INCREASING THE POTENTIALITY OF NURSES FOR PREVENTION OF VENTILATOR-ASSOCIATED PNEUMONIA

SUPANEE CHUCHAT

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Thesis
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INCREASING THE POTENTIALITY OF NURSES FOR PREVENTION OF VENTILATOR-ASSOCIATED PNEUMONIA

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ABSTRACT

Ventilator-associated pneumonia (VAP) is the second most common nosocomial infection with a high mortality rate. This quasi- intervention study was conducted to compare the knowledge and practice towards VAP prevention among nurses and incidence rates of VAP between pre and post- intervention program during April 2005 to February 2006 at Maharaj Nakhon Si Thammarat Hospital. The intervention programs included group discussion, brain storming, education and training practices on VAP prevention. The study samples included 40 nurses working in the studied medical ward. The studied nurses were interviewed by using a questionnaire and observed on practice guidelines for VAP prevention. The VAP incidence rates in pre and post-intervention period were determined according to infection control surveillance program of the hospital. Identification of the causative bacteria of VAP was also carried out in all cases of VAP patients.

Results revealed that the nurses ages ranged from 23 to 42 years old (mean 30.5 ± 5.8 years). Approximately 92.5% were registered nurses and 7.5% were technical nurses with duration of working of 8.7 years. About 52% of the studied nurses reported that they had no knowledge on VAP practice guidelines. The knowledge mean scores on VAP prevention after the intervention program were significantly higher than those pre-intervention (22.9 vs. 20.9, $p<0.001$).The proportion of nurses who practiced on VAP prevention (oral care, patients positioning, endotracheal tube suctioning, enteral feeding care and management of respiratory equipment) increased from 74.2% to 85.9% ($p<0.001$). The incidences of VAP declined from 21.1% to 13.3% or from 17.3 to 9.4 per 1,000 ventilator – days ($p<0.05$). The most common causative bacteria of VAP were *Acinetobacter baumannii* and *Pseudomonas aeruginosa* in the pre and post-intervention period, respectively. The results of this study suggested that understanding the practice guidelines for VAP prevention should be emphasized as standard nursing care for patients with mechanical ventilators. Application of the intervention program to all involved nurses could reduce incidence of VAP.

KEY WORDS: VENTILATOR-ASSOCIATED PNEUMONIA/ INTERVENTION STUDY/ NURSING PRACTICE GUIDELINES

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การเพิ่มศักยภาพของพยาบาลเพื่อป้องกันการติดเชื้อปอดอักเสบจากการใช้เครื่องช่วยหายใจ
(INCREASING THE POTENTIALITY OF NURSES FOR PREVENTION OF VENTILATOR-ASSOCIATED PNEUMONIA)

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บทคัดย่อ

ปอดอักเสบจากการใช้เครื่องช่วยหายใจเป็นการติดเชื้อที่พบเป็นอันดับสองของการติดเชื้อในโรงพยาบาลที่ทำให้อัตราป่วยตายสูง การศึกษาครั้งนี้เป็นแบบกึ่งทดลองเฝ้าสังเกตและติดตามผลของการดำเนินการเพื่อป้องกันการติดเชื้อปอดอักเสบจากการใช้เครื่องช่วยหายใจ โดยเปรียบเทียบความรู้ การปฏิบัติตามแนวทางการป้องกันปอดอักเสบจากการใช้เครื่องช่วยหายใจและอุบัติการณ์การเกิดปอดอักเสบจากการใช้เครื่องช่วยหายใจก่อนและหลังการดำเนินการ ซึ่งประกอบด้วย การสนทนากลุ่ม การให้ความรู้และฝึกปฏิบัติเพื่อป้องกันปอดอักเสบจากการใช้เครื่องช่วยหายใจ ระหว่าง เดือนเมษายน 2548 ถึง กุมภาพันธ์ 2549 กลุ่มตัวอย่างเป็นพยาบาล จำนวน 40 คนปฏิบัติงานในหอผู้ป่วยอายุรกรรม โรงพยาบาลมหาราชนครศรีธรรมราช เก็บข้อมูลโดยใช้แบบประเมินความรู้และสังเกตการปฏิบัติการพยาบาลตามแนวทางการดูแลผู้ป่วยเพื่อป้องกันปอดอักเสบจากการใช้เครื่องช่วยหายใจ เก็บข้อมูลอุบัติการณ์ปอดอักเสบจากการใช้เครื่องช่วยหายใจโดยใช้ระบบการเฝ้าระวังการติดเชื้อในโรงพยาบาลและตรวจหาแบคทีเรียที่เป็นสาเหตุปอดอักเสบจากการใช้เครื่องช่วยหายใจทั้งก่อนและหลัง ดำเนินการ

ผลการศึกษาพบว่า พยาบาลที่ศึกษามีอายุตั้งแต่ 23 ปี ถึง 42 ปี (อายุเฉลี่ย 30.5 ±5.8 ปี) ร้อยละ 92.5 เป็นพยาบาลวิชาชีพ และ ร้อยละ 7.5 เป็นพยาบาลเทคนิค มีประสบการการปฏิบัติงานด้านการพยาบาลเฉลี่ย 8.7 ปี ร้อยละ 52 ของพยาบาลไม่เคยรับทราบถึงแนวทางปฏิบัติเพื่อป้องกันปอดอักเสบจากการใช้เครื่องช่วยหายใจมาก่อน คะแนนเฉลี่ยความรู้ของพยาบาลเกี่ยวกับการป้องกันปอดอักเสบจากการใช้เครื่องช่วยหายใจหลังการฝึกอบรมเพิ่มขึ้นกว่าก่อนดำเนินการอย่างมีนัยสำคัญทางสถิติ (22.9 และ 20.9, $p<0.001$) การปฏิบัติตามแนวทางในการดูแลผู้ป่วยเพื่อป้องกันปอดอักเสบจากการใช้เครื่องช่วยหายใจทั้ง 5 หมวด (การทำความสะอาดปากและฟัน, การจัดท่าผู้ป่วย, การดูดเสมหะ, การดูแลให้อาหารทางสายยางและการจัดการเรื่องอุปกรณ์เครื่องช่วยหายใจ) เพิ่มขึ้นมากกว่าก่อนการฝึกอบรมอย่างมีนัยสำคัญทางสถิติ (ร้อยละ 85.9 และ 74.2, $p<0.001$) อุบัติการณ์การเกิดปอดอักเสบจากการใช้เครื่องช่วยหายใจลดลงจากร้อยละ 21.1 เหลือร้อยละ 13.3 หรือจาก 17.3 ครั้ง เหลือ 9.4 ครั้ง ต่อ 1,000 วันที่ใช้เครื่องช่วยหายใจ ($p<0.05$). แบคทีเรียที่เป็นสาเหตุของการเกิดปอดอักเสบจากการใช้เครื่องช่วยหายใจที่พบมากที่สุดในช่วงก่อนและหลังดำเนินการคือเชื้อ *Acinetobacter baumannii* และ *Pseudomonas aeruginosa* ตามลำดับ ผลการศึกษานี้มีข้อเสนอแนะว่าความเข้าใจเรื่องแนวทางปฏิบัติเพื่อป้องกันปอดอักเสบจากการใช้เครื่องช่วยหายใจควรนำไปใช้เป็นมาตรฐานในการดูแลผู้ป่วยที่ใช้เครื่องช่วยหายใจและการนำโครงการฝึกอบรมฯไปใช้กับพยาบาลทุกคนที่เกี่ยวข้อง จะช่วยลดอุบัติการณ์การเกิดปอดอักเสบจากการใช้เครื่องช่วยหายใจ

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INTRODUCTION

Rationale and justification

Nosocomial pneumonia is the second common nosocomial infections. It includes all cases of pneumonia that developed after 48 hours of admission in the hospital (1). The National Nosocomial Infection Surveillance System (NNIS) survey of 112 medical intensive care units in 97 NNIS hospitals in the United States between 1992 and 1997 indicated that nosocomial pneumonia was the second rank of nosocomial infection with 27% of all critically ill patients following urinary tract infection (1). The infection rate increased 6 – 21 folds in intubated patients, while non - intubated patients had infection rate only 0.3% (2,3). Patients who have endotracheal tubes in place and require mechanical ventilation are especially susceptible to ventilator – associated pneumonia (VAP) with estimated incidence ranging from 8% to 28% (1,4). Incidence rates per ventilator – days were 16.8 – 20.5 / 1,000 ventilator – days in different studies (5-8). In Thailand, the nosocomial infection surveillance at Songklanagarind and Siriraj hospitals among critically ill patients during 2001 to 2002 showed that the incidence rate of ventilator – associated pneumonia were 10.8 and 18.8 / 1,000 ventilator – days, respectively (9,10).

Analyses of pneumonia – associated morbidity have caused prolongation of hospitalization by 4.3 – 15.2 days (11,12). The mortality rate ranged from 24 to 50% and even up to 76% when the infection occurred with certain micro-organisms (4). A conservatively estimation of the direct cost of excess hospital stay due to pneumonia was $1.2 billion a year for the nation (13). Because of its reported frequency, associated high fatality rate and attendant costs, nosocomial pneumonia is a major infection control problem. Risk factors of nosocomial pneumonia may be grouped into host factors (intrinsic), clinical conditions that favor microbial colonization and aspiration, such as invasive

procedures, and exposure to contaminated equipment devices, hands, individuals, air, water, and solution and those extrinsic factors related to long ICU stay, previous exposure to antimicrobials and other drugs and nursing care (13).

Maharaj Nakhon Si Thammarat Hospital, a regional hospital, is a 1,000-bed hospital with primary to tertiary care facility. There are two ICUs (medical and surgical ICUs). Data from nosocomial infection surveillance in 2004 reported that proportion rate of VAP was 38.3% of total nosocomial infections and the incidence per ventilator – days was 11.3 / 1,000 ventilator – days (14). The medical ward (32 beds) services patients with critically medical illnesses, especially patients with condition of respiratory failure who were intubated and on mechanical ventilator treatment, both male and female patients. The trend of nosocomial pneumonia increases, especially the VAP rate. Data from October 2004 - March 2005 showed 48 episodes of VAP and a total of 4,796 ventilator - days among 752 intubated patients. The incidence rate was 6.4 % and incidence per ventilator – days was 10.2 / 1,000 ventilator – days (15). Prevention of VAP is advocated as an important goal of management for nosocomial infection. Evidence – based guidelines regarding preventive measures for nosocomial VAP are increasingly available in scientific literature. Recent studies indicated that education for healthcare workers who take care of the patients with mechanical ventilator could decrease VAP rates (16-19). Once infection control personnel understand the epidemiology of hospital acquired pneumonia, they can design strategies to decrease its incidence and to improve its outcome. Moreover, one of preventive measures of VAP is to reduce extrinsic risk factors, especially improvement of nursing care for patients who are receiving mechanical ventilator (3,20,21). In addition, reduction of exposure to contaminated equipment devices, hands and other environments should be implemented.

General objective

To increase knowledge and practice in nursing care of patients on mechanical ventilator for reducing the incidences rate of ventilator –associated pneumonia by using intervention program.

Specific objectives

1. To compare the knowledge towards VAP prevention between pre and post- intervention program among the studied nurses.
2. To compare the practice towards VAP prevention between pre and post-intervention program among the studied nurses.
3. To compare the incidence rate of VAP and causative bacteria in patients who received the nursing care from the studied nurses between pre and post-intervention program.

Scope of study

Intervention program for reducing the incidence of VAP and the causative bacteria of VAP were studied .The studied nurses working in the studied medical ward, Maharaj Nakhon Si Thammarat Hospital were interviewed of knowledge and observed their practice for prevention of VAP and compared between pre and post-intervention program. The intervention program included group discussion, brain storming, education and training practices on VAP prevention. Data from the patients who were admitted in the studied ward during the studied period such as demographic data, medical history and clinical signs and symptoms associated with VAP were recorded in VAP report form. The secretion samples from patients with VAP were collected by closed and sterile system for identification. The incidences rate of VAP and the causative bacteria of VAP were compared between pre and post- intervention.

Hypotheses

1. Mean knowledge score towards prevention of VAP among nurses working in the studied ward of the post- intervention should be more than that of the pre- intervention.

2. Mean practice score towards prevention of VAP among nurses working in the studied ward of the post- intervention should be more than that of the pre- intervention.

3. The incidence rate of VAP among the studied patients in the post- intervention should be lower than that of the pre- intervention.

Definition of terms

1. ventilator – associated pneumonia (VAP) refers specifically to nosocomial bacterial pneumonia that has developed in patients who are receiving mechanical ventilation. The ventilator – associated pneumonia is defined as nosocomial pneumonia in a patient on mechanical ventilatory support (by endotracheal tube or tracheostomy) for ≥ 48 hours. VAP was defined using the Center's for Disease Control and Prevention (CDC,2002) criteria (22). Clinically defined pneumonia includes:

Instructions, complete form only if x-ray criteria are met with **one** of the following:

New or progressive and persistent infiltrate

Consolidation

Cavitation

At least **one** of the following:

Fever (> 38° C/100.4° F) with no other cause

Leukopenia (< 4,000 WBC/mm³) or leukocytosis (> 12,000 WBC/mm³)

Altered mental status with no other cause, in > 70 years.

At least **two** of the following:

New onset of purulent sputum, or change in character of sputum, or increase respiratory secretions, or increase suctioning requirements

New onset or worsening cough, or dyspnea, or tachypnea

Rales or bronchial breath sounds

Worsening gas exchange (e.g., O_2 desats [e.g. $PaO_2/FiO_2 \leq 240$], or increase ventilation demand)

2. **Guideline for prevention of VAP** refers clinical practices guideline implemented for prevention of VAP. The details of guideline consisting of 5 categories included oral care, turning and positioning, endotracheal tube suctioning, enteral feeding, and management of respiratory equipment. The guideline was followed by Maharaj-Nakornsrithammaraj Hospital guideline which was modified from the Centers for Disease Control and Prevention (CDC) recommendations for the prevention of nosocomial pneumonia (20, 23).

Oral care refers to practice of nursing care in oral and dental care of patients. Most bacterial nosocomial pneumonia occurs by aspiration of bacteria colonizing in the oropharynx or upper gastrointestinal tract of the patient, greatly increasing the risk of nosocomial pneumonia. Frequent oral care can decrease the risk of VAP.

Turning and positioning refers to practice of nursing care to elevate the head of the bed to 30 – 45 degree (semi-recumbent position) and turn patients by side every 2 hours. Supine position has been associated with an increased risk of aspiration and VAP.

Endotracheal tube suctioning refers to practice of nursing care of the patient who was intubated with endotracheal or tracheostomy tube for respiration and suction of lower respiratory tract secretion to decrease the secretion collection in respiratory tract by aseptic technique.

Enteral feeding care refers to the delivery of liquid feedings through an enteral feeding tube. Feeding patients enterally increases the intragastric volume and increase the risk of aspiration of stomach contents. Contamination of the tube feed material as a potential source of colonization and VAP.

Management of respiratory equipment refers to practice of nursing care of the patients for respiration and suction secretion, changing ventilator circuits, disinfection and sterilization and maintenance of respiratory equipment.

3. Program intervention

The activities included the short-course training on ventilator-associated pneumonia prevention which consisted of practice guideline for the prevention of VAP, monitoring practices and giving regular feedback.

3.1 Group discussion and brain storming were the method of gathering in group in order to collect the data on problems and decision-making summary for developing the intervention program and the guideline implementation.

3.2 Educational module to improve knowledge and practice related to the prevention of VAP, included information on the following topics related to ventilator-associated pneumonia: 1) Epidemiology and scope of problems, 2) risk factors, 3) etiology, 4) definitions and 5) guideline for prevention of VAP.

3.3 Skill training on clinical practices for prevention of ventilator-associated pneumonia included hand washing technique, suctioning of respiratory tract secretion technique and sterilization or disinfection, and maintenance of respiratory equipment.

4. Incidence rate of ventilator-associated pneumonia was calculated both in terms of incidence rate and incidence density. Incidence rate was defined as a number of VAP per 100 studied patients, incidence density was defined as a number of VAP per 1,000 ventilator-days.

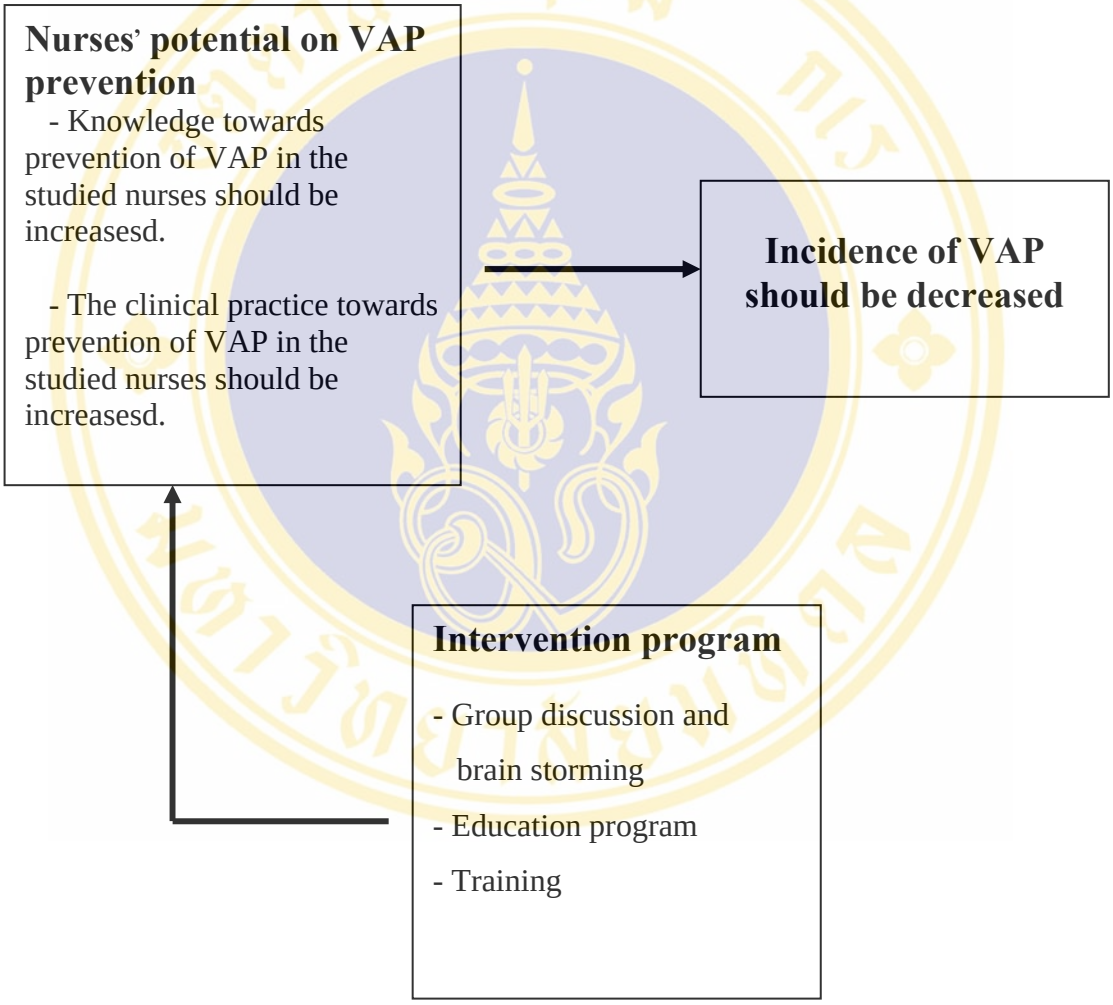
4.1 Incidence rate (%)

$$= \frac{\text{No. of VAP patients}}{\text{No. of patients on mechanical ventilator in the same period}} \times 100$$

4.2 Incidence density (/ 1,000 ventilator-days)

$$= \frac{\text{No. of VAP patients}}{\text{Total of ventilator-days in the same period}} \times 1{,}000$$

Conceptual framework



CHAPTER II
LITERATURE REVIEW

Ventilator-associated pneumonia (VAP) is defined as nosocomial pneumonia in a patient on mechanical ventilators support (by endotracheal tube or tracheostomy) for ≥48 hours (1). According to data from National Nosocomial Infection Surveillance System (NNIS) pneumonia is the second most common nosocomial infection occurring in US hospitals, accounting approximately for 15% of all hospital-acquired infections with fatality rates ranging from 20% to 50% (24,25). Patients who have endotracheal tubes in place and require mechanical ventilation are especially susceptible to ventilator – associated pneumonia resulting in excess mortality, prolonged lengths of hospitalization and increased medical care expanses (1,26,27). Most patients who have nosocomial pneumonia are infants, young children and persons > 65 years of age including those with severe underlying disease, immunosuppressant, depress sensorium, cardiopulmonary disease and persons who have thoracoabdominal surgery. These patients are mechanically associated with ventilation and at highest risk for acquiring infections (24, 28-30).

