general knowledge (p=0.004), ICM (p=0.018), oral care (p=0.026), and HOB (p=0.006).

Table 12: Mean knowledge scores of the intervention group according to place of work at baseline (n = 49).

Health area	Place of work	Mean (SD)	F statistics (df)	P value
ICM	Holy family Hospital	7.38 (1.1)	5.985	0.018
	Red Crescent Hospital	6.13 (2.3)		
Oral care	Holy family Hospital	7.57 (1.3)	5.262	0.026
	Red Crescent Hospital	6.26 (2.5)		
HOB	Holy family Hospital	6.76 (2.1)	8.356	0.006
	Red Crescent Hospital	4.95 (2.2)		
General Knowledge regarding VAP	Holy family Hospital	21.73 (3.2)	9.399	0.004
	Red Crescent Hospital	17.34 (6.4)		

For Control Group

By using one-way ANOVA to test the mean knowledge scores of the control group according to place of work at baseline (Table 13). Although there are differences in mean knowledge scores between nurses based on their place of work in the control group at baseline, significant differences were detected in one area solely. This area was HOB (p=0.006).

Table 13: Mean knowledge scores of the control group according to place of work at baseline (n = 38).

Health area	Place of work	Mean (SD)	F statistics (df)	P value
ICM	Hebron Government Hospital	6.83 (1.6)	1.493	0.230
	Caritas Hospital	7.50 (1.7)		
Oral care	Hebron Government Hospital	7.27 (1.2)	0.214	0.646
	Caritas Hospital	7.05 (1.7)		
HOB	Hebron Government Hospital	7.11 (1.7)	8.419	0.006
	Caritas Hospital	5.55 (1.5)		
General Knowledge regarding VAP	Hebron Government Hospital	21.22 (3.1)	1.025	0.318
	Caritas Hospital	20.10 (3.6)		

5.4 Inferential statistics of demographic variables in the study sample (at post test)

5.4.1: Within group factor analyses (Time effect)

One-way repeated measures ANOVA test was used to compare changes in general mean knowledge scores within the intervention group and control group from pre-test to post test. The results showed that, there was a significant difference of general mean knowledge score within intervention group based on time ($F = 59.32$, $p<0.001$) (Table. 14). Multiple paired t test were performed with adjusted α based on Bonferroni correction (Table. 14). Paired t- tests showed that there were significant differences between the pre-intervention and post-intervention mean difference (95% CI) = -6.35 (-8.00, -4.69) for the intervention group. In addition, the results showed that, there was a significant difference of specific mean knowledge score of all the 3 subscales areas within intervention group based on time ($p<0.001$). This result rejected the null hypothesis of the study which states: “After the completion of the twelve-weeks education intervention (at post-test), there will be no significant differences on the general knowledge scores regarding VAP and specific knowledge of the 3 subscale areas scores for intervention and control groups in NICU.

Table 14: Pre and post intervention VAP knowledge scores for the intervention group (n =49)

Health area	Measurement level	Pre-test Score (%)	Post-test Score (%)	MD (95% C.I.)	P value
ICM (10)	Pre-Post	68.0	88.8	-2.08 (-2.72, -1.45	<0.001
Oral care (10)		69.6	91.0	-2.14 (-2.77, -1.56)	<0.001
HOB (10)		59.2	80.4	-2.12 (-2.97, -1.27)	<0.001
General Knowledge (30)		65.7	86.7	-6.35 (-8.00, -4.69)	<0.001

For the control group, paired t- tests showed that there was no significant difference of general mean knowledge score regarding VAP within control group based on time between the pre-intervention and post-intervention mean difference (95% CI) = -0.27 (-2.04, 1.50, p = 0.758) (Table. 15). These results failed to reject the null hypothesis of the study which states: "After the completion of the twelve-weeks health education intervention (at post-test), there will be no significant difference in overall knowledge from pre-test to post-test for the intervention and control groups." As the conclusion, for general knowledge regarding VAP, there was a significant difference of mean knowledge score within intervention group, while for control group was not.

Table 15: Pre and post intervention VAP knowledge scores for the control group (n = 37)

Health area	Measurement level	Pre-test Score (%)	Post-test Score (%)	MD (95% C.I.)	P value
ICM (10)	Pre-Post	71.6	72.7	-0.11 (-0.88, 0.67)	0.778
Oral care (10)		71.4	71.6	-0.03 (-0.76, 0.70)	0.941
HOB (10)		63.0	64.3	-0.14 (-1.14, 1.14)	0.787
General Knowledge regarding VAP (30)		68.7	69.6	-0.27(-2.04, 1.50)	0.758

One-way Repeated Measures ANOVA within group analysis was applied followed by Pairwise Comparison with confidence interval adjustment.
MD = Mean difference
C.I. = Confidence interval.
Pairwise comparison with Bonferroni correction (to correct the level of correction)
Pre = baseline measurement of mean variable
Post = after three months measurement of mean variable

5.4.2: Between group factor analyses (Group effect regardless of time)

The significance in the mean knowledge score improvement between the intervention and control groups at post-test was tested using one-way repeated measures ANOVA and the results are presented in (Table. 16). The mean (95% CI) overall knowledge scores were higher in the intervention group (22.85, 95% CI: 22.00, 23.69) compared to the control group (20.73, 95% CI: 19.76, 21.70) in (Table. 16). The other 3 specific health mean knowledge scores were also significantly higher in the intervention compared to the control groups. Interestingly for the post test, both groups had the same lowest mean scores of specific health knowledge that is HOB (6.98 for the intervention group versus 6.37 for the control group).

Table 16: Comparison of overall mean knowledge scores regarding VAP between intervention and control groups using one-way repeated measures ANOVA (Group effect regardless of time).

Health area	Intervention group (n = 49)	Control group (n = 37)	F -statistic (df)	P value
	Mean (95% CI)	Mean (95% CI)		
ICM (10)	7.84 (7.48, 8.20)	7.22 (3.11, 3.60)	7.09 (1)	0.027
Oral care (10)	8.03 (7.70, 8.36)	7.15 (6.77, 7.53)	12.12 (1)	0.001
HOB (10)	6.98 (6.59, 7.37)	6.37 (5.92, 6.81)	4.27 (1)	0.042
General knowledge regarding VAP (30)	22.85 (22.00, 23.69)	20.73 (19.76, 21.70)	10.64 (1)	0.002

One-way repeated measures ANOVA between the groups analyses were applied.
Level of significance was set as 0.05 (two-tailed)

5.4.3: Within-between factor analyses (Time X group interaction/Group effect with regard of time)

There was significant difference of general mean knowledge score between the intervention and control groups based on time ($F = 25.05$, $p<0.001$). There was difference in mean knowledge score between the intervention and the control groups in post-intervention, but no difference during pre-intervention.

At pre-test, when multiple comparisons of mean specific knowledge of the 3 areas and confidence interval between the groups at each time point were conducted to check the time-group interaction analyses, the result indicated overlapping of mean with the corresponding confidence interval for another group in all 3 areas. Thus, there were no significant differences in specific mean knowledge score between the intervention and the control group in all specific areas in pre-test.

At post-test, when multiple comparisons of mean specific knowledge of the 3 areas and confidence interval between the groups at each time point were conducted to check the time-group interaction analyses, the result indicated no overlapping of mean with the corresponding confidence interval for another group. Therefore, there were significant differences in mean knowledge score between the intervention and the control group for the all 3 specific health areas on post-intervention (Table.17).

Table 17: General and specific knowledge scores regarding VAP of the intervention and control groups pre and post intervention program using one-way RM ANOVA (Time X group interaction)

Health area	Time	Intervention group (n=49)	Control group (n=37)	F statistics (df)	P value
		Mean (95% CI)	Mean (95% CI)		
ICM (10)	pre	6.80 (6.28, 7.31)	7.16 (6.57, 7.75)	16.14 (1)	<0.001
	post	8.88 (8.43, 9.32)	7.27 (6.76, 7.78)		
Oral care (10)	pre	6.96 (6.43, 7.49)	7.14 (6.53, 7.75)	19.77 (1)	<0.001
	post	9.10 (8.74, 9.46)	7.16 (6.75, 7.58)		
HOB (10)	pre	5.92 (5.31, 6.53)	6.30 (5.56, 7.00)	9.33 (1)	0.003
	post	8.04 (7.50, 8.58)	6.43 (5.81, 7.05)		
General knowledge regarding VAP (30)	pre	19.67 (18.35, 21.00)	20.60 (19.07, 22.12)	25.05 (1)	<0.001
	post	26.02 (25.06, 26.98)	20.87 (19.76, 21.97)		

5.4.4: Within group factor analyses (Time effect) by using two-way repeated measures ANOVA

Two-way repeated measures ANOVA test was used to compare general knowledge and specific knowledge of the 3 subscale areas of VAP prevention between pre and post-test (gender-previous training interaction) in the intervention group. The results showed that, there was a significant difference of mean knowledge score within gender-previous training of education in the intervention group based on time ($F = 46.75$, $p<0.001$). Multiple paired t-tests were performed with adjusted α based on Bonferroni correction (Table. 18). Paired t tests showed that there were significant differences in pre-intervention – post intervention; mean difference = -6.30 (-8.15, -4.44) for the intervention group. For specific health knowledge of the 3 subscale areas, paired t tests showed that there was also a significant difference in pre-intervention-post-intervention within the all 3 areas in the intervention group at post-intervention. The oral care area was the highest increase in mean knowledge scores; mean difference = -2.18, $p<0.001$. Whereas, HOB area was the lowest gain in mean knowledge scores; mean difference = -2.04, <0.001.

