PROMOTING SUCCESSFUL IN WEANING PATIENTS FROM MECHANICAL VENTILATION: EVIDENCE – BASED NURSING

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ABSTRACT

The aim of this study was to develop recommendations for promoting successful weaning from mechanical ventilation in adult patients in the intensive care unit based on evidence. The findings were obtained from analysis and synthesis where the results were relevant. The population intervention comparison and outcome (PICO) method was employed as the conceptual framework to search for evidence. This study evaluated the quality according to the study framework of DiCenso, Guyatt & Ciliska (2005), and evaluated the strength of evidence by the therapy pyramids of Grace (2009). A total of 35 evidence-based practices were selected for this study. The findings from analysis and synthesis of evidence yielded issues leading to recommendations for promoting successful weaning from mechanical ventilation were evaluated by a multidisciplinary team, i.e., daily screening for both physiological and psychological weaning readiness, weaning strategy, assessment and monitoring of patients throughout the weaning process to decreased duration of mechanical ventilation and reduced re-intubation rate.

According to this study, certain recommendations are suggested, i.e., the findings should be developed into clinical nursing practice guidelines that can be employed as standard care for patients on mechanical ventilation in the intensive care unit, promoting research for outcome evaluation, and continually improving knowledge for promoting successful weaning of patients from mechanical ventilation.

KEY WORDS: MECHANICAL VENTILATION / WEANING / SUCCESSFUL WEANING / PROMOTING / EVIDENCE-BASED NURSING

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การส่งเสริมความสำเร็จในการหย่าเครื่องช่วยหายใจของผู้ป่วยที่ใช้เครื่องช่วยหายใจ : การพยาบาลตามหลักฐานเชิงประจักษ์

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บทคัดย่อ

การศึกษานี้มีวัตถุประสงค์เพื่อพัฒนาข้อเสนอแนะจากหลักฐานเชิงประจักษ์ในการส่งเสริมความสำเร็จในการหย่าเครื่องช่วยหายใจของผู้ป่วยผู้ใหญ่ในหอผู้ป่วยวิกฤต ผลการศึกษาได้จากการวิเคราะห์และสังเคราะห์ความรู้ตามกระบวนการใช้ผลการวิจัยที่ได้จากหลักฐานเชิงประจักษ์ โดยใช้กรอบของ PICO ในการสืบค้น นำมาประเมินคุณภาพตามกรอบการศึกษาของ DiCenso, Guyatt & Ciliska (2005) และประเมินระดับความเข้มแข็งของหลักฐานเชิงประจักษ์ตามรูปแบบ Therapy Evidence Pyramids ของ Grace (2009) ผลการสืบค้นหลักฐานเชิงประจักษ์ที่ตรงกับขอบเขตการศึกษามีจำนวน 35 เรื่อง ผลการวิเคราะห์และสังเคราะห์หลักฐานเชิงประจักษ์ ได้ประเด็นเกี่ยวกับการส่งเสริมความสำเร็จในการหย่าเครื่องช่วยหายใจ ได้แก่ การประเมินความพร้อมในการหย่าเครื่องช่วยหายใจทั้งทางด้านร่างกายและจิตใจ วิธีในการหย่าเครื่องช่วยหายใจ การประเมินและติดตามผู้ป่วยตลอดกระบวนการหย่าเครื่องช่วยหายใจ โดยมุ่งเน้นการดูแลผู้ป่วยในการหย่าเครื่องช่วยหายใจแบบทีมสหสาขาวิชาชีพ เพื่อลดระยะเวลาการใช้เครื่องช่วยหายใจ และอัตราการใส่ท่อช่วยหายใจซ้ำ

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CHAPTER I
INTRODUCTION

1.1 Background and Significance of the Clinical Problem

Acute respiratory failure is a frequently encountered life-threatening critical condition caused by inability of the respiratory system to function with adequate gas exchange between the atmosphere and red blood cells (Balk & Gurka, 2008). Acute respiratory failure patients require intubation with mechanical ventilation, which is commonly encountered in the intensive care unit setting may be the result of a variety of causes and may not directly involve the lung or the respiratory muscles is important (Gosselink et al., 2008; Balk & Gurka, 2008). Mechanical ventilation is a significant therapy to maintain alveolar ventilation appropriate for the patient's metabolic needs and to correct hypoxemia, minimize oxygen transport and extending the time for the physicians to treat the initial etiology of the illness with the effect of returning respiratory function back to normal. (Fisher, Charlebois, Tribble, & Merrel., 2009; Chanchai Sittipan, 2009; Rozet & Domino, 2007).

The number of patients with acute respiratory failure in the intensive care unit treated by mechanical ventilators is increasing and projections for the future indicate escalation in developed countries, such as the United States (Carson et al., 2006) and developing countries, including Thailand (Norawee Juajamsai, 2008). Retrospective studies on patients who used mechanical ventilation in the United States in 1996–2002 found the number of patients to have increased from 284 to 314 per population of one hundred thousand people per year, or an increase of 21% over a period of 7 years. This finding concurs with the study of Needham and colleagues (2005) who investigated and predicted the number of patients requiring mechanical ventilators by 2026 would increase by 80% of the number of patients in 2000. In addition, 252,577 patients with acute respiratory failure were found to have been treated with mechanical ventilators for more than 96 hours in the United States in 2000 and this number has been projected to escalate to as high as 605,895 by 2020

(Ziberberg, Wit, Pirone, & Shorr, 2008). In Thailand, a number of patients with acute respiratory failure have been found to require mechanical ventilators. According to the statistics of the general medicine intensive care unit at Siriraj Hospital, in 2008, e.g. in the general patient ward, the respiratory intensive care unit and cardiovascular intensive care, 235 patients with acute respiratory failure required mechanical ventilators for more than 96 hours from 275 patients who required intubation (85.45%) (Medical Statistics Report Unit, Siriraj Hospital, 2008), which was consistent with the statistics of Srisaket Hospital in 2008 where 949 patients required mechanical ventilators, which was 98% of the daily number of patients, with mechanical ventilation duration of more than 96 hours, which was 73.5% of all intubated patients who required mechanical ventilation of an average 13.40 days at an average treatment cost of 54,656 baht per patient (Medical Statistics and Records, Srisaket Hospital, 2008). The aforementioned data indicated that large numbers of patients require mechanical ventilators in the intensive care unit and medical costs for hospitals increased (Rose & Nelson, 2006) by four times when compared to costs for patients who did not require mechanical ventilators (Alia & Esteban, 2000). Therefore, patients who receive treatments by mechanical ventilation are important and should receive the attention of healthcare teams in curing these patients of acute respiratory failure so they can be weaned from mechanical ventilators as soon as possible without undesirable complications due to mechanical ventilation.

Impacts and Complications from Mechanical ventilators

While mechanical ventilators are essential to improving oxygenation and can be lifesaving for critically ill patients with acute respiratory failure, intubation is considered an invasive treatment with physiological impacts on other systems of the body and complications from mechanical ventilation (Adisorn Wongsa, 2010), especially with prolonged mechanical ventilation for more than 96 hours (Zilberberg, Wit, Pirone, & Shorr, 2008), which has the following impacts on patients:

1. Physical Impacts

Use of positive pressure from mechanical ventilation to allow oxygen through the patients' respiratory system inhibits breathing muscles while reducing performance and weakenings breathing muscles (Carbery, 2008), a finding that

concurs with the experimental study of Levine and colleagues (2008) who investigated and compared the performance of diaphragmatic muscles following mechanical ventilation for 18-69 hours in brain dead patients kept on mechanical ventilation pending organ donations. The biopsy results from the diaphragms of patients undergoing surgery for removal of pulmonary tumors with mechanical ventilation for 2-3 hours revealed that patients on mechanical ventilation for more than 18 hours had non-functioning diaphragmatic muscles, thereby causing muscle atrophy from mechanical ventilation and increased risks for physical complications, such as ventilator-associated lung injury. The hazards of mechanical ventilator use are excessive pressure, or pulmonary barotrauma, which usually occurs in patients on maximum pressure at more than 50 water centimeters while inhaling (Frazier, 2008; Fisher et al., 2009). Intubation and mechanical ventilation reduces the efficiency of natural protective mechanisms of the lower respiratory tract, causes patients to loss the coughing reflex, reduces cilia function for eliminating foreign particles and causes more mucus accumulation in the respiratory tract, which becomes viscous and unable to be expelled by coughing, so patients contract hospital-acquired pneumonia and ventilator-associated pneumonia (VAP) (Brashers, 2008).

Ventilator-associated pneumonia is an infection frequently encountered in patients admitted to the Intensive Care Unit (ICU) and it is the most frequently encountered infection in hospitals at 28.4% as compared to other infections (Danchaiwijittra et al., 2005; American Thoracic Society, 2005), a finding that concurred with the EPIC which conducted a study in 10,038 in patients on mechanical ventilation in the ICUs of western European countries and found 31% of patients in the ICUs to have hospital- associated pneumonia while 83% of the hospital- acquired infections were infections caused by mechanical ventilation (Vincent, 2004). The chance of pneumonia increases with the duration of mechanical ventilation (Urden, Stacy, & Lough., 2010; Cason et al., 2006). According to a study on the incidence of hospital-associated pneumonia in general intensive care units in Thailand, Maharat Hospital in Chiang Mai, it was found that patients with hospital- associated pneumonia to require three times longer hospital stays, incur five times the cost and have 2.5 times the mortality rate of patients who do not have hospital- associated pneumonia (Pothirat, Inchai & Liewhiran, 2003)

Patients who use positive pressure mechanical ventilators are usually found to suffer hemodynamic imbalance and low blood pressure caused by the positive pressure of mechanical ventilators, so the average pressure in the chest cavity, the right atrium of the heart and veins increases, thereby resulting in decreased circulation from the veins into the right atrium with reduced preload leading to reduced stroke volume. Low blood pressure may also be encountered in dehydrated patients and patients with use of positive end-expiratory pressure (PEEP) or auto-PEEP (Adisorn Wongsa, 2010; Urden, Stacy, & Lough., 2010). Furthermore, 28% of patients on mechanical ventilators have also been found to have peptic ulcers and gastrointestinal hemorrhage (especially in patients on mechanical ventilators longer than 3-4 days), excessive secretion of acids in the stomach, and changes in the properties of the mucous membranes in the stomach. Hence, the stomach tissues are easily irritated with ulcers and bleeding leading to inhibited blood supply to the stomach lining (Putensen, Wrigge, & Hering, 2006). Moreover, patients who receive oxygen at concentrations of more than 50% for more than 48 hours or pure oxygen for more than 24 hours may have oxygen toxicity, which will destroy lung tissues and result in lung atelectasis (Anan Tantitam, 2009; Heuer & Scanlan, 2009).

Most patients on mechanical ventilators are prescribed constant bed rest and treatment by invasive catheters and monitoring equipment. Some patients may be treated with muscle relaxants or sedative drugs, so patients are unconscious or have reduced levels of consciousness with immobility or limited movement (American Journal of Critical Care, 2009). Problems with immobility and bed rest without physical movement reduce muscle strength by 1-1.5% per day (Morris, 2007). Patients on mechanical ventilators for more than 7 days have been found to have reduced muscular strength by 25 – 63% (De Jonghe et al., 2002) which can escalate to as high as 50 – 100% in patients with sepsis and multiple organ failure (Young & Hammond, 2004; Johnson, 2007). Muscle weakness, especially respiratory muscle weakness, causes reduced efficiency in coughing up mucous leading to mucous accumulation and tracheal obstruction, so patients have difficulty breathing and abnormal gas exchange (Cox et al., 2007). The short-term effects of muscle weakness are related to delayed extubation, while longer periods of mechanical ventilator use lengthen the period of time for weaning from mechanical ventilators. Therefore, successful weaning from the

mechanical ventilators becomes difficult. The long-term effects of muscle weakness reduce patients' functional status. Although patients return home, they will have weakness in the arm, leg and breathing muscles over a long period of time, consequently leading to decreased quality of life (Schweicket & Hall., 2007).

2. Psychological Impacts

Apart from causing the aforementioned physical impacts, mechanical ventilator use has also been found to have psychological impacts on patients, which causes patients to suffer from various treatments and procedures. According to a study by Rattanakorn Charernkul (2007) on the factors related to discomfort from oral intubation and the use of mechanical ventilators in 85 critical and common surgical patients who received oral intubation following surgery and used mechanical ventilators for more than 18 hours, all samples were found to have perceived discomfort while communication difficulties were found to be positively related to discomfort, difficulty breathing, anxiety, fear and pain, which were also found to be positively related to one another and causes of stress in patients on mechanical ventilators (Thomas & Thomas, 2003).

Patients who are intubated and use mechanical ventilators are not usually prepared before being put on mechanical ventilation. These patients have also been found to have higher levels of anxiety than patients who have not been on mechanical ventilation (Wong, Lopez-Nahas, & Mosassiotis, 2001). Intubation and use of mechanical ventilators compresses the larynx, so patients are unable to speak, or communicate lucidly so other people can understand or respond to their needs (Carroll, 2004; Orasa Panpakdee, 1998). Thus, patients suffer anxiety about mechanical ventilation and the unfamiliar environment in the ICU, which causes mental suffering for patients. (Cook, Meade & Perry, 2001; Pattaraporn Chanpradit, 2000) due to difficult communication and mental discomfort from ineffective communication (Rotondi et al., 2002). This finding concurred with the findings of Kwanruan Paerungsakun (2002) who studied situations causing stress in patients according to patients' and nurses' perceptions in the surgical intensive care unit and found patients' inability to communicate to be one of the five leading circumstances intubated patients perceived as stress.

According to the study of Wandee Rakim (2005) on the sleep quality of patients on mechanical ventilators, patients were found to have low quality of sleep, which was concurrent with the study of Yilan (2002) who found patients in hospitals to have low quality of sleep due to disturbances from physical discomfort and hospital environments. Sleep deficit without sleep quality affects the immune responses, respiratory function and perception processes of patients (Drouot, Cabello, & Ortho, 2008), which further affects physical performance and communication. Consequently, patients do not want to perform daily activities, perform any active movement or attempt breathing (Wang, Zhang, Li, & Wang, 2008). These patients are not ready to wean from mechanical ventilators and require extended mechanical ventilation over a long period of time (Blackwood, 2000). Moreover, there will also be long-term effects on the feelings and anxiety of patients after patients return home. According to the research of Samuelson, Lundberg and Fridlund (2007), patients on mechanical ventilators in the ICU suffer from nightmares, insomnia, paranoia, or fear of sounds resembling the sounds of mechanical ventilators, all of which affect quality of life for patients (Carson, 2006; Morris, 2007).

Despite the life-saving benefits of mechanical ventilation, mechanical ventilators are also a significant cause of numerous potentially unavoidable complications and impacts (Rose & Nelson, 2006). Using mechanical ventilation for a long period of time leads to poor prognosis, including increased patient mortality rates and higher medical costs (Goligher & Ferguson, 2006; Rose & Nelson, 2006). Chelluri and colleagues (2004), prospective, observational cohort study in 817 adult patients receiving prolonged mechanical ventilation and follow-up for 1 year to measured mortality rate and functional status. The finding was found the mortality rate after prolonged mechanical ventilation is high, long term mortality rate is associated with older age and poor pre-hospitalization functional status. Moreover, patients who required reintubation following failure to wean are found to have had a mortality rate as high as 43% in comparison to patients with successful weaning (MacIntyre et al., 2001). Therefore, mechanical ventilation requires an understanding of mechanical ventilator function, impacts on various systems of the body and potential complications associated with mechanical ventilator use. Patients require close monitoring while on mechanical ventilation so problems can be analyzed and solved

quickly. Furthermore, plans must be made for proper prevention and treatment for patients on mechanical ventilation. Lastly, the patients' duration of mechanical ventilation must include early weaning (Adisorn Wongsa, 2010). Complications prevent patients from being ready for weaning from mechanical ventilators, so patients require intubation and use mechanical ventilators for long periods of time (Chulay & Burns, 2005), which further increases intensive care unit and hospitals with further consequences in terms of resources, e.g. staff for monitoring and various equipment with increased medical costs (Burns et al., 2003; Carson, 2006; Bigatello et al., 2007; Thongchai, Bumroongkit, Jittawatanarat, & Chuajedton, 2007). Therefore, the care of patients on mechanical ventilators aimed at weaning and extubation as soon as possible is a significant clinical issue and a challenge for critical patients as well as multidisciplinary teams providing care for critical patients in ICUs (Boles et al., 2007; Gosselink et al., 2008).

Weaning from mechanical ventilation

Weaning from mechanical ventilation is the process of stopping the use of mechanical ventilation in breathing immediately or gradually reducing mechanical ventilation assistance until patients can be weaned from mechanical ventilation and able to spontaneous breathing (MacIntyre, 2005). Weaning from mechanical ventilation is an essential and universal element in the care of critically ill intubated patients receiving mechanical ventilation. The process of weaning from mechanical ventilation covers the process of caring for patients being released from mechanical ventilation with the end result of extubating patients (Boles et al., 2007). Numerous ongoing studies and researches are currently conducted on weaning from mechanical ventilation, but the findings have been vague regarding the best method for weaning from mechanical ventilation (Crocker & Kinnear, 2008). According to the study, weaning from mechanical ventilation has been found to require 40–50% of the entire duration of mechanical ventilation (Boles et al., 2007). Furthermore, 40–42% of patients have been found to be unsuccessful in weaning from mechanical ventilation and 24% of patients require reintubation following weaning from mechanical ventilation, while another 5–20% of patients require mechanical ventilation for long periods of time (White, O'Connor, & Kirby, 2008).

Duration of mechanical ventilation means the period of time patients are on mechanical ventilation from the time patients are first put on mechanical ventilation until patients can be weaned from mechanical ventilation because patients are able to breathe spontaneously. Mechanical ventilation may differ for each patient. Physical and psychological factors may have impacts on weaning from mechanical ventilation. These factors can be divided into six categories (MacIntyre et al., 2005) and summarized as follows:

1. Systemic factors consisting of age, severity of illness, malnutrition, chronic co-morbidities, such as cancer and chronic obstructive pulmonary disease.

2. Psychological factors, such as anxiety, confusion, depression and sleep deficit.

3. Mechanic factors such as increased work in breathing, reduced capacity of breathing muscles and obstruction of the upper respiratory tract.

4. Iatrogenic factors, such as unsuitable mechanical ventilation settings, lack of evaluations of readiness or ineffective evaluations of patient conditions and errors from use of medications.

5. Process of care factors, such as lack of guidelines for weaning from mechanical ventilation, insufficient numbers of medical and nursing staff and lack of experience in caregivers teams.

6. Complications from long-term hospital care, such as choking, infections, especially pulmonary infections and systemic infections, pressure sores and thrombosis in the veins.

Montira Udchumpisai and colleagues (2010) conducted a predictive study to determine the correlations between perceived illness severity, perceived sleep quality, anxiety, age, co-morbidities and illness severity associated with mechanical ventilation over long periods of time in 120 critical patients and found the group on mechanical ventilation for long periods of time to require mechanical ventilation due to sepsis or septic shock (48.5%). The factors of perceived illness severity, anxiety, co-morbidities and illness severity were positively related to mechanical ventilation use over long periods of time with statistical significance ($p < .05$), while perceived sleep quality was found to be negatively related to mechanical ventilation use over long periods of time with statistical significance ($p < .05$). Illness severity and anxiety

were able to jointly predict mechanical ventilation use over long periods of time in critical patients at 79.5% with statistical significance equaling .05.

Age is a factor related to duration of mechanical ventilation use in patients because age affects changing pulmonary function, reduces breath volume and increases risks for pneumonia and respiratory infections, so patients require mechanical ventilation for long periods of time and cannot be weaned (Delerme & Ray, 2008). This finding concurred with the study of Panakporn Rattanapanadda (2003) who found age to have a negative correlation with success in weaning from mechanical ventilation with statistical significance ($r = - 0.316$, $p < 0.01$) while being unable to predict weaning success.

It is evident that both physical and psychological factors, including the process of caring for critical patients, have impacts on the duration of mechanical ventilation and the time required for weaning from mechanical ventilation, which is an indicator of nursing outcomes demonstrating the quality of care provided for critical patients.

Stages of Weaning

The American Association of Critical Care Nurses divides the process of providing care for patients weaning from mechanical ventilation into three stages: the pre-weaning stage, the weaning stage and the post-weaning/outcome stage (Burns, et al., 2004; Rose & Nelson, 2006).

1. The pre-weaning stage is where the process of weaning from mechanical ventilation cannot begin due to diseases or the conditions requiring the use of mechanical ventilation have not been solved or improved, or when the patient's condition has been exacerbated with other complications. In this process, nurses and physician collabolate to discover and solve the causes of acute respiratory failure, which may help to moderately reduce levels of breathing assistance. This is the stage for both physical and psychological preparations of patients in weaning from mechanical ventilation, including various aspects of factors with effects on breathing and evaluations of readiness to begin weaning from mechanical ventilation. If patients are ready, having the patients try spontaneous breathing by entering the process of weaning from mechanical ventilation will be considered.

2. The weaning stage is the stage of weaning from mechanical ventilation by starting in patients with weaning readiness according to the criteria for deciding on readiness to be weaned from mechanical ventilation by spontaneous breathing trials (SBT) and choosing proper weaning methods from mechanical ventilation, monitoring and following-up on both physical and psychological changes in order to help patients successfully wean from mechanical ventilation.

3. The post-weaning/outcome stage is the end stage of weaning from mechanical ventilation when patients are able to breathe without using mechanical ventilation and ready for extubation or capable of spontaneous breathing for 24 hours. After extubation failures or failed weaning from mechanical ventilation, patients may continue to require periodic assistance by mechanical ventilation or they might die.

Assessment of Patient Readiness before Weaning from Mechanical Ventilation

Assessment of patient readiness before weaning from mechanical ventilation involves a search for patients who are ready to be weaned from mechanical ventilation and entering the process of weaning from mechanical ventilation more quickly (Urden, Stacy, & Lough, 2010). Therefore, patients require evaluations and promotion of readiness for weaning to prevent failure from premature weaning from mechanical ventilation (Burns et al., 2010; Boles et al., 2007). The criteria indicating the readiness of patients before weaning from mechanical ventilation are as follows:

1. Clinical assessments are the first and most important assessments before weaning from mechanical ventilation when patients can be treated for diseases or abnormalities causing them require mechanical ventilation (Burns et al., 2010; Crocker, & Kinnear, 2008; Boles et al., 2007; Maclntyre, 2007). Patients who are ready for weaning from mechanical ventilation should exhibit signs indicating that the disease or condition leading to acute respiratory failure in patients has improved with no fevers or reduced fevers, slower breathing and with no panting, reduced amounts of mucous in the airways with strength to cough and expel mucous (Bumroongkit et al., 2005; Boles et al., 2007; Goodman, 2006) without pain (Goodman, 2006; Marelich et al., 2001).

2. Objective measurements as follows:

2.1 Clinical stability.

2.1.1 Hemodynamic stability without active myocardial ischemia or angina pectoris, respiratory rates of < 30–35 breaths/minute (Epstein & Peerless., 2006; El-Khatib & Bou-Khalil., 2008; Boles et al., 2007), heart rates of ≤ 140 beats /minute, normal or near normal blood pressure, systolic BP 90–160 mmHg (Boles et al., 2007) without receiving vasopressors or vasopressor at only ≤ 5 μm/kg / min (McLean et al., 2006; Goodman, 2006; Epstein & Peerless., 2006) and Mean Arterial Pressure of ≥ 60 mmHg.

2.1.2 Balance Acid-Base and Electrolyte Balance - Patients to begin weaning from mechanical ventilation should have a acid-base and electrolyte balance within a normal range, especially in terms of potassium (normal value of 3.5–5.5 mEq/L), calcium (normal value of 8.8–10 mg/dl), magnesium (normal value of 1.5–2 mg/dl), phosphorus (normal value of 3.4–4.6 mg/dl). If these electrolytes are found to be abnormal, breathing muscles will be weak, especially in patients with diseases causing muscle weakness or patients with chronic obstructive pulmonary disease (Boles et al., 2007).

2.2 Level of Consciousness - Patients must have good consciousness with Glasgow Coma Scale scores of GCS > 10 (Marelich et al., 2001). Furthermore, patients must not receive pain relievers, muscle relaxants, or sedatives (Marelich et al., 2001; McLean et al., 2006; Goodman, 2006).

2.3 Lung mechanics were evaluated in terms of lung capacity which requires inhalation to expand and take air into the lungs and exhalation to expel air from the lungs. Lung capacity can be evaluated as follows:

2.3.1 Tidal volume > 5 ml/kg (Boles et al., 2007; Burns et al., 2010; El-Khatib & Bou-Khalil., 2008).

2.3.2 Minute volume ≤ 10 – 15 liters/minute (McLean et al., 2006; Marelich et al., 2001; El-Khatib & Bou-Khalil., 2008).

2.3.3 Vital capacity > 10–15 ml/kg (Boles et al., 2007; El-Khatib & Bou-Khalil., 2008).

2.3.4 Maximal inspiratory pressure (MIP) ≤ -20 to -25 cmH_2O (Boles et al., 2007) or negative inspiratory pressure >20 cmH_2O, positive expiratory pressure > 30 cmH_2O (Burns et al., 2010).

2.4 Adequate oxygenation refers to the ability of patients to maintain proper oxygen (O2) and carbon dioxide (CO2) balance in the red blood cells with low oxygen concentration levels, which can be evaluated as follows:

2.4.1 Oxygen saturation (SpO_2) measured in terms of oxygen saturation at the fingertips (pulse oximetry) > 90% while levels of oxygen concentration are 40% or PaO_2 / $FiO_2 \geq 150$ (Boles et al., 2007; El-Khatib & Bou-Khalil., 2008).

2.4.2 PaO_2 > 60 mercury millimeters, $PaCO_2$ 35–45 mercury millimeters in order to have pH levels at 7.30 – 7.45 (Burns et al., 2010; Bumroongkit et al., 2005).

2.4.3 PEEP ≤ 5-8 cmH_2 (Boles et al., 2007; El-Khatib & Bou-Khalil., 2008; Bumroongkit et al., 2005)

2.5 The Rapid Shallow Breathing Index (RSBI) is an indicator of successful weaning from mechanical ventilation (Thongchai et al., 2001; El-Khatib & Bou-Khalil., 2008; Boles et al., 2007). The RSBI is the respiratory rate of patients in one minute to obtain a tidal volume of 1 liter or calculations from the RSBI = f/Vt formula where “f” is frequency or respiratory rate (times/minute), “Vt” is the tidal volume measured in liter units. Measurements are made by attaching a spirometer to the patients’ intubation so patients can breathe for one minute. The minute volume can then be read and divided with respiratory rates in order to acquire the Vt. value. If the results are interpreted as f/Vt < 105, patients may successfully wean from mechanical ventilation while patients with f/Vt > 105 have little chance of successfully weaning from mechanical ventilation (Tobin & Jubran, 2006; Tananchai Boonburapong, 2008). According to the study, RSBI < 105 was found to be sensitive at 97% with specificity of 64%, which means that patients who failed to meet these criteria have a 3% chance of successfully weaning from mechanical ventilation while patients who meet the criteria will have a 64% chance of successfully weaning from mechanical ventilation (Amornchai Lertamornpong, 2010). This was found to be consistent with the study of Teixeira, Zimermann Hoher, de Leon, Brodt and Moreira (2008) which was a prospective cohort study to study frequency in evaluating RSBI used in evaluating f/VT < 105 to predict the success of patients in weaning from mechanical ventilation and weaning from mechanical

ventilation failure after SBT in 73 patients in general patient wards and surgical patient wards on ventilators for more than 48 hours and at 48 hours following extubation. RSBI evaluations were performed at 0, 30 and 120 minutes, respectively, in patients who practiced SBT and in patients following extubation. The study found patients who failed to be weaned from mechanical ventilators to have RSBI > 105 at 30 minutes while patients who had successfully been weaned from mechanical ventilators were found to have f / VT < 105 in the first minute of evaluation with no difference at 120 minutes with statistical significance, thereby indicating that the value of f / VT < 105 can be evaluated as readiness for weaning from mechanical ventilation and predict the success of patients able to breathe on their own for 30-120 minutes in weaning from mechanical ventilation. Patients who fail to be weaned from mechanical ventilation are usually unable to breathe independently from the first 30 minutes and should immediately stop weaning from mechanical ventilation.

El Khoury, Panos, Ying and Almoosa (2009) conducted a retrospective chart review of 154 patients with primary hypoxemic respiratory failure requiring mechanical ventilation for ≥ 24 hours in the general intensive care unit was performed to determine the predictive value of the PaO2 / FiO2 ratios, both independently and in combination with the standard Rapid Shallow Breathing Index (RSBI), for successful extubations, finding 142 (92%) patients were successfully extubated by using the criteria of PaO2 / FiO2 ratio < 200 or RSBI ≥ 70 to assess readiness for weaning from mechanical ventilation. Sensitivity and specificity were found at 70 and 56, respectively, while PaO2 / FiO2 ratio was ≥ 200 indicated a higher risk of reintubation.

Santiago, Khow and Toquieng (2002) conducted a cohort study in 54 patients on mechanical ventilation for more than 48 hours and found 36 (67%) patients able to be successfully weaned from mechanical ventilation. The best predictor of successful weaning from mechanical ventilation was found to be the spontaneous breathing index (SBT) and RSBI $\leq$ 105. Moreover, Modawal and colleagues (2003) conducted a retrospective study in 145 patients on mechanical ventilation in the recovery ward and found the best predictor of weaning from mechanical ventilation to be albumin levels of 2.2 $\pm$ 0.4 grams/deciliters and BUN levels of 25.7 $\pm$ 17.7 milligrams/deciliters).

Tanios and colleagues (2006) studied the efficiency of frequency tidal volume ratios (f/VT) in predicting successful weaning from mechanical ventilation and found evaluations of f/VT by using the criteria of < 105 times/minutes/L in combination with criteria for assessing readiness for weaning from mechanical ventilation were able to predict weaning success from mechanical ventilation better than the normally used criteria for assessing readiness for weaning from mechanical ventilation and helped patients achieve quicker success in weaning from mechanical ventilation by reducing the time on mechanical ventilation.

According to the literature review, accurate instruments with high reliability helped assess readiness before weaning from mechanical ventilation which included the evaluation form on readiness to be weaned from mechanical ventilation modified from the Burns Weaning Assessment Program (BWAP) containing 12 questions for evaluating overall conditions and psychological readiness and 14 questions for evaluating the respiratory system. The form contained a total of 26 questions (Burns et al., 2010) with the following evaluation details:

Assessments of overall condition consisted of 12 questions on the following physiological and psychological assessments:

1. Hemodynamic stability: stable heart rate and rhythm and blood pressure without the use of vasoactive agents (e.g. as needed antihypertensive medications, infusion of vasopressors with the exception of low-dose dopamine or dobutamine) or any oral agents administered on an as-needed or stat basis to control heart rate or blood pressure, which can be assessed by vital signs. Normal vital signs include heart rates of more than 50–120 beats/minutes, systolic blood pressure of approximately 90–120 mmHg, diastolic blood pressure of approximately 60–90 mmHg, no cardiac arrhythmia (Burns et al., 2010). If abnormalities are found in a patient, that patient should not be weaned from mechanical ventilation (Rose & Nelson, 2005).

2. Metabolic stability: assessments evaluated patient conditions conducive to increased or decreased rates of consumption, such as sepsis, seizures, fevers, infections or thyroid disarray. The white blood cell count and differential and other indices of infection or active metabolic processes are used for the interpretation that patients are not ready to be weaned from mechanical ventilation because these

symptoms will increase respiratory function and weakness of breathing muscles (Burns, 2003; Burns et al., 2010).

3. Anemia is evaluated in terms of normal hematocrit ≥ 25% with hemoglobin of more than 8–10 g/dl. Hematocrit is evaluated in conjunction with evidence of bleeding, use of blood products, and so on (Burns et al., 2010). If patients have anemia, oxygen will be reduced and the heart will insufficiency amounts of oxygen to supply the body leading to more difficult weaning from mechanical ventilation and requiring patients to use mechanical ventilation for a long period of time (MacIntyre, 2002).

4. Nutrition: Evaluated with a number of indices and clinical assessment. In patients in stable condition, serum level of albumin/prealbumin, which should be more than 2.5 g/dl. may be used in conjunction with provision of feeding. In patients without available nutrition markers, and assessment of whether the patients is receiving what has been ordered is used in conjunction with absorption (Burns et al., 2010). Patients should receive sufficient nutrients as quickly as possible in order to receive approximately 30–35 Kcal/kg/day (Bhurayanontachai, 2006) and receive protein at 1–1.5 gm/kg/day. If patients receive insufficient nutrients, they will suffer malnutrition which weakens the muscles and leads to muscular atrophy and patients may easily contract pulmonary infections. Furthermore, patients should receive more energy from fat than carbohydrates because the metabolic processes for carbohydrate foods cause more carbon dioxide to be expelled from the lungs by breathing more than protein and fat nutrients. Consequently, patients have difficulty breathing and require great physical exertion to breathe so weaning from mechanical ventilation becomes difficult (Burns et al., 2010 & Barr et al., 2004).

5. Fluid balance: Evaluation of bodyweight, fluid intake and output from the body as a cumulative and 24 hours the score is negative (Burns et al., 2010). The score is positive indicates pulmonary edema, which causes reduced gas exchanges in the lungs (Epstein, & Peerless, 2006).

6. Electrolyte balance should be within a normal range, especially for potassium (normal value = 3.5–5.2 mEq/L), calcium (normal value = 8.8–10 mg/dl), magnesium (normal value = 1.5–2 mg/dl), phosphorus (normal value = 3.4–4.6

mg/dl). If there are abnormalities, breathing muscles will become weak (Burger, 2007).

7. Excretions were assessed by symptoms of diarrhea, constipation and distention. These symptoms have impacts on weaning from mechanical ventilation. For example, when patients suffer fluid loss and electrolytes due to diarrhea, patients become weak and have no strength. Abdominal distention and constipation cause patients to feel discomfort, irritation and inability to breathe fully which leads to reduced lung capacity and chest expansion (Couchman et al., 2007; Orasa Panpakdee, 1998).

8. Assessment of lung pathology was assessed in terms of chest radigraph, a return to baseline findings or improvement in findings compared with the previous radiograph. New abnormal findings result in a no score. The pathologies relative on gas exchange and ventilation (Tananchai Boonburapong, 2009; Couchman et al., 2007; MacIntyre, 2001).

9. General body strength and endurance: This factor is evaluated relative to previous functional activity and state. The score is negative if progressive activity is not occurring (movement from supine in bed to dangling, holding self upright at side of bed, standing with help, marching in place at bedside, etc.). If a patent is able to sit in a chair at bedside, progressive increase in time in the chair is desirable. An activity regimen that is progressive with the help of a physical therapist is also a positive finding. (Choi, Tasota, & Hoffman, 2008; Burns et al., 2010).

10. Pain was assessed by asking if patients had any pain, including observation of presenting physical symptoms such as rapid pulse, perspiration, behavioral expressions, e.g. crying, furrowed brow, discomfort, etc. If patients had pain with inability to cough or breathe effectively, pain should be assessed and managed before weaning from mechanical ventilation (Couchman et al., 2007).

11.Sleep/rest was assessed by both quality and quantity with question patients about sleep and/or rest (Burns et al., 2010). Patients should sleep for at least 2–4 hours consecutively and for 6–8 hours per day. Inadequate sleep causes patients to become weak, stressed, irritated, sleepy and uncooperative in weaning from mechanical ventilation (Couchman et al., 2007; Vicky, 2003).

