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THE USE OF MANUAL HYPERINFLATION BY PHYSIOTHERAPISTS IN SOUTH AFRICA DURING THE TREATMENT OF RESPIRATORY COMPROMISED PATIENTS IN INTENSIVE CARE

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A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Masters of Science in Physiotherapy.

Johannesburg, 28th February 2013

DECLARATION

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

……

Signature

…….day of …… 2013

ABSTRACT

Objectives:

The objectives were to determine whether or not manual hyperinflation (MHI) is used as a treatment technique by physiotherapists on respiratory compromised patients in intensive care units (ICU), to determine physiotherapists' knowledge on the use of MHI (indications, contra-indications, treatment effect) as a treatment technique on respiratory compromised patients in ICU, to compare the physiotherapists' knowledge on the use of MHI to their utilisation of MHI in ICU, and to determine whether the effect of clinical experience has an influence on physiotherapists' decision making regarding the use of MHI in the ICU setting. The last objective was to investigate whether the working environment has an influence on the utilisation of MHI by physiotherapists practicing in adult ICUs in South Africa.

Methods:

A questionnaire was developed by undergraduate WITS physiotherapy students according to the available literature on the use of manual hyperinflation by physiotherapists. This questionnaire was further refined and adjustments were made according to inputs by a panel of experienced cardiopulmonary physiotherapists. Physiotherapists who practice cardiopulmonary physiotherapy in adult ICUs of hospitals in the government and private sectors in South Africa were identified then targeted for the study. The self administered questionnaire was then posted and emailed to the physiotherapists identified for inclusion into the study.

Results:

A total of 300 questionnaires were distributed among physiotherapists in South Africa. Of the 300 questionnaires distributed, 154 questionnaires were sent via the postal system and 146 were sent via email. The response rate for the posted questionnaires was 42.8% and 1.37% for the emailed questionnaires, giving a combined response rate of 22.3%. The results showed only 38% of South African physiotherapists perform MHI in adult ICUs in South Africa. The majority of physiotherapists (92%) who employ MHI in their daily treatment of patients acquired the skill as part of their undergraduate university training. The majority of respondents felt that the greatest benefits obtained from using MHI were in increasing lung volume (79%) as well as secretion clearance (84%). The vast majority (69%) of physiotherapists who participated in this survey were unsure of the MHI circuit's name that they used in their practice. Only 22% respondents stated that they used the Laerdal MHI circuit. The majority of respondents (91%) used suctioning in combination with MHI; 84% used vibrations in combination with MHI and only 49% used postural drainage in combination with MHI. Working environment and clinical experience did not have an influence on the utilisation of MHI.

Conclusion:

The survey of 67 physiotherapists, in 2012, working in adult ICUs of South Africa, indicated that MHI is not a widely used treatment technique. There is a general consensus regarding the benefits, contraindications and precautions regarding the use of MHI. This has been shown to be in line with current studies conducted in other countries. The survey does show that there is a need for the development of guidelines pertaining to the use of MHI. These findings support previously published recommendations that there are still some parameters for which guidelines are needed.

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LIST OF ABBREVIATIONS

°F	: Degrees Fahrenheit
ARDS	: Acute Respiratory Distress Syndrome
cells/mm^3	: Cells per Millimetre Cubed
cmH_2O	: Centimetres of Water
FiO_2	: Fraction of Inspired Oxygen
Hrs	: Hours
I:E	: Inspiratory to Expiratory Ratio
ICU	: Intensive Care Unit
MAP	: Mean Arterial Pressure
MHI	: Manual Hyperinflation
Min	: Minute
mmHg	: Millimetres of Mercury
MV	: Mechanical Ventilation
$PaCO_2$	: Partial Pressure of Carbon Dioxide in Arterial Blood
PEEP	: Positive-End Expiratory Pressure
PEFR	: Peak Expiratory Flow Rate
PIFR	: Peak Inspiratory Flow Rate
SASP	: South African Society of Physiotherapy
UK	: United Kingdom
VAP	: Ventilator Associated Pneumonia
V/Q	: Ventilation Perfusion Ratio

CHAPTER 1

1. INTRODUCTION

1.1 BACKGROUND

Physiotherapy intervention is regarded as an important component in the management of patients in intensive care and has been demonstrated to provide both short and medium term benefits (Zeppos, Patman, Berney, Adsett, Bridson, Paratz 2007). Patients in the intensive care unit (ICU) are at risk of developing various chest complications due to the effect of bed rest, mechanical ventilation (MV), critical care environment and their various admitting illnesses (Smith & Ellis 2000). In these patients, augmented mucous production and an impaired mucociliary clearance are common characteristics leading to the development of pulmonary infection and obstructive atelectasis (Lemes, Zin, Guimaraes 2009).

Physiotherapists are involved in the prevention and treatment of pulmonary, circulatory, musculoskeletal and associated complications that patients develop in ICU. The physiotherapist's role in ICU includes positioning, mobilisation, manual hyperinflation (MHI), percussion, vibration, suctioning, breathing exercises and the application of various bronchodilating, humidifying and mucolytic agents (Berney, Haines, Denehy 2012; Kumar, Maiya, Pereira 2007; Stiller 2000; Norrenburg & Vincent 2000; Denehy 1999). These chest physiotherapy techniques are employed to minimize pulmonary secretion retention, to maximize oxygenation, and to re-expand atelectic lung segments (Lemes, Zin, Guimaraes 2009; Robson 1998). In addition to chest treatment, mobilisation techniques and physical activity are employed by the ICU physiotherapist to prevent physical deconditioning and recumbency (Gosselink, Bott, Johnson, Dean, Nava, Norrenburg, Schonhofer, Stiller, van de Leur, Vincent 2008)

Manual hyperinflation was first documented and described as 'bag squeezing' by Clement and Hubsch in 1968 who said it was highly effective to clear bronchial secretions and re-inflate areas of collapsed lung (cited in Robson 1998). Manual hyperinflation was originally defined as inflating the lungs with oxygen and manual compression to a tidal volume of 1.0L, requiring a peak inspiratory pressure of between 20 and 40cmH_2O. More recent definitions include providing a larger tidal volume than baseline tidal volume to the patient and using a tidal volume which is 50% greater than that delivered by the ventilator (Maa, Hung, Hsu, Hsieh, Wang, Wang, Lin 2005). The technique involves using a rebreathing or self inflating circuit to provide the manual breath, usually with the addition of 100% oxygen (Denehy 1999). Manual hyperinflation is most commonly used as a treatment technique in the management of intubated patients in an ICU (Denehy 1999). Intubation and MV are

indicated in acute reversible respiratory failure. However, application of intermittent positive pressure ventilation is not without adverse pulmonary physiological effects. These include reduced functional residual capacity (FRC), increased ventilation:perfusion mismatch, decreased pulmonary compliance, oxygen toxicity, overt barotrauma and a reduction in surfactant (Berney, Haines, Denehy 2012; Bersten & Soni 2009). In addition, intubated critically ill patients are at high risk of developing nosocomial infections, especially nosocomial pneumonia or ventilator associated pneumonia (Denehy 1999).

Manual hyperinflation is a technique used to improve a patient's tidal volumes, mobilise secretions, improve pulmonary compliance, increase oxygenation prior to and after suctioning and to re-expand areas of atelectasis (Hodgson, Ntoumenopoulos, Dawson, Paratz 2007; Denehy 1999). With MHI the patient is disconnected from the mechanical ventilator, after which the lungs are inflated via a resuscitation bag. Manual hyperinflation can be used as an adjunct to manual techniques and postural drainage or as a treatment modality on its own to achieve the aforementioned goals (Denehy 1999).

Manual hyperinflation has been demonstrated in literature to be highly effective in improving pulmonary compliance and decreasing airway resistance (Maa et al., 2005; Blattner, Guaragna, Saadi 2008; Ntoumenopoulus 2005; Choi & Jones 2005; Berney & Denehy 2002) but clinical experience has shown that it is not a commonly used modality among South African physiotherapists.

1.2 STATEMENT OF PROBLEM AND JUSTIFICATION FOR RESEARCH

Research performed in the United Kingdom, Netherlands and Australia portrays valuable information regarding the use of MHI on an international level (Hodgson, Carroll, Denehy 1999; Norrenburg & Vincent 2000; Paulus, Binnekade, Middelhoek, Schultz, Vroom 2009). There is however little research done in South Africa regarding the use of MHI by physiotherapists who work in ICU. The purpose of this survey is to gain information about physiotherapists' use of MHI in the clinical setting in South Africa. The information obtained would create a platform to compare the use of MHI by the South African physiotherapy community with the international community to determine whether South African physiotherapists perform evidence-based practice (based on clinical experience and literature published) with regard to MHI.

1.3 RESEARCH QUESTION

Are physiotherapists in South Africa utilizing MHI in the treatment of respiratory compromised patients in ICU?

1.4 SIGNIFICANCE OF RESEARCH

Manual hyperinflation is used by physiotherapists in the respiratory management of intubated patients as mentioned above. It is an evidence based technique used to improve a patient's tidal volumes, mobilise secretions (Hodgson, Denehy, Ntoumenopoulus, Santaamaria, Carroll 2000), improve respiratory compliance and reduce airway resistance (Choi & Jones 2005), increase oxygenation prior to and after suctioning (Stiller, Jenkins, Grant 1996) and to re-expand areas of atelectasis (Hodgson et al., 2007; Denehy 1999). These proven benefits have been well documented in research conducted outside South Africa. The purpose of this survey is to see if South African physiotherapists practicing in adult ICUs use MHI regularly or not and whether they are aware of the evidence-based benefits of MHI. The results from the survey will also show whether years of clinical experience, knowledge on the technique of MHI, government or private practice and other demographics have an influence on a physiotherapist's decision to use or not use MHI as part of their physiotherapy management of ICU patients. We can then ultimately see if South African physiotherapy practice is similar to international physiotherapy practice with regards to the use of MHI in ICU.

1.5 RESEARCH AIM

To determine whether physiotherapists who work in adult ICUs in the private and/or public health care sectors throughout South Africa, utilise MHI in the treatment of respiratory compromised patients.

1.6 RESEARCH OBJECTIVES

- To determine whether or not MHI is used as a treatment technique by physiotherapists on respiratory compromised patients in ICU.

- To determine physiotherapists' knowledge on the use of MHI (indications, contra-indications, treatment effect) as a treatment technique on respiratory compromised patients in ICU.

- To compare the physiotherapists' knowledge of the use of MHI to their utilisation of MHI in ICU.

- To determine the effect of clinical experience of physiotherapists on their decision-making regarding the use of MHI in the ICU setting.

- To investigate whether the working environment has an influence on the utilisation of MHI by physiotherapists in South Africa.

1.7 STUDY DESIGN

A cross sectional study design utilising a self administered questionnaire by means of a survey was used to obtain data for the study.

Chapter 2 consists of an in-depth discussion of the literature on the indications for and use of MHI, circuit types available for the administration of MHI, the technique of administering MHI, contra-indications and precautions for the use of MHI and complications that may arise as a result of MHI.

CHAPTER 2

2. LITERATURE REVIEW

2.1 INTRODUCTION

This literature review aims to evaluate evidence found in the medical and physiotherapy literature on airway clearance, the technique of MHI and variability in its use as well as complications that may arise due to unsafe practice in the use of MHI.

In most hospitals in developed countries, physiotherapy is seen as an integral part of the management of patients in ICU (Zeppos et al., 2007; Stiller 2000). In view of the high costs associated with care in ICU, every attempt should continue to be made to prevent complications associated with prolonged immobility and critical illness and appropriately treat the primary underlying pathophysiology to minimise a patient's length of stay in ICU (Gosselink et al., 2008). There are common complications particularly associated with prolonged ICU stay, including deconditioning, muscle weakness, dyspnoea, depression and anxiety, and reduced health-related quality of life which may last months or even years after discharge from hospital. The role of the physiotherapist in ICU is to identify and treat acute, subacute and chronic respiratory conditions and prevention and treatment of the sequelae of immobilisation and recumbency (Gosselink et al., 2008).