Epidemiology

The National Nosocomial Infection Surveillance System has stratified the incidence density of nosocomial pneumonia by patients with use of mechanical ventilation and type of intensive-care unit (ICU). From 1986 through 1990, the median rate of ventilator – associated pneumonia cases per 1,000 ventilator-days ranged from 4.7 cases in pediatric ICUs to 34.4 cases in burn ICUs (31). In comparison, the median rate of non ventilator – associated pneumonia cases per 1,000 ICU-days ranges from zero case in pediatric and respiratory ICUs to 3.2 cases in trauma ICUs.

Nosocomial pneumonia has been associated with high fatality rates. Crude mortality rates of 20 - 50% and attributable mortality rates of 30 - 33% have been reported (32-39). Patients receiving mechanically assisted ventilation have higher mortality rates than patients without ventilation support. However other factors such as

underlying diseases and organ failure are stronger predictors of death in patients who have pneumonia (34, 40).

Nosocomial bacterial pneumonia often has been identified as a postoperative infection (29-30,41-42). In the study of the efficacy of nosocomial infection control, which was conducted in the 1970s, 75% of reported cases of nosocomial bacterial pneumonia occurred in patients who had a surgical operation. The risk was 38 times greater for patients who had thoracoabdominal procedures than for those who had procedures involving other body sites (42). More recent epidemiologic studies, including NNIS studies, have identified other subsets of patients at high risk for acquiring nosocomial bacterial pneumonia. Such patients include persons > 70 years of age, persons who have endotracheal intubation and/or mechanically assisted ventilation, a depressed level of consciousness, or underlying chronic lung disease; and persons who have previously had an episode of large-volume aspiration. Other risk factors included 24-hour ventilator-circuit changes, hospitalization during the fall or winter, stress-bleeding prophylaxis with cimitidine, administration of antimicrobials, presence of a nasogastric tube, severe trauma, and recent bronchoscopes (3, 30, 33, 40, 43-45).

Pathogenesis and etiologic agents

Bacteria can invade the lower respiratory tract by aspiration of oropharyngeal organisms, inhalation of aerosols containing bacteria or less frequently by hematogenous spread from a distant body site (Figure 1). In addition, bacterial translocation from the gastrointestinal tract has been hypothesized recently as a mechanism for infection. Of these routes, aspiration is believed to be the most important for both nosocomial and community-acquired pneumonia (33, 40, 42).

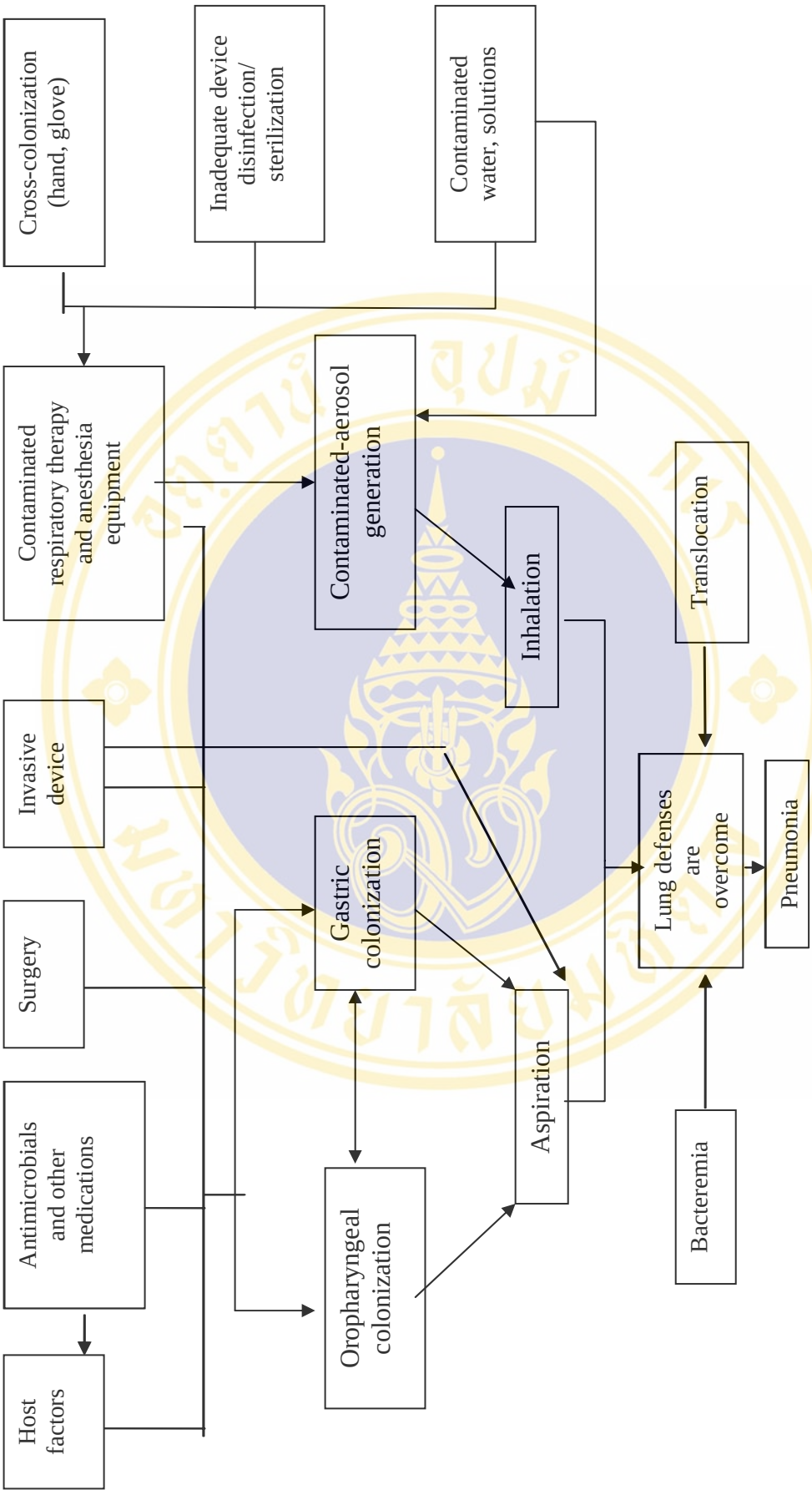


Figure 1 Pathogenesis of nosocomial bacterial pneumonia

Ventilator-associated pneumonia is typically categorized as either early-onset VAP (occurring in the first 3 - 4 days of mechanical ventilation) or late-onset VAP. This distinction is important microbiologically. The early-onset VAP is commonly caused by antibiotic-sensitive community-acquired organisms (eg, *Streptococcus pneumoniae, Haemophilus influenzae,* and *Staphylococcus aureus*) while the late-onset VAP is commonly caused by antibiotic-resistant nosocomial organisms (eg, *Pseudomonas aeruginosa*, methicillin-resistant *Staphylococcus aureus, Acinetobacter* species, and *Enterobacter* species). Most episodes of VAP are thought to develop from the aspiration of oropharyngeal secretions containing potentially pathogenic organisms. Aspiration of gastric secretions may also contribute, though likely to a lesser degree. Tracheal intubation interrupts the body's anatomic and physiologic defenses against aspiration, making mechanical ventilation a major risk factor for VAP (31, 46-49).

The pathogenesis of VAP is related to the number and virulence of organisms entering the lower airway and response of the host's mechanical, humoral and cellular defenses to the invasion. Local trauma and inflammation caused by endotracheal tube and possible leakage of contaminated secretions around the cuff and into the upper trachea increase lower airway colonization, risk of trachobronchitis and VAP (50). In addition, microorganisms aggregated in the biofilm on the surface of the endotracheal tube may have pathogenesis relevance for colonization of the trachea and possible embolization to the lung following maneuvers, such as endotracheal suctioning and bronchoscopy. Risk factors for tracheobronchial colonization with gram-negative bacteria (GNB) appear to be the same as those that favor pneumonia and include more severe illness, longer hospitalization, prior or concomitant use of antibiotics, malnutrition, azotemia, pulmonary disease, or nasogastric or endotracheal tubes in place (49,51-53).

Bacteria also can enter the lower respiratory tract of hospitalized patients through inhalation of aerosols generated primarily by contaminated respiratory-therapy or anesthesia-breathing equipment (24, 54-57). Outbreaks related to the use of respiratory-therapy equipment have been associated with contaminated nebulizer

which are humidification devices that produce large amounts of aerosol droplets <4 mm via ultrasound, spinning disk, or the Venturi mechanism (55-58). When the fluid in the reservoir of a nebulizer becomes contaminated with bacteria, the aerosol produced may contain high concentrations of bacteria that can be deposited deep in the patient's lower respiratory tract (44, 45).

Bacterial pneumonia has resulted, in rare instances, from hematogenous spread of infection to the lung from another infection site (e.g., pneumonia resulting from purulent phlebitis or right-sided endocarditis). Another mechanism, translocation of viable bacteria from the lumen of the gastrointestinal tract through epithelial mucosa to the mesenteric lymph nodes and to the lung, has been demonstrated in animal models (59). Translocation is postulated to occur in patients with immunosuppression, cancer, or burns (59), however, data are insufficient to describe this mechanism in humans (58).

The reported distribution of etiologic agents that cause nosocomial pneumonia differs between hospitals because of different patient populations and diagnostic methods employed (60-64). In general, however, bacteria have been the most frequently isolated pathogens (60-62, 65). During 1986–1989, aerobic bacteria comprised at least 73% and fungi 4% of isolates from sputum and tracheal aspirates obtained from patients who had pneumonia at the University of Michigan Hospitals and at hospitals participating in the National Nosocomial Infection Surveillance (NNIS) System; only a few anaerobic bacteria and no viruses were reported, probably because anaerobic and viral cultures were not performed routinely in the reporting hospitals (66). Similarly, cultures of bronchoscopic specimens obtained from mechanically ventilated patients who had pneumonia have rarely yielded anaerobes (66, 67). Nosocomial bacterial pneumonias are frequently polymicrobial (62, 68) and gram-negative bacilli are usually the predominant organisms (60, 61, 66, 69). However, *Staphylococcus aureus* (especially methicillin-resistant *S. aureus*) (70, 71) and other gram-positive cocci, including *Streptococcus pneumoniae* (61, 72), have emerged recently as important isolates (63). In addition, *Haemophilus influenzae* has been isolated from mechanically ventilated patients who had pneumonia that occurred within 48–96 hours after intubation (62, 66, 70). In hospitals participating in the NNIS, *Pseudomonas aeruginosa, Enterobacter* spp., *Klebsiella pneumoniae*,

Escherichia coli, Serratia marcescens, and *Proteus* spp. comprised 50% of the isolates from cultures of respiratory tract specimens obtained from patients for whom nosocomial pneumonia was diagnosed by using clinical criteria, *S. aureus* accounted for 16%, and *H.influenzae*, for 6% (66). Another study reported that gram-negative bacilli were presented in 75% of quantitative cultures of protected-specimen brushings (PSB) obtained from patients who had acquired nosocomial pneumonia after receiving mechanically assisted ventilation; 40% of these cultures were polymicrobial (61). In another published report, 20% of pathogens recovered from cultures of PSB, blood, pleural fluid, or percutaneous lung aspirate were gram-negative bacilli in pure culture, and 17% were polymicrobial. However, 54% of specimens did not yield any microorganism, probably because the patients from whom these cultures were obtained had been treated with antibiotics (69).

Diagnosis of VAP

Nosocomial bacterial pneumonia has been difficult to diagnose. Frequently, the criteria for diagnosis have been fever, cough, and development of purulent sputum, in conjunction with radiologic evidence of a new or progressive pulmonary infiltrate, a suggestive gram stain, and positive cultures of sputum, tracheal aspirate, pleural fluid, or blood. Although clinical findings in conjunction with cultures of sputum or tracheal specimens may be sensitive for bacterial pathogens, they are highly nonspecific, especially in patients receiving mechanically assisted ventilation; conversely, cultures of blood or pleural fluid have very low sensitivity (20).

The definition of VAP used based on the Centers for Disease Control and Prevention: National Nosocomial Infection Surveillance definitions (22), the criteria included:

Instructions: Complete form only if x-ray criteria are met with **one** of the following:

New or progressive and persistent infiltrate

Consolidation

Cavitation

At least **one** of the following:

Fever (> 38° C/100.4° F) with no other cause

Leukopenia (< 4,000 WBC/mm³) or leukocytosis (> 12,000 WBC/mm³)

Altered mental status with no other cause, in > 70 years.

At least **two** of the following:

New onset of purulent sputum, or change in character of sputum, or increase respiratory secretions, or increase suctioning requirements

New onset or worsening cough, or dyspnea, or tachypnea

Rales or bronchial breath sounds

Worsening gas exchange (e.g., O_2 desats [e.g. $PaO_2/FiO_2 \leq 240$], or increase ventilation demand)

Risk Factors

1. Host factors

Host factors, such as age, malnutrition, immunosuppression, and illness severity also relate to the presence of nosocomial pneumonia. Ventilator-associated pneumonia occurs more often in patients with acute respiratory distress syndrome and comorbidities, such as chronic obstructive pulmonary disease, ethanol abuse, central nervous system dysfunction, renal disease, diabetes, liver, and neoplastic disease, especially lung pathology, which weakens the host's defenses against bacterial colonization (24, 73, 74).

2. Device-related factors and colonization of the orpharynx and/or stomach by microorganisms

2.1 Intubation

In critically ill patients, several factors associated with intubation and mechanical ventilation alter normal defenses against infection. These factors increase the likelihood of VAP.

Lack of anatomic barriers. Once a patient is intubated, bacteria have direct access to the lower airways, because the endotracheal tube bypasses normal filtration mechanisms and the barrier function of the epiglottis. In addition, the endotracheal tube provides a direct route for inoculation of the lungs with such bacteria as *Pseudomonas aeruginosa.* Inoculation is caused by inadequate hand washing, using the same gloves from patient to patient, and contaminated respiratory devices, including in-line nebulizers, spirometers, oxygen sensors, bag-valve mask devices, and

suction catheters (75). *Pseudomonas aeruginosa* adapts and adheres to the respiratory tract better than does other gram-negative bacteria. The *Pseudomonas aeruginosa* pathogen also produces exoproducts that affect cellular function and structure in the tracheobronchial tree and impair host defenses (67, 76).

Impaired cough. Intubation interferes with natural host mechanisms by reducing the cough effort, interfering with mucociliary clearance, and injuring the epithelial layer, thereby exposing the basement membrane. These last two factors injury to the epitheium and basement membrane appear to play a key role in facilitating bacterial adherence and colonization (75).

Alteration of mucus and mucociliary clearance. Mucus is normally produced to trap bacteria, which is then removed by mucociliary clearance. Intubation may result in increased production of mucus and stagnation of mucus in the respiratory tract. These factors, combined with impaired mucociliary clearance, increase the risk of VAP (75).

2.2 Aspiration, enteral nutrition feedings

Another risk factor for VAP is enteral feedings. In results of a recent study, it was noted that 80% of all patients were colonized after 7 days of enteral feeding (77). Feeding patients enterally increased the intragastric volume and thereby increased the risk of aspiration of stomach contents. Contamination of the tube-fed material has also been identified as a potential source of colonization and VAP. Feedings may also alter gastric pH, increasing bacterial growth.

Aspiration of gastric contents

An increased incidence of VAP has been associated with subclinical aspiration of gastric contents(78). Several factors are related to aspiration of gastric contents and colonization of the respiratory tract by pathogens from the GI tract. Most critically ill patients have a nasogastric or nasoenteric tube inserted for gastric decompression or nutritional support. Such tubes increase the risk of aspiration through such mechanisms as reflux and translocation of bacteria. Medications and enteral feedings can alter the acidity of gastric juices, increasing the likelihood of bacterial growth. Improper positioning during feeding may also increase the risk for aspiration of GI contents.

Reflux. When nasogastric or nasoenteric tubes are placed, the gastroesophageal sphincter is violated, enhancing the potential for gastrointestinal reflux. Once reflux

occurs, the upper airway is exposed to an increased number of bacteria. Gastrointestinal tubes may also provide a mechanism for bacteria to migrate, referred to as translocation, up to the oropharynx and colonize the airway (24).

2.3 Stress ulcer prophylaxis

The use of antacids and H2 receptor-antagonists has been identified as contributing factors for the development of VAP (30). These drugs are prescribed in critically ill patients for stress ulcer prophylaxis. They increase the pH of gastric secretions, which affects the normal flora of the GI tract. Pathogens proliferate in gastric secretions, increasing the likelihood of VAP, aspiration of gastric contents should occur. Duodenal reflux and a gastric pH higher than 3.5 have been associated with increased bacterial colonization of the lower respiratory tract (30, 79).

In many studies during the past few years, the incidence of VAP has been recorded with administration of antacids, H_2 receptor-antagonists, or sucralfate to prevent stress ulcers. There is controversy about which therapy is best in critically ill patients. Kappstein *et al.* compared the incidence of VAP in 104 mechanically ventilated patients who were treated with cimetidine or sucralfate. The incidence of VAP was 45.5% in the cimetidine group and 26.5% in the sucralfate group. Mean gastric pH values was significantly lower in the group that received sucralfate, which decreases the likelihood of bacterial growth (80).

2.4 Supine positioning

Supine patient positioning may also facilitate aspiration, which may be decreased by semi recumbent positioning. Using radioactive-labeled enteral feeding, cumulative numbers of endotracheal counts were higher when patients were placed in a completely supine position (0°), compared with a semi recumbent position (45°) (81, 82). One randomized trial demonstrated a 3-fold reduction in the incidence of VAP in patients who were treated while in a semi recumbent position, compared with patients who were treated while completely supine (83).

