CHAPTER II

BACKGROUND

Assessment of the Quality of Nursing Care

The assessment of the quality of care is not new in nursing practice (Ott, 1987). Nurse has traditionally assessed her work as a part of the nursing process (Schofield, 1990). Concerns about the quality of care have been documented since the days of Nightingale (Ott, 1987). During the last forty years, the issues of standards of nursing care and quality assurance have grown in importance.

Assessment of Quality of Nursing Care in USA

The evolution of quality assessment in the nursing profession has been affected by several fundamental forces. Started in the United States in 1970, the Joint Commission on Accreditation of Hospitals (JCAH) required each hospital department to set up ongoing evaluation of the major clinical services provided to patients (McNeilly, 1987). The establishment of Professional Standards Review Organizations (PSROs) in 1972, as authorized by Public Law 92-603, greatly increased efforts among health care providers to evaluate and upgrade the quality of care.

From these pressure Rush-Presbyterian St.Luke's Medical Center and the Medicus Systems Coporation have developed and tested a process instrument for monitoring the quality of nursing care, under a contract with the Division of Nursing, Bureau of Health Resources Development. In 1973, The American Nurses Association established the standards of nursing practice, which described the steps in the nursing process. These standards have been modified and adapted by each clinical specialty. The standards provide a frame of reference for judging nursing care (American Nurses Association, 1974). After that, numerous studies have been conducted in various types of organizations to investigate the influence of selected variables on the quality of care. During the early period of quality assessment, most of the study were focused on the development of measuring tools such as: the Veterans Administration Nursing Care Quality Evaluation, the SCALE quality control plan developed at the University of Michigan, the Quality of Patient Care Scales developed at Wayne State University. Most noted worthy was on patients' outcomes (Amercan Nurses Association, 1976). Many in nursing has changed from studying the nurse to studying nursing practice (Hegyvary and Haussman, 1976; Gardner, 1981). Some of them examined the relationship between nursing process and patients' outcome (Eriksen, 1987).

Assessment of the Quality of Nursing Care in Thailand

In Thailand, there were several studies on the assessment of the quality of nursing care. Most of the studies emphasized on the delvelopment of measuring tools (Chumpirom, 1975; Thaveboon, 1979; Tuntiparacheva, 1978), while some of them assessed nursing performance (Hanucharurnkul et al. 1976; Petcharavutthigrai, 1976; Silaruk, 1980). Although concerns about the quality of nursing care has recently increased in several areas, there has been only one study at Ramathibodi Hospital that assesses the quality of mechanical ventilator care by observing the process of nursing activities and comparing the quality of care with the clinical outcome (Vannarit, 1983). The results indicate that the outcome relates significantly with the quality of nursing care provided. However, the investigator fails to control for the patient's background, the types of disease and the severity of disease, so the validity of the results still remains doubtful.

Methods of Quality Assessment

The quality of care can be measured in three components: structure, process and outcome (Donabedian, 1966; Jelinek, Haussman and Hegyvary, 1974; McMaster INCLEN, 1984). The structure approaches focus on the physical facilities, equipments, organizational pattern of the patient care system, styles of supervisor, including staff patterns, and their attributes (Bloch, 1975; Hegyvary and Haussman, 1976; Laing and Nish, 1981). The process approaches emphasize the actual performance of care, namely, what the nurse or provider does (Bloch, 1975; Hegyvary and Haussman, 1976; Laing and Nish, 1981). This assessment approach includes not only his/her actual visible behavior such as doing a tracheal suctioning, but also his/her invisible action such as dicision making. This form of evaluation, thus, concentrates on whether procedures are properly performed. On the other hand, the outcome approaches concentrate on the result of care in terms of changes in the recipient of that care or patient welfare (Hegyvary and and Haussman, 1976; Laing and Nish, 1981). The nurse looks for evidence of improved health status resulting from nursing interventions.

Experts debate whether evaluation should be focussed on structure, process or outcome. McMaster INCLEN (1984) stated that impressive diplomas and credentials can not guarantee clinical competence; unimpressive physical facilities can be the sites of excellent clinical care. This article also suggested not to read the article or the study that focuses only on health outcomes, since there are three ways in which the results of studies can be misleading: a) when unfavourable outcomes are rare, dangerous practices can appear innocuous when the study sample is small, b) when unfavorable outcomes are delayed, dangerous practices can appear innocuous when the study period is short and c) when unfavourable outcomes are determined primarily by factors other than process of care, spurious conclusions will be made.