The treatment techniques employed by the ICU physiotherapist for respiratory conditions consist of; 1) positioning, for optimal ventilation perfusion (V/Q) matching and postural drainage; 2) mobilisation, to optimise oxygen transport by enhancing alveolar ventilation and V/Q matching; 3) improving respiratory parameters by using chest clearance techniques (percussion, vibration and shaking), removing excess secretions by endotracheal suctioning and breathing exercises, and performing MHI to prevent atelectasis and recruit atelectatic areas in the lungs. Manual hyperinflation, as mentioned previously, can be used to improve compliance and increase alveolar recruitment, oxygenation and tidal volumes (Gosselink et al., 2008; Stiller 2000). Treatment techniques used in the prevention and treatment of the sequelae of immobilisation and recumbency consist of; 1) positioning, to prevent joint stiffness and soft tissue shortening; 2) mobilization, to optimise work capacity and functional independence and to improve cardiopulmonary fitness; 3) limb exercises, with the aim of maintaining or improving joint range of motion, soft-tissue length, muscle strength, and function, and decreasing the risk of thromboembolism (these can be performed as passive, active assisted, or active resisted exercises) (Gosselink et al., 2008; Stiller 2000).

2.2 AIRWAY CLEARANCE AND MANUAL HYPERINFLATION

Factors that lead to increased or retained mucus in patients in ICU due to impeded mucociliary function include endotracheal intubation, MV, the use of high concentrations of supplemental oxygen, and the effects of medications such as sedatives, narcotics and paralytic agents that reduce respiratory drive and aid cough suppression (Ntoumenopoulus 2005). Therefore, respiratory intervention (positioning, postural drainage, percussion, vibration, endotracheal suctioning and MHI) is used in the management of ventilated patients in the ICU to prevent mucus retention and pulmonary complications, improve oxygenation, and re-expand collapsed areas of the lung (Lemes, Zin, Guimaraes 2009).

Normal clearance of the airways can only take place by two means namely mucociliary clearance and cough. However, with intubation and MV, two-phase gas-liquid transport becomes an essential means of airway clearance. Two-phase gas-liquid flow is described as a critical gas flow rate that must be met before a liquid will be moved by it. The key to movement of secretions by two-phase gas-liquid flow is the relationship between inspiratory and expiratory flow. To achieve net movement in one direction of a viscoelastic liquid such as mucus, when the gas movement is bi-directional, the inspiratory flow rate must be at least 10% slower that the critical expiratory flow rate; that is an inspiratory expiratory flow rate ratio (I:E) of less than or equal to 0.9 (Kim, Iglesias, Rodriguez 1985). It is then assumed that this mucus must be cleared as it may obstruct an airway causing atelectasis, reduction in lung compliance or a breeding ground for infection and subsequent pneumonia (Smith & Ellis 2000). Retained airway mucus also places postoperative patients who are admitted to ICU for MV and monitoring at a greater risk of developing pulmonary complications due to impaired airway clearance mechanisms and an increased production in the amount of mucus produced postoperatively (Smith & Ellis 2000). A complication of retained mucus is ventilator-associated pneumonia (VAP). Ventilator-associated pneumonia is associated with significant morbidity and mortality in critically ill patients (Ntoumenopoulos, Presneill, McElholum, Cade 2002; Denehy 1999; Ntoumenopoulus, Gild, Cooper 1998). It is defined as parenchymal lung infection which occurs at least 48 hours after initiation of MV (Choi & Jones 2005). A streamlined definition for VAP was created by the Centres for Disease Control and Prevention based on their experience with ventilator associated complications and is outlined below:

Any one of the following:

1. Opacity, infiltrate, or consolidation (on chest x-ray) that appears, evolves, or persists over 72 hours (hrs) or more.
2. Cavitation (on chest x-ray).

Any one of the following:

1. Temperature increases above 100.4°F within past 24 hrs.
2. White blood cell less than 4,000 or greater than12,000 white blood cells per millimetre cubed (cells/mm^3) within the past 24 hrs.

Both of the following:

1. Two days of stable or decreasing daily minimum fraction of inspired oxygen (FiO_2) followed by increase in daily minimum fraction of inspired oxygen equal to or greater than 15 points sustained for two or more calendar days.

   OR

   Two days of stable or decreasing daily minimum positive end-expiratory pressure (PEEP) followed by increase in daily minimum PEEP by equal or more than 2.5 centimetres of water (cmH_2O) sustained for two or more calendar days.

   AND

1. Gram-negative stain of respiratory secretions with moderate ((2+) or more) neutrophils per low-power field within 72 hours.

(Kollef 2012)

The proposed mechanism for enhancing sputum clearance using MHI is the enhancement of the two-phase gas-liquid flow (Maxwell & Ellis 2003; Smith & Ellis 2000). Sputum is moved towards the central airway in this manner, as a result of higher expiratory than inspiratory flows generated with MHI, allowing the sputum to be suctioned from the patient's airway (Ntoumenopoulos 2005; Denehy 1999). Apart from the contribution that MHI plays in enhancement of the two-phase gas-liquid flow, Ntoumenopoulos (2005) stated that lung volume restoration during MHI may also play an important role in assisting secretion clearance due to increased elastic recoil.

2.3 INDICATIONS FOR AND APPLICATION OF MANUAL HYPERINFLATION

Indications for the use of MHI may include one or a combination of the following: a) to improve oxygenation prior to and after suctioning, b) to mobilise excessive secretions, c) to reinflate areas of collapsed lung and d) to improve static and dynamic compliance (Pryor & Prasad 2008; Patman, Jenkins, Stiller 2000; Denehy 1999). The literature surrounding the use of MHI in ICU for intubated and ventilated patients supports its use to reverse the effects of retained mucus to prevent the incidence of VAP, improve dynamic and static lung

compliance and reverse atelectasis (Maxwell & Ellis 2007; Maa et al., 2005; Paratz, Lipman, McAuliffe 2002; Hodgson et al., 2000; Denehy 1999).

Manual hyperinflation is a technique which provides a greater than baseline tidal volume to the lungs (Hodgson et al., 2000). The technique involves using a rebreathing or self inflating circuit to provide the manual breath to the patient, usually with the addition of 100% oxygen (Denehy 1999). The technique consists of five factors (Maa et al., 2005) namely a) the application of larger than normal breath (up to 150% of the tidal volume delivered by the mechanical ventilator); this is based on the hypothesis that by delivering a larger volume over time, MHI may increase the expiratory flow rate and assist in moving secretions; b) the use of a slow inspiratory flow rate (achieved by a slow compression of the resuscitation bag); this slow passive inflation of the lung is thought to generate a constant airway pressure re-expanding collapsed alveoli that have decreased compliance and increased resistance; c) an inspiratory pause; this is achieved by the operator maintaining their hold on the compressed resuscitation bag to allow for a constant pressure gradient for an appropriate length of time to complete distribution of the inflated air among all the ventilated lung parts; d) a pressure manometer must be added to the circuit to improve performance of MHI and optimise both safety and effectiveness of the treatment; e) quick release of the resuscitation bag to create a rapid decrease in the pressure in the circuit and thereby achieving a high peak expiratory flow rate (PEFR); the higher PEFR enables a reduction in the inspiration:expiration ratio (I:E), causing cephalad movement of secretions towards the trachea (Paulus, Veelo, Nijs, Beenen, Bresses, Mol, Binnekade, Schultz 2011; Maa et al., 2005).

The peak inspiratory pressure produced in the airways during MHI should be 20 – 40 cm H_2O, not exceeding the upper limit as barotrauma might occur (Maxwell & Ellis 2007; Maa et al., 2005). Barotrauma will result in leakage of proteins, air and fluid into the alveoli impairing gas exchange and decreasing lung compliance. Improved oxygenation occurs at 20 cmH_2O and alveolar recruitment at 30 cmH_2O (Redfern, Ellis, Holmes 2001; Rusterholz & Ellis 1998; McCarren & Chow Moi 1996). It is thus essential that a pressure manometer is used in the MHI circuit to monitor the inspiratory airway pressures generated to ensure that it stays within the required therapeutic range (20-40cm H_2O) to be delivered (Maxwell & Ellis 2007). It is important to note that tidal volume delivery may be adversely affected by the operator's hand size and grip strength (Rusterholz & Ellis 1998).

2.4 VARIABILITY IN USE OF MANUAL HYPERINFLATION

However simple the technique may sound there has been no conclusive evidence on a protocol for the method of delivery of these manual breaths or the performance of the MHI procedure (Paulus et al., 2009; Hodgson, Carroll, Denehy 1999; Rusterholz & Ellis 1998).

The most important finding in a study by Paulus et al., (2009) which investigated MHI of intubated and mechanically ventilated patients in Dutch ICU's, stated that most ICU nurses deviated from the factors that are thought to be important in the performance of MHI. These factors were the use of larger than normal tidal volume breaths and a slow inspiration combined with a fast expiration. The study also showed that less than half the ICUs don't have guidelines or standards for the performance of MHI. The fact that these guidelines or practicing standards for MHI don't exist in 50% of the ICU's was deemed important, as guidelines facilitate the delivery of a safe and appropriate use of the technique. Additionally guidelines can draw attention to possible clinical indications, contra-indications and potential complications associated with MHI.

Hodgson et al., (1999) conducted a survey of the use of MHI in Australian hospitals. The primary aim was to identify the current physiotherapy management of intubated patients being treated with MHI in Australian university teaching hospitals where physiotherapists were educated in clinical practice. Results showed that 24% of physiotherapists surveyed did not know the highest acceptable peak airway pressure and only 31% used an airway manometer to measure peak airway pressure when delivering MHI. The treatment sessions varied from two minutes to 45 minutes with the most common treatment duration being 10 minutes. Considerable variation was also seen in the number of breaths delivered per set (range of delivered breaths = 1 – 15). One of the few things that the respondents did agree upon was that 97% used side-lying with the affected lung uppermost while administering MHI.

Paulus et al., (2009) investigated the performance of MHI among trained intensive care nurses as mentioned above. The study concluded that the performance of MHI in a skills laboratory under controlled conditions did not comply with the factors of MHI suggested to be important for its efficacy and safety. Patman, Jenkins and Smith (2001) investigated the consistency and modification of MHI by physiotherapists. A sample of 17 physiotherapists was recruited from tertiary teaching hospitals with ICUs within the Perth metropolitan area (Western Australia). The main aim was to evaluate the consistency with which physiotherapists applied MHI to a test lung. The study was a quasi-experimental, randomised, repeated measures design with 16 volunteer physiotherapists. It was found that none of the physiotherapists using the Air Viva 2 MHI circuit were observed to incorporate a prolonged end inspiratory pause in their technique. With the Mapleson-B MHI circuit, some of the subjects delivered up to 2360 ml per inflation, resulting in peak airway pressures of up to 50 cmH_2O. Such high tidal volumes and peak airway pressures could result in volutrauma or barotraumas (Patman, Jenkins, Smith 2001; Redfern, Ellis, Holmes 2001; Hodgson, Carroll, Denehy 1999). Up until the time of this literature review, there has

been no literature published on the technique of delivery of MHI by physiotherapists to patients in ICU in the South African health care sector.

It has been left up to clinical experience more than anything to determine the therapeutic protocol for MHI in different clinical settings (McCarren & Chow Moi 1996). Even though this discretion occurs in the use of MHI, some physiotherapists employ certain techniques during the administration of MHI which vary from one clinical site to another. For instance, one cycle of MHI may consist of a slow inspiration of up to three seconds until the peak pressure is reached. This is followed by a two second end inspiratory pause and an uninterrupted release of the bag to allow for expiration. Quick expiration is used to stimulate a cough. The MHI treatment consists of a set number of these breaths and may continue for 10 – 20 minutes (Hodgson et al., 2007; Hodgson, Carroll, Denehy 1999). Other clinicians perform six MHI breaths interspersed with suctioning and repeat this cycle six times until all secretions are cleared (Hodgson et al., 2007; Patman, Jenkins, Smith 2001; Hodgson, Carroll, Denehy 1999**;** Ntoumenopoulus, Gild, Cooper 1998; McCarren & Chow Moi 1996). Guidelines are still required to standardise the use of MHI as a treatment technique. These relate specifically to the application time, number of breaths per set and peak airway pressure achieved. Most importantly, the safety issues regarding use of the technique need to be clarified (Hodgson, Carroll, Denehy 1999). These sentiments are echoed by Paulus et al., (2009) who stated that there was a need to develop and implement better guidelines for the efficacy and safety in the use of MHI. Denehy (1999) put forward recommendations after reviewing the available literature on MHI and these included a) education of therapists is essential to improve reliability and, potentially, effectiveness of the technique; b) outcomes of MHI depend upon the skill of the practitioner and type of equipment used; this fact must be considered when critically reviewing the literature; c) inclusion of a manometer in the circuit should be mandatory; d) an optimal treatment regimen for MHI needs to be established; this should include dosage, patient position and levels of pressures and volumes which are necessary to achieve effectiveness and maintain patient safety; e) the types of patient conditions which respond best to treatment with MHI need to be clarified; f) more research is necessary using secretion clearance as a primary outcome measure when studying the effects of MHI; and g) research examining the longer term outcomes of physiotherapy management in intubated patients is needed whilst acknowledging that controlled research in this area is difficult.