This result rejected the null hypothesis of the study which states: “After the completion of the twelve-weeks health education intervention (at post-test), there will be no significant differences on the general knowledge scores and specific knowledge regarding VAP of the 3 subscale areas scores for intervention and control groups at southern hospitals in West Bank.

For the control group, paired t tests showed that there was no significant difference in pre-intervention – post-intervention; mean difference = -1.46 (-3.64, 0.73) for the control group. The results indicated no significant difference in general mean knowledge score within gender-previous training in the within gender-previous training in the control group based on time ($F = 2.14$, $p=0.153$). For the specific knowledge of the 3 subscale areas, paired t tests showed that, there was also no significant difference in pre-intervention-post-intervention within the all 3 areas in the control group at post-test (Table. 18).

These results failed to reject the fourth null hypothesis of the study which states: “After the completion of the twelve-week education intervention (at post-test), there will be no significant difference in overall knowledge from pre-test to post-test for the intervention and control groups.” As the conclusion, for general knowledge and specific knowledge regarding VAP of the 3 subscale areas, there was a significant difference of mean knowledge score within intervention group, while for control group was not.

Table 18: Comparison of general and specific knowledge scores regarding VAP within each group based on time using Two-way RM- ANOVA (Time effect)

Health area	Measurement level	Intervention group (n = 49)			Control group (n = 37)		
		MD (95% CI)	F statistic	p-value	MD (95% CI)	F statistic	p-value
ICM (10)[1]	**Pre– post**	-2.09 (-2.81, -1.37)	34.06	<0.001	-0.50 (-1.45, 0.45)	1.14	0.293
Oral care (10)[1]		-2.18 (-2.89, -1.45)	38.17	<0.001	0.25 (-0.68, 1.18)	0.50	0.483
HOB (10)[1]		-2.04 (-2.96, -1.11)	19.52	<0.001	-1.21 (-2.36, -0.05)	2.73	0.101
General Knowledge regarding VAP (30)[1]		-6.30 (-8.15, -4.44)	46.75	<0.001	-1.46 (-3.64, 0.73)	2.14	0.153

Tow-way Repeated Measure ANOVA Between groups' analysis were applied.
MD = Mean Differences
CI = Confidence interval
Level of significance was set as 0.05 (two-tailed).
Pre = baseline measurement of mean variable (overall knowledge and specific knowledge regarding VAP of the 3 areas).
Post = after three months measurement of mean variable (overall knowledge and specific knowledge regarding VAP of the 3 areas).
1 = significant health area for the intervention group.

5.4.5: Between group factor analysis based on Gender (Gender effect)

For intervention group, two-way repeated measures ANOVA indicated that, there was no significant difference of the general mean knowledge scores between males and females in the intervention group based on gender ($F = 1.51$, $p=0.226$). Multiple paired t tests were performed with adjusted α based on Bonferroni correction (Table. 19). Paired t test showed that the mean knowledge scores for males was 21.89, 95% CI: 20.36, 23.41 and females was 23.29, 95% CI: 21.99, 24.59 in the intervention group (Table. 19). For the specific knowledge scores regarding VAP of the 3 subscale areas, there was significant difference of mean knowledge score between males and females in 1 of the 3 specific health areas in the intervention group at post-test based on gender. This area were, ($p=0.226$) for ICM, ($p=0.049$) for oral care and ($p=0.645$) for HOB (Table. 19).

This finding failed to reject the null hypothesis of the study in the areas of general health knowledge and the in the four significant specific areas which states: "After the completion of the twelve-weeks health education intervention (at post-test), there will be no significant differences on the overall health knowledge scores and specific knowledge scores of the 3 subscale areas between intervention and control groups as related to their gender, and previous training on post-test."

As the conclusion, for general knowledge regarding VAP, there was no significant difference of mean general knowledge score and there was significant difference of mean knowledge score between males and females in 1 of the 3 specific health areas in the intervention group based on gender.

For control group, two-way repeated measures ANOVA indicated that, there was no significant difference of the overall health mean knowledge scores between males and females in the control group based on gender ($F = 0.83$, $p=0.369$). Multiple paired t tests were performed with adjusted α based on Bonferroni correction (Table. 19). Paired t test showed that the mean knowledge scores for males was 20.25, 95% CI: 17.55, 22.95 and females was 20.45, 95% CI: 19.55, 21.54 in the control group (Table. 19). For the specific knowledge scores of the 3 subscale areas of VAP prevention, there was no significant difference in pre-intervention-post-intervention in the 3 areas in the control group at post-test (Table 19).

This finding failed to reject the fourth null hypothesis of the study in the areas of general knowledge and in the 3 specific health areas "After the completion of the twelve-weeks health education intervention (at post-test), there will be no significant differences on the overall health knowledge scores and specific health knowledge scores of the 3 subscale areas between the intervention and the control groups as related to their gender, and previous training at post-test."

As the conclusion, for overall knowledge regarding VAP, there was significant difference of mean knowledge score between males and females in 1 of the 3 specific health areas in the intervention group based on gender. In contrast, there was no significant difference of mean knowledge score in the 3 specific heath areas between males and females in the control group.

Table 19: Comparison of overall and specific mean knowledge score of the 3 areas between groups using Two-way RM ANOVA based on gender (Gender effect)

Health area	group	Intervention group (n=49, male 22 & female 27)			control group (n=37, male 4& female33)		
		Mean (95%CI)	F statistic	P value	Mean (95%CI)	F statistic	P value
ICM (10)[1]	Male	7.60 (7.05, 8.15)	0.001	0.226	6.50 (5.05, 7.95)	2.31	0.269
	Female	8.04 (7.57, 8.51)			7.35 (6.82, 7.89)		
Oral care (10)	Male	7.55 (6.97, 8.12)	0.43	0.049	7.38 (6.33, 8.42)	0.83	0.448
	Female	8.31 (7.82, 8.00)			6.96 (6.57, 7.34)		
HOB (10)	Male	6.74 (6.06, 7.42)	0.31	0.645	6.38 (5.10, 7.65)	9.23	0.839
	Female	6.94 (6.37, 7.52)			6.24 (5.77, 6.71)		
General Knowledge regarding VAP (30)	Male	21.89 (20.36, 23.41)	0.29	0.164	20.25 (17.55, 22.95)	3.51	0.836
	Female	23.29 (21.99, 24.59)			20.45 (19.55, 21.54)		

RM = Repeated Measures
CI = Confidence Interval

5.4.6: Between group factor analysis based on previous training (training effect)

For intervention group, two-way repeated measures ANOVA indicated that, there was no significant difference of general mean knowledge scores regarding VAP between trained and non-trained nurses in the intervention group based on previous training (F = 0.98, p=0.328). Multiple paired t tests were performed with adjusted α based on Bonferroni correction (Table 20). Paired t test showed that the mean knowledge scores for trained nurses was 22.10, 95% CI: 20.42, 23.78 and non-trained nurses was 23.08, 95% CI: 21.99, 24.17 in the intervention group (Table. 20). For the specific health knowledge scores of the 3 subscale areas, there was no significant difference in pre-intervention-post-intervention within the 3 areas in the intervention group at post-test. These areas were, (p=0.950) for ICM, (p=0.957) for oral care, and (p=0.580) for HOB (Table 20).

This finding failed to rejected the null hypothesis of the study in the areas of general knowledge regarding VAP and the in the 3 significant specific areas which states: "After the completion of the twelve-weeks health education intervention (at posttest), there will be no significant differences on the general knowledge scores regarding VAP and specific knowledge scores of the 3 subscale areas between the intervention and the control groups as related to their previous training at posttest." As the conclusion, for overall knowledge regarding VAP and specific knowledge regarding VAP of the 3 areas, there was no significant difference of mean general knowledge score regarding VAP and of the 3 specific areas between males and females in the intervention group based on previous training.

For control group, repeated measures ANOVA indicated that, there was no significant difference of general mean knowledge scores regarding VAP between trained and non-trained nurses in the control group based on previous training (F = 2.20, p=0.147). Multiple paired t tests were performed with adjusted α based on Bonferroni correction (Table 20). Paired t test showed that the mean knowledge scores for trained nurses was (19.82, 95% CI: 18.19, 21.45) and non-trained nurses were (20.76, 95% CI: 19.30, 22.23) in the control group (Table 20). For the specific knowledge scores of the 3 subscale areas, there was no significant difference in pre-intervention-post-intervention between the 3 areas in the control group at post-test.

These areas were, (p=0.360) for ICM, (p=0.380) for oral care, and (p=0.173) for HOB (Table 20).

This finding failed to reject the null hypothesis of the study in the areas of general knowledge and in the 3 specific health areas regarding VAP which states: “After the completion of the twelve-weeks health education intervention (at posttest), there will be no significant differences on the general knowledge scores regarding VAP and specific knowledge scores of the 3 subscale areas between the intervention and the control groups as related to their previous training on posttest.” As the conclusion, for general knowledge regarding VAP, there was no significant difference of mean knowledge score between males and females in the control group based on previous training. In addition, there was no significant difference of mean knowledge score in all 3 specific areas between males and females in the control group.