12.Anxiety: Scoring anxiety requires a response from the patient. If a patient cannot respond to question about anxiety, the factor is scored as not assessed. A no response is recorded when the anxiety is not controlled. Bedside clinicians can assess anxiety by using a score (1=least, 10=most). For patients who say they are anxiety, the clinicians may ask if they feel they need something to reduce their nervousness. When patients have a high score or request anxiety relief, this item is scored negatively (Burns et al., 2010). The aforementioned anxiety stimulates the sympathetic nervous system, so patients breathe faster, work harder to breathe and require more energy. Patients will have symptoms of panting and be unable to successfully to wean from mechanical ventilation (Couchman et al., 2007).

Respiratory system assessment consisted of 12 questions on respiratory characteristics and breathing work, elimination of mucous in the airways, strength and endurance of breathing muscles and pulmonary gas exchange capacity as follows:

1. Respiratory Rates and pattern: Both must be present for a positive score. Respirations >25 breaths/minute (sustained) is scored negatively, as is any pattern of breathing that is abnormal (e.g. chest abnormal asynchrony) (Burns et al., 2010).

2. Breathing sounds: Any adventitious sound result in a score of no, such as wheezing, which indicates narrowness or obstruction of the airways and rhonchi sounds which indicate that air has passed areas with mucous, etc. The breathing sounds can indicate lung pathologies with impacts on gas exchange in the lungs and failure in weaning from mechanical ventilation (Couchman et al., 2007; Burns et al., 2010).

3. Secretion: Both the amount and consistency of the secretion are noted. For a positive score, secretion should be thin and scant. (clinicians look at suctioning frequency in addition to the type of secretion quality and quantity). If patients have a large amount of thick mucous, they will be unable to expel the mucous by coughing, which will cause airway obstructions leading to reduced gas exchange in the lungs (Couchman et al., 2007). Therefore, the amount of mucous should be assessed and airways cleared prior to weaning from mechanical ventilation.

4. Assessments of the nervous system and muscles were performed to determine neuromuscular diseases or deformities, any condition that affects respiratory

function, such as neuromyopathies, multiple sclerosis, myasthenia gravis, Guillain–Barre syndrome, severe scoliosis, stroke with defects (Burns et al., 2010). Patients with the aforementioned diseases will have greater difficulty in weaning from mechanical ventilation (MacIntyre, 2002).

5. Abdominal distention assessments were performed to assess conditions causing patients to have abdominal distention such as ascites, obesity in patients with BMI of more than 27–27.5 or distension from ileus result in a negative score because the aforementioned conditions cause poor chest expansion (Rubin & van Der Schans, 2004).

6. Endotracheal or tracheal tube sizes: threshold is ≥7.5 millimeters (endotracheal tube of more than or equal to 7.0–7.5 mm. in Thai women and more than or equal to 7.5–8.0 in Thai men or ≥ 6.0 (tracheostomy) because small and long tubes will increase airway resistance and weaken breathing muscles due to increased work of breathing and thereby leading to failure in weaning from mechanical ventilation (Couchmana, et al., 2007).

7. Airway clearance: evaluate of ability to cough and swallow. If patients are able to cough effectively, patients can expel mucous (Chawiwan Tongchai, 2009).

8. Strength of breathing muscles was assessed in terms of negative inspiratory pressure (NIP), the threshold is ≤ 20 cmH_2O will be able to wean from mechanical ventilation and successful in weaning the value used to indirectly measure the strength of breathing muscles (Tananchai Boonburapong, 2008).

9. Positive expiratory pressure (PEP) assessments are also measurements of breathing muscle strength, the threshold is ≥ 30 cmH_2O. Patients with less than 30 cmH_2O with lung pathology who may have oxygen deficiency or increased work of breathing (Sumalee Kiatboonsri, 2002; Tananchai Boonburapong, 2008).

10. Spontaneous tidal volume (STV) assessments are measurements of breathing muscle endurance which should be spontaneous tidal volume ≥ 5 ml/kg. Therefore, patients who are ready to wean from mechanical ventilation should have a spontaneous tidal volume of 250–400 ml (Sumalee Kiatboonsri, 2002; Tananchai Boonburapong, 2008; Couchmana et al., 2007).

11. Vital capacity (VC) should exceed 10 ml/kg. or more than triple tidal volume. VC is a highly specific and sensitive measuring of strength and endurance of breathing muscles (Sumalee Kiatboonsri, 2002; Tananchai Boonburapong, 2008).

12. The pH level should be within the normal range from 7.3 to 7.45 to indicate acid-base balance (Mclean et al., 2006; Burns et al., 2010).

13. Partial pressure of arterial oxygen (PaO_2): The threshold is 60 mmHg with low-level positive end-expiratory pressure (PEEP) $\leq$ 5 cmH_2O and fraction of inspired oxygen (FiO_2) $\leq$ 40% (Mclean et al., 2006; Burns et al., 2010).

14. Partial pressure of arterial carbon dioxide ($PaCO_2$) and minute ventilation: $PaCO_2$ 40 mmHg or baseline value and minute ventilation $\leq$ 10 L/min. These 2 parameters are viewed together. A patients's baseline $PaCO_2$ (may be substituted for the threshold value). The threshold for both $PaCO_2$ and minute ventilation must be met to be scored positively. For example, a $PaCO_2$ of 40 mmHg with a minute ventilation of 20 L/min. is scored as no (Burns et al., 2010).

Assessment of readiness according to the BWAP assessment form was scored as follows:

Yes	means	Patients meet set criteria.
No	means	Patients fail to meet set criteria.
Not evaluated	means	Inability to evaluate the question, which must be deducted from the full number of questions.

The total scores for all 26 questions were evaluated in order to calculate percentage as follows:

$$\text{Calculated Scores (\%)} = \frac{\text{Number of ``Yes'' Answers x 100}}{\text{Total Number of Answers Calculated}}$$

In cases where patients were evaluated on a particular item such as inability to evaluate in Item 8 on negative inspiratory pressure (NIP) due to lack of instruments, the total number of items equaled 26–1 = 25.

After assessing readiness with the BWAP and using the score obtained to calculate percentage of readiness to wean from mechanical ventilation, if the calculated score was more than or equal to 50%, patients were deemed ready to wean from mechanical ventilation while calculated scores of less than 50% indicated that patients were not ready to wean from mechanical ventilation.

According to the study of Epstein and Peerless (2006) conducted in 40 surgical and trauma patients aged over 60 years who had received treatment with mechanical ventilation for more than three days in order to study the relationship between BWAP scores and factors associated with weaning from mechanical ventilation outcomes, 28 (70%) of the patients were found to have successfully weaned from mechanical ventilation. BWAP scores increased in patients who were successfully weaned from mechanical ventilation from 47% to 53% while BWAP scores were reduced from 52% to 50% in patients who failed to wean from mechanical ventilation. Younger patients have greater chance of successful weaning from mechanical ventilators than older patients while a negative balance of body fluids is related to the success of patients in weaning from mechanical ventilation with statistical significance ($P < 0.001$).

Miliner (2000) studied three forms for assessment of readiness to be weaned from mechanical ventilation, i.e. the American Association of Critical Nurses (AACN), the Burns Weaning Assessment Program (BWAP) and the Spaulding Rehabilitation Hospital, Boston and found the BWAP to be an evaluation form capable of comprehensively evaluating patients and helping patients successfully wean from mechanical ventilation. This was found to be concurrent with the study of Twibell, Siela and Mahmoodi (2003) who conducted a prospective study in 68 patients weaned from mechanical ventilation by using the BWAP and found that use of the BWAP (Burns, 2003; Burns et al., 2010) in evaluating readiness before weaning from mechanical ventilation increased the capacity of patients in weaning from mechanical ventilation.

The study of Suzanne M. Burns and colleagues (2010) on weaning from mechanical ventilation in patients on mechanical ventilation for more than three days comprised the study of a wider target group covering 1,889 patients on mechanical ventilation, except for children, who received treatment in 5 ICUs, i.e. a medical ICU, a surgical-trauma-burn ICU, a coronary care unit, a neurological ICU and a thoracic-cardiovascular postoperative ICU, for a period of five years by conducting evaluations on readiness to be weaned from mechanical ventilation using the Burns Weaning Assessment Program (BWAP). According to the study, 88% of patients achieved success in weaning from mechanical ventilation while only 22% of the patients were

not successful in weaning from mechanical ventilation. Furthermore, according to the findings, patients with BWAP scores of more than 50 points had greater chance of successfully weaning from mechanical ventilation than patients with scores of less than 50 points with statistical significance ($P < 0.001$). This study showed BWAP scores to be able to help in assessing readiness for weaning from mechanical ventilation and predicting success in weaning from mechanical ventilation among patients with different ages, genders and ICUs. Moreover, one advantage in assessing readiness to be weaned from mechanical ventilation by the BWAP was that the BWAP is a checklist evaluation form covering physical and psychological aspects which can be used in predicting successful weaning from mechanical ventilation.

According to this study, BWAP scores were capable of helping assess readiness for weaning from mechanical ventilation and predicting success in weaning from mechanical ventilation of patients with different ages, genders and ICUs. Moreover, one advantage in assessing readiness to be weaned from mechanical ventilation by the BWAP. The BWAP is a checklist evaluation form requiring only 5-10 minutes in assessing with coverage of both physical and psychological aspects while the form can also be used to predict success in weaning from mechanical ventilation. The BWAP had good implementation in assessing readiness to be weaned from mechanical ventilation in both general medicine and surgical patients. Furthermore, the aforementioned assessments have also helped to screen and discover factors with impact on weaning from mechanical ventilation which remain unresolved, which is helpful information in planning medical treatments and solving problems encountered with healthcare teams quickly so patients can have opportunities to be weaned from mechanical ventilation sooner.

Therefore, once patients are treated for whatever required the use mechanical ventilation, patients should begin immediate weaning from mechanical ventilation with support for rapid weaning from mechanical ventilation (Epstien, EL-Mokadem, & Purless, 2002; Crocker & Kinnear, 2008) because using mechanical ventilation over a long period of time results in complications together with higher mortality rates and medical costs (Boles et al., 2007). Patients should be assessed for weaning from mechanical ventilation readiness from the early stages of the process of weaning from mechanical ventilation when patients have been intubated for least 24

hours (Burns et al., 2003; MacIntyre, 2001). Effective assessments of weaning from mechanical ventilation readiness with the use of proper weaning protocols are the best weaning from mechanical ventilation methods (Rose & Nelson, 2006) so the process of weaning from mechanical ventilation can be effective and successful (Boles, et al., 2007), which will reduce the time required for mechanical ventilation, complications caused by use of mechanical ventilation, medical costs and hospital stays with positive effects on patients (Burns, 2003; Bigatello et al., 2007). Nurses play a key role in systematically assessing readiness for weaning from mechanical ventilation. Without assessment of readiness, some patients will not be able to start weaning from mechanical ventilation, even though patients may be ready to be weaned from mechanical ventilation. However, some patients may have begun weaning from mechanical ventilation before they are ready, so the patients have tired breathing, weakness, fatigue and failed weaning from mechanical ventilation in addition to difficulties in future weaning from mechanical ventilation due to weakened breathing muscles and patients feel afraid and anxious about weaning from mechanical ventilation (Chawiwan Tongchai, 2009).

Mechanical Ventilation Weaning Methods

Weaning from mechanical ventilation depends on the conditions and problems of each patient. The process of weaning from mechanical ventilation can be divided into 6 categories (Thananchai Boonburapong, 2009) as follows:

1. Physician-directed weaning. The physician oversees and directs everything associated with the weaning from mechanical ventilation.

2. Nurse-directed weaning. In this method, the nurse is the one overseeing the weaning from mechanical ventilation, which is a method commonly encountered in Thai hospitals. Following the physician's decision to wean from the mechanical ventilator, the nurse will be the one performing the weaning so the patient can eventually be weaned from the mechanical ventilator. The nurse performing the weaning must have knowledge about the weaning process for both physician-directed and therapist-driven protocols (TDP). The nurse must also be able to assess pulmonary reserve and remain near the patient during the trail weaning.

3. Patient-directed weaning. This is the method where the patient removes the endotracheal tube by himself/herself (self-extubation) and the patient is able to breathe without the help of the mechanical ventilator, so it is comparable to having the patient able to wean from the machine by himself/herself.

4. Therapist-driven, protocol-directed weaning. This weaning method is performed by a respiratory therapist in line with the weaning protocol established for use in the medical facility after the physician's decision to issue an order stating that the patient should be weaned from the mechanical ventilator. This method may not be suitable for Thai hospital context because the number of respiratory therapists remains deficient.

5. Nurse-Driven, Protocol-Directed Weaning. This is protocol-directed weaning used in medical facilities without respiratory therapists. Physicians and nurses set the protocol together. The nurse performing the weaning according to the weaning protocol must have knowledge, understanding and skills to evaluate the patient and monitor the patient during spontaneous breathing trial (SBT). Implementing foreign TDP in Thailand by nurses may not be as successful as when it is done by a therapist. Having weaning protocol will promote successful and efficient weaning from mechanical ventilation.

6. Computer-directed weaning (CDW). A computer-controlled weaning system or automatic weaning modes, such as Adaptive Support Ventilation (ASV), are available in new models of mechanical ventilators offering control of ventilation levels, e.g. tidal volume, respiratory rate and end-tidal CO_2 when the patients can breathe more on their own, the mechanical ventilator will reduce the assistance until the patient is eventually able to spontaneous breathing better than the set value. Next, the machine stops assisting the patient and a signal indicates that the patient no longer requires the machine.

Chaiwat Bumrungkit and colleagues (2005) conducted a prospective study to evaluate the efficiency of mechanical ventilation weaning by protocol-directed weaning as compared to physician-directed weaning. The findings indicate weaning using the set protocol to be more efficient than physician-directed weaning in terms of length of time required in the weaning, thereby reducing the number of days in the intensive care unit with no negative impacts.

Onuma Chaiwat and colleagues (Chaiwat et al., 2010) conducted a study aimed at comparing the periods of time for which patients are on mechanical ventilation between protocol based nurse-directed methods, weaning done by receiving daily screening and spontaneous breathing trials by nurse and physician-directed methods and weaning done by the physician in 100 patients receiving abdominal surgery. The findings indicated protocol-directed weaning by nurses to be efficient and capable of significantly reducing mechanical ventilator duration with $p < 0.001$ as compared to physician-directed weaning methods conducted by the physician. The two methods had the same re-intubation at 72 hours following the removal of the endotracheal tube. These findings concur with the findings of the study of Blackwood and colleagues who found that nurses play a leading role in nurse-led protocolized weaning and can reduce ventilator duration and the ICU stays.

Successful mechanical ventilator weaning requires cooperation from physicians, nurses and patients. Every stage of the weaning requires science and art in caring for and monitoring patients since the assessment of physical and emotional readiness and the selection of weaning methods as suitable for each patient (Crocker, 2009).

Weaning techniques can be divided into 3 main groups (Thananchai Boonburapong, 2009) as follows:

1. Abrupt discontinuation is weaning immediately after successful spontaneous breathing trial in the cases where patients who have received breathing assistance for a short period of time and when the breathing muscles are not yet atrophied. Spontaneous breathing trials are used in patients meeting weaning criteria and the patient has a chance to wean successfully at the first attempt. SBT may be carried out by one of the following methods: remove the mechanical ventilator from the patient and let the patient breathe spontaneously via a T-piece. The patient receives as much air flow as needed from oxygen given through the T-piece and the atmosphere. The patient must overcome the airway resistance spontaneously by giving FiO_2 in amounts greater than or equal to the original level of 0.1. FiO_2 at 0.4 is normally used. If a nebulizer is used, adjust the oxygen level to 40% (Thananchai Bunburapong, 2009) or let the patient breathe spontaneously via mechanical ventilator with a spontaneous breathing mode. Perform SBT without removing the mechanical

ventilator, but the patient must stimulate the mechanical ventilator and overcome the airway resistance by using CPAP 5-8 cm water or via low level of continuous positive airway pressure (CPAP) (Thananchai Bunburapong, 2009; Boles et al., 2007). Let the patient breathe spontaneously for 30-120 minutes. Patients who cannot breathe spontaneously tend to be tired within the first 30 minutes. These patients should not be allowed to breathe via endotracheal tube longer than 120 minutes because they may be too tired due to the increased workload from overcoming the airway resistance (Thananchai Bunburapong, 2009; Epstein, 2009; Robertson et al., 2008). In practice, weaning methods and spontaneous trial duration vary greatly. There is a chance as high as 85% that patients who pass spontaneous breathing trials (SBT) can be removed from the endotracheal tube (Epstein, 2009).

2. Gradual weaning techniques are carried out by gradually reducing the breathing assistance and gradually increasing muscle function. This muscle reloading process is recommended for patients who meet weaning criteria but fail at spontaneous breathing due to respiratory muscle weakness or fatigue. This method may be considered for use in patients on mechanical ventilation for long periods of time, e.g. no more than 5-7 days without SBT. Gradual weaning techniques include the following: T-piece weaning, Weaning with partial ventilator support modes such as Pressure Support Ventilation (PSV), Synchronized Intermittent Mandatory Ventilation (SIMV), SIMV along with PSV, Continuous positive airway pressure (CPAP) (Thananchai Bunburapong, 2009).

T-piece weaning is unassisted spontaneous breathing via a T-piece. The patient tries to breathe as well as possible (once daily T-piece trial) or for a period of time, switching back and forth between full assistance (intermittent T-piece trial) with gradual increase on spontaneous breathing time until the patient can breathe spontaneously. From studies on once daily T-piece trials and in comparison with many time T-piece trials, no differences were found between the two methods (Esteban et al., 1995). Therefore, the T-piece is commonly used in the weaning once a day, beginning in the morning after the patient has fully rested (Amornchai Lertamornpong, 2010). T-piece weaning is considered a traditional and conventional technique. The physician lets the patient breathe using a T-piece daily as strength conditioning by letting the muscles work spontaneously for a time and switching with complete rest.

Only 30-45 minutes is required to observe the patient's condition, then the endotracheal tube can be removed if the patient's condition is good or when the patient has no weaning criteria (Amornchai Lertamornpong, 2011). The patient should not be allowed to breathe until he/she is tired. Rather, spontaneous breathing should cease before any sign of respiratory muscle weakness occurs. During rest, the patient should receive full support assisted ventilation (Thananchai Bunburapong, 2009; Amornchai Lertamornpong, 2011). The remaining period of time must be sufficient to allow the breathing muscles to recover from fatigue. There is no evidence about recommendation for minimum effective rest periods. For patients with failed trials, the patient's breathing muscles should be allowed to rest for 24 hours because fatigued respiratory and diaphragmatic muscles require at least 24 hours rest for recovery (Amornchai Lertamornpong, 2011).

Pressure Support Ventilation (PSV) is respiratory assistance that adjusts workload by adjusting pressure support level (PS). This form of ventilation is used 21% of the time to wean patients from mechanical ventilation in the intensive care unit (Boles et al., 2007) because patients are the ones establishing spontaneous breathing (Burns, et al., 2004). The ventilator tries to maintain stabilized pressure throughout the inhalation and the inhalation is then switched to exhalation when the flow cycle is reduced to a certain level. With this form of breathing, the patient establishes respiratory rate, time taken to inhale and inspiratory flow rate by using endurance condition and increasing workload. Thus, this method is suitable for weaning by gradually reducing PS when the patient is ready with stronger breathing. The advantage of PSV is that it can reduce workload required of patients in overcoming the resistance from the valve, circuit and ET tube during each breath; the result is more effective and stable workload pressure-volume characteristics because every breath is assisted by the mechanical ventilator (Thananchai Bunburapong, 2009).

Synchronized Intermittent Mandatory Ventilation (SIMV) is gradual weaning. With this method, the mechanical ventilator needs not be removed from the patient with gradual respiratory training by setting the machine respiratory rate at low. The patient will have spontaneous breathing alternated with the mechanical ventilation. This allows the respiratory muscles to work harder and reduces respiratory muscle weakness. The respiratory rate is usually set at 10-12 times/minute. If the

patient's condition is good, the rate is reduced by 1-2 times/minute/time until the setting is less than 5 times/minute. Furthermore, when the patient is capable of spontaneous breathing for 24 hours, the consideration for complete removal of mechanical ventilation may be made. This method is suitable for patients with weak hearts requiring gradual weaning and does not require great changes in intrathoractic pressure. PSV should also be considered to reduce workload (Thananchai Bunburapong, 2009).

Continuous positive airway pressure (CPAP) is positive end expiratory pressure (PEEP) therapy used in patients who breathe spontaneously. It is not a weaning technique because CPAP is already non-assisted spontaneous breathing. CPAP or PEEP is an expiratory airway pressure therapy to prevent all of the air from being exhaled from the lungs, so the pulmonary alveoli from collapsing or further expanding while PEEP is not being used. This is useful in patients with alveolar collapse, atelectasis or pulmonary edema because it improves gas exchange and reduces workload. Another advantage is to allow air to enter the lungs easier for the next breath, reducing the workload required for the breathing and helping stimulate the mechanical ventilator more easily in patients with air remaining in the lungs during exhalation (auto-PEP) (Thananchai Bunburapong, 2009).

3. Trial Extubation or the Sink or Swim (SOS) Weaning Approach - A number of patients whose weaning indices are not reliable or not assessable and the use of T-piece SBT usually result in weaning failure because spontaneous breathing through the ET tube creates high airway resistance preventing the patient from spontaneous breathing. Trial weaning is recommended for this group of patients by removing the mechanical ventilator and removing the ET tube, then monitoring for trial failure. If there is a clinical condition indicating a need for mechanical ventilation, the ET tube is re-connected or non-invasive positive pressure ventilation may be used. Such cases involve patients with COPD and neuromuscular diseases. Tracheostomy may help T-piece weaning become more successful because it can reduce dead space and resistance in comparison to the ET tube (Thananchai Bunburapong, 2009; Burns, Adhikari, Keenan & Meade, 2009).

Each weaning technique suits patients differently, depending upon the patient's ability to breathe and respiratory strength. Studies involving mechanical

ventilator weaning, include the randomized control trial conducted by Brochard and colleagues (1994) who studied the efficiency of 3 weaning techniques in 109 patients. The patients were randomly divided into 3 groups as follows: Group 1, 35 patients using T-piece; Group 2; 43 patients using SIMV; and Group 3, 31 patients using PSV. For this study, the PSV was initially adjusted respiratory rate to 20-30 breaths/minute. Patients who were able to tolerate this rate were adjusted down to 2 times per day with 2-4 cmH_2O. When the patient was no longer able to tolerate, the pressure was adjusted up to the previous level. Furthermore, when the patient was able to tolerate PSV at less than or equal to 8 cmH_2O for 24 hours, the patient was removed from the mechanical ventilator. Each group would use PEEP at 4 cmH_2O whereby the group with PSV had minimum failure with statistical significance ($p < 0.001$) (23%), followed by the groups with SIMV (42%) and T-piece (43%). The group with PSV had the shortest weaning time.

In 1995, Esteban and colleagues conducted a study on 130 patients with weaning difficulty by randomly dividing the samples into the following four groups: Group 1 with 29 patients using SIMV; Group 2 with 37 patients using PSV; Group 3 with 33 patients using Intermittent T-piece; and Group 4 with 31 patients using once daily T-piece. In this study, PSV was adjusted to less than 25 breaths/minute with two downward adjustments daily by 2-4 cmH_2O each time. If the patient was able to tolerate PSV at as much as 5 cmH_2O for 2 hours, the ventilator was removed. The study revealed the group using T-piece once daily to have more success than the group with SIMV and PSV with statistical significance, but there were no differences in the group with Intermittent T-piece. T-piece trial is the weaning method with the shortest weaning time with an average of 3 days, comparing to PSV and SIMV which had an average of 4 and 5 days, respectively. The studies of Brochard and colleagues and Esteban and colleagues yielded different findings from different PSV adjustments and weaning criteria. Thus, the results could not be compared to one another. One aspect of the studies shared was that the SIMV method had the highest failure rate among the weaning methods.

In addition to the aforementioned commonly used weaning methods, developments have been made in the mode of ventilation to help wean patients more quickly by using computers in the weaning process, or what is called Automatic

Weaning Mode, e.g. ASV or Smart Care. The mechanical ventilator automatically reduces assistance, depending upon the patient's demand in the form of Continuous Positive Airway Pressure (CPAP 0 and Pressure Support with adjustment of respiratory pressure by the computer (Sirichai Sang-ngammongkol and Adisorn Wongsa, 2011; Thananchai Bunburapong, 2009). However, these methods are not commonly used due to their high prices. Moreover, although the machines function automatically, the physician or machine controller is still needed to oversee the machine like a plane needs to be controlled by a pilot. Not every physician or nurse can use these mechanical ventilators to wean patients quickly. These methods are usually used with patients with weaning difficulty (Thananchai Bunburapong, 2009).

The above findings concur with the study of Figueroa-Casas, Montoya, Arzabala and Connery (2010) who conducted a randomized controlled trial comparing Spontaneous Breathing Trials (SBTs) and Automatic Tube Compensation (ATC) with Continuous Positive Airway Pressure (CPAP) in 122 adult patients on mechanical ventilation for over 24 hours, finding no statistical significance ($p= 0.09$) between using SBT along with ATC and using the CPAP weaning method in terms of weaning duration, failure rate and using mechanical ventilation duration. However, the ATC weaning method was found to be safe because the failure tendency decreased in this group of patients.

Weaning failure/Trial Failure

Weaning failure is defined similarly by different individuals. For example, Thananchai Bunburapong (2008) defines weaning failure as the condition when spontaneous breathing is unsuccessful despite several weaning attempts and long weaning duration. Burns (2010) defines weaning failure as the state when the patient must be put back on mechanical ventilation after being removed from mechanical ventilation, or returned to the ventilator within 24 hours, or unable to successfully weaned from the mechanical ventilator within 14 days.

Boles and colleagues (2007) defined weaning failure as a condition where patients fail at spontaneous breathing trials, require reintubation and/or mechanical ventilation again within 48 hours after being removed from the ventilator or die within 48 hours following ventilator removal. According to Boles and colleagues, patients

with failed spontaneous breathing trials have the following characteristics: 1) Symptoms such as agitation, lethargy, profuse perspiration and increased breathing effort; 2) Presenting symptoms, such as a rapid respiratory rate, rapid heart rate, cardiac arrhythmia, hypertension, blood-oxygen deficiency. Current situations reveal that 40-42 percent of patients fail at breathing trials and 24 percent require reintubation while 5-20 percent requires prolonged mechanical ventilation (White, O'Conner, & Kirby, 2008).

During weaning, spontaneous breathing depends upon 3 main factors, i.e. respiratory muscle strength, applied respiratory load and CNS drive. Weaning failure is usually caused by an imbalance of the 3 factors, leading to respiratory muscle fatigue, leading to an inability to build respiratory strength and reduced ventilation (Attawuth Deesomchok, 2008; Boles et al, 2007). Weaning failure is usually caused by the imbalance of the patient's ability to breathe and workload (El-Khatib & Bou-Khalil, 2008) as follows:

1. Reasons requiring mechanical ventilation have not been remedied or improved, e.g. the conditions of heart attack, infection, high fever or encephalitis continue to exist (Boles et al, 2007; Maclntyre, 2007).

2. Applied Respiratory Load. Weaning success relies on the respiratory muscle's ability to overcome the breathing workload, i.e., resistance and compliance of the respiratory system (Attawuth Deesomchok, 2008; Boles et al, 2007). For example, the workload caused by the body's problems with oxygen intake causes breathing muscles to require more oxygen. In patients with asthma and chronic obstructive pulmonary disease, the patient has abnormalities in the pulmonary alveoli reducing lung compliance by the contraction of bronchospasms, secretion plugging, dry mucus obstruction in the respiratory tract, or breathing through an endotracheal tube that is too small.

These problems raise resistive load and patients need to use more breathing power. In addition, the condition where the air is left in the lungs after exhalation and causes alveolar pressure remains positive at all times for both the inhalation and exhalation, or what is called auto PEEP (Maclntyre, 2007). Patients with Chronic Obstructive Pulmonary Disease are another reason for failed weaning because patients need to exert more breathing strength than usual (Matic et al., 2007).

In addition, unsuitable mechanical ventilator settings, such as peak inspiratory flow rate or trigger sensitivity, can force patients to use stronger breathing power, so they breathe with the mechanical ventilator (ventilator dyssynchorony) (Attawuth Deesomchok, 2010; Boles et al, 2007).

3. Gas Exchange Factor. Abnormal gas exchange during reduced ventilation occurs for a number of reasons, e.g. pulmonary disease causes ventilation–perfusion mismatch and shunting in order to maintain sufficient oxygen levels and leading to oxygen deficiency (Cook et al., 2001; Balk & Gurka., 2008).

4. Cardiac Load. Spontaneous breathing during weaning makes pressure in the chest cavity negative, thereby leading to increasing venous return, increased after load of the left ventricle; the cardiac muscle uses more oxygen which results in abnormal cardiac function, especially in patients with cardiac problems before and during the illness, e.g. cardiac ischemia or cardiac valvular disease, reducing the blood flow from the heart and leading to heart failure and deficient oxygen supply for the body (Attawuth Deesomchok, 2008; Boles et al, 2007). Cardiac ischemia occurs during weaning and can reduce left ventricle expansion leading to pulmonary edema and increasing respiratory workload. Other factors increase respiratory workload, e.g. excessive pulmonary alveoli expansion gives increased resistance the pulmonary arteries; less blood enters the right ventricle and cardiac output reduces within one minute; metabolic demand increases during mechanical ventilation weaning and sepsis does not improve (Attawut Deesomchok, 2010).

5. Neuromuscular Competence. Patients who have failed at weaning trials may have abnormality from both depressed central drive due to metabolic alkalosis, or from receiving tranquilizers, thereby causing spontaneous breathing to be flawed, e.g. the patient has received such high amounts of tranquilizers and analgesics that the respiratory system if affected with failure of nervous and muscular systems, so patients require more depressed central drive. Increased airway resistance, imbalance mechanical load of breathing muscles, respiratory muscle weakness and critical illness neuromuscular abnormalities are encountered at rates of 50-100% (Boles, et al, 2007) caused by prolong mechanical ventilation or unsuitable ventilation assistance and prolonged treatment in the ICU (Attawut Deesomchok, 2011). Critical patients staying in the ICU may develop muscle weakness at 1-1.5% per day (Morris, 2007) and

muscle strength may decrease by 25-63% in patients on mechanical ventilation for over 7 days (De Jonghe et al., 2002).

6. Malnutrition is commonly encountered in chronically ill patients and patients on mechanical ventilation in which most patients receive nutrients via rubber tube inserted into the stomach. For this reason, patients may not have sufficient nutrients to meet the body's demands, which leads to a reduction in ventilator drive as well as muscular mass because protein deficiency can cause the muscles to deform, which can affect breathing muscle function and make weaning more difficult. On the contrary, over-nutrition or obesity can inhibit respiratory flexibility with increased closing volume, functional residual capacity proportion and more work to breathe (Attawuth Deesomchok, 2011; Boles et al, 2007). Food with high cholesterol and carbohydrate content may negatively affect the mechanical ventilator by generating excessive amounts of carbon dioxide which in turn becomes a problem in gas exchange, air ventilation and breathing muscles (Cook et al, 2010).

7. Acid-Base and Electrolyte Imbalance affects loss of respiratory muscular functionality, e.g. intravenous phosphate, magnesium and potassium conditions weaken muscles, while inhibited thyroid or adrenal function can contribute to difficult weaning. Using corticosteroids while the patient is in critical condition may weaken the muscles and result in longer duration on mechanical ventilation as well as impacts on blood glucose control (Attawuth Deesomchok, 2010).

8. Anemia. During spontaneous breathing, breathing muscles require more oxygen, but patients with anemia have low hemoglobin levels resulting in poor oxygen supply to breathing muscles and various organs, thereby causing the heart to work harder (Attawuth Desomchoak, 2011; Burns et al., 2010).

9. Psychological Dysfunction. Using mechanical ventilators over long periods of time may affect patients' emotional and mental states. Delirium is a condition where the brain suffers acute dysfunction in cognition and arousal. The problem is related to the use of stimulants, pain, prolonged immobilization, oxygen deficiency and insomnia where are encountered at rates ranging from 22 to 80% and the aforementioned are among the reasons for extended stays in the intensive care unit and higher mortality rates. Anxiety is encountered at rates ranging from 30-75%. Patients experience fatigue and problems with communication and sleep (Attawuth

Deesomchok, 2010; Boles et al, 2007). In patients who cannot communicate with other people, anxiety levels are even more intense, thereby leading to prolonged use of mechanical ventilation. Patients are afraid to breathe spontaneously with added anxiety and despair. Emotions and fear can directly impact the respiratory forms because patients who suffer anxiety tend to express their feelings by panting with muscular fatigue (Boles et al, 2007; Maclntyre, 2007). Depression may also be encountered together with delirium (Attawuth Deesomchok, 2011; Boles et al, 2007).

The decision to stop spontaneous breathing trials depends upon the patient's presenting clinical symptoms. However, the weaning criteria used to indicate trial failure is declining values of pulmonary reserve parameters. If the evaluator monitors changes in pulmonary reserve parameters during spontaneous breathing trials, the symptoms will quickly be detected and the decision to stop the trial can be made in time. When fatigue, anxiety, accelerated heart rate, elevated blood pressure and oxygen sat < 90 % are encountered it may be too late, because the patient will be too tired and unable to tolerate the conditions. The patient may remember the fatigue during spontaneous breathing trials and feel afraid to perform the next trial. Thus, weaning criteria is established. Patients who cannot breathe spontaneously have the following characteristics (Boles et al, 2007; Crocker, 2009; El-Khatib & Bou-Khalil, 2008):

1. Respiratory rate >35 breaths/minute or >25 breaths/minute for 2 hours.
2. Oxygen saturation (SaO_2) < 90%.
3. Pulse >140 beats/minute or increase or decrease >20% before spontaneous breathing trials.
4. Systolic blood pressure >189 mmHg or < 90 mmHg or increases or decreases >20% before spontaneous breathing trial.
5. The patient complain fatique, cannot breathe or becomes agitated with profuse perspiration.
6. Difficulty breathing/shortness of breath (dyspnea) with the use of neck muscles, collapsed chest, thoracic cavity and abdomen alternated with breathing.

Stroetz and colleagues (1995) reported that using only clinical data in decisions to remove endotracheal tubes has only 37% sensitivity and 79% specificity. The study of Esteban and colleagues (1995) reported physicians expected 60% of the

patients to not be candidates for weaning from mechanical ventilation. In addition 50% of the patients who removed the ventilator spontaneously could breathe spontaneously without requiring reintubation. These data support the idea that numerous patients are ready to wean from mechanical ventilation and can successfully remove the endotracheal tube. In practice, however, physicians are unable to tell whether or not patients are ready, so patients require prolonged mechanical ventilation. This is a practical dispute requiring further study.

The International Consensus Conference divides weaning into the following three groups according to weaning difficulty and duration (Boles et al., 2007; Brochard & Thille, 2009):

1. The simple weaning group includes patients who successfully pass the initial SBT and are successfully extubated on the first attempt without difficulty. This group should be assessed for weaning readiness as soon as possible. It has been found that 60-70 percent of these patients can be weaned without weaning complications.

2. The difficult weaning group includes patients who fail initial weaning and require up to three SBT or as long as 7 days from the first SBT to achieve successful weaning. This group accounts for 20-25 percent of all patients.

3. The prolonged weaning group includes patients who fail at least three weaning attempts or require > 7 days of weaning after the first SBT. This group accounts for 10-15 percent and is usually the group receiving.

Classifying weaning type helps in planning management and promotes weaning success because failed weaning is a condition affecting patient conditions and mortality with acute heart failure. Thus, identifying and correcting the cause for failed weaning trails, promoting illness recovery and weaning readiness with daily weaning readiness assessment and selecting a suitable weaning method can promote successful weaning from mechanical ventilation and eventually lead to the removal of the endotracheal tube (Boles et al, 2007).

Promoting Successful Weaning

The Royal Thai Institute Dictionary of 1999 defines promotion as a task, object or issue a person carries out in order to support or improve.