Research conducted since the publication of these recommendations aimed to address some of these issues such as the effect of MHI on secretion clearance and the type of patient that responds best to MHI; however, to date not much is known about whether education received on the application of MHI influences clinical reasoning of the therapist and safe practical application of MHI in view of manometer usage and tidal volume

delivered; optimal treatment regimes for MHI or longer term outcomes of MHI in the management of intubated patients.

2.5 MANUAL HYPERINFLATION CIRCUITS

There are various circuits available for the administration of MHI. Hodgson, Carroll and Denehy (1999) undertook a survey of MHI in Australian hospitals. They found that there was a wide variation in the type of circuit used for MHI, with some facilities using up to three different circuits. The choice of circuit employed is based on individual preference or the circuit available in the ICU (Denehy 1999). The most common MHI circuits used in Australia were the Magill circuit followed by the Laerdal circuit. Interestingly there were some differences across states and this may be due to personal preference or unit policy. In the United Kingdom (UK) the most commonly used MHI circuit used was the Water's followed by the Mapleson-C and in Hong Kong the Laerdal MHI circuit was most commonly used (Jones, Hutchinson, Oh 1992). Currently there is no information available regarding the type of circuits used by South African physiotherapists. The question regarding which MHI circuit should be used, is more than simply one of commercial interest, personal preference or unit policy, as the properties of the different circuits may influence treatment options as well as treatment effectiveness. In a study done by McCarren and Chow Moi (1996) it was found that the technique of MHI was significantly influenced by the type of circuit used.

2.5.1 Circuit Comparison and Secretion Clearance

Hodgson et al., (2007) conducted a study to examine the short term effects of the Mapleson-C circuit to the Laerdal circuit in removing secretions and improving ventilation and gas exchange during MHI. A prospective, randomised, cross-over design was used where patients acted as their own controls. All participants received both interventions on one day, one in the morning and one in the afternoon. Intervention consisted of a physiotherapist administering suction and MHI with either the Laerdal or Mapleson-C circuit and intervention lasted 20 min. Baseline measurements of ventilation and gas exchange were performed in supine. These measures were taken again 30 and 60 min post intervention. All measurements were recorded by a second physiotherapist who was not blinded to patient allocation. Secretion clearance during MHI was measured in weight per grams. The study had inclusion and exclusion criteria and 20 participants were recruited from the ICU in Alfred Hospital in Melbourne, Australia. The study concluded that the Mapleson-C circuit cleared significantly more secretions than the Laerdal circuit. The increase in sputum cleared by the Mapleson-C circuit was explained by results from previous studies which showed that the Mapleson-C circuit delivered higher PEFR, peak inspiratory pressure and tidal volume when compared to the Laerdal circuit (Hodgson et al., 2007; Savian, Chan, Paratz 2005). The higher PEFR, peak inspiratory pressure and tidal volume would decrease the I:E ratio improving secretion mobilisation in a cephalad

direction according to the two-phase gas-liquid flow. However the study did not find a difference between the circuits in ventilation or gas exchange. The study by Hodgson et al., (2007) found that it was difficult to achieve 40cmH_2O pressure during MHI due to the pressure releasing design of the expiratory valve of the Laerdal circuit; this consistently resulted in a greater I:E ratio when compared to the Mapleson-C circuit, resulting in lower expiratory flow and ultimately a reduction in the amount of secretions suctioned.

2.5.2 **Comparing the Flow Rates of the Different MHI Circuits**

Maxwell and Ellis (2003) studied the effect of circuit type, volume delivered and rapid release on flow rates during MHI. Using a test lung model, 15 physiotherapists performed 11 trials using the Air Viva 2, a Mapleson-C and a Mapleson-F circuit, both with and without rapid release, and delivering two volumes. For the first trial (choice trial) subjects selected the MHI circuit of their choice and performed MHI as they would be aiming to enhance secretion removal. The subjects then performed the other 10 trials (standardised trial). For the standardised trials, 24 different order combinations of circuit type, volume delivered and release technique were designed and each combination was recorded on a card and placed in a sealed envelope. When the subjects arrived they randomly drew an envelope that was not replaced. A custom-designed data acquisition and analysis system was used for this study, of which the accuracy and reliability had been reported on by a study done by Maxwell, Crosbie, Ellis 2001. This analysis system calculated the volume delivered and recorded the peak inspiratory flow rate (PIFR) and the PEFR. The results showed that the PEFR was faster using the rapid release and that this was statistically significant for all trials irrespective of circuit type or target volume. There was an increase in PEFR when the Mapleson circuits were compared with the Air Viva 2, and the increase was greater for the Mapleson-F compared to the Mapleson-C. The mean I:E ratio was less than 0.9 for standardised trails thus, indicating that net cephalad movement of mucus would be achieved irrespective of the circuit type; however the mean I:E ratio for the Mapleson circuits was 0.52, significantly lower than 0.71 for the Air Viva 2. This demonstrates that the Mapleson circuits have the ability to generate a higher PEFR and clear more secretions than the Air Viva 2 circuit.

These findings corresponded to the results of the study done by Hodgson et al., (2007), discussed above, which showed the Mapleson-C circuit cleared more secretions when compared to the Laerdal circuit. Even though the study by Maxwell and Ellis (2003) compared the Mapleson circuit and the Air Viva 2 and the study by Hodgson et al., (2007) compared the Mapleson-C circuit to the Laerdal circuit, Denehy (1999) found that the Mapleson and Magill circuits were very similar as were the Air Viva and Laerdal circuits, thereby allowing for comparisons to be made between these circuits. The Mapleson and Magill circuits are recommended over the Air Viva 2 and Laerdal circuits when performing

MHI for secretion clearance as the Mapleson circuits produce a lower I:E ratio at a target volume (Ntoumenopoulus 2005; Maxwell & Ellis 2003).

The study of PEFR and different circuits was then taken a step further when Savian, Chan and Paratz (2005) studied the effect of PEEP level on PEFR during MHI. The study aimed to determine the effect of increased PEEP or decreased compliance on PEFR. The study was a blinded, randomised controlled trial performed on a test lung simulator, by 10 physiotherapists experienced in MHI and intensive care practice from the Alfred Hospital in Australia. Two circuits, the Laerdal and the Mapleson-C circuits were used to compare the PEFR and tidal volume generated in a lung model at six different levels of PEEP and two levels of compliance. The study showed that the Mapleson C circuit was capable of producing a PEFR that is theoretically capable of annular two-phase gas-liquid flow at all levels of PEEP up to 15 cmH_2O. The Laerdal circuit was not effective at a PEEP of more than 10 cmH_2O. Patients often receive a high PEEP through MV for various reasons, including intrapulmonary and extrapulmonary ARDS, pulmonary odema, and impaired gaseous exchange. This study showed that it would be advantageous to use the Mapleson-C over the Laerdal circuit, during MHI for secretion clearance when a PEEP of over 10 cmH_2O is required. The findings of this study correlated with the findings reported by Hodgson et al., (2007), Ntoumenopoulus (2005) and Maxwell and Ellis (2003).

2.5.3 Circuit Comparison and Technique of Delivering Manual Hyperinflation

McCarren and Chow Moi (1996) conducted a study to describe the technique of MHI as applied by physiotherapists. The study was a randomised cross-over design, using the Macgill and Laerdal circuits on a test lung. There were four test conditions: two lung compliance settings (atelectasis and no atelectasis) and two MHI circuits (Macgill and Laerdal). The physiotherapists were blind to the compliance settings on the test lung. The results showed a significant difference between the two MHI circuits in airway pressure, tidal volume and inflation flow rates. The Magill circuit applied a significantly higher tidal volume and airway pressure than the Laerdal circuit but the flow rates were significantly lower in the Magill circuit. A mean positive expiratory pressure of 3.31cmH_2O was produced with the Macgill circuit as a consequence of the higher airway pressure delivered by the circuit. Therefore the higher PEEP, tidal volume and airway pressure delivered by the Macgill circuit make it the circuit of choice for expanding atelectatic areas of the lung (McCarren & Chow Moi 1996).

The most obvious explanation for the different measurable outcomes between the circuits would be the physical characteristics of the circuits. The inflation capacity, compliance of the bag, type of expiratory valve and the gas source port are the more notable differences. The Macgill and Mapleson circuits both have a 2L capacity whereas, the Laerdal and Air

Viva2 circuits have a 1.6L capacity (Savian, Chan, Paratz 2005; McCarren & Chow Moi 1996). The silicone reservoir bag of the Air Viva 2 and the Laerdal is less compliant than the Mapleson and Macgill rubber reservoir bag (Savian, Chan, Paratz 2005). When the silicon bag is compressed, areas not in direct contact with the operator's hand tend to compress as well, increasing the PIFR for the Air Viva 2 and Laerdal Circuits. In contrast, only the areas of the rubber bag of the Magill and Mapleson circuits that is in direct contact with the operator's hands contribute to the volume delivered, thus a smaller volume is delivered resulting in lower PIFR (Maxwell & Ellis 2003). The expiratory fish mouth valve on the Laerdal and Air Viva 2 circuits allows the gas to leak during the end inspiratory hold and therefore there is a loss of pressure and volume, resulting in a lower PEFR (increased I:E ratio) and reduced PEEP. In contrast, with the Mapleson and Macgill circuits both the operator manipulated valve and the proximal position of the gas port allows the continuous filling of the gas into the lung thus permitting the volume and airway pressure to increase at end inspiration; thus resulting in an increased expiratory flow rate, reduced I:E ratio for improved mucus clearance and increased PEEP that facilitates the re-expansion of atelectatic areas (Savian, Chan, Paratz 2005; Maxwell & Ellis 2004; McCarren & Chow Moi 1996).

2.6 PRECAUTIONS AND CONTRAINDICATIONS TO USE OF MANUAL HYPERINFLATION

Complications with the application of MHI can arise from the incorrect use of MHI and incorrect patient selection. In order to ensure safe effective delivery of MHI in patient care, patients should not have any of the following: acute respiratory distress syndrome (acute stage) as the lung is more susceptible to barotraumas due to fluid leakage into the interstitial spaces as well as the alveoli resulting in decreased compliance and shunting (Pryor & Prasad 2008); acute pulmonary oedema; bronchospasm that does not respond to bronchodilator therapy; raised intracranial pressure greater than 10 millimetres of mercury (mmHg) (Pryor & Prasad 2008); unstable blood pressure (mean arterial pressure (MAP) less than 75 mmHg with a fluctuation of 15 mmHg with positional change or a heart rate greater than 130 beats/minute) (Berney, Denehy, Pretto 2004); untreated pneumothorax or haemothorax (Hodgson et al., 2000; Hodgson, Carroll, Denehy 1999; Denehy 1999) or those requiring high peak inspiratory pressures from the mechanical ventilator, as the addition of increased inspiratory volume and pressure from MHI can cause Barotrauma (Redfern, Ellis, Holmes 2001; Denehy 1999) or requiring high levels of respiratory support (FiO_2 > 0.7 and PEEP > 10cmH_2O) (Savian, Paratz, Davies 2006). Manual hyperinflation should not be performed on any patient that has the potential to deteriorate when disconnected from MV to set up the MHI system (Redfern, Ellis, Holmes 2001). The patient's bedside monitor should be observed closely during the application of MHI for any haemodynamic changes as MHI leads to an increased pulmonary artery pressure and decreased MAP. This in turn can result in a decreased cardiac output and right atrial

pressure, and an increased systemic vascular resistance and intrathoracic pressure all which compromise venous return (Blattner, Guaragna, Saadi 2008; Pryor & Prasad 2008). Manual hyperinflation can reduce respiratory drive by lowering the partial pressure of carbon dioxide in arterial blood ($PaCO_2$); this is an important consideration in the treatment of patients with chronic obstructive pulmonary disease (Ntoumenopoulos 2005).