Table 20: Comparison of General and specific mean knowledge score of the 3 areas between groups using Two-way RM ANOVA based on previous training (previous training effect)

Health area	group	Intervention group (n=49, male 22& female 27)			control group (n=37, male 4& female 33)		
		Mean (95%CI)	F statistic	P value	Mean (95%CI)	F statistic	P value
ICM (10)	Trained	7.83 (7.23, 8.44)	0.004	0.950	7.50 (6.63, 8.37)	0.86	0.360
	Not-trained	7.81 (7.41, 8.20)			6.85 (6.07, 7.64)		
Oral care (10)	Trained	7.76 (7.13, 8.40)	0.003	0.957	6.46 (5.83, 7.07)	0.79	0.380
	Not-trained	8.09 (7.68, 8.50)			7.42 (6.50, 7.98)		
HOB (10)	Trained	6.50 (5.76, 7.25)	0.31	0.580	5.86 (5.10, 6.63)	1.94	0.173
	Not-trained	7.18 (6.70, 7.67)			6.49 (5.80, 7.19)		
General Knowledge regarding VAP (30)	Trained	22.10(20.42, 23.78)	0.06	0.816	19.82 (18.19, 21.45)	0.002	0.962
	Not-trained	23.08(21.99, 24.17)			20.76 (19.30, 22.23)		

RM = Repeated Measures
CI = Confidence Interval

5.4.7: Between group factor analysis based on Years of Experience (Experience effect)

For intervention group, two-way repeated measures ANOVA indicated that, there was no significant difference of general mean knowledge scores regarding VAP between nurses in the intervention group based on years of experience (F = 2.26, p=0.095). Multiple paired t tests were performed with adjusted α based on Bonferroni correction (Table. 21). Paired t test showed that the mean knowledge scores for nurses with less than 1 year of experience were 23.88, 95% CI: 21.88, 25.87; 23.88, 95% CI: 20.87, 23.47 for nurses with 1-5 years, 22.45, 95% CI: 20.43, 24.47 for nurses with 6-10 years and non-trained nurses were 24.83, 95% CI: 21.15, 28.51 for nurses with more than 10 years in the intervention group (Table. 21). For the specific knowledge scores regarding VAP of the 3 subscale areas, there was no significant difference in pre-intervention-post-intervention within the 3 areas in the intervention group at post-test. These areas were, (p=0.095) for ICM, (p=0.613) for oral care, and (p=0.602) for HOB (Table. 21).

This finding failed to rejected the null hypothesis of the study in the areas of general knowledge regarding VAP and the in the 3 significant specific areas which states: "After the completion of the twelve-weeks health education intervention (at posttest), there will be no significant differences on the general knowledge scores regarding VAP and specific knowledge scores regarding VAP of the 3 subscale areas between the intervention and the control groups as related to their years of experience at posttest." As the conclusion, for overall health knowledge and specific health knowledge of the 3 areas, there was no significant difference of mean general knowledge score and of the 3 specific areas between trained and non-trained nurses in the intervention group based on years of experience.

For control group, repeated measures ANOVA indicated that, there was no significant difference of general mean knowledge scores regarding VAP between nurses in the control group based on years of experience (F = 1.48, p=0.240). Multiple paired t tests were performed with adjusted α based on Bonferroni correction (Table. 21). Paired t test showed that the mean knowledge scores for nurses with less than 1 year of experience were 21.75, 95% CI: 19.59, 23.91; 19.78, 95% CI: 18.02, 21.54 for nurses with 1-5 years, 20.50, 95% CI: 18.50, 22.50 for nurses with 6-10 years and 18.45, 95% CI: 15.71, 21.18 for nurses with more than 10 years in the control group

(Table. 21). For the specific knowledge scores regarding VAP of the 3 subscale areas, there was no significant difference in pre-intervention-post-intervention between the 3 areas in the control group at post-test. These areas were, (p=0.864) for ICM, (p=0.060) for oral care, and (p=0.185) for HOB (Table. 21).

This finding failed to reject the null hypothesis of the study in the areas of general knowledge regarding VAP and in the 3 specific areas which states: "After the completion of the twelve-weeks health education intervention (at posttest), there will be no significant differences on the general knowledge scores regarding VAP and specific knowledge scores regarding VAP of the 3 subscale areas between intervention and control groups as related to their years of experience at posttest." As the conclusion, for general knowledge regarding VAP, there was no significant difference of mean knowledge score between trained and non-trained nurses in the control group based on years of experience. In addition, there was no significant difference of mean knowledge score in all 3 specific areas between trained and non-trained nurses in the control group.

Table 21: Comparison of overall and specific mean knowledge score of the 3 areas between groups using Two-way RM ANOVA based on Years of Experience (Experience effect)

Health area	group	Intervention group (n=49, male 22& female 27)			control group (n=37, male 4& female 33)		
		Mean (95%CI)	F statistic	P value	Mean (95%CI)	F statistic	P value
ICM (10)	Less than 1 year	8.30 (7.62, 8.98)	2.26	0.095	6.92(5.84, 8.00)	0.246	0.864
	Between 1-5 yrs	7.50 (7.06, 8.94)			6.78 (5.90, 7.66)		
	Between 6-10 yrs	7.80 (7.11, 8.49)			6.43 (5.43, 7.43)		
	More than 10 yrs	8.83 (7.58, 10.09)			7.05 (5.68, 8.42)		
Oral care (1)	Less than 1 year	8.31 (7.55, 9.08)	0.608	0.613	7.67 (6.81, 8.53)	2.734	0.060
	Between 1-5 yrs	7.77 (7.27, 8.27)			6.94 (6.24, 7.65)		
	Between 6-10 yrs	8.10 (7.33, 8.88)			7.64 (6.85, 8.44)		
	More than 10 yrs	8.33 (6.92, 9.75)			5.98 (4.89, 7.07)		
HOB (10)	Less than 1 year	7.27(6.32, 8.22)	0.626	0.602	7.17 (6.12, 8.22)	1.711	0.185
	Between 1-5 yrs	6.90 (6.28, 7.52)			6.06 (5.20, 6.91)		
	Between 6-10 yrs	6.55 (5.59, 7.51)			6.43 (5.46, 7.40)		
	More than 10 yrs	7.67 (5.92, 9.42)			5.41 (4.09, 6.74)		
General Knowledge regarding VAP (30)	Less than 1 year	23.88(21.88, 25.87)	1.169	0.333	21.75 (19.59, 23.91)	1.395	0.263
	Between 1-5 yrs	22.17 (20.87, 23.47)			19.78 (18.02, 21.54)		
	Between 6-10 yrs	22.45 (20.43, 24.47)			20.50 (18.50, 22.50)		
	More than 10 yrs	24.83 (21.15, 28.51)			18.45 (15.71, 21.18)		

RM = Repeated Measures
CI = Confidence Interval
1 = significant health area for the intervention group. 2 = significant health areas for the control group.

5.4.8: Between group factor analysis based on Place of Work (Place of Work effect)

For intervention group, two-way repeated measures ANOVA indicated that, there was no significant difference of the general mean knowledge scores regarding VAP between nurses' working in Holy Family Hospital and nurses' working in Red Crescent Hospital in the intervention group based on place of work (F=3.26, p=0.078). Multiple paired t tests were performed with adjusted α based on Bonferroni correction (Table. 22). Paired t test showed that the mean knowledge scores for nurses' from Holy Family Hospital was 24.02, 95% CI: 22.69, 25.35 and for nurses' from Red Crescent Hospital was 21.55, 95% CI: 20.24, 22.87 in the intervention group (Table. 22). For the specific health knowledge scores of the 3 subscale areas, there was significant difference in pre-intervention-post-intervention within 2 of the 3 areas in the intervention group at post-test. This area were, (p=0.035) for oral care and (p=0.016) for HOB (Table. 22).

This finding rejected the null hypothesis of the study in the areas of general knowledge regarding VAP and in 2 of the 3 specific health areas, whereas, in the other specific area was failed to reject the third specific areas which states: "After the completion of the twelve-weeks health education intervention (at post-test), there will be no significant differences on the overall knowledge scores regarding VAP and specific knowledge scores regarding VAP of the 3 subscale areas between the intervention and the control groups as related to their level of education, and place of work at post-test."

As the conclusion, for overall knowledge regarding VAP, there was a significant difference of mean general knowledge score regarding VAP and in 2 of the 3 specific areas between nurses in different hospitals in the intervention group based on place of work, whereas, no significant differences of the third specific health area.

For control group, two-way repeated measures ANOVA indicated that, there was no significant difference of the general mean knowledge scores regarding VAP between nurses' working in Hebron Hospital and nurses' working in Caritas Hospital in the control group based on place of work (F = 2.26, p=0.142). Multiple paired t tests were performed with adjusted α based on Bonferroni correction (Table. 22). Paired t test showed that the mean knowledge scores for nurses' working in Hebron Hospital was 20.75, 95% CI: 19.44, 22.06 and nurses' working in Caritas Hospital was 20.54, 95% CI: 18.98, 22.11 in the control group (Table. 22). For the specific knowledge scores regarding VAP of the 3 subscale areas, there was no significant difference in pre-intervention-post-intervention within the 3 areas in the control group at post-test (Table. 22).

This finding failed to reject the fourth null hypothesis of the study in the areas of general knowledge regarding VAP and in the 3 specific areas which states: "After the completion of the twelve-weeks health education intervention (at post-test), there will be no significant differences on the overall knowledge scores regarding VAP and specific knowledge scores regarding VAP of the 3 subscale areas between the intervention and the control groups as related to their level of education, and place of work at post-test."

