A PILOT STUDY OF EXTUBATION FROM MECHANICAL VENTILATION AND THE EFFECT OF CHEST PHYSIOTHERAPY INTERVENTION

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DECLARATION

I, Winnifred Keabecoe Ngubeni, declare that this research report is my own work. It is being submitted for the degree Masters of Science in Physiotherapy at the University of the Witwatersrand, Johannesburg. It has not been submitted before any degree or examination at this or any other University.

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ABSTRACT

Background

It is a common practice for physiotherapists working in Intensive Care Unit (ICU) to treat patients who are intubated and mechanically ventilated and assist with extubation. The role of chest physiotherapy treatment (CPT) with extubation hasn't been scientifically proven to be effective.

Purpose of the Study

The purpose of this pilot study was to determine whether the omission of one CPT prior to extubation influences the outcome of patients four-hours after extubation.

Methods

A randomized-controlled trial (RCT) was conducted in an academic hospital with 20-cardiothoracic and general ICU beds. Patients consented to participate in the study after ethical clearance was obtained from University of Witwatersrand Committee for Research on Human Subjects. Twenty-two patients were randomly assigned to a control group to receive CPT and suctioning prior to extubation (*n=12)* or to an experimental group to receive suctioning only prior to extubation (*n=10)*. All patients were then re-assessed four-hours after extubation to assess the difference in outcome measures in arterial blood gases (ABG), breathing pattern, peak expiratory flow rate (PEFR), respiratory rate (RR), cough effectiveness and re-intubation rate. Groups were compared with respect to the categorical parameters using the Fischer's exact test. A two-sample t-test with unequal variances and a non-parametric Mann-Whitney test were used to compare the ABG and RR results between the groups.

Results and Discussion

The ABG, breathing pattern, RR, and cough effectiveness were not statistically significant between the groups. PEFR could not be measured due to the inability to follow instruction by the majority of patients. None of the patients required re-intubation within 24-hours. Eight patients in each group received CPT after four-hours due to clinical findings of an ineffective cough, added sounds and abnormal breathing patterns.

Conclusion:

Patients in the control group had a significant shorter period of mechanical ventilation (MV) than those allocated in the experimental group. However eight patients in both groups required CPT treatment when assessed four hours after extubation.

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LIST OF ABBREVIATIONS

%	:	percentage
ABG	:	arterial blood gas
ACBT	:	active cycle of breathing technique
ARDS	:	acute respiratory distress syndrome
ARF	:	acute respiratory failure
AVR	:	aortic valve replacement
CABG	:	coronary artery bypass graft
CMV	:	conventional mechanical ventilation
CO	:	cardiac output
CO_2	:	carbon dioxide
COPD	:	chronic obstructive pulmonary disease
CPAP	:	continuous positive airway pressure
CPT	:	chest physiotherapy
CT	:	cardiothoracic
CVS	:	cardiovascular
FET	:	forced expiration technique
FiO_2	:	fractional concentration of oxygen in inspired gas
FRC	:	functional residual capacity
GIT	:	gastointestinal
GCS	:	glascow coma scale
HCO_3	:	bicarbonate
HR	:	heart rate
ICP	:	intracranial pressure
ICU	:	intensive care unit
kPa	:	kilo pascal
M	:	medical
MAP	:	mean airway pressure
MH	:	manual hyperinflation
mmol/P	:	millimol per liter
MV	:	mechanical ventilation
MVR	:	mitral valve replacement
n	:	sample size
N	:	neuro
NaCl	:	sodium chloride

NIPPV	:	non-invasive positive pressure ventilation
O_2	:	oxygen
$PaCO_2$	:	partial pressure of carbon dioxide in arterial blood
PaO_2	:	partial pressure of oxygen in arterial blood
PaO_2/FIO_2	:	ratio of partial pressure of oxygen in arterial blood to fractional concentration of oxygen in inspired gas
PEEP	:	positive end expiratory pressure
PEFR	:	peak expiratory flow rate
PD	:	postural drainage
pH	:	hydrogen ion concentration
PPV	:	positive pressure ventilation
PS	:	pressure support
RCT	:	randomized controlled trial
RR	:	respiratory rate
SaO_2	:	arterial oxygen saturation
SD	:	standard deviation
SIMV	:	synchronized intermittent mandatory ventilation
TIPS	:	therapist implemented patient-specific
VAP	:	ventilator-associated pneumonia
V/Q	:	ventilation/perfusion ratio
WOB	:	work of breathing

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

The Intensive Care Unit (ICU) was established during the 1950s. Mechanical ventilation (MV) was rapidly developed to manage patients postoperatively and those with poliomyelitis (Norrenberg and Vincent 2002). Respiratory care was intensified during the epidemic of poliomyelitis in Copenhagen in 1952 (Lassen 1953). Critically ill patients are commonly managed in ICU, however it is not only limited to post-operative care. The ICU "has become a concentration not only of critically ill patients and advanced technology, but also of expert personnel with specialist training" (Norrenberg and Vincent 2000). Despite the benefits of ventilatory support, secretion clearance may be adversely affected by inadequate humidification, suctioning and certain medication administered to patients (Judson and Sahn 1994). Patients in ICU are traditionally managed by members of a multidisciplinary team. These members may vary from unit to unit, but mainly consist of medical doctors, nursing staff, physiotherapists and dieticians. The role of the physiotherapist in ICU may vary depending on factors such as staffing levels and expertise (Stiller 2000). Other support services needed in ICU are radiographic and laboratory services (Task Force 1991).

Two studies were identified that were conducted to determine the role of physiotherapists working in ICU in Europe and South Africa. Questionnaires were sent out to various hospitals targeting physiotherapists working in ICU. The response rate was 22% in the European study (Norrenberg and Vincent 2000) compared to 60% response rate in the South African study (Van Aswegen and Potterton 2005). In comparison, there was no statistical difference between the European and South African studies in relation to the use of respiratory therapy (98% vs. 98%), mobilization (100% vs. 98%) and positioning (90% vs. 95%) by physiotherapists respectively. There was a significant difference between the European and South African studies in the role of physiotherapy with regard to extubation from MV (25% vs. 65%) and suctioning (70% vs. 98%). This study was conducted in an academic hospital where physiotherapists performed chest physiotherapy treatment (CPT), positioning, mobilization, exercises (both actively and passively) and assisted with suctioning and extubation of patients in the ICU.

Acute respiratory failure (ARF) may be managed with the application of positive pressure ventilation either invasively by using conventional mechanical ventilation (CMV) or non-invasively by using non-invasive positive pressure ventilation (NIPPV) delivered through a mask. Studies have been conducted to compare the two methods of application of positive pressure ventilation (PPV) to improve gas exchange (Conti et al 2002; Honrubia et al 2005). In both studies some patients allocated to the NIPPV group were managed successfully and avoided intubation (48% vs. 50% respectively) meanwhile 100% of patients in the CMV group were intubated. NIPPV was shown to be the preferred treatment method as CMV is normally associated with prolonged MV and the risk of the development of complications. Wysocki and colleagues (1993) further investigated the indication for NIPPV in patients with ARF, who were all managed with NIPPV. The results showed 47% success and 53% failure rate, but all had improvement in gas exchange after one hour application of NIPPV. The results also showed that carbon dioxide (CO_2) retention was a better indication of NIPPV than severe hypoxemia.

This study will only concentrate on MV as a management of ARF in the ICU. The guidelines for ventilator management of such patients include ventilatory support, airway management (which entails intubation and secretion clearance) and extubation (Task Force 1991). The aims of CPT in ICU are to promote more efficient breathing patterns, prevent accumulation of secretions, improve the mobilization and removal of secretions, and improve the distribution of ventilation as well as cardiopulmonary endurance (Scanlan 1990). These aims can be achieved by using invasive or non-invasive techniques. Airway clearance techniques such as manual techniques (percussion and vibration), postural drainage (PD), active cycle of breathing technique (ACBT) and coughing are non-invasive methods and suctioning is an invasive method employed to achieve these aims (Piccuito 2005).

Stiller and colleagues (1990) conducted a study to compare multimodality CPT with simple CPT in patients with acute lobar atelectasis. Intensive six-hour treatment sessions of multimodality CPT (positioning, vibration, manual hyperinflation (MH) and suction) led to significant and faster resolution of atelectasis as seen on chest roentgenogram after one treatment intervention compared to patients in the simple CPT (MH and suctioning) group. Wong's case study (2000) showed that the 24-hour availability of physiotherapy treatment may resolve atelectasis and assist in avoiding intubation. Ntoumenopoulos and colleagues (2002) conducted a study on intubated patients to investigate the effectiveness of CPT, which is commonly aimed at secretion clearance, on the prevalence of ventilator-associated pneumonia (VAP). The intervention group received CPT that included positioning, suctioning and chest vibrations and was independently associated with a reduction in VAP. These studies highlight the important role that physiotherapists play in the ICU.

However there is controversy about the efficacy of certain CPT techniques in some patient populations**.** A study was done to evaluate the effectiveness of physiotherapy for the management of pulmonary complications in mechanically ventilated trauma patients (Ntoumenopoulos, Gild and Cooper 1998). The patients were randomly allocated to either the physiotherapy group (A) or nursing care group (B). Patients in both groups received routine nursing care (two-hourly turn and suctioning) and musculoskeletal (passive and active exercises) treatment. Patients in group A had additional physiotherapy treatment (MH and PD) twice a day. The sample size was small, with 22 patients in group (A) and 24 in group (B) and four and eight patients respectively were excluded from this study when they developed pneumonia. As long-term ventilation is associated with development of pneumonia, the results of patients who were ventilated for seven days or more were investigated. Days of MV and ICU stay were the same in both groups and some patients developed nosocomial pneumonia. The results were not statistically significant hence physiotherapy treatment was not associated with a reduction in the incidence of nosocomial pneumonia in trauma patients (Ntoumenopoulos, Gild and Cooper 1998). Stiller and colleagues (1994) found that prophylactic CPT did not prevent postoperative pulmonary complications in adults after coronary artery surgery.

Alexander, Weingarten and Mohsenifar (1996) conducted a randomized study to investigate whether chest physiotherapy was provided to appropriate patients. The results showed that more than 50% of CPT treatments were ordered for inappropriate indications. The delivery of CPT was then limited to patients with appropriate indications such as atelectasis and those who produced copious secretions. The results of this study were the cost-effectiveness of appropriate physiotherapy referrals without increasing mortality rate or length of stay of patients. Evidence-based practice is mandatory for all service providers in ICU, including physiotherapists, considering the cost associated with management of ICU patients (Stiller 2000). CPT may prolong the duration of MV in critically ill patients ventilated for more than 48-hours (Templeton and Palazzo 2007) and may be associated with side effects, such as bronchospasm or short term hypoxemia (Selsby 1989) hence evidence-based practice is encouraged.