2.7 USE OF MANUAL HYPERINFLATION AS AN ADJUNCT TO PHYSIOTHERAPY

Denehy (1999) stated that in a survey done by King and Morrell (1992) in the United Kingdom (UK) on 176 public hospitals, it was found that 79% of hospital physiotherapists performed MHI and 98% agreed that it was an effective technique. Hodgson, Carroll and Denehy (1999) conducted a survey of MHI in Australian hospitals. The primary aim was to examine the use of MHI by physiotherapists in ICU. The survey was conducted using closed questions by means of a telephonic interview. The study was done on 32 targeted hospitals and the most senior physiotherapist was interviewed at each hospital. The authors stated that 91% of senior physiotherapists used MHI as treatment technique. Paulus et al., (2009) conducted a survey into current practice and knowledge on MHI in intubated and mechanically ventilated patients among ICU nurses in the Netherlands. The questionnaire was self-administered. Out of the 115 surveyed ICUs, 89 ICUs completed and returned the questionnaire. The study concluded that MHI was practised in 96% of the ICUs and was only considered a 'daily routine' procedure in the treatment of 27% of the patients. In the study done by Hodgson, Carroll and Denehy (1999) as mentioned above, 66% of the physiotherapists responded that MHI was a routine treatment for ventilated patients.

From the information presented in this literature review it is reasonable to assume that MHI is a popular choice of treatment technique among physiotherapists and nurses on an international level for use in ventilated and intubated patients in ICU especially considering the growing evidence-base for its implementation in the clinical setting. Using search engines MEDLINE, Scopus and Pubmed no research could be found on the frequency with which MHI is performed by physiotherapists in South Africa.

The next chapter of this research report will describe the methodology that was followed to conduct a survey among physiotherapists who work in ICU in South Africa in order to answer the research question.

CHAPTER 3

3. 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, 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 cross sectional study design utilising a self administered questionnaire was used to obtain data for the study.

3.2 SUBJECTS

3.2.1 Sample Selection and Demographics

Physiotherapists who practice cardiopulmonary physiotherapy in adult ICUs of hospitals in the government and private sectors in South Africa were targeted for the study. There were 5 200 physiotherapists registered with the Health Professions Council of South Africa in 2011. However not all the registered physiotherapists worked in ICU as fields of interests were expected to be different. Therefore to determine the number of private practice physiotherapists (countrywide) whose field of interest was cardiopulmonary physiotherapy, identification was achieved through reviewing the South African Society of Physiotherapy Cardiopulmonary Physiotherapy Rehabilitation Group (CPRG) membership register, of which there were 146 members. To target the physiotherapists who practiced cardiopulmonary physiotherapy in the government sector, the Department of Health was contacted to locate secondary, tertiary and quaternary hospitals (countrywide) in the government health sector. In total 50 government hospitals were contacted telephonically to determine whether they had an ICU facility with a physiotherapy department servicing the ICU. Of the 50 hospitals contacted telephonically, 17 hospitals had an ICU facility with a physiotherapy department servicing it. The process of contacting the government hospital departments started on the 1st June 2011 and the last hospital was contacted on the 15th June 2011. All questionnaires were returned by the 1st August 2011.

3.2.2 Inclusion Criteria

Physiotherapists who practiced cardiopulmonary physiotherapy in an adult ICU setting and who were registered with the Health Professions Council of South Africa were considered for inclusion in the survey.

3.2.3 Exclusion Criteria

Physiotherapists who did not treat patients in ICU, physiotherapy students and physiotherapy assistants were excluded from the survey.

3.2.4 Sample Size

The target population was the number of physiotherapists who worked in adult ICU in the public or private sectors in South Africa. One hundred and fifty four physiotherapists in the government sector and 146 physiotherapists in the private sector were invited to participate in the survey.

3.3 STUDY PROCEDURES

3.3.1 Instrumentation

The questionnaire (Appendix 1) was developed by undergraduate WITS physiotherapy students according to the available literature on the use of manual hyperinflation by physiotherapists. A meeting was convened between the undergraduate students and a group of five physiotherapists who work daily in an ICU environment, to review the first draft of the questionnaire. Corrections were made to the questionnaire by the undergraduate students according to the suggestions made by the five ICU physiotherapists. A second draft of the questionnaire was made with the corrections and circulated to the five ICU physiotherapists. The five ICU physiotherapists gave consensus regarding the content and language use in the questionnaire. The questionnaire was then finalised by the undergraduate physiotherapy students. The questionnaire was then received by the researcher and alterations were made to the grouping of certain questions, in order to divide the questionnaire into three sections. This was done with the help of a statistician to make the collection and analysis of the data less complicated. Once the questionnaire was completed it was then handed over to a group consisting of three experts in the field of cardiopulmonary physiotherapy. They were tasked with making suggestions in regard to the structure and questions to be asked in the questionnaire. The recommendations put forward by the three experts were to change the order of the questions to be asked; this was then done to provide a more logical flow to the questions in the questionnaire. The questionnaire was finalised and ready for distribution. The physiotherapy experts who were involved in this part of the study were not included as part of the sample population for the survey.

3.3.2 Data Collection Procedure

Identification of physiotherapists that fit the inclusion criteria for the survey was done as outlined in section 3.2.1. The national chair person of the CPRG was contacted telephonically on the 1st June 2011 to gain permission to distribute the questionnaire to their members. Once permission had been granted, the questionnaire was emailed to the chair

person of the CPRG and the secretary of the CPRG distributed it to the CPRG members in June 2011 via email.

A follow up email was sent two and four weeks later to remind the special interest group members to complete and return the questionnaire to the researcher via fax, email or post.

The heads of department of physiotherapy in each of the 17 government hospitals were contacted telephonically with information about the study. The details of the study were discussed with the heads of department and physiotherapists who met the inclusion criteria were identified with the help of the head of department. The correct postage address for each hospital physiotherapy department was obtained from the head of department and a set number of questionnaires (depending on the number of physiotherapists who worked in ICU in that hospital) were mailed to that particular government hospital. These questionnaires were then distributed by the head of department to the identified physiotherapists in their department to complete. Once completed the heads of department returned the questionnaires in the pre-stamped envelopes provided. The heads of each department were contacted at two and four weeks to remind them to complete and return the questionnaires. All returned questionnaires were analysed by the researcher and statistician.

3.4 ETHICAL CONSIDERATIONS

Ethical clearance to conduct this survey was granted by the Human Research Ethics Committee (Medical) of the University of the Witwatersrand. The clearance certificate number granted by the Human Research Ethics Committee (Medical) of the University of the Witwatersrand was M10M101112. The clearance certificate can be found in appendix two of this research report. Participation in the study was voluntary and no-one was penalised for not taking part in the study. All questionnaires were accompanied by an information sheet and returned questionnaires implied consent to participate in the survey. The information sheet can be found in appendix three. The questionnaire was coded so that the individual physiotherapist who completed it would remain anonymous.

3.5 STATISTICAL ANALYSIS

Descriptive data analysis was used to analyse the data obtained from the questionnaires. Demographic information described by continuous parameters such as age and number of years practiced was summarized by using means, medians and standard deviations. Demographic information described by categorical parameters such as gender, work sector, use of MHI was summarised using frequencies and percentages. Associations between various demographics and the use of MHI were investigated using the Chi-squared test of independence. Logistical regression was used to ascertain the use of MHI

in relation to the following variables: on whether being male or female; having a postgraduate degree; the number years practiced as a physiotherapist; knowledge of the use of MHI or the working environment influenced the decision to use MHI or not. The STATA 11 statistics and data analysis software package was used for data analysis. A p-value of less than 0.05 was deemed statistically significant.

The results and analysis of the data collected during this study will be presented in chapter 4.

CHAPTER 4

4. RESULTS

This chapter describes the results obtained from the survey that was described in the previous chapter. Figures are used to present the study results for easier interpretation and understanding of the study outcomes. Standard deviations are rounded off to one decimal point and p-values to two decimal points.

A total of 300 questionnaires were distributed among physiotherapists in South Africa who suited the inclusion criteria. Of the 300 questionnaires distributed, 154 questionnaires were sent via the postal system and 146 were sent via email. Of the 154 sent via the postal system, 76 were returned but 10 of the completed questionnaires did not meet the inclusion criteria as they were filled out by physiotherapists who worked in a paediatric ICU setting. The response rate for the postal questionnaires was 42.8%. Of the 146 emailed questionnaires only two were returned. One via fax and the other via email; the one via fax was excluded as it did not meet the inclusion criteria. The response rate for the emailed questionnaires was 1.37%, resulting in a combined response rate of 22.3%.

4.1 STUDY POPULATION

The majority of the respondents (n=66) were female (n=50). The mean age was 28 years (±SD 8.2). The youngest respondent was 22 and the oldest 62 years. The different universities from which the physiotherapists graduated are summarized in Figure 4.1.

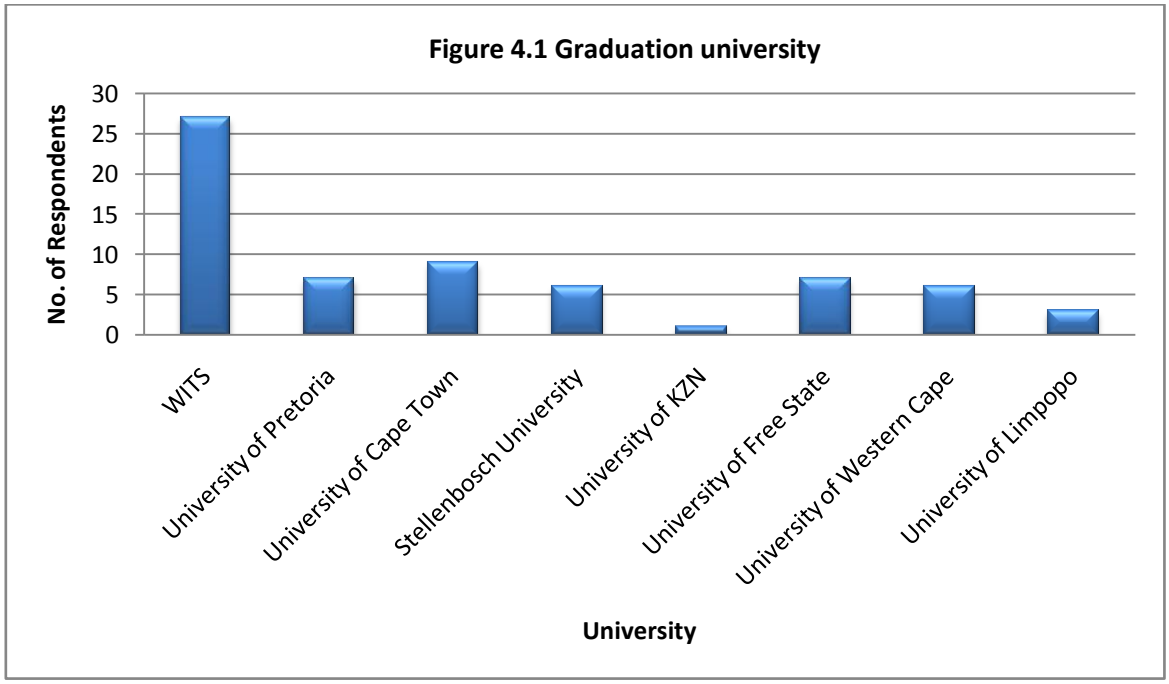


Figure 4.1: Graduation University

WITS: University of the Witwatersrand KZN: Kwa-Zulu Natal

The majority of respondents (41%) graduated from the University of the Witwatersrand.

The number of respondents who had a postgraduate degree in physiotherapy is represented in Figure 4.2.