Although outcomes might indicate good or bad care in the aggregate, they do not give an insight into the nature and location of the deficiencies or strengths to which the outcome might be attributed (Donabedian, 1966). Bloch (1975) also believes that the patient's outcomes are influenced by many factors besides the nursing care. Prominent among these factors is the care he/she receives from other health care provider, especially physicians. Hegyvary and Haussman (1976) believed that the most valid measure of the quality of nursing care should focus on the nursing activities performed in the actual delivery of nursing care to the patient: the process model of patient care.

The investigator who wants to measure the nursing activity (process) and outcome must control for many confounders such as the types of disease, the severity and prognosis of disease, the diagnostic test, treatment and patient compliance (McMaster INCLEN,1984). Most of these factors are usually out of nurses responsibility and it is extremely difficult to control in regular basis.

For the care of patients with mechanical ventilation, since most of the related procedures are life saving and the patients' condition needs team approach, nursing care is one of the most important factors that contribute to the quality of this care. It is also extremely difficult to define outcome criteria solely attributed to nursing alone. At the present time, we do have a degree of current knowledge about what nursing care should be in terms of mechanical ventilation. So process evaluation can be distinctly valuable, is rather readily implementable, and may be more useful.

<u>Nursing Care of the Patients with Mechanical Ventilation</u>

1. Definition of Mechanical Ventilation

Mechanical ventilation refers to the mechanical augmentation of a patient's spontaneous ventilation with positive pressure, in order to improve adequate lung function (Joyce,1983). It is required when a patient's lungs can no longer provide a gas exchange adequately to supply tissues with oxygen or in the case of ventilation failures (Popovich, 1983; Spearman, Sheldon and Egan, 1982; Thelan, Davie and Urdan, 1990).

2. Causes of Ventilation Failure

There are several causes of ventilation failure; some of these are:

Neurological impairment which adversely affects central ventilatory control, such as: overdose with CNS depressant drugs, increase intracranial pressure, and brain stem injuries or brain stem lesions,

Neuromuscular impairments which adversely affect respiratory muscle function, such as: poliomyelitis, myasthenia gravis, muscular dystrophies, Guillain-Barre' syndrome, tetanus, botulism and skeletal muscle paralysis secondary to pharmacological agents,

Primary respiratory impairment resulting in abnormalities in ventilation and/or gas exchange, such as: chronic lung disease with a superimposed acute ventilatory failure, adult respiratory distress syndrome, status asthmaticus, severe ventilation/ perfusion defects, tension pneumothorax, flail chest, pulmonary burns, near-drowning, fibrotic lung diseases, pulmonary edema and carbon monoxide poisoning.

Functions of Mechanical Ventilation

Mechanical ventilatory support can improve the patient's status by: a) improving alveolar ventilation, b) decreasing the work of breathing, c) improving acid-base status, d) improving gas distribution in the lung (Joyce,1983).

Nursing Consideration for Mechanical Ventilation

Because of the complexity of the causative factors of ventilation failure and also of the machines and procedures required for use with machines, nurses caring for patients who are being mechanically ventilated must understand the following (Nielson, 1980): a) why the patient requires ventilatory assistance, b) how the particular ventilator with its special setting alters the patient's physiology and ventilatory pattern and control, c) what dangers and possible complications accompany the use of the ventilators, d) the nursing assessments and interventions necessary for comprehensive patient care.

Classification of Ventilators

Ventilators can be classified according to many different functional characteristics. However, they are most commonly classified by their cycling mechanisms which triggers the machine into inspiration and their limiting mechanisms (what limits or ends inspiration). One distinction in classifying respirators is negative and positive pressure ventilator.

1. Negative Pressure Ventilators

Negative pressure ventilators mimic the normal mode of ventilation where air is sucked into the lungs (Nielson, 1980). An example is the iron lung. Enclosed within a vacuum chamber, the chest wall is pulled outward. Ambient air rushes in through the upper airway which is outside of sealed chamber. These ventilators are not used often. They are bulky, hinder nursing care and require a fairly flexible chest wall. The negative intrapleural pressure must be undisturbed.