1.2 STATEMENT AND SIGNIFICANCE OF THE PROBLEM

Ongoing assessment of the patient in ICU is essential to ensure optimal care. Discontinuation of ventilatory support is indicated once the patient meets the criteria for extubation. Prior to extubation all patients receive CPT and some of these patients still fail to sustain sufficient respiratory function and to protect their airway after extubation, hence require re-intubation. On the other hand, some of the self-extubated patients, who did not receive CPT treatment prior to extubation, manage well and never require re-intubation. Current practice in our ICU is that patients receive routine CPT prior to extubation and are monitored closely for signs of respiratory failure thereafter. With cost saving and evidence-based practice in mind, the researcher will set out to investigate whether the omission of a single CPT treatment immediately prior to extubation influences the outcome of the patient after extubation.

1.3 RESEARCH QUESTION

Does the omission of one CPT treatment immediately prior to extubation influence the outcome of the patient as assessed four hours after extubation?

1.4 THE AIM OF THE STUDY

To assess whether the omission of one CPT treatment immediately prior to extubation influences the outcome of the patient four hours after extubation.

1.5 THE OBJECTIVES OF THE STUDY

- To compare arterial blood gas (ABG) results and oxygen saturation (SaO_2) four hours after extubation between the control and experimental groups.

- To compare the difference in breathing pattern four hours after extubation between the control and experimental groups.

- To compare the difference in peak expiratory flow rate (PEFR) four hours after extubation between the control and experimental groups.

- To compare the difference in respiratory rate (RR) four hours after extubation between the control and experimental groups.

- To compare the difference in cough effectiveness four hours after extubation between the control and experimental groups.

- To compare the difference in the rate of re-intubation four hours after extubation between the control and experimental groups.

1.6 THE TYPE OF STUDY DONE

A randomized control trial (RCT) was conducted.

1.7 SUMMARY AND CONCLUSION

The aim of this pilot study was to determine the need for CPT in extubated patients as a result of omission of one CPT treatment prior to extubation. In the next chapter, a summary of the literature pertaining to the indications for admission in ICU as well as airway management and extubation will be presented. The researcher will also review the physiotherapy treatment techniques used in ICU and highlight the evidence for these techniques.

CHAPTER 2

LITERATURE REVIEW

2.1 THE HISTORY OF CHEST PHYSIOTHERAPY

Physiotherapy practices existed in the ancient times and various components of physiotherapy were gradually discovered. Techniques of massage and gymnastics were practiced for health promotion in the 1580s and later breathing exercises were recognized to promote health and also to improve voice production for singers (Innocenti 1995). In 1894, the society of Masseuses was formed and published a book which also addressed respiratory movements that aimed at promoting more rapid oxygenation of blood. In 1898 Quicke recommended patients to be positioned in prone lying with the head lower than the feet and assume the position for half an hour or more to assist with secretion clearance (Quicke, cited in Innocenti 1995, p682) This method was described as intermittent use of posture (Innocenti 1995). Ewart (1901) described a continuous postural method for patients diagnosed with bronchiectasis and chronic bronchial affections and recommended it over intermittent use of posture. Some patients with tubercular cavities were instructed to lean over the edge of the bed with the aim of emptying secretions. Nelson (1934) described various positions to optimize PD.

Physical and breathing exercises were described by MacMahon (1915) for soldiers suffering from trauma of the lung, pleura and diaphragm during the war. Localized breathing was designed to expand lung tissue, to assist with discharge of pus, to break down adhesions, to restore movement and shape of chest wall. During the 1940s physiotherapy practices such as breathing exercises, PD, postural correction, mobilizing exercises and the use of inhalers for patients with chest and heart conditions continued to progress. CPT was demonstrated to be effective in preventing post-operative pulmonary complications (Palmer and Sellick 1953). This study was conducted on 180 post-operative patients who were allocated to either the experimental group (received PD with percussion and vibration and inhalation before and after surgery) or the control group (received breathing exercises only before and after surgery). Nine percent of the patients in the experimental group developed atelectasis postoperatively compared to 43% in the control group. The results suggested that inhalation combined with the physiotherapy regime was necessary for the prevention of atelectasis.

Respiratory care was intensified during the epidemic of poliomyelitis in Copenhagen in 1952 (Lassen 1953). Tracheotomy was performed in about 250 cases during the epidemic of poliomyelitis due to invariable stagnation of secretions in the upper airway which lead to inadequate ventilation. During this time physiotherapists become accepted and recognized as integral members of the ICU team (Lassen 1953) in the management of patients during and after their critical illness. As acutely ill patients were managed in ICU, the role of physiotherapists was also recognized and summarized by Holderness and Cooper (1968). The role of physiotherapy was described as a) maintenance or restoration of full expansion, b) maintenance of full range of movement of all joints, c) prevention of the accumulation of secretions d) prevention of circulatory complications, e) prevention of muscle atrophy and lastly prevention of the development of pressure sores.

Norrenberg and Vincent (2000) conducted a study to determine the role of physiotherapists in European ICUs. They found that physiotherapists performed respiratory therapy, mobilization and positioning in almost 100% of ICUs. A similar study was conducted in South Africa to determine the role of physiotherapists working in ICU in both the government and private sectors of health care (Van Aswegen and Potterton 2005). This study revealed that physiotherapists working in the government sector were mostly involved with manual techniques (100%), suctioning (100%), extubation (65%), and positioning (94%). The respondents in the private sector were also involved in the same components of physiotherapy and rated 100%, 98%, 65% and 92% respectively. Van Aswegen and Potterton (2005) also compared their results with those of Norrenberg and Vincent (2000). In the European study the suctioning (70%) and extubation (25%) practices were different compared to the South African studies (98% and 65%) respectively and were statistically significant.

This section provided a short summary of the development of physiotherapy and the profession's subsequent involvement in the treatment of patients in ICU. One of the reasons for admitting patients to ICU is for management of respiratory failure and will be discussed further.

2.2 RESPIRATORY FAILURE

Alveolar gas exchange and ventilation may be affected by a wide diversity of conditions that may result in one of two types of respiratory failure. 'Respiratory failure is failure of the respiratory system to provide adequate gas exchange for metabolic requirements' (Hough 2001). The mechanism of respiratory failure may manifest in either failure of gas exchange (Type I) or failure of ventilation (Type II) (Hough 2001). Type I (hypoxemic) respiratory failure is caused by abnormalities of oxygenation [low partial pressure of oxygen in arterial blood (PaO_2)] (Scanlan 1990). 'Hypoxemic respiratory failure is caused by failure of respiratory system' (Hough 2001). Classical examples of Type I respiratory failure are pneumonia, asthma and pulmonary oedema (Oh 2003) and are associated with ventilation-perfusion (V/Q) mismatch, diffusion defect, right-to-left shunt, and alveolar hypoventilation (Hess and Kacmarek 2002).

Type II (hypercapnic) respiratory failure results from inadequate ventilation (Scanlan 1990) and is associated with an elevated partial pressure of carbon dioxide in arterial blood ($PaCO_2$) (Hess and Kacmarek 2002). 'Hypercapnic respiratory failure is caused by failure of the respiratory pump and can be acute or chronic' (Hough 2001). Type II respiratory failure may occur in low PaO_2 and high $PaCO_2$ conditions such as chronic bronchitis, head injury and chest wall injuries (Oh 2003).

2.3 MANAGEMENT OF RESPIRATORY FAILURE

The decision to intubate and mechanically ventilate a patient is based on his/her work of breathing (WOB), oxygenation and effectiveness of ventilation (Pierce 1995). MV is indicated for patients who are unable to oxygenate adequately, ventilate adequately or both (Hough 2001). Type I respiratory failure can either be managed with oxygen (O_2) therapy for less severe cases of hypoxemia (Turner and Tasker 2002), continuous positive airway pressure (CPAP) or with NIPPV for moderate hypoxaemia. In cases where the patient is severely ill and presents with severe hypoxemia, for example in acute respiratory distress syndrome (ARDS), pneumonia or chronic obstructive pulmonary disease (COPD), intubation and MV is considered (Hess and Kacmarek 2002; Pierce 1995). The aims of ventilatory support are to correct hypoxemia, to decrease the WOB and to improve alveolar ventilation (Williams-Colon and Thalken 1990). The correction of hypoxemia may be achieved by regulating the fractional concentration of oxygen in inspired gas (FiO_2) and applying positive end-expiratory pressure (PEEP), with the aim of maintaining SaO_2 of at least 90% (Pierce 1995). PEEP maintains the pressure in the patient's lungs above the atmospheric pressure at the end of expiration to prevent atelectasis and also recruits atelectatic alveoli (Pierce 1995; Scanlan 1990). Patients in ICU need continuous monitoring and support (Hough 2001) hence abnormal blood gas results warrants changes in ventilator settings in order to maintain adequate oxygenation and ventilation.

Respiratory acidosis is characterized by $PaCO_2$ > 45mmHg and hydrogen ion concentration (pH) < 7.35. Respiratory alkalosis is characterized by pH > 7.45 and $PaCO_2$ < 35mmHg (Piece 1995). Type II respiratory failure is associated with respiratory acidosis and hypoxaemia (Hough 2001). Respiratory acidosis is corrected by adjusting the tidal volume and RR settings on the ventilator (Pierce 1995) to blow out $PaCO_2$. The researcher will discuss conventional mechanical ventilation further as it is applicable to the methodology used in this study.

CMV refers to an invasive method of administering ventilatory support. An artificial airway (endotracheal tube) is inserted into the trachea, (through a nasal or oral route) or directly in the trachea (tracheostomy tube) (Simmons 1990). The indications for intubation are to (a) facilitate the removal of secretions, (b) relieve airway obstruction, (c) protect the lower airway from aspiration and (d) facilitate the application of PPV (Simmons 1990). The process of MV is completely different from the normal mechanism of respiration. When a spontaneous inspiration is initiated, muscular effort is exerted by contraction of the diaphragm and external intercostals muscles, creating a negative pressure in the lungs which leads to the movement of air from the atmosphere into the lungs (Pierce 1995). With MV, inspiration will take place due to the generation of positive pressure by an artificial process from a lower to a higher positive pressure (alveolar and intrapleural) (Pierce 1995).

The treating doctor decides on the desired mode of MV to ensure optimal interaction between the patient and the ventilator to achieve adequate ventilatory support and gas exchange. The patient's pathological condition is considered when choosing a particular mode of ventilation (Scanlan 1990) and also depends on the WOB the patient is able to perform. The mode of ventilation chosen for the subjects in this study was based on the reason for admission to ICU. Subjects in this study were managed with either synchronized intermittent mandatory ventilation (SIMV) alone or in conjunction with pressure support (PS) or with volume control mode. With SIMV mode the patient is guaranteed a preset amount of tidal volume and number of breaths, and the patient may initiate breaths in between the mandatory breaths (Pierce 1995). When the SIMV mode is used in conjunction with PS, only the spontaneous breaths are augmented by the delivery of a preset amount of inspiratory positive pressure (Pierce 1995). With volume control, also known as continuous mandatory ventilation, the patient is guaranteed a preset amount of tidal volume and number of breaths per minute and the ventilator performs all the WOB without any spontaneous efforts from the patient (Pierce 1995). Patients are gradually weaned off ventilatory support once spontaneous breathes are detected. This will be elaborated upon further in the section on weaning and extubation. Tracheostomy is indicated when prolonged need for intubation arises for example the management of patients who sustained severe injuries such as blunt chest trauma or head injury (Simmons 1990). However, tracheostomy will not be discussed any further as it is not relevant to this study.