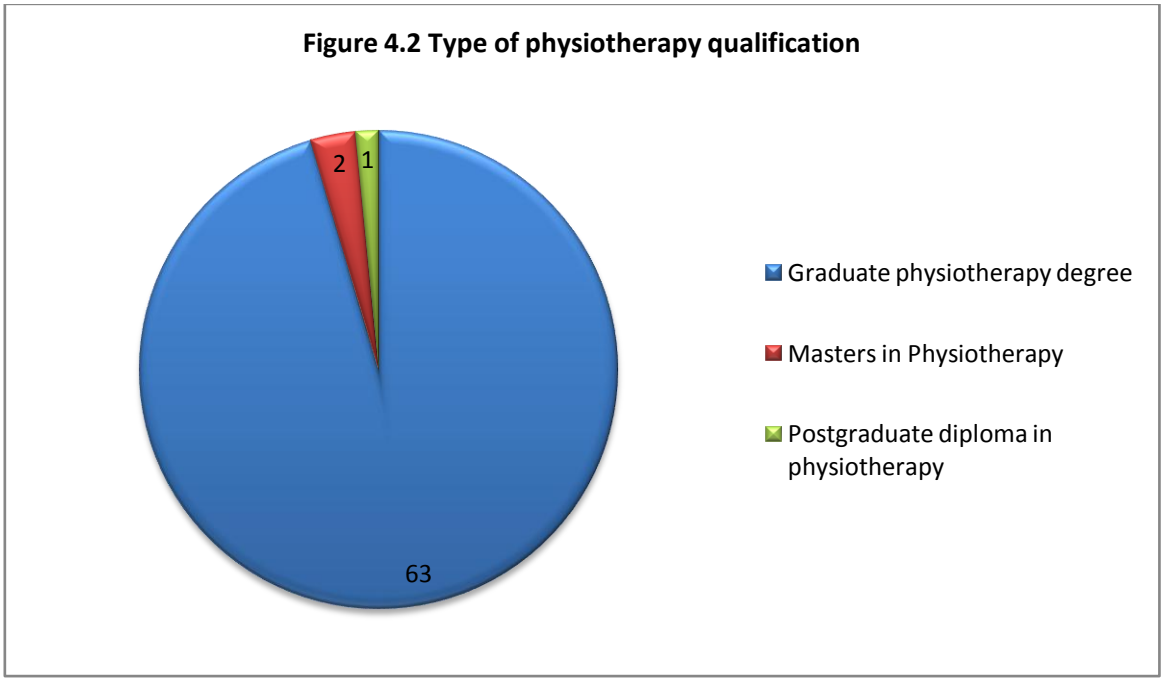


Figure 4.2: Type of Physiotherapy Qualification

Of the three respondents with a postgraduate physiotherapy education, two had a Master of Science in Physiotherapy and one had a postgraduate certificate in physiotherapy.
The number of years that the respondents practiced as qualified physiotherapists registered with the HPCSA is displayed in Figure 4.3.

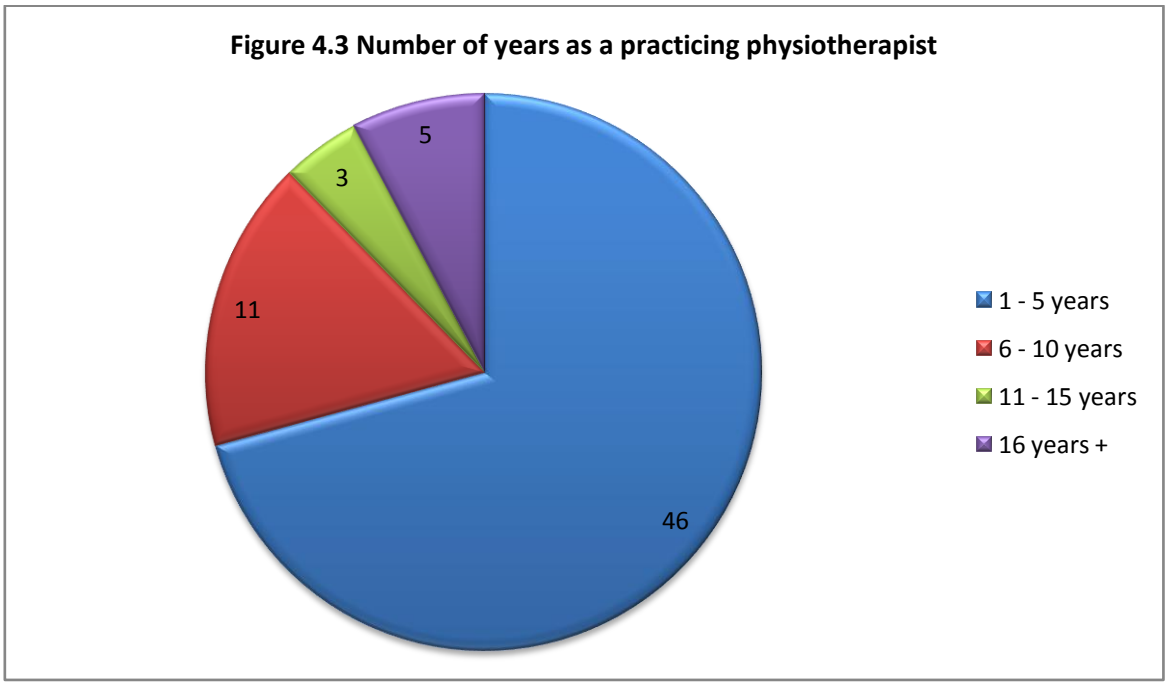


Figure 4.3: Number of Years as a Practicing Physiotherapist

The majority of respondents (n=46; 77%) had been qualified between one to five years.

The different sectors of employment of the respondents are summarized in Figure 4.4.

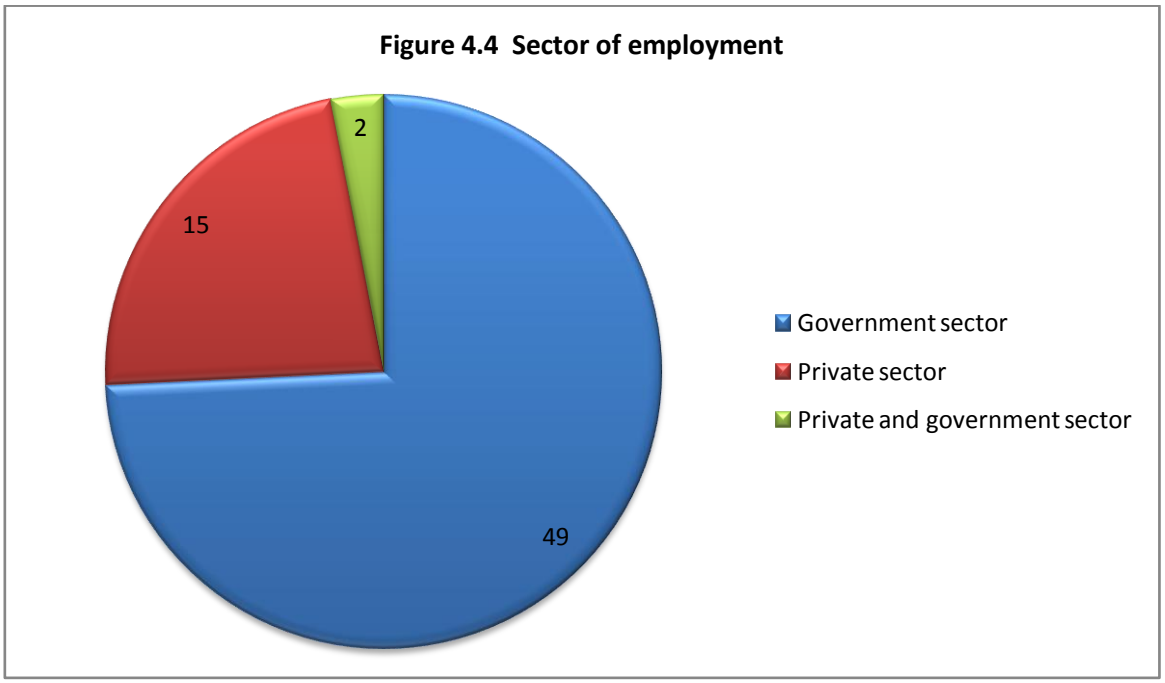


Figure 4.4: Sector of Employment

The majority of respondents (n=49; 74%) were employed in the government sector.

A mean number of 6.3 ICU patients (±SD 3.2) were reportedly being treated by the respondents per day. The minimum number of patients treated daily was two and the maximum 16 patients per day.

The type of ICU that the respondents worked in is summarized in Figure 4.5.

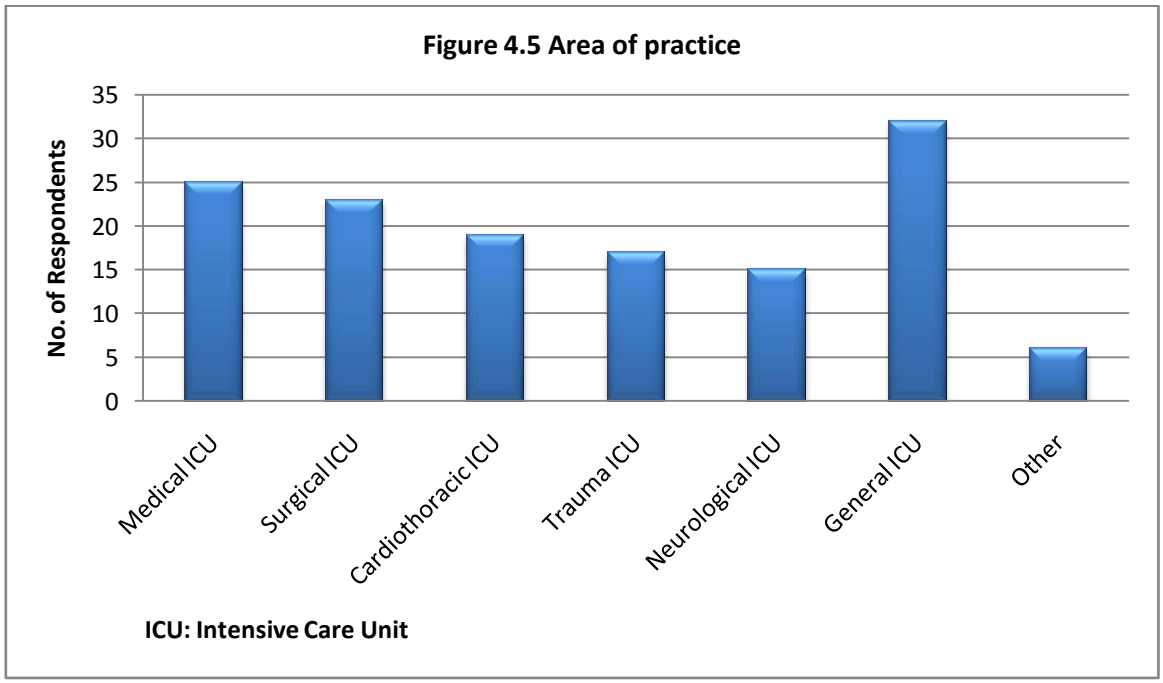


Figure 4.5: Area of Practice

Most of the respondents worked in a general ICU setting. The option “Other” in the questionnaire represented the respondents’ area of work other than the options provided. There were six respondents that marked “other” and all six of the respondents indicated that their place of work was in a paediatric ICU.

4.2 KNOWLEDGE ON MANUAL HYPERINFLATION

Thirty-eight percent of physiotherapists (n=25) used MHI as part of patient care in an ICU setting, and 62% (n=41) did not use MHI in an ICU setting. Of the physiotherapists (n=25) who used MHI, 21 of the physiotherapists were from the government sector and four were from the private sector. The results were not significant (p=0.32). Figure 4.6 displays information about where the respondents learnt to perform MHI.