3. Conditions requiring prolonged use of mechanical ventilators support with potential exposure to contaminated respiratory equipment and/or contact with contaminated or colonized hands of HCWs.

3.1 Mechanically assisted ventilation and endotracheal intubation

Patients receiving continuous, mechanically assisted ventilation have 6–21 times of the risk for acquiring nosocomial pneumonia compared with patients not receiving ventilators support (24,84). One study indicated that the risk for developing ventilator-associated pneumonia increased by 1% per day (61). This increased risk was attributed partially to carriage of oropharyngeal organisms upon passage of the endotracheal tube into the trachea during intubation, as well as to depress host defenses secondary to the patient's severe underlying illness. In addition, bacteria can aggregate on the surface of the tube over time and form a glycocalyx (i.e., a biofilm) that protects the bacteria from the action of antimicrobial agents or host defenses (74, 85). Some researchers believe that these bacterial aggregates can become dislodged by ventilation flow, tube manipulation, or suctioning and subsequently embolize into the lower respiratory tract and cause focal pneumonia (86).

3.2 Cross-Colonization via Hands of HCWs

Pathogens that cause nosocomial pneumonia (e.g., gram-negative bacilli and *S. aureus*) are ubiquitous in hospitals, especially in intensive or critical-care areas. Transmission of these microorganisms to patients frequently occurs via an attending HCW's hands that have become contaminated or transiently colonized with the microorganisms. Procedures, such as tracheal suctioning and manipulation of the ventilator circuit or endotracheal tubes increase the opportunity for cross-contamination (87-89). The risk for cross-contamination can be reduced by using aseptic techniques and sterile or disinfected equipment and by eliminating pathogens from the hands of HCWs (3, 21).

3.3 Contamination of devices used on the respiratory tract

Devices used on the respiratory tract for respiratory therapy (e.g., nebulizers), diagnostic examination (e.g., bronchoscopes and spirometers), and administration of anesthesia are potential reservoirs and vehicles for infectious microorganisms. Routes of transmission might be from device to patient, from one patient to another, or from one body site to the lower respiratory tract of the same patient via hand or device. Contaminated reservoirs of aerosol-producing devices (e.g., nebulizers) can allow the growth of hydrophilic bacteria that subsequently can be aerosolized during use of the device. Gram-negative bacilli can multiply to substantial concentrations in nebulizer fluid and increase the risk for pneumonia in patients using such devices (90-92).

Recommendations for preventing bacterial nosocomial pneumonia

As in previous CDC guidelines (20), each recommendation is categorized on the basis of existing scientific evidence, theoretical rationale, applicability, and economic impact. However, the previous CDC system of categorizing recommendations has been modified as follows:

CATEGORY IA	Strongly recommended for all hospitals and strongly supported by well-designed experimental or epidemiologic studies.
CATEGORY IB	Strongly recommended for all hospitals and viewed as effective by experts in the field and a consensus of HICPAC. These recommendations are based on strong rationale and suggestive evidence, even though definitive scientific studies may not have been done.
CATEGORY II	Suggested for implementation in many hospitals. These recommendations may be supported by suggestive clinical or epidemiologic studies, a strong theoretical rationale, or definitive studies applicable to some but not all hospitals.
NO RECOMMENDATION; UNRESOLVED ISSUE	Practices for which insufficient evidence or consensus regarding efficacy exists.

I. Staff Education and Infection Surveillance

A. Staff education

Educate HCWs regarding nosocomial bacterial pneumonias and infection control procedures used to prevent these pneumonias. CATEGORY IA

B. Surveillance

1. Conduct surveillance of bacterial pneumonia among ICU patients at high risk for nosocomial bacterial pneumonia (e.g., patients receiving mechanically assisted ventilation and selected postoperative patients) to determine trends and identify potential problems. Include data regarding the causative microorganisms and their antimicrobial susceptibility patterns. Express data as rates (e.g., number of

infected patients or infections per 100 ICU days or per 1,000 ventilator-days) to facilitate intrahospital comparisons and determination of trends. CATEGORY IA

2. Do not routinely perform surveillance cultures of patients or of equipmentor devices used for respiratory therapy, pulmonary-function testing, or delivery of inhalation anesthesia. CATEGORY IA

II. Interrupting transmission of microorganisms

A. Sterilization or disinfection and maintenance of equipment and devices

1. **General measures**

a. Thoroughly clean all equipment and devices before sterilization or disinfection. CATEGORY IA

b. Sterilize or use high-level disinfection for semicritical equipment or devices(i.e., items that comes into direct or indirect contact with mucous membranes of the lower respiratory tract). High-level disinfection can be achieved either by wet heat pasteurization at 76^0 C for 30 minutes or by using liquid chemical disinfectants approved as sterilants/ disinfectants by the Environmental Protection Agency and cleared for marketing for use on medical instruments by the Office of Device Evaluation, Center for Devices and Radiologic Health, Food and Drug Administration. Follow disinfection with appropriate rinsing, drying, and packaging, taking care not to contaminate the items in the process. CATEGORY IB

c. (1) Use sterile (not distilled, nonsterile) water for rinsing reusable semicritical equipment and devices used on the respiratory tract after they have been disinfected chemically. CATEGORYIB

(2) No Recommendation for using tap water (as an alternative to sterile water) to rinse reusable semicritical equipment and devices used on the respiratory tract after such items have been subjected to high level disinfection, regardless of whether rinsing is followed by drying with or without the use of alcohol. UNRESOLVED ISSUE

d. Do not reprocess equipment or devices that are manufactured

for a single use only, unless data indicate that reprocessing such items poses no threat to the patient, is cost-effective, and does not change the structural integrity or function of the equipment or device. CATEGORY IB

2. **Mechanical ventilators, breathing circuits, humidifiers, and nebulizers**

A. **Mechanical ventilators.** Do not routinely sterilize or disinfect the internal machinery of mechanical ventilators. CATEGORY IA

B. **Ventilator circuits with humidifiers**

(1) Do not routinely change more frequently than every 48 hours the breathing circuit, including tubing and exhalation valve, and the attached bubbling or wick humidifier of a ventilator that is being used on an individual patient. CATEGORY IA

(2) No Recommendation for the maximum length of time after which the breathing circuit and the attached bubbling or wick humidifier of a ventilator being used on a patient should be changed. UNRESOLVED ISSUE

(3) Sterilize reusable breathing circuits and bubbling or wick Humidifiers or subject them to high-level disinfection between their uses on different patients. CATEGORY IB

(4) Periodically drain and discard any condensate that collects in the tubing of a mechanical ventilator, taking precautions not to allow condensate to drain toward the patient. Wash hands after performing the procedure or handling the fluid. CATEGORY IB

(5) No Recommendation for placing a filter or trap at the distal end of the expiratory-phase tubing of the breathing circuit to collect condensate. UNRESOLVED ISSUE

(6) Do not place bacterial filters between the humidifier reservoir and the inspiratory-phase tubing of the breathing circuit of a mechanical ventilator. CATEGORY IB

(7) Humidifier fluids

a) Use sterile water to fill bubbling humidifiers. CATEGORY II

b) Use sterile, distilled, or tap water to fill wick humidifiers. CATEGORY II

c) No Recommendation for preferential use of a closed, continuous feed humidification system. UNRESOLVED ISSUE

C. Ventilator breathing circuits with hygroscopic condenser-humidifiers or heat-moisture exchangers

(1) No Recommendation for preferential use of hygroscopic condenser humidifier or heat-moisture exchanger rather than a heated humidifier to prevent nosocomial pneumonia. UNRESOLVEDISSUE

(2) Change the hygroscopic condenser-humidifier or heat-moisture exchanger according to the manufacturer's recommendation and/or when evidence of gross contamination or mechanical dysfunction of the device is present. CATEGORY IB

(3) Do not routinely change the breathing circuit attached to a hygroscopic condenser-humidifier or heat-moisture exchanger while it is being used on a patient. CATEGORY IB

3. **Wall humidifiers**

a. Follow manufacturers' instructions for using and maintaining wall oxygen humidifiers unless data indicate that modifying the instructions poses no threat to the patient and is cost-effective. CATEGORY IB

b. Between uses on different patients, change the tubing, including any nasal prongs or mask, used to deliver oxygen from a wall outlet. CATEGORY IB

4. **Small-volume medication nebulizers: "in-line" and hand-held nebulizers**

a. (1) Between treatments on the same patient, disinfect, rinse with sterile water, or air-dry small-volume medication nebulizers. CATEGORY IB

(2) No Recommendation for using tap water as an alternative to sterile water when rinsing reusable small-volume medication nebulizers between treatments on the same patient. UNRESOLVED ISSUE

b. Between uses on different patients, replace nebulizers with those that have undergone sterilization or high-level disinfection. CATEGORY IB

c. Use only sterile fluids for nebulization, and dispense these fluids aseptically. CATEGORY IA

d. If multi-dose medication vials are used, handle, dispense, and store them according to manufacturers' instructions. CATEGORY IB

5. **Large-volume nebulizers and mist tents**

a. Do not use large-volume room-air humidifiers that create aerosols (e.g.,by Venturi principle, ultrasound, or spinning disk) and thus are actually nebulizers, unless they can be sterilized or subjected to high-level disinfection at least daily and filled only with sterile water. CATEGORY IA

b. Sterilize large-volume nebulizers that are used for inhalation therapy (e.g., for tracheostomized patients) or subject them to high-level disinfection between uses on different patients and after every 24 hours of use on the same patient . CATEGORY IB

c. (1) Use mist-tent nebulizers and reservoirs that have undergone sterilization or high-level disinfection, and replace these items between uses on different patients . CATEGORY IB

(2) No Recommendation regarding the frequency of changing mist-tent nebulizers and reservoirs while such devices are being used on one patient. UNRESOLVED ISSUE

6. **Other devices used in association with respiratory therapy**

a. Between uses on different patients, sterilize or subject to high-level disinfection portable respirometers, oxygen sensors, and other respiratory devices used on multiple patients. CATEGORY IB

b. (1) Between uses on different patients, sterilize or subject to high-level disinfection reusable hand-powered resuscitation bags (e.g., Ambu bags). CATEGORY IA

(2) No Recommendation regarding the frequency of changing hydrophobic filters placed on the connection port of resuscitation bags. UNRESOLVED ISSUE

7. **Anesthesia machines and breathing systems or patient circuits**

a. Do not routinely sterilize or disinfect the internal machinery of anesthesia equipment. CATEGORY IA

b. Clean and then sterilize or subject to high-level liquid chemical disinfection or pasteurization reusable components of the breathing system or patient circuit (e.g., tracheal tube or face mask, inspiratory and expiratory breathing tubing, y-piece, reservoir bag, humidifier, and humidifier tubing) between uses on different patients by following the device manufacturers' instructions for reprocessing such components . CATEGORY IB

c. No Recommendation for the frequency of routinely cleaning and disinfecting unidirectional valves and carbon dioxide absorber chambers . UNRESOLVED ISSUE

d. Follow published guidelines and/or manufacturers' instructions regarding in-use maintenance, cleaning, and disinfection or sterilization of other components or attachments of the breathing system or patient circuit of anesthesia equipment. CATEGORY IB

e. Periodically drain and discard any condensate that collects in the tubing of a breathing circuit, taking precautions not to allow condensate to drain toward the patient. After performing the procedure or handling the fluid, wash hands with soap and water or with a waterless hand washing preparation. CATEGORY IB

f. No Recommendation for placing a bacterial filter in the breathing system or patient circuit of anesthesia equipment. UNRESOLVED ISSUE

8. **Pulmonary-function testing equipment**

a. Do not routinely sterilize or disinfect the internal machinery of pulmonary- function testing machines between uses on different patients . CATEGORY II

b. Sterilize or subject to high-level liquid-chemical disinfection or pasteurization reusable mouthpieces and tubing or connectors between uses on different patients, or follow the device manufacturers' instructions for their reprocessing. CATEGORY IB

B. Interrupting person-to-person transmission of bacteria

1. **Hand washing**

Regardless of whether gloves are worn, wash hands after contact with mucous membranes, respiratory secretions, or objects contaminated with respiratory secretions. Regardless of whether gloves are worn, wash hands both before and after contact with a) a patient who has an endotracheal or tracheostomy tube in place and b) any respiratory device that is used on the patient. CATEGORY IA

2. **Barrier precautions**

a. Wear gloves for handling respiratory secretions or objects contaminated with respiratory secretions of any patient. CATEGORY IA

b. Change gloves and wash hands a) after contact with a patient; b) after handling respiratory secretions or objects contaminated with secretions from one patient and before contact with another patient, object, or environmental surface; and c) between contacts with a contaminated body site and the respiratory tract of, or respiratory device on, the same patient . CATEGORY IA

c. Wear a gown if soiling with respiratory secretions from a patient is anticipated, and change the gown after such contact and before providing care to another patient. CATEGORY IB

3. **Care of patients who have a tracheostomy**

a. Perform tracheostomy under sterile conditions. CATEGORY IB

b. When changing a tracheostomy tube, use aseptic techniques and replace the tube with one that has undergone sterilization or high-level disinfection. CATEGORY IB

4. **Suctioning of respiratory tract secretions**

a. No Recommendation for wearing sterile gloves rather than clean but non sterile gloves when suctioning a patient’s respiratory secretions. UNRESOLVED ISSUE

b. If the open-suction system is employed, use a sterile single-use catheter. CATEGORY II

c. Use only sterile fluid to remove secretions from the suction catheter if the catheter is to be used for re-entry into the patient’s lower respiratory tract. CATEGORY IB

d. No Recommendation for preferential use of the multiuse closed-system suction catheter or the single-use open-system catheter for prevention of pneumonia . UNRESOLVED ISSUE

e. Change the entire length of suction-collection tubing between uses on different patients. CATEGORY IB

f. Change suction-collection canisters between uses on different patients except when used in short-term–care units. CATEGORY IB

III. Modifying host risk for infection

A. Precautions for preventing endogenous pneumonia

Discontinue enteral-tube feeding and remove devices such as endotracheal, tracheostomy, and/or enteral (i.e., orogastric, nasogastric, or jejunal) tubes from patients as soon as the clinical indications for these are resolved. CATEGORY IB

1. **Preventing aspiration associated with enteral feeding**

a. If the maneuver is not contraindicated, elevate at an angle of 30º–45º the head of the bed of a patient at high risk for aspiration pneumonia (e.g., a patient receiving mechanically assisted ventilation and/or who has an enteral tube in place). CATEGORY IB

b. Routinely verify the appropriate placement of the feeding tube. CATEGORY IB

c. Routinely assess the patient's intestinal motility (e.g., by auscultating for bowel sounds and measuring residual gastric volume or abdominal girth) and adjust the rate and volume of enteral feeding to avoid regurgitation. CATEGORY IB

d. No Recommendation for the preferential use of small-bore tubes for enteral feeding . UNRESOLVED ISSUE

e. No Recommendation for administering enteral feeding continuously or intermittently. UNRESOLVED ISSUE

f. No Recommendation for preferentially placing the feeding tubes (e.g.,jejunal tubes) distal to the pylorus. UNRESOLVED ISSUE

2. **Preventing aspiration associated with endotracheal intubation**

a. No Recommendation for using orotracheal rather than nasotracheal tube to prevent nosocomial pneumonia. UNRESOLVED ISSUE

b. No Recommendation for routinely using an endotracheal tube with a dorsal lumen above the endotracheal cuff to allow drainage (i.e., by suctioning) of tracheal secretions that accumulate in the patient's subglottic area. UNRESOLVED ISSUE

c. Before deflating the cuff of an endotracheal tube in preparation for tube removal, or before moving the tube, ensure that secretions are cleared from above the tube cuff. CATEGORY IB

3. **Preventing gastric colonization**

a. If stress-bleeding prophylaxis is needed for a patient receiving mechanically assisted ventilation, use an agent that does not raise the patient's gastric pH . CATEGORY II

b. No Recommendation for selective decontamination of a critically ill, mechanically ventilated, or ICU patient's digestive tract with oral and/or intravenous antimicrobials to prevent gram-negative bacillary (or Candida sp.) pneumonia. UNRESOLVED ISSUE

c. No Recommendation for routine acidification of gastric feedings to prevent nosocomial pneumonia. UNRESOLVED ISSUE

B. Preventing postoperative pneumonia

1. Instruct preoperative patients, especially those at high risk for Contracting pneumonia, regarding frequent coughing, taking deep breaths, and ambulating as soon as medically indicated during the postoperative period. Patients at high risk include those who will receive anesthesia especially those who will have an abdominal, thoracic, head, or neck operation and those who have substantial pulmonary dysfunction (e.g., patients who have chronic obstructive lung disease, a musculoskeletal abnormality of the chest, or abnormal pulmonary function tests). CATEGORY IB

2. Encourage postoperative patients to cough frequently, take deep

breaths, move about the bed, and ambulate unless these actions are medically contraindicated. CATEGORY IB

3. Control pain that interferes with coughing and deep breathing during the immediate postoperative period by a) using systemic analgesia, including patient-controlled analgesia, with as little cough suppressant effect as possible; b) providing appropriate support for abdominal wounds, such as tightly placing a pillow across the abdomen; or c) administering regional analgesia (e.g., epidural analgesia). CATEGORY IB

4. Use an incentive spirometer or intermittent positive-pressure breathing equipment on patients at high risk for contracting postoperative pneumonia. CATEGORY II

C. Other prophylactic procedures for pneumonia

1. **Vaccination of patients**

Vaccinate patients at high risk for complications of pneumococcal infections with pneumococcal polysaccharide vaccine. Such patients include persons ages >65 years; adults who have chronic cardiovascular or pulmonary disease, diabetes mellitus, alcoholism, cirrhosis, or cerebrospinal fluid leaks; and children and adults who are immunosuppressed or who have functional or anatomic asplenia or HIV infection . CATEGORY IA

2. **Antimicrobial prophylaxis**

Do not routinely administer systemic antimicrobial agents to prevent nosocomial pneumonia. CATEGORY IA

3. **Use of rotating “kinetic” beds or continuous lateral rotational therapy**

No Recommendation for the routine use of kinetic beds or continuous lateral rotational therapy (i.e., placing the patient on a bed that turns intermittently or continuously on its longitudinal axis) for prevention of nosocomial pneumonia in patients in the ICU, critically ill patients, or patients immobilized by illness and/or trauma. UNRESOLVED ISSUE

Guidelines for prevention of ventilator-associated pneumonia

1. Oral care, as oral secretion pool, pathogens colonize the teeth and oral mucosa. Contaminated oral secretions flow to the subglottic area, where small amounts may be aspirated. The patients in acute care setting or residents in long term care facilities who are at high risk for health care associated pneumonia. Oropharyngeal cleaning and decontamination with an antiseptic agent should remove dental plague that promotes bacterial growth. By oropharyngeal cleaning 2 times per day and when dirty with special mouth wash by soft toothbrush or applicators or chlorhexidine-based solution may prevent or reduce oropharyngeal colonization. If patient can't expectorate during brushing or rinsing, simultaneous oral suctioning should be performed (102).

2. Patient position, semi-recumbent positioning is generally defined as elevation of the head of the bed to 45 degrees and continued for the duration of mechanical ventilation. Semi-recumbent position can reduce VAP rates by 18% and decreases the patient's risk of aspirating gastric contents or oropharyngeal and naso-pharyngeal secretions. The patient can also breathe easier, as elevating the head of the bed lets gravity reduce the work of the diaphragm, and may let abdominal organs rest lower in the abdomen cavity. As a result, the diaphragm can move more easily and deeply during inspiration. Keeping the head of the bed elevated means: the patient's position should be checked frequently because they may tend to slide down in the bed (102).