2.4 COMPLICATIONS THAT ARISE DUE TO MECHANICAL VENTILATION

Patients who receive MV might develop haemodynamic instability due to the mechanism of positive pressure ventilation (Conti et al 2002). PPV impedes venous return to the heart due to the positive intrapleural pressure that it creates and in turn decreases cardiac output (CO) which results in a reduction of renal, hepatic and splanchnic blood flow (Hough 2001; Pierce 1995). 'Haemodynamic compromise is also likely to occur if mean airway pressure (MAP) is high; inspiratory time prolonged or mean expiratory pressure raised as with PEEP' (Hough 2001). MV is also associated with alveolar over distention which is due to an increased MAP, large tidal volume and the use of PEEP. This may result in compression of adjacent pulmonary capillaries and regional hypoperfusion (Pierce 1995) that could lead to altered oxygenation.

A second complication of intubation and MV is laryngeal and/or tracheal injury due to the presence of the artificial airway. Laryngeal injuries include glottic stenosis, oedema and vocal cord paralysis (Hess and Kacmarek 2002).Tracheal injuries (tracheal stenosis and tracheomalacia) are caused by high endotracheal cuff pressures that compress the tracheal mucosa (Hess and Kacmarek 2002). This complication may be avoided by adhering to protocols for cuff inflation. The movement of the tube, especially with self extubation and excessive neck flexion and extension, may cause abrasion and could be avoided by securing the endotracheal tube firmly to the nose or mouth (Plevak and Ward 1997). Malposition of the tube (either high or low), mouth or lip pressure sore development, laryngospasm, glottic oedema, tracheobronchial fistula, tracheomalacia and tracheal stenosis are additional complications that may arise (Pierce 1995).

Another potential complication of MV is atelectasis. In any position assumed by the patient, ventilation-perfusion (V/Q) mismatch occurs. The non-dependent areas of the lungs are preferentially ventilated by the application of PPV (Woodard and Jones 2002) because the diaphragm becomes inactive due to sedation. The prolonged application of high levels of FiO_2 displaces alveolar and blood nitrogen and may result in atelectasis (Pierce 1995). Absorption atelectasis may also occur due to low tidal volume ventilation with high FiO_2 (Hough 2001). 'Spontaneous breathing draws ventilation down to the dependent lung regions, causing a downward ventilation gradient' (Hough 2001). With PPV this gradient is reversed, unless if the mode of ventilation encourages spontaneous breathing. The reversed ventilation gradient leads to the dependent areas receiving the least ventilation and result in progressive atelectasis (Hough 2001).

The presence of an artificial airway may impair the effectiveness of a cough and affect the mucociliary activity (Hess and Kacmarek 2002). Impaired mucociliary activity may be due to inadequate humidification, underlying lung pathology, high FiO_2, drugs (such as narcotics) and airway trauma due to suctioning (Hess and Kacmarek 2002). The patient's cough may be ineffective due to the depression of the neurological status, a decreased functional residual capacity (FRC) due to abnormal glottic function and result in accumulation of secretions (Judson and Sahn 1994; Hess and Kacmarek 2002; Pierce 1995). An inability to cough effectively, (either due to respiratory muscle weakness or pain) may also be observed in patients breathing spontaneously in ICU after extubation and therefore physiotherapists should be familiar with assistance techniques and cough stimulation (Ciesla 1996).

Contamination of the lower airway may occur due to intubation, which bypasses the normal filtering mechanism of the upper airway. Artigas and colleagues (2001) conducted a prospective cohort study to determine risk factors for the development of nosocomial pneumonia in critically ill trauma patients. The study sample was a group of 103 patients admitted with varying conditions and 22.3% of them developed nosocomial pneumonia. The group with nosocomial pneumonia had a significant increase in days spend on MV and longer ICU stay. The most important risk factor identified by the authors for development of nosocomial pneumonia was prolonged MV, especially with PEEP. The assumption was that PEEP is normally used to treat patients with severe ARF and was therefore associated with prolonged MV. Other independent risk factors for nosocomial pneumonia were the presence of a nasogastric tube as well as continuous enteral feeding due to the risk of aspiration. The authors did mention that the main problem they experienced was the identification of pneumonia, which could have impacted on the results. Fagon and colleagues (1993) stated that pneumonias occurring in ventilated patients are associated with high mortality as compared to patients who had underlying disease (excluding pneumonia) alone.

2.5 THE ROLE OF PHYSIOTHERAPISTS IN ICU

The physiotherapist is regarded as an integral member of the multidisciplinary team that is responsible for the management of patients in ICU in most hospitals in developed countries (Stiller 2000). The most common intervention practiced by physiotherapists in ICU is chest physiotherapy (Norrenberg and Vincent 2000; Stiller 2000; Van Aswegen and Potterton 2005). CPT includes various techniques which will be discussed briefly and supported by the literature.

2.5.1 Manual Techniques

Physiotherapists use various manual techniques such as percussions, vibrations and shaking to treat cardiopulmonary complications. Shaking and vibrations are done during the expiratory phase of the respiratory cycle and are used to aid the removal of secretions from the tracheobronchial tree (Pryor et al 2002; Scanlan 1990). The physiotherapist places her hand on the chest wall and once the patient takes a deep breath, rapid vibratory motion is applied to the chest wall on expiration (Scanlan 1990). Chest percussions are done throughout the respiratory cycle. The indication of percussions is to assist with the mobilization of tenacious secretions from the tracheobronchial tree (Pryor et al 2002; Scanlan 1990). Gallon (1991) conducted a study on nine bronchiectatic patients to determine the effect of manual chest percussion. The results showed a significant production of secretions when percussion was done in conjunction with other physiotherapy modalities. These modalities may vary from one study to the other but mainly include PD or modified positioning, suctioning, MH, and ACBT as observed in other studies (Ntoumenopoulos et al 2002; Stiller et al 1996; Wong 2000). Multimodality physiotherapy treatment was demonstrated to be more effective than single modality physiotherapy treatment (Stiller et al 1990) or breathing exercises alone (Palmer and Sellick 1953) in resolving acute lobar atelectasis.

2.5.2 Positioning

Routine positioning is done by nurses and physiotherapists with the aim of reducing adverse effects of bed mobility such as bedsores and pulmonary complications (Dean 2002). Positioning is often used to facilitate the mobilization of secretions from specific lung segments with the assistance of gravitational forces (known as PD); to improve the distribution of ventilation (dependent positioning) and to relieve dyspnea (relaxation technique) (Scanlan 1990). Alternate side lying is the most common position used in the ICU to assist with secretion clearance (Dean 2002). In fact, Stiller and colleagues (1990) showed that side lying with the affected lung uppermost in a head down tilt position was most effective in the management of acute atelectasis**.** A follow up study also showed that modified PD or PD in addition to MH and suctioning hourly brought about the resolution of atelectasis after one treatment session (Stiller et al 1996).

Berney and colleagues (2004) found that the addition of a head down tilt position to physiotherapy treatment in the ICU enhanced secretion production. Patients with predominantly unilateral lung disease may have improved oxygenation when nursed in lateral side lying with the good lung down (Pierce 1995). Positioning intubated and mechanically ventilated patients in a semi recumbent position has been shown to minimize the aspiration of gastric contents to the lower airway (Torres et al 1992).

2.5.3 Suction

Suction is defined as an invasive airway clearance technique to aspirate material from the upper airway mechanically (Plevak and Ward 1997). Suctioning is indicated when an individual is unable to expectorate secretions due to an ineffective cough (Pryor et al 2002), which may be the result of loss of consciousness and/ or the inability to protect the airway (Plevak and Ward 1997). The process of suctioning should be timed with interventions carried out in ICU such as change in the patient's position and during or after physiotherapy because of the greater prevalence of upper airway secretions (Ciesla 1996) following these procedures.

2.5.4 Manual Hyperinflation (MH)

This technique refers to the delivery of a volume of gas greater than tidal volume to the patient's lungs via an endotracheal tube or tracheostomy or through a face mask (Barker and Eales 1994; Risley and Jones 2003). Physiotherapists use MH for recruitment of atelectatic lung segments (Hodgson, Carroll and Denehy 1999; Van Aswegen and Eales 2004). In addition, MH is commonly used to (a) aid the removal of secretions, (b) improve static lung compliance**,** and (c) improve oxygenation (Berney and Denehy 2002; Hodgson et al 2000; Van Aswegen and Eales 2004). The use of MH has been reported to enhance secretion clearance compared to side lying alone (Hodgson et al 2000).

2.5.5 Active Cycle of Breathing Technique (ACBT)

This modality is commonly used to facilitate the mobilization and removal of secretions from the airways. ACBT is a cycle of thoracic expansion exercises, breathing control and FET for use in patients with excessive airway secretions (Pryor et al 2002). Atelectasis was shown to be effectively managed with ACBT. Wong (2000) conducted a case report on a patient with a medical history of COPD, who developed type I respiratory failure after explorative laparatomy. The patient received physiotherapy treatment comprising of ACBT, huffing and coughing (to facilitate expectoration of secretions), mobilization and exercises. The patient had dyspnea and couldn't cope with manual techniques. This physiotherapy regime was successful and intubation and MV was avoided.

2.6 THE PHYSIOTHERAPY MANAGEMENT OF COMPLICATIONS THAT ARISE DUE TO MECHANICAL VENTILATION

Intubated and mechanically ventilated patients are at risk of the development of complications such as accumulation of secretions, atelectasis and pneumonia (Konrad et al 1994). The techniques used by physiotherapists to manage these complications will be discussed further.

2.6.1 Accumulation of Secretions

As discussed previously, intubated patients in ICU frequently have impaired mucus transport and an impaired cough mechanism, which lead to accumulation of secretions and the development of pneumonia (Konrad et al 1994; Pierce 1995). Several studies have been conducted to investigate the efficacy of CPT in various hospital settings.

Ntoumenopoulos and colleagues (2002) conducted a study to investigate the effectiveness of CPT in intubated and mechanically ventilated patients with the aim of enhancing airway clearance. Patients were allocated to either an intervention group (n = 24) or a control group (n = 36) in a non-randomized pattern after meeting the inclusion criteria such as being mechanically ventilated for at least 48 hours. The intervention group had CPT comprising of vibrations, modified or gravitational postural drainage, and suctioning rendered twice a day, while the control group had cardiopulmonary assessment and musculoskeletal physiotherapy. The intervention group had a significant reduction in the frequency of VAP compared to the control group (8% vs. 39% respectively). There were no statistical differences in ICU length of stay or mortality.