2. Positive Pressure Ventilators

Positive pressure ventilators are more practical. They inflate the lungs by pushing air into them. This reverses the pressure dynamic of normal inspiration, but it is necessary in situations in which the negative intrapleural pressure is lost or the lungs are stiff and noncompliant. The positive pressure ventilators may subdivided in to volume-cycled, pressure-cycled, and time-cycled (Thelan, Davie and Urden, 1980)

Volume cycled ventilators are designed to deliver the preset volume of air to the patient. The machine can deliver the volume of gas despited changes in pressure within the patient's lung volume, there operator is alerted by an audible and visible alarm. To avoid barotrauma to the lungs, pressure limits can be programed into the ventilator. When the pressure limit is exceeded, the ventilator will spill the remaining volume of gas out of the system, but baring this situation, the ventilator will deliver the set volume throughout considerable pressure ranges.

Pressure cycled ventilators deliver gas until a preset pressure is reached. The volume delivered is dependent on lung compliance and varies from breath to breath when the pressure within patients's lung increase or decrease for any reason. Blockage at any point between machine and lungs will not stop the ventilator but the patient will recieve no volume. Pressure cycled ventilator are not useful for ventilation of critically ill patients because pressure ventilators do not adapt well to changes in lung compliance and resistance.

Time-cycled ventilators deliver gas during a preset time interval. They are less popular because of the difficulty in delivering consistent tidal volumes in the presence of changing respiratory dynamics. Tidal volume is regulated by adjusting the length of inspiration and the flow rate of the pressurized gas. If a patient's lungs are not compliant the flow rate can be increased to maintain effective tidal volume while leaving the inspiratory time unchanged. Tidal volume and maximum inspiratory pressure may vary from breath to breath. Since the airway pressures generated by a high flow rate could become excessive and dangerous, time-cycled ventilators also have fail-safe beyond which the ventilator cease to push gas into the lungs. Time-cycled ventilators such as the BABY bird or Bourns infant ventilator are used for neonates and infants. Other time-cycled ventilator such as the Emerson postoperative ventilation or Engstrom are used for adults.

Nielson (1980) stated that most of the ventilators used for long term mechanical ventilation are volume limited, positive pressure ventilators. Examples of this type are the Puritan Bennett MA-1 and MA-2 ventilators, the Bourns Bear 1 and Bear 2 ventilator, the Emerson Post-Op and IMV ventilator, and the Ohio CCV ventilator. Another type of commonly used ventilator is the pressure limited, positive pressure ventilator. Common examples of this type of ventilator are the Bird Mark-7, Mark 7A., Mark 8, Mark 8A, Mark 14 (McPherson, 1981) and Puritan Bennett PR-II (Joyce, 1983).

The following discussion of the various functions and settings for ventilators and the ways in which they can control ventilation is primarily focused on pressure-cycled ventilator, especially the Birds's respirator, since it is a ventilator used in the majority of cases in Maharaj Nakorn Chiang Mai Hospital.

Pressure-cycled ventilators are most commonly used to administer increased positive pressure breathing (IPPB) therapy but can also be useful for continuous ventilatory support under proper monitoring conditions. The major point to the use of pressure-cycled machines is that the volume of gas the patient receives is variable. If an anxious, restless or uncomfortable patient shuts off air inflow, he might not receive a volume large enough to sufficiently expand alveoli. In addition, if the patient develops such problems as pulmonary infiltrates and edema, the lungs will become less compliant. This will cause the ventilator to terminate inspiration with gradually less volume, setting up a vicious cycle involving atelectasis and further reduction in compliance.

Physiological Changes in Patients with Mechanical Ventilation

During positive pressure ventilation, inspiration results from the application of a positive pressure to the lungs. This results in an increase in intrapulmonary and intrathoracic pressures as well as lung volume. Because of this increase in mean intrathoracic pressure during inspiration, venous return, and therefore, cardiac output are decreased and blood pressure falls. Normally, this is quickly corrected by a compensatory increase in peripheral venous pressure which results in a normalization of venous return. However, in patients with poor vascular compensating mechanisms or a reduced intravascular volume, there can be a dramatic reduction in cardiac output during mechanical ventilation.

Compared with normal persons, patients with mechanical ventilation have to make a great deal of adjustment of his/her physiological functions. For normal spontaneous ventilation, intrathoracic pressure is negative during the entire ventilatory cycle. During the inspiratory phase, the inspiratory muscles contract. This results in a decrease in the intrathoracic and intrapulmonary pressures and an increase in the volume of the thorax. This is the period of maximum venous return to the right heart because of the increased negativity of the intrathoracic pressure. Spontaneous expiration is passive due to inspiratory muscle relaxation and the normal recoil tendency of the lung: thoracic volume decreases and intrathoracic pressure increases, but remains negative. It is then necessary for nurses to apply this normal physiology of ventilation and understand the physiological changes after provided mechanical ventilator to patients.