3. Suctioning sputum refers to practice of nursing care the patients who would be intubated endotracheal tube or tracheostomy tube for respiration and suctioning of lower respiratory tract secretion. It could decrease of collection secretion in respiratory tract and should be done by aseptic technique in the process. Keeping the endotracheal tube cuff pressure between 20 – 30 cmH_2O will prevent bacterial pathogens from leaking around the cuff into the lower respiratory tract and avoids problem related to excessive cuff pressure (102).

4. Enteral feeding: Feeding should start as soon as possible and try to make the least regurgitation of feeding. This can be done by setting the patients in semi-recumbent position, avoiding the gastric residual which has to be followed up to adjust

the appropriate quantity and time for feeding. To avoiding some medicines which decrease the movement of gastrointestinal tract (muscle relaxants), such as narcotics and anticholinergics drug, prescribing metocloparmide occasionally to activate the squeeze and movement of gastrointestinal tract. The patient's tolerance of enteral feeding, auscultative bowel sounds and measure abdominal girth should be monitored frequently. Measuring of residual gastric volume should be made at least every 4 hours during continuous feeding and before each intermittent feeding to decrease the likelihood of gastric distension and aspiration. Less than 200 ml is generally considered as an acceptable amount of gastric residual volume although this can vary from institution to institution. If residual volume is more than 200 ml, stop the enteral feeding for 2 hours then reassess residual volume (21).

5. Management of respiratory equipment. The ventilator circuit has been studied closely because of its possible role in VAP. At present, it is suggested to change the circuit after 48 hour use. According to the study of Silvestei L et al.
a patient who was incubation up to 3 days caught infection of the respiratory tract for 28.0% (93). The study of contamination of microbial agents in the ventilator circuit by Wiblin RT found that the amount of microbial was increased and caused VAP during 3 – 5 days after using the ventilator. Hence, it is necessary to change the ventilator circuit at least every 72 hours. In case of the patients need to apply the aerosol nebulizer since there is a treatment to prescribe the bronchodilator, it is possible to have contamination which can lead to be VAP by inhalations the disease into their lungs. It was necessary to change the ventilator circuit every time between each patient. During the period of waiting to reuse it again, the circuit should be kept steriled and rubbed all over tar joints of the aerosol nebulizer by 70% alcohol every time before and after use (28).

Current research articles related to VAP

The intervention program used in this study was adapted from the concept of hospital accreditation to perform the quality of services by gathering in group of people. All personnel were encouraged to join in solving the problems in order to improve the continuous quality improvement (CQI) process. Brain storming to solve the problems and to improve process of master plan, monitoring and decision-making

summary for developing the intervention program and practice guideline implementation.

Continuous quality improvement (CQI) refers to the approved process of administration in hospital by objective to process of master plan, monitoring, and to set standard guideline which will be implemented continuously and regularly. The purposes were to maximize the effectiveness of nursing care for patients and make everyone be happy in job. The process of continuous quality improvement concepts needs to the highest achievement with efficiency by collaboration from every personnel within the organization (94).

Seubsaion *et al* (95) conducted a study at Buddhachinarat hospital. The results demonstrated the intervention program could decrease infection in the patients in the Intensive Care Unit (ICU). It was found that infections occurred before and after the improvement were 22.8 and 19.2 for 100 patients, respectively. The results appeared that the process of developing the quality of nursing could provide knowledge and skills on prevention and control of infection.

The study of Nenprom (96) in the nursery ward appeared to solve the problems occurring in the ward. The nurses could solve the problems through their strictly following and performing the guideline on prevention of VAP. It was found that percentages of the correct practice increased from 57.2% to 91.8% and 93.9% after intervention within the first and the second months.

Incidence of VAP could be found more often in the Intensive Care Unit (ICU) and the infection increased the mortality rate. According to the patients with low resistance and various supported factors, such as the ignore of nursing personnel to follow the practice on prevention of VAP which consisted of several practices including oral hygiene, setting the position and turn over, providing enteral feeding, suctioning sputum and taking care of respiratory equipment. If nursing personnel strictly practiced and performed their duties along with the principles on prevention of VAP, they could decrease the incidence rate of VAP. Other factors related to the incidence of VAP were ages, underlying disease, level of consciousness, severity of illness and duration of mechanical ventilator. There were many ways to activate and encourage those nursing personnel to strictly follow and perform their duties according to the principles of prevention and control of infection, but it was found that

those ways could not last longer and not sufficiently drive the nursing personnel to strictly follow the principles. Hence, there was a concept to incorporate all personnel collaborating and helping in solving the problems more in every stages ranging from analyzing the problems to performing. It appeared that this concept was better one in order to develop and encourage all nursing personnel to follow and perform their duties and it's hoped to be last longer (94).

CHAPTER III
MATERIALS AND METHODS

1. Study design and method

This study design of intervention (one group pre and post- observation) was carried out among nurses working in the medical ward of Maharaj Nakhon Si Thammarat Hospital. It included 37 registered nurses and 3 technical nurses. The studied nurses who voluntarily participated and signed informed consents were interviewed about knowledge and practice towards prevention of VAP. Other information of data, such as, the incidence rate and causative agents of VAP in the ward in the last year, was assessed. After that, the program intervention to reduce the VAP incidence by the participation of the studied nurses was developed and approved. After the program intervention was implemented, the knowledge and practice towards prevention of VAP as well as the incidence rates and causative bacteria of VAP were assessed again. Data were collected from April, 2005 to February, 2006.

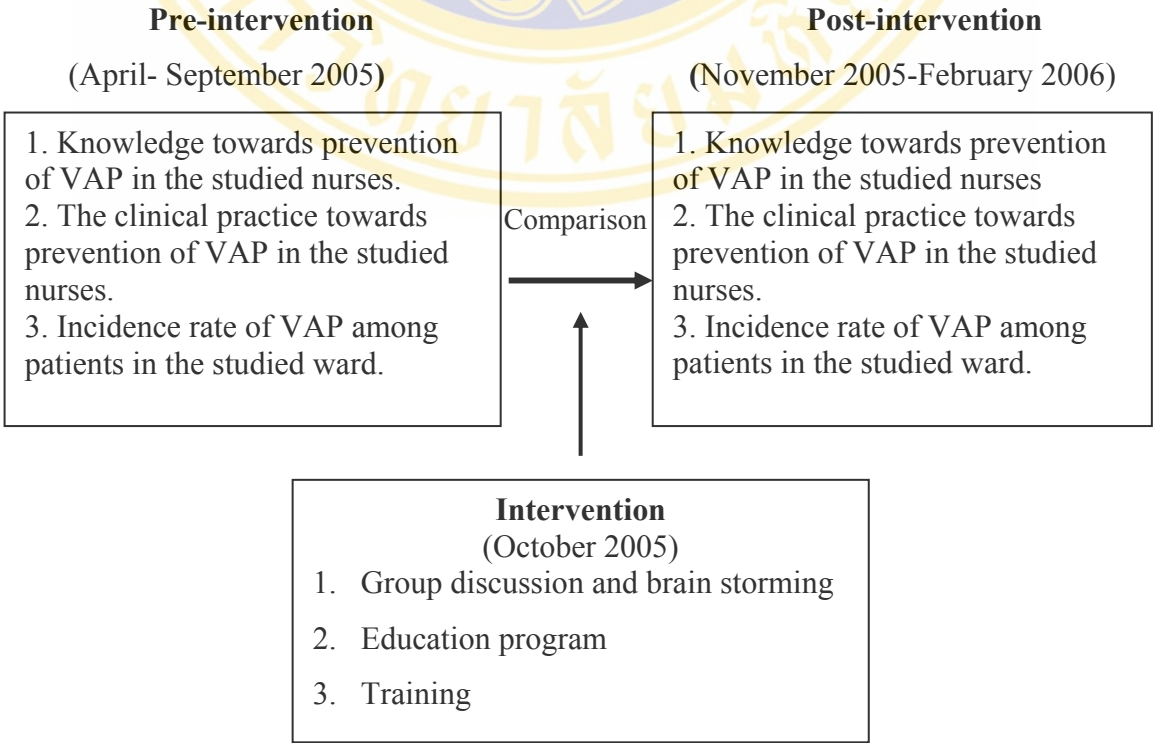


Figure 2 Study design and duration of data collection

2. Study samples

The study sample included 37 registered nurses and 3 technical nurses working in the medical ward of Maharaj Nakhon Si Thammarat Hospital**.**

For the VAP incidence observation, the estimated sample size of patients was calculated from the following formula (97).

$$n = \frac{\left[Z\alpha\sqrt{Po\ (1\text{-}Po)} + Z\beta\sqrt{P_1\ (1\text{-}P_1)}\right]^2}{\left[Po - P_1\right]^2}$$

Where, n = The estimated sample size.

α = The level of statistical significance was set at 0.05

$1\text{-}\beta$ = The power of discrimination value 95 %

P_1 = The incidence rate of VAP (post-intervention) = 0.05

P_0 = The incidence rate of VAP (pre-intervention) = 0.11 (incidence rate of VAP of Maharaj Nakhon Si Thammarat Hospital during 2003-2004) (14).

$\alpha = \beta = 0.05$, $Z\alpha = Z\beta = 1.645$ (one-tailed calculation)

$$n = \frac{\left[1.645\sqrt{0.11\ (1\text{-}0.11)} + 1.645\sqrt{0.05\ (1\text{-}0.05)}\right]^2}{\left[0.11 - 0.05\right]^2}$$

$n = 211$

Therefore, at least 211 intubated patients in each observation period (pre and post-intervention) were required for this study.

Inclusion criteria

The patients who were endotracheal or tracheostomy intubated and mechanically ventilated more than 48 hours after admission in the studied ward.

Exclusion criteria

1. The patients who used mechanical ventilator less than 48 hours after admission in the studied ward.
2. The patients with nosocomial pneumonia or community acquired pneumonia before endotracheal or tracheostomy intubation and on ventilator support.

Study site

The medical ward of Maharaj Nakhon Si Thammarat Hospital consisted of 32 bed services adult patients with critically medical illnesses. Total patients with condition of respiratory failure who were intubated and on mechanical ventilator (Bird' s respirator) treatment, both male and female patients were admitted. This ward was opened unit and consisted of four separated rooms each with 8 beds, no isolation room and no air conditioning. The nurse-patient ratio was 1:3 in morning shift (8 a.m. - 4 p.m.) and 1:4 in night shift (4 p.m. – 8 a.m.). The patient families also participated in taking care of patients. Management of respiratory equipment such as disinfection and sterilization and changing ventilator circuit was done by respiratory equipment center.

3. Research tools

The research tools used in this study consisted of 2 categories.

1. Research tools for data collection

1.1 Structured questionnaire. It consisted of 2 parts.

Part 1. The socio- demographic data of the studied nurses. The characteristics included age, education level, and working experiences**.**

Part 2. Knowledge towards prevention of VAP. It included 2 items, which consisted of 25 questions with total score 25.

Criteria of scoring

Correct = one score

Incorrect /didn' t know = zero score

Criteria for sufficient knowledge and practice of studied nurses should be ≥ 80% of total scores.

1.2 The nurses practice observation record form.

The observation record form used for clinical practices of the studied nurses, who took care of the patients, was followed Maharaj Nakhon Si Thammarat Hospital guideline modified from the Centers for Disease Control and Prevention (CDC) recommendations for prevention of nosocomial pneumonia. This observation record was done by the researcher and the studied nurses were observed their practice at least 2-3 times of each 5 categories in pre and post-intervention period.

The details of observation record consisted of 5 categories including oral care (5 items), turning and positioning (3 items), endotracheal tube suctioning (18 items), enteral feeding care (9 items) and management of respiratory equipment (5 items). This observation record form included date, time and persons involved in the situation by check list the following;

Practice (one score) refers to correct practice

No practice (zero score) refers to no practice or incorrect practice

1.3 Ventilator-associated pneumonia report form

Ventilator-associated pneumonia report form used for recording the data of patients who were admitted in the studied ward, consisted of 5 parts:

Part 1 General characteristics of patients including age, sex, date of admission/ discharge, diagnosis, underlying disease, and level of consciousness.

Part 2 Treatment history including invasive procedures, stress ulcer prophylalaxis and receiving steroids.

Part 3 Clinical signs and symptoms associated with VAP, laboratory results including white blood cell count, and chest x-ray.

Part 4 Results of microbiological investigation.

Part 5 Treatment of VAP.

1.4 Laboratory methods for detecting the causative bacteria of VAP

1.4.1 Secretion specimens from patients were collected and transferred in media to microbiology laboratory and cultured in Blood agar, Chocolate agar and Maconkey agar plate.

1.4.2 Preparation of smear and gram stain was carried out.

1.4.3 All plates were incubated at 35 – 37° C for 18 – 24 hours. Suspected colonies were identified by biochemical test and antibiotic susceptibility test was performed further (98, 99) (Appendix D).

2. Program intervention

The program intervention included the short-course training on VAP prevention which consisted of clinical practice guideline for prevention of VAP, practice monitoring and giving regular feedback. The intervention included:

2.1 Group discussion and brain storming for developing the intervention program and the guideline implementation. The studied nurses were divided into 8 groups. Each group consisted of 5-6 persons and they were meeting at 3 – 4 p.m. in Monday to Friday. The researcher was the moderator and Infection Control Nurse (ICN) was a researcher assistant.

2.2 Skill training on clinical practices to prevention of VAP including hand washing technique, suctioning of respiratory tract secretion technique and sterilization or disinfection of respiratory equipment.

2.3 Educational module to improve knowledge and practice related to the prevention of VAP, including information on the following topics related to ventilator-associated pneumonia: 1) Epidemiology and scope of problems, 2) risk factors, 3) etiology, 4) definitions and 5) guideline for prevention of VAP. The studied nurses were divided into 2 groups. Each group consisted of 20 persons and they were meeting at 3 - 4 p.m. in last week of pre-intervention period.

Details of intervention program were shown in Appendix E.

4. Steps of data collection

The study period was from April, 2005 to February, 2006

1. Inform the Director of Maharaj Nakhon Si Thammarat Hospital and Head of the studied nurses for collecting the data.

2. Asking the Head of the medical ward and the nurses for permission and to elucidate objective for cooperating and collecting the data.

3. The researcher proceeded on the process of the participating action research as the followings:

3.1 Survey of the problems, pre - intervention period. (4 month-study)

3.1.1 Retrospective data collection for determining the incidence rate and causative bacteria of VAP was done. Data were collected from medical records and were recorded in VAP report form (April to July 2005).

3.1.2 The studied nurses were observed for the clinical practice on nursing care for prevention of VAP by the researcher during the routine nursing activities in the first month of the intervention. Total 40 nursing personnel were

observed their practice at least 2-3 times in the morning shift (8 a.m. – 4 p.m.). (September 2005)

3.1.3 The studied nurses completed a structured questionnaire, which consisted of 2 parts, testing their baseline knowledge for prevention of VAP in the pre-intervention.

3.2 Suggesting solution and developing plan of action. (October 2005)

3.2.1 Group discussion and brain storming. The researcher organized the meeting groups to orientate the studied nurses for planning and problem solving by selection of 5 - 6 persons for each group. The meeting period was 1 hour at 3 – 4 p.m. in Monday to Friday (first week of period). The researcher was the moderator and Infection Control Nurse (ICN) was an assistant. After the meeting finished, all group members concluded and confirmed the progression results and problem solving to practice.

3.3.2 Skill training on clinical practices to prevent VAP including hand washing technique, suctioning of respiratory tract secretion technique. During the routine nursing activities, the studied nurses were trained for hand washing technique and suctioning of respiratory tract secretion. Training was observed by the researcher and ICN.

Healthcare workers at respiratory equipment center were trained including cleaning, disinfection with appropriate rinsing, drying, and packaging for sterilization, taking care not to contaminate the items in process.

3.2.3 Education program to improve knowledge and practice related to prevention of VAP, included information on the following topics related to VAP: 1) Epidemiology and scope of problems, 2) risk factors, 3) etiology, 4) definitions and 5) guideline for prevention of VAP. The studied nurses were divided into 2 groups. Each group consisted of 20 persons and they were meeting at 3 – 4 p.m. in last week of this period. Education program was provided by the researcher and ICN, power point presentation and fact sheets towards practice guideline for VAP prevention and used on posters posted in studied ward. After that, the studied nurses developing ideas in nursing discussion until the problems were solved.

The studied nurses practiced according to the standard guideline of VAP prevention. The researcher evaluated program 1 month after finished the program intervention.

3.3 Evaluation: post-intervention period.(November 2005 to February 2006)

3.3.1 The studied nurses completed a structured questionnaire, which consisted of 2 parts, the post-intervention knowledge for prevention of VAP.

3.3.2 The studied nurses were observed for the clinical practice on nursing care for prevention of VAP by the researcher during the routine nursing activities in the first month on the post- intervention. Total 40 nursing personnel were observed their practice at least 2-3 times in the morning shift (8 a.m. – 4 p.m.). (November 2005).

3.3.3 The incidence rate and the causative bacteria of VAP among patients admitted in the studied ward at the time period were assessed. Data were recorded in VAP report form (November 2005 to February 2006).

5. Data Analysis

1. The general characteristics of the studied nurses and studied patients were described by percentage, mean and standard deviation.

2. The knowledge scores of the studied nurses were compared between pre-intervention and post- intervention using paired t-test.

3. The clinical practice towards prevention of VAP of the studied nurses were analyzed by frequency, percentage and compared between pre- intervention and post-intervention using the Chi-square test.

4. The incidence rate of VAP was compared between pre- intervention and post- intervention using the Chi-square test.

6. Ethical issues

The research protocol was submitted and approved by the Ethical Committee of Mahidol University. Written consents for interviewing and observing during the study were obtained from all participated subjects. Collected data were used only for the purpose of this study. All information obtained during interviews was confidential.

CHAPTER IV
RESULTS

Results were presented into 3 parts as follows:

1. Socio-demographic characteristics of studied nurses in a studied ward.
2. Comparison of the studied nurses' knowledge and practice between pre and post- intervention.
   2.1 Knowledge towards ventilator-associated pneumonia prevention.
   2.2 Practice towards ventilator-associated pneumonia prevention.
3. Comparison of studied patients between pre and post- intervention.
   3.1 Socio-demographic characteristics and medical history.
   3.2 Incidence of ventilator-associated pneumonia and microorganisms causing the infection.

1. Socio-demographic characteristics of studied nurses in a studied medical ward.

There were 40 nurses working in a studied medical ward. The age ranged from 23 to 42 years old (mean 30.5 ±5.8 years). Most of them (92.5%) were register nurses and 7.5% were technical nurses. Approximately 37% have working experience in the hospital less than 5 years and 32% have worked for 6-10 years. The mean duration of working was 8.7 years. A half of them have working experience in a studied medical ward more than 2 years. Most studied nurses (90%) had ever received training for respiratory care, 87.5% had ever received training towards infection control of nosocomial infection. However, 62.5% had never received training towards VAP prevention and about 52.5% had no knowledge towards guideline practice for VAP prevention (Table 1).