Successful weaning refers to the fact that the patient is able to breathe spontaneously over 48 hours after the removal of the endotraceal tube, or that the patient is able to remove the endotracheal tube after weaning with spontaneous breathing for 30 minutes to 2 hours without breathing difficulty (Boles et al., 2007).

Thus, the promotion of weaning success means an action or method providing assistance or support so the patient can be weaned at a faster rate, and the patient is able to breathe spontaneously for over 48 hours after the removal of the endotracheal tube, or the patient is able to remove the endotracheal tube after weaning with ability to breathe spontaneously for 30 minutes to 2 hours without breathing difficulty, thereby leading to a reduction in mechanical ventilation duration and post-weaning re-intubation.

According to the literature review, factors promoting weaning success are weaning readiness, weaning methods and multidisciplinary teams (Cook et al., 2003; Gooman, 2006; Tonnelier et al., 2005). Hence, weaning preparation and assessment of readiness of the patient's physical and emotional state is essential to weaning success (Burns et al., 2010; Crocker & Kinnear, 2008; Boles et al., 2007; Maclntyre, 2007; El-Khatib & Bou-Khalil., 2008; Bumroongkit et al., 2005; McLean et al., 2006; Goodman, 2006; Epstein, & Peerless., 2006). In addition, weaning success depends on the application of skilled judgment, decision-making with medical and nursing intervention received by the patient (El-Khatib & Bou-Khalil, 2008) according to the following details:

Pre-Weaning Preparation, Evaluation, Physical and Emotional Readiness

Weaning or removal of mechanical ventilation when the patient is not ready may cause complications and even death. Weaning in patients who are ready with proper timing helps promote successful weaning from mechanical ventilation and reduces complications from the use of mechanical ventilators (Burns, 2003; Maclntyre, 2001; Rose & Nelson, 2006).

Panaporn Rattanapanadda (2003) conducted a descriptive study on predictive factors for weaning success in patients who were well aware of the decisions to be weaned from the mechanical ventilators > 6 hours using T-piece or

CPAP methods. The sample group comprised 119 patients with 107 were successfully weaned and 12 patients failed at weaning. The study revealed that readiness and respiratory assistance before weaning were positively related to weaning success with statistical significance ($r = 0.347$, $p < 0.01$; $r = 0.199$, $p < 0.05$, respectively). The factor capable of predicting weaning success was the duration of mechanical ventilator use and weaning readiness, which are capable of jointly predicting 54.30 percent of deviations in logistic equations. Thus, patients should be weaned as soon as possible once the condition requiring mechanical ventilation has been resolved for improved respiratory function. Nurses and health care staff should prepare patients physically and emotionally before weaning in order to achieve weaning success.

These findings concur with the findings of the study of Rujee Plangwan (2004) who conducted research on a quasi experimental pre-test post-test design to study feelings of uncertainty before and after weaning. Feelings of uncertainty include lack of confidence with unsafe feelings in threatening and unfamiliar situations, which could occur in patients weaning from mechanical ventilators because patients feel unsafe and lack confidence in spontaneous breathing. The sample group comprised 40 patients on mechanical ventilation for the first time with mechanical ventilation duration of < 6 hours who were weaned by using T-piece method. The sample group was divided into control and experimental groups with 20 patients in each group. The control group received routine nursing care and the experimental group systematically received weaning with motivational information during the weaning process. At 2 hours before weaning, both groups were found to have feelings of uncertainty to a moderate degree. The experimental group had fewer feelings of uncertainty after the experiment than before the experiment ($p < 0.001$) and the patients in the control group had fewer feelings of uncertainty after the experiment than patients receiving routine nursing care ($p < 0.001$). Thus, nurses should use the provision of information and build confidence for weaning patients in order to reduce feelings of uncertainty.

Selecting Weaning Methods

Weaning success also depends upon weaning methods. According to the literature review, the weaning methods commonly used are spontaneous breathing through T-Piece, Synchronized Intermittent Mandatory Ventilation (SIMV) and

Pressure Support Ventilator (PSV) (Urden, Stacy, & Lough, 2010). According to one randomized controlled trial on the effectiveness of the 3 weaning methods, i.e. Intermittent T-piece, SIMV and PSV, in patients with difficulty weaning, PSV was found to contribute to weaning success more than and faster than other methods (Brochard et al., 1994). According to the study of Esteban and colleagues (1995) who conducted a randomized controlled trial during the subsequent year in patients with difficulty weaning, Once Daily T-piece was found to be the most effective method with no differences from the Intermittent T-piece method because there is greater chance more patients will be successfully weaned from the mechanical ventilator and there is no need for reintubation within 48 hours than in SIMV and PSV methods. However, the differences in the two studies cannot be compared because PSV adjustment and criteria for the endotracheal tube removal are different. The similarity was that SIMV was found to be the least successful weaning method. In patients with chronic obstructive pulmonary disease using mechanical ventilators longer than 15 days, a study was conducted to compare T-piece and PSV weaning methods. Both methods were found to be capable of weaning the patients with equal success. However, using T-piece tends to require shorter mechanical ventilation use (Vitacca et al., 2001). Thus, the T-piece method should be the method of first choice for weaning adult patients because weaning is more successful and faster (Esteban et al., 1995) Moreover, the method is suitable for intensive care units because it is easy to practice and inexpensive.

Cooperation in the Multi-disciplinary Team

In addition to patient readiness and suitable weaning methods, coordination with a multidisciplinary team is also necessary for the weaning process in order to communicate the patient's data during weaning with cooperative planning to assist the patient and remedy problems so weaning can be successful with reduced mechanical ventilator duration, which affects the length of ICU and hospital stays (Orasa Ngimraksa, 2003; Crocker & Kinnear, 2008; Boles et al., 2007; Maclntyre, 2007; El-Khatib & Bou-Khalil., 2008; Bumroongkit et al., 2005; McLean et al., 2006; Goodman, 2006).

Orasa Ngimraksa (2003) conducted a retrospective study comparing weaning duration using different weaning methods in patients with different ages, diseases and severity. The sample group comprised 20 patients on mechanical ventilation in the general patient ward whereby 10 patients received cooperation in weaning and 10 patients received routine weaning methods. The findings revealed weaning duration in patients receiving weaning coordination/cooperation to be shorter than in the group of patients receiving routine nursing care only with statistical significance ($p < 0.05$). The researcher recommends that nurses and physicians coordinate/cooperate in the weaning process in order to minimize weaning duration.

Henneman (2001) asserted that every stage of weaning requires cooperation from multidisciplinary teams with skills and expertise, such as physicians, nurses, respiratory therapists, nutritionists, speech therapists and physical therapists who communicate, plan and cooperate in caring, promoting, stimulating and encouraging patients during the weaning process. This finding concurs with the study of Henneman and colleagues (2002) who conducted a study in 137 patients on mechanical ventilation for at least 7 days in intensive care units, finding that planning within the multidisciplinary team in cooperation with the patient's family was able to effectively reduce weaning duration.

Weaning Protocol

Weaning delay is a result of inconsistent care in the weaning process as well as caregiver expertise (Crocker & Scholes, 2009). Having weaning protocol promotes weaning success. The concepts of collaborative practice and evidence-based practice involve patient-centered weaning without focusing only on having knowledge and understanding of the science of weaning, because weaning mechanical ventilators are both art and science requiring integrated care (Crocker, 2009). In practice, nurses are the people close to patients and providing care patients 24 hours a day. Hence, nurses require knowledge and understanding about weaning assessment criteria, which must be reviewed from evidence-based practice and support predictions of weaning success. Nurses must also possess practical skills and promote weaning skills with the weaning protocol as a nursing practice guideline (Blackwood, 2009).

Chaiwat Bumrunkit and colleagues (2005) conducted a prospective study aimed at assessing the efficiency of protocol-directed weaning in 196 patients as compared to physician-directed weaning. According to the retrospective report, protocol-directed weaning in the intensive care unit was found to be more efficient than physician-directed weaning with statistical significance ($p < 0.005$) while weaning duration, mechanical ventilation duration and intensive care unit stays were reduced with no negative impacts on patients.

According to the study of Kanthima Pisitkul, Apirak Pallawatwichai and Staporn Thitiwichianlert (2002), ventilator weaning protocol in the general patient ward at Phra Mongkut Klao Hospital was able to reduce weaning duration as compared to physician-directed weaning with statistical significance. This finding concurred with the findings of the study of Jurawan Surakul (2004), who found that using a planned program to care for patients on mechanical ventilation in general medicine and surgical patients at Songkhla Hospital was able to enhance the efficiency of patient care by reducing hospital stay and medical costs. In addition, physicians and nurses should cooperate to help minimize weaning duration.

The above findings concur with the study of Pensi La-or (2006), who conducted quasi-experimental research to study the efficiency of a weaning program for patients with respiratory failure in the intensive care unit at Nakhon Nayok Hospital, finding that patients weaned in line with the weaning program had greater success in weaning from mechanical ventilation than normal weaning and weaning decreased duration with statistical significance. Tonnelier and colleagues (2005) conducted a cohort study in 104 patients on the impacts of protocol-directed weaning, finding protocol-directed weaning to play a major part in promoting reduced weaning duration, thereby enabling patients to have the endotracheal tube removed sooner with decreased incidence of pneumonia due to mechanical ventilation.

Burns and colleagues (2003) studied care planning for 510 patients on mechanical ventilation for durations of longer than 3 days, finding that multidisciplinary team-directed weaning reduced weaning duration from 10 days to 9 days, intensive care unit stays from 15 days to 9 days, mortality rates from 38% to 31% and average medical costs by approximately 3,225 dollars per patient. These findings concur with the study of Chaweewan, Thongchai and colleagues (2007) who

conducted a study on the use of weaning protocol on the basis of knowledge obtained from evidence-based practice. The protocol of the National Health and Medical Research Council of Australia (NHMRC) was used by comparing with a group of 494 patients without protocol-directed weaning, finding protocol-directed weaning to be able to reduce weaning duration, number of days on mechanical ventilation, number of days staying in the hospital and medical costs with statistical significance ($p=0.01$). However, there were no differences in the re-intubation rates for the two methods.

According to the literature review, it is evident that protocol-directed weaning method is more efficient than physician-directed weaning when used in cooperation with a multidisciplinary team in the weaning process in terms of duration of mechanical ventilation and reduced ICU stay without negative impacts on patients. This allows the patient to be assessed for physical and emotional readiness which will promote rapid and efficient weaning that is free from complications from using mechanical ventilation. Therefore, each organization should develop its own protocol by a multidisciplinary team on the basis of knowledge from scientific data and the staff must develop decision-making skills as well as supporting techniques in order to promote weaning success.

Rehabilitation

Rehabilitation is necessary for weaning patients from mechanical ventilators because patients can develop disabilities in various systems, such as muscle atrophy, weakness and fatigue with deformed joints and shrinkage, difficulty breathing, anxiety and depression. These conditions affect the patient's quality of life and the weaning success (Boles et al., 2007; Gosselink et al., 2008). Chiang and colleagues conducted a study to examine the effects of respiratory muscular training and physical training on weaning duration and physical performance in 39 patients with prolonged use of mechanical ventilators in the medical respiratory care center. According to the findings, the body was able to improve the functional status of patients with endotracheal tubes during the 6-week physical training program by improving limb muscle strength and the patients had stronger breathing muscles so they could breathe spontaneously and have longer ventilator-free time. When compared with the group receiving routine nursing care, the patients in the group

receiving routine nursing care only were found to have consistently weakened muscles. In patients with immobilization, especially those on mechanical ventilation, limb muscle strength had declined tremendously and thus become a reason for prolonged use of the mechanical ventilator.

Schweickert and colleagues (2009) conducted a randomized controlled trial to compare the efficiency of physical and occupational therapy in patients receiving routine nursing care with sedatives and mechanical ventilation duration of over 72 hours in the general intensive care unit. The findings revealed that patients receiving physical and occupational therapy had better capacity for self-reliance and were better able to walk independently upon discharge from the hospital than the patients in the control group with statistical significance. Furthermore, these patients had shorter periods of delirium with ventilator-free days sooner than the patients in the control group with statistical significance. Moreover, 95% of the patients receiving routine nursing care were unable to walk after weaning from mechanical ventilation, thereby impacting the patient's quality of life in the long run.

Morris and colleagues (2008) conducted a study comparing the effects of physical therapy using mobility protocol by a mobility team in 330 patients with acute respiratory failure who were on mechanical ventilation and patients receiving routine nursing care in the general patient ward during 2004 to 2006. The findings indicated that physical therapy using mobility protocol by a mobility team was able to reduce the patient's number of days spent in bed ($p < 0.001$), ICU stays ($p = 0.027$) and hospital stays in survivors ($p = 0.006$) with statistical significance at no additional cost. Frequency and physical therapy beginning during the patient's stay in ICU were found to be related to the patient's hospitalization stay with statistical significance ($p < 0.001$). Although this research did not measure duration of the patient's mechanical ventilator, physical therapy using mobility protocol by a mobility team was found to be beneficial for rehabilitation and capable of reducing intensive care unit stays and hospital stays at no additional cost, thereby leading to positive outcomes in the care of patients on mechanical ventilation.

Thus, rehabilitation plays a role in restoring the patient's body to its normal condition. Rehabilitation can be done since the patient is beginning to recover from the illness by making adjustments suitable with the patient's condition. Physical

therapy will help improve mechanical ventilator weaning efficiency and help patients have longer periods of ventilator-free time (Schweickert et al., 2009. & Chiang et al, 2006) by strengthening breathing muscles (Porta et al, 2005., & Chiang et al, 2006). In particular, upper-extremity training helps improve inspiratory muscle capacity to increase muscle strength and tolerance (Porta et al. 2005). Increasing muscle strength and tolerance by allowing active and passive movements as well as exercise, suitable posture arrangement, respiratory muscle training and respiratory training, coughing training and effective mucous management with emotional and mental support (Boles et al., 2007), including physical and emotional rehabilitation are all important factors in caring for critical patients. The cooperative efforts of the multidisciplinary team in the form of physiotherapy protocol or programs are essential in order to help patients receive regular therapy in order to prevent muscle weakness (Schweickert et al., 2009; Bailey et al., 2007 & Morris et al., 2008). Physiotherapy should begin as early as possible during the treatment in the critical patient ward. Once the patient's neurologic, respiratory and circulatory readiness are stable, rehabilitation can begin safely, thereby resulting in restored physical function. It is important, however, that exercise only be performed under the supervision of a physical therapist or expert team (Bailey et al., 2007; Schweickert et al.,2009 & Morris et al., 2008).

1.2 Clinical Question

Weaning is an important step in caring for critical patients with respiratory failure who require mechanical ventilation. The weaning process covers liberation from mechanical ventilation and extubation. This is due to the fact that weaning takes nearly half of the patient's time on mechanical ventilation (Boles et al., 2007). The degree of weaning difficulty differs for each patient. Weaning success depends on the patient's readiness, illness severity, anxiety, co-morbidities (Monthira Udchumpisai, 2011), the multidisciplinary team's knowledge and expertise (Blackwood & Wilson-Barnett., 2007), including the ability of communication and cooperation between the multidisciplinary team. All of these factors can affect weaning success and the

patient's mechanical ventilation duration (Rumpke & Zimmerman., 2010; Goodman, 2006; Tonnelier et al., 2005).

According to the investigator's past experience in the respiratory intensive care unit at Sisaket Hospital in weaning by routine methods following mechanical ventilation, the physician is the one who makes decisions about when to start the weaning process and selects alternative weaning methods while the mechanical ventilators vary in terms of function. The nurses wean the patients from the mechanical ventilator according to treatment plans, in compliance with standards for the care of patients on mechanical ventilation in the intensive care unit and according to each nurse's experience and skills. When the patients have problems or changes in condition during weaning from mechanical ventilation, they will immediately be put on a mechanical ventilator. Thus, nursing practice guidelines vary and lack uniformity. The lack of clear weaning guidelines disrupts care and delays the weaning process, thereby resulting in prolonged periods of time for weaning, which subsequently prolongs the duration of ventilator use or causes the patient to be weaned prematurely, which can lead to potential complications and weaning failure. Consequently, intensive care unit stays are extended and more resources are required, e.g. staff and medical supplies, with higher medical costs (Burns, 2004; Carson, 2006; Bigatello et al., 2007).

Thus, successful weaning remains a practical issue for nurses and multidisciplinary teams. This study aimed to find recommendations to promote successful weaning from mechanical ventilation developed according to evidence-based findings obtained from evidence-based practice in order to improve the quality of care provided for patients on mechanical ventilation, reduce the duration of mechanical ventilator and re-intubation rates as suitable for real practice and the context of the agency to promote the quality of care.

1.3 Purposes of the Study

To develop the recommendation for promoting successful weaning from mechanical ventilation in adult patients based on evidence.

1.4 Expected Outcomes

1. Integration the new knowledge base on evidence to develop the recommendation for promoting successful weaning from mechanical ventilation in intensive care unit**.**

2. Development of nursing care quality in term of promoting successful weaning from mechanical ventilation in intensive care unit according to evidence.

3. Development of nursing care quality in term of promoting successful weaning from mechanical ventilation in intensive care unit according to evidence.

CHAPTER II
METHODOLOGY

This study comprised a search for evidence to support and develop recommendations for promoting successful mechanical ventilation weaning in patients on mechanical ventilators in the intensive care unit, which involved the following steps in conducting the search for evidence:

2.1 Evidence Search Strategy

2.2 Appraisal Methods and Level of Evidence

2.1 Search Strategy

The evidence search strategy for knowledge from evidence includes both research articles and various expert opinions. The evidence search was carried out systematically to get the relevant evidence. The evidence was then analyzed, synthesized and developed to make recommendations for promoting success in weaning patients from mechanical ventilation, which involved the following steps:

2.1.1 Framework for the Evidence Search

In this study, the scope and criteria were set for the search for research and evidence by establishing questions for the search according to Melnyk and Fineout-Overholt's PICO format (2005) in order to obtain evidence concerned with promoting successful weaning from mechanical ventilation as needed with full coverage specific to the group of patients on mechanical ventilation and with the outcome evaluation needed as follows:

P (Population) : Patients weaning from mechanical ventilation.

I (Intervention) : Method for promoting successful mechanical ventilation weaning.

C (Comparison) : None.

O (Outcome) : Decreased duration of mechanical ventilation; reduced re-intubation rates.

2.1.2 Scope for the Search

The framework for establishing questions in order to conduct the aforementioned search enabled the investigator to set keywords for reviewing and searching in English. The key words employed in the search comprised the following:

P (Population) : weaning / discontinuance / liberation from mechanical ventilation patients

I (Intervention) : weaning method, readiness of weaning from mechanical ventilation, mechanical ventilation management, weaning protocol, weaning program, weaning assessment, weaning guideline, promoting of weaning from mechanical ventilation, successful weaning from mechanical ventilation and weaning intervention.

C (Comparison) : None

O (Outcome) : Decreased duration of mechanical ventilation; reduced re-intubation rates.

In conducting the search, the investigator combined key words with the conjunctions “and” and “or” in order to help find evidence on the issue required for the study.

2.1.3. Designating Sources Used in the Search

1. The evidence search was conducted with a computer and comprised the following:

1.1 The search for evidence was conducted in health science electronic databases of both the Mahidol University electronic database for the systematic literature review and single researches concerned with successful mechanical ventilation weaning, namely, Cochrane Library, Cumulative Index to Nursing and Allied Health (CINAHL), MEDLINE, Journal@Ovid Full Text, BMJ Journals Online, Science Direct, PubMed, Blackwell Synergy, High wire press, Wiley Interscience & Pro Quest Nursing and Springer Link.

1.2 The evidence search from the online searching services of institutes or organizations provide the service of disseminating related medical data. The service network can be linked with institutes or organizations so articles or journals can be requested in full text, e.g. from the following databases: ThaiLIS Digital, www.joannabriggs.edu.au. and www.guidelines.gov.

2. Manual Search

The manual search was conducted in journals, thesis dissertations related to promoting mechanical ventilation weaning success in libraries under the jurisdiction of Mahidol University in full text and from taking the titles of research with abstract only obtained from electronic databases to search for full text versions in related text books in both Thai and English. The manual search was conducted in combination with the search from electronic databases from health journals, thesis dissertations because the content had not yet been published in electronic databases or new research loaded onto electronic databases had not yet been referenced. The search for full text helped the investigator obtain more details on the research.

3. Appended reference documents or encyclopedias to the items were searched by looking for the reference documents or encyclopedias appended to research related to promoting successful mechanical ventilation weaning obtained from various databases, especially from appended documents or encyclopedias from the systematic review so the details on each sample of original articles on research with greater clarity and coverage.

2.1.4 Scope of Selecting

The scope for selecting the evidence was concerned with promoting successful mechanical ventilation weaning. The evidence was selected in groups of adult patients on mechanical ventilation in the critical care unit who were aged 18 years or older. The samples were sought in articles published both in Thailand and abroad covering a period from the year 2000 until the present (2011). Only researches in full text in Thai and English were selected, so the evidence could be up-to-date with academic content containing new knowledge from ongoing researches.

Evidence was excluded from the study according to the following criteria: evidence or research publishing abstract only, ongoing studies or studies with incomplete experimentation; research not concurrent with the issue to be studied; pilot studies and studies employing non-invasive ventilators not involving mechanical ventilation weaning; studies not evaluating the successful outcomes of mechanical ventilation weaning to reducing mechanical ventilator durations and re-intubation rates in patients admitted to critical care units.

2.2 Appraisal Methods and Level of Evidence.

2.2.1 Evaluating Evidence Quality

The strength of the evidence to answer any clinical question depends on the quantity and quality of the evidence and consistency of finding across studies. Once the evidence search had yielded the evidence meeting the inclusion criteria for the research from the data sources, the evidence obtained had to be critically evaluated and analyzed in terms of quantity and quality in order to select the evidence concerned with the clinical problem and feasibility to apply the research findings as a summary for promoting successful mechanical ventilation weaning. The evidence was evaluated according to guidelines for evaluating evidence using the criteria of DiCenso, Guyatt and Ciliska (2005), which evaluates in terms of the following three issues:

1. Are the results valid?

The research process was assessed from research design to the analysis and summary of the results in order to assess the validity of research. In assessing the validity of the systematic review, the research questions about the validity of the review address of the choice of topic, the search for studies and the quality of the studies were found. A high quality systematic review has a clear focus on a specific and sensible clinical question, usually one about a therapy of some sort. The search for relevant studies was thorough. The review has explicit and appropriate standards for selecting studies to be included, and ideally only high-quality studies (i.e. those with a low risk of biased results) were retained. Moreover, the objective was to make use of checklists and agreement of independent raters. As for the assessment of the validity

of the randomized controlled trials (RCT), evaluation was carried out by an appropriate evidence model and with effort to minimize the investigator's bias by considering the patients randomized of the samples into control and experimental groups. Randomization concealed the intervention provided for the number of the samples group, following up and assessing the variable of the control and experimental groups. Lastly, the data yielded by the evidence were properly analyzed.

2. What are the results?

The results were assessed to summarize the research finding, statistical significance and clinical relevance by considering the evidence finding of a systematic review in the form of an analysis plan, the authors of the systematic review have identified which outcomes and studies are truly comparable to each other. If they have correctly grouped studies of the same phenomenon in similar study samples together, the results of those studies should be similar to each other. This can be checked by the following questions: "Is the overall processing of the study appropriate?" "Are there similarities in the findings of each study?" and, "How can the evidence finding be summarized?" The evidence finding of the randomized controlled trials were assessed in term of questions: "How large was the intervention effect?" and, "How precise was the estimate of the intervention effect?" whether the treatment or intervention outcomes were carried out efficiently, and if so, how? In the case of the categorical outcomes, how are the risk reduction, relative risk and absolute risk reduction values? As for the case of continuous outcomes, how much is the difference between mean scores? Do the research finding have statistical significance and clinical relevance, and if so, how?

3. How can I apply the results to patients care?

The results were assessed for consideration of implementation feasibility by considering the patients, the circumstances, and the unit which consider the following 3 questions: "Were the study patients similar to the patients in my clinical setting? "Were all important outcomes considered? and "Are the likely intervention benefits worth the potential harm and cost?" Application of the evidence finding from the systematic review to the care of the patients requires consideration of all relevant and irrelevant outcomes. The benefits to be received by the patients should also be considered more than the medical expense and risk. The difference among the sub-

groups should be considered i.e. the patients' beliefs and values, and the context of the unit. As for application of the evidence finding in the patients' care in the randomized controlled trials, the similarities of the samples group in the evidence should be considered with interested patients groups in terms whether or not the intervention can be implemented, whether or not the unit characteristics are the same as the evidence, and whether or not the intervention is applicable to the unit by considering expenses or hazards and the benefits to be gained by the patients.

2.2.2 Evaluating Levels of Evidence

Evaluating the levels of evidence involves evaluations after the desired evidence has been obtained. In this study, the promotion of successful weaning from mechanical ventilation in adult patients at the intensive care unit is the clinical problem categorized in the therapy domain questions. The investigator evaluated the strength of evidence pyramids of therapy, based on the levels for strength of evidence of Jeanne Grace (Grace, 2009), which was modified from levels for strength of evidence in the research of Guyette and Rennie in 2002, which levels for strength of evidence indicate how strength the evidence supporting the specific recommendations is, and they generally mirror the strength the evidence pyramids for therapy and implemented in nursing practice education into the following seven levels:

Level 1 – The number of one randomized controlled trial - Evidence obtained from systematic reviews, interventions, actual implementation of evidence in patients by using randomized controlled experimental processes and finding effects according to research findings (N of 1 randomized clinical trial), systematic reviews, or meta-analysis of well-designed randomized controlled trials with findings that concur with research questions and quality single randomized controlled trials.

Level 2 – Systematic review of RCTs were evidence obtained from systematic reviews of well-designed randomized controlled trials or meta-analysis of randomized controlled trials.

Level 3 – High quality single randomized trials were evidence obtained from well designed high quality single randomized controlled trials.

Level 4 – Systematic reviews of observational studies were evidence obtained from systematic reviews of non-experimental researches with retrospective studies, cohort studies or case-control studies.

Level 5 – Single observational study-patient important outcome was evidence obtained from single non-experimental researches with retrospective studies, cohort studies or case-control studies focusing on patient important outcome.

Level 6 – Physiologic studies were evidence obtained from single descriptive or qualitative studies and physiological studies.

Level 7 – Unsystematic clinical observations were evidence with wide general studies from observation without systematic literature reviews, opinions of qualified experts, or specialists in specific professions in the care and treatment of patients in descriptive form.

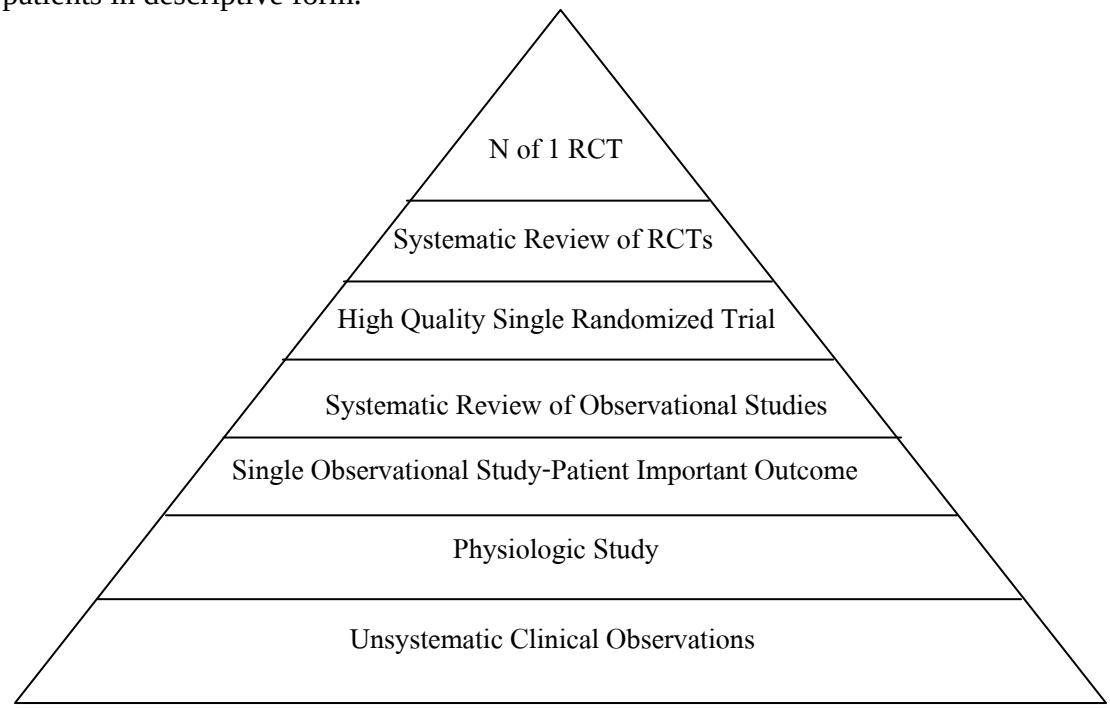

Figure 2.1 – Evaluation of Levels of Strength of Evidence (Grace, 2009)

It can be concluded that, in the process for evidence-based inquiry, the investigator defined the framework of evidence-based inquiry by using principles of the PICO framework to search systematically for related literature and studies by setting objectives, scopes and sources in searching for evidence-based literature or studies concerned with promoting success in weaning from mechanical ventilation

with identical or similar characteristics to the patients aged over 18 years that required mechanical ventilation in intensive care unit. The expected outcome was decreased duration of mechanical ventilation and reduced re-intubation rates. After obtaining evidence, the studies were assessed for quality on 3 topics by employing the conceptual framework of DiCenso, Guyatt and Cliska (2005): 1) “Are the results valid?” 2) “What are the results?” 3) “How can I apply the results to patients care?” The strength of the evidence was assessed according to the principles of Guyatt and Rennie (2002) to acquire evidence capable of efficiently solving clinical problems.

In addition, the investigator used the evidence to extract relevant contents, analyze, and synthesize data along with all relevant contents to summarize of the key issues and recommendations from evidence indicating high reliability levels of efficiency for procedures and treatments for safe implementation of the evidence obtained as practice guidelines for promoting success in weaning from mechanical ventilation for adult patients on mechanical ventilation in the intensive care unit.

CHAPTER III
FINDINGS

3.1 Findings of the Evidence-based inquiry

After searching through 52 articles related to promoting mechanical ventilation weaning success in adult patients obtained from electronic databases and manual searches, 35 articles were found to meet the criteria and were included, whereas 17 articles did not meet the criteria and therefore were excluded. The excluded articles had been conducted in population groups with indirect research, 3 articles had been conducted on mechical ventilation weaning in pediatric patients, 2 articles had been conducted in pilot studies and studies currently in progress or incomplete because the experiment was ongoing, 6 articles were not applicable to the clinical problem or the objectives of the study, 1 article was with abstract only but no full text and 2 articles did not evaluate the outcomes in patients in mechanical ventilation weaning, e.g. evaluation of the efficiency of the mechanical ventilator or medical instruments were not available in the unit, such as instruments for measuring maximum inspiratory pressure, etc., as well as 1 article which contained no clarity about the management or the research findings and 2 articles conducted over ten years ago with newer published research with greater reliability. The included articles comprised of:

- Four evidence from systematic reviews of randomized controlled trials (RCT) or meta-analysis. (Level 2)
- Five evidence from high quality single randomized trials. (Level 3)
- One evidence from systematic review of observational studies. (Level 4)
- Twenty-one evidence from single observational study-patient important outcomes. (Level 5)
- Two evidence from physiologic study, evidence from descriptive and qualitative studies. (Level 6)

- Two evidence from unsystematic clinical observations comprise evidence containing general studies with wide scopes from observations without systematic literature reviews, professional or expert opinions in specific professional groups in the care and treatment of patients in descriptive (Level 7).

The quality of evidence of the studies were evaluated the levels for strength of evidence according to the evaluation criteria of Jeanne Grace (Grace, 2009). Then the data were analyzed and synthesized, after which the relevant contents were summarized in order to develop recommendations for promoting mechanical ventilation weaning success from evidence. The details of the search for data and the strength of evidence by the search are shown in Figure 3.1 and Table 3.1, respectively.

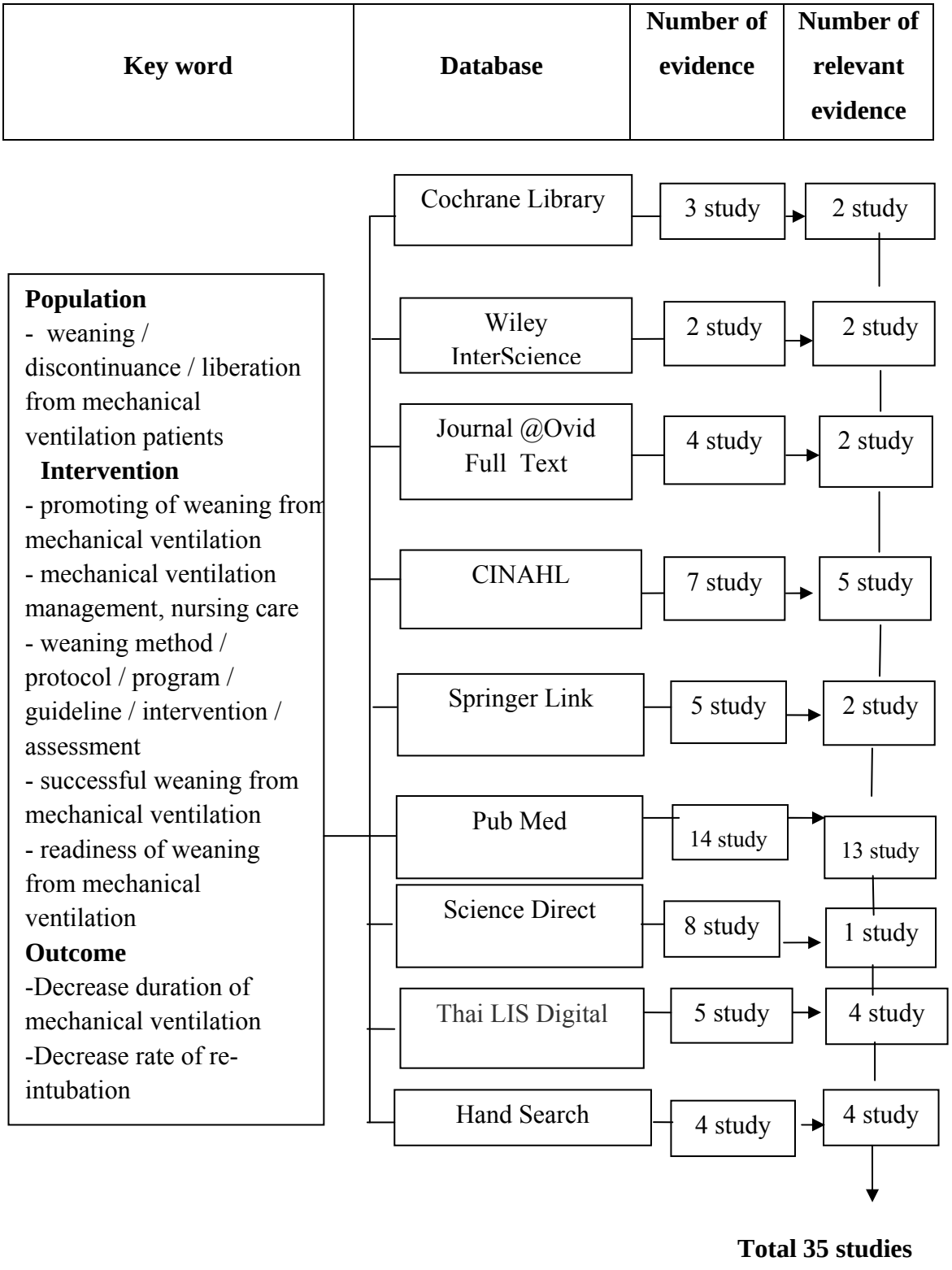

Figure 3.1 Findings of the Evidence

Table 3.1 : Summary and classification of level of the findings by evaluation criteria of Grace (2009)

No.	Databases	Authors / Years/Title/ published research	Level of evidence
1.	CINAHL	Meade, M., Guyatt, G., Sinuff, T., Griffith, L., Hand, L., Toprani, G., & Cook, D. J. (2001). Trials Comparing Alternative Weaning Modes and Discontinuation Assessments. Chest, 120, 425S-437S.	Systematic review of RCTs / Level 2
2	Wiley InterScience	Rose, L., Nelson, S. (2006). Issues in weaning from mechanical ventilation: literature review. Journal of Advanced Nursing. 54 (1), 73-78.	Integrative Literature review and Meta-analysis / Level 2
3	Wiley InterScience	White, V., Currey, J., & Botti, M. (2011). Multidisciplinary Team Developed and Implemented Protocols to Assist Mechanical Ventilation Weaning: A Systematic Review of Literature. Worldviews on Evidence-Based Nursing, 8(1), 51–59.	Systematic Review of Literature and Meta-analysis / Level 2
4.	Cochrane Library	Burns, K.E., Adhikari, N.K., Keenan, S.P., & Meade, M.O. (2010). Noninvasive positive pressure ventilation as a weaning strategy for intubated adults with respiratory failure (Review). The Cochrane Collaboration, 8.	Systematic review of RCTs / Level 2
5.	PubMed	Girard, T. D., Kress, J. P., Fuchs, B. D., Thomason, J. W., Schweickert, W. D ., Pun, B. T., et al .(2008). Efficacy and safety of a paired sedation and ventilator weaning protocol for mechanically ventilated patients in intensive care (Awakening and Breathing	Randomized controlled trial / Level 3

Table 3.1 : Summary and classification of level of the findings by evaluation criteria of Grace (2009) (cont.)