Modes of Operation

There are five modes: assist, control, assist-control, intermittent mandatory ventilation and synchronized intermittent ventilation.

Assist Mode. This mode is used in patients who have spontaneous respiration but inadequate alveolar ventilation (Wade, 1982). This mode allows the patient to breathe at his/her own rate. However, if the patient becomes apneic or bradypneic, there is no back-up mechanism to insure adequate minute ventilation delivery. There is some mechanism for adjusting the amount of patient effort required before the ventilator cycles on. This adjustable mechanism is usually called the sensitivity or patient effort control (Spearman, Sheldon and Egan, 1982).

Control Mode. It is used for patients with few or no spontaneous respirations or when it is desirable to abolish ventilatory drive (Wade, 1982). In this mode of mechanical support the patient is totally dependent of a functioning ventilator system. The machine is set at a predetermined respiratory cycle (rate, pressure and tidal volume) and is independent of the patient's efforts or breathing pattern.

Assist-Control Mode. This is a commonly used ventilatory mode which combines patient triggering with a mechanically set rate as a backup system. This mode allow the patient to initiate a mechanical breath with any adequate inspiratory effort, while insuring a minimum fixed respiratory rate which is set as the control (back-up) rate. In this case the control rate is a guarantor in case the patient's breathing pattern slows or stop completely.

Intermittent Mandatory Ventilation (IMV). This is a mode of ventilation that combines a controlled mechanical rate with spontaneous breathing. In this mode, some system is provided for fresh gas from which spontaneous breathing can occur at a rate and volume that is patient determined. This spontaneous breathing occurs between the preset mechanical IMV breaths. IMV has been used both as a weaning method and as a primary mode of ventilatory support in infants and adults. IMV allows the patient to provide some of the work of breathing during ventilatory support. When the patient is capable of providing more work, the ventilator's control rate is decreased accordingly. This allows for smooth transitions during ventilatory support and may have advantages for decreasing the mean intrathoracic pressure compared to controlled ventilation because of the spontaneous efforts.

Synchronized Intermittent Mandatory Ventilation (SIMV). While IMV is a control rate combined with spontaneous breathing, SIMV is an assisted rate combined with spontaneous breathing. With SIMV, each mechanical breath is usually triggered by the patient in the same manner as assist mode. SIMV is really a technical deviation from IMV, and otherwise they are used in the same manner. Other terms used by manufacturers to describe this same mode are intermittent demand ventilation (IDV) and intermittent assisted ventilation (IAV).

Complications of Mechanical Ventilation

Positive pressure ventilation cannot duplicate normal respiration (Moses and Steinberg, 1979). Many complications can occur if inappropriate care is provided; these complications may occur directly within the respiratory system or distantly in other organ systems.

Lung Atelectasis. Normal adults breath with a tidal volume of 400 to 500 ml and breath spontaneous deep breaths to total lung capacity every five to ten minutes; if this pattern is altered to a pattern of shallow monotonous tidal ventilation without deep breaths, gradual alveolar collapse begins within one hour. After several hours of such abnormal ventilation, gross atelectasis can occur (Bartlett, Gazzanigo and Geraghty, 1973). If maximal inflations to total lung capacity are included in mechanical ventilator care, either by mechanical positive pressure inflation setting or manually, this attempt will benefit to prevent microatelectasis.

Air Leakage. Positive pressure may cause air to leak into subcutaneous tissue around an improperly inflated cuff, resulting in subcutaneous emphysema. In addition, patients on mechanical ventilation may develop gastric distension and paralytic ileus from swallowd air. Nurses need to check regularly for bowel sound and proper inflation of cuffed endotracheal tube may be helpful.

Pulmonary edema. Pulmonary edema is another complication of mechanical ventilation as the nebulizer increases fluid intake and the humidifier prevents normal water loss. Daily weight and accurate intake and output measurements are important for the detection of abnormal fluid gain and possible consequences of pulmonary edema.

Acid-Base Imbalance. Patients on the respirator may suffer from acid-base imbalance, especially respiratory alkalosis from hyperventilation.