Table 1 Socio-demographic characteristics of studied nurses in the medical ward of Maharaj-Nakornsrithammaraj Hospital (n=40)

Characteristics	Number	Percentage
Age (years)		
20 – 29	21	52.5
30 – 39	12	30.0
≥ 40	7	17.5
Mean ± SD = 30.48 ±5.8 Range = 23-42 years		
Education		
Certificate of technical nurse	3	7.5
Bachelor's of nursing	35	87.5
Master's degree of nursing	2	5.0
Duration of working experience in the hospital (years)		
≤ 5	15	37.5
6-10	13	32.5
11-15	4	10.0
> 15	8	20.0
Mean ± SD = 8.7 ± 6.2 Range = 0.6 -21 years		
Duration of experience in a studied medical ward (years)		
≤ 1	14	35.0
1-2	6	15.0
> 2	20	50.0
Mean ± SD = 1.2 ± .8 Range = 0 .6 – 2.6 years		
Experienced in training for respiratory care		
Yes	36	90.0
No	4	10.0
Have you ever received training towards infection control of nosocomial infection?		
Yes	35	87.5
No	5	12.5
Have you ever received training towards VAP prevention?		
Yes	15	37.5
No	25	62.5
Have you ever known towards guideline practice for VAP prevention?		
Yes	19	47.5
No	21	52.5

2. Comparison of studied nurses' knowledge and practice between pre and post- intervention.

2.1 Knowledge towards ventilator-associated pneumonia (VAP) prevention.

Pre- intervention, most studied nurses knew the cause of ventilator-associated pneumonia and nursing care patients with mechanical ventilator, for example: 100% knew that bacterial colonization of oropharyngeal could invade the lower respiratory tract by aspiration of gastric contents or via hands of health care workers (HCWs) during suction with neglector aseptic technique. However, only 40-45% knew that retaining of nasogastric tube was one of risk factors of VAP (Table 2). When we classified the knowledge scores into 2 levels, total score of ≥ 80 % (≥20 scores) and < 80% (<20 scores). It showed that, pre-intervention, 82% of the studied nurses had total score ≥ 80 % compared with 97.5% in the post- intervention (Table 3). The mean score of each group of knowledge post- intervention was significantly higher than that pre-intervention ($p < 0.001$) (Table 4).

Table 2 Comparison of knowledge towards VAP prevention among the studied nurses pre and post- intervention by each item (n= 40)

Items	No (%) of studied nurses who answered correctly	
	Pre- intervention	Post- intervention
1. The cause of VAP		
1.1 Bacterial colonization of oropharyngeal can invade the lower respiratory tract by aspiration of gastric contents.	40 (100.0)	40 (100.0)
1.2 Bacterial colonization of oropharyngeal can invade the lower respiratory tract by inhalation of aerosols containing bacteria.	33 (82.5)	35 (87.5)
1.3 Inadequate sterilization and disinfection of respiratory equipment may also increase risk of VAP.	39 (97.5)	38 (95.0)
1.4 During patient suction with neglector aseptic technique, bacteria can invade the lower respiratory tract via hands of HCWs.	40 (100.0)	40 (100.0)

Table 2 Comparison of knowledge towards VAP prevention among the studied nurses pre and post- intervention by each item (n= 40) (continued)

Items	No (%) of studied nurses who answered correctly	
	Pre- intervention	Post- intervention
1.5 Retaining of nasogastric tube is not one of risk factors of VAP.	18 (45.0)	29 (72.5)
1.6 The use of antacids and cimitidine drugs, is not one of risk factors of VAP.	16 (40.0)	23 (57.5)
1.7 Overuse of antibiotics is not one of risk factors of antibiotics resistance VAP.	30 (75.0)	38 (95.0)
1.8 Neglected oral hygiene is one of risk factors of aspirate pneumonia.	28 (70.0)	34(85.0)
2. Nursing care patients with mechanical ventilator.		
2.1 Hand washing is unnecessary after patient suction because of the use of sterile gloves.	39 (97.5)	40 (100.0)
2.2 The frequent unnecessary suction may introduce organisms into the lower respiratory tract.	33 (82.5)	35 (87.5)
2.3 During suction, you can use most regulation pressure because it is easy to clear airway.	39 (97.5)	40 (100.0)
2.4 Timing of patients suction should not be more than 10-15 seconds.	39 (97.5)	40 (100.0)
2.5 After tracheal suction, patients should be hyperventilated with O_2 until peripheral blood keeps $O_2 > 90\%$.	35 (87.5)	40 (100.0)
2.6 For hand hygiene, soap and water or a waterless hand antiseptic should be used before and after ventilator contact or patient suction.	40 (100.0)	40 (100.0)
2.7 Place patients in semi-recumbent position with head of bed elevated 30°-40°, is one of preventive measures of VAP.	35 (87.5)	38 (95.0)

Table 2 Comparison of knowledge towards VAP prevention among the studied nurses pre and post- intervention by each item (n= 40) (continued)

Items	No (%) of studied nurses who answered correctly	
	Pre- intervention	Post- intervention
2.8 Turning body position every 2 hrs, is one of preventive measures of VAP.	31 (77.5)	38 (95.0)
2.9 After using the spirometer from one patient, it must be cleaned with 70% alcohol.	39 (97.5)	40 (100.0)
2.10 Aseptic technique should be unnecessary when changing ventilator circuits.	38 (95.0)	39 (97.5)
2.11 Drain ventilator circuits condensate before repositioning patients, because it should be returned to patients.	37 (92.5)	39 (97.5)
2.12 Drain condensate from ventilator circuits, it is unnecessary to avoid contamination.	39 (97.5)	39 (97.5)
2.13 Change often ventilator circuits, will prevent the VAP.	28 (70.0)	31 (77.5)
2.14 Dressing tracheostomy wound every 12 hours or frequently if it is necessary.	36 (90.0)	39 (97.5)
2.15 Use only sterile water for nubelization and dispense these fluids aseptically.	26 (65.0)	39 (97.5)
2.16 Sterile reusable respiratory equipment such as ventilator circuits, humidifiers, and nebulizers between their uses on different patients.	40 (100.0)	40 (100.0)
2.17 When sterile volume nebulizer at least minimum level, should add sterile water.	29 (72.5)	35 (87.5)

Table 3 Comparison of knowledge score levels towards VAP prevention among the studied nurses pre and post- intervention (n = 40)

Knowledge score levels	No (%) of studied nurses who knew towards VAP prevention	
	Pre- intervention	Post- intervention
The cause of VAP		
≥ 6 scores	27 (67.5)	39 (97.5)
< 6 scores	13 (32.5)	1 (2.5)
Nursing care patients with mechanical ventilator		
≥ 14 scores	32 (80.0)	40 (100.0)
< 14 scores	8 (20.0)	0 (0)
Total		
≥ 20 scores	33 (82.5)	39 (97.5)
< 20 scores	7 (17.5)	1 (2.5)

Criteria for dividing the level: score ≥ 80 % and < 80%

Table 4 Means and standard deviations of knowledge scores towards VAP prevention among the studied nurses pre and post- intervention (n = 40)

Group of knowledge	Pre- intervention	Post- intervention	p-value
	$\bar{X}$ ± SD of knowledge scores		
1. The cause of VAP	5.95 ±1.01	6.85±0.70	<0.0001*
2. Nursing care patients with mechanical ventilator	14.85 ±1.70	16.10±0.95	<0.0001*
Total	20.90 ±2.27	22.95±1.36	<0.0001*

* Statistically significant difference by paired- t test at $\alpha = 0.05$

2.2 Practice towards ventilator-associated pneumonia prevention

Pre- intervention, only 43.6 % of practice frequency towards hand washing or use of clean gloves before oral care and 55.5 % of practice towards changing position of patients' head to the side or place in semi-fowlers were correct. Post- intervention, these percentages of the correct practice were significantly higher than that pre-intervention ($p < 0.001$). Details are shown in Table 5.

Table 5 Comparison of practice towards VAP prevention on oral care of studied nurses pre and post- intervention (n = 110 times of observation)

Item	Times (%) of correct practice observation		p-value
	Pre- intervention	Post- intervention	
1. Position patients head to the side or place in semi-fowlers.	61 (55.5)	87 (79.1)	<0.001*
2. Hand washing or use clean gloves	48 (43.6)	86 (78.2)	<0.001*
3. Forceps or cotton buds or tooth brush, use of special mouth wash for mouth care	110 (100.0)	110 (100.0)	n/a
4. Use suction swab for cleaning of oral secretion.	110 (100.0)	110 (100)	n/a
5. Were given oral care at least two times a day.	110 (100.0)	110 (100.0)	n/a
Total	439 (79.8)	503 (91.4)	<0.001*

* Statistically significant difference by χ^2 test at $\alpha = 0.05$

n/a not applicable

Table 6 shows practice towards VAP prevention on turning and repositioning by observing 110 times of nursing care. Pre- intervention, 64.5% to 76.4% of practice frequencies towards VAP prevention were correct. Post-intervention, these percentages of the correct practice were significantly higher than that pre- intervention ($p < 0.001$). Details are shown in Table 6.

Table 6 Comparison of practice towards VAP prevention on turning and repositioning of studied nurses pre and post- intervention
(n = 110 times of observation)

Item	Times (%) of correct practice observation		p-value
	Pre- intervention	Post- intervention	
1. Checking of endotracheal tube position, drain ventilator circuit condensate before patients repositioning.	84 (76.4)	104 (94.5)	<0.001*
2. Place patients in semi-recumbent position with head elevated 30°-40° unless medically contraindication.	71 (64.5)	88 (80.0)	<0.001*
3. Changes patient position every 2 hours.	77 (70.0)	88 (80.0)	<0.001*
Total	232 (70.3)	280 (84.8)	<0.001*

* Statistically significant difference by χ^2 test at $\alpha = 0.05$

Table 7 shows practice towards VAP prevention on endotracheal tube suctioning by observing 110 times of nursing care. Pre- intervention, 16.4% to 100% of practices towards VAP prevention were correct. Post- intervention, the percentages of most items of the correct practice were significantly higher than that pre-intervention ($p < 0.001$). Details are shown in Table 7.

Table 7 Comparison of practice towards VAP prevention on endotracheal tube suctioning of studied nurses pre and post- intervention (n = 110 times of observation)

Item	Times (%) of correct practice observation		p-value
	Pre- intervention	Post- intervention	
1. Assess patients need for suctioning, determined by lung sounds or other assessments.	78 (70.9)	91 (82.7)	0.055
2. Patients in semi-recumbent position, with to turn the face towards opposite the lung sounds.	34 (30.9)	55 (50.0)	0.006*
3. Hand washing or alcohol hand rubs	18 (16.4)	52 (47.3)	<0.001*
4. Wearing the mask	110 (100.0)	110 (100.0)	n/a
5. Use sterile gloves	110 (100.0)	110 (100.0)	n/a
6. To prepare sterile tubes for suction	110 (100.0)	110 (100.0)	n/a
7. Secure one end of connecting tube to suction machine by aseptic technique	99 (90.0)	110 (100.0)	0.001*
8. Adjusted vacuum pressure level not more than 80-120 mmHg	49 (44.5)	58 (52.7)	0.280
9. Assistant help for removing the endotracheal tube	57 (51.8)	82 (74.5)	<0.001*
10. Assistant clean tube and joint of ambu bag by 70% alcohol before patients hyperventilated with 100% O_2	95 (86.4)	107 (97.3)	0.006*
11. Gently but quickly insert catheter with dominant hand until resistance is met, then pull back 1-2 cm. (10-15 sec)	95 (86.4)	98 (89.1)	0.681

Table 7 Comparison of practice towards VAP prevention on endotracheal tube suctioning of studied nurses pre and post- intervention (n = 110 times of observation) (continued)

Item	Times (%) of correct practice observation		p-value
	Pre-intervention	Post-intervention	
12. Assistant help for hyperventilation by 100 % oxygen after the suction	110 (100.0)	110 (100.0)	n/a
13. Cleaned joint of endotracheal tube by 70% alcohol and inserted tube to ventilator	97 (88.2)	105 (95.5)	0.085
14. Release the suction tubes in the infectious rubbish	110 (100.0)	110 (100.0)	n/a
15. Cleaned joint of ambu bag by 70% alcohol and cover by sterile gauze	63 (57.3)	76 (69.1)	0.093
16. Only one resuscitating bag for one patient	110 (100.0)	110 (100.0)	n/a
17. Place patients in semi-recumbent position	74 (67.3)	88 (80.0)	0.046*
18. Hand washing or alcohol hand rubs	40 (36.4)	71 (64.5)	<0.001*
Total	1,459 (73.6)	1,663 (83.4)	<0.001*

* Statistically significant difference by χ^2 test at $\alpha = 0.05$

n/a not applicable

Table 8 shows practice towards VAP prevention on enteral feeding by observing 110 times of nursing care. Pre- intervention, 10% to 100% of practice frequencies towards VAP prevention were correct. Post- intervention, the percentages of most items of the correct practice were significantly higher than those pre-intervention ($p < 0.001$). Details are shown in Table 8.

Table 8 Comparison of practice towards VAP prevention on enteral feeding of studied nurses pre and post- intervention (n = 110 times of observation)

Item	Times (%) of correct practice observation		P-value
	Pre-intervention	Post-intervention	
1. Hand washing or alcohol hand rubs	11 (10.0)	46 (41.8)	<0.001*
2. Clear air way before enteral feeding	109 (99.1)	109 (99.1)	n/a
3. Patients in semi-recumbent position with head elevated 30°-40°	79 (71.8)	90 (81.8)	0.110
4. Test naso gastric tube position	100 (90.9)	105 (95.5)	0.284
5. Check residual volumes if more than 50 ml should be delayed	110 (100.0)	110 (100.0)	n/a
6. Place nutrition container with elevated at least 1 foot from patient body, to release slowly by gravity	83 (75.5)	110 (100.0)	<0.001*
7. Stop enteral feeding when patients aspirated and clear airway	110 (100.0)	110 (100.0)	n/a
8. Feeding water 50- 100 ml and clean NG tube by 70 % alcohol	35 (31.8)	66 (60.0)	<0.001*
9. Fowler's position and no suction after the feeding within 1-2 hours	94 (85.5)	95 (86.4)	1.000
Total	741 (74.8)	841 (84.9)	<0.001*

* Statistically significant difference by χ^2 test at $\alpha = 0.05$

n/a not applicable

Table 9 shows practice towards VAP prevention on management of respiratory equipment by observing 110 times of nursing care. Pre- intervention, 20% to 93.6% of practice frequencies towards VAP prevention were correct. Post- intervention, the percentages of most items of the correct practice were significantly higher than that pre- intervention ($p < 0.001$). Details are shown in Table 9.

Table 9 Comparison of practice towards VAP prevention on management of respiratory equipment of studied nurses pre and post- intervention (n = 110 times of observation)

Item	Times (%) of correct practice observation		p-value
	Pre-intervention	Post-intervention	
1. Rinsed off water in the tubing of mechanical ventilator circuit	92 (83.6)	106 (96.4)	0.003*
2. When sterile large-volume nebulizer at least minimum level, should be rinsed before to added sterile water.	22 (20.0)	84 (76.4)	<0.001*
3. Changed the ventilator circuit every 7 days per policy using aseptic technique.	93 (84.5)	95 (86.4)	0.848
4. Changed the aerosal nebulizer every 24 hours, only one for one patient and that have sterilization between uses on different patients.	85 (77.3)	107 (97.3)	<0.001*
5. Take care the endotracheal tube to the correct position every 8 hours	103 (93.6)	110 (100.0)	0.007*
Total	395 (71.8)	502 (91.3)	<0.001*

* Statistically significant difference by χ^2 test at $\alpha = 0.05$

Totally, 4,400 times of observation towards VAP prevention guideline, post-intervention, the percentages of observation of practice on oral care, turning and repositioning, endotracheal tube suctioning, enteral feeding and management of respiratory equipment of the correct practice were significantly higher than those of the pre- intervention ($p<0.001$) (Table 10). The mean score of correct practice of each category in the post-intervention was significantly higher than that the pre-intervention ($p<0.001$) (Table 11).

Table 10 Percentage of overall nursing care to VAP prevention guidelines among studied nurses pre and post- intervention (n = 4,400 times of observation)

Category	Total of observation	Times (%) of correct practice observation		p-value
		Pre-intervention	Post-intervention	
1. Oral care	550	439 (79.8)	503 (91.4)	<0.001*
2. Turning and repositioning	330	232 (70.3)	280 (84.8)	<0.001*
3. Endotracheal tube suctioning	1,980	1,459 (73.7)	1,653 (83.5)	<0.001*
4. Enteral feeding care	990	741 (74.8)	841 (84.9)	<0.001*
5. Management of respiratory equipment	550	395 (71.8)	502 (91.3)	<0.001*
Overall	4,400	3,266 (74.2)	3,779 (85.9)	<0.001*

* Statistically significant difference by χ^2 test at $\alpha = 0.05$

Table 11 Means and standard deviations of correct practice scores towards VAP prevention among the studied nurses pre and post- intervention

Category	Total score	$\bar{X}$ ± SD of correct practice		p-value
		Pre-intervention	Post-intervention	
1. Oral care	5	3.99 ± 0.65	4.57 ± 0.53	<0.001*
2. Turning and repositioning	3	2.11 ± 0.78	2.55 ± 0.54	<0.001*
3. Endotracheal tube suctioning	18	13.26 ± 1.96	15.03 ± 1.53	<0.001*
4. Enteral feeding care	9	6.65 ± 1.01	7.65 ± 1.01	<0.001*
5. Management of respiratory equipment	5	3.59 ± 0.82	4.56 ± 0.57	<0.001*
Overall	40	29.60 ± 2.94	34.35 ± 2.44	<0.001*

* Statistically significant difference by paired- t test at $\alpha = 0.05$

3. Comparison of studied patients between pre and post- intervention.

3.1 Socio-demographic characteristics

The studied patients included 431 cases who used mechanical ventilator pre and post- intervention program of VAP prevention (213 cases and 218 cases, respectively) in the studied medical ward of Maharaj Nakhon Si Thammarat Hospital.

Four months of pre- intervention period, 213 patients (57.7% male and 42.3% female) were studied. The patients' age ranged from 17 to 103 years with the mean age of 67.7 years. Approximately 81% had underlying diseases. The principle diagnosis was 26.3% of cerebrovascular diseases, 23% of respiratory system, 15% of heart and blood circulation disease and others. The patients who had good consciousness were 40.4%, 42.7% were semi-coma and 16.9% were coma. About 35.2% received ventilator less than 5 ventilator-days, 34.3% received 5-10 ventilator-days and 30.5% received more than 10 ventilator-days (the mean was 12.2 days). Approximately

66.2% were admitted in the studied medical ward less than 10 days. The mean of admission day was 12.8 days. The patients who had tracheostomy tube with ventilators were 13.6%. The status of studied patients when as ward discharged, 43.7% were dead and 34.3% were improved.

Four months of post- intervention program, 218 patients (54.1% male and 45.9% female) were studied. The patients' age ranged from 15 to 96 years with the mean age of 67.1 years. Approximately 78% had underlying diseases. The principle diagnosis was 32.1% of cerebrovascular diseases, 31.7% of respiratory system, 11.9% of heart and blood circulation disease and others. The patients who had good consciousness level were 29.4%, 44% were semi-coma and 26.6% were coma. About 25.7% received ventilator less than 5 ventilator-days, 23.4% received 5-10 ventilator-days and 50.9% received more than 10 ventilator-days (the mean was 14.2 days). Approximately 55% were admitted in the studied medical ward less than 10 days. The mean of admission day was 12.8 days. The patients who had tracheostomy tube with ventilators were 12.8%. The status of studied patients when at ward discharged, 43.6% were dead and 26.1% were improved.