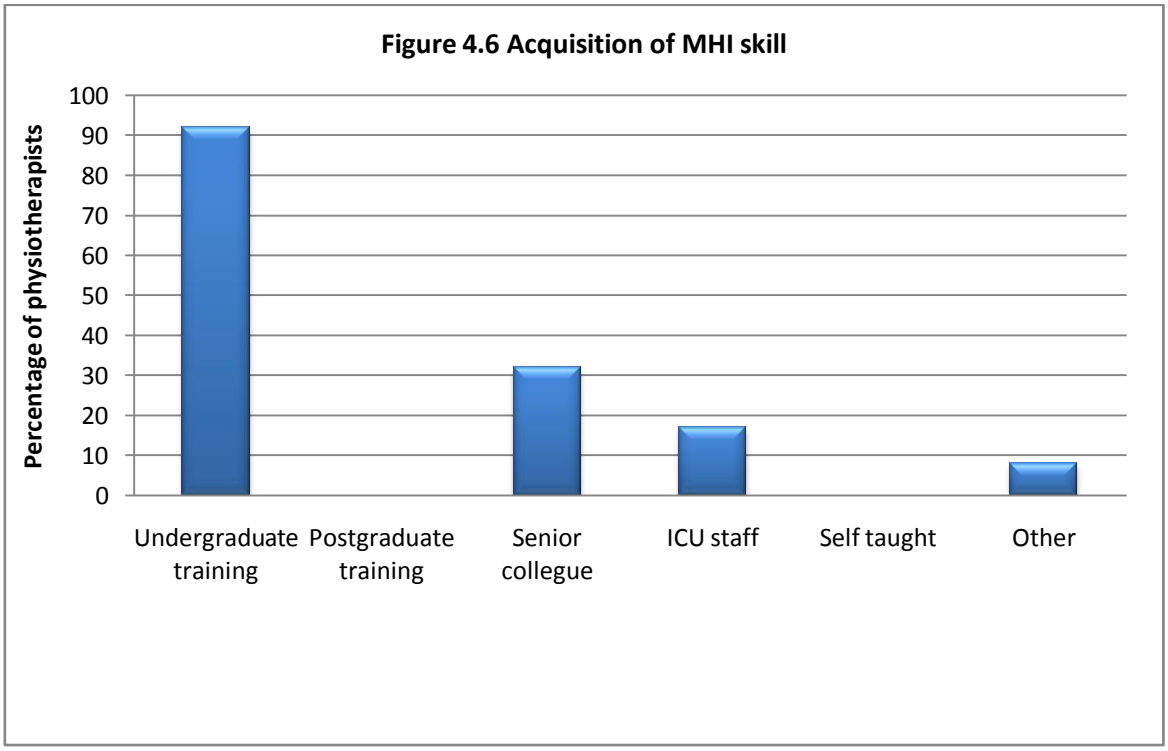


Figure 4.6: Acquisition of MHI Skill

The majority of the 25 physiotherapists (92%) who employ MHI in their daily treatment of patients acquired the skill as part of their undergraduate university training. The eight percent, who reported to have acquired the skill in the “other” column, was taught by anaesthetists in the ICU. None of the respondents acquired the skill to perform MHI through self-taught methods or by undergoing postgraduate training.

Reasons that respondents put forward for not using MHI as part of their patient management in ICU are displayed in Figure 4.7.

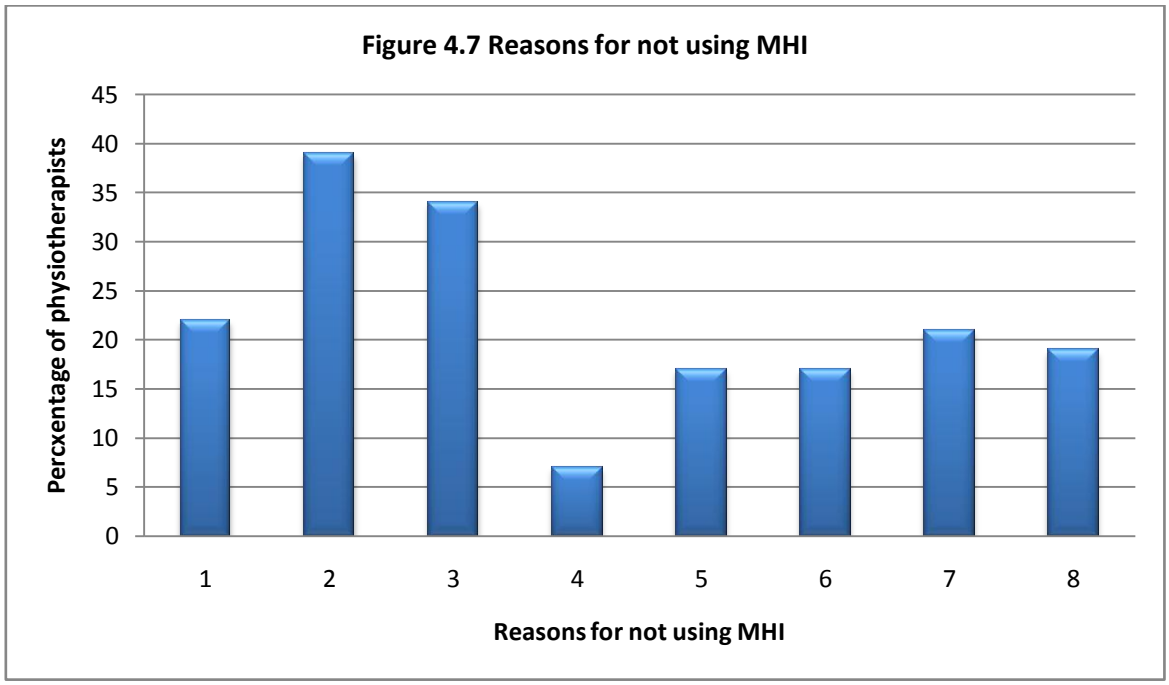


Figure 4.7: Reasons for not Using MHI

1: Do not know how to use MHI. 2: Have not been adequately trained to use MHI. 3: Know how to use MHI, but do not feel confident. 4: The nurses do it. 5: Do not have the equipment for MHI. 6: Not enough research has proven it is effective. 7: No clinical benefits have been observed. 8: The technique is time consuming

Sixty-two percent of respondents (n=41) indicated that they do not use MHI as part of patient management in ICU. The majority (39%) reported that they felt they had not been adequately trained to perform the technique. Some reported that they did not feel confident in using MHI despite having had training and others reported that they had not observed any clinical benefits from performing MHI.

The physiotherapists were presented with options on the considered benefits of using MHI, irrespective of whether they used the technique or not. Results are summarized in Figure 4.8.

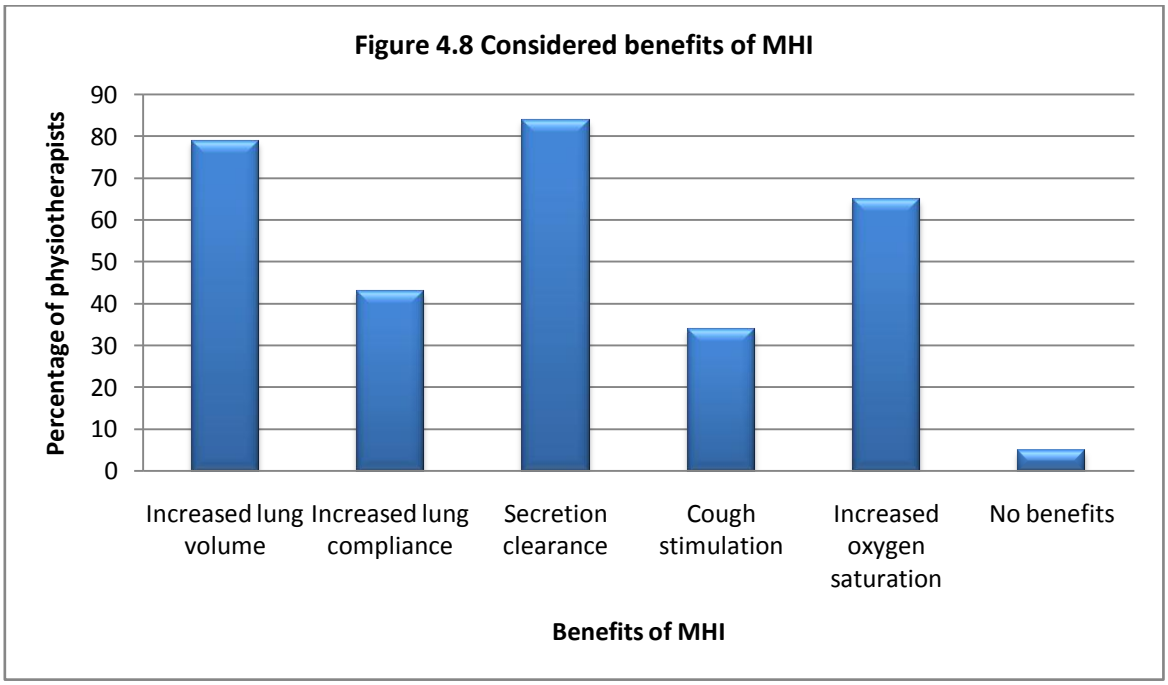


Figure 4.8: Considered Benefit of MHI

The majority of respondents felt that the greatest benefits obtained from using MHI were in increasing lung volume (79%) as well as secretion clearance (84%). Only five percent of physiotherapists (n=3) felt that there were no benefits associated with using MHI.

The physiotherapists were asked to comment on whether or not they use a manometer in the MHI circuit. If they do not use a manometer they were asked to state the reason why. Forty-seven percent of physiotherapists utilised a manometer in the MHI circuit; however 53% did not. Forty percent of the physiotherapists who did not use a manometer in the MHI circuit stated that they did not know what a manometer was used for or they were unsure of how to use it. The remaining respondents said that there were no manometers available in the ICU setting that they worked in.

The physiotherapists were asked to comment on what they felt is the safe maximum airway pressure that can be delivered while performing MHI. Results are displayed in Figure 4.9.

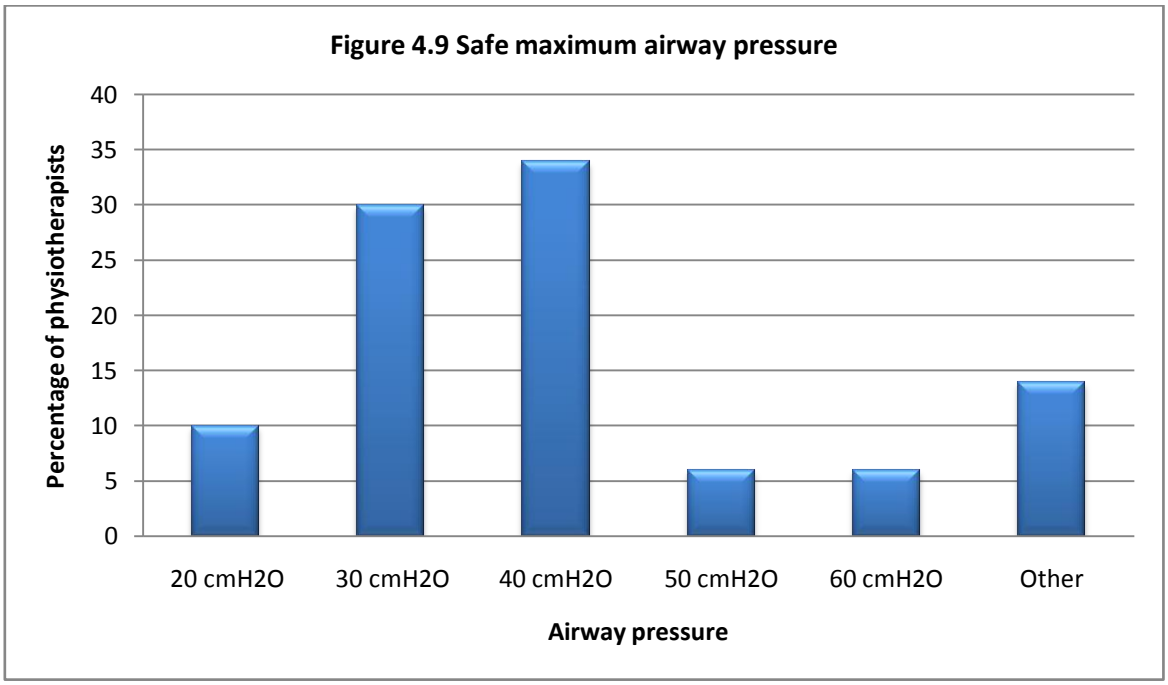


Figure 4.9: Safe Maximum Airway Pressure

Most of the respondents indicated that safe maximum airway pressures generated during MHI is 30 cmH_2O (30%) and 40 cmH_2O (34%), respectively. The physiotherapists (14%) who marked "other" indicated that they did not know what the safe maximum airway pressure was. Of concern is the fact that some physiotherapists thought airway pressures of 50 – 60 cmH_2O were safe during MHI.

Physiotherapists were asked when they thought a PEEP valve should be used as part of a MHI circuit. Results are summarized in Figure 4.10 below.