2.6.2 Atelectasis

As mentioned, atelectasis of the dependent lung regions is common in intubated and mechanically ventilated patients and certain components of CPT were shown to be effective in the management of atelectasis. Patients in ICU frequently have impaired mucous transport which is associated with the retention of secretions and pneumonia (Konrad et al 1994). Artificial airway (endotracheal tube or tracheostomy) also compromises both mucociliary function and cough effectiveness (Plevak and Ward 1997). A study conducted by Khamiees and colleagues (2001) showed that excessive endotracheal secretions, especially in the absence of a good cough, could lead to bronchial plugging, atelectasis, and/or aspiration pneumonitis, all of which can cause respiratory failure.

Stiller and colleagues (1990) conducted a study to investigate whether multimodality physiotherapy treatment was more effective than a single modality physiotherapy regime in treating patients with acute lobar atelectasis. Patients were allocated to either the experimental or control group in an alternate fashion. Seven patients were allocated to the experimental group and had vibrations, MH (or deep breathing exercise) positioning (with the affected lung uppermost) and suctioning (or coughing) as their treatment regime. In the control group seven patients had MH (or deep breathing exercises) and suctioning (or coughing) alone. Treatment was rendered hourly for six hours in both groups. A significant resolution of atelectasis was observed in the experimental group subjects compared to the control group after one treatment intervention. The results showed that the addition of positioning and vibrations added value to the efficacy of a simple chest treatment (MH and suctioning alone). Stiller and colleagues (1996) conducted a follow up study comparing five physiotherapy regimes. The results showed that patients who received modified PD with or without vibrations (group 2 or 3), or PD (group 4) in addition to MH and suctioning hourly had a better resolution of atelectasis after an hourly treatment session for six, 24 and even 48 hours later than those who had hourly MH and suctioning alone for six hours (group 1). In both studies the small samples sizes could have influenced the results obtained.

Van Aswegen and Eales (2004) described a case study on one patient who was assaulted and sustained severe facial injury and presented with low Glasgow Coma

Scale (GCS). The patient's condition deteriorated as a right lung collapse developed. The patient presented with Type II respiratory failure which warranted intubation and MV to protect the airway. The patient was then transferred to ICU for further management and CPT was commenced, which consisted of modified PD (left side lying with the head elevated due to facial oedema), percussion and vibrations, MH and suctioning. The patient had significant improvement in oxygenation after the first treatment session and resolution of atelectasis within 24-hours.

2.6.3 Decreased Lung Compliance

Prolonged atelectasis may result in pulmonary infection and hypoxemia. The consequence of prolonged atelectasis may be a reduction in pulmonary compliance making ventilation difficult (Berney and Denehy 2002).

Berney and colleagues (2004) conducted a study on 20 patients who were intubated and mechanically ventilated. The purpose of the study was to investigate the effect of a head-down tilt during physiotherapy treatment on sputum production. Patients were randomly allocated to receive MH treatment in both supine and head-down tilt (35^0- 45^0 elevation) positions during two different sessions on one day. Static lung compliance was measured before and after physiotherapy treatment. Compliance improved significantly after physiotherapy treatment that included MH in both positions. The study also showed a significant improvement (25%) in sputum production with the addition of a head-down tilt rather than supine position.

MH was shown to be effective in improving static lung compliance in critically ill patients (Hodgson et al 2000). The study was conducted on 18 mechanically ventilated patients who acted as their own controls. Patients were randomly allocated to receive either MH (consisted of side lying position, suctioning and MH) or side lying (positioning and suctioning) treatment first and had two sessions per day. The MH group had a significant increase in secretion clearance and total static compliance, which was still present 20 minutes after treatment. Mean arterial pressure and heart rate (HR) were not statistically different between the two treatment sessions.

WEANING AND EXTUBATION

Weaning of the intubated patient involves the gradual reduction and removal of ventilatory support and restoration of the patient's spontaneous breaths (Halliday 2004: Turner and Tasker 2002). The process of weaning commences once the patient is alert and cooperative, an improvement in clinical condition is observed and the patient has the ability to clear bronchial secretions adequately (Turner and Tasker 2002). The weaning process requires ongoing assessment and planning by all members of the critical care team (Henneman et al 2001) and should be tailored to the needs of each patient (Scanlan 1990). Readiness to wean is defined as normal blood electrolyte levels and body temperature, resolution of respiratory failure (Hess and Kacmarek 2002), haemodynamic stability, the ability to initiate adequate respiratory drive (maintain normal $PaCO_2$) and adequate nutritional support (to prevent muscle weakness and failure) (Woodard and Jones 2002).

To date, several studies have been conducted to determine the best technique for weaning patients from MV. Saura and colleagues (1996) conducted a study to analyze the effect of the implementation of a weaning protocol on clinical outcomes. The weaning protocol group was retrospectively compared to the historical group of patients. Patients in the protocol group (n = 51) had a significant shorter duration of MV and ICU stay compared to the historical control group (n = 50). Kollef and colleagues (1997) conducted a study comparing two weaning methods from MV. Protocol directed weaning from MV (performed by nurses and respiratory therapists) was shown to be a safe technique and led to extubation more rapidly than physician directed weaning. Consequently, the protocol-directed weaning group had a significantly reduced duration of MV and more successful weaning than the physician –directed weaning group. Scheinhorn and colleagues (2001) compared the outcomes of patients on a therapist implemented patient-specific (TIPS) weaning protocol to patients on a physician-directed weaning protocol in a retrospective study design (conducted two years previously). The average duration of weaning from MV was significantly reduced in the TIPS group compared to the physician-directed group. Results from the three above mentioned studies would suggest that a multidisciplinary approach to weaning is effective and reduces the risk of complications associated with this procedure.

Weaning is performed by the gradual reduction of mandatory breaths performed by the ventilator (e.g. SIMV) and thus allowing the patient to initiate more spontaneous breaths while receiving some PS from the ventilator (Woodard and Jones 2002). PS is reduced once the patient is able to maintain adequate oxygenation and maintain normal levels of $PaCO_2$. Weaning is progressed to either CPAP or T-piece (Woodard and Jones 2002). CPAP weaning is the application of positive pressure to spontaneous breaths during inspiration and expiration. The aim of CPAP is to prevent alveolar collapse, improve FRC and enhance oxygenation (Pierce 1995). During T-piece weaning the patient is disconnected from the ventilator and performs all WOB spontaneously while receiving humidified oxygen (Pierce 1995). Once the patient is able to maintain oxygenation and a normal breathing pattern on CPAP or a T-piece, the patient is ready for extubation (Pierce 1995).

During the weaning period the patient should be monitored for signs of respiratory muscle fatigue such as tachypnoea and respiratory paradoxus (abnormal breathing pattern) (Hess 1997). The length of the weaning process varies and is dependent on the individual's ability to cope with the procedure. The weaning process may be short in uncomplicated patients for example in controlled extubation post operatively. The process may be prolonged in a long-term ventilated patient and is initiated by reducing sedation and using positioning for optimal diaphragmatic excursion (Woodard and Jones 2002).

Extubation is the process of removing the endotracheal tube once the patient can protect his/her airway and the underlying problems have been resolved. Successful extubation requires a patient to be able to mobilize and expectorate their secretions and to protect their own airway after removal of the artificial airway (Hess and Kacmarek 2002). Early successful extubation will reduce the risk of complications due to prolonged MV.

Extubation may fail due to various reasons such as the inability to cough, nosocomial pneumonia, atelectasis and bronchospasm as observed in Saura's study (1996). Extubation failure prolongs ICU stay, the duration of MV which leads to the need for tracheostomy and it is associated with higher hospital mortality (Epstein 2002). Extubation failure is synergistically enhanced in the presence of abundant endotracheal secretions and poor cough strength (Khamiees et al 2001). Health care workers also overlook the influence of individual tolerance and fatigue on successful weaning and extubation**.** Re-intubation is a prolonged means of airway protection and/or ventilatory support, not a predictor of mortality (Daley, Garcia-Perez and Ross 1996). Demling and colleagues (1988) compared the incidence of extubation failure of patients managed in general surgical ICU vs. trauma/burns unit by using standardized criteria. Patients in the trauma unit were young and in good health, and had 3% failure rate. The reason for extubation failure was that patients couldn't protect the airway and clear secretions. Patients in the general surgical ICU had 4.4% failure rate and the reason was the need for further ventilatory support. The mortality rate was 10% in the trauma unit compared to 40% in the general surgical ICU which was dependent on the underlying disease process. In an attempt to reduce these problems thorough patient assessment and collaborative teamwork is emphasized in ICU worldwide.

2.8. CONCLUSION OF LITERATURE REVIEW

The literature presented in this chapter portrayed the management of respiratory failure through intubation and MV, complications that arise due to MV and the role of physiotherapy in the management of these complications as well as the process of weaning and extubation. However there is a dearth of literature on the effectiveness of CPT immediately prior to extubation and how the inclusion or omission thereof might influence patient outcome. The next chapter of this report will describe the methodology that was followed in order to conduct the RCT.

CHAPTER 3

RESEARCH METHODOLOGY

The methodology discussed in this chapter is based on the findings of the literature review discussed in Chapter 2. The study design, sample population, hypotheses tested, data collection procedure and instruments used are discussed in detail. The main methods used for data analysis are given. Ethical considerations are addressed towards the end of this chapter.

3.1 STUDY DESIGN

A randomized control trial was done.

3.2 RESEARCH METHOD

Quantitative data was collected. Respiratory function was assessed (RR, breathing pattern, cough effectiveness, PEFR). Gas exchange was assessed (ABG analysis) as well as lung sounds (auscultation).

3.3 VARIABLES

Independent variable: Omission of one CPT session prior to extubation.

Dependent variables:

- Respiratory function (RR, breathing pattern, cough effectiveness and PEFR). Normal values used were according to those published by Middleton S and Middleton PG (2002, p. 11). The effectiveness of the cough was a subjective assessment and was only assessed by the researcher to reduce bias.
- Breath sounds (auscultation)
- Gas exchange [pH, $PaCO_2$, partial pressure of oxygen in arterial blood (PaO_2), bicarbonate (HCO_3), FiO_2, SaO_2] Normal values used were according to those published by Middleton S and Middleton PG (2002, p 21).

3.4 HYPOTHESES

- The omission of one CPT treatment immediately prior to extubation leads to higher indication for CPT in patients when assessed four hours post extubation.

- The null hypothesis: There is no difference in the indication for CPT four hours after extubation between the groups.

3.5 SAMPLE SELECTION

The study sample consisted of all patients admitted to Dr George Mukhari Hospital ICU, intubated and mechanically ventilated. Patients had to meet set criteria prior to extubation: (1) HR < 140 beats /min, (2) RR < 35 breaths /min, (3) PaO_2/FIO_2 ratio of > 200, (4) awake and oriented, (5) not requiring vasoactive or inotropic agents, (6) PEEP < 5cm of water.