When the researcher compared some socio-demographic characteristics and patient medical history pre and post- intervention, it showed statistical significance on principle diagnosis ($p= 0.022$), level of consciousness ($p= 0.014$), ventilator-days ($p <0.001$), nasogastric tube feeding ($p = 0.001$) and use of steroid drug ($p= 0.006$). Details are shown in Table 12

Table 12 Socio-demographic characteristics and medical history of studied patients pre and post- intervention

Characteristics	Pre-intervention (n=213)	Post-intervention (n=218)	p-value
	No (%)	No (%)	
Gender			
Male	123 (57.7)	118 (54.1)	0.509
Female	90 (42.3)	100 (45.9)	
Age (years)			
15-40	15 (7.0)	14 (6.4)	0.314
41-60	39 (18.3)	53 (24.3)	
>60	159 (74.6)	151 (69.3)	
Mean ±SD	67.7±15.4	67.1±15.8	
Range	17-103	15 - 96	
Underlying diseases			
Yes	173 (81.2)	171 (78.4)	0.549
No	40 (18.8)	47 (21.6)	
Principle diagnosis			
Respiratory system	49 (23.0)	69 (31.7)	0.022*
Cerebrovascular diseases	56 (26.3)	70 (32.1)	
Heart and blood circulation	32 (15.1)	26 (11.9)	
Others	76 (35.7)	53 (24.3)	
Consciousness			
Coma	36 (16.9)	58 (26.6)	0.014*
Semi-coma	91 (42.7)	96 (44.0)	
Good conscious	86 (40.4)	64 (29.4)	
Ventilator-days (days)			
< 5	75 (35.2)	56 (25.7)	< 0.001*
5– 10	73 (34.3)	51 (23.4)	
> 10	65 (30.5)	111 (50.9)	
Mean ±SD	12.2±15.7	14.2±12.9	
Range	3 -114	3 -77	
Length of stay (days)			0.057
<10	141 (66.2)	120 (55.0)	
10-20	35 (16.4)	50 (22.9)	
> 20	37 (17.4)	48 (22.0)	
Mean ±SD	12.8±15.8	12.8±12.4	
Range	3 - 114	3 - 77	

Table 12 Socio-demographic characteristics and medical history of studied patients pre and post- intervention (continued)

Characteristics	Pre-intervention (n=213)	Post-intervention (n=218)	p-value
	No (%)	No (%)	
Tracheostomy tube			
Yes	29 (13.6)	28 (12.8)	0.925
No	184 (86.4)	190 (87.2)	
Nasogastric tube feeding			
Yes	204 (95.8)	188 (86.2)	0.001*
No	9 (4.2)	30 (13.8)	
Stress ulcer prophylaxis			
Yes	121 (56.8)	141 (64.7)	0.115
No	92 (43.2)	77 (35.3)	
Use of steroid drug			
Yes	17 (8.0)	4 (1.8)	0.006*
No	196 (92.0)	214 (98.2)	
Status as discharge			
Improve	73 (34.3)	57 (26.1)	0.987
Dead	93 (43.7)	95 (43.6)	
Others	47 (22.1)	66 (30.3)	

* Statistically significant difference by χ^2 test at $\alpha = 0.05$

3.2 Incidence of VAP and microorganisms causing the infection in studied patients pre and post- intervention.

Ventilator-Associated Pneumonia incidence rates, during the four- month observation pre- intervention, a total of 45 episodes (45 cases) occurred in 213 patients or 2,606 ventilator - days. This was calculated to the incidence rate of 21.1% (45/213) or incidence density rate of 17.3 per 1,000 ventilator-days (45/2,606). Post-intervention 4 months, 29 episodes (29 cases) occurred in 218 patients or 3,092 ventilator - days. The incidence rate of VAP was declined to 13.3% (29/218) or incidence density rate was 9.4 per 1,000 ventilator- days (29/3,092). Details are shown in Table 13 and incidence of VAP by patients characteristics are shown in Table 14.

Table 13 Incidence of VAP in studied patient's pre and post- intervention

Numbers and rate	Pre-intervention	Post-intervention
No. of studied patients	213	218
No. of patients with VAP	45	29
Total of ventilator-days	2,606	3,092
Incidence rate (%)	21.1	13.3
Incidence density rate (/ 1,000 ventilator-days)	17.3	9.4

Table 14 Incidence of VAP patients by characteristics pre and post- intervention

Characteristics	Pre- intervention		Post- intervention	
	No. of studied patients	No(%) of patients with VAP	No. of studied patients	No(%) of patients with VAP
Gender				
Male	123	24 (19.5)	118	12 (10.2)
Female	90	21 (23.3)	100	17 (17.0)
Age (years)				
15-40	15	0 (0)	14	3 (21.4)
41-60	39	3 (7.7)	53	5 (9.4)
>60	159	42 (26.4)	151	21 (13.9)
Underlying diseases				
Yes	173	38 (22.0)	171	23 (13.5)
No	40	7 (17.5)	47	6 (12.8)
Consciousness				
Coma	36	11 (30.6)	58	7 (12.1)
Semi-coma	91	23 (25.3)	96	16 (16.7)
Good conscious	86	11 (12.8)	64	6 (9.4)
Principle diagnosis				
Respiratory system	49	10 (20.4)	69	9 (13.0)
Cerebrovascular diseases	56	15 (26.8)	70	11 (15.7)
Heart and blood circulation	32	6 (18.8)	26	1 (3.8)
Others	76	14 (18.4)	53	8 (15.1)

Table 14 Incidence of VAP patients by characteristics pre and post- intervention (continued)

Characteristics	Pre- intervention		Post- intervention	
	No. of studied patients	No(%) of patients with VAP	No. of studied patients	No(%) of patients with VAP
Tracheostomy tube				
Yes	29	11 (37.9)	28	11 (39.3)
No	184	34 (18.5)	190	18 (9.5)
Nasogastric tube feeding				
Yes	204	44 (21.6)	188	29 (15.4)
No	9	1 (11.1)	30	0 (0)
Stress ulcer prophylaxis				
Yes	121	31 (25.6)	141	26 (18.4)
No	92	14 (15.2)	77	3 (3.9)
Use of steroid drug				
Yes	17	5 (29.4)	4	0 (0)
No	196	40 (20.4)	214	29 (13.6)
Ventilator-days (days)				
2 – 4	75	3 (4.0)	56	0 (0)
5 – 10	73	15 (20.5)	51	1 (2.0)
> 10	65	27 (41.5)	111	28 (25.2)
Length of stay (days)				
<10	141	22 (15.6)	120	2 (1.7)
10-20	35	7 (20.0)	50	11 (22.0)
> 20	37	16 (43.2)	48	16 (33.3)
Total	213	45 (21.1)	218	29 (13.3)

Table 15 shows the causative bacteria in studied patients with VAP pre and post- intervention. Pre- intervention, the causative bacteria from 45 patients with VAP were 66.7% of gram negative bacteria, 6.7% of gram positive bacteria, 15.6% of mixed bacterial cultures and 11.1% of no bacterial growth. The majority of VAP cases were caused by *Acinetobacter baumannii* (35.6%), followed by *Pseudomonas aeruginosa* (17.8%) and *Klebseilla pneumoniae* (11.1%).

Post- intervention, the result of secretion cultures from 29 patients with VAP showed 62.1% of gram negative bacteria, 10.3% of gram positive bacteria, 24.1% of mixed bacterial cultures and 3.4% of no bacterial growth. The majority of VAP cases were caused by *Pseudomonas aeruginosa* (34.5%), followed by *Acinetobacter baumannii* (20.7%) and *Staphylococcus aureus* (10.3%).

Table 15 Causative bacteria in studied VAP patients pre and post- intervention (n = 45 cases and 29 cases, respectively)

Causative bacteria	Pre- intervention		Post- intervention	
	No	%	No	%
Gram negative				
Acinetobacter baumannii	16	35.6	6	20.7
Pseudomonas aeruginosa	8	17.8	10	34.5
Klebseilla pneumoniae	5	11.1	1	3.4
E.coli	1	2.2	0	0
Enterococcus fecalis	1	2.2	0	0
Enterobacter spp.	0	0	1	3.4
Total	31	68.9	18	62.1
Gram positive				
Methicillin resistant *Staphylococcus aureus* (MRSA)	1	2.2	0	0
Coag neg staphylococcus	1	2.2	0	0
Staphylococcus aureus	0	0	3	10.3
Total	2	4.4	3	10.3
Mixed bacterial growth				
A. baumannii and *P.aeruginosa*	1	2.2	1	3.4
A. baumannii and *K. pneumoniae*	2	4.4	1	3.4
A. baumannii and *E.coli*	1	2.2	0	0
P. aeruginosa and MRSA	1	2.2	2	6.9
K. pneumoniae and *Enterobacter* spp.	1	2.2	0	0
E.coli and *Acinetobacter* spp.	1	2.2	0	0
P. aeruginosa and *K. pneumoniae*	0	0	1	3.4
A. baumannii and *Enterobacter* spp.	0	0	1	3.4
Acinetobacter baumannii and MRSA	0	0	1	3.4
Total	7	15.6	7	24.1
No bacterial growth	5	11.1	1	3.4

CHAPTER V
DISCUSSION

This chapter is intended to discuss the study of knowledge, practice towards ventilator-associated pneumonia prevention among studied nurses and incidence rates of patients with ventilator-associated pneumonia pre and post-intervention.

1. Knowledge and practice towards VAP prevention

Pre-intervention, totally 40 nurses voluntarily participated in the study. About 67.5% had good level of knowledge towards a cause of VAP (scores ≥ 80% of total scores) and 80% had good level of knowledge towards nursing care of patients with mechanical ventilator. Post- intervention, the mean of knowledge scores was significantly higher than that before intervention (22.9 vs. 20.9, $p< 0.001$). The results corresponded with the study of Charearnlap in 1997(100) and Prawaltip in 1997 (101). The nurses ever trained on nosocomial infection prevention and control got higher mean scores than those never trained.

After implementing intervention program on prevention of VAP, the studied nurses markedly improved their practice more than pre- intervention.

Guideline of oral care, pre- intervention, it was found that only 43.6% of the studied group had practiced hand washing before oral care. Although, some nurses knew that hand washing was very important to prevent nosocomial infection, they were not motivated to practice. Hand washing before and after the nursing care was important because it decreased the amount of microorganism on the hands. Hixon *et al* (102) showed that after promoting the nurses who were worked in nursery intensive care unit about gloving and hand washing before and after nursing care, the nosocomial infections could be controlled. As well as, doing patients position on the bed and elevating of patient's head about 30- 45 degree from base was practice 55.5%. Effects of the position to turn face upwards for such a long time on collecting secretions in respiratory tract and aspiration secretions into lungs were previously reported. Tablan *et al* (24) showed that the patients who used ventilators and position

with face upwards had amount of secretions in trachea more than the patients who had a head slope about 30 – 45 degree from base. Post- intervention, the percentage of patients who received proper oral care was 91.4%. For individual aspects of hand washing and patient's position head to side or place in semi – fowler's position, it showed significantly higher percentages when compared with pre- intervention ($p< 0.001$).

Guideline of patient position on turning and repositioning, pre- intervention, the percentage of patients who received proper care was 70.3%. For individual aspects, 64.5% of patients received proper position care on the bed and turn patients by side to slope about 30 – 45 degree from base. Semi-recumbence was generally continued for duration of mechanical ventilation. Therefore, changing patient's position every two hours and semi-recumbent positioning could prevent aspiration of gastric secretions and decreased amount of secretions in respiratory tract (21). Drakulovic *et al* (83) reported that patients who used ventilators and semi-recumbent positioning had 5 % incidence of VAP while the patients who used ventilators and supine positioning had 23 % incidence of VAP. In addition, the incidence of VAP increased for 50% when the enteral feeding patients were turned up by side. Post-intervention, the percentage of patients who received proper care on patient position was 84.8%. For individual aspects of place patients in semi-recumbent position with head elevated 30 – 45 degree, changing patient position every two hours and checking of endotracheal tube position were statistically significant when compared with post-intervention ($p< 0.001$).

Guideline of endotracheal tube suctioning, pre- intervention, the percentage of patients who received proper care was 73.6%. For individual aspects, 16.4% had hand washing before suctioning and 36.4% had hand washing after suctioning. Pathogens that cause nosocomial pneumonia are ubiquitous in hospitals, especially in intensive or critical care areas. Transmission of these microorganisms to patients frequently occurs via an attending HCW' s hands that become contaminated or transiently colonized with the microorganisms. Procedures such as suctioning and manipulation of ventilator circuit or endotracheal tube increase the opportunity for cross-contamination (88-89). Several studies have shown that hand washing practices can be easily improved nosocomial infection prevention and reduced microorganisms on hands (102-104). As

well as, only 44.5% of patients received adjust vacuum pressure level not more than 80 – 120 mmHg before suctioning. High pressure vacuum causes injury to tracheal wall and cilia that dwelling place of bacterial growth. Guideline of enteral feeding, pre- intervention, 74.8% of patients received overall enteral feeding care according to the guideline. For individual aspects of enteral feeding, practice on hand washing before feeding was 10%. Cleaning the nasogastric tube by 70% alcohol after feeding had been practiced was 31.8%, so that no cleaning the nasogastric tube could be contaminated the pathogens at the tip of nasogastric tube and into stomach and causes of VAP because of the patients aspirations of gastric secretions from the stomach to esophagus and into respiratory tract and aspirated in lung (24). Therefore, before feeding, the fowler's position on the bed had been practiced of 71.8%. Because of increase of pressure in thoracic gravity and abdomen in patients using ventilator, enteral feeding slowly be done followed by fowler's positioning for 1 hour after enteral feeding (102).

Guideline of management of respiratory equipment, pre- intervention, 71.8% of patients received overall management of respiratory equipment care according to the guideline. For individual item, adding sterile water to the nebulizer jar by aseptic technique and rinsing before adding sterile water had been practiced of 20%. Berrouane *et al* (105) showed that the contamination of respiratory circuit increased pathogens causing of VAP on the third and the fifth day of using ventilator. Cases in which aerosol was used for inhalation therapy might be a cause of and increased pathogens leading to VAP from inhalation the pathogens into lung (54). Contaminated reservoir of aerosol devices allows the growth of hydrophilic bacteria that subsequently can be aerosolized during use of the device. Gram-negative bacilli can multiply to substantial concentrations in nebulizer fluid and increase the risk for VAP (90-92). Previous studies reported contaminations on respiratory circuits from exogenous pathogens into lung as a cause of VAP (55).

In summary, post- intervention the studied nurses had percentages of practices towards VAP prevention higher than pre-intervention, especially practices on oral care ($p < 0.001$), turning and repositioning ($p < 0.001$), endotracheal tube suctioning

(p <0.001), enteral feeding (p <0.001) and management of respiratory equipment (p <0.001). These practices were reported that could reduce the VAP incidence (106).

2. Incidences and causative agents of VAP

Comparison of VAP incidences during the pre- and post-intervention program showed the decreased in the incidence from 21.1% to 13.3% or 17.3 to 9.4 per 1,000 ventilator – days (p<0.05). The VAP patients in the pre- and post-intervention periods were not different statistically in many aspects, such as gender, age, underlying diseases, length of ward stay, the presence of tracheostomy tube, stress ulcer prophylaxis and status at discharged. However, number of patients' diseases on respiratory and cerebrovascular systems were higher in the post-intervention period than those of pre-intervention period (p<0.002). Moreover, disease severity of post-intervention patients such as number of comatose patients (p<0.014) and ventilator-days (p<0.001) were higher than those of pre-intervention period. Severity of illness, prolong ventilator-days, use of steroids and nasogastric tube feeding are common risk factors of VAP (28-30). In spite of higher number of comatose patients and longer ventilation days, the incidence of VAP was decreased during the post-intervention period. The decreased incidence could be partly due to the intervention program. As we observed the significantly increasing in practice on oral care, patients' repositioning, endotracheal suctioning, enteral feeding care and proper care of respiratory equipment among the patients' on mechanical ventilators.

The hospital- wide VAP incidence of Maharaj Nakhon Si Thammarat Hospital in 2004 was 11.3 per 1,000 ventilator-days, slightly higher than the post-intervention incidence of the present study (9.4 per 1,000 ventilator – days). However, it should not be compared, since the case definition of VAP in this study was followed CDC (22), rather than those of routine infection control surveillance of the hospital. Since the patients using mechanical ventilator less than 48 hours and those with diagnosis of pneumonia prior to ventilated support were excluded in this study.

The secretion specimens from patients with ventilator-associated pneumonia were cultured. Pre- intervention, microorganisms in the cultures were 66.7% of gram negative , 6.7% of gram positive and 15.6% of mixed bacterial growth. The majority of VAP cases were caused by *Acinetobacter baumannii* (35.6%), followed by

Pseudomonas aeruginosa (17.8%) and *Klebseilla pneumoniae* (11.1%). Post-intervention, microorganisms in the cultures were 62.1% of gram negative, 10.3% of gram positive and 24.1% of mixed bacterial growth. The majority of VAP cases were caused by *Pseudomonas aeruginosa* (34.5%) followed by *Acinetobacter baumannii* (20.7%) and *Staphylococcus aureus* (10.3 %). Nosocomial bacterial pneumonia is frequently polymicrobial organisms and gram negative bacilli are usually the predominant organisms (60, 62). Another study reported that gram negative bacilli were presented in 75% of quantitative cultures of protected specimen brushings (PSB) obtained from patients who had VAP, and 40% of these cultures were polymicrobial organisms (61). In the pre and post-intervention study, the secretion specimens from patients with VAP were 11.1% and 3.4 % no bacterial growth. It was probably due to the patients were obtained had treated with antibiotics (69) or probably because anaerobic bacteria and viral cultures were not performed routinely in the hospital.

3. Intervention program

Pre-intervention, it was found that the studied nurses had low practice in some items. The nurses discussed on problems such as knowledge towards prevention of VAP, cross-contamination technique in procedures and contaminated respiratory devices. The program intervention was developed by the researcher including group discussion and brain storming, education module and skill training on clinical practices on prevention of VAP such as hand washing technique, suctioning of respiratory tract secretion technique, sterilization or disinfection of respiratory equipment, posters presentation for VAP prevention and monitoring the clinical practices. After intervention program, it was found that the studied nurses have been improved on knowledge and practice to prevention of VAP more than pre-intervention. From the study of Lally *et al* (107) found that improving the task quality according to concept of the quality control group through PDCA (Plan, Do, Check and Act) circle could decrease incidence of VAP. However, development of the quality of services by integrating several methods was better than by one method (108), such as after encouraging hand washing of nursing personnel by education program, managing environment and collaborating to solve the problems, it was found that hand washing of nursing personnel was increased significantly (109). There were many

ways to activate and encourage those nursing personnel to strictly follow and perform their duties according to the principles of prevention and control of infection, but it was found that those ways could not last longer and drive the nursing personnel to strictly follow the principles sufficiently (94).The studied nurses in this study to agree with the intervention program and to encourage of nursing personnel to follow their practice by continuously.