No.	Databases	Authors / Years/Title/ published research	Level of evidence
		Controlled trial): a randomised controlled trial. Lancet, 371, 126–34.	
6.	CINAHL	Marelich, G. P., Murin, S., Battistella, F., Inciardi, J., Vierra, T., & Roby, M. (2000). Protocol Weaning of Mechanical Ventilation in Medical and Surgical Patients by Respiratory Care Practitioners and Nurses Effect on Weaning Time and Incidence of Ventilator-Associated Pneumonia. Chest, 118(2), 459–467.	Randomized controlled trial / Level 3
7.	PubMed	Chaiwat, O., Sarima, N., Niyompanitpattana, K., Komoltri, C., Udomphorn, Y., & Kongsayreepong. (2010). Protocol-Directed vs. Physician-Directed Weaning from Ventilator in Intra-Abdominal Surgical Patients. Journal of the Medical Association of Thailand, 93(8), 930-6.	Randomized controlled trial / Level 3
8.	PubMed	Matic, I., Danic, D., Majeric-Kogler, J., Jurjevic, M., Mirkovic, I., Vucinic.N. M. (2007). Chronic Obstructive Pulmonary Disease and Weaning of Difficult-to-wean Patients from Mechanical Ventilation: Randomized Prospective Study. Croatia Medicine Journal, 48, 51-58.	Randomized controlled trial / Level 3
9.	PubMed	Tanios, M. A., Nevins, M. L., Hendra, K. P., Cardinal, P., Allan, J. E., Naumova, E. N., & Epstein, S. K. (2006). A randomized,	Randomized controlled trial / Level 3

Table 3.1 : Summary and classification of level of the findings by evaluation criteria of Grace (2009) (cont.)

No.	Databases	Authors / Years/Title/ published research	Level of evidence
		controlled trial of the role of weaning predictors in clinical decision making. Critical Care Medicine, 34 (10), 2530–2535	
10.	Cochrane Library	Blackwood, B., Alderdice, F., Burns, K.E., Cardwell, C.R., Lavery, G., & O'Halloran, P. (2011). Protocolized versus non-protocolized weaning for reducing the duration of mechanical ventilation in critically ill adult patients (Review). The Cochrane Collaboration, 4, 1-71.	Systematic review of observational studies / Level 4
11.	CINAHL	Barr, J., Hecht, M., Flavin, K.E., Khorana, A., &. Gould, M.K. (2004). Outcomes in Critically Ill Patients Before and After the Implementation of an Evidence-Based Nutritional Management Protocol. Chest, 125;1446-1457	Prospective study / Level 5
12.	Springer Link	Malkoc, M., Karadibak, D., & Yıldırım, Y. (2009). The effect of physiotherapy on ventilatory dependency and the length of stay in an intensive care unit. International Journal of Rehabilitation Research, 32(1), 85–88.	Prospective study / Level 5
13.	PubMed	Esteban, A., Frutos-Vivar, F., Ferguson, N. D., Aradi, Y., Apezteufa, C., Gonzales, M., et al. (2004). Noninvasive Positive-Pressure Ventilation for Respiratory Failure after Extubation. The New England Journal of	Prospective cohort study / Level 5

Table 3.1 : Summary and classification of level of the findings by evaluation criteria of Grace (2009) (cont.)

No.	Databases	Authors / Years/Title/ published research	Level of evidence
		Medicine, 350(24), 2452 – 2460.	
14.	PubMed	Henneman, E., Dracup, K., Ganz, T., Molayeme, O., Cooper, C. B. (2002). Using a collaborative weaning plan to decrease duration of mechanical ventilation and length of stay in the intensive care unit for patients receiving long-term ventilation. American Journal of Critical Care, 11(2), 132–142.	quasi-experimental design / Level 5
15.	PubMed	Bumroongkit, C., Liwsrisakun, C., Deesomechok, A., Theerakittikul, T., & Porthirat, C. (2005). Efficacy of weaning protocol in medical intensive care unit of tertiary care center. Journal of the Medical Association of Thailand, 8(1), 52-57.	Prospective Cohort study / Level 5
16.	Springer Link	Ezingeard, E., Diconne, E., Guyomarc'h, S., Venet, C., Page, D., Gery, P., et al. (2006). Weaning from mechanical ventilation with pressure support in patients failing a T-tube trial of spontaneous breathing. Intensive Care Medicine, 32, 165–169.	a prospective, non-randomized study / Level 5
17.	PubMed	Chittawatanarat, K., & Thongchai, C. (2009). Spontaneous Breathing Trial with Low Pressure Support Protocol for Weaning Respirator in Surgical ICU**.** Journal of the Medical Association of Thailand, 92(10), 1306-1312.	a retrospective study / Level 5

Table 3.1 : Summary and classification of level of the findings by evaluation criteria of Grace (2009) (cont.)

No.	Databases	Authors / Years/Title/ published research	Level of evidence
18.	Science direct	Robertson, T. E., Sona, C., Schallom, L., Buckles, M., Cracchiolo, L., Schuerer, D., et al. (2008). Improved Extubation Rates and Earlier Liberation from Mechanical Ventilation with Implementation of a Daily Spontaneous Breathing Trial Protocol. Journal College of Surgeons, 206, 489-495.	Prospective cohort study / Level 5
19.	PubMed	Walsh, T. S., Dodds, S. & McArdle, F. (2004). Evaluation of simple criteria to predict successful weaning from mechanical ventilation in intensive care patients. British Journal of Anaesthesia, 92(6), 793-9.	Prospective observation cohort study / Level 5
20..	Journal @Ovid Full Text	Rumpke, A. L., & Zimmerman, B. A. (2010). Implementation of a Multidisciplinary Ventilator Weaning and Sedation Protocol in a Community Intensive Care Unit. Dimensions of Critical Care Nursing, 29(1), 40-49.	Prospective observation research / Level 5
21.	PubMed	Twibell, R., Siela, D., & Mahmoodi, M. (2003). Subjective Perception and Physiological Variables During Weaning From Mechanical Ventilation. American Association of Critical Care, 12(2), 104–112.	Descriptive, correlational, and prospective study / Level 5
22.	Journal @Ovid Full Text	Burns, S. M., Earven, S., Fisher, C., Lewis, R., Merrell, P., Schubart, J. R., Truwit, J. D., Bleck, T. P. (2003). Implementation of an	quasi-experimental design / Level 5

Table 3.1 : Summary and classification of level of the findings by evaluation criteria of Grace (2009) (cont.)

No.	Databases	Authors / Years/Title/ published research	Level of evidence
		institutional program to improve clinical and financial outcomes of mechanically ventilated patients: One-year outcomes and lessons learned. Critical Care Medicine, 31(12), 2752-2763.	
23.	PubMed	Morris, P. E., Goad, A., Thompson, C., Taylor, K., Harry, B., Passmore, L., et al. (2008). Early intensive care unit mobility therapy in the treatment of acute respiratory failure. Critical Care Medicine, 36(8), 2238–2243.	Prospective cohort study / Level 5
24.	CINAHL	Burns, S. M., Fisher, C., Tribble, S. S., Lewis, R., Merrel, P., Conaway, M. R. and Bleck, T. P. (2010). Multifactor clinical score and outcome of mechanical ventilation weaning trial: Burns Wean Assessment Program. American Journal of Critical Care, 19(5), 431-439.	prospective study / Level 5
25.	CINAHL	Epstein, C., & Peerless, J. R. (2006). Weaning readiness and fluid balance in older critically ill surgical patient. American Journal Critical Care, 15(1), 54-64.	Single correlational research / Level 5
26.	ThaiLIS	Supaporn Sanpila. (2003). Effects of Preparatory Information on Anxiety and Successed of Mechanical Ventilation Weaning. Master of Nursing Science Thesis in Adult Nursing, Graduate School, Khon Kaen University	Quasi-experimental research / Level 5

Table 3.1 : Summary and classification of level of the findings by evaluation criteria of Grace (2009) (cont.)

No.	Databases	Authors / Years/Title/ published research	Level of evidence
27.	Hand Search	Pensri La-or, Wanlapa Kunsongkeit, Supaporn Daungpaeng and Khemaradee Masingboon. (2007). The effectiveness of weaning ventilator protocol on success of weaning and duration of mechanical ventilator in patients with respiratory failure. The Journal of Faculty of Nursing Burapha University, 15(2), 11-22.	Quasi-experimental research / Level 5
28.	ThaiLIS	Mullika Choatseenin. (2005). Effects of Multidisciplinary Ventilator Weaning Team Approach on Weaning Time and Weaning Success of Surgical Critically Ill Patients. A Thesis for the degree of master of nursing science (Adult Nursing), Faculty of graduate studies, Chiang Mai University.	Quasi-experimental research / Level 5
29.	Hand Search	Wipapat Sungkhaw. (2001). The effects of providing information and relaxation technique on anxiety in weaning from mechanical ventilation. A Thesis for the degree of master of nursing science (Adult Nursing), Faculty of graduate studies, Mahidol University.	Quasi-experimental research / Level 5
30.	Hand Search	Jiraporn Chontichachalalauk, Porntip Malathum, Somchit Hanucharumkuf, & Charn Kredboonsri, (2008). The Effect of Music Therapy on Anxiety, Physiological Responses, and Weaning Parameters in	Quasi-experimental research / Level 5

Table 3.1 : Summary and classification of level of the findings by evaluation criteria of Grace (2009) (cont.)

No.	Databases	Authors / Years/Title/ published research	Level of evidence
		Patients during Weaning from Mechanical Ventilation. Ramathibodi Nursing Journal, 14(3), 328-346.	
31.	Hand Search	Ruji Plangwan. (2004). The effects for providing information and instilling reassurance on uncertainty in weaning from mechanical ventilation. A Thesis for the degree of master of nursing science (Adult Nursing), Faculty of graduate studies, Mahidol University.	Quasi-experimental research / Level 5
32.	ThaiLIS	Siriwan Wattanasin, (2007). The relationship among weaning readiness, dyspnea, fatigue and successful weaning from mechanical ventilation. The Journal of Faculty of Nursing Burapha University, 15(1), 22-34.	Descriptive research / Level 6
33.	ThaiLIS	Montira Udchumpisai, et al., (2010). Factors influencing prolonged mechanical ventilation in critically–ill medical patients. Thai Journal of Cardio-Thoracic Nursing, 21(1), 14-30	Correlational Predictive research / Level 6
34.	PubMed	Boles, J. M., Bion, J., Connors, A., Herridge, H., Marsh1, B., Melote, C., Pearl, R., Silverman, H., Stanchina, M., Vieillard-Baron, A., Welte, T. (2007). Weaning from mechanical ventilation. European Respiratory Journal, 29(5), 1033–1056.	Unsystematic clinical observation / Level 7

Table 3.1 : Summary and classification of level of the findings by evaluation criteria of Grace (2009) (cont.)

No.	Databases	Authors / Years/Title/ published research	Level of evidence
35.	PubMed	Macintyre, N. R. (2001). Evidence-Based Guidelines for Weaning and Discontinuing Ventilatory Support : A Collective Task Force Facilitated by the American College of Chest Physicians; the American Association for Respiratory Care; and the American College of Critical Care Medicine. Chest, 120(6), 375S-396S	Unsystematic clinical observation / Level 7

3.2 Evaluating the Quality of the Evidence

The 35 articles of evidence were assessed for feasibility as shown in Table A.1 (Appendix A) in order to set the recommendations for promoting weaning success using the evaluation criteria of DiCenso, Guyatt and Ciliska (2005). The evidence was evaluated based on the following three issues:

1. Are the results valid?

According to the 35 articles, the evidence findings were concurrent with the clinical issue on promoting weaning success in adult patients on mechanical ventilation directed by a multidisciplinary team.

In four evidence from systematic reviews of randomized controlled trials or metaanalysis, the study provide valid it was designed the higher levels of strength of evidence pyramids for therapy was generally preferable to evidence from any single study. Investigators explicitly state inclusion and exclusion criteria for evidence, the quality of primary study designs was high and sample sizes are large, conduct a comprehensive review of the available evidence for a specifically defined clinical question. The results of similar studies are presented together and the combined results are summarized in a metaanalysis.

In five evidence from randomized controlled trials, provide the strong evidence for therapy to accomplish this control was a true experiment, implemented in health care as randomized clinical trials. The hallmarks of this study design are that the investigators can control which subjects are exposed to the cause and which ones aren't (manipulation of the independent variable) and that subjects are assigned to the exposure and comparison groups by chance alone (randomization), then follow participants forward in time to determine the effect of the intervention and analyzed all patients in the groups to which they were randomized, regardless of whather patients received their assigned intervension. The number of the samples group are large enough to clinically meaningful.

In twenty-one evidence from single observational study-patient important outcomes, which observational study designs provide relatively strong evidence to guide our practice. The investigetors identifies groups of patients who are exposed and not exposed to the intervension, document the baseline characteristics of both groups and demonstate their comparability or use statistical techniques to adjust for differences and follows them forward in time to monitor the target outcome. The results of the quality evaluation of the cohort studies and the case-control study were valid with proper settings for population, risk factors and outcomes studied were clearly described, relevance of the outcomes studied and similality of the study subjects to patients of interest.

In two evidence from physiologic study, evidence from descriptive and qualitative studies, the studies provide valid it was good evidence in relevance of the outcomes studied and similality of the study subjects to patients of interest.

In unsystematic clinical observations, study designs provide relatively good evidence of a literature reviews from evidence- based practices and opinions of qualified experts and specialists specific professions relevant of organizations in caring for patients on mechanical ventilation to guide our practice. The studies are directly related to the outcomes studied, setting and similality of the study subjects to patients of interest.

2. What are the results?

Most of the 35 articles were conducted in a varied intensive care units cared for medical and surgical patients on mechanical ventilation. For most part, the findings illustrated evidence of reduction in the duration of mechanical ventilation, weaning duration and length of stay in ICU with use of standardized weaning protocols performed by a multidisciplinary team. All studies used readiness to wean criteria for protocol entry, but the criteria varied each study.

All of the findings were analyzed and synthesized. The systematic reviews of randomized controlled trials or metaanalysis were found to have properly processed the overall findings of the studies there was level of statistically significant among studies at p-values < 0.01, use the 95% confidence interval, provide the relative risk (RR), and analysis results by metaanalysis.

The randomized controlled trials, There is some evidence of a reduction in the duration of mechanical ventilation, weaning duration, adverse event, and ICU length of stay with use of standardized protocols the results are reliable by reporting $p < 0.05$ (95% CI). One study described usual practice as weaning method according to sedative protocols with statistical and clinical significance at p-values < 0.01, 95% confidence interval.

The remaining results of evidence from summarize provided to significant intervention benefit in clinical outcome of mechanical ventilation weaning, the tests usually use for statistical significance p-values < 0.05, and the computations for clinical importance all depend on the outcomes of interest are expressed.

3. How can I apply the results to patients care?

The recommendation for promoting successful weaning from mechanical ventilation in adult patients based on evidence had feasibility to nursing implementation into an effective practice guideline for promoting successful weaning from mechanical ventilation which consistent of clinical problems of interest. In addition to helping guide our decisions about worthwhile clinical practices can be very helpful tools for evaluation of patients.

The results of the study will apply implementation in real situations to the patients of interest. Nurses can independently implement the recommendation for evaluating weaning readiness by using the weaning readiness assessment tool, i.e., clinical assessments, Burns Weaning Assessment Program (BWAP), and rapid shallow breathing index (RSBI). However, did not nursing workloads and nurse-patient ratios with no risks for patients in implementation, but should be trained for using the assessment tool to optimization outcome and capacity in monitoring and following up on patients' evaluations.

Weaning protocols must be developed using and evidence-based approach by key stakeholders of the multidisciplinary teams involved in mechanical ventilation weaning decision practices. The results of the study will apply to develop weaning protocols as appropriate which depending on environment that favours collaboration between nursing and medical staff, autonomous nursing decision-making in relation to weaning practices, But may have different effect because of variations in contextual factors, such as location setting, organization culture, political climate, and organizational resources.

3.3 Sythesizing Evidence

The investigator obtained a total of 35 evidence on the topic of promoting mechanical ventilation weaning success. The reliability level of each study was evaluated using the evaluation criteria of Grace (2009). The data from the evidence was then analyzed and summarized into a collective table as shown in Table A.2 (Appendix B). The relevant contents were then synthesized into recommendations for for promoting weaning success.

Summarizing the Synthesis of Evidence

According to the 35 evidence, the investigator was able to draw conclusions from the key contents in the evidence that nursing roles in promoting weaning success consist of assessment, promotion and consistent follow-up throughout the weaning process.

Weaning from mechanical ventilation is a process which reduces the respiratory assistance in patients on mechanical ventilation support so as to enable them to breathe by themselves and eventually to stop the use of the mechanical ventilation once a patient's condition has improved. The level of breathing assistance is reduced until the patient can breathe spontaneously through abrupt or gradual discontinuation and the endotracheal tube is removed (Boles et al., 2007/Level 7). The weaning process is divided by the American Association of Critical Care Nurses into 3 phases, namely, pre-weaning, weaning and post-weaning or outcome phases (Rose & Nelson, 2006/Level 2).

Pre-Weaning Phase

This is the phase for identifying or determining and resolving the reasons for respiratory failure as well as making decision to wean the patient from mechanical ventilation.

1. Weaning readiness assessment is the first step of mechanical ventilator weaning. It is significant for the identification of patients with weaning readiness and prevents patients who are not ready to be weaned from mechanical ventilation before the time is right (Robertson et al., 2008/Level 5). The readiness of patients who have required mechanical ventilation for more than 24 hours might be assessed daily in the mornings by physicians or nurses before weaning, while keeping treatment plans on target for the patients in weaning (Chittawatanarat & Thongchai., 2009/Level 5; Ezingeard et al., 2006/Level 3; Tanios et al., 2006/Level 3; Twibell, Siela & Mahmoodi., 2003/Level 5; Matic et al., 2007/Level 3; Chaiwat et al., 2010/Level 3; Ezingeard et al., 2006/Level 3; Girard et al., 2008/Level 3), at which time weaning should be considered as soon as possible. Patients with weaning readiness should be allowed to perform spontaneous breathing trials (SBT) which can reduce weaning delay and help patients be weaned from mechanical ventilation better and sooner with shorter duration of weaning (Bumroongkit et al., 2005/Level 5; Marelich et al., 2000/Level 3; Chaiwat et al., 2010/Level 3; Blackwood et al., 2011/Level 4; Burns et al., 2003/Level 5), fewer complications (Marelich et al., 2000/Level 3) and lowered medical costs with shortened lengths of stay in the ICU as well (Burns et al., 2003/Level 5). In addition, evaluation helps multidisciplinary teams identify the issues

or obstacles preventing a patient from weaning readiness and eliminates these issues so the patient can begin weaning sooner (Boles et al., 2007/Level 7). Weaning assessment must be performed for physiological and psychological readiness (Burns et al., 2003/Level 5). The assessment consists of the following:

1.1 General clinical assessment as follows:

1.1.1 The reason requiring mechanical ventilation (Chittawatanarat & Thongchai., 2009/Level 5; Ezingeard et al., 2006/Level 5). The patient must not have a fever or the core temperature must be lower than 38 °C, because fever conditions require more breathing strength (Rumpke & Zimmerman., 2010/Level 5; Walsh et al., 2004/Level 5), pain score < 4 (Chaiwat et al., 2010/Level 3; Marelich et al., 2000/Level 3; Rumpke & Zimmerman, 2010/Level 5; Walsh et al., 2004/Level 5), Hemoglobin > 7 g/dl ± 1 or Hematocrit ≥ 25 %, because low hemoglobin leads to oxygen deficiency (Pensri La-or et al., 2007/Level 5; Walsh et al., 2004/Level 5), Plasma Na+ concentration > 128 and < 150 mmol litre ± 1 and Plasma K+ concentration > 3.0 and < 5.0 mmol litre ± 1 (Walsh et al., 2004/Level 5).

1.1.2 Evaluating Level of Consciousness: The patient must have a good level of consciousness (Tanios et al., 2006/Level 5; Chaiwat et al., 2010/Level 3) according to the following criteria: easy to wake up (Tanios et al., 2006/Level 3); able to communicate and follow orders (Chaiwat et al. 2010/Level 3 ; Walsh et al., 2004/Level 5) with Glasgow Coma Scale (GCS) ≥ 10 (Marelich et al., 2000/Level 3; Pensri La-or et al., 2007/Level 5), Richmond Agitation-Sedation Scale (RASS) ≥ -2 (Girard et al. 2003/Level 3) and does not receive muscle relaxants or sedatives regularly, then the patient will be able to be extubated successfully (Rumpke & Zimmerman, 2010/Level 5; Ezingeard et al., 2006/Level 5; Pensri La-or, 2006/Level 5).

1.1.3 Breathing Evaluation: The patient needs to be able to cough stimulating to excret secretion during suctioning (Tanios et al., 2006/Level 3; Marelich et al., 2000/Level 3; Rumpke & Zimmerman, 2010/Level 5; Walsh et al., 2004/Level 5; Pensri La-or et al., 2007/Level 5), reduced mucous amount with a good gag reflex (Rumpke & Zimmerman, 2010/Level 5; Pensri La-or et al., 2007/Level 5).

1.2. Evaluation of hemodynamic variables with normal and stable circulation assessed by vital signs (Rumpke & Zimmerman, 2010/Level 5; Chittawatanarat & Thongchai., 2009./Level 5), without vasopressors to stimulate the pressure or with the exception of low-doses, e.g., dopamine ≤ 5μg/kg/BW (Tanios et al., 2006/Level 3; Marelich et al., 2000/Level 3; Chaiwat et al., 2010/Level 3; Matic et al., 2007/Level 3; Ezingeard et al., 2006/Level 5; Rumpke & Zimmerman, 2010/Level 5; Chittawatanarat & Thongchai, 2009/Level 5; Walsh et al., 2004/Level 5; Epstein & Peerless, 2006/Level 5; Pensri La-or et al., 2007/Level 5) or norepineprine < 5 μg/min (Chaiwat et al. 2010/Level 3), or high blood pressure with Systolic BP > 60 or < 180 mmHg (Blackwood et al, 2011./Level 4; Pensri La-or et al., 2007./Level 5) with mean airway pressure (MAP) ≥ 60 mmHg (Tanios et al., 2006/Level 3; Marelich et al., 2000/Level 3) and heart rate > 50 beats/minute or < 140 beats/minute (Chaiwat et al. 2010/Level 3; Matic et al., 2007/Level 3; Rumpke & Zimmerman, 2010/Level 5; Chittawatanarat & Thongchai, 2009/Level 5; Epstein & Peerless, 2006/Level 5; Pensri La-or et al., 2007./Level 5).

1.3 Evaluation of Lung Mechanics: Lung mechanics was assessed in terms of the muscles strength and endurance of breathing assessment of the patient's strength to breathe spontaneously as follows:

1.3.1 Ability to spontaneous breathing with tidal volume (Vt) > 5 ml/kg (Blackwood et al, 2011./Level 4; Walsh et al., 2004./Level 5) and vital capacity > 10 ml/kg indicating that the patient's breathing muscle strength is sufficient for spontaneous breathing with minute ventilation (MV) < 10-15 liters/minute. If MV over 15 liters/minute is an indicator that the patient requires a great deal of strength to breathe then there is less chance for weaning success (Marelich et al., 2000/Level 3; Chaiwat et al., 2010/Level 3; Epstein & Peerless, 2006/Level 5).

1.3.2 Measuring lung compliance and resistance can assess the patient's exertion to breathe. The patient's static compliance is < 25 cmH_2O (Marelich et al., 2000/Level 3; Chaiwat et al., 2010/Level 3; Walsh et al., 2004/Level 5).

1.3.3 Respiratory rate < 30-35 breaths/minute (Chaiwat et al., 2010/Level 3; Blackwood & Wilson-Barnett, 2007/Level 3; Rumpke, &

Zimmerman, 2010/Level 3; Chittawatanarat & Thongchai, 2009/Level 5; Epstein & Peerless, 2006./Level 7; Boles et al., 2007/Level 7; Pensri La-or et al., 2007./Level 5).

1.3.4 Maximum inspiratory pressure (PImax) can assess breathing muscle strength. PImax should be ≤ -25 cmH2O (Matic et al., 2007/Level 3; Boles et al., 2007/Level 7).

1.4 Gas exchange assessment – the patient beginning to be weaned from mechanical ventilation should have sufficient gas exchange. This can be assessed as follows:

1.4.1 O_2Sat > 90% (Rumpke & Zimmerman, 2010/Level 5; Chaiwat et al., 2010/Level 3; Epstein & Peerless, 2006/Level 5; Pensri La-or et al., 2007/Level 5) or $PaO_2 \geq 60$ mmHg, sufficient carbondioxide exchange with pH > 7.3 (Epstein & Peerless, 2006/Level 5; Matic et al., 2007/Level 3), while receiving oxygen from the mechanical ventilator $FiO_2 \leq 0.5$, PEEP ≤ 5 cmH_2O 5 (Tanios et al., 2006/Level 3; Chaiwat et al., 2010/Level 3; Matic et al., 2007/Level 3 ; Ezingeard et al., 2006/Level 5; Rumpke & Zimmerman, 2010/Level 5; Chittawatanarat & Thongchai., 2009/Level 5; Epstein & Peerless, 2006/Level 5; Pensri La-or et al., 2007/Level 5) or PSV ≤ 10 cmH_2O (Rumpke & Zimmerman, 2010/Level 5).

1.4.2 $PaO_2/FiO_2 \geq 200$ indicates adequate gas exchange in the lungs (Marelich et al., 2000/Level 3; Chaiwat et al., 2010/Level 3; Matic et al., 2007/Level 3).

1.5 Weaning readiness assessment from Burns Weaning Assessment Program (BWAP). It can evaluate both general factors and emotional state with respiratory factors assessment, which consisted of 26 factors, i.e. 14 respiratory and 12 general factors for 26 questions (100%). If the calculated score is greater than or equal to 50%, the patient is ready for weaning. If the score is lower than 50%, the patient is not ready for weaning (Burns et al., 2010/Level 5 ; Epstein & Peerless, 2006/Level 5; Burns et al., 2003/Level 5; Rujee Plangwan, 2004/Level 5; Wipapat Sungkao, 2001/Level 5; Twibell, Siela & Mahmoodi., 2003/Level 5; Rattanapon Buddeesak, 2007/Level 5).

1.6 The rapid shallow breathing index (RSBI) assessment, which is an index indicating the patient's weaning success, can be calculated from the

formula RSBI = f/Vt where f is frequency or breathing rate (times/minute) and Vt is tidal volume in liters. To measure, a spirometer is connected to the endotracheal tube and the patient breathes for one minute. The minute volume is then divided by the breathing rate to obtain Vt. To interpret the results, f/Vt < 105 means high likelihood for weaning success and f/Vt >105 means the chance for weaning success is low (Chaiwat et al. 2010/Level 3; Matic et al., 2007/Level 3; Tanios et al., 2006/Level 3).

1.7 Psychological Readiness Assessment – This is an indicator of potential weaning success and is used when physical changes are unclear. Furthermore, it can indicate the level of anxiety that the patient is facing (Suphapon Sanpila, 2003/level 5). This indicator assesses the patient's level of anxiety and needs (Wipapat Sungkao, 2001/level 5; Suphapon Sanpila/Level 5; Monthira Udchumpisai, 2011/Level 5) using visual analong anxiety scale or numeric rating scale for quick and easy assessment of patients on mechanical ventilation (Monthira Udchumpisai, 2011/level 5; Jiraporn Chonthichachalarak, 2008/Level 5).

2. Promoting Physiological and Psychological Weaning Readiness

2.1 Reducing anxiety and feelings of uncertainty in using the mechanical ventilator helps patients relax. For example, using music therapy allowing the patient hear nature's sounds and other music by playing audio recorders and listening via earphones for 30 minutes (Jiraporn Chontichachalarak, 2008/level 5), using relaxation techniques with deep breathing for 30 minutes or when required by the patient (Wipapat Sungkao, 2001/ Level 5).

2.2 Promoting patients in resting fully with adequate sleep by assessing the patient's sleeping patterns (Monthira Udchumpisai, 2011/Level 5) and performing sedative assessment by assessing with the Richmond Agitation-Sedation Scale every 24 hours (Rumpke & Zimmerman, 2010/Level 5) and assessing spontaneous awakening using the validated sedation scale so the patient receives sedatives in proper amounts (Girard et al., 2008/Level 3). Thus, nurses should determine the factors disrupting the patient's sleeping patterns and promote the patient in having adequate sleep; cease unnecessary use of sedatives and allow the patient receive pain management disrupting mechanical ventilation and mechanical ventilation weaning (Rumpke & Zimmerman, 2010/Level 5).

2.3 Promoting nutritional condition so the patient meets the body's calorie requirements to improve the patient's strength and endurance. This type of assessment is done from the time the patient is first admitted into the ICU and the patient's daily calorie requirement is calculated by using the Harris-Benedict equation. The patient must receive low carbodydrate formula nutritional support via enteral tube within 24 hours at the rate of 10–25 ml/hr in the beginning and increased to 25 ml/hr every 8 hours. However, the patient must not be overfed with any residual gastric content > 100 ml for over 4 hours. Patients with residual gastric content > 100 ml must have meals at two-hour intervals. If residual gastric content is more than 100 ml and the patient unable to receive enteral nutrition with moderately or severely malnourished conditions, the patient should be given TPN within 72 hours (Barr et al., 2004/Level 5).

2.4 Promoting patients in receiving whole body rehabilitation and early mobility physical therapy in patients receiving mechanical ventilation over 48-72 hours (without restrictions) by giving a passive range of motion therapy (PROM) upper and lower extremity joints along with posture change every 2 hours in unconscious patients at least twice a day, five days a week (Morris et al., 2008/Level 5).

- Upper extremity PROM involves finger flexion and extension; wrist flexion, extension, and ulnar and radial deviation; elbow flexion, extension, supination and pronation; shoulder flexion, abduction, and internal and external rotation; shoulder extension was deferred due to positioning in bed.

- Lower extremity PROM involves toe flexion and extension; ankle dorsiflexion, plantarflexion, inversion and eversion; knee flexion and extension; and hip flexion, abduction, adduction, internal and external rotation; hip extension was generally deferred due to positioning in bed.

- Assist the patients with chest physiotherapy at least twice a day, five days a week, e.g., altered postural drainage, percussion, vibration, coughing, stimulation techniques, deep breathing exercises, suction, bed exercises & mobilization (without restrictions) (Malkoc, Karadibak, & Yıldırım., 2009/Level 5).

Activities that should be performed for conscious patients are passive ROM and posture changes every 2 hours. The patients should be stimulated

with an active resistant sitting position at least 3 times/day along with bed mobility training, positioning and transfer training by physical therapists for a short period of seven days during the treatment in the ICU (Morris et al., 2008/Level 5), which can reduce mechanical ventilation times and lengths of stay in the ICU (Morris et al., 2008/Level 5; Malkoc et al., 2009/Level 5).

3. Continual Evaluation and Follow Up – Evaluate weaning readiness in patient on mechanical ventilation every day in the morning together with the physician (Girard et al., 2008/Level 3, Rose & Nelson, 2006/Level 2; Boles et al., 2007/Level 7; MacIntyre, 2001/Level 7) by assessing clinical readiness using the Burns Weaning Assessment Program (BWAP) together with the Rapid Shallow Breathing Index (RSBI) and resolve the issues preventing the patients from readiness for mechanical ventilation weaning.

Weaning Phase

When patients meet the criteria for weaning readiness, the physician should be consulted to consider plans for beginning weaning by having patients performing SBT or gradual mechanical ventilation weaning by slowly reducing breathing assistance provided by mechanical ventilation until patients are able to breathe on their own as appropriate for each patient (Rose & Nelson., 2006/Level 2) as follows:

1. Information should be provided for patients to prepare patients for weaning. Before weaning from mechanical ventilation, patients should receive explanations and information in order to understand the reasons for weaning from mechanical ventilation by providing information regarding weaning protocol, weaning practices and the necessity for extubation in a manner than is easy to understand, such as by having patients listen to an audio recording of information with flipcharts/slides for 30 minutes (Supaporn Sanpila/Level 5) in order to build cooperation in weaning, so patients can be at ease, free from anxiety and have confidence about physiological readiness that patients can breathe safely on their own (Wipapat Sangkao, 2001/Level 5; Rujee Plangwan, 2004/Level 5; Supaporn Sanpila/Level 5).

2. The physician determine of weaning techniques that are suitable for each patient:

2.2.1 Abrupt discontinuation is weaning from mechanical ventilation immediately after a successful weaning trial. Spontaneous Breathing Trial (SBT) is used to assess the patient's ability to breathe spontaneously following extubation (Robertson et al., 2008/Level 5; Matic et al., 2007/Level 3; Girard et al., 2008/Level 3) by having the patient to breathe spontaneously along with oxygen through a T-Piece 3–8 liters/minute (Bumroongkit et al., 2005/Level 5; Marelich et al., 2000/Level 3; Meade et al., 2001/Level 2) or allowing the patient to breathe spontaneously without removing the mechanical ventilator using the pressure support ventilation method (PSV) by setting pressure support ≤ 8 cmH_2O, PEEP ≤ 5-8 cmH_2O (Bumroongkit et al., 2005/Level 5; Chaiwat et al., 2010/Level 3; Girard et al., 2008/Level 3; Chittawatanarat,& Thongchai., 2009/Level 5) or Continuous Positive Airway Pressure (CPAP) by adjusting the mechanical ventilator to CPAP ≤ 5 cmH_2O (Bumroongkit et al., 2005/Level 5; Tanios et al., 2006/Level 3), allowing the patient to continue spontaneous breathing for at least 30-120 minutes. If the patient can breathe spontaneously without difficulty or meets the criteria for mechanical ventilation weaning, a physician should be consulted to consider extubation (Bumroongkit et al., 2005/Level 5; Ruji Plangwan, 2004/Level 5; Marelich et al., 2000/Level 3; Tanios et al., 2006/Level 3; Robertson et al., 2008/Level 5; Chaiwat et al., 2010/Level 3; Girard et al., 2008/Level 3; Ezingeard et al., 2006/Level 5; Mullika Choatsinin., 2005./Level 5; Rumpke & Zimmerman, 2010/Level 5; Chittawatanarat & Thongchai, 2009/Level 5).