As the conclusion, for overall knowledge regarding VAP, there was significant difference of mean knowledge score regarding VAP between nurses' working in Holy Family Hospital and nurses' working in Red Crescent Hospital in 2 of the 3 specific areas in the intervention group based on place of work. In contrast, there was no significant difference of mean knowledge score in the 3 specific heath areas between nurses' working in Hebron Hospital and nurses' working in Caritas Hospital.

Table 22: Comparison of overall and specific mean knowledge score of the 3 areas between groups using Two-way RM ANOVA based on Place of Work (Place effect)

Health area	Hospital	Intervention group (n=49) Mean (95% CI)	F statistics (df)	P value	Hospital	Control group (n=37) Mean (95% CI)	F statistics (df)	P value
ICM (10)	H.F.H.	8.12 (7.63, 8.61)	3.259 (1)	0.078	Hebron H.	6.97 (6.31, 7.64)	0.063 (1)	0.803
	R.C.H.	7.50 (7.01, 8.00)			Caritas H.	7.10 (6.31, 7.89)		
Oral care (10)	H.F.H.	8.44 (7.93, 8.95)	4.728 (1)	0.035	Hebron H.	7.36 (6.53, 7.75)	0.407 (1)	0.528
	R.C.H.	7.67 (6.16, 8.17)			Caritas H.	7.10 (6.48, 7.73)		
HOB (10)	H.F.H.	7.46 (6.85, 8.08)	6.287 (1)	0.016	Hebron H.	6.42 (5.80, 7.04)	0.28 (1)	0.869
	R.C.H.	6.39 (5.78, 7.00)			Caritas H.	6.34 (5.60, 7.08)		
General Knowledge regarding VAP (30)	H.F.H.	24.02 (22.69, 25.35)	7.092 (1)	0.011	Hebron H.	20.75 (19.44, 22.06)	0.043 (1)	0.837
	R.C.H.	21.55 (20.24, 22.87)			Caritas H.	20.54 (18.98, 22.11)		

RM = Repeated Measures
CI = Confidence Interval
H.F.H. = Holy Family Hospital
R.C.H. = Red Crescent Hospital
1 = significant health area for the intervention group.
2 = significant health areas for the control group.

5.4.9: Within-between factors analyses (Time X Gender X Previous Training)

Time X Gender X previous training on General knowledge

For intervention group

Overall, there was no significant difference of general mean knowledge score regarding VAP between gender and previous training between nurses in the intervention group based on time (F = 0.09, p=0.763).When multiple comparisons of the general mean knowledge and confidence interval between the gender and previous training in the intervention group at each time were conducted to check the time-gender, time-previous training, and time-gender-previous training interaction analysis, the results showed overlapping of mean knowledge of pre-male-trained with the corresponding confidence interval for the pre-male-not-trained. Thus, there was no significant difference in the mean knowledge between the two groups (pre-Male-trained) (Table. 23). In addition, the results showed overlapping of pre-female-trained with the corresponding confidence interval for the pre-female/not-trained. Thus, there was no significant difference in mean knowledge between the two groups (pre-male-trained – pre-female-trained. After the conclusion of the intervention (post-test), the mean knowledge of male-trained group increased by 2 points in post-test, whereas the changes in mean knowledge of male/not-trained group was 2.2 points in post-test, the increment of mean knowledge score of female/trained was 2.2 points in post-test, and the mean knowledge of female/not-trained group increased by 1.9 points. Therefore, the four groups showed an increase in mean knowledge score after the intervention, the mean differences were not significant; after multiple comparisons among the four post-test mean cells, all of the mean differences were not significant.

For control group

Overall, there was no significant difference of mean general knowledge score regarding VAP between gender and previous training between nurses in the intervention group based on time (F = 0.32, p=0.578). When multiple comparisons of the general mean knowledge regarding VAP and confidence interval between the gender and male/trained track in the control group at each time were conducted to check the time-gender, time-previous training, and time-gender-previous training interaction analysis, the results showed overlapping of pre-mean knowledge of male/scientific with the corresponding confidence interval for the pre-male/previous training. Thus, there was no significant difference in mean knowledge between the two mean cells (pre-male/previous training – pre-male/previous training) (Table. 23). In addition, the results showed no overlapping of pre-female/previous training with the corresponding confidence interval for the pre-female/non-previous training. Thus, there was no significant difference in the mean knowledge between the two mean cells (pre-female/previous training – pre-female/non-previous training).

Table 23: Comparison of general health mean knowledge score among two different groups (intervention & control groups) based on time (Gender X Previous training)

Time	Intervention group (n=49)			Control group (n=37)		
	Group	Mean score	95% C.I.	group	Mean score	95% C.I.
PRE	Male-trained (n=6)	6.67	5.09, 8.25	Male-trained (n=4)	5.50	3.85, 7.15
	Male not-trained (n=16)	6.44	5.47, 7.40	Male not-trained (n=7)	7.50	5.48, 9.53
	Female trained (n=9)	6.89	5.60, 8.18	Female trained (n=9)	7.82	6.83, 8.81
	Female not-trained (n=18)	7.11	6.20, 8.02	Female not-trained (n=17)	7.12	6.43, 7.84
POST	Male-trained (n=6)	8.67	7.65, 9.68	Male-trained (n=4)	5.70	5.48, 9.53
	Male not-trained (n=16)	8.63	8.00, 9.25	Male not-trained (n=7)	7.55	5.50, 9.62
	Female trained (n=9)	9.11	8.28, 9.94	Female trained (n=9)	7.18	5.96, 8.40
	Female not-trained (n=18)	9.06	8.47, 9.64	Female not-trained (n=17)	7.27	6.41, 8.14

Two–way Repeated measures ANOVA between group analyses with regard to time analysis was applied.
Assumption of normality, homogeneity of variances and homogeneity of regression were checked and were fulfilled.
C.I. = Confidence interval.
PRE= Baseline measurement of mean knowledge
POST = after three months measurement of mean knowledge

Chapter six

Discussion

6.1 Introduction

This chapter summarizes the study and conclusions drawn from the data analysis in chapter five. It also provides a discussion of the implications for actions and recommendations for further research. The focus of this research project is to examine the effectiveness of the educational intervention program in improving nurses' knowledge about VAP prevention using bundle protocol in neonatal intensive care unit at Southern West Bank Hospitals.

This research has compared the changes in VAP prevention knowledge among NICU nurses who participated in an intervention program (intervention group) with those who did not participate in the program (control group).

VAP is a serious complication of mechanical ventilation with high morbidity and mortality rates (Augustyn, 2007; Restrepo et al., 2010). NICU nurses' knowledge and role in preventing VAP is paramount in reducing the occurrence of VAP. This study therefore focuses on assessing NICU nurses' basic knowledge for VAP, and whether an educational intervention program improved knowledge. Although plenty of literature exists on VAP prevention and protocols (Youngquist et al., 2007; Lawrence and Fulbrook, 2011; Gallagher, 2012), fewer studies have focused on the impact of in-service education in increasing knowledge for VAP prevention (Tolentino-DelosReyes, Ruppert, and Shaio, 2007; Welch and Austin, 2008).

6.2 Specific Research Outcomes

6.2.1 At baseline effects—General knowledge.

The present study confirms that the general knowledge regarding VAP prevention in pre-test is unsatisfactory. At pre-test, nurses in both, the control and intervention groups, took that same test at baseline and both groups displayed almost similar results. Nurses in the intervention group (n=49) answered 65.7% of the 30 items correctly for the general knowledge regarding VAP, while the control group (n=38) answered 68.7% of the 30 items correctly for the general knowledge regarding VAP of the questionnaires. Those results indicate that nurses in both the control and the intervention groups at Southern West Bank Hospitals have poor general knowledge regarding VAP at baseline, which shows that there is a need of educational intervention programs in order to improve their knowledge level, which is in line with previous many studies, Meherali et al. (2011), Nesami and Amiri, (2013), Ahmed and Abosamra, (2015) and Gatell et al. (2012), these studies showed that the level of knowledge is low before the educational program and this could be related to the fact that hospitals and health related institutions have little focus on teaching VAP prevention. According Badawy (2014) pre test showed that almost 90% of the sample had unsatisfactory level about general information on VAP and the authors focused on the need for educational programs in order to improve their knowledge level. While incongruent with previous study results by Musvosvi (2013), the results have showed that both the interventional group and the control group possessed very good baseline knowledge.

6.2.2 Intervention effects—General knowledge.

Interestingly, the results of the study have showed significant increases in VAP knowledge for NICU nurses in the intervention group. The general mean score for nurses in the intervention group increased slightly over two points after receiving the VAP education, and this concordance with many studies conducted by Meherali et al. (2011) and Gatell et al. (2012), who showed that the knowledge scores of participants increased significantly after the educational intervention. Another quasi-experimental study conducted by Subramanian et al. (2013), showed that the nurse-led educational intervention had a significant effect ($p < 0.001$) on the nurses' knowledge of VAP in their test scores (pre-intervention 63.17; post-intervention 95.99), so within time cycles knowledge could improve because these periods give the nurses the needed time to comprehend what they have learned and to refresh their memories. While the general mean score for the nurses in the control group did not change over the same time frame; indicating that education and training are a determinable factor in enhancing nurses' knowledge about VAP. No significant difference was found for general knowledge scores by gender ($p=0.164$), previous training ($p=0.816$), and years of experiences (p=0.333) and this could be related to the fact that participant lack previous training and there is no follow up from the continuous education at the participants institutions. This matches with a study conducted by El Khatib et al. (2010), who did not find any significant differences between health professionals with more than five years ICU experience, and the reason behind that might not be having enough participants with less than 1 year of ICU experience for comparison between them. Also similar studies conducted by Said (2012) and Musvosvi (2013), showed that the knowledge doesn't differ among groups depending on ICU experience, while incongruent with a previous study by Ahmed and Abosamra, (2015), showed that the nurses with more experienced performed significantly better than less experienced colleagues.