3.6 INCLUSION AND EXCLUSION CRITERIA

The inclusion criteria was (1) any patient older than 18 years irrespective of their condition, (2) mechanically ventilated and intubated for < 5 days, (3) eligible for extubation on or before day 5. Patients excluded from the study were those who were mechanically ventilated for more than 5 days.

3.7 DATA COLLECTION

The researcher and research assistant (qualified physiotherapist with ten years experience) attended twice daily ward rounds in the ICU to identify potential subjects for the study. All patients received CPT treatment twice daily throughout their ICU stay. CPT comprised percussion, vibrations, alternate side lying, deep breathing exercises, and coughing while suctioning.

Once the patient was deemed ready for extubation, the sister in charge of the patient informed the researcher telephonically. The researcher explained the study to the patient or relative using the subject information sheet (see appendix I) and obtained informed consent from either the patient or relative prior to enrolment in the study. The patient's haemodynamic status and ABG results were recorded by the researcher on the outcome measurement sheet (see appendix III). The researcher then informed the research assistant that the patient was ready for extubation. Patients who met the inclusion criteria were randomly allocated to either experimental or control group by the research assistant using an Excel generated randomization list (see appendix IV). A consecutive sampling technique was used.

The sister in charge of the patient and the research assistant had to prepare the patient for extubation. The patient's baseline haemodynamic status was monitored throughout the treatment session. The research assistant explained the extubation procedure and the benefits of suctioning to the patient, and pre-oxygenated the patient. Treatment and extubation of the patient was carried out by the research assistant. Patients allocated to the control group received CPT, as described above, and suctioning prior to extubation. Patients in the experimental group were only suctioned and extubated. All patients were placed in a semi fowler's position just before extubation to eliminate the possibility of aspiration. The patients were instructed to take a deep breath, the endotracheal tube cuff was deflated and pulled out and the patient was instructed to cough. Once the patient was extubated, he/she was nebulized with a bronchodilator (Atrovent and Berotec) to prevent post extubation bronchospasm and thereafter administered with the prescribed humidified oxygen therapy.

Hourly observations and ABG were done by the sister in charge of the patient to ensure that the patient was coping and was haemodynamically stable. Four hours post extubation, the researcher recorded the patient's haemodynamic status and ABG results on the outcome measurement sheet (see appendix III). Physiotherapy chest assessment (which included RR, respiratory pattern, PEFR, cough and auscultation) and treatment was carried out by the researcher following any abnormal findings which warranted CPT. The presence of secretions was addressed with mobilization and loosening of secretions through nebulization therapy with 0.9% sodium chloride (NaCl) solution, modified PD, ACBT and manual chest therapy and was complimented by coughing and/or suctioning to remove secretions.

3.8 DATA ANALYSES

Demographic information described by continuous parameters such as age, and length of MV was summarized using means and standard deviations (SD). A two sample t-test was performed on the above parameters. Demographic information described by categorical parameters such as breathing pattern, cough effectiveness and auscultation findings were summarized using frequencies, percentages and cross tables. Groups were compared with respect to the categorical parameters using the Fischer's exact test. Quantitative information (RR) was expressed as means and SD. A two-sample t-test with unequal variances and a non-parametric Mann-Whitney test were used to compare the ABG and RR results between the groups. The STATA 8 statistical software package was used for all statistical analyses and throughout testing was done at the 0.05 level of significance. A sample size of 35 patients per group would give 80% power to detect a change from 0.25 to 0.05 in the extubation failure rate between the experimental and the control groups.

3.9 ETHICAL CONSIDERATIONS

Ethical clearance was obtained from the University of the Witwatersrand Committee for Research on Human Subjects (clearance number M050210 – see appendix II). Permission was obtained from the Chief Executive Officer at Dr George Mukhari Hospital to conduct the study.

Written consent was obtained from all subjects who participated in the study. Confidentiality was maintained by coding all data that was captured on the Outcome Measurement Sheets and the database on the computer. Subjects were allowed to withdraw from this study at any time without compromise of regular treatment.

The results obtained through the above mentioned methodological process are described in chapter 4.

CHAPTER 4

4.1 RESULTS

This chapter describes the results obtained from the RCT that was discussed in the previous chapter.

Data were collected from January – April 2007 and a total of 22 patients fitted the inclusion criteria for this study. The demographic characteristics of these patients are summarized in Table 4.1 below.

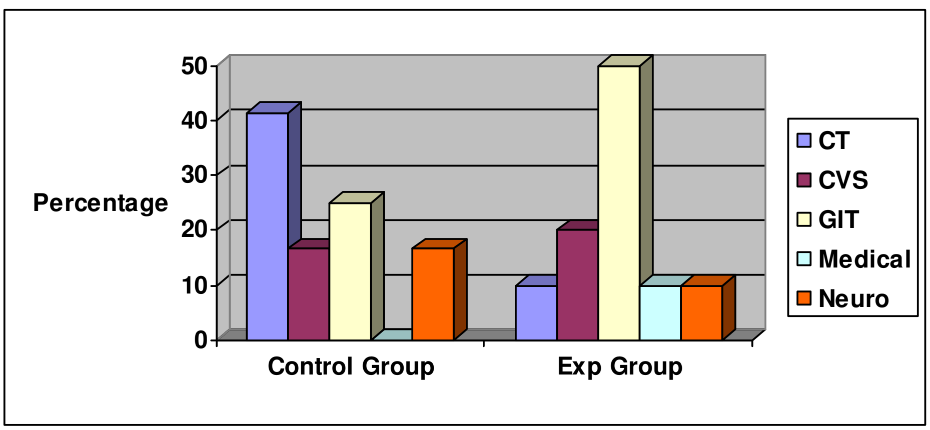
Table 4.1: Characteristics of Participants

Variable	Control group (n = 12)	Experimental group (n = 10)	P-value
Age (years)	30.4 (10.3)	40.7 (19.8)	0.161
Sex	7 Male 5 Female	5 Male 5 Female	NS
Length of MV (days)	0.58 (0.6)	2.4 (1.1)	0.000*

**Data expressed as mean (± SD) or numbers; * = p < 0.05; NS = not significant*

There was no significant difference in age or sex between the groups. Subjects in the control group had a significantly shorter period of MV than those in the experimental group. Figure 4.1 depicts the admission diagnoses for subjects in each group.

Figure 4.1: Admission Diagnoses of Subjects



**CT = cardiothoracic surgery; CVS = cardiac/cardiovascular surgery; GIT = gastro-intestinal surgery; Medical = medical conditions; Neuro = neurosurgery*

The majority of subjects in the control group underwent cardiothoracic and gastro-intestinal surgery whereas the majority of those in the experimental group underwent gastro-intestinal surgery.

ABG results, taken four hours after extubation, are summarized in table 4.2. Results for 21 subjects were obtained. Results for the remaining subject could not be obtained due to the absence of an arterial line at the time of assessment.

Table 4.2: Arterial Blood Gas Results for Subjects in the Control and the Experimental Groups as Measured Four Hours after Extubation.

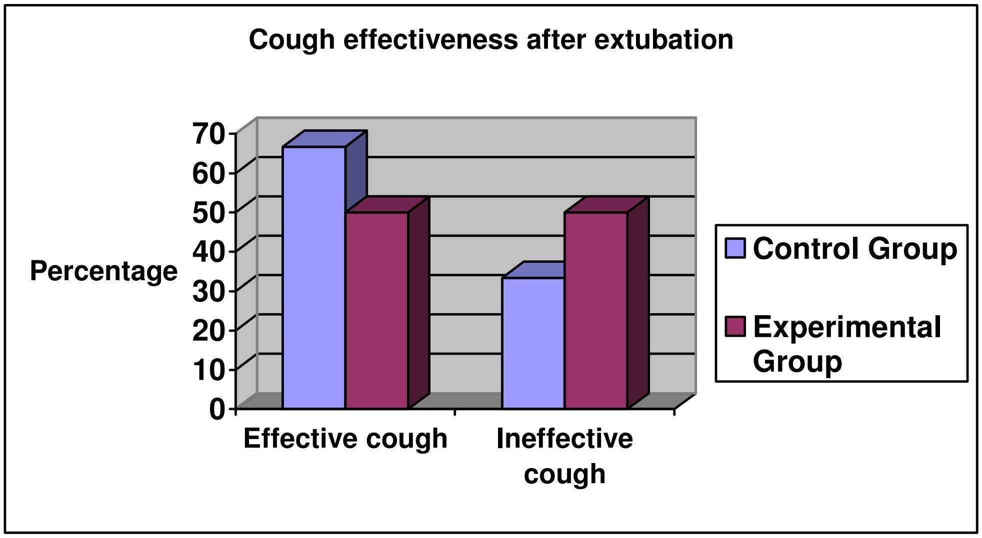
Variable	Control group (n = 11)	Experimental group (n = 10)	P value
pH	7.39 (0.01)	7.4 (0.02)	0.92
PaCO2 (kPa)	5.42 (0.16)	5.57 (0.42)	0.74
PaO2 (kPa)	13.66 (1.35)	12.11 (1.26)	0.41
HCO3 (mmol/L)	24.86 (1.00)	25.37 (1.25)	0.75
Fi02	0.48 (0.06)	0.51 (0.03)	0.73
SaO2 (%)	95.76 (1.73)	97.53 (0.71)	0.36

**Data expressed as mean (±SD); kPa = kilo pascal; mmol/L = millimol per liter; % = percentage.*

No statistically significant differences were observed for ABG results between the two groups four hours after extubation.

Nine subjects in the control group and seven subjects in the experimental group presented with normal breathing patterns on assessment four hours after extubation. Three subjects in each group presented with abnormal breathing patterns due to postoperative pain but this was not statistically significant ($p = 1.00$). Subjects in the control group presented with a mean RR of 25.4 breaths/minute (SD = 7.4) and those in the experimental group with 29.8 breaths/minute (SD = 8.2) four hours after extubation. This difference was not statistically meaningful ($p = 0.228$) but did have some clinical relevance. Findings for the assessment of cough effectiveness four hours after extubation for subjects in both groups are summarized in Figure 4.2 below.