2.2.2 The gradual weaning technique involves slow weaning from the mechanical ventilator (Rose & Nelson, 2006/Level 2). This method is generally used in patients who have been on mechanical ventilation for periods longer than 3–5 days (Rumpke & Zimmerman, 2010/Level 3). For patients who tried weaning and failed at least once, and patients with poor cardiopulmonary reserve with previous lung pathology, e.g. COPD patients or patients on mechanical ventilation via a tracheostomy tube (Boles et al., 2007/Level 7; Matic et al., 2007/Level 3). A physician must be consulted before weaning to consider the four methods for gradual weaning techniques according to pulmonary reserve as follows:

- Using a T-Piece is a technique in which the patients have to perform spontaneous breathing with the oxygen at 3-8 liters/minute through a

T-Piece with FiO_2 at no less than the FiO_2used with the mechanical ventilator, switching between using the mechanical ventilator and begin spontaneous breathing through a T-Piece at 3–8 liters/minute for five minutes, then switch with the mechanical ventilator for at least one hour. When the patient is able to breathe well, spontaneous breathing is increased to 5-10 minutes until the patient can breathe spontaneously for two hours (Ruji Plangwan, 2004/Level 5).

- First begin with Synchronized Intermittent Mandatory Ventilation (SIMV) by adjusting ventilator settings at the rate of 10–14 breaths/min, PEEP 5 cmH_2O, pressure support (PS) 12–15 cmH_2O. Next, gradually reduce to 2-4 breaths/minute every 2-4 hours until SIMV = 0, PS can begin reducing or a T-piece can be used (Blackwood & Wilson-Barnett, 2007/Level 3).

- Pressure Support Ventilation (PSV) begins with adjustment of the mechanical ventilation at PEEP ≤ 5 cm H_2O, PS 15–25 cm H_2O, and gradually reducing PS to 1–2 cmH_2O every 2-4 hours until PS can be lowered to 10–12 cm H_2O beginning to perform SBT with a T-piece (Blackwood & Wilson-Barnett, 2007/Level 3).

- Continuous positive airway pressure (CPAP) begins with adjusting the mechanical ventilator at CPAP 0-5 cmH_2O, $FiO_2 < 0.5$ for a period of 20 minutes and measuring RSBI. If RSBI ≤ 100 the patient can continue spontaneous breathing for a full 30–120 minutes (Rumpke & Zimmerman, 2010/Level 3).

3. Consider initiating weaning from mechanical ventilation by performing SBT at appropriate times every day in the morning after patients have fully rested and slept during the night (Pensri La-or et al., 2007/Level 5; Tanios et al., 2006/Level 3).

4. Patients who are ready to wean may be allowed to try spontaneous breathing for 2-5 minutes to assess and determine whether or not the patient can breathe spontaneously for 30-120 minutes (Matic et al., 2007/Level 3; Chittawatanarat & Thongchai, 2009/Level 5; Roberson et al., 2008/Level 3).

5. Monitor and assess the results of SBTs. Patients should not perform SBTs until they are unable to spontaneous breathing and require mechanical ventilation (Epstein, 2009/Level 2). Patients should cancel or stop SBTs at night (Pensri La-or, 2006/Level 5; Bumroongkit et al., 2005/Level 5) or when patients have

symptoms meeting the criteria for halting weaning from mechanical ventilation so patients can rest and weaning readiness can be reassessed in combination with performing SBTs again the next morning (Chaiwat et al., 2010/Level 3). Decisions should be made by using assessment criteria consisting of objective and subjective criteria for ending SBT/weaning failure as follows:

The objective criteria are as follows:

- The respiratory rate < 6 breaths/minute or ≥ 30 breaths /minute for a period over 15 minutes (Bumroongkit et al., 2005/Level 5; Girard et al., 2008/Level 3; Chittawatanarat & Thongchai., 2009/Level 5; Epstein & Peerless., 2006/Level 5; Ruji Plangwan, 2004/Level 5; Boles et al., 2007/Level 7; Roberson et al., 2008/Level 3; Girard et al., 2008/Level 3; Chaiwat et al. 2010/Level 3; Marelich et al., 2000/Level 3) or respiratory rate > 35 breaths/minute in two hours (Matic et al., 2007/Level 3).

- Oxygen saturation (SaO_2) less than 92 % (Girard et al., 2008/Level 3; Chittawatanarat & Thongchai, 2009/Level 5; Matic et al., 2007/Level 3; Bumroongkit et al., 2005/Level 5; Epstein & Peerless., 2006/Level 5; Ruji Plangwan, 2004/Level 5; Boles et al., 2007/Level 7; Roberson et al., 2008/Level 3; Girard et al., 2008/Level 3; Chaiwat et al. 2010/Level 3; Marelich et al., 2000/Level 3) or abnormal arterial blood gas (ABG) in that PaO2 ≤ 50–60 mmHg or SaO2 < 90% while receiving $FiO_2 \geq 0.5$ or $PaCO_2$ > 50 mmHg or $PaCO_2$ increases > 8 mmHg, pH < 7.32 or pH decreases ≥ 0.07 pH units (Boles et al., 2007/Level 7).

- Having a pulse of over 140 beats/minute or an increase or decrease of over 20% from the level before spontaneous breathing trials (Bumroongkit et al., 2005/Level 5; Epstein & Peerless., 2006/Level 5; Ruji Plangwan, 2004 level 5; Boles et al., 2007/Level 7; Roberson et al., 2008/Level 3; Girard et al., 2008/Level 3; Matic et al., 2007/Level 3; Chittawatanarat & Thongchai, 2009/Level 5; Chaiwat et al. 2010/Level 3).

- Systolic blood pressure higher than 180 mmHg or lower than 90 mmHg. or there is an increase or decrease over 20% from the level before spontaneous breathing trial (Bumroongkit et al., 2005/Level 5; Epstein & Peerless., 2006/Level 5; Ruji Plangwan, 2004/Level 5; Boles et al., 2007/Level 7; Roberson et

al., 2008/Level 3; Girard et al., 2008/Level 3; Matic et al., 2007/Level 3; Chittawatanarat & Thongchai, 2009/Level 5; Chaiwat et al. 2010/Level 3).

- Spontaneous Tidal volume < 5 ml/kg (Marelich et al., 2000/Level 3; Epstein & Peerless., 2006/Level 5).

- RSBI > 105 (Roberson et al., 2008/Level 3; Chittawatanarat & Thongchai, 2009/Level 5).

Subjective or clinical criteria such as:

- Level of consciousness is reduced (Boles et al., 2007/Level 7; Roberson et al., 2008/Level 3; Chaiwat et al. 2010/Level 3); patients say breathing is exhausting; they are restless and perspire profusely with high levels of anxiety or pain (Bumroongkit et al., 2005/Level 5; Boles et al., 2007/Level 7; Roberson et al., 2008/Level 3; Marelich et al., 2000/Level 3; Girard et al., 2008/Level 3; Chittawatanarat & Thongchai, 2009/Level 5; Chaiwat et al. 2010/Level 3).

- Difficulty breathing and dyspnea; use of the accessory muscles; chest and abdominal movement are not synchronized; perspiration (diaphoresis) (Marelich et al., 2000/Level 3; Boles et al., 2007/Level 7; Girard et al., 2008/Level 3; Matic et al., 2007/Level 3; Chittawatanarat & Thongchai, 2009/Level 5), or abnormal breathing sounds (Bumroongkit et al., 2005/Level 5).

- Symptoms or presenting symptoms of cardiac arrhythmia or chest pain (Bumroongkit et al., 2005/Level 5; Boles et al., 2007/Level 7; Girard et al., 2008/Level 3; Chaiwat et al. 2010/Level 3).

6. Patients who are unable to do a spontaneous breathing trial for 120 minutes, have symptoms of weak breathing muscles, or symptoms meeting the criteria for ending weaning from mechanical ventilation should receive breathing assistance by allowing them to rest on mechanical ventilation in the same setting before beginning SBT for a minimum of 24 hours (Chaiwat et al. 2010/Level 3; Chittawatanarat & Thongchai, 2009/Level 5). Patients should be assessed for weaning readiness the next morning and be promoted to begin SBT again (Rumpke & Zimmerman, 2010/Level 3).

7. While weaning from mechanical ventilation, weaning parameters should be assessed, monitored, and recorded in weaning flow sheets in order to monitor patients for communications within teams, such as continual recording of

respiratory rate, heart rate, blood pressure, minute volume (MV) , tidal volume (Vt), oxygen saturation, arterial blood gas (ABG) in the period before beginning SBT, during SBT and at the end of SBT along with identification of causes for stopping weaning from mechanical ventilation (Pensri La-or et al., 2007/Level 5; Chittawatanarat & Thongchai, 2009/Level 5; Ezingeard et al., 2006/Level 5; Henneman et al., 2002/Level 5). And there should be assessments of dyspnea and fatigue by questioning patients directly by using visual analog scales of patients periodically when patients are weaning from mechanical ventilation (Twibell & Mahmoodi, 2003/Level 3; Siriwan Wattanasin, 2007/Level 6).

8. Patients who failed to wean from mechanical ventilation should be assessed by the multidisciplinary team for the causes of the weaning failure. The WHEANS NOT criteria may be used in assessments consisting of W: wheeze; H: heart, HT; E: electrolyte; A: airway, anxiety, aspiration, alkalosis; N: neuromuscular; S: sepsis, sedation N: nutrition (over/under); O: opiate, obesity; T: thyroid (Bumroongkit et al., 2005/Level 5).

Post-Weaning/Outcome Stage

The post weaning stage is the stage of assessing weaning results of patients and post-extubation care of patients who have been weaned successfully in order to promote the abilities of patients to breathe effectively after extubation and to prevent re-intubation.

Patients with weaning success refers to patients who are able to spontaneous breathing trial for 30-120 minutes consecutively without mechanical ventilation and are able to be extubated without reintubation and being put back on mechanical ventilation within 48 hours after extubation (Boles et al., 2007./Level 7; Matic et al., 2007/Level 3).

Patients who have spontaneous breathing trial for more than 30-120 minutes as judged by assessment criteria consisting of objective and subjective criteria should receive consultation from healthcare teams so they can be assessed for extubation (Matic et al., 2007/Level 3; Marelich et al., 2000/Level 3; Girard et al., 2008/Level 3; Chittawatanarat & Thongchai, 2009/Level 5; Ruji Plangwan, 2004/Level 3; Roberson et al., 2008/Level 3; Chaiwat et al. 2010/Level 3;

Bumroongkit et al., 2005/Level 3; Rumpke & Zimmerman, 2010/Level 3; Ezingeard et al., 2006/Level 3) with the following extubation steps:

1. Provision of data prior to extubation regarding extubation, practices during extubation and after extubation, including care to be received after extubation (Ruji Plangwan, 2004 /Level 5; Wipapat Sangkao, 2001/Level 5).

2. Before extubation, nurses and phhysician must be sure patients are able to protect their own respiratory tracts. Ability to protect the respiratory tract depends on effective coughing, normal swallowing function and low amounts of mucous. Patients' coughing efficiency should be assessed (Bumroongkit et al., 2005/Level 5; Ruji Plangwan, 2004 /Level 5) from effort to cough at suctioning and amounts of mucous (Bumroongkit et al., 2005/Level 5; Pensri La-or et al., 2007/Level 5).

3. Gag reflex assessment to assess the patient's ability to cough and swallow (Pensri La-or et al., 2007/Level 5).

4. Assessment of level of consciousness. Patients with good levels of consciousness will have good coughing efficiency and good clearing of the respiratory tract (Pensri La-or et al., 2007/Level 5).

5. Assessment of vital signs to assess physiological changes to occur after extubation (Pensri La-or et al., 2007/Level 5; Ruji Plangwan, 2004/Level 5; Bumroongkit et al., 2005/Level 5).

6. Performance of the cuff leak test (Bumroongkit et al., 2005/Level 5; Pensri La-or et al., 2007/Level 5).

7. Promoting patients in receiving sufficient oxygen by giving supplemental oxygen (Esteban et al., 2004/Level 5) via O_2 mask with bag or cannula 3 -5 Lit/min. to have oxygen saturation > 90% (Pensri La-or et al., 2007 /Level 5).

8. Promoting clearing the respiratory tract and adequate humidity so mucous becomes thinner and less viscous; after extubation, the sleeping postures of patients should be arranged for the head to be at 45 degrees. Patients should receive respiratory physiotherapy, bronchodilators and other treatments according to treatment plans (Esteban et al., 2004/Level 5).

9. Patients must be closely monitored for symptoms over a minimum of 24-72 hours following extubation (Esteban et al., 2004/Level 5; Pensri

La-or, 2005/Level 5), e.g. breathing rates, abnormal breathing characteristics, presenting symptoms of fatigue in breathing muscles, oxygen saturation and vital signs (Esteban et al., 2004/Level 5), especially patients at high risk for failed extubation (Epstein., 2009/Level 2; Ferrer et al., 2005/Level 3) such as patients aged > 65 years, patients requiring intubation due to heart failure, patients who failed SBTs more than once, patients with more than one co-morbidity with APACHE II scores of > 12 during extubation, patients with $PaCO_2$ > 45mmHg after extubation and patients with little strength to cough.

10. Consideration for using a non-invasive ventilator (NIV) during the first 48 hours after extubation in patients at high risk for failed extubation (Meade et al, 2001/Level 2; Esteban et al., 2004/Level 5; Burns et al, 2010/Level 2) consisting of patients aged > 65 years, patients with history of heart disease or heart failure, patients with COPD, cancer, cirrhosis of the liver, chronic renal failure, patients with arterial blood gas containing $PaCO_2$ > 45 mmHg from a blood test taken before mechanical ventilation (hypercapnia), patients without strength to cough, or patients who have had more than one weaning failure (patients who are difficult to wean) so patients can be extubated more quickly, especially in COPD patients. Patients will be extubated and receive breathing assistance immediately with NIV (PSV+CPAP) then they will be gradually weaned from NIV (Burns et al., 2010/Level 2).

11. Patients with difficulty breathing, larynx swelling or occlusion of the upper respiratory tract should consult physician for reintubation when having one of the symptoms meeting the criteria for extubation failure (Boles et al., 2007/Level 7), as follows:

- A large amount of mucous blocking the respiratory tract.
- Respiratory rate > 25 breaths/minute in 2 hrs.
- Heart rate > 140 beats/minute or increased-decreased by ≥ 20 %.
- Presenting symptoms of muscles weakness of breathing.
- SaO2 < 90% or < 85 % while giving high FiO_2.

- Hypotension Systolic BP < 90 mmHg for a period of over 30 minutes while receiving adequate volume loading and/or use of vasopressors.

- PaO2 < 80 mmHg while using $FiO_2 \geq 0.50$.

- Hypercapnia with $PaCO_2$ > 45 mmHg or ≥ 20% from pre-extubation, pH < 7.33.

Patients with weaning failure means patients who do not pass spontaneous breathing trials for periods as long as 30-120 minutes (spontaneous breathing trial failure) or patients who have been re-intubated and return to mechanical ventilation within 48 hours after extubation (Boles et al., 2007/Level 7)

3.4 Recommendations

Weaning from mechanical ventilation is a routine practiced every day in the ICU and each ICU tends to have different weaning practices. Thus, attempts have been made to find the best way for suitable and safe weaning from mechanical ventilation that is not too soon that it may harm the patient because the patient is not ready to be weaned but not too late because prolonged use of mechanical ventilation is correlated with the occurrence of complications, mortality rates and increased medical costs as well as the issues on the management of the limited numbers of beds and the patient's suffering from mechanical ventilator use that lasts longer than necessary.

A series of stages in the process of care, from intubation and initiation of mechanical ventilation through initiation of the weaning effort to the ultimate liberation from mechanical ventilation and successful extubation (Boles et al., 2007/Level 7). The weaning process can be divided into 3 stages, i.e. pre-weaning, weaning, and post-weaning stages (Rose & Nelson, 2006/Level 2). Thus, promoting weaning success is aimed to reducing duration of mechanical ventilation and preventing re-intubation. According 35 evidences, the investigator was able to summarize the findings into recommendations for promoting success in weaning patients from mechanical ventilation according to the following weaning phases:

Promotion in Pre-Weaning Stage

The pre-weaning phase is the stage where nurses and multidisciplinary teams promote physiological and psychological readiness in order to enable patients to enter the weaning process as soon as possible by performing daily screening of weaning readiness in combination with searching for problems and obstacles preventing patients from being ready to wean and resolving factors which are obstacles to weaning with promotion for patients with weanig readiness to begin spontaneous breathing trials (SBT).

1. Patients requiring mechanical ventilation for > 24 hrs, a search for all the causes that may be contributing to ventilator dependence should be screened readiness to wean everyday in the morning with multidisciplinary teams to monitor readiness to begin weaning from mechanical ventilation. Furthermore, the patients' barriers to weaning should be resolved (Girard et al., 2008/Level 3, Rose & Nelson, 2006/Level 2; Boles et al., 2007/Level 7; MacIntyre, 2001/Level 7).

2. Assessment of physiological and psychological readiness for weaning can be performed by using the following instruments:

2.1 Clinical assessments. Patients must be ready in 4 aspects comprising:

2.1.1 Evidence of some reversal of the underlying cause of respiratory failure. (Chittawatanarat & Thongchai., 2009/Level 5; Ezingeard et al., 2006/Level 5; MacIntyre, 2001/Level 7).

2.1.2 Adequate oxygenation: O_2 Sat > 90% or $PaO_2 \geq 60$ mmHg , $PaO_2/FiO_2 > 200$ and pH > 7.3, required $FiO_2 \leq 0.4$ - 0.5, PEEP ≤ 5-8 cmH_2O (Tanios et al., 2006/Level 3; Chaiwat et al., 2010/Level 3; Matic et al., 2007/Level 3; Ezingeard et al., 2006/Level 5; Rumpke & Zimmerman, 2010/Level 5; Chittawatanarat & Thongchai., 2009/Level 5; Epstein & Peerless, 2006/Level 5; Pensri La-or et al., 2007/Level 5).

2.1.3 Hemodynamic stability as defined by the absence of clinically important hypotension and requiring no vasopressors or only low-dose vasopressors (e.g., dopamine or dobutamine ≤ 5μg/kg/min. or norepineprine dose < 5 μg/min) (Tanios et al., 2006/Level 3; Marelich et al., 2000/Level 3; Chaiwat et al., 2010/Level 3; Matic et al., 2007/Level3; Ezingeard et

al., 2006/Level 5; Rumpke & Zimmerman, 2010/Level 5; Chittawatanarat & Thongchai, 2009/Level 5; Walsh et al., 2004/Level 5; Epstein & Peerless, 2006/Level 5; Pensri La-or et al., 2007/Level 5).

2.1.4 The capability to initiate an inspiratory effort, lower amounts of mucous, coughing reflex and good gag reflex (Tanios et al., 2006/Level 3; Marelich et al., 2000/Level 3; Rumpke & Zimmerman, 2010/Level 5; Walsh et al., 2004/Level 5; Pensri La-or et al., 2007/Level 5; MacIntyre, 2001/Level 7).

2.2 Burns Weaning Assessment Program (BWAP) is a 26 factor weaning assessment worksheet and scoring instrument used to reduce practice variability in the clinical management of patients receiving mechanical ventilation, which covers physiological and psychological aspects with feasibility for implementation in various patients on mechanical ventilation without limitations in terms of age, gender and characteristics of critical patients. This instrument is popularly used in assessing weaning readiness. If the calculated score is $\geq$ 50%, patients are ready to be weaned from mechanical ventilation (Epstein & Peerless, 2006/Level 7; Burns et al., 2003/Level 3; Ruji Plangwan, 2004/Level 3; Wipapat Sangkao, 2001/Level 3; Twibell, Siela & Mahmoodi., 2003/Level 5; Pensri La-or et al., 2007/Level 5; Burns et al., 2010/Level 5).

2.3 The rapid shallow breathing index (RSBI). If the calculation of f /V_T values < 105 is considered predictive of weaning success. Used in combination with evaluations of clinical weaning readiness, this method is more efficient than routinely implemented evaluations of clinical readiness for weaning (Chaiwat et al. 2010/Level 3; Matic et al., 2007/Level 3; Boles et al., 2007/Level 7; Tanios et al., 2006/Level 2).

3. Psychological readiness is evaluated by assessing levels of anxiety and being aware of patient' needs (Wipapat Sangkao, 2001/Level 5; Supaporn Sanpila/Level 5; Montira Udchumpisai, 2010/Level 5) by using the visual analog anxiety scale or the numeric rating scale, which can easily and quickly assess patients on mechanical ventilation (Montira Udchumpisai, 2010/Level 5; Jiraporn Contichachalalak, 2008/Level 5).

4. Promoting physiological and psychological readiness of patients comprises the following:

4.1 Reduced anxiety and uncertainty in using mechanical ventilation by promoting the use of complementary therapy to help patients feel relaxed, e.g. music therapy (Jiraporn Chontichachalalak, 2008/Level 5) or relaxation techniques by breathing deeply for 30 minutes or when patients want to do. (Wipapat Sangkao, 2001/Level 5).

4.2 Promoting patients to rest and sleep adequately by assessing sleeping patterns (Montira Udchumpisai, 2010/Level 6) with pain assessments by using the numeric rating scale or visual analog scales (Rumpke & Zimmerman, 2010/Level 5; Montira Udchumpisai, 2010/Level 6) and promoting patients in receiving effective pain management. In patients who cannot communicate, false information, which makes pain management ineffective, is the result. Therefore, patients usually receive pain management with sedative management (Girard et al., 2008/Level 5; Rumpke & Zimmerman, 2010/Level 5).

4.3 Promoting patients in receiving proper sedative management. by using a sedative algorithm or daily interruption of sedative use to assess the spontaneous awakening of patients and reduce the use of sedatives drug every 4 hours, in assessing patients will make sedative management more effective and receive sedatives in proper dosages, enables patients to perform spontaneous breathing trials (Girard et al., 2008/Level 5; Rumpke & Zimmerman, 2010/Level 5). Therefore, the use of instruments, such as the Richmond Agitation-Sedation Scale (RASS), Sedative-Agitation Scale (SAS) or validated sedation scale (Rumpke & Zimmerman, 2010/Level 5; Girard et al., 2008/Level 3). Nurses should determine the causes of disruptions in sleeping patterns of patients and promote patients in sleeping adequately in combination with stopping the use of unnecessary sedatives and having proper pain management.

4.4 Collaborate with multidisciplinary teams to optimize patient's nutrition status. Initiating nutrition assessments and early nutritional support by receiving early enteral tube feeding with low carbohydrate formulas in ICU patients within 48 to 72 hours of ICU admission without overfed. Patients should be assessed in order to calculate daily calorie needs by using the Harris-Benedict equation. If the

patient is unable to receive enteral nutrition under moderately or severely malnourished conditions, the patient should be given TPN within 72 hours. (Barr et al., 2004/Level 5; Boles et al., 2007/Level 7).

4.5 Monitor for optimal fluid and electrolyte status. Senior adults on mechanical ventilation should receive daily assessments of fluid balance and be monitored for positive fluid balance, which is a factor that causes patients to fail in weaning from mechanical ventilation (Epstein & Peerless., 2006/Level 5).

4.6 Administer physiotherapy, as appropriate by whole body rehabilitation and mobility in patients on mechanical ventilation for more than 48-72 hours (with no restrictions). Unconscious patients should receive a passive range of motion therapy (PROM) upper & lower extremity joints, in combination with changes of posture every 2 hours by nurses or physiotherapists (Morris et al., 2008/Level 5). Patients should receive chest physiotherapy as appropriate, e.g. modifying postural drainage, percussion, vibration, coughing, stimulation techniques, deep breathing exercises, suction, bed exercises & mobilization (Malkoc et al., 2009/Level 5). Conscious patients should receive passive ROM and posture changes every 2 hours by increasing stimulation of active resistance along with bed mobility training, positioning and transfer training for a short period from physiotherapists (Morris et al., 2008/Level 5). Types of therapies should be modified as suitable for the conditions of each patient (Morris et al., 2008/Level 5; Malkoc et al., 2009/Level 5).

Promotion in the Weaning Stage

When patients meet the weaning readiness criteria, a physician should be consulted about beginning the weaning process by having the patient perform spontaneous breathing trials (SBT) or gradually weaning the patients by slowly reducing the settings on the mechanical ventilator a little bit at a time until the patient can breathe independently.

1. Consider initiating to wean the patient by spontaneous breathing trials at appropriate times every morning after the patient has fully rested and slept during the night (Pensri La-or et al., 2007/Level 5; Tanios et al. 2006/Level 3).

2. Information should be provided for patients to prepare them for weaning. Patients should receive explanations and information on the goals of

weaning, weaning processes, proper practices during weaning, safety and care while weaning in combination with reassurance in spontaneous breathing trial in order to reduce anxiety and uncertainty in weaning. Methods for promoting patient readiness include activities, such as having patients listen to an audio recording of information with flipcharts or slides and training in deep breathing relaxation techniques in order to build cooperation in weaning, so patients can be at ease and free from anxiety with confidence about physiological readiness that patients can breathe safely on their own. (Wipapat Sangkao, 2001/Level 5; Ruji Plangwan, 2004/Level 5; Supaporn Sanpila/Level 5). During weaning, patients should be encouraged to practice rhythmic, regular, deep breathing (Wipapat Sangkao, 2544/Level 5).

3. Promote the best use of the patient's energy by initiating weaning trials after the patient is well rested (Rose & Nelson, 2006/Level 2; Boles et al., 2007/Level 7; MacIntyre, 2001/Level 7).

4. Consult with physician about patients who exhibit weaning readiness and performed spontaneous breathing trials by considering the the following weaning methods as suitable for each patient (Rose & Nelson, 2006/Level 2; Boles et al., 2007/Level 7; MacIntyre, 2001/Level 7).

5. Spontaneous breathing trials (SBT). SBT is the major diagnostic test to determine if patients can be successfully extubated. An initial brief period of spontaneous breathing at 2-5 minutes can be used to assess the capability of continuing onto a formal SBT at least once daily SBTs to identify patients who are ready for liberation from the ventilator (Matic et al., 2007/Level 3; Girard et al., 2008/Level 3; MacIntyre, 2001/Level 7; Robertson et al., 2008/Level 5;)

6. The initial SBT should last 30 min and consist of either T-tube breathing with oxygen provided 3–8 liters/minute or low levels of PS (5–8 cmH2O in adults patients) with or without PEEP $\leq$ 5 cmH_2O (Bumroongkit et al., 2005/Level 5; Chaiwat et al., 2010/Level 3; Girard et al., 2008/Level 3; Chittawatanarat,& Thongchai., 2009/Level 5; Rose & Nelson, 2006/Level 2; Boles et al., 2007/Level 7)

7. Gradual weaning involves slowly reducing the level of assisted breathing a little bit at a time according to the patients' capacity for indepent breathing. This method is generally used with patients who have been on mechanical ventilation for longer than 3–5 days (Rumpke & Zimmerman, 2010/Level 3;

MacIntyre, 2001/Level 7), patients who have previously been able to perform SBT at least once (Ezingeard et al., 2006/Level 3) and patients who have poor cardiopulmonary reserve, with previous pulmonary pathologies, such as COPD or patients who use tracheostomy tubes (Boles et al., 2007/Level 2; Matic et al., 2007/Level 3). A physician must be consulted before weaning from mechanical ventilation in order to consider gradual weaning techniques as follows:

7.2.1 T-Piece – Have patients practice spontaneous breathing accompanied. Begin with having the patient breath spontaneously through the 3-8 liter/minute T-piece for a period of 5 minutes at FiO_2 setting not lower than the FiO_2 used with the mechanical ventilator and alternate with the mechanical ventilator for at least one hour. When the patient is able to breathe well, gradually increase the amount of time the patient breathes spontaneously for 5–10 minutes per time until the patient is able to breathe spontaneously for as long as 2 hours (Ruji Plangwan, 2004/Level 5).

7.2.2 Pressure Support Ventilation (PSV) – Begin with adusting the setting for the mechanical ventilator at PEEP $\leq$ 5 cmH_2O, PS 15–25 cmH_2O, then gradually reduce PS to 1–2 cmH_2O every 2-4 hours until the setting can be reduced to PS 5–8 cm H_2O for as long as 1-2 hours. Next, consider removing the endotracheal tube (Matic et al., 2007/Level 3; Chittawatanarat & Thongchai, 2009/Level 5). After the PS has been lowered to approximately 3 minutes, the patient should be monitored for any changes in tidal volume, breathing rate, oxygen saturation, heart rate and blood pressure (Chittawatanarat & Thongchai, 2009/Level 5).

8. The evidence findings revealed that there is no best method of weaning in weaning from mechanical ventilation. However, there is referential evidence proposing that the T- piece and pressure support ventilation (PSV) methods can reduce mechanical ventilation times when compared to other methods (Meade et al., 2001/Level 2; Rose & Nelson, 2006/Level 2; Chittawatanarat & Thongchai, 2009/Level 5; Matic et al., 2007/Level 3; Ezingeard et al., 2006/Level 3; Chittawatanarat & Thongchai, 2009/Level 5; Boles et al., 2007./Level 7)

9. PSV can also be used in combination with low CPAP (not exceeding 5 cmH_2O) especially in COPD patients (Matic et al., 2007/Level 3). However, synchronized intermittent mandatory ventilation (SIMV) weaning should be avoided

because there is evidence showing the method to experience more mechanical ventilation weaning failure than other methods (Boles et al., 2007./Level 7).

10. The period of time suitable for SBT with the T-piece and PSV methods is 30 minutes, which is a sufficient period of time to decide about weaning success or failure. In cases of uncertainty and when patients have changing unstable conditions, the SBT period should be extended to 120 minutes, especially in patients with underlying diseases, e.g. lung disease or heart disease, as co-morbidities. Or the period of time may be extended as deemed fitting by the physician and as safe for the patient (Matic et al., 2007/Level 3; MacIntyre, 2001/Level 7).

11.The criteria with which to assess patient tolerance during SBTs are the respiratory pattern, the adequacy of gas exchange, hemodynamic stability, and subjective comfort (MacIntyre, 2001/Level 7).

12. In weaning from mechanical ventilation, weaning parameters should be assessed, monitored and recorded in weaning flow sheets in order to monitor patients for communications within teams, such as continual recording of level of consciousness, respiratory rate, heart rate, blood pressure, minute volume (MV), tidal volume (Vt), rapid shallow breathing index, oxygen saturation, EKG and arterial blood gas (ABG) in the period before beginning SBT, during SBT and at the end of SBT along with identification of causes for stopping weaning from mechanical ventilation (Jiraporn Chotichalarak, 2008/Level 5; Pensir La-or et al., 2007/Level 5) Furthrmore, dyspnea and fatigue should be assessed by questioning patients directly and using the visual analog scales of patients periodically when patients are weaning from mechanical ventilation (Sirwan Wattansin, 2007/Level 6; Twibell & Mahmoodi, 2003 / Level 3)

13. Follow-up and evaluate the results of ability to endure spontaneous breathing, signs of respiratory muscle fatigue (e.g., paradoxical abdominal wall motion, dyspnea, hypoxemia and hypoxia while weaning is in process) (Pensir La-or et al., 2007/Level 5; Chittawatanarat & Thongchai, 2009. / Level 5; Ezingeard et al., 2006. / Level 5; Henneman et al., 2002 / Level 5) and evaluation of dyspnea fatigue of patients from time to time as weaning by direct questioning of patients using visual analog scales (Sirwan Wattansin, 2007/Level 6; Twibell & Mahmoodi, 2003 / Level 3)

14. Avoid delaying return of patient with fatigued respiratory muscle to mechanical ventilation (Epstein, 2009/Level 2; Sirwan Wattansin, 2007/Level 6). SBT should be cancelled or terminate weaning at night (Pensri La-or, 2006/Level 5; Bumroongkit et al., 2005/Level 5), then re-evaluating of weaning readiness and perform spontaneous breathing trials in the morning of the next day (Chaiwat et al. 2010/Level 3).

15. The tolerance of an SBT criteria as follows:

15.1 Objective measurements indicating tolerance/success:

- Gas exchange acceptability (Spo2 ≥ 92%; Po2 ≥ 50–60 mm Hg; pH ≥ 7.32; increase in Paco2 ≥ 10 mm Hg) (Girard et al., 2008/Level 3; Matic et al., 2007/Level 3; Bumroongkit et al., 2005/Level 5; Ruji Plangwan, 2004/Level 5; Boles et al., 2007/Level ; Roberson et al., 2008/Level 3; Chaiwat et al. 2010/Level 3; Marelich et al., 2000/Level 3; MacIntyre, 2001/Level 7).

-Hemodynamic stability (HR < 120–140 beats/min; HR not changed > 20%; systolic BP < 180–200 and > 90 mm Hg; BP not changed > 20%, no vasopressors required) (Roberson et al., 2008/Level 3; Girard et al., 2008/Level 3; Matic et al., 2007/Level 3; Chittawatanarat & Thongchai, 2009/Level 5; Chaiwat et al. 2010/Level 3; Boles et al., 2007/Level 7; MacIntyre, 2001/Level 7).

- Stable ventilatory pattern (e.g., RR ≤ 30–35 breaths/min. (Bumroongkit et al., 2005/Level 5; Ruji Plangwan, 2004/Level 5; Boles et al., 2007/Level 7; Roberson et al., 2008/Level 3; Chaiwat et al. 2010/Level 3; Marelich et al., 2000/Level 3; MacIntyre, 2001/Level 7), RSBI > 105 (Roberson et al., 2008/Level 3; Chittawatanarat & Thongchai, 2009/Level 5) or Spontaneous Tidal volume < 5 ml (Marelich et al., 2000/Level 3; Epstein & Peerless., 2006/Level 5)

15.2 Subjective clinical assessments indicating intolerance failure

- Change in mental status (e.g., somnolence, coma, agitation, anxiety or pain) (Roberson et al., 2008/Level 3; Chaiwat et al. 2010/Level 3; Boles et al., 2007/Level 7; MacIntyre, 2001/Level 7).

- Onset or worsening of discomfort, diaphoresis, and signs of increased work of breathing (use of accessory respiratory muscles, and thoracoabdominal paradox) (Marelich et al., 2000/Level 3; Boles et al., 2007/Level 7;

Girard et al., 2008/Level 3; Matic et al., 2007/Level 3; Chittawatanarat & Thongchai, 2009/Level 5) or abnormal breathing sounds (Bumroongkit et al., 2005/Level 5).

Promotion during the Post-Weaning Stage

The post-weaning phase is the stage where importance is given to caring for patients closely in order to prevent reintubation (Epstein, 2009/Level 2). Therefore, patients should be closely monitored for respiratory failure over a minimum of 24-72 hours after extubation (Esteban et al., 2004/Level 3).

1. When patients are able to perform SBT for more than 30-120 minutes, they should be assessed for extubation readiness. The criteria for assessing extubation readiness should be as follows:

1.1 Mental status: alart and able to respond to commands (Pensri La-or et al., 2007/Level 5).

1.2 Good cough and gag reflex, able to protect airway and clear secretions in the respiratory tract (Bumroongkit et al., 2005/Level 5; Pensri La-or et al., 2007/Level 5; Ruji Plangwan, 2004/Level 5; MacIntyre, 2001/Level 7).

1.3 Occlusion of the Upper Respiratory Tract– Patients should be tested with the cuff leak test. Patients able to move air around endotracheal tube with cuff deflated and end of tube occluded (Bumroongkit et al., 2005/Level 5; Pensri La-or et al., 2007/Level 5).