Surprisingly, the results of the current study have indicated no significant differences between male and female nurses in the both groups on general knowledge regarding VAP, and this is consistent with the Yaseen and Salameh, (2015) and Blot et al. (2007), this could be related to smaller sample size of male nurses relative to the female sample in this study, while incongruent with a previous study results by Badawy (2014), males have been associated with better knowledge scores than females.

One of the interesting findings in the current study is that there are no significant differences between trained and non-trained nurses in relation to knowledge about VAP. The majority of nurses in both groups (the intervention and the control groups) didn’t have any previous training about the prevention of VAP with a percent of 69.4% and 68.4%, respectively. An important point to mention is that having a training or not has no effect unless a continuous training and more focus on this topic in nursing curriculum was done and in continuous education programs. The results of this study are similar with the results of a previous study by Yaseen & Salameh (2015), where it showed that the main barriers to using VAP guidelines are lack of VAP training courses.

However, significant difference has been found of knowledge scores by place of work (p= 0.011), the result has indicated that, there was significant difference of the general mean knowledge scores regarding VAP between nurses’ working in Holy Family Hospital and nurses’ working in Red Crescent Hospital in the intervention group. Holy Family Hospital has higher scores compared to Red Crescent Hospital. The researcher has suggested these differences may be due to 1) Holy Family hospital has a continuous education committee. 2) Nurses have higher level of education and this has a positive role in improving the level of knowledge in Holy Family Hospital. Documenting a knowledge change is important to illustrate the nurses' knowledge acquisition and that this intervention program is effective for teaching VAP content to this experimental group. The data suggest that the group's post-test general scores increased as a result of the VAP education intervention. Findings from this study showed that NICU nurses' knowledge of VAP prevention improved after an educational intervention program.

This study rises from the need to consider the impact of educational intervention on nurses' knowledge to prevent VAP. Although knowledge does not always guarantee safe clinical practice (Blot et al., 2007), safe practice in the NICU cannot occur without basic knowledge. In another study, Tolentino-DelosReyes, Ruppert, and Shaio, (2007) conducted a clinical education project to evaluate critical care nurses' knowledge of the ventilator bundle in preventing ventilator-associated pneumonia. Results of that study showed that nurses performed better in the posttest after a 30-minute educational session ($P < .001$).

Other studies also provide evidence on the impact of knowledge in reducing rates of hospital-acquired infections after educational programs (Apisarnthanarak et al., 2011; Berenholtz et al., 2004). Although this current study doesn't take VAP rates before and after the educational intervention, nurses' knowledge of VAP prevention improved after education.

6.2.3 Intervention effects— specific Knowledge areas.

A significant improvement in ICM scores for nurses in the experimental group is evident in the study. Nurses in the experimental group showed a significant change ($p<0.001$) from the pre-ICM score to post-ICM score by an average increase of almost two points, while nurses in the control group showed no change in ICM score over time. The Provincial Infectious Diseases Advisory Committee (2008), published a document regarding multiple aspects of infectious disease identification, prevention and control focused on the point that training and experience related to health care infection prevention and control programs are responsible for directing infection prevention and control activities including implementing, monitoring and increasing knowledge about infection control measures.

No significant difference was found for ICM scores by gender (p=0.226), previous training (p=0.950) indicated that, there was no significant difference within these areas at post-test. The researcher has suggested this result may be due to 1) The educational program was beneficial among all nurses in the intervention group. Nevertheless, females scored higher in the mean of knowledge score than males in ICM, oral care, and HOB areas, but the difference was not significant; this result is consistent with studies by Yaseen and Salameh, (2015) and Blot et al. (2007), this may be caused by the smaller sample size of male nurses relative to the female sample.

On the other hand, significant differences were detected for oral care scores (p=0.035), HOB scores (p=0.016) by place of work indicating that there was significant difference in pre-intervention-post-intervention within 2 areas in the intervention group at post-test, while nurses in the control group showed no change in these areas over time. The researcher has suggested these differences within areas may be due to 1) There was more attention on these areas by nursing in Holy Family Hospital. 2) This hospital has a continuous education committee. 3) Nurses have higher level of education and this has a positive role in improving the level of knowledge in Holy Family Hospital. The results of this study is concurring with a previous study by ALBERTSEN (2010), show that the place of work and relationships in the work could affect personnel stress level and in turn their learning abilities.

Overall, the findings of this study complements the findings of other previous studies conducted in similar domains. Also found that the knowledge level of nurses can be increased by providing them education; continuous education is very important for nurses.

6.3 Implications for Nursing Education and Practice

VAP, although often preventable, has a large impact on morbidity and mortality. Nurses play a key role in preventing VAP. Many of the interventions are part of routine nursing care. Education for all healthcare providers should focus on the risk factors for VAP and on preventive measures. In order to further decrease the incidence of VAP, protocols and monitoring tools must be developed and followed. Several opportunities to reduce the incidence of VAP are immediately available to the clinician. Many are no-cost or minimal-cost interventions, and should be implemented as part of routine care protocols. VAP increases patients' care time, length of stay, and morbidity rate. Consequently, all these negative impacts will increase the health care costs. Since intubated patients are having a high risk of acquiring VAP, preventive measures are the key. Care of the critically ill should be directed at applying interventions that reduce mortality, minimize morbidity, shorten the length of stay, and reduce cost.

Reducing VAP through the simple measures does exactly that. It is recommended that the clinician's practice include; elevation of the head properly, minimization of sedation, sedation vacations, oral care as described above, and of course excellent hand hygiene. VAP is not a new diagnosis. Education and research on the prevention of this life-threatening problem should be ongoing in order to improve overall quality by reducing future morbidities, mortalities, length of stay, and hospital cost.

Results of this study have the potential to provide guidance to nurses and other health care workers who are in the front line of the fight against VAP, allowing them to improve clinical practice. In-service education and awareness allows NICU nurses to continue on a path leading to improved outcomes.

Results of this study will be communicated to the infection control team, NICU nurses and respiratory team in a scheduled in-service for infection control and used as an opportunity for discussion on further study and/or suggestions for change. This study adds to the growing evidence in research, the importance of educational in-services in improving nursing knowledge and consequently improves nurses' clinical practices.

The following recommendations are made for nursing education and practice:

1- Hospital administrations in collaboration with continuous education should focus on establishing educational programs and protocols to prevent and reduce the incidence of VAP and to enhance nurses' knowledge on preventions of Ventilator-Associated Pneumonia.

2- The need of integration of VAP education in nursing curricula at universities, because the higher educational level for nurses increase positively the knowledge in giving the accurate care for the patients and trying to limit the risk of infections.

3- Ongoing in-service training must be introduced into hospitals and ICUs to improve knowledge on prevention of VAP. Also, high compliance is needed to prevent VAP using the bundle strategy. Clearly, simply having a policy in place is insufficient to reduce VAP rates. Monitoring bundle compliance and implementing interventions to ensure high compliance are needed in order to see a decrease in rates.

4- Policy makers should not just put protocols and set rules; they should do regular check up and auditing tours to monitor nurses adherence.

5- Orientation of new NICU nurses should include education on VAP prevention because treating this topic as one of the basis for the care provided for patients, would enforce the idea of how important and critical is working according guidelines to prevent VAP.

6- ICU environment should enable a nurse to translate knowledge into practice by ensuring availability of facilities like hand washing sinks, soap and disinfectants for cleaning and disinfecting equipments, adoption of acceptable guidelines based on evidence based medicine practice is also recommended.

7- Motivation of opinion leaders amongst nurses in the units should be done to promote their colleagues in putting guidelines for prevention of VAP into- practice.

8- Learning resources such as articles, journals and electronic resources should be made accessible in the units for staff members.

9- Manuals, information booklets and self-instruction module may be developed in areas of prevention of VAP.

10- Nurses should take initiative to improve their knowledge and practices by using online education, virtual learning, booklets, posters and brochures.

11- Posters and simple illustrations about prevention of VAP should be available in every intensive care unit.

6.4 Recommendations for Further Research

The high morbidity, mortality, and costs of treating VAP remain a concern in nursing. This means that even small gains in preventive measures can translate into thousands of lives and millions of dollars saved in healthcare. This study has produced positive results indicating an overall improvement in knowledge regarding VAP after an educational intervention among a selected group of NICU nurses. In order to keep up with knowledge and skills, NICU nurses need ongoing development and education. Evidence based practice is the core of the new, updated research. To have a good practice and knowledge, we should manifest and engage more in research. As a research it is believed that when we connect practice and what the literature says, we get the ultimate level of care. Unit protocols should be reviewed regularly as updates and new evidence for best practice are constantly emerging and staff should be educated on the updated protocols.