Oxygen Toxicity. Patients receiving oxygen concentration greater than 50% for prolonged periods may develop oxygen toxicity with the following signs and symptoms: retrosternal pain, decreased vital capacity, sore throat, nasal congestion and cough.

Psychological Stress. Patients undergoing mechanical ventilation are under psychological stress (Wade, 1982). The respiratory system is normally used to express a variety of feelings such as laughing, crying, sobbing, singing and sighing. The intubation results in the loss of glottic and laryngeal functions which makes it most difficult for patients to express these feelings. Bergbom-Engberg and Haljanae (1989) found that patients who had been respirator-treated had felt anxiety and/or fear during the treatment. Inablity to talk and communicate was found to be the dominating reason for evoking such feeling. In order to reduce these stresses, attempt should be done to establish new method of communication as required by individual patients. These measures may help to decrease anxiety and fear.

The majority of patients also experience feelings of frustration, anxiety, anger, dependency, denial, and a sense of hopelessness during mechanical ventilation . They need to be reassured that their doctors and nurses are capable of taking care of them since emotional stress has a marked effect on respiration: anger causes hyperventilation and often breath holding, and suppression of anger may result in dyspnea.

Mechanically ventilated patients also suffer from lack of sleep. In any intensive care units, the patient is usually subjected to the clicking of monitors, clanking of ventilators and bubbling of chest drainage systems, in addition to the human interaction around him. Time schedules of nursing activities are often exhausting, monitoring vital signs, suctioning, turning, coughing, E.K.G., X-rays, and so on. As it is impossible to provide nursing care in separate room in all intensive care units, these can add to the sensory overload and resulting deprivation. As sleep deprivation continues, the patient may become confused. Moreover, being in a room without windows and with constant light and noise levels may lead the patient to gradually lose of perception of reality.

<u>Associated Procedures for Mechanical Ventilation</u>

1. Endotracheal Intubation

Ventilation failure is the primary reason for intubation. A patient requiring ventilatory support for prolonged intervals must have an artificial airway. For the initiation of artifitial airway, a cuffed endotracheal tube is the device of choice to maintain close circuit system.

An endotracheal tube may be inserted via the nose or mouth to facilitate suctioning, to bypass an upper airway obstruction, and to permit connection of the patient to a resuscitation bag or mechanical ventilator. There are many types of endotracheal tubes. They are usually constructed of rubber or plastic and are available in a number of sizes with or without and inflatable cuff. The size of tube is an important consideration when a patient is to be intubated, whether the nasal or the oral route is used. Because airways resistance is increased in long narrow tubes( ), the physician will generally choose the largest tube that a patient can safely tolerate. Normally this procedure are performed by anesthesiologist in the operating room to provide general anesthesia or in the emergency situation it may be performed by attending doctor.

Nurses can assist this procedure by preparing the patient and equipments appropriately. When the patient to be intubated is conscious, the necessity for the treatment is explained to the patient and his immediate family by the patient's physician. The nurse should explain the procedure, making sure that the patient understands that he will be unable to speak while he has the endotracheal tube in place. The nurse should reassure him that someone will always be with him and that he will be kept as comfortable as possible. The patient must also be shown new methods by which he can communicate such as; ask yes or no question, paper and pencil, picture board, maintain eye contact, validate meaning of attempted verbal and nonverbal expression, and explain that patient will be able to speak after extubation.

The equipments required for endotracheal intubation include endotracheal tubes of various sizes, a laryngoscope with a selection of different-sized blades, lubricant, topical and local anesthetic agents, Magill forceps, gauze swabs, adhesive tape, Tincture Benzoin, plastic syringes, and a stylet to add rigidity to the tube during insertion. In addition, equipment for oxygenation, ventilation, suction apparatus, and cardiac resuscitation should be available.

It is the nurse's responsibility to check the cuffs on the endotracheal tubes prior to use and to lubricate the selected tube. The laryngoscope light must be working; batteries and extra bulbs should be at hand; and suction equipment must also be working. Special consideration is given to the length and type of suction catheter used. The catheter must be of an adequate length to traverse the length of endotracheal tube and enter the left and right main bronchus in order for secretions to be removed effectively. After intubated, patient may be ventilated by self-inflating bag or connected to mechanical ventilator.

2. Initiation of Mechanical Ventilation

Before setting mechanical ventilation, especially Bird's respirator, the following considerations have to be taken into account: tidal volume, respiratory rate, inspiratory/expiratory ratio, oxygen concentration and pressure setting.