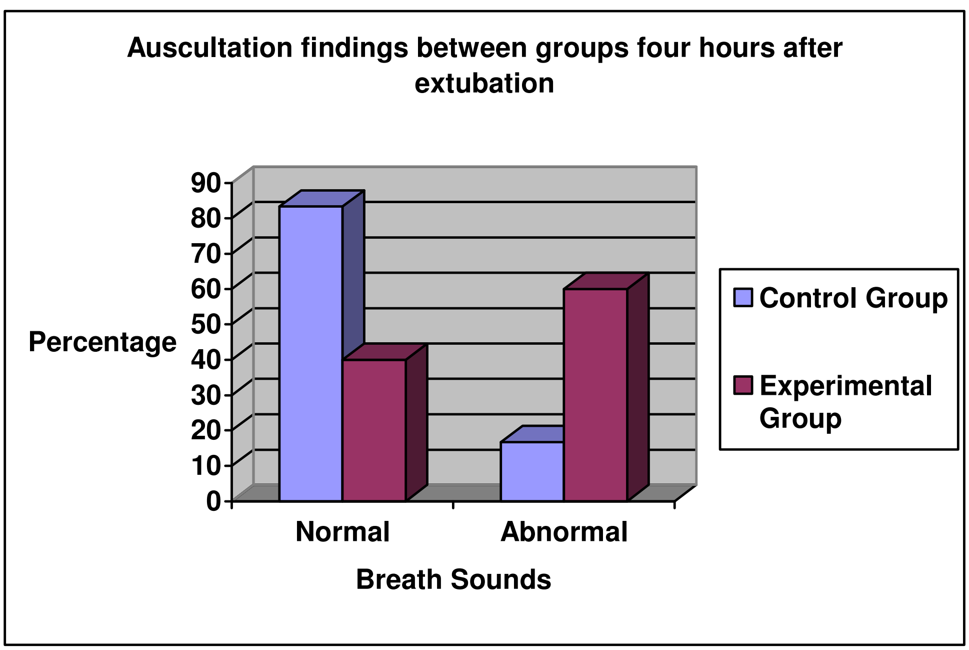
Figure 4.2: Cough Effectiveness Four Hours after Extubation



Eight subjects in the control group and five in the experimental group presented with an effective cough four hours after extubation. Four subjects in the control group and five in the experimental group presented with an ineffective cough effort but this was not statistically significant (p = 0.66).

Results of the auscultation findings for subjects in both groups are summarized in Figure 4.3.

Figure 4.3: Auscultation Findings Four Hours after Extubation



Ten subjects in the control group and four in the experimental group presented with normal breath sounds on auscultation four hours after extubation. Two subjects in the control group and six in the experimental group presented with added sounds (coarse crackles) four hours after extubation and this was statistically significant ($p = 0.04$).

Peak expiratory flow rate turned out to be a poor outcome measure as some subjects were unable to perform this maneuver due to high levels of postoperative pain and others were unable to follow instructions for the correct use of the PEFR instrument. The results obtained from the remaining subjects were too few for statistical analyses.

Eight subjects in each group received physiotherapy treatment four hours after extubation due to abnormal breathing patterns, ineffective cough efforts and added sounds on auscultation.

None of the subjects in either group required re-intubation when assessed four hours after extubation.

This chapter summarized the results obtained through the RCT that was performed on subjects admitted to Dr George Mukhari hospital ICU between January and April 2007. The next chapter offers an in-depth discussion of these results.

CHAPTER 5

DISCUSSION

The main findings of this pilot study were that the omission of one CPT treatment prior to extubation led subjects in the experimental group to present with a higher mean RR and significantly more abnormal breath sounds on auscultation four hours after extubation compared to those in the control group. However, an equal amount of subjects in both groups required CPT treatment four hours after extubation.

Patients normally present with complications following surgery. Hough (2001) described some respiratory complications after surgery as atelectasis, hypoxaemia and chest infection. Chest infection occurs due to intubation and impaired mucociliary activity due to anesthesia (Hough 2001). Pain leads to inhibition of breathing and immobility and may affect the patient's ability to cough, reduce FRC and result in atelectasis (Hough 2001). Abdominal surgery has less direct effect on respiration (Hough 2001) but the distention of the abdomen leads to reduction of tidal volume due to diaphragmatic splinting. The incision through the rectus abdominis muscle will decrease the patient's ability to cough effectively resulting in secretion retention postoperatively. Following thoracic surgery [aortic valve replacement (AVR), mitral valve replacement (MVR), coronary artery bypass graft (CABG)] patients may present with cardiovascular instability, which may restrict bed mobility. The CABG may result in impaired cerebral perfusion and cause disorientation (Hough 2001). The pain associated with thoracic surgery occurs as a result of the incision of the muscles and resection of the rib causing restricted chest and shoulder movement and eventually decreased tidal volume. Incision through the sternum contributes to postoperative pain experienced and also leads to reduced cough effectiveness (Jeyansingham et al 1998).

The physiotherapist is regarded as an integral member of the multidisciplinary team that is responsible for the management of patients in ICU in most hospitals in developed countries (Stiller 2000). The general principles of physiotherapy management of a postoperative patient are to maintain adequate lung ventilation, to promote reinflation of areas of atelectasis, to aid with removal of bronchial secretions, to ensure correct posture, to assist in bed mobility and ensure early ambulation (Ridley and Heinl-Green 2002). If the patient is unable to mobilize, either due to pain or surgical procedure, the patient should be positioned comfortably in bed (Hough

2001). Patients may be positioned in supported crook lying or side lying, which ease the load of abdominal contents on the diaphragm (Jenkins and Tucker 2002). Optimum lung volumes may be achieved by assuming an upright position as it increases FRC, therefore high sitting, sitting out of bed and ambulation may also be encouraged (Jenkins and Tucker 2002). Mobilization of secretions may be enhanced by various techniques such as PD, manual techniques, supported coughing and huffing. The patient should be taught wound support. In the absence of a strong productive cough, the patient may be suctioned to ensure secretion clearance. Adequate pain management is imperative prior to airway clearance (Jenkins and Tucker 2002). The patient should be advised on upper limb exercises and posture correction (Ridley and Heinl-Green 2002) to avoid patients leaning towards the incision side. These physiotherapy management principles do not vary much in the treatment of patients with various surgical incisions.

Chest physiotherapy is an accepted treatment method in the ICU as well as on the wards as evidence in the literature showed that it increases pulmonary volumes, is effective in the clearance of excessive pulmonary secretions and re-inflates atelectatic lung segments. Evidence also suggests that CPT leads to improvements in oxygenation, lung compliance and CO_2 clearance and reduces the incidence of VAP (Hodgson et al 2000; Ntoumenopoulos et al 2002; Van Aswegen and Eales 2004).

Results from the current pilot study showed that subjects in the experimental group had a significantly longer period of intubation than those in the control group. This might have been due to the difference in admission diagnoses between these subjects. The majority of subjects in the control group underwent elective surgery for AVR, MVR or for CABG. These subjects were admitted to ICU for controlled extubation, did not require prolonged MV and did not present with many respiratory problems. Some subjects in the control group suffered from empyema and had decortications and other had gastro-intestinal surgery. Subjects in the experimental group mostly suffered from abdominal gunshot wounds or bowel obstruction. Penetrating abdominal injuries carry a high risk of infection (Feliciano 2004) and multiple organ injury (Adesanya et al 2000). Therefore these subjects often require longer periods of MV and sedation. The abovementioned differences could have attributed to the difference in MV time observed between the groups.

The longer period of intubation and MV in the experimental group might have led to the development of respiratory muscle atrophy. Dean (2006) stated that disuse atrophy starts at cellular level after only 4 hours of bed rest. These subjects also presented with a significantly higher RR than those in the control group that could be explained by the above mentioned respiratory muscle weakness. However, most of these subjects underwent laparotomy incisions. Postoperative pain could also have contributed to higher observed RR in the experimental group.

Subjects in the experimental group had significantly more added sounds on auscultation four hours after extubation than those in the control group. Various authors stated that MV led to decreased FRC due to lower volumes in dependent lung segments (Dean 2006; Woodard and Jones 2002). Endotracheal or tracheostomy tube also compromises both mucociliary function and cough effectiveness (Plevak and Ward 1997). As mentioned in the previous chapter, some patients were unable to do PEFR due to high levels of pain experienced postoperatively. Pain could lead to poor cough effort that would cause secretion retention especially in subjects with laparotomy incisions. Thus the presence of more added sounds on auscultation for subjects in the experimental group could be ascribed to low lung volumes and the poor cough efforts observed after extubation.

However, despite the difference in results observed between the two groups, an equal amount of subjects from both groups presented with indications for CPT treatment four hours after extubation. The researcher concluded from this observation that the omission of one CPT treatment immediately prior to extubation might not have influenced the subjects' outcome much in the experimental group. The presentation of these subjects after extubation was more likely to be due to the longer period of MV and the effect of postoperative pain on respiratory function.

The researcher was unable to identify any studies that investigated the effectiveness of CPT treatment immediately prior to extubation in adult subjects. Several researchers investigated the effect of CPT in the paediatric population after extubation (Al-Alalyan, Dyer and Khan 1996; Bagley et al 2005; Bloomfield et al 1998; Flenady and Gray 2002; Halliday 2004). Results showed that CPT did not reduce the incidence of post-extubation lobar collapse but did reduce the need for re-intubation when rendered one- to two-hourly after extubation. The researcher was able to identify two studies that investigated the effectiveness of CPT treatment on adult subjects after extubation. Papadopoulos and colleagues (2005) investigated the effect of CPT immediately after extubation on a group of ICU patients with various diagnoses. A RCT was done. The experimental group received physiotherapy in the form of limb exercises, deep breathing, chest percussions and vibrations, assisted coughing and FET. The control group received advice. The authors found that subjects in the experimental group had significant improvement in vital capacity as well as maximum negative inspiratory pressure. The authors concluded that CPT could play an important role in the success of weaning and extubation. Porta and colleagues (2005) investigated the effect of upper limb exercise training, in addition to conventional physiotherapy treatment, after extubation on the outcome of patients who received MV < 4 days in a respiratory ICU. A RCT was done. They found that subjects who performed the exercises had greater exercise capacity and endurance than their counterparts in the control group. They concluded that upper limb exercises enhanced the effect of conventional physiotherapy in these subjects after extubation. These studies highlight the important role that physiotherapy plays in the period after extubation to prevent complications that may lead to re-intubation.

None of the subjects in this pilot study required re-intubation. However, many subjects in both groups required CPT treatment when assessed four hours after extubation. Based on these results the null hypothesis is accepted which stated that there is no difference in the indication for CPT four hours after extubation between the groups even if one CPT session is omitted immediately prior to extubation.

CHAPTER 6

LIMITATIONS AND RECOMMENDATIONS

The researcher identified the following limitations while conducting this study:

- The major limitation of this pilot study was the small sample size. The interpretation of the results of this study should be done with caution as a Type II error could have occurred during data analysis.

- Secondly, some patients were unable to follow instructions for the correct use of the PEFR instrument due to high levels of postoperative pain; hence there were too few results to be statistically analyzed

The researcher therefore recommends the following:

- A follow-up study (using a similar methodology) should be conducted over a longer time period to investigate the impact of the omission of one physiotherapy treatment immediately prior to extubation on the outcome of patients four hours later.

- PEFR measurement should be omitted as outcome measure in future studies as it was not feasible for use in the early period after surgery due to postoperative pain experienced by patients.

- The level of postoperative pain experienced by subjects should be objectively measured if a follow-up study was to be conducted.

CHAPTER 7

CONCLUSION

The aim of this pilot study was to determine whether the omission of one CPT treatment immediately prior to extubation influenced the outcome of patients four hours after extubation. A RCT was conducted and quantitative data were collected and analyzed to answer the research question. The most significant finding of this pilot study was that there was no difference in the indication for CPT between the groups when assessed four hours after extubation.