Several limitations in this study should be considered. First, the study was performed at a single medical ward by compared pre and post- intervention. Because of the ethical issue, there was no a control group in this study. Other possible factors, such as other education program, developing the policy for the nursing quality improvement of hospital accreditation and patient' s factors might occur coincident with the intervention that resulted in VAP rates (confounding factors). Second, in the period of pre and post- intervention, data were collected by observation method; this raised the possibility of changes in temporary behavior (Hawthorne effect). A final limitation of study, this research studied in nurses only, in the same time, other health care workers were not included i.e. physicians, medical students, nurse students and patient families who also participated in taking care of patients.

CHAPTER VI
CONCLUSION AND RECOMMENDATION

Conclusion

This intervention study was carried out to compare the studied nurses' knowledge and practice towards ventilator-associated pneumonia prevention between pre and post- intervention program. All 40 studied nurses working in the medical ward of Maharaj Nakhon Si Thammarat Hospital were interviewed by using a questionnaire about knowledge towards VAP prevention and observed on practice guidelines for VAP prevention. Other information of data, such as, the incidence rates and causative bacteria of VAP in the last year were assessed. The intervention program included group discussion and brain storming, education module and training practice on VAP prevention. Post - intervention, the knowledge, practice guideline for VAP prevention and incidence rate and causative bacteria of VAP were assessed again.

Post - intervention, the knowledge mean score towards VAP prevention was significantly higher than that of the pre - intervention ($p< 0.001$). Percentage of overall nursing care practice to VAP prevention guidelines including oral care, turning and repositioning, endotracheal tube suctioning, enteral feeding and management of respiratory equipment increased from 74.2% to 85.9% ($p < 0.001$).

A total of 413 patients, 213 cases in a period of pre- intervention and 218 cases in a period of post- intervention, who were admitted in the studied medical ward and received ventilators for more than 48 hours, were included in the study. Pre-intervention, 45 patients had developed VAP and the incidence rate was 21.1% (45/213) or incidence density rate was 17.3 per 1,000 ventilator-days. Post-intervention, the incidence rate of VAP was declined to 13.3% or incidence density rate was 9.4 per 1,000 ventilator-days ($p < 0.05$). The majority of causative bacteria in patients with VAP pre and post- intervention were gram negative bacteria (68.9% and 61.2%, respectively).

In conclusion, the results of this study suggested that understanding the practice guidelines for VAP prevention should be emphasized as a standard nursing care for patient with mechanical ventilator. Application of the intervention program to all involved nurses could reduce incidence of VAP.

Recommendations of the study

1. To apply the intervention programs to develop the policy for the nursing quality improvement on VAP prevention by continuously improving the nursing care and to decrease the risks and incidence of VAP.

2. The chief officers and head nurse should have an orientation of practice guideline on VAP prevention to all involved nurses taking care of patients on mechanical ventilator.

Recommendations for further study

1. To evaluate outcomes other than ventilator-associated pneumonia, such as VAP mortality or antimicrobial susceptibility patterns to determine trends and identify potential problems.

2. To improve and extend the intervention program for studying the effectiveness of this program to reduce the incidence rate of other nosocomial infections in the hospital.

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APPENDIX

APPENDIX A
QUESTIONNAIRE

Questionnaire towards prevention of ventilator-associated pneumonia (VAP)

Place to fill content or on √ the correct answer

Part 1 General characteristics

1. Age.....years

2. Level of education

1 ( ) Certificate of technical nurse

2 ( ) Bachelor's of nursing

3 ( ) Others.....

3. Duration of working experience in hospital.....years.....months

4. Duration of experience in medical ward.....years.....months

5. Experienced in training for respiratory care

1 ( ) No

2 ( ) Yes, by.....

6. Have you ever received training towards infection control of nosocomial infection?

1 ( ) No

2 ( ) Yes, by.....

7. Have you ever received training towards VAP prevention**?**

1 ( ) No

2 ( ) Yes, by.....

8. Have you ever known towards practice guideline for VAP prevention?

1 ( ) No

2 ( ) Yes, by.....

Part 2 Knowledge towards VAP prevention

	yes	no	Don't know
1. The cause of VAP			
1.1 Bacterial colonization of oropharyngeal can invade the lower respiratory tract by aspiration of gastric contents.			
1.2 Bacterial colonization of oropharyngeal can invade the lower respiratory tract by inhalation of aerosols containing bacteria.			
1.3 Inadequate sterilization and disinfection of respiratory equipment may also increase risk of VAP.			
1.4 During patient suction with neglector aseptic technique, bacteria can invade the lower respiratory tract via hands of HCWs.			
1.5 Retaining of nasogastric tube is not one of risk factors of VAP.			
1.6 The use of antacids and cimitidine drugs is not one of risk factors of VAP.			
1.7 Overuse of antibiotics is not one of risk factors of antibiotics resistance VAP.			
1.8 Neglected oral hygiene is one of risk factors of aspirate pneumonia.			
2. Nursing care of patients with mechanical ventilator.			
2.1 Hand washing is unnecessary after patient suction because of the use of sterile gloves.			
2.2 The frequent unnecessary suction may introduce organisms into the lower respiratory tract.			
2.3 During suction, you can use most regulation pressure because it is easy to clear airway.			
2.4 Timing of patients suction should not be more than 10-15 seconds / time.			
2.5 After tracheal suction, patients should be hyperventilated with O_2 until peripheral blood keeps $O_2 > 90\%$.			

Part 2 Knowledge towards VAP prevention (continued)

	yes	no	Don't know
2.6 For hand hygiene, soap and water or a waterless hand antiseptic should be used before and after ventilator contact or patient suction.			
2.7 Place patients in semi-recumbent position with head of bed elevated 30°-40°, is one of preventive measures of VAP.			
2.8 Turning body position every 2 hrs, is one of preventive measures of VAP.			
2.9 After using the spirometer from one patient, it must be cleaned with 70% alcohol.			
2.10 Aseptic technique should be unnecessary when changing ventilator circuits.			
2.11 Drain ventilator circuits condensate before repositioning patients, because it should be returned to patients.			
2.12 Drain condensate from ventilator circuits, it is unnecessary to avoid contamination.			
2.13 Change often ventilator circuits, will prevent the VAP.			
2.14 Dressing tracheostomy wound every 12 hours or frequently if it is necessary.			
2.15 Use only sterile water for nubelization and dispense these fluids aseptically.			
2.16 Sterile reusable respiratory equipment such as ventilator circuits, humidifiers, and nebulizers between their uses on different patients.			
2.17 When sterile volume nebulizer at least minimum level, should add sterile water.			

APPENDIX B
OBSERVATION RECORD

Observation records on practice of nursing care of studied nurses on prevention of ventilator-associated pneumonia

Category 1 Oral care

Name			Remark
Date	……./……./…….		
Procedure	Correct practice (1)	No practice or incorrect practice (0)	
1. Position patients head to the side or place in semi-fowlers			
2. Hand washing or use clean gloves			
3. Forceps or cotton buds or tooth brush, use of special mouth wash for mouth care			
4. Use suction swab to cleaning of oral secretion.			
5. The patients are provided oral care at least two times a day			

Category 2 Turning and repositioning

Name			Remark
Date	……./……./…….		
Procedure	Correct practice (1)	No practice or incorrect practice (0)	
1. Checking of endotracheal tube position. Drain ventilator circuit condensate before patients repositioning			
2. Place patients in semi-recumbent with head elevated 30°-40° unless medically contraindication.			
3. Patients should be turning and reposition every 2 hours.			

Category 3 Endotracheal tube suctioning

Name			Remark
Date	……./……./…….		
Procedure	Correct practice (1)	No practice or incorrect practice (0)	
1. Assess patients need for suctioning, determined by lung sounds or other assessments.			
2. Place patients in semi-recumbent position, with to turn the face towards opposite the lung sounds.			

Category 3 Endotracheal tube suctioning (continued)

Name			
Date	……./……./…….		
Procedure	Correct practice (1)	No practice or incorrect practice (0)	Remark
3. Hand washing or alcohol hand rubs			
4. Wearing the mask			
5. Use sterile gloves			
6. To prepare sterile tubes for suction			
7. Secure one end of connecting tube to suction machine by aseptic technique			
8. Adjusted vacuum pressure level not more than 80-120 mmHg			
9. Assistant help for removing the endotracheal tube			
10. Assistant clean tube and joint of ambu bag by 70% alcohol before patients hyperventilated with 100% O_2			
11. Gently but quickly insert catheter with dominant hand until resistance is met, then pull back 1-2 cm. Time should not exceed 10-15 seconds.			
12. Assistant help for hyperventilation by 100 % oxygen after the suction			
13. Cleaned joint of endotracheal tube by 70% alcohol and inserted tube to ventilator			
14. Release the suction tubes in the infectious rubbish			
15. Cleaned joint of ambu bag by 70% alcohol and cover by sterile gauze			
16. Only one resuscitating bag for one patient			
17. Place patients in semi-recumbent position			
18. Hand washing or alcohol hand rubs			

Category 4 Enteral feeding care

Name			Remark
Date	……./……./…….		
Procedure	Correct practice (1)	No practice or incorrect practice (0)	
1. Hand washing or alcohol hand rubs			
2. Clear air way before enteral feeding			
3. Place patients in semi-recumbent position with head elevated 30°-40°			
4. Test naso gastric tube position			
5. Check residual volumes if more than 50 ml should be delayed			
6. Place nutrition container with elevated at least 1 foot from patient body, to release slowly by gravity.			
7. Stop enteral feeding when patients aspirated and clear airway			
8. Feeding water 50- 100ml after the enteral feeding and clean NG tube by 70 % alcohol			
9. Fowler's position on the bed and no suction after the enteral feeding within 1-2 hours			

Category 5 Management of respiratory equipment

Name			Remark
Date	……./……./…….		
Procedure	Correct practice (1)	No practice or incorrect practice (0)	
1. Rinsed off water in the tubing of mechanical ventilator circuit			
2. When sterile large-volume nebulizers at least minimum level, should be rinsed before to added sterile water.			
3. Changed the ventilator circuit every 7 days per policy using aseptic technique.			
4. Changed the aerosal nebulizer every 24 hours, only one for one patient and that have sterilization between uses on different patients.			
5. Take care the endotracheal tube to the correct position every 8 hours			

APPENDIX C

VENTILATOR-ASSOCIATED PNEUMONIA REPORT FORM

Serial No _____

Section 1 General characteristics

Name_____ H.N._____ A.N. _____

Sex _____

Age _____ years.

Date of admission _____ Ward _____

Date to transfer to medical ward _____

Date to move out/ discharge _____ Ward _____

Status as ward discharge ( ) Improve ( ) Dead ( ) Others _____

Principle diagnosis _____

Underlying disease

( ) COPD ( ) Cerebro vascular disease

( ) Others_____

( ) No

Conscious levels ( ) Good consciousness ( ) Semi coma ( ) Coma

Section 2 Treatment history

	ON	**OFF**
Endotracheal tube ( ) oral ( ) nasal	……/……./……..	……/……/…….
On ventilator	……/……./……..	……/……/…….
Tracheostomy tube	……/……./……..	……/……/…….
NG tube feeding	……/……./……..	……/……/…….
Stress ulcer prophylaxis	……/……./……..	……/……/…….
Receive steroids during admission	……/……./……..	……/……/…….

Section 3 Signs and Symptoms of ventilator-associated pneumonia

Date of onset

X-rays		At least **one** of the following: ( ) New or progressive and persistent infiltration ( ) Consolidation ( ) Cavitation ( ) Pneumatocele in < 1 yrs.	……/……../……. ……/……../……. ……/……../……. ……/……../…….
Signs & Symptoms	At least one	( ) fever > 38 ^{o} C ( ) Leukopenia (<4000 wbc/mm^3) ( ) Leukocytosis (>= 12000 wbc/mm^3) ( ) Altered mental status with no other cause (>=70 yrs.)	……/……../……. ……/……../……. ……/……../……. ……/……../…….
	At least two	( ) New onset of purulent sputum or change in character of sputum ( ) New onset or worsening cough or dyspnea or tachypnea ( ) Rales or bronchial breath sounds ( ) Worsening gas exchange	……/……../……. ……/……../……. ……/……../……. ……/……../…….
Summary		( ) Non VAP ( ) VAP Date of onset ……../……../……	

Section 4 Results of laboratory procedure

Date/month/year	Type of specimen	Organism pathogens

Section 5 Treatments of VAP

Antibiotics	Dose of ATB	Time- period	Costs of ATB

APPENDIX D

BACTERIAL CULTURE PREPARATION

Gram stain

Solution

1. Crystal violet 2.0 gm
   Methyl alcohol 100 ml.
2. Iodine crystals 1.0 gm
   Potassium iodine 2.0 gm
   Distilled water 300 ml.
3. Ethyl alcohol 95% or Ethyl alcohol 2 parts, plus acetone 1 part
4. Safranin, saturated solution 10 ml.
   Distilled water 90 ml.

Procedure

1. Stain the smear with crystal violet for 15 to 30 sec.
2. Wash with water
3. Cover the slide with iodine solution for 1 minute.
4. Wash with water
5. Decolorize with alcohol until the washings have only a slight violet color. This will require only a few seconds for thin films of bacterial cultures.
6. Wash with water and counterstain with safranin for 30 seconds.
7. Wash, blot and dry.

Media

1. Blood agar plate (BA)
   - Blood agar base medium 500 ml.
   - Sterile blood 20 ml.
2. Chocolate agar plate (CA)
   - Blood agar base medium 500 ml.

- Sterile blood 20 ml.
- Heat until blood become brown or chocolate in color

3. MacConkey agar plate (MA)

- Peptone 17.0 gm.
- Proteose peptone 3.0 gm.
- Lactose 10.0 gm.
- Bile salts 1.5 gm.
- Sodium chloride 5.0 gm.
- Agar 13.5 gm.
- Neutral red 0.03 gm.
- Crystal violet 0.001 gm.
- Distilled water 1,000 ml.

4. Fluid thioglycollate medium

- Trypticase 12 gm.
- 1 – Crytine 0.5 gm.
- Yeast extract 5.0 gm.
- Dextrose 5.0 gm.
- Sodium thioglycollate 0.5 gm.
- Agar 0.75 gm.
- Water 1,000 ml.

Identification

After making gram stain of the organism, culture specimens on media agar plate should be identified and reported the morphology of colony. A different colony were picked and inoculated on to nutrient agar (NA) slant and triple sugar iron agar (TSI). NA slant and TSI tubes were incubated 37°C overnight. The suspected colonies were further identified by biochemical tests.

Biochemical Tests

1. Biochemical tests for identification of gram positive bacteria

After incubation of NA slant overnight, the suspected colony was picked for gram' s stain. Gram positive cocci were further examined for catalase test, coaggulase test and glucose oxidation-fermentation test. (Figure 3).

1.1 Catalase test

Inoculate isolated colony into glass slide and then drop 3% H_2O_2 reagent on bacteria. In 30 seconds, an air bubble is observed for indicating catalase activity positive.

1.2 Coagulase test

Inoculate isolated colony on NA slant in the plasma tube. Incubated the suspension for 4 hours at 37°C and observe for the presence of a gel or clot that cannot be resuspended by gentle shaking.

1.3 Glucose oxidation-fermentation test

Inoculate isolated colony on NA slant by stabbing into two test tubes of glucose O/F media at the bottom, then cover one tube with sterile paraffin oil as the fermentative test tube. Another tube without paraffin oil cover is the oxidation test tube. The tubes are incubated at 37°C 1-5 days then observe color changed from purple to yellow for utilizing glucose or positive result.

2. Biochemical tests for identification of gram negative bacteria

Suspected colony on MA was picked up and inoculated into TSI for screening as bacteria in the family Enterobacteriaceae (TSI = K/A, A/A) and non glucose fermentative bacteria (TSI = K/N). Then the colony on TSI was performed gram' s stain and further identified by other biochemical tests as shown in Figure 4 and Figure 5.

2.1 Triple sugar iron agar (TSI)

Colony is inoculated in TSI agar by streaking on slant and stab into the bottom of medium. After incubation at 37°C for 24 hours, color of slant and butt is interpreted as follow:

Alkaline slant (red)/ acid butt (yellow) the organisms utilize glucose only.

Acid slant (yellow)/ acid butt (yellow) the organisms utilize glucose with lactose or sucrose.

2.2 Oxidase test

Soak small pieces of the filter paper with 1% aqueous tetramethyl-p-phenyl-enediamine dihydrochloride. Colony from TSI is inoculated by rubbing on filter-paper. A blue color within 10 seconds is a positive oxidase test.

2.3 Methyl red (MR) test

The colony is inoculated into MR-VP medium. After 24 hours incubation at 37°C, 5 drops of methyl red test solution is added into the medium. The test is read immediately after adding the reagent. A red color is read as positive. A yellow color is read as negative.

2.4 Voges-Proskauer (VP) test

The colony is inoculated into MR-VP medium and tested for the production of acetyl methylcarbinol. After 24 hr incubation at 37°C, 6 drops of 5% alpha-naphthol in absolute ethyl alcohol and 3 drops of 40% potassium hydroxid are added into the medium. A positive test develop a red color within 15 to 30 min.

2.5 Citrate test

The colony is inoculated into Simon' s citrate agar. After incubation at 37°C for 24 hr, a positive test show the development of Prussian blue color in the medium, which indicate that organism can utilize citrate as a sole source of carbon.

2.6 Urease test

Inoculate colony into urea agar slant. The media are incubated at 37°C for 24 hours. Urease positive produces alkaline products, which turn the phenol red indicator red to purple.

2.7 Indole test

Inoculate the colony into a broth that contains tryptophan, and incubate for at least 24 hours. Then drop Kovac' reagent 4-5 drops to the broth. Gently shake the tube, and observe for a pink color in a ring around the interface between the broth and the alcohol reagent, which rises to the surface. Indole positive shows a red ring in the lower portion of the alcohol phase layer above the medium. Indole negative shows either only a cloudy ring or a slightly yellow color ring at the alcohol interface.