Tidal Volume. This is the amount of air exchanged with each normal breath and can be measured on inspiration or expiration, the appropriate amount is estimated as 10 to 15 cc/kg of body weight. For individuals of average weight, this translates to between 500 and 1000 cc.

Respiratory Rate. The rate is usually set between 10 and 14 breaths/minute. Slower rates with higher tidal volumes are prefered, since this limits the amount of time that positive pressure is applied into the lungs.

Inspiratory/Expiratory Ratio. Mechanical ventilators are most helpful to the patient when they closely approximate normal breathing patterns. During normal breathing, the expiratory phase (expiration plus the pause between breaths) is about twice as long as the inspiratory phase. This allows for optimal and passive emptying of the lungs. Ventilators can be adjusted to maintain this approximate ratio by controlling the flow rate of the gas being pushed into the lungs during inspiration. It is safer to appropriately limit the inspiratory time when using a positive pressure ventilator, since this will decrease the mean airway pressure and the risk that accompany higher pressure.

Oxygen Concentration. The percentage of oxygen used will vary with the paitent's arterial blood gases. Concentrations of 50 percent or less are considered relatively safe for prolonged ventilatory support. Every effort is made to use the lowest concentration as possible in order to avoid alveolar damage. Pressure-cycled ventilators lack the ability to deliver precisely controlled levels of oxygen. They can be deliver only 100 percent, 40 percent and 21 percent oxygen. The gas is warmed to 37 C and humidified to 100 percent saturation to protect tracheal mucosa from irritation and to promote the clearance of secretion.

Pressure. The pressure setting is important with pressure-cycled ventilators because it regulates the machine. There are two gauges for pressure. One gauge sets a maximum inspiratory pressure, or the pressure at which inspiration will end, usually 20 to 30 cm of water pressure. The other dial shows a continuous reading of the actual pressure within the system. It rises and falls with each ventilation.

3. Caring for Patients with Cuffed Tube

Patients who require mechanical ventilation need a cuffed tube to facilitate close circuit system and nurses who take care of these patients should be concerned about its limitation.

An essential part of this care is an appropriate inflation and deflation techniques of the cuffs. Since it is a positive pressure cuffs, it can affect the area around it if inappropriate pressure or volume is applied. The object of proper inflation is to place the minimal volume of air in the cuff that will allow optimal sealing of the airway. This technique of inflation is called the minimal leak technique (MLT) or minimal occluding volume (MOV). Use of the minimal occluding volume (MOV) necessary to create an airtight seal will act to avoid undue pressure on the tracheal mucosa and, thus, keep ischemia at a minimum. The actual intracuff pressure should be kept below 20 mmHg. In order to prevent fatal mishap in emergency situation such as leaking of tube cuff's, the rule that must never be broken in intensive care areas is that duplicate airways and appropriate intubation and ventilation equipment must be at the bedside at all times.

4. Tracheal Suctioning

Suctioning is one of the important procedure needed for patients who require mechanical ventilation. Since the patient with an artificial airway is not capable of effectively coughing, the mobilization of secretions from the trachea must be facilitated by suctioning. In order to minimize the incidence of complications and mucosal damage, this procedure should not be performed on a routine basis. Some evidence of tracheal secretions such as; dyspnea, excessive coughing, pressure alarm sounding on ventilator, visible secretion in tube/or increased rhonchi should be present, because unnecessary suctioning may irritate the mucosa and stimulate secretion production (Jung and Gottliet, 1976; Thambiran and Ripley, 1966). Strictly sterile technique must always be followed. This includes the use of sterile glove or forceps for handling the suction catheter, sterile suction catheter, appropriate sterile rinsing solutions and sterile container for clearing the catheter.

The patients must be oxygenated before and after suctioning with 100% oxygen by using self-inflating bag or by increasing the FiO_2 to the spontaneously breathing patient, this provides the greatest degree of oxygen reserve in the alveoli (Shim et al., 1969). The appropriate suctioning method starts with selecting appropriate amount of vacuum, inserting the catheter without applying vacuum until it is obviously past the tip of the airway and approximately at the level of the carina(Thambiran and Ripley, 1966). The catheter should not be in the airway for longer than 10 to 15 seconds (Jung and Gottliet, 1976; Shim et al., 1969). Before repeating the suctioning process, the patient should be re-oxygenated and ventilated for at least 5 deep breaths and has returned to base-line vital signs. Following tracheal suction, the same catheter can be used to suction the oropharynx and the nose but must never be re-used in the trachea. Tracheal secretion specimens for culture and sensitivity should be obtained when the secretions change in color, amount and consistency.