Also, more research should be done in Palestine about the VAP incidence and how to prevent it. Also, to fix the gaps in literature, consistency and collaboration between researchers should be done in order to cover all the aspects related for VAP prevention. ICU training programs should include evidence based guidelines for prevention of VAP. Also, Nursing lecturers and clinical facilitators should incorporate evidence based measures to prevent VAP daily in ICU's and use learning opportunities in the units to raise the topic

Plus, further research with larger samples in multiple facilities is recommended to see if similar results will be attained. Moreover, research should be conducted to test knowledge levels of nurses prior to and after educational programs on evidence based guidelines for prevention of VAP to assess if nurses gained knowledge after exposure to educational programs. Similar study conducted by Said (2012), recommended including large sample size in other hospitals which provide care for critically ill patients in Tanzania, further research on factors affecting implementation of VAP prevention strategies is recommended.

Also, conduct observational studies for the practice in order to see if nurse's adheres to the educational program guidelines. The future research needs new strategies, such as respiratory team and physician's engagement in the educational programs. Finally, research may be directed toward understanding the effectiveness of specific elements of educational programs interventions, and the context in which they are being implemented in order to understand which combination lead most reliable success. And more detailed study of the cost of VAP prevention strategies.

6.5 Limitations of the Study

1- The findings of the study cannot be generalized to other populations as the study was conducted on only four hospitals.

2- The small sample size (n=87) does not necessarily represent all NICU nurses' knowledge therefore the findings cannot be generalized to other NICU nursing populations.

3- Limited time (only 3 months) in implement the multimodal intervention programs to improve the nurses' knowledge in the intervention group demands effort and high workload on the researcher.

6.6 Conclusion

Nursing knowledge regarding VAP preventive measures significantly has improved after education programs and the practice measures to prevent VAP. Ongoing studies with different and larger sample populations will continue to add to these findings.

In-service promotion intervention used in this study was appropriate, effortless, and inexpensive, that made it being distinguished from other interventions reported in the literature which were time extensive, labor-intensive, and cost expensive.

References

1. Abd El-Aziz, M.A. (2014). Effect of educational program on nurses, knowledge and skills about oral care for traumatized patients. *AAMJ,* 12(1), pp. 25-47.

2. Aelami, M.H., Lotfi, M. and Zingg, W. (2014). Ventilator-associated pneumonia in neonates, infants and children. *Antimicrob Resist Infect Control,* 3, p. 30.

3. Afjeh, S.A., Sabzehei, M.K., Karimi, A. et al. (2012). Surveillance of ventilator-associated pneumonia in a neonatal intensive care unit: characteristics, risk factors, and outcome. *Arch Iran Me,* 15(9), pp. 568 – 571.

4. Ahmed, G.E. and Abosamra, O.M. (2015). Knowledge of Pediatric Critical Care Nurses Regarding Evidence Based Guidelines for Prevention of Ventilator Associated Pneumonia (VAP). *Journal of Education and Practice,* 6(9), pp. 94-101.

5. Albertsen, K., Rugulies, R., Garde, A. et al. (2010). The effect of the work environment and performance-based self-esteem on cognitive stress symptoms among Danish knowledge workers. *Scandinavian Journal of Public Health,* 38(3), pp. 81–89.

6. Alc_on, A., Fa`bregas, N. and Torres, A. (2003). Hospital-acquired pneumonia: etiologic considerations. *Infect Dis Clin North Am,* 17, pp. 679–95.

7. Aly, H., Badawy, M., El-Kholy, A. et al. (2008). Randomized, controlled trial on tracheal colonization of ventilated infants: Can gravity prevent ventilator-pneumonia? *Pediatrics,* 122(4), pp. 770-774.

8. Al-Sayaghi, K.M. (2014). Prevention of ventilator-associated pneumonia. A knowledge survey among intensive care nurses in Yemen. *Saudi Med J,* 35(3), pp. 269-76.

9. Apisarnthanarak, U., Warren, D.K., and Fraser, V.K. (2011). The long term outcome of a multifaceted intervention to reduce ventilator-associated pneumonia: Can zero really achieved? *American Journal of Infection control,* 39(7), pp. 613-614.

10. Augustyn, B. (2007). Ventilator-associate pneumonia: Risk factors and prevention. *Critical Care Nurse*, 27(4), pp. 32-39.

11. Azab, S.F., Sherbiny, H.S., Saleh, S.H. et al. (2015). Reducing ventilator-associated pneumonia in neonatal intensive care unit using "VAP prevention Bundle": a cohort study. *BMC Infectious Diseases,* 15, p. 314.

12. Badawy, M.I. (2014). Impact of a Structured Teaching Program for Prevention of Ventilator Associated Pneumonia on Knowledge and Practices of Intensive Care Nurses at Central Quwesna Hospital, Egypt. *Med. J. Cairo Univ,* 82(1), pp. 803-813.

13. Babcock, H. (2004). An educational intervention to reduce ventilator-associated pneumonia in an integrated health system: A comparison of effects. *Chest*, 125(6), pp. 2224-2231.

14. Badr, M.A., Ali, Y.F., Albanna, E.A. et al. (2011). Ventilator associated pneumonia in critically-ill neonates admitted to neonatal intensive care unit, Zagazig University Hospitals. *Iran J Pediatr*, 21(4), pp. 418–424.

15. Baltimore, R.S. (2003). The difficulty of diagnosing ventilator-associated pneumonia. *Pediatrics*, 112(6), pp. 1420–1.

16. Bénet, Th., Allaouchiche, B., Argaud, L. et al. (2012). Impact of surveillance of hospital-acquired infections on the incidence of ventilator associated pneumonia in intensive care units: a quasi-experimental study. *Critical Care*, 16(4), R161

17. Berenholtz, S.M., Pronovost, P.J., Lipsett, P.A. et al. (2004). Eliminating catheter-related bloodstream infections in the intensive care unit. *Critical Care Medicine*, 32(10), pp. 2014 –2020.

18. Blot, S., Lisboa, T., Angles, R. et al. (2011). Prevention of VAP: Is zero rate possible? *Clinics in Chest Medicine*, 32(3), pp. 591-9.

19. Blot, S.I., Labeau, S. & Vandijck, D. et al. (2007). Evidence based guidelines for the prevention of ventilator associated pneumonia: results of a knowledge test among intensive care nurses. *Intensivecare medicine*, 33, pp. 1463 – 1467.

20. Bonten, M.J., Kollef, M.H. and Hall, J.B. (2004). Risk factors for ventilator-associated pneumonia: from epidemiology to patient management. *Clin Infect Dis*, 38(8), pp. 1141–49.

21. Bonten, M.J., Kollef, M.H. and Hall, J.B. (2004). Risk factors for ventilator-associated pneumonia: from epidemiology to patient management. *Clin Infect Dis*, 38(8), pp. 1141–49.

22. Bockhim, E.D. (2011). Effect of a nursing educational intervention on the prevention of ventilator associated pneumonia in the neonatal intensive care unit. A research paper submitted to the graduate school in partial fulfillment of the requirements for the degree masters of Science. Ball State University Muncie, Indiana.

23. Brown, M.K. and DiBlasi, R.M. (2011). Mechanical Ventilation of the Premature Neonate. *Respiratory care*, 56(9), pp. 1298-1312.

24. Cal, P.E. (2015). Ventilator-Associated Pneumonia Prevention Bundle. Project Submitted in Partial Fulfillment of the Requirements for the Degree of Doctor of Nursing Practice, Walden University.

25. Centers for Disease Control and Prevention. (2009). Device-associated events: Ventilator-associated pneumonia event. Available at: http://www.cdc.gov/nhsn/PDFs/pscManual/6pscVAPcurrent.pdf.

26. Centers for Disease Control and Prevention. (2010). Protocols and definitions device- associated module: Ventilator associated pneumonia (VAP). Available at: http://www.cdc.gov/nhsn/PDFs/slides/VAP-DA_gcm.pdf

27. Cernada, M., Brugada, M., Golombek, S. et al. (2013). Ventilator-Associated Pneumonia in Neonatal Patients: An Update. *Neonatology,* 14, pp. 55-61.

28. Chlebicki, M.P. and Safdar, N. (2007). Topical chlorhexidine for prevention of ventilator associated pneumonia: a meta-analysis. *Crit Care Med,* 35(2), pp. 595–602.

29. Donowitz, L.G. (1989). Nosocomial infection in neonatal intensive care units. *Am. J. Infect. Control*, 17, pp. 250–257.

30. El-Khatib, M.F., Zeineldine, S., Ayoub, C. et al. (2010) Critical care clinicians' knowledge of evidence-based guidelines for preventing ventilator-associated pneumonia. *American Association of Critical Care Nurses*,19(3), pp. 272-277.

31. Fanaroff, A.A., Stoll, B.J., Wright, L.L. et al. (2007). Trendsin neonatal morbidity and mortality for very low birthweight infants. *Am J Obstet Gynecol*, 196(147), pp. 141–148.

32. Fallahi, M., Dasht, A.S., Naeempour,N. et al. (2014). Ventilator-Associated Pneumonia in Hospitalized Newborns in a Neonatal Intensive Care Unit. *Arch Pediatr Infect Dis,* 2(3), e16514.

33. Feldman, C., Kassel, M., Cantrell, J. et al. (1999). The presence and sequence of endotracheal tube colonization in patients undergoing mechanical ventilation. *Eur Respir J,* 13(3), pp. 546–51.

34. Forman, M. L. and Stiehm. E. R. (1969). Impaired opsonic activity but normal phagocytosis in low-birth-weight infants. *N. Engl. J. Med,* 281**,** pp. 926-931.