2. The post-weaning phase for successful weaning from mechanical ventilation and extubation can be promoted as follows:

2.1 Promoting patients in receiving sufficient oxygen by providing supplemental oxygen after extubation via O_2 mask with bag or cannula 3-5 Lit/min. for oxygen saturation > 90% (Pensri La-or, 2007/Level 5; Esteban et al., 2004/Level 5).

2.2 Promote of airway patency and the ability of the patient to protect the airway, and sufficient humidity in the respiratory tract, cough efficiency in combination with postures for heads of bed at 45 degrees, administering bronchodilators, and respiratory physiotherapy, as appropriate according to treatment plans (Esteban et al., 2004/Level 5; Wipapat Sangkao., 2001/Level 5; Pensri La-or et al., 2007/Level 5).

3. Close monitoring and follow-up of symptoms for a minimum of 24-72 hours after the removal of the endotracheal tube (Esteban et al., 2004/Level 5; Pensri La-or et al., 2007/Level 5), such as monitoring of respiratory rates and pattern, abnormal characteristics of breathing, presenting symptoms of weakened breathing muscles, oxygen saturation and vital signs (Esteban et al., 2004/Level 5; Siriwan Wattanasin, 2007/Level 6). Physicians should be consulted about re-intubation in cases where patients have difficulty breathing, swollen larynx or occlusion of the upper respiratory tract.

4. Closed follow up in patients at high risk for failed extubation, i.e. patients aged > 65 years, patients with history of heart disease or heart failure, patients with COPD, cancer, cirrhosis of the liver, chronic renal failure, patients with multiple co-morbidities and APACHE II scores of > 12 during extubation, patients with arterial blood gas containing $PaCO_2$ > 45 mmHg from arterial blood gas before mechanical ventilation (hypercapnia), patients without strength to cough, or patients who have had more than one weaning failure (patients who are difficult to wean) (Epstein., 2009. / Level 2).

5. In patients at high risk for failed extubation, non-invasive ventilation may be considered during the first 48 hours after removal of the endotracheal tube (Meade et al, 2001/Level 2; Esteban et al., 2004/Level 5; Burns et al, 2010/Level 2), especially in COPD patients (Burns et al, 2010/Level 2). Patients will be extubated and receive breathing assistance immediately with NIV (PSV+CPAP), after which gradual weaning from the NIV may be considered during the first 48 hours after removal of the endotracheal tube with close monitoring for respiratory failure, especially in COPD patients (Meade et al, 2001. / Level 2; Esteban et al., 2004. / Level 5; Burns et al, 2010. / Level 2). NIV should not be routinely used in such instances as the event of extubation failure (Burns et al, 2010. / Level 2; Meade et al, 2001. / Level 2).

6. Patients who have failed at initial SBT should rest and receive sufficient breathing assistance. Moreover, they should be placed on full mechanical ventilation or receive breathing assistance from mechanical ventilator modes in the same setting for 24 hours prior to SBT. Healthcare teams should check these patients with detailed reviews of laboratory test results with physician to search for and resolved the reasons for SBT failure (MacIntyre, 2001/Level 7; Bumroongkit et al., 2005/Level 5; Chaiwat et al. 2010/Level 3; Boles et al., 2007/Level 7).

7. Patients with difficulty breathing, larynx swelling or obstruction of the upper respiratory tract should consult with physician for early re-intubation when having one of the following symptoms meeting the criteria for extubation failure (Boles et al., 2007. / Level 7; MacIntyre, 2001/Level 7) :

8. In the post-weaning phase, patients can be readily categorised into three groups based on the difficulty and duration of the weaning process. (Boles et al., 2007/Level 7) in order to jointly plan with multidisciplinary teams in management to promote weaning success properly and according to the needs of patients. Patients can be divided into the following three groups:

- The simple weaning group includes patients who have successfully passed the initial SBT and are successfully extubated on the first attempt. This group must be detected for weaning readiness as soon as possible and supported in terms of weaning readiness in order to search for patients with suitable SBTs (Boles et al., 2007/Level 7).

- The difficult weaning group includes patients who require up to three SBTs, or as long as 7 days from the first SBT, to achieve successful weaning. Nurses need to help assure the weaning process requires as little time as possible (Boles et al., 2007/Level 7).

- The prolonged weaning group includes patients who require more than three SBTs, or > 7 days of weaning after the first SBT. These patients usually receive tracheostomy (Boles et al., 2007/Level 7). Solving problems and promoting success in weaning from mechanical ventilation requires overall care and treatment in the aspects of promoting nutrition, sleep, muscle rehabilitation and psychosocial care. This group of patients should receive care in weaning centers.

CHAPTER IV
CONCLUSION AND SUGGESTIONS

Conclusion

Weaning from mechanical ventilation is a significant process in the care of patients using mechanical ventilation. Patients are generally intubated and placed on mechanical ventilation when their own ventilatory and/or gas exchange capabilities are outstripped by the demands placed on them from a variety of diseases. Mechanical ventilation also is required when the respiratory drive is incapable of initiating ventilatory activity due to either disease processes or drugs. As the conditions that warranted placing the patient on the ventilator stabilize and begin to resolve, attention should be placed on removing the mechanical ventilation as quickly as possible to reduce complication rates for mechanical ventilation. Successful mechanical ventilation weaning remains a problem in practice and is fraught with difficulty for nurses and health care teams due to the factor of patients' physiological and psychological readiness which differs from patient to patient, the competence of health care team staff, communication and cooperation on heath care teams, all of which affect the success of mechanical ventilation weaning.

This study was conducted with the objective of recommending methods for the promotion of successful weaning from mechanical ventilation in adult patients. This study is an analysis of all types of evidence related to weaning from mechanical ventilation in adult patients at the intensive care unit by synthesizing knowledge according to the process of implementing the findings acquired from evidence. The methods for searching from health science electronic databases electronic databases were as follows: Cochrane Library, Cumulative Index to Nursing and Allied Health (CINAHL), MEDLINE, Journal@Ovid Full Text, BMJ Journals Online, Science Direct, PubMed, Blackwell Synergy, High wire press, Wiley Interscience & Pro Quest Nursing and Springer Link. And the service network can be linked with institutes or organizations to request articles or journals in full text from the following databases:

ThaiLIS Digital; www.joannabriggs.edu.au and www.guidelines.gov with a manual search from thesis dissertations and thematic papers from other universities or evidence published in Thai and English from 2000–2011 by using all levels of evidence.

The investigator obtained 52 articles relevant to the clinical issue and excluded 17 articles which had been conducted in pediatric patients, population groups with indirection research, pilot studies and studies currently in progress or incomplete studies, studies with abstract only and no evaluation of the outcomes in patients weaning of mechanical ventilation, thereby leaving 35 articles capable of responding to the issues set in the evidence objectives. The levels of strength of the evidence were categorized as follows: 4 articles were Level 2 systematic reviews of RCTs with meta-analysis; 5 articles were Level 3 high quality single randomized trials; 1 articles was a Level 4 systematic review of observational studies; 21 articles were Level 5 single observational study-patient significant outcomes, non-experimental research with prospective cohort studies; 2 articles were Level 6 physiologic studies, descriptive and qualitative studies and 1 articles was Level 7 an unsystematic clinical observation of widely physiologic studies, expert or specialist opinions in specific professional groups of patient care. After the evidence had passed quality evaluation according to the conceptual framework of DiCenso, Guyatt and Ciliska (2005) and the levels of strength of evidence according to the model of Grece (2009), the investigator analyzed and synthesized all evidence by reading the details to extract on relevant issues and recorded the details extracted in the table for synthesized contents. The synthesized topics can be summarized to promote mechanical ventilation weaning success.

Overall, the evidence findings revealed that the promoting mechanical ventilation success in patients on mechanical ventilation in intensive care units were obtained from evidence with the expected outcome of reducing the duration of mechanical ventilation and decreasing re-intubation rates. These recommendations comprise three stages, i.e. the pre-weaning stage, the weaning stage and the post-weaning/outcome stage as follows:

1. The pre-weaning stage is focused on assessment of readiness to wean. The readiness of patients who have required mechanical ventilation for more than 24 hours might be assessed daily in the mornings by physicians or nurses before weaning

by using the weaning readiness assessment tools, i.e., clinical assessments, Burns Weaning Assessment Program (BWAP), and rapid shallow breathing index (RSBI). In addition, nurses should develop a nursing care plan and provide nursing intervention to improve the problem factors and promote assist patients to start weaning more easily. Along with physiological and psychological readiness of patients comprises the reduced anxiety and uncertainty, rest and sleep adequately, proper sedative management, optimize patient's nutrition status, and administer physiotherapy, as appropriate.

2. The weaning from mechanical ventilation stage is focused on the optimal intervention performed to spontaneous breathing trials (SBT) or gradually weaning the patients, and selecting a suitable mechanical weaning method for each patient and continually following up on changes while weaning and discontinue SBT according to the criteria for terminate mechanical ventilation weaning. In addition, the nursing intervention includes the bedside monitoring, assessment of toleration of waning, and the provision of psychological support.

3. The post weaning stage comprises evaluating the effects of weaning, readiness for removal of the endotracheal tube and close bedside monitoring after removing the endotracheal tube in order to prevent re-intubation.

The analysis and synthesis to develop the recommendation and could be developed into an effective practice guideline for promoting successful weaning from mechanical ventilation in adult patients in the intensive care unit based on evidence. Hence, the investigator recommends the following should be considered as early as possible in patients receiving mechanical ventilation. Formal weaning assessments for patients receiving mechanical ventilation for respiratory failure should be performed during spontaneous breathing rather than while the patient is still receiving substantial ventilatory support. Spontaneous breathing trial (SBT) is the major diagnostic test to determine whether or not patients can be successfully extubated. An initial brief period of spontaneous breathing can be used to assess the capability of continuing onto a formal SBT. The criteria with which to assess patient tolerance during SBTs are the respiratory pattern, the adequacy of gas exchange, hemodynamic stability and subjective comfort. The tolerance of SBTs lasting 30-120 minutes should prompt consideration of permanent ventilator discontinuation. The decision to use these criteria must be individualized. Some patients not satisfying all of the above criteria,

such as patients with chronic hypoxemia values below the thresholds cited may be ready for attempts at weaning from mechanical ventilation.

The weaning success is defined as patients who are able to spontaneous breathing trial for 30-120 minutes and the absence of mechanical ventilation 48 hours following extubation. The removal of the artificial airway from a patient who has successfully been discontinued from mechanical ventilation should be based on assessments of airway patency and the ability of the patient to protect the airway.

Weaning failure is defined as either the failure of SBT or the need for re-intubation within 48 hours following extubation. Failure of SBT is defined as follows: 1) objective indices of failure, such as tachypnoea, tachycardia, hypertension, hypotension, hypoxaemia or acidosis, arrhythmia; and 2) subjective indices, such as agitation or distress, depressed mental status, diaphoresis and evidence of increasing effort. Patients receiving mechanical ventilation for respiratory failure who fail an SBT should receive a stable, non-fatiguing, comfortable form of mechanical ventilation support**,** followed by determination of the cause for the failed SBT. Once reversible causes for failure are corrected and when the patient continues to meet the criteria for weaning, subsequent SBTs should be performed every 24 hours.

NIV techniques to shorten the duration of intubation should be considered in selected patients, especially those with hypercapnic respiratory failure. NIV should not be routinely used as in the event of extubation failure and should be used with caution in those patients with hypoxic respiratory failure. Patients can be readily categorized into three groups in the simple weaning, difficult weaning and prolonged weaning groups based on the difficulty and duration of the weaning process.

Weaning protocols carried out by a multidisciplinary team significantly affect mechanical ventilation weaning success and achieve greater success than physician-directed weaning. The protocol elements in weaning from mechanical ventilation consist of three components, such as daily screening for weaning readiness to make clinical decisions, guidelines for reducing breathing assistance and weaning strategy including well-monitored SBT with criteria for success or failure in weaning from mechanical ventilation, extubation criteria, and management after a failed SBT. The most effective clinical decision-making about the processes of weaning from mechanical ventilation is derived from effective communication and planning by

multidisciplinary teams and can result in good outcomes for patients, i.e. reduce duration of weaning, minimize the complications associated with weaning, decrease length of stay in the intensive care unit, lower treatment costs and decrease re-intubation rates, while supporting teamwork and communication among multidisciplinary teams.

In addition nurses can practice safely and efficiently in order to promote mechanical ventilation weaning success in patients with definite clinical practice guidelines based on evidence-based practice. Nurses should recognize the importance of developing nursing knowledge and capacity in monitoring and following up on patients' evaluations at each stage of the weaning process from mechanical ventilation by using knowledge obtained from evidence-based practice and holding training for the continuous development of new knowledge.

Suggestions

The suggestions for promoting successful mechanical ventilation weaning in patients on mechanical ventilation in intensive care units were obtained from evidence with the goal of reducing the duration of mechanical ventilation and decreasing re-intubation rates. These suggestions for nursing implementation as follow 2 topics:

Weaning process

1. The weaning process should be based on the continuous evaluation of the patient's readiness to wean, which collect data every day both during mechanical ventilation, during a spontaneous breathing trial and extubation for close monitoring of the mechanisms responsible of the respiratory failure and on the progressive transferring of the work of breathing from mechanical ventilation weaning to the patient.

2. The findings revealed no best method for weaning from mechanical ventilation. However, there is referential evidence proposing that the T- piece and PSV methods can reduce mechanical ventilation times when compared to other methods. PSV can also be used with or without the combination of low CPAP (not exceeding 5 cmH_2O), especially in COPD patients. However, SIMV weaning should be avoided

because there is evidence showing the method to experience more mechanical ventilation weaning failure than other methods.

3. The use of noninvasive mechanical ventilation to facilitate weaning should be considered, especially in patients with COPD. NIV should not be routinely used in such instances as the event of extubation failure.

4. Patients who fail to wean from mechanical ventilation should be reassessed by the multidisciplinary team for the causes of the weaning failure and assessed for weaning readiness on the next morning. Consideration of resuming a gradual weaning technique should be discussed with physicians.

5. In the post-weaning phase, consideration should be given to assessment of weaning effects and classification of patients into three groups; simple weaning, difficult weaning, and prolonged weaning group according to difficulty and length of the weaning from mechanical ventilation in order to plan with healthcare teams in management to promote weaning success properly and according to the needs of patients.

6. Mechanical ventilation weaning by use of weaning multidisciplinary team, outcome managers and weaning protocols show promise for improvement in outcome, lowering hospital cost, and effective weaning from mechanical ventilation with decreased mortality, whether the weaning is physician-directed or nurse-directed. Weaning protocols help accelerate weaning from mechanical ventilation and achieve greater success than physician-directed weaning. But may have different effect because of variations in contextual factors, such as location setting, organization culture, political climate, and organizational resources.

7. Weaning protocols have been shown to be safe and effective in reducing the time spent on mechanical ventilation. The protocols very in more way than in composition alone. Weaning protocols are generally based on three components:

- The first component is a list of objective criteria based on general clinical factors used to help decide if a patient is ready to breathe without of a ventilator, often referred to as ‘readiness to wean’ criteria

- The second component consists of structured guidelines for reducing mechanical ventilation support. This may abrupt, for example spontaneous

breathing trials, or gradual by using a stepwise reduction in support to achieve discontinuation, for example SIMV or PSV.

- The third component consists of a list of criteria for deciding if the patient is ready for extubation.

8. Weaning protocols must be developed using and evidence-based approach by key stakeholders of the multidisciplinary teams involved in mechanical ventilation weaning decision practices. All physicians should have ready access to the protocol and all members of multidisciplinary teams should evaluate and revise the protocol as new evidence emerges.

9. Prior to implementation based on weaning protocol, all members of multidisciplinary teams should be instruction, demonstration, including practices in terms of contents, details, nursing practices according to weaning protocol and instruments in order to have understanding and expertise.

10. Nurses must have knowledge on all aspects of nursing care, decision making processes concerning weaning protocol and efficient communication between physician and multidisciplinary teams in order to achieve maximum efficiency.

11. Nurse-led protocol-directed weaning was shown to reduce the duration of mechanical ventilation and length of ICU stay, Moreover, it has been shown that nurses can safely wean patients, but this is dependent on a number of factor such as skill mix, team structure, and unit management. So that has indicated the following nursing considerations are important in the weaning process:

- Patient allocation and skill of the nurse, such as experience, knowledge, confidence and expertise.
- Continuity of care and ability to get to know the patient.
- System of patient care delivery, task-orientated vs. individualized patient care.
- Timing of weaning in the patients' day.

12. In addition to weaning protocol, another key feature in the management of weaning is the use of sedative and analgesia. Sedative management is influence to the duration of mechanical ventilation. Recent clinical trials evaluating sedative protocol, daily interruption of sedatives and intermittent use of sedatives have

also reported reductions in the duration of mechanical ventilation and ICU stay, might use in combination with weaning protocol.

13. Promoting successful weaning of patients from mechanical ventilation requires effective nursing intervention to address the patient's basic care needs, such as provide information, sleep deprivation, nutrition imbalanced or less than body requirements and fluid volume, pain, anxiety, activity intolerance, risk for mobility, and impaired bed or physical.

Weaning readiness assessment and instrument

1. Comprehensive assessment of the patient's needs and progress toward weaning, monitoring of the weaning parameters, and following established goals promote successful weaning. Multidisciplinary and comprehensive approaches to wean based on nurse monitoring and promoting a weaning plan with continuity have demonstrated positive outcome.

2. While weaning from mechanical ventilation, weaning parameters should be assessed, monitored, and recorded in weaning flow sheets in order to continuous monitor patients for communications and weaning plan within teams

3. Nurses should have instruments for evaluating weaning readiness, which covers physiological and psychological for implementation in the care of patients being weaned from mechanical ventilation. The readiness of patients who have required mechanical ventilation for more than 24 hours might be assessed daily in the mornings by physicians or nurses before weaning, while keeping treatment plans on target for the patients in weaning.

4. Burns Weaning Assessment Program (BWAP) is a 26 factor weaning assessment worksheet and scoring instrument used to reduce practice variability in the clinical management of patients receiving mechanical ventilation, which is easy to use in a checklist format, while administration takes only 5–10 minutes by nurses, which covers physiological and psychological aspects with feasibility for implementation in various patients on mechanical ventilation without limitations in terms of age, gender and characteristics of critical patients.

5. The rapid shallow breathing index (RSBI), if the calculation of f /V_T values are < 105, a high likelihood for weaning success is indicated, when used in combination with evaluations of clinical weaning readiness, this method is more

efficient than routinely implemented evaluations of clinical readiness for weaning alone. The calculation of f /V_T should be demonstration, including practices in terms of contents, details, nursing practices in order to have understanding and expertise.

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APPENDICES

APPENDIX A

Table A.1 Evaluation of the evidence.

No	Researcher name/ Publish year / Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
1.	Meade, M., et al. (2001). Trials Comparing Alternative Weaning Modes and Discontinuation Assessments.	**Sample** Patients on mechanical ventilation > 48 hr. **Setting :** Intensive care unit **Intervention :** Selection of randomized trials and observational studies has a control group relevant assessment the readiness of weaning from mechanical ventilation, weaning methods, Strategies for extubation that relate the weaning process was conducted to review published research studies from	**The strength of the evidence:** Level 2 **1. Are the results valid?:** The findings are reliable because the study was a systematic review. The objectives of this study were clear with appropriate search strategies in a systematic, comprehensive and consistent with the objectives. Selection of randomized controlled trials (RCTs) and observational studies has a control group by 2 reviewers to examined and evaluate research quality, Presents a summary table for each study, Subgroup analysis of data are clearly and appropriate **2. What are the results?:** The study identified 16 RCTs of methods for weaning patients from mechanical ventilation, 8 of which were trials of discontinuation assessment strategies, 5 of which were trials of stepwise reduction in mechanical ventilation support and 3 of which were trials comparing alternative ventilation mode for weaning periods lasting < 48 hrs. The overall results found that a trials of spontaneous breathing suggest the possibility that multiple daily T-piece weaning or pressure support may be superior to synchronized intermittent

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publish year/ Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
		1997 to 1999 based on electronics searches and hand searched by 2 reviewers examined and evaluate research quality.	mandatory ventilation (SIMV). And suggest early extubation with the back-up institution of noninvasive positive-pressure ventilation as needed may be useful strategy in selected patients **3. How can I apply the results to patient care?:** The result can be applied In patients weaning from mechanical ventilation at the respiratory care unit to select the effectively weaning methods with physician such as multiple daily T-piece weaning or pressure support and avoid SIMV methods.
2.	Rose, L., Nelson, S. (2006). Issues in weaning from mechanical ventilation: literature review.	**Sample :** Patients on mechanical ventilation **Setting :** Intensive care unit **Intervention** : the literature was reviewed have focused on accurate weaning readiness assessment, methods and organizational aspects that influence the weaning process from 1986 to 2004 by accessing the following databases: Medline, Proquest, Science Direct, CINAHL, and Blackwell Science. Search for the RCT and non-RCT and results	**The strength of the evidence:** Level 2 **1. Are the results valid?:** The findings are reliable because the study was a integrative literature review of RCT and non-RCT and meta-analysis, The process of synthesis of the research was clear, so the sum of the systematic research have greater reliability. The research objectives were clear with clear specification of the population studied **2. What are the results?:** According to 14 RCTs and 12 non-RCT 12 Overall summary of the findings: Weaning protocol is an efficient instrument for promoting successful weaning patients from mechanical ventilation. Weaning protocol and weaning process are effective in reducing the duration of mechanical ventilation that helps communication and patient care between nurses and multidisciplinary teams in evaluating clinical readiness to wean from mechanical ventilation in combination selecting methods for weaning from mechanical ventilation. Pressure support ventilation is an effective method and nurses require knowledge regarding the processes of weaning

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publish year/ Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
		of the study was a meta-analysis.	**3. How can I apply the results to patient care?:** The findings can be implemented in the care of patients because the population group comprised patients on mechanical ventilation Implementation of the evaluating clinical readiness to wean from mechanical ventilation and develop of weaning protocol that appropriate to the context of the agency. Weaning protocol efficiency relies upon the cooperation of nurses and weaning multidisciplinary teams within organizations.
3.	White, V., Currey, J., & Botti, M. (2011). Multidisciplinary Team Developed and Implemented Protocols to Assist Mechanical Ventilation Weaning: A Systematic Review of Literature	**Sample :** adult patients (aged 16 years and over) mechanically ventilated via an endotracheal tube **Setting :** intensive care unit (ICU) **Data collection:** A systematic review was conducted to review published research studies from January 1999 to Selection the studies of Randomized and quasi-randomised controlled (two-sample cohort designs) that a comparative study of weaning from mechanical ventilation guidelines by a multidisciplinary team with usual care.	**The strength of the evidence:** Level 2 **1. Are the results valid?:** The findings of Systematic review was defined the selection criteria and exclusion criteria, the data and procedures associated with each study were presented. The quality of the selected research was sufficient by two reviewers conducted data extraction and determined methodological quality of all randomized and nonrandomized controlled studies. The results are consistent with the outcome measure. Analysis results by Meta-analysis at $p < 0.05$ (95% CI) are reliable. **2. What are the results?:** According to the three pre-post interventional studies, the overall conclusion was show equivocal support for weaning protocols develops and implemented by the multidisciplinary teams for reducing duration of mechanical ventilation (test of overall effect p value = 0.01), that can be reduce the duration of mechanical ventilation up to 4 days compared with the physician-directed weaning (usual care). **3. How can I apply the results to patient care?:** Research conducted in the intensive care unit

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publish year/ Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
			patients receiving mechanical ventilation weaning. The sample group possesses characteristics similar to the patient group of interest. Communication and organizational processes must be addressed for multidisciplinary protocols to be effective.
4.	Burns, K.E., et al. (2010). Noninvasive positive pressure ventilation as a weaning strategy for intubated adults with respiratory failure (Review).	**Sample :** Adult patients mechanical ventilation intubated due to respiratory failure, ≥ 24 hour **Setting :** intensive care unit (ICU) **Intervention :** Data collection Selected the Randomized and quasi-randomised controlled study to compare methods of early extubation by using non-invasive positive positive ventilation after extubation. Compared to invasive positive ventilation weaning.	**The strength of the evidence:** Level 2 **1. Are the results valid?:** The findings of Systematic review was comprehensive and consistent with the objectives. The study had clearly set inclusion and exclusion criteria, the quality of the selected research was sufficient, the data and procedures associated with each study was presented and the results are consistent with the outcome measure. **2. What are the results?:** According to 12 RCTs, NPPV significantly decreased mortality rates (RR 0.55, 95 CI 0.38 - 0.79, P = 0.001), ventilator associated pneumonia rates (RR 0.29, 95% CI 0.19 - 0.45, P < 0.00001), duration of mechanical ventilation (WMD -5.64 days, 95% CI -9.50 to -1.77, P = 0.004) and lengths of ICU and hospital stay (WMD -6.27 days, 95% CI -8.77 to -3.78, P < 0.00001 & -7.19 days, 95% CI -10.80 to -3.58, P < 0.0001, especially) in COPD patients when compared to IPPV **3. How can I apply the results to patient care?:** The sample group possesses characteristics similar to the patient group of interest can be applied in the early extubation and using a Non-invasive ventilation after extubation, especially in patients with COPD.

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name / Publish year / Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
5.	Girard, T. D., et al .(2008). Efficacy and safety of a paired sedation and ventilator weaning protocol for mechanically ventilated patients in intensive care (Awakening and Breathing Controlled trial): a randomised controlled trial.	**Sample :** The patients required mechanical ventilation ≥ 12 hrs. was being weaned **Setting :** 4 Medical centers in tertiary-care hospitals, USA. **Intervention :** The intervention group (n = 168): the patient to management with a daily spontaneous awakening trials (SAT) protocol followed by an spontaneous breathing trials (SBT) or with sedation control group (n = 168): the patient to management with usual care plus a daily SBT	**The strength of the evidence:** Level 3 **1. Are the results valid?:** Research design of RCT has a validity and reliability. number of samples was sufficient, the sample group was randomly assigned to the group was clearly explained, the experimental and control groups had similar characteristics from the start. Comparison analyses was conducted between the members in the control and experimental group members who dropped out which the dependent variable is the same. The results are reliable by reporting $p < 0.05$ (95% CI). **2. What are the results?:** SBTs with daily spontaneous awakening trials helped decreases stays in ICUs and hospitals (9.1 days vs 12.9 days; $p = 0.01$ & 14.9 days vs 19.2 days; $p = 0.04$, respectively) with lower mortality rates. (HR 0.68, 95% CI 0.50–0.92; $p = 0.01$) compared with the patients received SBTs with use of sedatives in routine care. **3. How can I apply the results to patient care?:** The sample group possesses characteristics similar to the patient group of interest and patients in clinics met inclusion criteria that the findings can be implemented in the care of patients who required weaning in intensive care unit, Such as assessing daily screening of weaning readiness and spontaneous awakening trials (SATs) by validated sedation scale to monitor the level of awareness and proper management of the sedative to be ready to wean faster.

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publish year / Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
6.	Marelich, G. P., et al. (2000). Protocol Weaning of Mechanical Ventilation in Medical and Surgical Patients by Respiratory Care Practitioners and Nurses Effect on Weaning Time and Incidence of Ventilator Associated Pneumonia.	**Sample :** patients receiving mechanical ventilation total of 335. **Setting :** 3 ICU (MICU & trauma / surgical), USA **Intervention :** The control group (n = 169): usual practice weaning. The experimental group (n = 166): According to wean follow the ventilator management protocol (VMP) by RNs and RTs. Include twice daily screening of readiness to wean, 30-minute SBT (< 72-hrs ventilated) or try gradual reduction of PEEP, PS and IMV (> 72-hrs ventilated) and physician report on successful SBT.	**The strength of the evidence:** Level 3 **1. Are the results valid?:** The research design of the randomized controlled trials (RCT) was validity and reliability. The sample size was sufficient. The selection bias was clear by considering .The researcher has been trained in the intervention and data collection are reliable **2. What are the results?:** Ventilator management protocol (VMP) efficiently reduced mechanical ventilation time for patients($p = 0.0001$) and minimized complications from pneumonia from use of mechanical ventilators ($p = 0.061$). **3. How can I apply the results to patient care?:** The results can be implemented in the care to promoting successful mechanical ventilator weaning in patients on mechanical ventilators in the intensive care unit. Weaning from mechanical ventilation according to the protocol by nurses efficiently reduced mechanical ventilation time relate with Assess readiness to begin weaning from mechanical ventilation twice a day, Criteria for assessing weaning readiness and criteria for ending SBTs. Do not effect on the routine care and risk to patients.

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publish year / Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
7.	Chaiwat, O., et al. (2010). Protocol-Directed vs. Physician-Directed Weaning from Ventilator in Intra-Abdominal Surgical Patients.	**Sample :** intra-abdominal surgical patients requiring mechanical ventilation for more than 24 hours total of 100. **Setting :** General surgical ICU, Siriraj Hospital **Intervention :** The control group (n = 49): the patients receiving weaning from mechanical ventilation by a physician-directed The experimental group (n = 51): the patients receiving protocol-directed weaning to daily screening and spontaneous breathing trial by nurses	**The strength of the evidence:** Level 3 **1. Are the results valid?:** The research design was appropriate. The research procedures was reported in the form of a comprehensive search in line with the objectives. Intervention and outcomes consistent with the objectives. The sample size was sufficient. The intervention by the physician and nurses have been trained in the use of intervention. The results were reliable by reporting p <05. **2. What are the results?:** Protocol-directed weaning based on nurse-directed weaning efficiently reduced mechanical ventilation time in abdominal surgery patients without increasing re-intubation rates within 72 hours when compared to physician-directed weaning ($p < 0.001$). **3. How can I apply the results to patient care?:** The results can be implemented in the care of patients weaning from mechanical ventilation by assessing daily screening of weaning readiness and trial spontaneous breathing by nurses was found safe and able to reduce mechanical ventilation time. Especially in hospitals that lack medical staff. The nurse should be trained to expertise and experience of the weaning protocol.

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publish year / Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
8.	Matic, I., et al. (2007). Chronic Obstructive Pulmonary Disease and Weaning of Difficult-to-wean Patients from Mechanical Ventilation: Randomized Prospective Study.	**Sample :** Patients with chronic obstructive pulmonary disease requiring mechanical ventilation> 24 hours total of136 . **Setting :** multidisciplinary intensive care unit (ICU), Croatia. **Intervention :** The group that use the weaning method with the T-piece Number of 31 and PSV Number of 32	**The strength of the evidence:** Level 3 **1. Are the results valid?:** The findings are reliable because the study was a randomized prospective study, so the findings have greater reliability. The sample group was properly selected and inclusion-exclusion criteria set. The same instruments with accuracy and reliability were used in measurements and measure methods between the sample and control groups except for weaning method. The results were reliable by reporting $p < 0.01$ **2. What are the results?:** Trial spontaneous breathing by using PSV in COPD patients was able to reduce mechanical ventilation time and decreased weaning failure rate in 2 hrs when compared to T-piece. ($P < 0.001$) **3. How can I apply the results to patient care?:** The results can be used to select the method to wean of patients with COPD who failed the 2 hour spontaneous breathing trial has more favorable outcome when PSV rather than T-piece method in started at PS 18 cmH_2O and gradually reduced by 2-4 cmH_2O until pressure support of 5 cmH_2O was reached over a period of 2 hours enabled patients to have greater success in weaning. Include appropriate an evaluation of readiness to wean and evaluation criteria for extubation failure.

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publishing year/Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
9.	Tanios et al. (2006). A randomized, controlled trial of the role of weaning predictors in clinical decision making.	**Sample:** Patients requiring mechanical ventilation ≥ 24 hours total of 304. **Setting :** ICU at 3 Academic teaching hospitals **Intervention :** The control group (n = 151): Patients were screened daily for measures of oxygenation, cough and secretions, adequate mental status, and hemodynamic stability. And *f*/VT was measured but not used in the decision The experimental group (n = 153): Patients were screened clinical readiness for weaning and Evaluation of *f*/VT by using the criteria of < 105 used in the decision to wean	**The strength of the evidence:** Level 3 **1. Are the results valid?:** The findings are reliable because the study was a Randomized, blinded controlled trial to comparison evaluation of the *f* / VT <105 with screened clinical readiness for weaning so the findings have greater reliability. The sample group was properly selected and inclusion-exclusion criteria set. The results were reliable by reporting $p < 0.05$ **2. What are the results?:** The average time for weaning from mechanical ventilation in the group with *f*/VT by using the criteria of < 105 times/minutes/L with criteria for evaluating readiness to wean from mechanical ventilation was shorter than the group without *f*/VT evaluation in deciding to mechanical ventilation.($p = .04$) **3. How can I apply the results to patient care?:** The findings can be implemented in the care of patients because the population group had similar to patients of interest who requiring mechanical ventilation in intensive care unit. The findings can be implemented in the care of patients in terms of Evaluation of *f*/VT by using the criteria of < 105 was capable of predicting success in weaning from mechanical ventilation in combination with evaluations of clinical weaning readiness was more efficient that routinely implemented evaluations of clinical readiness for weaning from mechanical ventilation, to be benefits for patients and did not increase cost and did not waste time

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publish year / Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
10.	Blackwood, B., et al. (2011). Protocolized versus non-protocolized weaning for reducing the duration of mechanical ventilation in critically ill adult patients	**Sample:** adult patients requiring mechanical ventilation via nasotracheal and orotracheal tube. **Setting :** intensive care units **Intervention :** Data collection a systematic review was searched accessing the electronics databases included randomized and quasi-randomized controlled trials of protocolized weaning versus non-protocolized weaning from mechanical ventilation in critically ill adults and explore variation in outcomes of ventilator duration, mortality, Adverse event , quality of life , weaning duration, ICU & Hospital length of stay and Cost	**The strength of the evidence:** Level 4 **1. Are the results valid?:** The research design as a Systematic review of RCT & non-RCT was suitable. The objectives of the studies were clearly stated, systematic and comprehensive searches were conducted in line with the research objectives and by proper methods. The data collection method and analyzes were appropriate and concurrent with the explanation of the findings. **2. What are the results?:** All 11 studies had trials which found the average total mechanical ventilation weaning time in the protocol group to have reduced (N = 10 trials, 95% CI 9% - 39%, P = 0.006) decreased of weaning duration 78% (N = 6 trials, 95% CI 31% - 93%, P = 0.009) and ICU length of stay to have reduced by 10% (N = 8 trials, 95% CI 2% - 19%, P = 0.02) **3. How can I apply the results to patient care?:** The population group and setting had the same characteristics as the target group sought for study. The findings can be implemented in the care of patients in terms of promoted weaning success consisting of criteria for assessing weaning readiness (general clinical parameters), SBT methods, reduction of levels of assistance provided by mechanical ventilation, and criteria in assessing extubation readiness following weaning protocol in the ICU

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publish year / Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
11.	Barr, J., et al. (2004). Outcomes in Critically Ill Patients Before and After the Implementation of an Evidence-Based Nutritional Management Protocol	**Sample:** Patients requiring mechanical ventilation > 48 hours total of 200. **Setting :** medical-surgical ICUs of two teaching hospitals **Intervention:** Pre-implementation group (n=100) : received usual care Post-implementation group (n=100): Implementation of an evidence-based ICU nutritional management protocol, assessed for nutrition and early nutritional support and use of enteral nutrition (EN) by Enteral tube feed were to be start within 24 hr of ICU stay	**The strength of the evidence:** Level 5 **1. Are the results valid?:** The findings are directly related to the problem studied i.e. Patients requiring mechanical ventilation in ICU. The research design as comparative study. The methods and procedures was clear. The results were reliable by reporting p -values < 0.05 **2. What are the results?:** Patients in the post-implementation group were fed more frequently via the enteral route (78% vs 68%, respectively; p = 0.08) and this difference was statistically significant after adjusting for severity of illness, baseline nutritional status, and other factors (odds ratio, 2.4; 95% CI, 1.2 to 5.0; p = 0.009). The mean (± SD) duration of mechanical ventilation was shorter in the post-implementation group (17.9 ± 31.3 vs 11.2 ± 19.5 days, respectively; p = 0.11) The risk of death was 56% lower in patients who received enteral nutrition (hazard ratio, 0.44; 95% CI, 0.24 to 0.80; p = 0.007). **3. How can I apply the results to patient care?:** The findings can be implemented in the care of patients because the study patients similar to the patients in clinical setting. An evidence-based nutritional management protocol increased the likelihood that ICU patients would receive enteral nutrition, and shortened their duration of mechanical ventilation. Patients in ICUs should be assessed for nutrition and early nutritional support and use of EN by enteral tube feed were to be start within 24 hr of ICU stay at a rate of 10–25 mL/hr and increasing by 25 mL/hr every 8 hrs. in the absence gastric residuals > 100 ml over a 4 hrs period if patients unable to receive EN and moderately or severely malnourished were to receive total parenteral nutrition within 72 hrs.