2.8 Motility test

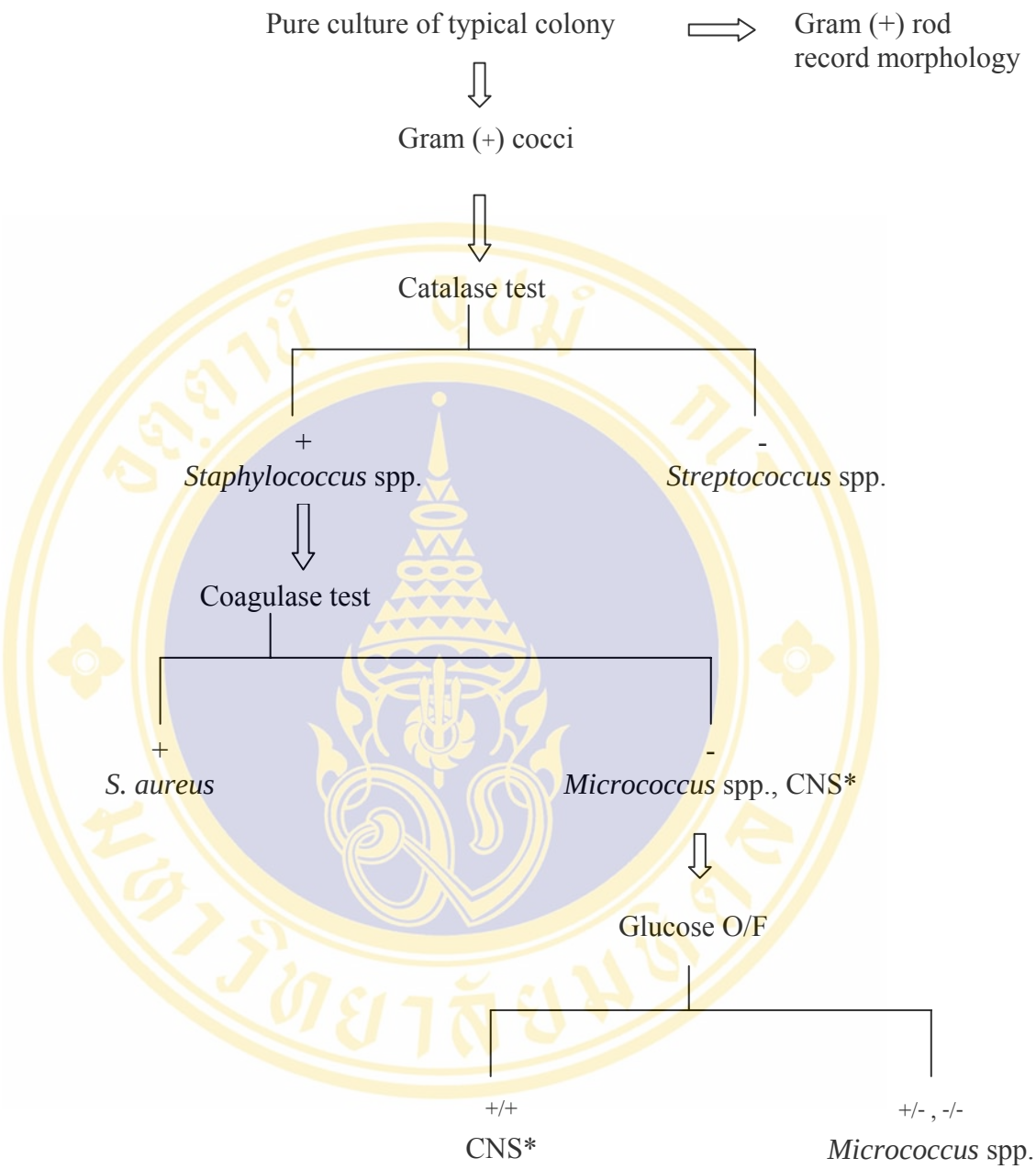
Colony is inoculated by stabbing a straight wire carrying the inoculum one vertically in to the center of the semisolid media to a depth of approximately 2 cm. After overnight incubation, motility in evident as a haze of growth extending into the agar from the stab line.

2.9 Decarboxylase test

Inoculate colony into tube contain tested amino acid (i.e. Lysine, Ornithine) then incubated at 37°C for 24 hours. Utilization of amino acids produce alkaline end products that the result in purple color. Bacteria that do not have decarboxylase lysine ferment the small amount of glucose, yielding acid by products and causing the bromcresol purple to turn the butt yellow.

2.10 Glucose O/F test

The colony is inoculated in both tubes of O/F glucose. The medium in one of the two identical tubes is overlayed with sterile melted paraffin approximately 1 cm deep to prevent oxygen from reaching the inoculum. The tubes are incubated at 35°C for as long as 4 days and examine daily for production of acid, as indicated by change from green to yellow.



CNS* = Coagulase negative Staphylococcus

Figure 3 Identification of gram positive bacteria

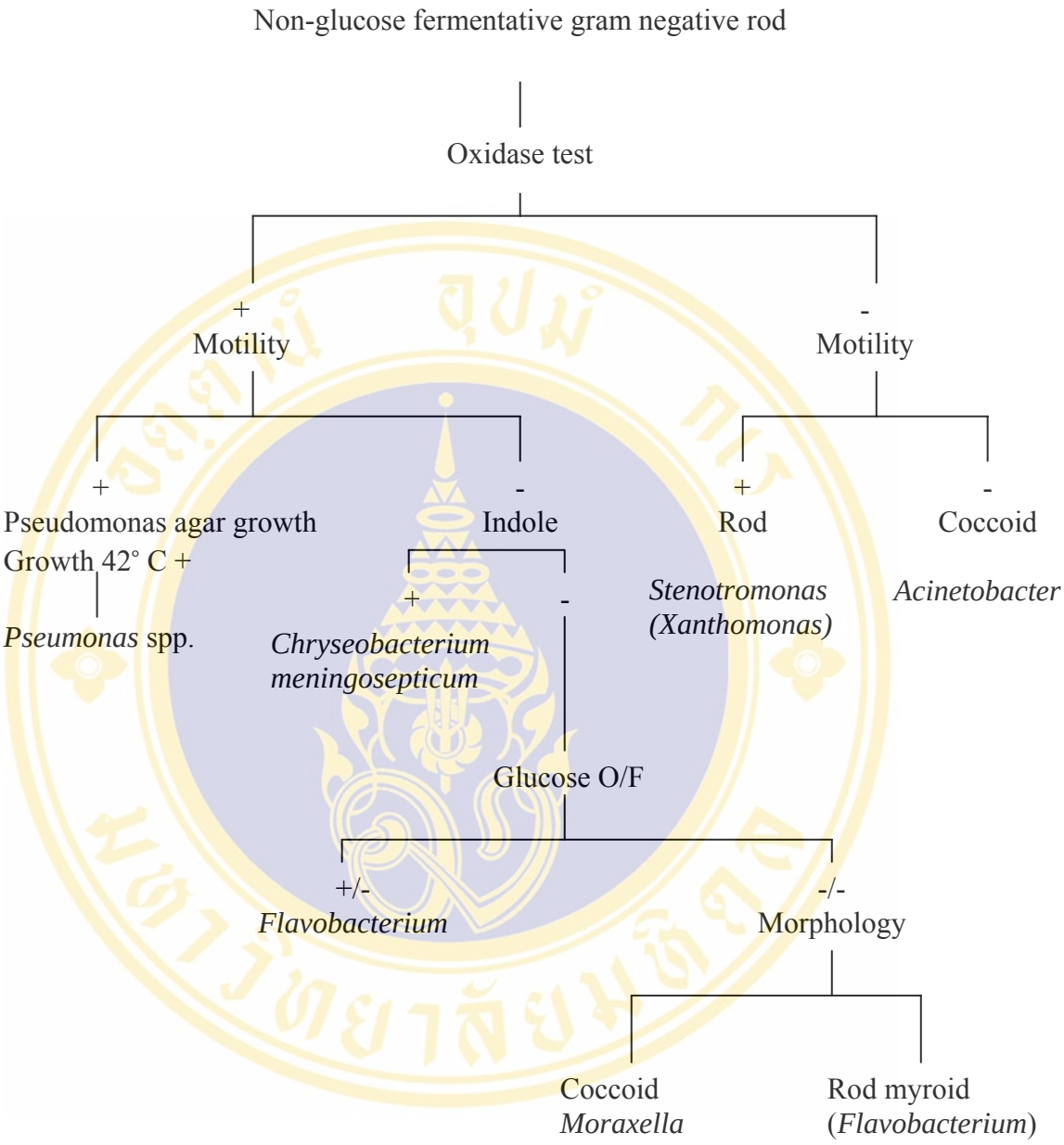


Figure 4 Identification of non glucose fermentative bacteria

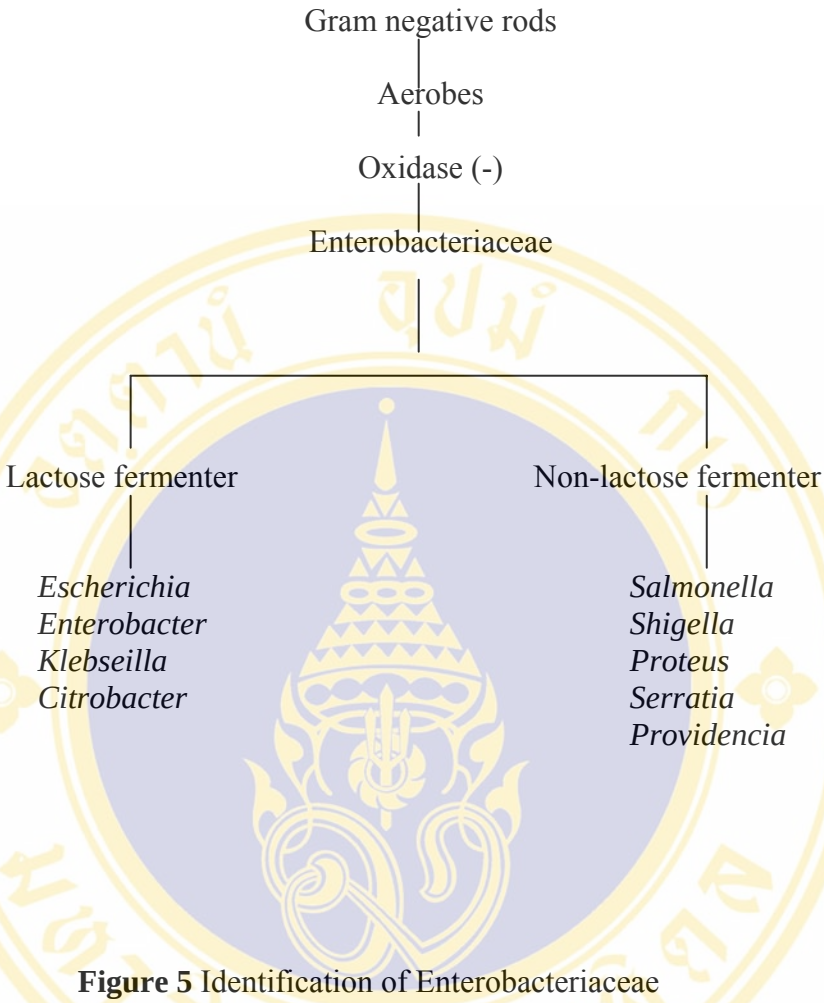


Figure 5 Identification of Enterobacteriaceae

APPENDIX E

INTERVENTION PROGRAM

1. Group discussion and brain storming

The researcher organized the meeting groups to orientate the studied nurses for planning and problem solving, discussion and brain storming for developing the practice guideline implementation. The studied nurses were divided into 8 groups. Each group consisted about 5-6 persons and they were meeting at 3 - 4 p.m. in Monday to Friday. The researcher was the moderator and Infection Control Nurse (ICN) was an assistant. After the meeting finished, all group members concluded and confirmed the progression results and problem solving to practice.

2. Skill training on clinical practices to prevention of VAP:

2.1 Hand washing technique:

Hand washing or disinfection is the most important technique in the prevention of cross-infection. To wash hands properly, rub all parts of the hands and wrists with soap and water or an alcohol-based hand sanitizer. Wash hands for at least 15 seconds or more. Protocols of hand washing shown in Figure 5.

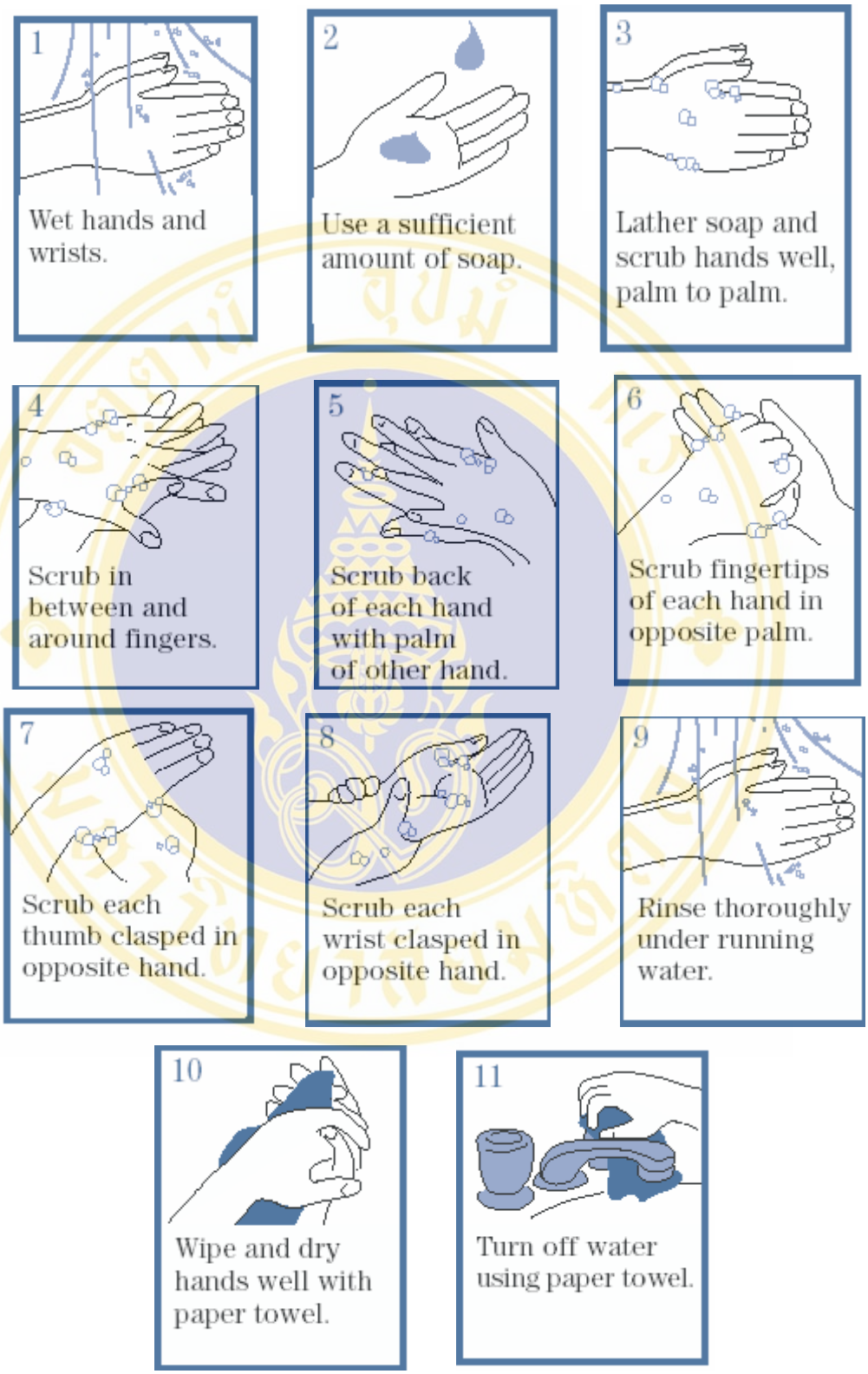


Figure 6 Protocol of hand washing with soap and water

Source: http://www.rcn.org.uk /RCN_Handwashing_Technique.pdf

2.2 Endotracheal tube suctioning:

1) There should be 2 persons: One is to do suction and another one is a helper.

2) Assess patients need for suctioning, determined by lung sounds or other assessments which part of secretion was located most.

3) Place patients in semi-recumbent position, with to turn the face towards opposite the lung sounds.

4) Hand washing every time before suction and wearing the mask.

5) To prepare sterile tubes for suction, outside diameter of suction catheter not more than half of the diameter on open hole of the endotracheal tube or tracheostomy tube.

4) Turn on the pressure gauge approximate 80 – 120 mmHg. Then should were sterilized gloves, secure one end of connecting tube to suction machine by aseptic technique.

5) Gently but quickly insert catheter with dominant hand until resistance is met, then pull back 1-2 cm, time should not exceed 10-15 seconds. Then provide 100% oxygen by pressing resuscitation bag flow 5 – 10 liters/minute in order to help the patient's respiration 4 – 5 times before doing the suctioning next time.

6) After having done the suctioning, clean the ventilator joints with 70% alcohol before connecting them into the endotracheal tube and cleaned joint of resuscitation bag by 70% alcohol and cover by sterile gauze. Then listen lung sounds again to assess the efficiency of suction, check the position of endotracheal tube and used ventilator.

7) Only one resuscitating bag for one patient and the suction catheter should be sterilization or single use.

8) To check the pressure cuff of endotracheal tube regularly in the level of 20 cm.H_2O to prevent of saliva over the level of cuff will be aspirated into the lower of respiratory tract.

2.3 Management of respiratory equipment:

Healthcare care workers at respiratory equipment center were trained for management of respiratory equipment such as, ventilator circuit, humidifiers, small volume medication nebulizers and resuscitation bag. Intervention included:

- Cleaning
- Disinfection
- Rinsing, drying, and packaging for sterilization, taking care not to contaminate the items in process.
- Changing ventilator circuit with aseptic technique.

3. Education program to improve knowledge and practice related to the prevention of ventilator-associated pneumonia:

2.1 Epidemiology and scope of problems

2.2 Risk factors

2.3 Etiology

2.4 Definitions and diagnosis of VAP

2.5 Guidelines for prevention of VAP.

(Presentation with power point and fact sheets)

APPENDIX F

PICTURES PRESENTING

Figure 7,8 Group discussion

Figure 9,10 Educating

PICTURES PRESENTING (cont.)

Figure 11 Poster presentation

Figure 12, 13 Hand washing presentation

PICTURES PRESENTING (cont.)

Figure 14, 15 Practices

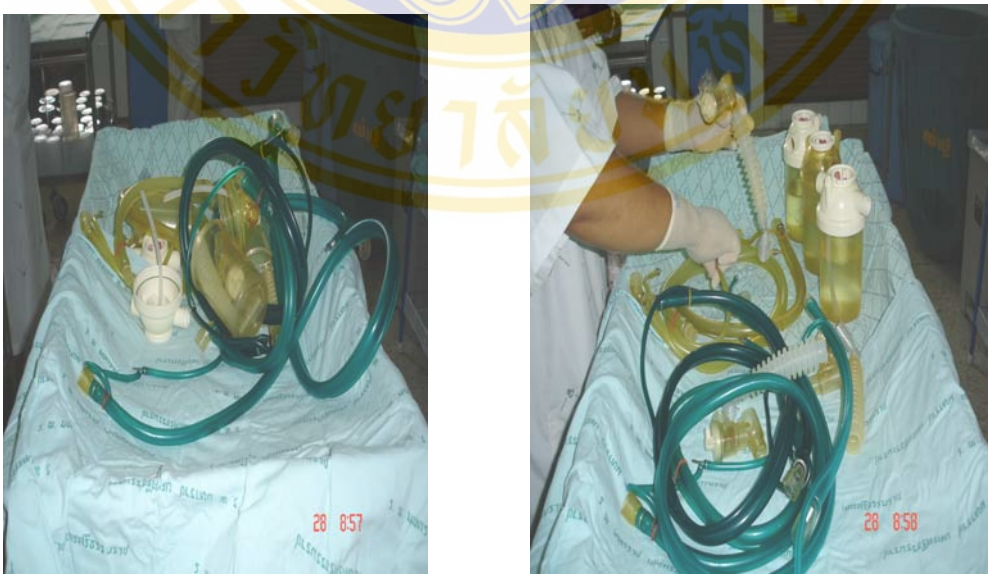


Figure 16, 17 Management of respiratory equipment

BIOGRAPHY

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