35. Foglia, E., Meier M.D., and Elward, A. (2007).Ventilator-Associated Pneumonia in Neonatal and Pediatric Intensive Care Unit Patients. *Clinical Microbiology Reviews,* 20(3), pp. 409-425.

36. Garland, J.S. (2010). Strategies to prevent ventilator-associated pneumonia in neonates. *Clinical Perinatology,* 37(3), pp. 629-643.

37. Gatell, M.J., Roig, M.S., Vian, O. et al. (2012). Assessment of a training programme for the prevention of ventilator-associated pneumonia. *Nursing in Critical Care*, 17(6), pp. 285-292.

38. Gallagher, J.V. (2012). Implementation of ventilator-associated pneumonia clinical guideline (Bundle). *The Journal for Nurse Practitioners,* 8(5), pp. 377-382.

39. Goldmann, D.A., Freeman, J., Durbin, W.A. (1983). Nosocomial infection and death in a neonatal intensive care unit. *J Infect Dis*, 147(4), pp. 635 – 641.

40. Gomes,V. (2010). knowledge of intensive care nurses of evidence based guidelines for prevention of ventilator associated pneumonia. A research report submitted in partial fulfillment of the requirements for the degree of Master of Science in Nursing, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg.

41. Grap, M.J., Munro, C.L., Hummel, R.S. et al. (2005). Effect of backrest elevation on the development of ventilator-associated pneumonia. *American Journal of Critical Care*, 14,(4), pp. 325-332.

42. Harpin, V. A. and Rutter, N. (1983). Barrier properties of the newborn infant's skin. *J. Pediatr*, 102(3), pp. 419-425.

43. Hentschel, J., Bru¨ngger, B., Stu¨di, K. et al. (2005). Prospective surveillance of nosocomial infections in a Swiss NICU: low risk of pneumonia on nasal continuous positive airway pressure. *Infection*, 33(5), pp. 350–5.

44. Institute for Healthcare Improvement. (2012). How-to guide: Prevent ventilator-associated pneumonia. Available at: http://www.ihi.org/resources/Pages/Tools/HowtoGuidePreventVAP.aspx

45. Jansson, M., Ala-Kokko, T., Ylipalosaari, P. et al. (2013). Critical care nurses' knowledge of, adherence to and barriers towards evidence-based guidelines for the prevention of ventilator-associated pneumonia – A survey study. *Intensive & Critical Care Nursing*, 29, pp. 216-227.

46. Kiyoshi-Teo, H., Cabana, M., Froelicher, E. et al. (2014). Adherence to institution specific ventilator-associated pneumonia prevention guidelines. *American Journal of Critical Care,* 23(3), pp. 201-215.

47. Kollef, M.H. (2004). Prevention of hospital-associated pneumonia and ventilator associated pneumonia. *Crit Care Med,* 32(6), pp. 1396–405.

48. Labeau, S., Vandijck, D., Claes, B. et al. (2007). Critical care nurses' knowledge of evidence-based guidelines for preventing ventilator-associated pneumonia: An evaluation questionnaire. *American Journal of Critical Care,* 16(4), pp. 371-377.

49. Labeau, S., Vandijck , D., Rello, J. et al. (2008). Evidence-based guidelines for the prevention of ventilator-associated pneumonia: results of a knowledge test among European intensive care nurses. *J Hosp Infec,* 70(2), pp. 180-5.

50. Lawrence, P. and Fulbrook, P. (2011). The ventilator care bundle and its impact on ventilator-associated pneumonia: A review of the evidence. *Nursing in Critical Care,* 16(5), pp. 222–234.

51. Meherali, S.M., Parpio, Y., Ali, T.S. et al. (2011). Nurses' knowledge of evidence-based guidelines for prevention of ventilator associated pneumonia in critical care areas: a pre and post test design. *J Ayub Med Coll Abbottabad,* 23(1), pp. 146-149.

52. Miller, J.D. and Carlo, W..A. (2008). Pulmonary complications of mechanical ventilation in neonates. *Clin Perinatol,* 35(2), pp. 273–281.

53. Moradi, M., Nili, F., Nayeri, F. et al. (2013). Study of characteristics, risk factors and outcome for ventilator associated pneumonia in neonatal intensive care unit patients. *Tehran Univ Med J,* 71(6), pp. 373-381.

54. Muscedere, J., Dodek, P., Keenan, S. et al. (2008). Comprehensive evidence based clinical practice guidelines for ventilator-associated pneumonia: Prevention. *J Crit Care*, 23, pp. 126-137.

55. Musvosvi, E. (2013). The impact of in-service education on ICU nurses knowledge and compliance with practice for preventing ventilator-associated pneumonia. A research report submitted in partial fulfillment of the requirements for the degree of Master of Science in Nursing, Faculty of California State University, Chico.

56. Nesami, M.B. and Amiri, M. (2014). Nurses' knowledge of evidence- based guidelines for preventing ventilator-associated pneumonia in intensive care units. Journal of Nursing and Midwifery Sciences, 1(1), pp. 44-48.

57. Pineda, L.A., Saliba, R.G. and ElSolh, A.A. (2006). Effect of oral decontamination with chlorhexidine on the incidence of nosocomial pneumonia: a meta-analysis. *Crit Care,* 10(1), p. 35.

58. Pittet, D., Dharan, S., Touveneau, V. et al. (1999). Bacterial contamination of the hands of hospital staff during routine patient care. *Arch. Intern. Med*.159(9), pp. 821-826.

59. Polit, D. and Beck, C. (2011). *Nursing research. Generating and assessing evidence for nursing practice.* 9th ed. Philadelphia: Lippincott Williams & Wilkins.

60. Pravikoff, D., Tanner, A., and Pierce, S. (2005). Readiness of U.S nurses for evidence based practice. *American Journal of Nursing*, 105(9), pp. 40-51.

61. Rello, J., Afonso, E., Lisboa, T. et al. (2012). A care bundle approach for prevention of ventilator-associated pneumonia. *Clin Microbiol Infect,* 19(4), pp. 363–369.

62. Resar, R., Pronovost, P., Haraden, C. et al. (2005). Using a bundle approach to improve ventilator care processes and reduce ventilator-associated pneumonia. *Jt Comm J Qual Patient Saf,* 31(5), pp. 243–8.

63. Restrepo, M.I., Anzueto, A., Arroliga, A.C. et al. (2010). The economic burden of Ventilator Associated Pneumonia Based on total resource utilization. *Infection Control Hospital Epidemiology,* 31(5), pp. 509-515.

64. Ricart, M., Lorente, C., Diaz, E. et al. (2003). Nursing adherence with evidence-based guidelines for preventing ventilator-associated pneumonia. *Critical Care Medicine*, 31(11), pp. 2693 –2696.

65. Ruzieh, M. Al-Ardeh, M. and Nazzal, Z. (2013). Incidence and Risk Factors of Ventilator Associated Pneumonia (VAP) in Palestine Hospitals. 2(2), p. 625 Available at: http://dx.doi.org/10.4172/scientificreports.625

66. Safdar, N., Musuuza, J.S., Xie, A. et al. (2016). Management of ventilator-associated pneumonia in intensive care units: a mixed methods study assessing barriers and facilitators to guideline adherence. *BMC Infectious Diseases,* 16, 349.

67. Said, A.T. (2012). Knowledge and practice of intensive care nurses on prevention of ventilator associated pneumonia at Muhimbili national hospital, MSc Nursing (Critical Care and Trauma) Dissertation. Muhimbili University of Health and Allied Sciences, Daressalaam, Tanzania.

68. Salahuddin, N., Zafar, A., Sukhyani, L. et al. (2004). Reducing ventilator-associated pneumonia rates through a staff education programme. *Journal of Hospital Infectio*n, 57(3), pp. 223-7.

69. Schmidt, F. (1986). Impact of Job Experience and Ability on Job Knowledge, Work Sample Performance, and Supervisory Ratings of. *Journal of Applied Psychology,* 73(1), pp. 46-57.

70. Sole, M. L., Poalillo, J. F., Byers, F. et al. (2002). Bacterial growth in secretions and on suctioning equipment of orally intubated patients: a pilot study. *Am. J. Crit. Care,* 11(2), pp. 141-149.

71. Subramanian, P., Choy, K.L., Gobal, S.V. et al. (2013). Impact of education on ventilator-associated pneumonia in the intensive care unit. Singapore Med J, 54(5), pp. 281-284.

72. Tekin, R. Dal, T. Pirinccioglu, H. et al. (2013). A 4-year surveillance of device-associated nosocomial infections in a neonatal intensive care unit. *Pediatr Neonatol*, 54(5), pp. 303-308.

73. The Concise Oxford Dictionary. 1990. 8th Edition. Oxford: Clarendon Press.

74. The Provincial Infectious Diseases Advisory Committee, (2008), Best Practices for Infection Prevention and Control Programs in Ontario. Available at:http://www.virox.com/files_docs/content/pdf/msds/PIDACBestPractices.pdf

75. Tolentino-DelosReyes, A.F., Ruppert, S.D., and Shaio, S.P. (2007). Evidence-based practice: Use of the ventilator bundle to prevent ventilator associated pneumonia. *American Journal of Critical Care*, 16(1), pp. 20-27.