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name / Publish year / Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
12.	Malkoc, M., Karadibak, D., & Yıldırım, Y. (2009). The effect of physiotherapy on ventilatory dependency and the length of stay in an intensive care unit	**Sample:** Patients requiring mechanical ventilation total of 510. **Setting :** multidisciplinary internal medicine intensive care, Turkey **Intervention :** control group (n= 233) : received standard nursing care, not receiving physiotherapy Intervention group (n= 277) : received chest physiotherapy program 2 time/ day, 5 days / week i.e. modifying postural drainage, percussion, vibration, coughing, stimulation techniques, deep breathing exercises, suction, bed exercises & mobilization.	**The strength of the evidence:** Level 5 **1. Are the results valid?:** The research design as a prospective study was suitable. The sample group was properly selected and inclusion-exclusion criteria set. The sample size was sufficient. However, a detailed description of intervention were not clear. The results were reliable by reporting p -values < 0.05 **2. What are the results?:** Control patients had a longer period of ventilator dependency than the intervention patients and this difference was statistically significant (20.0 ± 6.1 vs 14.0 ± 5.9, P < 0.05). and length of stay in the ICU was significantly lower in the intervention group than in the control group (15.8 ± 8. 5 vs 25.5 ± 4.5 , P < 0.05) **3. How can I apply the results to patient care?:** The findings can be implemented in the care of patients because the study patients similar to the patients in clinical setting. The results show that physiotherapy has a great impact on ventilatory dependency and length of stay in the ICU. Nurses can be apply physiotherapy with routine care and not increase the workload on the job such as modifying postural drainage, percussion, vibration, coughing, stimulation techniques, deep breathing exercises, suction, bed exercises & mobilization. At least 2 times / day, 5 days per week to be benefits, which required continuous practice.

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name / Publish year / Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
13.	Esteban, A., et al. (2004). Noninvasive Positive-Pressure Ventilation (NPPV) for Respiratory Failure after Extubation.	**Sample:** Patients who were electively extubated after at least 48 hours of mechanical ventilation and who had respiratory failure within the subsequent 48 hours total of 221 Patients. **Setting :** 37 centers in eight countries **Intervention:** noninvasive ventilation group (n=114) : received Noninvasive positive-pressure ventilation protocol standard medical therapy group (n=107): received standard medical therapy, i. e. supplemental oxygen, respiratory physiotherapy, bronchodilators and other treatments.	**The strength of the evidence:** Level 5 **1. Are the results valid?:** The sample group was suitable from 37 ICU in 8 countries . The investigator indentifies specified appropriate inclusion criteria and groups of patients who are exposed and not exposed to the health services intervention and follows in time to monitor the target outcome to assess the effects of NPPV in post weaning stage . **2. What are the results?:** There was no difference between the noninvasive-ventilation group and the standard-therapy group in the need for reintubation (rate of reintubation, 48 % in both groups; relative risk in the noninvasive-ventilation group, 0.99; 95% CI, 0.76 to 1.30). The rate of death in the intensive care unit was higher in the noninvasive-ventilation group than in the standard-therapy group (25 % vs. 14 %; RR, 1.78; 95% CI, 1.03 to 3.20; P=0.048), and the median time from respiratory failure to reintubation was longer in the noninvasive-ventilation group (12 hours vs. 2 hours 30 minutes, P=0.02) compared to standard medical therapy. **3. How can I apply the results to patient care?:** Noninvasive positive pressure ventilation did not reduce re-intubation rates in the post-weaning phase. The findings can be implemented in the care of patients in terms of post-weaning care including evaluated and close monitored to prevent respiratory failure after extubation in 48 patients were closely in ICU providing supplemental oxygen, respiratory physiotherapy, bronchodilators and re-intubation at the appropriate time when met criteria.

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publishing year/Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
14.	Henneman, E., et al. (2002). Using a collaborative weaning plan to decrease duration of mechanical ventilation and length of stay in the intensive care unit for patients receiving long-term ventilation.	**Sample:** Patients requiring mechanical ventilation ≥ 7 days via tracheostomy or endotracheal tube total of 137. **Setting :** medical ICU ,University of California Los Angeles **Intervention :** A quasi-experimental design was used to compare patients' outcomes 1 year before (July 1995-June 1996) and 1 year after (July 1996-June 1997) the implementation of a new structure to support a collaborative approach to weaning. Comparison group (n=55) and Experimental group (n=82)	**The strength of the evidence:** Level 5 **1. Are the results valid?:** The quasi-experimental design on the appropriate designs for evaluating of a collaborative weaning plan on mechanical ventilation time of patients on mechanical ventilation. The sample size was sufficient and the research questions were clear with clear specification of the population studied in patients requiring mechanical ventilation. The findings are reliable because the study was measure outcome before and after of an intervention and follows in a year to monitor the target outcome. The results were reliable by reporting p -values < 0.05 **2. What are the results?:** The median duration of mechanical ventilation ($\chi 2 = 6.1$, P= .02), median length of stay in the medical ICU ($\chi 2=9.1$, P =.004), and the median cost per stay in the medical ICU were all less in the experimental group than in the comparison group **3. How can I apply the results to patient care?:** The findings can be implemented in the care of patients in terms of the multidisciplinary team with morning visits of patients and planning of weaning from mechanical ventilation by making records on weaning boards and weaning flow sheets to monitor and communicate within the team was able to reduce duration of ventilator.

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publish year / Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
15.	Bumroongkit, C., Liwsrisakun, C., Deesomechok, A., Theerakittikul, T., & Porthirat, C. (2005). Efficacy of weaning protocol in medical intensive care unit of tertiary care center.	**Sample :** Patients requiring mechanical ventilation total of 196. **Setting :** medical ICU of Maharaj Nakorn Chiang Mai Hospital, Chiang Mai **Intervention :** A comparative study between retrospective studies of physician-directed weaning as controls (N = 198) reviewed from July 2000 to July 2002 and the prospective studies of protocol-directed weaning as intervention (N = 196) enrolled from October 2002 to October 2003	**The strength of the evidence:** Level 5 **1. Are the results valid?:** The research and data collection into 2 phases to evaluate weaning efficiency of the protocol-directed weaning from mechanical ventilator compared to physician-directed weaning. The study followed-up on the sample group completely for a sufficient period of time. Follows in 2 years to monitor the target outcome. The research question, sample group and outcome the investigator identifies were clear. The statistical analysis was appropriate. There are reliable reports that $p < 0.05$. **2. What are the results?:** Protocol-directed weaning proved to have more efficacy in weaning patients from mechanical ventilation than physician-directed weaning and an able to reduce of weaning duration and ICU length of stay without deteriorating effect to the patients ($p < 0.05$). **3. How can I apply the results to patient care?:** Protocol-directed weaning is safe and effective in reduce mechanical ventilation times and ICU length of stay. The findings can be implemented in the care of patients in terms of evaluation of weaning readiness, criteria for ending weaning, and evaluation of causes of weaning failure. The findings can be implemented in the care of patients because the study patients similar to the patients in clinical setting.

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publish year / Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
16.	Ezingeard, E., et al. (2006). Weaning from mechanical ventilation with pressure support in patients failing a T-tube trial of spontaneous breathing.	**Sample :** Patients requiring mechanical ventilation ≥ 24 hour total of 118. **Setting :** two medico-surgical intensive care units**,** French **Intervention :** All patients under MV >24 hr. meeting the criteria for a weaning test underwent a 30-min T-tube trial. (n=87) If this was successful, they were immediately extubated. Otherwise, a 30-min trial with +7 cm H2O PS was initiated with an individualized pressurization slope and trigger adjustment (n=21). If all weaning criteria were met, the patients were extubated; otherwise, MV was reinstated.	**The strength of the evidence:** Level 5 **1. Are the results valid?:** The findings are reliable because the study was a prospective, non-randomized study. The sample group was properly selected and inclusion-exclusion criteria set. The sample size was sufficient and specification of the population studied in patients requiring mechanical ventilation. The research question was clear to compare weaning method between single T-tube SBT and SBT with pressure support. The same instruments with accuracy and reliability were used in measurements and measure methods between the sample and control groups. The study followed-up on the sample group completely for a sufficient period of time. **2. What are the results?:** The extubation failure rate at 48 hrs did not differ significantly between the groups: 11/87 (13%) versus 4/21 (19%), P=0.39. A significantly higher percentage of patients with COPD was extubated after the trial with PS (8/21–38%) than after a single T-tube trial (11/87–13%) (P=0.003). **3. How can I apply the results to patient care?:** The findings can be implemented in the care of patients who failed T-piece SBT by using PS with +7 cm H2O PS was initiated with an individualized pressurization slope and trigger adjustment could be extubaed earlier with no increase re-intubation rates, particularly benefit to COPD patients and most difficult to wean with close monitoring of blood pressure, O_2 Sat, heart rate, and respiratory rate.

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publish year / Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
17.	Chittawatanarat, K., & Thongchai, C. (2009). Spontaneous Breathing Trial with Low Pressure Support Protocol for Weaning Respirator in Surgical ICU.	**Sample :** Patients requiring mechanical ventilation total of 577. **Setting :** the general surgical intensive care unit in a tertiary care university hospital in Chiang Mai, Thailand. **Intervention :** liberal group (n=222): patients were weaned by their host surgeons or team (non-protocol directed group) and Low pressure support protocol (n=355) : Patients underwent once daily spontaneous breathing trial with low-pressure support protocol had the pressure support level decreased to 5-7 cm of water for up to two hours each day. If signs of intolerance occurred, the process was restrained while patients who tolerated the two-hour trial without signs of distress were extubated.	**The strength of the evidence:** Level 5 **1. Are the results valid?:** The findings are reliable because the study was a prospective controlled study. The research question was clear. The sample group was properly selected and inclusion-exclusion criteria set. The same instruments with accuracy and reliability were used in measurements and measure methods between the sample and control groups. **2. What are the results?:** The median (inter-quartile) range duration of weaning process (29.5 (48) vs. 2.25 (2.9), $p < 0.001$), ventilator day (3 (4) vs. 2 (3), $p < 0.001$), and length of ICU stay (5 (5) vs. 3 (3), $p < 0.001$) were shorter in the protocol group than the liberal group. Multivariate linear regression model also revealed significantly less duration of weaning process in the protocol group than the liberal group in terms of weaning time (-63.6 (-74.7 to -2.6) hours), ventilator day (-3.0 (-3.7 to -2.2) days), and length of ICU stay (-2.9 days (-3.7 to -2.0); $p < 0.001$) (95% CI) **3. How can I apply the results to patient care?:** Weaning from mechanical ventilation in surgical patients by spontaneous breathing trial with low pressure support at 5-7 cmH_2O for 30-120 minutes and monitoring changes in tidal volume, respiratory rates, oxygen saturation, heart rates and blood pressure at 3 minutes after reducing PS was effective to weaning from mechanical ventilation. The results of this studies showed a significant intervention benefit.

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publish year / Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
18.	Robertson, T. E., et al. (2008). Improved Extubation Rates and Earlier Liberation from Mechanical Ventilation with Implementation of a Daily Spontaneous-Breathing Trial Protocol.	**Sample :** Patients requiring mechanical ventilation >24 hr. total of 547. **Setting :** Surgical intensive care unit. Hospitals in the state of Missouri in St Louis, USA. **Intervention :** The sample group will be followed by weaning from mechanical ventilation. protocol-driven daily SBT, which include safety screen, 2-minute screen, 30-120 minute trial and evaluation criteria for stopping SBT then evaluation of the first of 8 week and 8 week the last of the study.	**The strength of the evidence:** Level 5 **1. Are the results valid?:** The research question, sample group and outcome of prospective cohort study the investigators identifies were clear. The study followed-up in a year to monitor the target outcome on the sample group completely for a sufficient period of time. The sample size was sufficient. The statistics are appropriate. Analysis and discussion consistent the objectives. **2. What are the results?:** Daily spontaneous breathing trials protocol efficiently in improvement of extubation rate without a change in the re-intubation rates. (increased from 27% to 42%, $p < 0.02$) **3. How can I apply the results to patient care?:** The results of this studies showed a significant intervention benefit in surgical. The findings are directly related to the problem studied can be implemented in the care of patients in terms of daily safety screening readiness to wean of mechanical ventilation by spontaneous breathing trials in short 2 minute of the safety then to increase to 30–120 minutes if the patients as tolerated. Closely assess the patient changes in physical symptoms and try to stop spontaneous breathing followed the termination criteria.

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publish year / Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
19.	Walsh, T. S., Dodds, S. & McArdle, F. (2004). Evaluation of simple criteria to predict successful weaning from mechanical ventilation in intensive care patients.	**Sample :** Adult patients requiring mechanical ventilation total of 325. **Setting :** general intensive care unit (ICU) **Intervention :** The weaning checklist used: **1.** Cooperative and pain free **2.** Good enough reflex to tracheal suctioning **3.** PaO_2 to FiO_2 ratio >200 **4.** PEEP < 10 cmH_2O **5.** Hb > 7 g2dl, Temp = 36 – 38.5 ^{O}C **6.** Plasma K^+ > 3 or < 5 mmol. **7.** Na^+ > 128 or < 150 mmol. **8.** Inotropic reduced or unchanged over previous 24 hr. **9.** Spontaneous ventilation > 6 beat / min.	**The strength of the evidence:** Level 5 **1. Are the results valid?:** The research question, instrument, setting and outcome were clearly stated. The sample group was sufficient and inclusion-exclusion criteria was set and had clearly specified methodology, procedures are sufficient details. The study followed-up in 164 days to monitor the target outcome on the sample group completely for a sufficient period of time. **2. What are the results?:** The ventilation patients (67%) achieved ventilation independence during ICU admission and in this group 83% met the set criteria. Checklist metabolic, cardio-respiratory and neurological evaluations were reliable in predicting weaning readiness at the specificity value of 89%, positive predictive value of 94%, and positive likelihood ratio (LR) of 7.6. The simple criteria was strong predictor of subsequent ventilator independence when criteria were met by day 1 or 2 but weaker when met by ≥ 4 days. **3. How can I apply the results to patient care?:** The findings can be implemented in the care of patients in the term of evaluation of simple criteria to predict successful weaning from mechanical ventilation in intensive care patients. Checklists for metabolic, cardio-respiratory and neurological evaluations are instruments for readiness of weaning. The sample group had characteristics similar to the patients in intensive care unit.

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publish year / Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
20.	Rumpke, A. L., & Zimmerman, B. A. (2010). Implementation of a Multidisciplinary Ventilator-Weaning and Sedation Protocol in a Community Intensive Care Unit.	**Sample :** Patients requiring mechanical ventilation > 96 hr. total of 27. **Setting :** mixed medical, surgical, community intensive care unit **Intervention :** The sample group will be followed the Ventilator-Weaning and Sedation Protocol by Multidisciplinary team, which include assessment the general readiness to wean, Sedative assessment by Richmond Agitation-Sedation Scale every 24 hour Pain Assessment, Education and Staff Acceptance. Evaluation for a period of 5 weeks.	**The strength of the evidence:** Level 5 **1. Are the results valid?:** The objectives of the studies were clearly stated. Intervention group only 15 cases. The inclusion and exclusion criteria were not clearly explained. The intervention by a multidisciplinary team has been training to practice follow protocol. The results have a good outcome. **2. What are the results?:** Patients who received care according to the weaning and sedative protocol were able to be extubated (15 patients) without re-intubation. Only one patient had to be re-intubated more than 24 hours after extubation. **3. How can I apply the results to patient care?:** Patients requiring mechanical ventilation should be assessment general readiness to weaning from mechanical ventilation., Sedative Assessment, Pain Assessment by multidisciplinary team that receive training on the assessment and the process of weaning from mechanical ventilation. Particularly, critical care nurses work in intensive care unit 24 hrs result to weaning from mechanical ventilation more efficient. Can be applied in ICU patients that a manner similar to the sample.

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publish year / Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
21.	Twibell, R., Siela, D., & Mahmoodi, M. (2003). Subjective Perception and Physiological Variables During Weaning From Mechanical Ventilation.	**Sample :** 68 adult patients who received mechanical ventilation for at least 24 hr. **Setting :** medical-surgical intensive care unit in Midwestern state **Intervention :** - The subjective perceptions of dyspnea, fatigue, self-efficacy was measured by using visual analog scales. - physiological variables was measured by using the Burns Wean Assessment Program (BWAP)	**The strength of the evidence:** Level 3 **1. Are the results valid?:** The prospective studies was evaluated in terms of clarity of research questions by considering settings for population, sample group was suitable and outcomes of the study were clearly stated. The research tools for evaluating outcomes were suitable, valid and reliable the evaluation methods were suitable between group by researchers and 2 critical care nurses. A limitation of the study was details. The statistics used for the data analysis were appropriate. The results were reliable by reporting p -values < 0.05 **2. What are the results? :** The reported indicate that PaO_2, $PaCO_2$, stable hemodynamic status, adequate cough and swallow reflexes are strong correlate of weaning outcome. (p=.05) subjective perceptions were associated with physiological variables but not with weaning outcome **3. How can I apply the results to patient care?:** The findings can be implemented in the care of patients in the term of indicators of readiness to be weaned is necessary for timely , efficient weaning from MV both of primary assessment include physiological variables relate to gas exchange, hemodynamic status, diaphragmatic expansion, and airway clearance by using the Burns Wean Assessment Program (BWAP) can be modified and secondary assessment include perceptions of dyspnea, fatique, and self-efficacy. the patients safely to wean and consistent with the work in ICU.

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publish year / Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
22.	Burns, S. M., et al. (2003). Implementation of an institutional program to improve clinical and financial outcomes of mechanically ventilated patients: One-year outcomes and lessons learned.	**Sample :** Adult patients requiring mechanical ventilation > 3 days total of 1,105. **Setting :** 5 ICU (CCU, medical ICU, neuroscience ICU, surgical trauma ICU and thoracic cardiovascular ICU) in Atlantic academic medical center **Intervention :** (Outcome management; OM) 1). Evidence-based clinical pathway 2). Protocol of weaning and sedation use. 3). 4 APN to management and monitor the program. -pre- OM (n=595) : Retrospective baseline 18 mo.) - post-OM (n=510) : prospective 12 mo.) patients were weaned by Outcome management program	**The strength of the evidence:** Level 3 **1. Are the results valid?:** The findings are reliable because the study was a quasi-experiment research, before and after measure outcome in **t**he large sample group from 5 intensive care to represented the specified population in adult patients requiring mechanical ventilation. The results were reliable by reporting p-values < 0.01 **2. What are the results?:** Statistically significant differences in clinical outcome were demonstrated in the OM patients compared with those managed before OM. Outcome included: 1). Ventilator duration (median declined from 10 to 9; P = .001) 2). ICU length of stay (median declined from 15 to12; P = .008) 3). Hospital length of stay (median declined from 22 to20; P = .001) 4). Mortality rate (median declined from 38% to 31%; P = .02) 5). Cost saving than $ 3,000,000 were realized in the OM group. **3. How can I apply the results to patient care?:** This result was the following: 1). Daily assessment by using the Burns Wean Assessment Program (BWAP) 2). Management and monitoring by nurse. 3). Communication of multidisciplinary teams during daily round and throughout a plan of care. The result should be promoting the quality of care that can apply in clinical practice.

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publish year / Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
23.	Morris, P. E., et al. (2008). Early intensive care unit mobility therapy in the treatment of acute respiratory failure.	**Sample :** Patients with acute respiratory failure requiring mechanical ventilation via endotracheal tube> 48 - 72 hrs. total Of 304. **Setting :** 7 Medical intensive care unit (MICU) in USA **Intervention :** the protocol group; n=165 received the physical therapy by using mobility protocol by the mobility team period of 24 months. Including upper & lower PROM, Bed mobility training, Active Resistant , Positioning and transfer training compare with usual care; n=165	**The strength of the evidence:** Level 5 **1. Are the results valid?:** A prospective cohort study the findings are reliable because this study in the 7 ICU are similar had baseline characteristics were similar between groups. The sample group was sufficient to represented the specified population and inclusion-exclusion criteria was set and had clearly specified methodology. **2. What are the results?:** The primary outcome was the proportion of patients receiving physical therapy in patients surviving to hospital discharge. More Protocol patients received at least one physical therapy session than did Usual Care (80% vs. 47%, $p \leq .001$). Protocol patients were out of bed earlier (5 vs. 11 days, $p \leq .001$), For Protocol patients had intensive care unit length of stay and hospital length of stay shorter than usual care group (5.5 vs 6.9 day, $p = .027$; 11.2 vs 14.5, $p = .006$) The frequency and duration of physical therapy in the ICU patients was associated with length of hospital stay significantly ($p < .001$) and can reduce costs up to $ 251,258 in 24 months **3. How can I apply the results to patient care?:** The sample group had characteristics similar to the patient group of interest . The findings can be implemented in the care of mobility therapy in critical patients on mechanical ventilation by performing passive range of motion therapy (PROM) upper and lower extremity with stimulation including active resistance by bed mobility training, positioning, and transfer training, was able to prevent muscle weakness and reduce durations of hospital stay.

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publish year / Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
24.	Burns, S. M., et al. (2010). Multifactor clinical score and outcome of mechanical ventilation weaning trial: Burns Wean Assessment Program.	**Sample :** Adult patients receiving mechanical ventilation ≥ 72 hrs. Total of 1,889. **Setting :** 5 adult critical care units (surgical, medical, neurological, thoracic-cardiovascular, and coronary care) **Intervention :** advanced practice nurses collected scores within 24 hours of a weaning attempt. All patients were managed similarly by using a multidisciplinary pathway, the Burns Wean Assessment Program checklist, protocols for weaning trials, and sedation guidelines.	**The strength of the evidence:** Level 5 **1. Are the results valid?:** The findings are reliable because the study was a prospective study in the large population and large sample size from 5 ICU. The proper of statistics and hypothesis can explain clearly. **2. What are the results?:** Of 1889 weaning attempts, 1669 (88%) were successful, and 220 (12%) were unsuccessful. Patients with Burns Wean Assessment Program scores greater than 50 were significantly more likely to be weaned successfully (P = .001) than were patients with lower scores. A BWAP score of 50 or greater, this rule would correctly indicate 70% of successful weaning and 78% of unsuccessful weaning. **3. How can I apply the results to patient care**?: The findings can be implemented in the care of patients to assessment readiness to wean a comprehensive assessment of the readiness of the general condition, psychological and evaluation of the respiratory system by The Burns Wean Assessment Program at > 50 points may be helpful in care planning and management and in determining weaning potential of adult patients on mechanical ventilation and in predicting success although the use of wean screens in weaning from mechanical ventilation**.** Nurses can be evaluated independently but should be practicing the skills to evaluate BWAP for more accuracy.

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publish year / Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
25.	Epstein, C., & Peerless, J. R. (2006). Weaning readiness and fluid balance in older critically ill surgical patient.	**Sample :** Patients with endotracheal intubation recieving mechanical ventilation > 3 days , age > 60 years total 40. **Setting :** Trauma and surgical ICU in a trauma center, USA. **Intervention :** The sample group will be followed the Weaning Protocol until success of weaning or until the end of study 14 days to evaluate variables of study, such as gas exchange, Hemodynamic, fluid balance, oxygen cost of breathing, BWAP scale & pain scale,	**The strength of the evidence:** Level 5 **1. Are the results valid?:** Research design are appropriate. The objectives of the studies were clearly. The sample group was sufficient and inclusion-exclusion criteria was set and had clearly specified methodology. The data analyzes consistent with the objectives of the study and the clinical problem. **2. What are the results?:** 28 patients (70%) successful of weaning from mechanical ventilation. In the first of the patients were successful of weaning showed negative fluid balance (P = .04). The mean of central venous pressure was decreased significantly (P <.001). The patients who failed weaning from mechanical ventilation showed that positive fluid balance. **3. How can I apply the results to patient care?:** The findings can be implemented in the care of patients in the term of strictly assessment of the fluids balance and monitoring for positive fluid balance in the elderly patients on mechanical ventilation should receive daily evaluations of fluid balance by, which is a factor that caused failed weaning from mechanical ventilation. Consistent with the routine of the work to raise awareness in the medical treatment of elderly patients in ICU which have a fluid imbalance.

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publish year / Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
26.	Supaporn Sanpila. (2003). Effects of Preparatory Information on Anxiety and Successed of Mechanical Ventilation Weaning.	**Sample :** Patients with respiratory failure requiring mechanical ventilation in the ICU total of 30. **Setting :** Intensive Care Unit in Loei Hospital **Intervention :** experimental group (n=15) Receiving usual care with preparatory information to anxiety reduction and successes of weaning from mechanical Ventilation by tape recording with flip charts divided the second set for 30 minutes. Compared with the control group (n = 15) received only usual care	**The strength of the evidence:** Level 5 **1. Are the results valid?:** The research questions were clear with clear specification of the population studied. The sample group was properly selected were selected randomly by using matched samples technique had homogeniety and inclusion-exclusion criteria set. The research instruments with validity and reliability were used in measurements and measure methods between the sample and control groups. The results were reliable by reporting p - values < 0.05 **2. What are the results?:** The patients who received the preparatory information had a lower mean score of state anxiety before weaning from mechanical ventilator and had more successful of ventilation weaning than the patients who did not received the preparatory information ($p<.05$). While the physiological responses such as heart rates, respiratory rates, systolic blood pressures and oxygen saturation had no statistically significant differences ($p>.05$). **3. How can I apply the results to patient care?:** The findings can be implemented in the care of patients in the term information provided before weaning consisted about weaning methods, practice of patients during weaning and evaluated of anxiety because physical changes may be unclear or unable to indicate confronted levels of anxiety in order to reduce anxiety for good conscious patients and promote readiness in weaning in ICU and created benefits for patients and did not increase expenses.

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publish year / Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
27.	Pensri La-or, Wanlapa Kunsongkeit, Supaporn Daungpaeng and Khemaradee Masingboon. (2007). The effectiveness of weaning ventilator protocol on success of weaning and duration of mechanical ventilator in patients with respiratory failure.	**Sample :** 40 patients received mechanical ventilation with respiratory failure. **Setting :** Intensive care unit at Nakhon Nayok Hospital **Intervention :** The sample group were randomized to the Weaning ventilator protocol group (Intervention group; n=20) received Weaning ventilator protocol of which integrated the collaboration between physician and nurses into weaning process and to the usual weaning ventilator group (control group; n=20)	**The strength of the evidence:** Level 5 **1. Are the results valid?:** The findings are reliable because the study was a quasi-experiment research. The sample group was properly selected had homogeneity and inclusion-exclusion criteria set. The research instruments with validity and reliability were used in measurements and measure methods between the sample and control groups. The results were reliable by reporting p-values < 0.05 **2. What are the results?:** The Weaning ventilator protocol group had more significantly increased successful weaning than the control group (P < .01). The Weaning ventilator protocol group had a significantly decreased duration of using mechanical ventilator usage than the control group (p < .01) **3. How can I apply the results to patient care?:** The findings can be implemented in the care of patients to the cooperation between physician and nurses into weaning process included and daily screen readiness for spontaneous breathing trial by using BWAP for follow-up, closed monitoring, e.g. SpO_2, RR, HR, Systolic blood pressure, RSBI, MV , pattern of breath and stop spontaneous breathing trials as appropriate according to the criteria. Did not increase the burdens for users, but created benefits for patients and did not increase expenses.

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publish year / Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
28.	Mullika Choatseenin. (2005). Effects of Multidisciplinary Ventilator Weaning Team Approach on Weaning Time and Weaning Success of Surgical Critically Ill Patients.	**Sample :** the patients received mechanical ventilation ≥ 3 days total of 20 **Setting :** Surgical Intensive Care Unit of Uttaradit Hospital **Intervention :** Experimental group used multidisciplinary team for ventilator weaning (n=10) included roles of the team, assessment readiness to wean , weaning method, weaning protocol and weaning flow sheet, demographic data record form, and weaning time record form with control group (n=10) used conventional method	**The strength of the evidence:** Level 5 **1. Are the results valid?:** The findings are reliable because the study was a quasi-experiment research. The sample group was properly selected were divided into 2 group and had homogeneity to matched pair by the severity of illness as measured by APCHE II score, and inclusion-exclusion criteria set. The research instruments with validity and reliability were used in measurements and measure methods between the sample and control groups. The results were reliable by reporting p -values < 0.01 **2. What are the results?:** The results showed that weaning time of experimental group was significantly shorter than control group at the level of .01. Weaning success between experimental group and control group showed no difference. **3. How can I apply the results to patient care?:** The sample group had characteristics and setting similar to the patient group of interest . The findings can be applied in the care of patients in the term of a multidisciplinary team approach could be implemented along with weaning protocol in order to shorten the weaning time in surgical critically ill patients with mechanical ventilation Pre-weaning stage, the multidisciplinary team should be round patients in the every morning and assess the readiness for weaning from mechanical ventilation. at the weaning stage by having patients perform trial spontaneous breathing, monitoring and observing symptoms, recording data and ending weaning in flow sheet according to protocol promoted success in weaning from mechanical ventilation.

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publish year / Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
29.	Wipapat Sungkhaw. (2001). The effects of providing information and relaxation technique on anxiety in weaning from mechanical ventilation	**Sample :** 32 adult patients who have been weaning with T-piece method. **Setting :** Intensive care unit, Siriraj Hospital and Phyathai 1 Hospital. **Intervention :** - The experimental group (n=16) was provided information and relaxation. - Provided information about Physiological readiness, Process of weaning, Activity during weaning, Security and caring during weaning, Communication for aiding request, Instilling of confidence in ability to breath and Deep breathing relaxation technique. - The control group (n=16) was provided normal nursing care.	**The strength of the evidence:** Level 5 **1. Are the results valid?:** The research questions were clear with clear specification of the population studied and consistent with the objectives study. The numbers of samples were appropriately from calculated size. The research instruments with validity and reliability were used in measurements, intervention by researcher for the validity of the information content provided **2. What are the results?:** The mean scores on anxiety in weaning of patients who received information and used relaxation technique were significant lower than before experiment. ($p < .001$) **3. How can I apply the results to patient care?:** Providing information and using relaxation technique before weaning is a good mean in improving nursing care by decreased the anxiety of the patients during weaning mechanical ventilation. This result can apply in clinical practice because the study patients similar to the patients in same adult ICU, Patient safety and confidence while weaning from mechanical ventilation. The critical care nurse can practice independent roles.

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publish year /Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
30.	Jiraporn Chontichachalalauk, (2008). The Effect of Music Therapy on Anxiety, Physiological Responses, and Weaning Parameters in Patients during Weaning from Mechanical Ventilation.	**Sample :** 20 adult patients who have been weaning mechanical ventilation. **Setting : 3** Medical ICU (ICU, CCU, Intermediate Care Unit) in Ramathibodi Hospital. **Intervention :** - The experimental phase : the patients have been listening music in 30 minutes. - The control phase: the patients have not been listening music - To measure anxiety, heart rate, respiratory rate, blood pressure, tidal volume and rapid shallow breathing index in both phase.	**The strength of the evidence:** Level 5 **1. Are the results valid?:** The findings are reliable because the study was a quasi-experimental crossover design. A sample of the same group as the control and experimental periods. The research instruments with validity and reliability were used in measurements and measure methods between the sample and control groups. The study followed-up on the sample group completely for a sufficient period of time. **2. What are the results?:** During listening music, the patients have been anxiety, respiratory rate and blood pressure were significantly decreased more than in during not listening music. ($P < .05$) **3. How can I apply the results to patient care?:** In music therapy, patients listened to natural sounding music by turning on audio recorders for 30 minutes, which helped reduce anxiety and promoted relaxation during weaning from mechanical ventilation without weaning variables change (O_2 sat, TV, Rapid shallow breathing index) this study showed that music therapy can help in the process of weaning patients from mechanical ventilation because it reduces anxiety level and some physiologic responses, which in turn, may help the patients to conserve their energy and to promote their recovery. The result of this study could apply to practice because the study patients similar to the patients in same adult ICU and nurses can practice independent roles.

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publish year/ Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
31.	Ruji Plangwan. (2004). The effects for providing information and instilling reassurance on uncertainty in weaning from mechanical ventilation.	**Sample :** 40 patients who have been weaning mechanical ventilation with T-piece method. **Setting :** surgical ICU and medical ICU at Somdej Prapinklao Hospital and medical ICU at Somdej Pranangchao Sirikit hospital in Bangkok. **Intervention :** The experimental group (n=20): received information and instilling reassurance The control group (n=20): received routine nursing care.	**The strength of the evidence:** Level 5 **1. Are the results valid?:** The findings are reliable because the study was a quasi-experiment research. The sample group was properly selected had homogeneity and inclusion-exclusion criteria set. The research instruments with tested for content validity and reliability were used in measurements and measure methods between the sample and control groups. The results were reliable by reporting p -values < 0.05 **2. What are the results?:** The result from this study showed that before and at 2 hr. after weaning from mechanical ventilation, most patients in both group had moderate uncertainty. The patients who received the provided information and instilling reassurance on uncertainty had a lower mean score of uncertainty after intervention (p<.001). which were lower than patients who received routine care. (p<.001) **3. How can I apply the results to patient care?:** Nurse should provided information was concerned with the goals of weaning, weaning processes, proper practices during weaning, safety and care while weaning in combination with stilling instilling reassurance to reduce the uncertainty of patients being weaned from mechanical ventilation. The result of this study could apply to practice because the study patients similar to the patients in same adult ICU and nurses can practice independent roles**.** Did not increase the burdens for users, but created benefits for patients

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publish year / Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
32.	Siriwan Wattanasin, (2007). The relationship among weaning readiness, dyspnea, fatigue and successful weaning from mechanical ventilation	**Sample :** 54 patients who received mechanical ventilation > 3 days. **Setting :** surgical ICU, medical ICU and medical unit at Chonburi Hospital and Somdetpraboromarachathevee Na Sriracha Hospital **Intervention :** The instruments for data collection consisted demographic data record, assessment of dyspnea, assessment of fatique and the Burns Wean Assessment Program (BWAP) and daily follow up success of wean.	**The strength of the evidence:** Level 6 **1. Are the results valid?:** The research had clear objectives. The research design as a descriptive research was suitable. The research instruments with tested for content validity and reliability were used in measurements. Methods of collecting data was clearly explained and study results are reliable. The results were reliable by reporting p -values < 0.01 **2. What are the results?:** Dyspnea and fatigue were negatively related to weaning success ($p = -0.47$, $p < .01$; $p = -0.38$,$p < .01$). Weaning readiness was positively related to weaning success with statistical significance ($p = 0.52$, $p < .01$). **3. How can I apply the results to patient care?:** The result of this study could apply to practice. Patients have immediate weaning from mechanical ventilation when the underlying pathological process is significantly reversed. Accurate weaning readiness and factors associated with dyspnea and fatigue should all be evaluated in all patients for whom weaning is planned.