It is essential that the applied oxygen gas be warmed and humidified because the patient with an artificial airway does not have the availability of the upper airway to heat and humidify the inspired air. Without appropriate humidification of the artificial air, the incidence of obstruction caused by drying of secretions will be great (Dugan and Samson, 1963). With appropriate heating and humidification of inspired gas, the incidence of obstruction of the airway by secretions is extremely rare.

The major complications of airway suctioning are hypoxemia, arrhythmia, hypotension and lung collapse (Shim et al., 1969; Shapiro, Harrison and Trout, 1979). Acute hypoxemia during the suctioning process will manifest by heart rate abnormality. Any significant change in heart rate or rhythm during suctioning must be presumed to be due to hypoxemia. Ventilation and oxygenation must be immediately reestablished. Significant cardiac arrhythmias may occur during the period of suctioning due to two sources: arterial hypoxemia leading to myocardial hypoxia or vagal stimulation secondary to tracheal irritation.

Hypotension may occur from either of the two circumstances: profound bradycardia resulting from vagal stimulation or prolonged coughing maneuvers during the suctioning process. Tracheal irritation from the suction catheter may stimulate tracheal and carinal reflexes resulting in paroxysmal cough-like maneuvers which interrupt ventilation. These coughing maneuvers, along with bradycardia, can have a severe effect on both venous return and cardiac output. Hypoxemia, arrhythmia, and hypotension are best avoided by appropriate suctioning techniques, including pre and intermittent oxygenation with high concentration of oxygen, limiting the suctioning process to 10 seconds or less and close cardiac monitoring.

Lung collapse can be another serious complication of inserting a large suction catheter into a small diameter endotracheal tube resulting in inadequate space for air to entrain around the catheter. When a vacuum is applied, the lung may collapse. This problem is avoided by using a catheter whose diameter is smaller than the radius of endotracheal tube. A rule of thumb is that the suction catheter should not occupy more than a half of the internal diameter of the tube being suctioned.

5. Weaning from Mechanical Ventilator and Extubation

When a patient's ventilatory status is improved sufficiently, the decision is usually made to wean the patient from mechanical ventilation. If the patient has been on mechanical ventilation for only a short period of time (up to a few days) he can be detached from the machine under close observation, then extubated and maintained on oxygen by face mask. But if he has been on the respirator for more than a few days, the patient will require more gradual separation. Weaning, or discontinuing ventilator support will be successful only if the patient is able to ventilate well enough to supply both his baseline oxygen demands and the additional oxygen required by the work of breathing (Nielson, 1980).

Weaning is best started at a time when the patient is rested and calm and there are no external demands on the patient (Nielson, 1980). This external demand should not be attempted at the same time, or just after, such activities as a bath, chest x-ray, dressing change, or other stressful or tiring procedure. Patient should be sitting or in high Fowler's position to facilitate ventilation. Before the actual weaning process, the nurse must explain the procedure to the patient. The patient should be reassured that nurses are not going to take the machine away and that he can go back on it at any time he needs to do so. The amount of time the patients spent off the machine may have to be adjusted according to the patient response. The nurse should stay at the bedside during the early stages of the weaning process to help reassure the patient and observe his responses. Patient tolerance of weaning is evaluated using both subjective and objective data.

Hypoventilation may lead to hypercapnia and hypoxemia. Clinical signs of hypercapnia are flushing, dulling of the sensorium, and increased blood pressure. Clinical signs of hypoxemia are restlessness, agitation, drowsiness, confusion, arrhythmias, pulmonary edema, diaphoresis and coolness. The vital signs that should be monitored during weaning include pulse, blood pressure, tidal volume, breathing frequency, and minute ventilation. Blood pressure, pulse and respiratory rate should be monitored at 5-minute intervals during the first 30 minutes of a weaning session. If the rise in blood pressure is greater than 20 mmHg, the pulse rate increases to 120 beats per minute, the respiratory rate is greater than 30 breaths per minute, or if the patient becomes anxious, it is recommended that the patient be put back on the ventilator. At the end of 30 minutes if the vital signs are stable, arterial blood gas should be checked and the vital capacity measured.