76. Torres, A. and Ewing, S. (2004). Diagnosing ventilator associated pneumonia. *New Engl J,* 350(5), pp. 433-5.

77. Tripathi, S.H., Malik, G.K., Jain, A. et al. (2010). Study of ventilator associated pneumonia in neonatal intensive care unit: characteristics, risk factors and outcome. *Internet J Med Update*, 5(1), pp. 12–19.

78. Urden, L.D., Stacy, K.M. and Lough, M.E. (2009). Pulmonary disorders. *Critical Care Nursing Diagnosis and Management*, pp. 551-585.

79. Welch, S. and Austin, C. (2008). Development of an ICU preceptor program based on the AACN Synergy Model for Patient Care. *Critical Care Nurse*, 28(2), p.6.

80. Won, S.P., Chou, H.C., Hsieh, W.S. et al. (2004). Hand washing program for the prevention of nosocomial infections in a neonatal intensive care unit. *Infection Control and Hospital Epidemiology,* 25(9), pp. 742-746.

81. Yaseen, R.W and Salameh, T.N. (2015). Saudi Critical Care Nurses' Knowledge Of and Barriers toward Adherence to Prevention of Ventilator Associated Pneumonia Guidelines. *Journal of Nursing and Health Science***,** 4(2), pp. PP 65-69.

82. Youngquist, P., Carroll, M., Farber, M. et al. (2007). Implementing a ventilator bundle in a community hospital. *The Joint Commission Journal on Quality and Patient Safety,* 33(4), pp. 219-225.

83. Zack, J., Garrison, T., Trovillion, E. et al. (2002). Effect of an education program aimed at reducing the occurrence of ventilator-associated pneumonia. *Critical Care Medicine,* 30(11), pp. 2407–2412.

84. Zaiton, H.I. and Elhanafy, E.Y. (2015). Impact of Implementation Nursing Guidelines on Minimizing Ventilator Associated Pneumonia among Intensive Care Patients. *Advances in Life Science and Technology*, 29, pp. 40-51.

85. Zhou, Q., Lee, SK., Jiang, S.Y. et al. (2013). Efficacy of an infection control program in reducing ventilator-associated pneumonia in a Chinese neonatal intensive care unit. *Am J Infect Control,* 41(11), pp. 1059-1064.

Appendices

Appendix 1: Pre-post test form

Dear participant:

You are invited to participate in a research study entitled with “Nurse’s Knowledge of Ventilator-Associated Pneumonia Bundle Protocol in the Neonatal Setting at Southern Palestinian Hospitals: An Intervention Study”.

The aim of the study is to assess the effectiveness of a structured teaching program for prevention of ventilator associated pneumonia (VAP) on knowledge of neonatal intensive care nurses at Bethlehem and Hebron Hospitals in Palestine. Your participation in this study is voluntary and you are free to withdraw your participation from this study at any time. The information in this study will only be used for research purposes and nobody can identify the information of any participant.

Thank you for your kind cooperation.

Kamil Hussien.

Faculty of Health Professions.

Nursing Department.

Al-Quds University.

<u>Socio demographic characteristics of the nursing staff of Neonatal Intensive Care Units:</u>

Socio demographic and background data:	
1.Gender: □ M □F	**Age:** **20 – 24 years old** **25 -29 years old** **30 – 34 years old** **35 – 39 years old** **40 years old and above**
2. Previous training on guidelines of prevention of VAP:	**a. Yes** **b. No**
3. Level of education:	**1. Diploma** **2. BSN** **3. High diploma** **4. MSN** **5. PhD**
4. Years of experience in NICU:	**□ Less than 1 year □ 1-5 years** **□ 6-10 years** **□ more than 10 years**
5. Place of work:	**□ Holy Family Hospital** **□ Caritas Hospital** **□ Hebron Governmental Hospital** **□ Red Crescent Hospital**

Knowledge questions responses regarding ventilator associated pneumonia and preventive bundle practices

1) The next 10 questions ask about infection control measures:

1. Continuous education of NICU nurses on prevention of nosocomial infection can be associated with:

A. Increased rates of VAP

B. Decreased rates of VAP

C. Does not influence the rates VAP

D. I do not know

2. Increased the nurse – patient ratio who work with patients in critical care setting is associated with:

A. Increased risk for VAP

B. Decreased risk for VAP

C. Does not influence the risk for VAP

D. I do not know

3. Frequency of ventilator circuit changes:

A. It is recommended to change circuits every day.

B. It is recommended to change circuits when visibly soiled or malfunction.

C. It is recommended to change circuits every month.

D. I do not know.

4. Ventilator and bedside maintenance:

A. It is recommended to decontaminate respiratory and bedside equipment with germicidal wipes routinely every shift and whenever soiled.

B. It is recommended to decontaminate respiratory and bedside equipment with germicidal wipes whenever soiled.

C. Decontamination of respiratory and bedside equipment with germicidal wipes does not influence the risk of VAP.

D. I do not know.

5. Condensation in the ventilator circuit:

A. It is recommended to drain tubing condensation away from patient routinely before care and before position changes

B. It is recommended to drain tubing condensation away from patient frequently

C. Condensation in the ventilator circuit does not influence the risk of VAP

D. I do not know

6. It is recommended to change humidifier of ventilator :

A. Every day.

B. Every week.

C. Every month.

D. I do not know.

7. Routine hand washing is one of the most important strategies to reduce nosocomial infections.

a. True b. False

8. Decreasing length of ventilator days is the most important strategy for the prevention of ventilator-associated pneumonia.

a. True b. False.

9. Neonates are at higher risk of ventilator-associated pneumonia because of immature immune systems and immature mucous membrane barrier protection.

a. True b. False.

10. Most common organisms that may cause VAP: Pseudomonas aeruginosa, Staphylococcus aureus, E. coli and Klebsiella pneumoniae.

a. True b. False.

2) The next 10 questions ask about oral care in care of ventilated patients:

1. It is recommended to perform Oral care by using a swab moistened with mouth wash and sterile water:

A. One time per shift.

B. Every 3 hours.

C. Whenever necessary.

D. I do not know.

2. Insertion of the suction catheter into the endotracheal tube:

A. Is a sterile procedure

B. Is a clean procedure

C. Can be a clean or a sterile procedure

D. I do not know.

3. ETT suctioning should be done to patient:

A. Every 3 hours.

B. Routinely to every shift.

C. As needed.

D. I do not know.

4. A nurse is required to dispose a suction catheter:

A. Immediately after one single use

B. Can be cleaned and used twice

C. Can be used without being cleaned

D. I do not know

5. Which of the following is best recommended routine when intubating a premature infant?

A. Oral intubation is recommended.

B. Nasal intubation is recommended.

C. Both routes of intubation can be recommended.

D. I do not know.

6. Over feeding a ventilated patient is associated with:

A. Increased the risk for VAP

B. Decreased the risk for VAP

C. Do not influence the risk for VAP

D. I do not know.

7. All of the following are risk factors for ventilator-associated pneumonia (VAP), except:

A. Polycythemia of the Newborn.

B. Long duration of mechanical ventilation.

C. Multiple intubations.

D. Crowding & understaffing.

8. All of the following are signs of worsening gas exchange, except:

A. Oxygen desaturation.

B. Increased oxygen requirement.

C. Decreased oxygen requirement.

D. Increased ventilator support.

9. Breast milk has been associated with a lower risk of sepsis in preterm infants:

a. True b. False

10. Neonates may be at greater risk for aspiration because their ET tubes are cuffed:

a. True b. False

3). The next 10 questions ask about NICU Providers' knowledge of Head of Bed (HOB) and positioning in Care of Ventilated Patients:

1. Patient positioning:

A. Supine positioning is recommended

B. Semi recumbent positioning is recommended

C. The position of the patient does not influence the risk for VAP

D. I do not know

2. VAP can be decreased by about 35-45% by head of bed elevation by:

A. 15-30 degrees

B. 30-45 degrees

C. 45- 60 degrees

D. I do not know

3. Head of bed elevation prevents:

A. Reflux and aspiration of bacteria from the stomach into the airways.

B. Over distention of the stomach

C. Increased gastric residual volume

D. Bed sores.

4. Maintaining head of bed elevation in intubated premature infant is a:

A. High cost, low risk intervention.

B. Low cost, low risk intervention.

C. Simple, but not useful intervention.

D. I do not know.

5. Head of bed elevation has been shown to decrease VAP and:

A. Not create adverse effects, minimal risk or cost.

B. Improve mechanical ventilation.

C. Decrease sedation of the patient.

D. Increase pressure ulcers.

6. Interventions to prevent VAP for the neonates should begin when?

A. When the premature infant is admitted to the NICU.

B. When the premature infant initially receives oxygen.

C. When the premature infant is intubated.

D. When the premature infant has increased oxygen demands while ventilated.

7. Early weaning:

A. Early weaning reduce the risk for VAP

B. Early weaning increase the risk for VAP

C. Early weaning do not influence the risk for VAP

D. I do not know

8. Unplanned extubation is associated with increased risk of aspiration therefore:

A. Increase the risk for VAP

B. Decrease the risk for VAP

C. Do not influence the risk for VAP

D. I do not know

9. The colonization of bacteria that causes VAP occurs in:

A. Respiratory system.

B. Digestive system.

C. Urinary system.

D. Digestive and respiratory systems.

10. Ventilator-associated pneumonia (VAP) would occur in patients who have received mechanical ventilation for longer than:

A. 12 hrs.

B. 24 hrs.

C. 36 hrs.

D. 48 hrs.