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publish year / Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
33.	Montira Udchumpisai. (2010). Factors influencing prolonged mechanical ventilation in critically – ill medical patients.	**Sample :** 120 patients who requiring mechanical ventilation ≥ 48 hrs. **Setting :** medical intensive care unit, coronary care unit, and respiratory care unit at Siriraj Hospital and King Chulalongkorn Memorial Hospital, Bangkok, Thailand, **Intervention :** Data collection was performed by using the Carlson co-morbidity index score, the Acute Physiology and Chronic Health Evaluation II (APACHE II), the perception of illness scale, the perception of quality sleep scale, and the visual analog anxiety scale. In the first intubation and mechanical ventilation after 96 hour.	**The strength of the evidence:** Level 6 **1. Are the results valid?:** The research questions were clear with clear specification of the population studied and consistent with the objectives study. The numbers of samples were appropriately from calculated size. The research instruments with validity and reliability were used in measurements. The results were reliable by reporting p -values < 0.05 **2. What are the results?:** The results of the study showed that prolonged mechanically ventilated (PMV) patients in the medical ICU have 80.8%, a significant and positive relationship between perception of illness, anxiety, co-morbidity, and severity of illness and prolonged mechanical ventilation (PMV) (rbp =.402; rbp = .512; rbp = .352; rbp = .629, by p < .05). Perception of quality sleep had a significant and negative relationship with PMV (rbp = -.261, p < .05), but age and PMV were not related (rbp = .160, p > .05). Finally, severity of illness and anxiety could predict PMV, accounting for 79.5% of the variance (Negelkerke R2 = .795). **3. How can I apply the results to patient care?:** Nursing care for patients on mechanical ventilation should evaluation of factors associated with long mechanical ventilation, e.g. severity of illness and anxiety, promotion of quality of sleep and reduced anxiety to support patients in receiving physical, psychological and psycho-social care included in a nursing practice to reduce the length of mechanical and mechanical ventilation times.

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publish year/ Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
34.	Boles, J. M., Bion, J., Connors, A., Herridge, H., Marsh1, B., Melote, C., Pearl, R., Silverman, H., Stanchina, M., Vieillard-Baron, A., Welte, T. (2007). Weaning from mechanical ventilation.	**Sample :** Patients with mechanical ventilation **Setting :** Not specified. **Intervention:** Review of knowledge regarding weaning processes from evidence- based practices regarding best methods for weaning processes in patients requiring mechanical ventilation which was a cooperation between the European Respiratory Society, the American Thoracic Society, the European Society of Intensive Care Medicine, the Society of Critical Care Medicine and the Society de Reanimation de Lange Francaise in 2007	**The strength of the evidence:** Level 7 **1. Are the results valid?:** The research findings are directly related to the problem studied for promoting successful mechanical ventilator weaning in patients on mechanical ventilators in the intensive care unit. The research had clear objectives. The findings are reliable because the study was the a literature reviews from evidence- based practices and opinions of qualified experts and specialists specific professions of relevant organizations in caring for patients on mechanical ventilation. **2. What are the results?:** The overall findings of the study can be summarized as weaning should be considered as early as possible clinicians should be evaluate readiness to weaning to allow prompt initiate of the weaning process by SBT with T-piece, low levels of PS (5–8 cmH_2O in adults), or PEEP 5 cmH_2O for initial SBT last 30 minutes. Patients who failed the first of SBT should considered to be weaned by pressure support or assist-control ventilation modes and readily categorized into three groups based on the difficulty and duration of the weaning process, i.e. the simple weaning, difficult weaning and the prolonged weaning group. **3. How can I apply the results to patient care?:** The findings were specific to the population studied. The findings can be implemented to the care of patients in terms of evaluate readiness to weaning, weaning methods and readily categorized into three groups based on the difficulty and duration of the weaning process for further planning in weaning from mechanical ventilation.

Table A.1 Evaluation of the evidence. (cont.)

No	Researcher name/ Publish year/ Title	Sample / Setting / Intervention	Analysis of result of research and empirical evidence quality
35.	Macintyre, N. R. (2001). Evidence-Based Guidelines for Weaning and Discontinuing Ventilatory Support : A Collective Task Force Facilitated by American College of Chest Physicians; American Association Respiratory Care; and the American College of Critical Care Medicine	**Sample :** Patients with mechanical ventilation **Setting :** Not specified. **Intervention:** Review of knowledge focus on weaning from mechanical ventilation from evidence-based practices in patients requiring mechanical ventilation which was a cooperation between the American College of Chest Physicians, American Association for Respiratory Care and American College of Critical Care Medicine	**The strength of the evidence:** Level 7 **1. Are the results valid?:** The research findings are directly related to the problem studied and he same as study population for in patients on mechanical ventilators in the intensive care unit. Methods of collecting data was clearly explained and study results are reliable because the study was the a literature reviews from evidence- based practices and opinions of qualified experts and specialists specific professions of relevant organizations in caring for patients on mechanical ventilation. **2. What are the results?:** The overall findings of the study can be summarized as evaluation of weaning readiness should begin in patients on mechanical ventilation for > 24 hrs must be prepared in the following four aspects: improvement of the causes for using mechanical ventilation, adequate oxygen exchange, stable circulation and good cough reflex, who are ready should perform spontaneous breathing trials for a minimum of 30-120 minutes. Patients who have had weaning failure should be determined and resolved with re-evaluation of weaning readiness every 24 hrs. **3. How can I apply the results to patient care?:** The findings can be implemented in patient care in terms of evaluation of weaning readiness, duration of spontaneous breathing trials and gradual weaning method for prolong mechanical ventilation.

APPENDIX B

Table A.2 - Collective Table Summarizing Issues from Evidence

No	Author/Year	Research Objectives and Methodology	Research Findings	Conclusion of Implementation
1.	Meade, M., et al. (2001)	Objectives: To discover conclusions regarding efficient processes for weaning from mechanical ventilation in patients have used mechanical ventilation for more than 48 hours. Methodology: Systematic review of RCTs/Level 2.	Sixteen RCTs were found with different criteria for assessing patients' readiness for trial spontaneous breathing, criteria for successful weaning from mechanical ventilation, criteria for failed weaning from mechanical ventilation, including the methods for weaning from mechanical ventilation in each study. Overall, breathing trials by multiple daily T-piece weaning, or pressure support was found to be more effective than synchronized intermittent mandatory ventilation and patients should be early extubated as possible. After extubation, noninvasive positive-pressure ventilation should be used because the method has yielded good outcomes for patients.	Weaning from mechanical ventilation phase: breathing trials by multiple daily T-piece weaning or pressure support are effective methods. Noninvasive positive-pressure ventilation During post-weaning from mechanical ventilation: patients should be early extubated as possible. After extubation, noninvasive positive-pressure ventilation should be used.

Table A.2 - Collective Table Summarizing Issues from Evidence-Based Practices (cont.)

No.	Author/Year	Research Objectives and Methodology	Research Findings	Conclusion of Implementation
2.	Rose, L., Nelson, S. (2006)	Objectives: To study efficient methods for weaning from mechanical ventilation. Methodology: Integrative literature review and meta-analysis/Level 2.	1. Overall summary of the findings: 2. Weaning from mechanical ventilation according to weaning protocol was efficient in reduce mechanical ventilation time. 3. Weaning protocol efficiency relies upon the cooperation of nurses and weaning multidisciplinary teams within organizations. Nurses play key roles in providing care for patients on mechanical ventilation and nurses are leaders in weaning from mechanical ventilation by using weaning protocol. Nurses must have knowledge covering the issues of nursing care, decision-making processes about the steps for weaning from mechanical ventilation and efficient communications between doctors and multidisciplinary teams. Nurses should also improve knowledge and special expertise to increase their competence in patient care. Patients should receive weaning readiness evaluation covering all six aspects of demographic characteristics,	Weaning protocol is an efficient instrument for promoting successful weaning patients from mechanical ventilation that helps communication and patient care between nurses and multidisciplinary teams in evaluating clinical readiness to wean from mechanical ventilation in combination with the rapid shallow breathing index and selecting methods for weaning from mechanical ventilation. Pressure support ventilation is an effective method and nurses require knowledge regarding the processes of weaning from mechanical ventilation.

Table A.2 - Collective Table Summarizing Issues from Evidence-Based Practices (cont.)

No.	Author/Year	Research Objectives and Methodology	Research Findings	Conclusion of Implementation
2.	Rose, L., Nelson, S. (2006) (cont'd)		subjective signs, haemodynamic variables, lung mechanics, gas exchange and severity of illness measures in combination with the rapid shallow breathing index, which is a frequently used factor for predicting readiness for weaning from mechanical ventilation with high predictive speed and specificity. Weaning from mechanical ventilation by pressure support ventilation can reduce mechanical ventilation time when compared to other methods.	
3.	White, V., Currey, J., & Botti, M. (2011).	Objectives: To determine if ventilation-weaning protocols developed and implemented by multidisciplinary teams reducing the duration of mechanical ventilation in adult ICU patients compared to usual care. Methodology: Systematic review of literature and meta analysis/Level 2.	According to the three pre-post interventional studies, the overall conclusion was show equivocal support for weaning protocols develops and implemented by the multidisciplinary teams for reducing duration of mechanical ventilation (test of overall effect p value = 0.01).	Weaning from mechanical ventilation according to practice guidelines by multidisciplinary teams is an effective method for promoting successful weaning from mechanical ventilation and leads to effective communication processes within organizations in providing care of weaning patients

Table A.2 - Collective Table Summarizing Issues from Evidence-Based Practices (cont.)

No.	Author/Year	Research Objectives and Methodology	Research Findings	Conclusion of Implementation
4.	Burns, K. E. A., Adhikari, N. K. J., Keenan, S. P., & Meade , M. (2010)	Objectives: To study the effects of non-invasive positive pressure ventilation weaning (NPPV) when compared with invasive positive ventilation weaning (IPPV). Methodology: Meta-analysis and systematic review/Level 2.	According to 12 RCTs, NPPV significantly decreased mortality rates, ventilator associated pneumonia rates, duration of mechanical ventilation and lengths of ICU and hospital stay, especially in COPD patients when compared to IPPV.	NPPV is an efficient method for decreased complications from intubation and use of mechanical ventilation in COPD patients with heart failure who require mechanical ventilation.
5.	Girard, T. D., et al .(2008).	Objectives: To assess the effects of SBTs with daily spontaneous awakening trials (SATs) protocol (n = 168) and SBTs with use of sedatives in routine care (n = 168). Methodology: Randomized controlled trial/Level 3.	SBTs with daily spontaneous awakening trials helped decreases stays in ICUs and hospitals with lower mortality rates compared with the Patients received SBTs with use of sedatives in routine care.	Daily evaluations levels of consciousness and awareness by using the validated sedation scale every 4 hrs to help patients receive sedatives property enabled patients to spontaneous breathing longer and reduced the lengths of stay in ICUs and hospitals.
6.		Objectives: To study the effects of ventilator management protocol (VMP) in patients on mechanical	Ventilator management protocol (VMP) efficiently reduced mechanical ventilation time for patients and	Weaning from mechanical ventilation according to the protocol by nurses efficiently reduced mechanical ventilation time relate with:

Table A.2 - Collective Table Summarizing Issues from Evidence-Based Practices (cont.)

No.	Author/Year	Research Objectives and Methodology	Research Findings	Conclusion of Implementation
6.	Marelich, G. P., et al. (2000).	ventilation (n = 335). Methodology: Randomized controlled trial/Level 3.	minimized complications from pneumonia from use of mechanical ventilators.	- Assess readiness to begin weaning from mechanical ventilation twice a day. - Criteria for assessing weaning readiness. - Criteria for ending SBTs.
7.	Chaiwat, O., et al. (2010)	Objectives: To compare protocol based nurse-directed (n = 49) and physician directed methods (n = 51) in abdominal surgery patients with mechanical ventilation time. Methodology: Randomized controlled trial/Level 3.	Protocol-directed weaning based on nurse-directed weaning efficiently reduced mechanical ventilation time in abdominal surgery patients without increasing re-intubation rates within 72 hours when compared to physician-directed weaning.	Weaning from mechanical ventilation by assessing daily screening of weaning readiness and trial spontaneous breathing by nurses was found safe and able to reduce mechanical ventilation time.
8.	Matic, I., et al. (2007)	Objectives: To compare mechanical ventilation weaning methods, i.e. T-tube and pressure support ventilation (PSV) in COPD patients (n = 136). Methodology: Prospective, randomized trial/Level 3.	Trial spontaneous breathing by using PSV in COPD patients was able to reduce mechanical ventilation time when compared to T-piece.	Patients with COPD who failed the 2 hour spontaneous breathing trial has more favorable outcome when PSV rather than T-piece method in started at PS 18 cmH_2O and gradually reduced by 2-4 cmH_2O until pressure support of 5 cmH_2O was reached over a period of 2 hours enabled patients to have greater success in weaning.

Table A.2 - Collective Table Summarizing Issues from Evidence-Based Practices (cont.)

No.	Author/Year	Research Objectives and Methodology	Research Findings	Conclusion of Implementation
9.	Tanios, M. A., (2006).	Objectives: To assess the efficiency of frequency tidal volume ratio (*f*/VT) in predicting successful weaning from mechanical ventilation (n = 304). Methodology: Randomized, blinded controlled trial/Level 3.	The average weaning time from mechanical ventilation in the group with *f*/VT by using the criteria of < 105 with criteria for evaluating readiness to wean from mechanical ventilation was shorter than the group without *f*/VT evaluation in deciding to mechanical ventilation.	Evaluation of *f*/VT by using the criteria of < 105 was capable of predicting success in weaning from mechanical ventilation in combination with evaluations of clinical weaning readiness was more efficient that routinely implemented evaluations of clinical readiness for weaning from mechanical ventilation.
10.	Blackwood, B., et al. (2011).	Objectives: To assess the effects of weaning protocols compared to non-protocol weaning from mechanical ventilation Methodology: Systematic review of RCT & non-RCT/Level 4.	All 11 studies had trials which found the average total mechanical ventilation weaning time in the protocol group to have reduced by 78% and the ICU stay by 10%.	Weaning protocol in the ICU effectively promoted weaning success consisting of criteria for assessing weaning readiness (general clinical parameters), SBT methods, reduction of levels of assistance provided by mechanical ventilation, and criteria in assessing extubation readiness.
11.	Barr, J., et al. (2004).	Objectives: To assess the effects of care for critical patients on mechanical ventilation according to the nutritional management protocol (n = 200).	Nutritional management protocol promoted patients to receive enteral nutrition (EN) with shorter duration of mechanical ventilation (p=0.11) and enteral nutrition was associated with a	Patients on MV in ICUs should be assessed for nutrition and early nutritional support and use of EN by enteral tube feed start within 24 hr of ICU stay at a rate of 10–25 mL/hr and increasing by 25 mL/hr every 8 hrs. in the absence gastric

Table A.2 - Collective Table Summarizing Issues from Evidence-Based Practices (cont.)

No.	Author/Year	Research Objectives and Methodology	Research Findings	Conclusion of Implementation
11.	Barr, J., et al. (2004).	Methodology:Prospective study/Level 5.	reduced risk of death (p=0.007)	residuals > 100 ml over 4 hrs period if unable to receive EN and moderate to severe malnutrition were to receive total parenteral nutrition within 72 hrs.
12.	Malkoc, M., Karadibak, D., & and Yıldırım, Y. (2009).	Objectives: To assess the effects of physiotherapy on ventilator dependency and lengths of intensive care unit (ICU) stay (n = 510). Methodology: Prospective study/Level 5.	Patients who received physiotherapy had shorter mechanical ventilation times and lengths of stay in the ICU than patients who did not receive physiotherapy.	Physiotherapy, i.e. changing postural drainage, percussion, vibration, stimulation techniques, deep breathing exercises, suction, coughing, bed exercises & mobility at least twice daily and five days/week in mechanical ventilation patients in ICUs to help reduce ventilation/ICU times.
13.	Esteban, A., et al. (2004).	Objectives: To assess the effects of noninvasive positive pressure ventilation (NPPV) (n = 114) compared to standard medical therapy (n = 107). Methodology: Prospective cohort study /Level 5.	Use of noninvasive ventilation following failed extubations did not help reduce re-intubation or mortality rates in ICUs when compared to standard medical therapy with statistical significance (p = .048). Furthermore, re-intubation rates were found to be related to increased mortality rates.	NPPV did not reduce re-intubation rates in the post-weaning phase. Evaluations and close follow-up monitoring should be done to prevent respiratory failure over a period of 48 hr. following extubation in the ICU by providing oxygen to support use of bronchodilators, physiotherapy and re-intubation according to criteria.

Table A.2 - Collective Table Summarizing Issues from Evidence-Based Practices (cont.)

No.	Author/Year	Research Objectives and Methodology	Research Findings	Conclusion of Implementation
14.	Henneman, E., et al. (2002).	Objectives: To assess the effects of a collaborative weaning plan on mechanical ventilation time of patients on mechanical ventilation ≥ 7 days (n = 137). Methodology: quasi-experimental design/Level 5.	Patients weaned from mechanical ventilation by a collaborative weaning plan were found to have reduced mechanical ventilation times, shorter stays in ICUs, and lower treatment expenses.	Joint planning by the multidisciplinary team with morning visits of patients and planning of weaning from mechanical ventilation by making records on weaning boards and weaning flow sheets to monitor and communicate within the team was able to reduce duration of ventilator.
15.	Bumroongkit, C., et al. (2005).	Objectives: To evaluate weaning efficiency of the protocol-directed weaning from mechanical ventilator (n = 198) compared to physician-directed weaning (n = 198). Methodology: Prospective Cohort study/Level 5.	Protocol-directed weaning proved to have more efficacy in weaning patients from mechanical ventilation than physician-directed weaning and an able to reduce of weaning duration and ICU length of stay without deteriorating effect to the patients ($p < 0.05$).	Protocol-directed weaning is safe and effective in reduce mechanical ventilation times and ICU length of stay consisting of evaluation of weaning readiness, criteria for ending weaning, and evaluation of causes of weaning failure

Table A.2 - Collective Table Summarizing Issues from Evidence-Based Practices (cont.)

No.	Author/Year	Research Objectives and Methodology	Research Findings	Conclusion of Implementation
16.	Ezingeard, E., et al. (2006).	Objectives: To study and compare weaning from mechanical ventilation between single T-tube SBT (n = 87) and SBT with pressure support (n = 21). Methodology: A prospective, non-randomized study/Level 5.	The extubation failure rate at 48 hrs did not differ significantly between the groups: 11/87 (13%) versus 4/21 (19%), P=0.39. A significantly higher percentage of patients with COPD was extubated after the trial with PS (8/21–38%) than after a single T-tube trial (11/87–13%) (P=0.003).	The patients who failed T-piece SBT by using PS could be extubaed earlier with no increase re-intubation rates, particularly benefit to COPD patients and most difficult to wean with close monitoring of BP, O_2Sat, HR, and RR.
17.	Chittawatanarat, K., & Thongchai, C. (2009).	Objectives: To compare the efficiency between spontaneous breathing trial with low pressure support protocol (n = 355) and liberal non-protocol directed method (n = 222). Methodology: a retrospective /Level 5.	Spontaneous breathing trial with low pressure support protocol for liberal from mechanical ventilator was effective to reduce weaning time, ventilator day and length of stay in general surgery intensive care unit when compared to routine methods.	Weaning from mechanical ventilation in surgical patients by spontaneous breathing trial with low pressure support at 5-7 cmH_2O for 30-120 minutes and monitoring changes in tidal volume, respiratory rates, oxygen saturation, heart rates and blood pressure at 3 minutes after reducing PS was effective to weaning

Table A.2 - Collective Table Summarizing Issues from Evidence-Based Practices (cont.)

No.	Author/Year	Research Objectives and Methodology	Research Findings	Conclusion of Implementation
18.	Robertson, T. E., et al. (2008).	Objectives: To assess the efficiency of protocol-driven daily SBT on rates of extubation and weaning times from mechanical ventilation (n = 457). Methodology: Prospective cohort study/Level 5.	Daily spontaneous breathing trials protocol efficiently in improvement of extubation rate without a change in the re-intubation rates. (increased from 27% to 42%, $p < 0.02$)	Perform spontaneous breathing trial should be safety screens are evaluations of patient readiness to wean by non-physician providers. spontaneous breathing trial at PEEP 5 cmH_2O without pressure support over a short period of two minutes before a spontaneous breathing trial lasting 30 minutes with monitoring of symptoms sign
19.	Walsh, T. S., Dodds, S. & McArdle, F. (2004).	Objectives: To evaluated a checklist of simple bedside criteria to predict successful discontinuation of mechanical ventilation in severely ill patients (n = 325). Methodology: Prospective observation cohort study/Level 5.	Checklist metabolic, cardio-respiratory and neurological evaluations were reliable in predicting weaning readiness at the specificity value of 89%, positive predictive value of 94%, and positive likelihood ratio (LR) of 7.6.	Checklists for metabolic, cardio-respiratory and neurological evaluations are instruments for readiness of weaning comprising of: 1) cooperative and pain free, 2) good cough reflex, 3) PaO_2 / FiO_2 ratio > 200 4). PEEP < 10 $cmHO_2$ 5). Hb > 7 g/dl, Temp 36 – 38.5^o C 6). Plasma K^+ 3-5 mmol 7). Na^+ 128-150 mmol 8). Inotropic reduced 9). RR > 6/min.

Table A.2 - Collective Table Summarizing Issues from Evidence-Based Practices (cont.)

No	Author/Year	Research Objectives and Methodology	Research Findings	Conclusion of Implementation
20.	Rumpke, A. L., & Zimmerman, B. A. (2010).	Objectives: To assess the efficiency of multidisciplinary ventilator-weaning and sedation protocol in weaning patients from mechanical ventilation (n = 27). Methodology: Prospective observation research/Level 5.	Patients who received care according to the weaning and sedative protocol were able to be extubated (15 patients) without re-intubation. Only one patient had to be re-intubated more than 24 hours after extubation.	- Multidisciplinary team-directed meaning was efficient in promoting successful weaning from mechanical ventilation. - Sedative evaluations and pain evaluations of weaning patients' readiness every 24 hours promoted quicker success in weaning from mechanical ventilation.
21.	Twibell, R., Siela, D., & Mahmoodi, M. (2003).	Objectives: To explore the subjective perceptions of dyspnea, fatigue, self-efficacy, and physiological variables in patients being weaning from mechanical ventilation (MV) (n = 68). Methodology: Descriptive, correlational, and prospective study/Level 5.	The reported indicate that PaO_2, $PaCO_2$, stable memodynamic status, adequate cough and swallow reflexes are strong correlate of weaning outcome. (p=.05) subjective perceptions were associated with physiological variables but not with weaning outcome	Indicators of readiness to be weaned is necessary for timely , efficient weaning from MV both of primary assessment include physiological variables relate to gas exchange, hemodynamic status, diaphragmatic expansion, and airway clearance by using the Burns Weaning Evaluation Program can be modified and secondary assessment include perceptions of dyspnea, fatigue, and self-efficacy

Table A.2 - Collective Table Summarizing Issues from Evidence-Based Practices (cont.)

No	Author/Year	Research Objectives and Methodology	Research Findings	Conclusion of Implementation
22.	Burns, S. M., et al. (2003).	Objectives: To effects of systematic management in the care of patients on mechanical ventilation > 3 days on clinical and financial results. Methodology: Quasi-experimental design/Level 5.	Systematic management of care in the care of patients on mechanical ventilation (MV) by the multidisciplinary team was able to reduce ventilator duration, ICU & Hospital length of stay, mortality rates, and save treatment expenses.	Promoting success in weaning from MV consisted of evaluation of weaning readiness by using the Burns Weaning Evaluation Program, monitoring of patients by nurses, and communications of multidisciplinary teams in jointly planning patient care in each day.
23.	Morris, P. E., et al. (2008).	Objectives: To compare the effects of physical therapy by using mobility protocol by the mobility team (n = 165) compared patients who received usual care (n = 165). Methodology: Prospective cohort study/Level 5.	Mobility team using a mobility protocol initiated earlier physical therapy that was feasible, safe, did not increased costs, and was associated with decreased ICU & hospital length of stay ($p<.025$ & $p=.006$) compared with patients who received usual care.	Mobility therapy in critical patients on mechanical ventilation by performing passive range of motion therapy (PROM) upper and lower extremity with stimulation including active resistance by bed mobility training, positioning, and transfer training, was able to prevent muscle weakness and reduce durations of hospital stay.

Table A.2 - Collective Table Summarizing Issues from Evidence-Based Practices (cont.)

No	Author/Year	Research Objectives and Methodology	Research Findings	Conclusion of Implementation
24.	Burns, S. M., et al. (2010).	Objectives: To determine the relationship between BWAP scores and the effects of weaning from mechanical ventilation in patients on mechanical ventilation for ≥ 3 days (n = 1,889). Methodology: prospective study /Level 5.	Evaluation of patients' weaning readiness by the Burns Weaning Evaluation Program at the BWAP score of > 50 points had chances of successfully weaning from mechanical ventilation with significance (P < .001) at a sensitivity value of 70% and a specificity value of 78%.	The Burns Weaning Evaluation Program (BWAP) at > 50 points is an effective instrument in assessing the weaning readiness of adult patients on mechanical ventilation and in predicting success in weaning from mechanical ventilation. The instrument can be implemented in patients of different ages, genders and critical patient wards.
25.	Epstein, C., & Peerless, J. R. (2006).	Objectives: To study factors associated with success in weaning from mechanical ventilation in elderly patients (n = 40). Methodology: Single correlational research/Level 5.	28 patients (70%) were successfully weaned from mechanical ventilation were found to have negative fluid balance and average values of central venous pressure which gradually reduced while patients who did not successfully wean were found to have positive fluid balance.	Senior patients on mechanical ventilation should receive daily evaluations of fluid balance by monitoring for positive fluid balance, which is a factor that caused failed weaning from mechanical ventilation in patients.

Table A.2 - Collective Table Summarizing Issues from Evidence-Based Practices (cont.)

No	Author/Year	Research Objectives and Methodology	Research Findings	Conclusion of Implementation
26.	Supaporn Sanpila. (2003).	Objectives: to study the effects of Preparatory information to anxiety reduction and successes of weaning from mechanical ventilation Methodology: Quasi-experimental research /Level 5.	Providing preparatory information before weaning from mechanical ventilation has reduced anxiety score and had more successful of ventilation weaning than the patients who received usual care ($p<.05$).	Information provided before weaning consisted about weaning methods, practice of patients during weaning and evaluated of anxiety because physical changes may be unclear or unable to indicate confronted levels of anxiety in order to reduce anxiety and promote readiness in weaning
27.	Pensri La-o, Wanlapa Kunsongkeit, Supaporn Duangpaeng, & Khemeradee Masingboon (2007).	Objectives: To determine the efficiency of weaning ventilator protocol in patients with respiratory failure ($n = 40$). Methodology: Quasi-experimental research/Level 5.	Patients weaned from mechanical ventilation according to weaning ventilator protocol achieved weaning success and reduced duration of mechanical ventilation more than routine methods statistical significance at $p < 0.05$.	weaning ventilator protocol which was integrated the cooperation between physician and nurses into weaning process included and daily screen readiness for spontaneous breathing trial by using BWAP for follow-up, closed monitoring and stop spontaneous breathing trials as appropriate according to the criteria

Table A.2 - Collective Table Summarizing Issues from Evidence-Based Practices (cont.)

No.	Author/Year	Research Objectives and Methodology	Research Findings	Conclusion of Implementation
28.	Mullika Choatseenin. (2005).	Objectives: To study the effects of weaning from mechanical ventilation by multidisciplinary teams in critical surgical patients (n = 32). Methodology: Quasi-experimental research/Level 5.	Patients weaned from mechanical ventilation by multidisciplinary teams had shorter weaning times than the group receiving routine weaning from mechanical ventilation with statistical significance at 0.01.	Collaboration of multidisciplinary teams from the pre-weaning phase by jointly assessing weaning patients' readiness at the weaning stage by having patients perform trial spontaneous breathing, monitoring and observing symptoms, recording data and ending weaning according to protocol promoted success in weaning from mechanical ventilation.
29.	Wipapat Sungkhaw. (2001).	Objectives: To determine the effects of providing information and relaxation techniques to reduce anxiety in patients weaning from mechanical ventilation (n = 32). Methodology: Quasi-experimental research/Level 5.	The patients who received providing information and relaxation techniques before weaning from mechanical ventilation can able to reduce anxiety with significance ($p < .001$).	Providing information on the readiness of weaning, weaning processes, practices during weaning, safety care received about 30 minute during weaning, and training of deep breathing relaxation technique during on mechanical ventilation for every two hours or when patients want promoted patients' readiness in weaning from mechanical ventilation.

Table A.2 - Collective Table Summarizing Issues from Evidence-Based Practices (cont.)

No.	Author/Year	Research Objectives and Methodology	Research Findings	Conclusion of Implementation
30.	Jiraporn Chontichachalarak. (2008).	Objectives: To study the effects of music therapy on anxiety, physiological response, and variables in patients weaning from mechanical ventilation (n = 20). Methodology: Quasi-experimental research/Level 5.	Use of music therapy during weaning can reduce anxiety, breathing rates, and average arterial pressure without impact on heart rates and weaning variables of patients while listening to music. ($p<.05$)	In music therapy, patients listened to natural sounding music by turning on audio recorders and listening to music for 30 minutes, which helped reduce anxiety and promoted relaxation during weaning from mechanical ventilation without weaning variables change (O_2 sat, TV, Rapid shallow breathing index)
31.	Ruji Plangwan. (2004).	Objectives: To determine the effects of providing information and stilling reassurance on uncertainty in the patients being weaned from mechanical ventilation. Methodology: Quasi-experimental research/Level 5.	Patients who received the information and stilling reassurance on uncertainty had lower mean scores of uncertainty, which were lower than patients who received routine care. ($p<.001$)	Pre-weaning, during weaning provision of information was concerned with the goals of weaning, weaning processes, proper practices during weaning, safety and care while weaning in combination with stilling reassurance in spontaneous breathing trial were methods which promoted patient readiness and confidence in weaning reduce anxiety and uncertainty in weaning
32.	Siriwan Wattanasin, (2007).	Objectives: To study the relationships among weaning readiness, dyspnea, fatigue, and successful weaning from mechanical ventilation (n = 54). Methodology: Descriptive	Dyspnea and fatigue were negatively related to weaning success ($p = -0.47$, $p < .01$; $p = -0.38$, $p < .01$). Weaning readiness was positively related to weaning	Patients have immediate weaning from mechanical ventilation when the underlying pathological process is significantly reversed. Accurate weaning readiness and factors associated with dyspnea and fatigue should all be evaluated in

Table A.2 - Collective Table Summarizing Issues from Evidence-Based Practices (cont.)

No.	Author/Year	Research Objectives and Methodology	Research Findings	Conclusion of Implementation
32.	Siriwan Wattanasin, (2007).	research/Level 6.	success with statistical significance ($p = 0.52$, $p < .01$).	all patients for whom weaning is planned.
33.	Montira Udchumpisai. Et al (2010).	Objectives: To study the relationships of perceived severity of illness, perceived quality of sleep, anxiety, age, co-morbidity, and severity of illness with long mechanical ventilation times patients (n = 120). Methodology: Correlational predictive research/Level 6.	Perceived severity of illness, anxiety, co-morbidities and severity of illness were positively related to long mechanical ventilation times Severity of illness and anxiety were capable of predicting long mechanical ventilation time and perceived quality of sleep was negatively related to long mechanical ventilation time ($p < .05$).	Nursing care for patients on mechanical ventilation should include the evaluation of factors associated with long mechanical ventilation, e.g. perceived severity of illness, anxiety, co-morbidity, severity of illness, promotion of quality of sleep and reduced anxiety to support patients in receiving physical, psychological and psycho-social care to reduce the mechanical ventilation times.
34.	Boles, J. M. et al. (2007)	Objectives: To provide recommendations regarding weaning processes from evidence-based practices regarding best methods for weaning processes. Methodology: Unsystematic clinical observation/Level 7.	The overall findings of the study can be summarized as follows: 1. Patients should be readily categorized into three groups based on the difficulty and duration of the weaning process, i.e. the simple weaning, the difficult weaning and the prolonged weaning group.	Weaning should be considered as early as possible clinicians should be evaluate as possible clinicians should be evaluate readiness to weaning to allow prompt initiate of the weaning process by SBT with T-piece, low levels of PS (5–8 cmH_2O in adults), or PEEP 5 cmH_2O for initial SBT should be last 30 minutes.

Table A.2 - Collective Table Summarizing Issues from Evidence-Based Practices (cont.)

No.	Author/Year	Research Objectives and Methodology	Research Findings	Conclusion of Implementation
34.	Boles, J. M. et al. (2007) (cont'd)		2. Patients should be considered for weaning as soon as possible. 3. Spontaneous breathing trial (SBT) is major diagnostic test to determine if patients can be successful extubated 4. In the beginning, patients should perform SBT for a minimum of 30 min. with T-piece, low levels of PS (5–8 cmH_2O in adults) or PEEP 5 cmH_2O. 5. Patients who failed the first of SBT should choose to wean by pressure support or assist-control ventilation modes. 6. Noninvasive ventilation (NIV) techniques should be used for a short period of time following extubation in patients at risk for respiratory failure.	Patients who failed the first of SBT should considered to be weaned by pressure support or assist-control ventilation modes. And considered for a short period of time after extubation in patients with risks. Monitored for symptoms of respiratory failure after extubation for a minimum of 48 hours. Patients should be divided into three groups according to difficulty and duration of the weaning process comprising the simple weaning, difficult weaning and prolonged weaning group for further planning in weaning from mechanical ventilation.

Table A.2 - Collective Table Summarizing Issues from Evidence-Based Practices (cont.)

No.	Author/Year	Research Objectives and Methodology	Research Findings	Conclusion of Implementation
35.	MacIntyre, N.R.(2001).	Objectives: To study and review knowledge about weaning from mechanical ventilation acquired from evidence-based practices in patients on mechanical ventilation which was a cooperation between the American College of Chest Physicians, the American Association for	The findings provided the following recommendations: 1. Patients requiring mechanical ventilation for > 24 hrs, a search for all the causes that may be contributing to ventilator dependence . 2. Patients should be assessed for readiness weaning as follows: - The causes of respiratory failure must be solved. - Adequate oxygen exchange, e.g. PaO2/Fio2 ratio > 150–200, PEEP ≤ 5- 8 cmH2O, Fio2 ≤ 0.4-0.5, pH ≥ 7.25. - Hemodynamic stable, the absence of active myocardial ischemia and clinically significant hypotension; no use of vasopressors, or only low-dose of vasopressors, such as dopamine or dobutamine < µg/kg/min. - The capability to initiate and inspiratory effort.	Evaluation of weaning readiness should begin in patients on mechanical ventilation for > 24 hours. Patients must be prepared in the following four aspects: improvement of the causes for using mechanical ventilation, adequate oxygen exchange, stable circulation and good cough reflex. Patients who are ready should perform spontaneous breathing trials for a minimum of 30-120 minutes. Patients who are successfully weaned from mechanical ventilation should assess of airway patency, and ability of the patients to protect the airway prior to extubation. Patients who have had weaning failure should be assesses to determine and resolve causes of the failure with evaluations of readiness and beginning to wean from mechanical ventilation every 24 hours.

Table A.2 - Collective Table Summarizing Issues from Evidence-Based Practices (cont.)

No.	Author/Year	Research Objectives and Methodology	Research Findings	Conclusion of Implementation
35.	MacIntyre, N.R.(2001). (Cont'd)	Respiratory Care, and the American College of Critical Care Medicine. Methodology: Unsystematic clinical observation/Level 7.	3. In evaluating weaning readiness, SBT should be performed. Assess patients tolerance during SBT of 30-120 minutes are the respiratory patterns, adequate gas exchange, hemodynamic stability and comfortable 4. Successfully weaned patients should be assessment of airway patency and the ability to protect the airway before extubation. 5. In patients who have failed on SBT should have the causes of the failed SBT determined and resolved with re-evaluation of weaning readiness every 24 hrs .from of ventilator support.	Weaning strategies in the prolong mechanical ventilation patients should be slow-paced and should include gradually lengthening self-breathing trial in weaning care unit.

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