This pilot study on the influence of the omission of one CPT session immediately prior to extubation on the outcome of subjects four hours after extubation (in those ventilated less than five days) was the first of its kind to be conducted in Pretoria and in South Africa. Various limitations were identified during the data collection phase and interpretation of these results should be done with caution.

In conclusion the omission of one CPT treatment immediately prior to extubation did not have a negative impact on the outcome of patients in the experimental group. However there does seem to be an important role for physiotherapists to play in the ICU after patients are extubated as many subjects in both groups were in need of CPT treatment four hours after extubation. Physiotherapy intervention is thus very important in order to prevent complications that may lead to re-intubation and prolonged ICU stay.

REFERENCES

Adesanya AA, Da Rocha-Afodu JT, Ekanem EE and Afolabi IR 2000, 'Factors affecting mortality and morbidity in patients with abdominal gunshot wounds', *Injury*, vol. 31, p. 397 – 404.

Al-Alalyan S, Dyer D and Khan B, 1996, 'Chest physiotherapy and post atelectasis in infants', *Pediatric Pulmonology,* vol.21, no 4, p 227-230.

Alexandra EA, Weingarten S and Mohsenifer Z 1996, 'Clinical strategies to reduce utilization of chest physiotherapy without compromising patient care', *Chest* vol. 110, p 430-432.

Artigas AT, Dronda SB, Valles EC, Marco J, Uson MCV, Figueras P, Suarez FJ and Hernandez A 2001, 'Risk factors for nosocomial pneumonia in critically ill trauma patients', *Critical Care Medicine* vol. 29, no. 2, p 304-309.

Bagley CE, Gray PH, Tudehope DI, Flenady V, Shearman AD and Lamont A 2005, 'Routine neonatal postextubation chest physiotherapy: A randomized controlled trial', *Journal of Paediatrics and Child Health* vol. 41, no. 11, p 592-597.

Barker M and Eales CJ 1994, 'Ambubagging as a therapeutic technique: Clinical guidelines', *Physiotherapy* vol. 50, no. 2, p 26-27.

Berney S and Denehy L 2002, 'A comparison of the effects of manual and ventilator hyperinflation on static lung compliance and sputum production in intubated and ventilated intensive care patients', *Physiotherapy Research International* vol. 7, p. 100-108.

Berney S, Denehy L and Pretto J 2004, 'Head-down tilt and manual hyperinflation enhance sputum clearance in patients who are intubated and ventilated', *Australian Journal of Physiotherapy* vol. 50, p 9-14.

Bloomfield FH, Teele RL, Voss M, Knight DB and Harding JE 1998, 'The role of neonatal chest physiotherapy in preventing postextubation atelectasis', *Journal of Pediatrics*, vol. 133, no. 2, p. 269 – 271.

Ciesla ND 1996, 'Chest physical therapy for patients in the intensive care unit', *Physical Therapy,* vol. 76, no 6, p 609-625.

Conti G, Antonelli M, Navalesi P, Rocco M, Bufi M, Spadetta G and Meduri GU 2002, 'Noninvasive vs conventional mechanical ventilation in patients with chronic obstructive pulmonary disease after failure of medical treatment in the ward: a randomized trial', *Intensive Care Medicine* vol. 28, p 1701-1707.

Daley BD, Garcia-Perez F and Ross SE 1996, 'Reintubation as an outcome predictor in trauma patients', *Chest* vol. 110, p 1577-1580.

Dean E 2002, 'Effects of positioning and mobilization' In: Pryor JA & Prasad SA (eds) Physiotherapy for respiratory and cardiac problems: adults and paediatrics, 3rd edition, p143-159, Edinburgh, Churchill Livingstone Publishers

Dean E 2006. In: Frownfelter D, Dean E (eds) Cardiovascular and Pulmonary Physical Therapy: Evidence and Practice, 4th edition, p 263 – 306: 307-324. Missouri, Mosby.

Demling RH, Read T and Lind LJ, Flanagan HL 1988, 'Incidence of morbidity of extubation failure in surgical intensive care unit patients', *Critical Care Medicine* vol. 16, no 6, p 573-577.

Epstein SK 2002, 'Decision to extubate', *Intensive Care Medicine* vol. 28, p 535 – 546.

Ewart W, 1901, 'The treatment of bronchiectasis and of chronic bronchial affections by posture and by respiratory exercises'*, Lancet,* p 70-72

Fagon J, Chastre J, Hance AJ, Montavers P, Novara A and Gibert C 1993, 'Nosocomial pneumonia in ventilated patients: a cohort study evaluating attributable mortality and hospital stay', *American Journal of Medicine* vol. 94, p 281-288.

Feliciano DV 2004, 'Abdominal vascular injury', In: EE Moore, DV Feliciano, KL Mattox (eds), *Trauma*, 5th edn, McGraw-Hill Professional, New York, p. 755 – 778.

Flenady VJ and Gray PH 2002, 'Chest physiotherapy for preventing morbidity in babies being extubated from mechanical ventilation', *Cochrane Database of Systematic Reviews* vol. 2, CD000283.

Gallon A, 1991. ‘Evaluation of chest percussion in the treatment of patients with copious sputum production’, *Respiratory Medicine* vol. 85, p 45-51.

Halliday HL 2004, ‘What interventions facilitate weaning from the ventilator? A review of the evidence from systematic reviews’, *Paediatric Respiratory Reviews,* vol. 5, supplement A, p. S347 – S352.

Henneman E, Dracup K, Ganz T, Molayeme O and Cooper C 2001, ‘Effect of a collaborative weaning plan on patient outcome in the critical care setting’, *Critical Care Medicine* vol. 29, no. 2, p 297-303.

Hess DR 1997, ‘Mechanical ventilation of adult patients: Initiation, management and weaning’ In: Burton G, Hodgkin J & Ward JJ and associate editors Hess DR, Pilbeam SP, Tietsort JA: Respiratory Care: A guide to clinical practice, 4th edn, p 611-641.Philadephia, Lippincott-Raven Publishers.

Hess DR and Kacmarek RM 2002. In: Essentials of mechanical ventilation, 2nd edition, p 113-120; 295-306; 307-315. McGraw-Hill Publisher

Hodgson C, Carroll S and Denehy L 1999, ‘A survey of manual hyperinflation in Australian hospitals’, *Australian Journal of Physiotherapy*, vol. 45, p 185-193.

Hodgson C, Denehy L, Ntoumenopoulos G, Santamaria J and Carroll S 2000, ‘An investigation of the early effects of manual lung hyperinflation in critically ill patients’, *Anesthesia and Intensive Care* vol. 28, p 255-261.

Holderness AE and Cooper RJ 1968, ‘The role of physiotherapists in the Intensive Care Unit’, *Physiotherapy,* vol. 54, no. 3, p 90-93

Honrubia T, Lopez FJG, Franco N, Mas M, Guevara M, Daguerre M, Alia I, Algora A and Galdos P 2005, ‘Noninvasive versus conventional mechanical ventilation in acute respiratory failure: A multicentre, randomized controlled trial’, *Chest* vol. 128, p 3916-3924.

Hough A 2001, Physiotherapy in respiratory care: An evidence-based approach to respiratory and cardiac management, 3rd edn, p 96-118: 119-146: 184-210: 248-286: 317-342: 343-360: Cheltenham, Nelson Thornes**.**

Innocenti D 1995, 'An overview of the development of breathing exercises into the specialty of physiotherapy for heart and lung condition', Physiotherapy*, vol*. 81, no. 7, p 681-93

Jenkins S and Tucker B 2002. Patients'problems, management and outcomes, In Pryor JA, Prasad SA (eds) Physiotherapy for respiratory and cardiac problems: Adults and Paediatrics, 3rd edition, p 243-80, Edinburgh, Churchill Livingstone

Jeyansingham K, Kanagasabay R, Morritt G, Smith B, Smith M and Treasure T 1998, 'The Cardiothoracic Unit', In: Smith M, Ball V (eds) Cardiovascular/Respiratory Physiotherapy, p 119 – 144. Italy, Mosby International.

Judson MA and Sahn SA 1994, 'Mobilzation of secretions in ICU patients', *Respiratory Care* vol. 39, no 3, p 213-226.

Khamiees M, Raju P, DeGirolamo A, Amoateng-Adjepong Y and Manthous CA 2001, 'Predictors of extubation outcome in patients who have successfully completed a spontaneous breathing trial', *Chest* vol. 120, p 1262-1270.

Kollef MH, Shapiro SD, Silver P, St. John RE, Prentice D, Sauer S, Ahrens TS, Shannon W and Baker-Clinkscale D 1997, 'A randomized, controlled trial of protocol-directed versus physician-directed weaning from mechanical ventilation', *Critical Care Medicine* vol. 25, no. 4, p 567-574.

Konrad F, Schreiber T, Brecht-Kraus D and Georgieff M 1994, 'Mucociliary transport in ICU patients', *Chest* vol. 105, no 1 p 237-41.

Lassen HCA 1953, 'A preliminary report on the 1952 epidemic of poliomyelitis in Copenhagen with special reference to treatment of acute respiratory insufficiency'**,** *Lancet* vol. 1, p 37-41

MacMahon C, 1915,'Breathing and physical exercises for use in cases of wounds in the pleura, lung and diaphragm'. *Lancet* vol. 2, p 769-770.

Middleton S and Middleton PG 2002,'Assessment and investigations of patients' problems' In: Pryor JA, Prasad SA (eds) Physiotherapy for respiratory and cardiac problems: Adults and Paediatrics, 3rd edition, p 3-25, Edinburgh, Churchill Livingstone.

Nelson HP 1934, 'Postural drainage of the lung', *British Medical Journal,* vol. 2, p 251-255

Norrenberg M and Vincent JL 2000, 'A profile of European intensive care unit physiotherapists', *Intensive Care Medicine* vol. 26, p 988-94.

Norrenberg M and Vincent JL 2002, 'Physiotherapy in ICU: Useful or Useless?' European Society of Anaesthesiologists. http://www.euroanesthesia.org. Accessed 18 July 2006.

Ntoumenopoulos G, Gild A and Cooper DJ 1998, 'The effect of manual lung hyperinflation and postural drainage on pulmonary complications in mechanically ventilated trauma patients', *Anaesthesia and Intensive Care* vol. 26, p 492-496

Ntoumenopoulos G, Presneill JJ, McElholum M and Cade JF 2002, 'Chest physiotherapy for the prevention of ventilator-associated pneumonia', *Intensive Care Medicine,* vol. 28, p 850-856

Oh TE 2003, 'Oxygen therapy', In: Berstern AD, Soni N, Oh TE (eds) Oh's Intensive Care Manual, 5th edn, p 275-282. Edinburgh, Butterworth Heinemann

Palmer KNV and Sellick BA 1953, 'The prevention of postoperative pulmonary atelectasis' *Lancet* p 164-8.