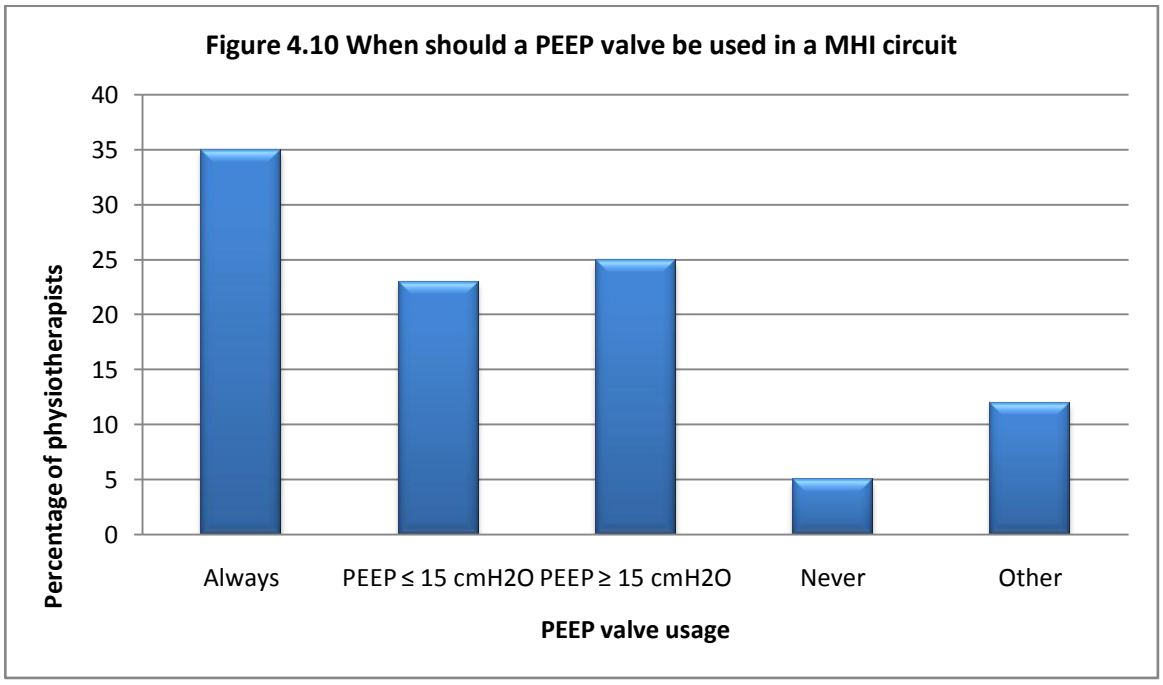


Figure 4.10: When should a PEEP Valve be used in a MHI Circuit

Thirty-five percent of the physiotherapists reported that they would use a PEEP valve in a MHI circuit irrespective of what PEEP setting is set on the ventilator. The respondents (12%) who marked “other” stated that they were not sure of what a PEEP valve was or how to use one as part of a MHI circuit.

In this survey physiotherapists were asked which clinical conditions would pose a precaution or contraindication to the performance of MHI. They were also asked which clinical conditions would not pose a precaution or contraindication to the use of MHI. Their responses are displayed in Figure 4.11.

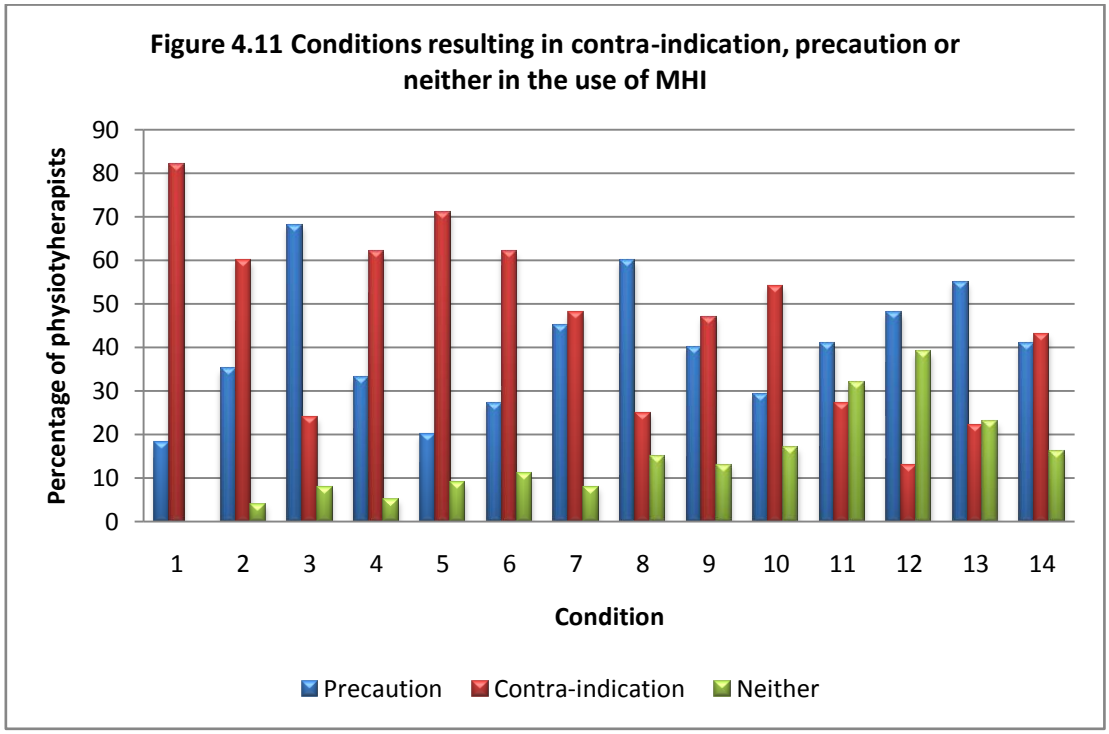


Figure 4.11: Conditions Resulting in Contra-Indication, Precaution or Neither in the use of MHI

1: Undrained pneumothorax/haemothorax/pleural effusion. 2: Unstable cardiovascular system. 3: High peak airway pressure. 4: Raised intracranial pressure. 5: Haemoptysis. 6: Lung bullae. 7: Bronchospasm. 8: PEEP greater than 15 cmH_2O. 9: Pulmonary oedema. 10: Bronchopleural fistula. 11: Lung abscess. 12: Rib fracture. 13: Multiple rib fractures. 14: Flail rib segment.

Figure 4.11 represents conditions that would indicate whether MHI should be used as a precaution, contra-indication or neither to treatment. When a patient has 1) an undrained pneumothorax/haemothorax/pleural effusion; 2) unstable cardiovascular system; 3) high peak airway pressure; 4) raised ICP; 5) haemoptysis; 6) lung bullae; 8) PEEP greater than 15 cmH_2O; 10) bronchopleural fistula or 13) multiple rib fractures, there was consensus of more than 50% of the physiotherapists that MHI should be used as a precaution, contra-

indication or neither during treatment. When a patient has 7) bronchospasm; 9) pulmonary oedema; 11) lung abscess; 12) rib fracture or 14) flail rib segment there was confusion amongst the physiotherapists as to whether MHI should be used as a precaution, contra-indication or neither during treatment.

The availability of MHI equipment could influence the use of this technique by physiotherapists and therefore this issue was explored during this survey. Results are displayed in Figure 4.12.

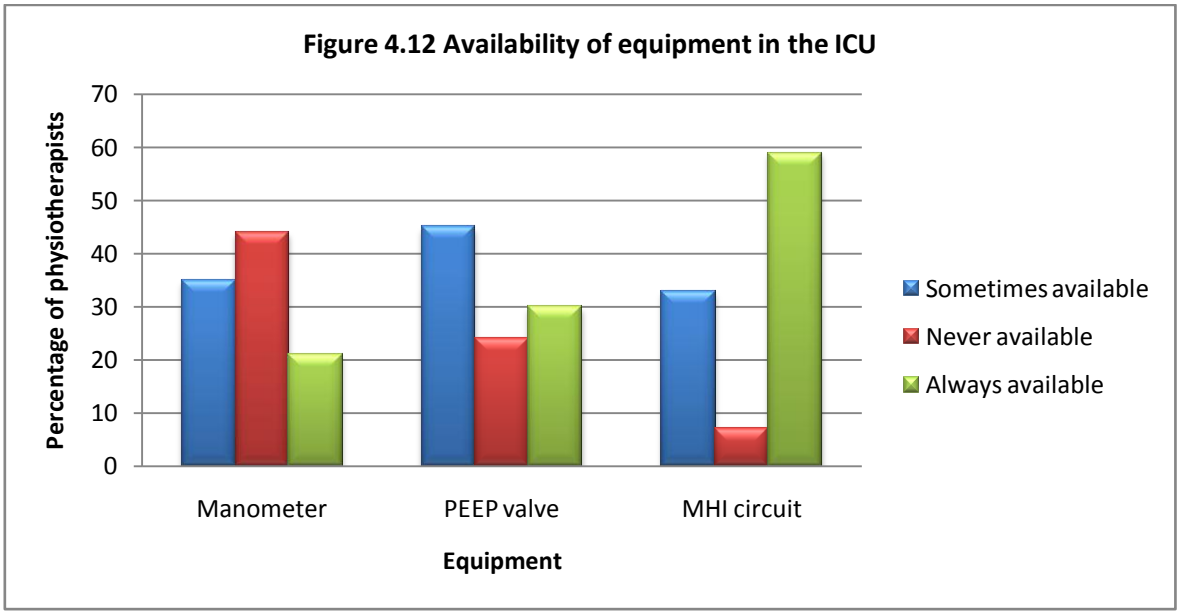


Figure 4.12: Availability of Equipment in the ICU

Fifty-nine percent of respondents indicated that their ICUs readily have MHI circuits available to use during physiotherapy treatment and only eight percent of respondents reported that their ICU never have MHI circuits available. Respondents indicated that a manometer was only available 21% of the time and never available 44% of the time in their respective ICUs. The reported availability of a PEEP valve fluctuated between always available 30% of the time; sometimes available 45% of the time and never available 24% of the time.

4.3 CLINICAL APPLICATION OF MHI

Figure 4.13 represents the number of patients that the respondents felt were eligible to receive MHI on a daily basis.

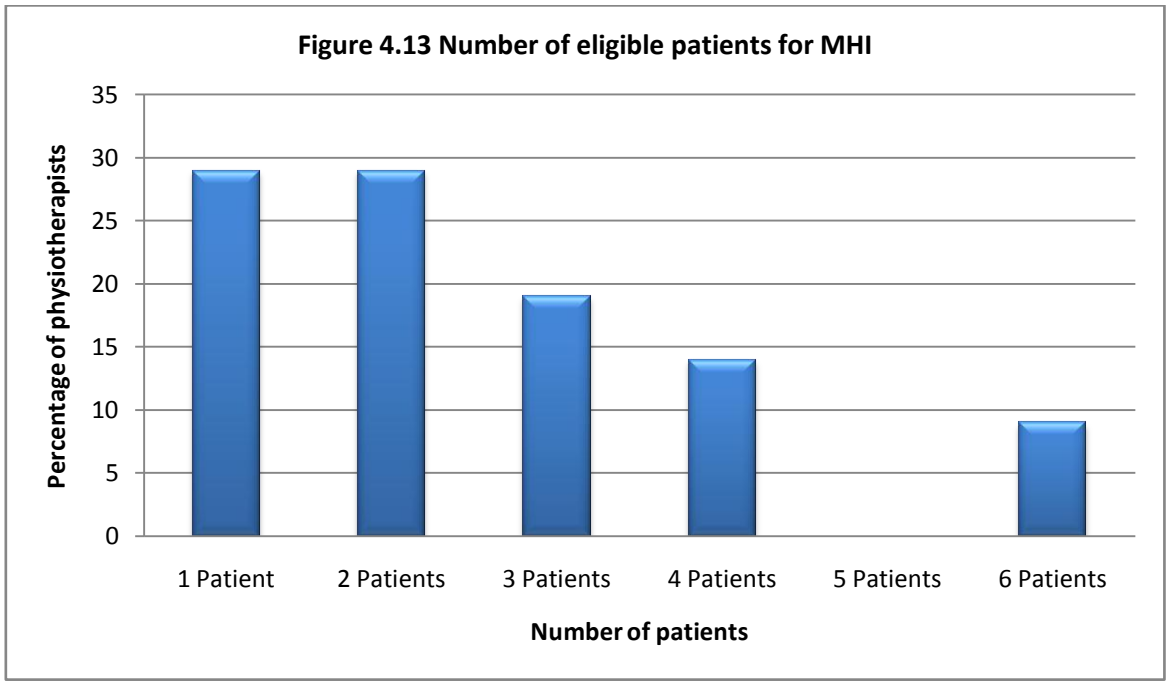


Figure 4.13: Number of Eligible Patients for MHI

An equal percentage of respondents (29%) stated that there were one or two patients eligible for MHI on a daily basis in the ICUs that they practice in. Only nine percent of respondents stated that they had six patients eligible for MHI on a daily basis.