Papadopoulos ES, Kyprianou TH and Nanas S 2005, 'Chest physiotherapy is effective in the management of intensive care unit patients immediately after extubation', *Critical Care* vol. 9, supplement 1 P128.

Piccuito CM 2005, 'Airway clearance techniques', In: Kacmarek RM, Dimas S, Mack CW (eds) The essentials of respiratory care, 4th edition, p 639-658. Elsevier Mosby

Pierce L.N.B, 1995. In: Pierce L.N.B Guide to Mechanical Ventilation and Intensive Respiratory Care, 1st edition, p 24-56: 92-121: 147- 174**:** 175-205: 206-242, Philadephia, W.B Saunders

Plevak DJ and Ward JJ, 1997' Airway management' In Burton G, Hodgkin J & Ward JJ, and associate editors Hess DR, Pilbeam SP, Tietsort JA: Respiratory care: A guide to clinical practice, 4th edn, p 555-609. Philadephia, Lippincott-Raven Publishers

Porta R, Vitacca M, Gile LS, Clini E, Bianchi L, Zanotti E and Ambrosino N 2005, 'Supported arm training in patients recently weaned from mechanical ventilation', *Chest* vol. 128, no. 4, p 2511 – 20

Pryor JA, Webber BA, Bethune D, Enright S, Howarth A, Potter HM and Tagg L 2002,'Physiotherapy techniques' In: Pryor JA, Prasad SA (eds) Physiotherapy for respiratory and cardiac problems: Adults and Paediatrics, 3rd edition, p161-242, Edinburgh, Churchill Livingstone.

Ridley SC and Heinl-Green A, 2002. 'Surgery for adults' In: Pryor JA, Prasad SA (eds) Physiotherapy for respiratory and cardiac problems: Adults and Paediatrics, 3rd edition, p377-423, Edinburgh, Churchill Livingstone.

Risley JG and Jones MO 2003, 'Physiotherapy in intensive care' In: Bersten AD, Soni N, Oh T (eds) Intensive Care Manual, 5th edn, p33-40. Edinburgh, Butterworth Heinemann.

Saura P, Blanch L, Mestre J, Valles J, Artigas A and Fernandez R 1996, 'Clinical consequences of the implementation of a weaning protocol', *Intensive Care Medicine* vol. 22, p 1052-6.

Scanlan CL 1990, In: Scanlan C.L, Spearman C, Sheldon R.L. Egan's Fundamentals of Respiratory Care, 5th edition, p 177-202: 655-680: 683-699: 740-779: Missouri, Mosby Company

Scheinhorn DJ, Chao DC, Stearn-Hassenpflug M and Wallace WA 2001, 'Outcome in post-ICU mechanical ventilation: A therapist-implemented weaning protocol', *Chest* vol. 119, no 1p 236-42.

Selsby DS 1989, 'Chest physiotherapy: May be harmful in some patients', *British Medical Journal* vol. 298, p 541-2.

Simmons KF 1990, 'Airway care' In: Scanlan CL, Spearman C, Sheldon RL (eds) Egan's Fundamentals of Respiratory Care, 5th edn, p 483-512. Missouri, Mosby Company.

Stiller K, Geake T, Taylor J, Grant R and Hall B 1990, 'Acute lobar atelectasis: a comparison of two chest physiotherapy regimes', *Chest* vol. 98, p 1336-40.

Stiller K, Montarello J, Wallace M, Daff M, Grant R, Jenkins S, Hall B, Yates H 1994. 'Efficacy of breathing and coughing exercises in the prevention of pulmonary complications after coronary artery surgery'. *Chest:* 105: p 741-47.

Stiller K, Jenkins S, Grant R, Geake T, Taylor J and Hall B 1996, 'Acute lobar atelectasis: a comparison of five physiotherapy regimes', *Physiotherapy Theory and Practice* vol. 12, p 197-209.

Stiller K 2000, 'Physiotherapy in intensive care: Towards an evidence-based practice', *Chest* vol. 118, no 6, p 1801-13.

Task Force on Guidelines: Society of Critical Care Medicine 1991, 'Guidelines for standards of care for patients with acute respiratory failure on mechanical ventilatory support', *Critical Care Medicine* vol. 19, p 275-278.

Templeton M and Palazzo MGA 2007, 'Chest physiotherapy prolongs duration of ventilation in the critically ill ventilated for more than 48 hours', *Intensive Care Medicine*, vol. 33, p. 1938 – 45.

Torres A, Serra-Batlles J, Ros E, Piera C, de la Bellacasa JP, Cobos A, Lomena F and Rodriguez-Roisin R 1992, 'Pulmonary aspiration of gastric contents in patients receiving mechanical ventilation: The effect of body positioning', *Annals of Internal Medicine* vol. 116, p 540-3.

Turner JS and Tasker RC, 2002, 'Mechanical support' In: Pryor JA, Prasad SA (eds) Physiotherapy for respiratory and cardiac problems: Adults and Paediatrics, 3rd edition, p 301-322. Edinburgh, Churchill Livingstone.

Van Aswegen H and Eales CJ 2004, 'The effectiveness of manual hyperinflation during the physiotherapy management of acute atelectasis: A case report', *South African Journal of Physiotherapy* vol. 60, no. 1, p 29-32.

Van Aswegen H and Potterton J 2005, 'A pilot survey of the current scope of practice of South African physiotherapists in intensive care units', *South African Journal of Physiotherapy* vol. 61, no. 1, p 17-21.

Williams-Colon S and Thalken F 1990, 'Management and monitoring of the patient in respiratory failure' In: Scanlan CL, Spearman C, Sheldon RL (eds) Egan's Fundamentals of Respiratory Care, 5th edn, p 780-835. Missouri, Mosby Company.

Wong WP 2000, 'Physical therapy for a patient in acute respiratory failure', *Physical Therapy* vol. 80, no. 7, p 662-70.

Woodard F and Jones M 2002, 'Intensive care for the critically ill adult' In: Pryor JA, Prasad SA (eds) Physiotherapy for respiratory and cardiac problems: Adults and Paediatrics, 3rd edn, p 347-375. Edinburgh, Churchill Livingstone.

Wysocki M, Tric L, Wolff MA, Gertner J, Millet H and Herman B 1993, 'Noninvasive pressure support ventilation in patients with acute respiratory failure', *Chest* vol. 103, no. 3, p 907-13.

APPENDIX I

CONSENT FORM

Re: ………………………….. (Patient's name)

I, …………………………………., hereby certify that I am related to the above mentioned patient (relationship ………………….). I have read the information regarding the aims and objectives of the study, I and was provided the opportunity to ask questions. The purpose for conducting this study is clear to me.

I hereby give an informed consent, on behalf of ……………………………………, to be part of the study. I am aware of the standard procedures of liberating patients from the artificial airway, which are safely practiced throughout the world. I understand that by participating in this study, ……………………………….. will be randomly placed in any research group, i.e. group undergoing standard procedures or the group not undergoing these procedures prior liberation of the artificial airway. I understand that the aim of this study is to compare the outcome of these procedures in both groups. The results of this study will equip health care workers in ICU with the best strategy of liberating patients from an artificial airway. I am fully aware that the results of this study may be used for scientific purposes and may be published.

……………………… …………………………… …………………………

Name of the relative Signature Date

………………….. ………………………… …………………………

Witness Signature Date

Statement by the Researcher

I provided verbal and written information regarding the study to the patient's relative.

……………………….. …………………………… ……………………

Name of researcher Signed at Date

PATIENT / RELATIVE'S INFORMATION SHEET

My name is Keabecoe, I am a postgraduate student at the University of Witwatersrand. I am conducting a study to investigate whether chest physiotherapy in combination with suctioning, is a necessary procedure prior to the removal of an artificial airway. These are techniques used in ICU to clear the airway prior to extubation worldwide. It is not known if there would be a disadvantage to patients if they do not receive chest physiotherapy treatment prior to extubation. This study will help us to determine whether chest physiotherapy treatment prior to extubation is necessary or not. Participation in this study will not prolong patients ICU stay.

The reasons for including your relative in this study are your relative has been admitted in ICU, he/she is older than 18 years, required breathing (respiratory) support less than 5 days, and now he/she is regarded as ready for removal of an artificial airway. Your relative is invited to participate in this study. There will be two groups; one will receive chest physiotherapy (exercise for clearing secretions) and suctioning prior to the removal of the tube (control), and the other group will receive only suction prior to extubation (experimental). Both groups will receive chest physiotherapy treatment throughout their ICU stay. Patients will be randomly assigned to any group, and this will not affect routine physiotherapy management during his/her ICU stay. The research assistant will do the intervention on all patients allocated in both groups. The following factors will be assessed within 4 hours after the tube for breathing has been removed, breathing rate, heart rate, saturation, PEFR, cough and chest X-ray blood gases and the breathing pattern.

Patient's participation in this study is completely voluntary and has the right to withdraw from the study at any time without prejudice. Any information obtained, related to this study, will be strictly confidential. The results obtained from this study may be published in medical journals. Patient's identity will not be utilized in order to maintain anonymity

Thank you for your participation.

Ngubeni Winnifred Keabecoe

APPENDIX II

Ethical Clearance Certificate

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Ngubeni

CLEARANCE CERTIFICATE	**PROTOCOL NUMBER M050210**
PROJECT	A Study of Extubation from Mechanical Ventilation and the Effect of Chest Physiotherapy Intervention
INVESTIGATORS	Mrs W Ngubeni
DEPARTMENT	Dept of Physiotherapy
DATE CONSIDERED	05.02.25
DECISION OF THE COMMITTEE*	Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 05.04.15 **CHAIRPERSON** ....
(Professor PE Cleaton-Jones)

*Guidelines for written 'informed consent' attached where applicable

cc: Supervisor : H vanAswegen

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10005, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

APPENDIX III

OUTCOME MEASUREMENT SHEET

Randomized no:	

Physiological data

ABG	Prior extubation	30 minutes after	1 hour	2 hours	4 hours
Ph					
PaCO2					
PaO2					
HCO3					
Saturation					
FIO2					

Haemodynamic status:

	Prior extubation	30 minutes after	1 hour	2 hours	4 hours
Heart rate					
Temperature					
B.P					

Physiotherapy Chest assessment

	4 hours
Respiratory Rate	
Respiratory Pattern	
PEFR	
Cough	

Chest X-ray interpretation: (Doctor: ……………………………………….)

……………………………………………………………………………………………

Physiotherapy treatment rendered. YES/ NO

APPENDIX IV

Pt ID	RCT list
1	Group1
2	Group1
3	Group2
4	Group1
5	Group1
6	Group1
7	Group1
8	Group2
9	Group1
10	Group2
11	Group2
12	Group2
13	Group1
14	Group2
15	Group1
16	Group1
17	Group1
18	Group2
19	Group2
20	Group2
21	Group1
22	Group2
23	Group1
24	Group2
25	Group2
26	Group2
27	Group1
28	Group2
29	Group1
30	Group2

Group 1 = Chest Physio before extubation

Group 2 = No chest physio before extubation.