Physiotherapists were asked which clinical conditions they thought would be an indication for the performance of MHI. Results are summarized in Figure 4.14 below.

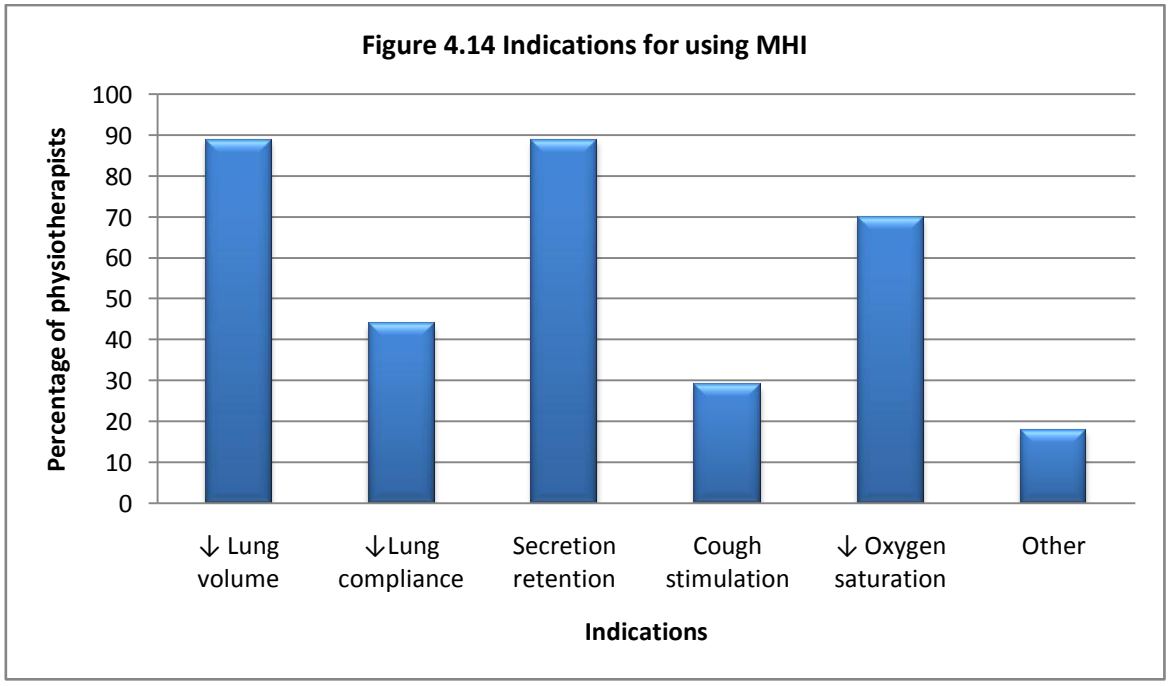


Figure 4.14: Indications for Using MHI

Eighty-nine percent of the respondents felt that a decreased lung volume and secretion retention respectively were indications to implement MHI as part of patient treatment. Physiotherapists reported “other” indications for the use of MHI such as for respiratory muscle training (n=1) and to decrease an elevated intracranial pressure (n=1).

Figure 4.15 represents the different MHI circuits used by the physiotherapists during clinical practice.

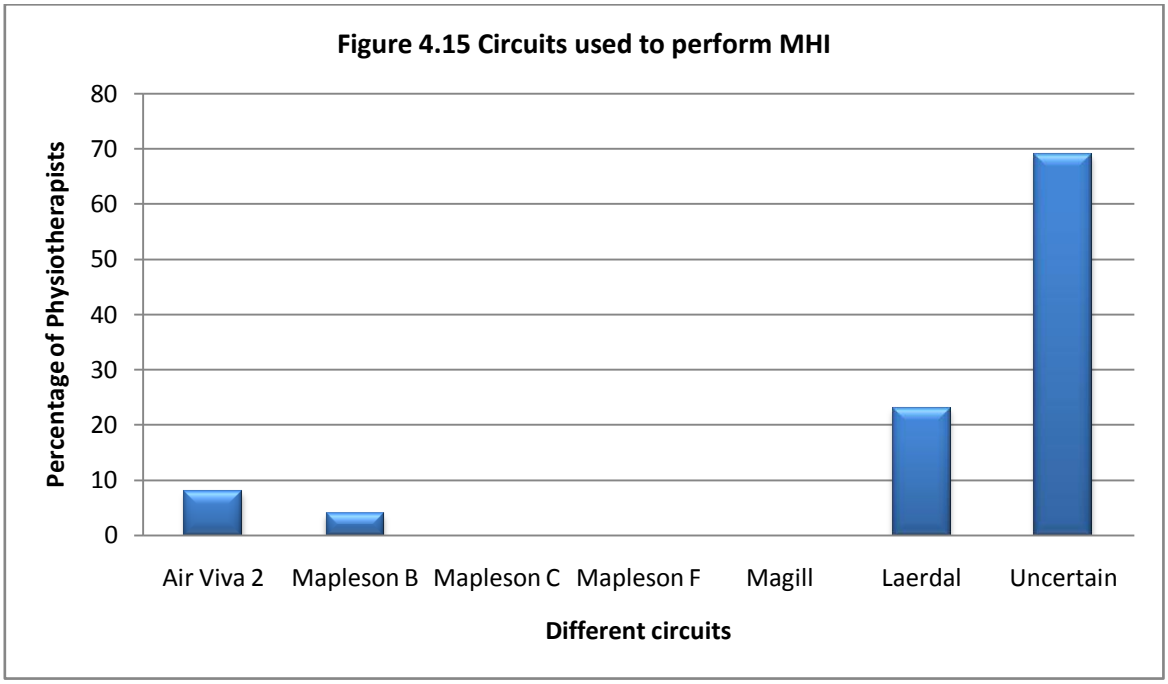


Figure 4.15: Circuits used to Perform MHI

The vast majority (69%) of physiotherapists who participated in this survey were unsure of the MHI circuit’s name that they used in their practice. Twenty-two percent of respondents stated that they used the Laerdal MHI circuit. Few of the respondents used the Mapleson B and Air Viva 2 MHI circuits.

Figure 4.16 represents the phases of the delivery of MHI that respondents use during clinical practice.

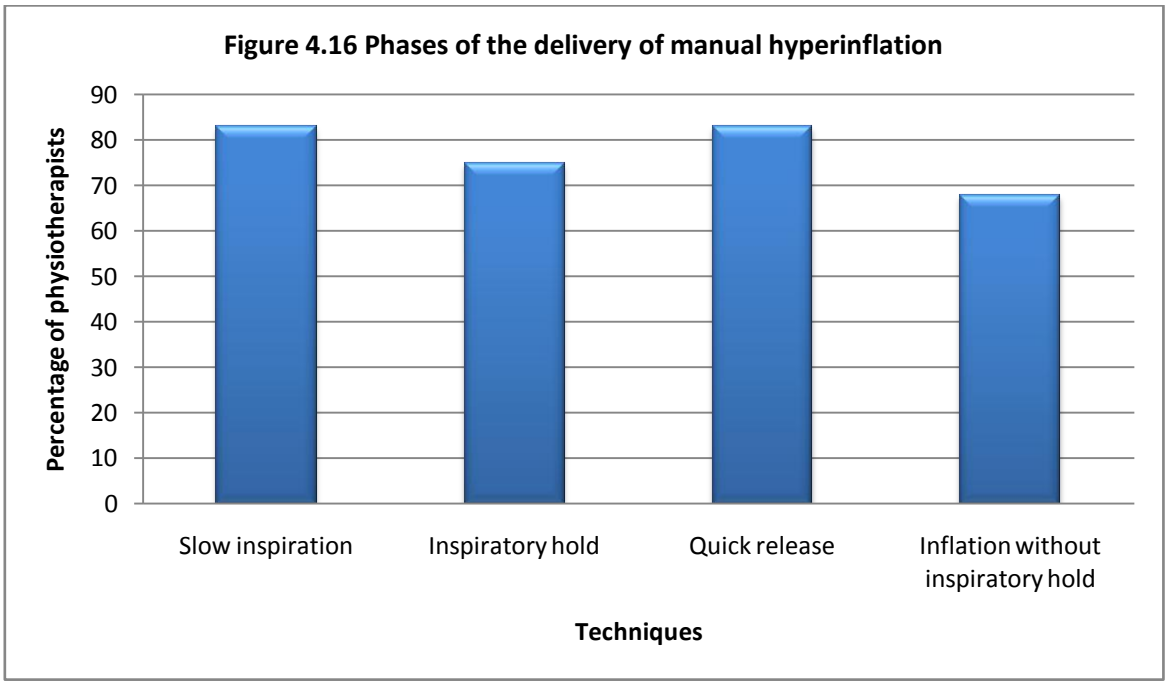


Figure 4.16: Phases of the Delivery of Manual Hyperinflation

All four phases of the delivery of MHI were performed by more than 68% of the physiotherapists who participated in this survey. The slow inspiration and quick release phases were performed by 83% of the physiotherapists.

The participants were asked how many number of MHI breaths they performed per set during a treatment. Results are displayed in Figure 4.17.

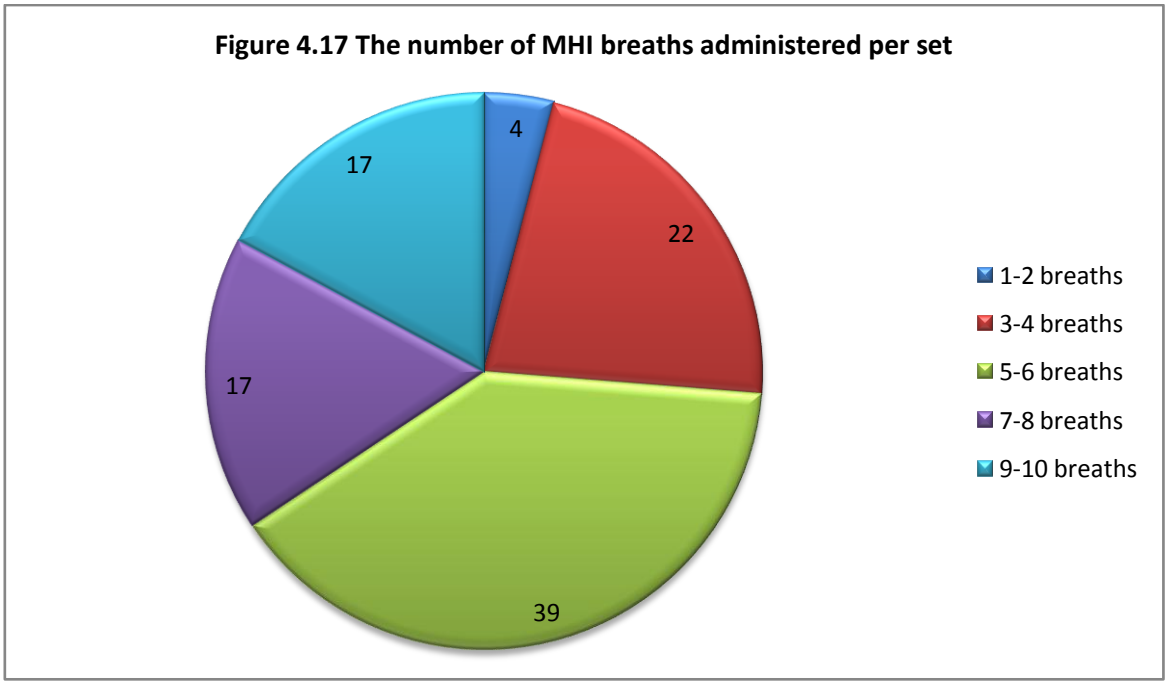


Figure 4.17: The Number of MHI Breaths Administered per Set

The majority (39%) of physiotherapists reported that they used 5-6 MHI breaths per set, whereas 22% of the physiotherapists used 3-4 MHI breaths per set during patient treatment.

The participants were asked which techniques they used in combination with MHI during patient treatment. Their responses are shown in Figure 4.18.

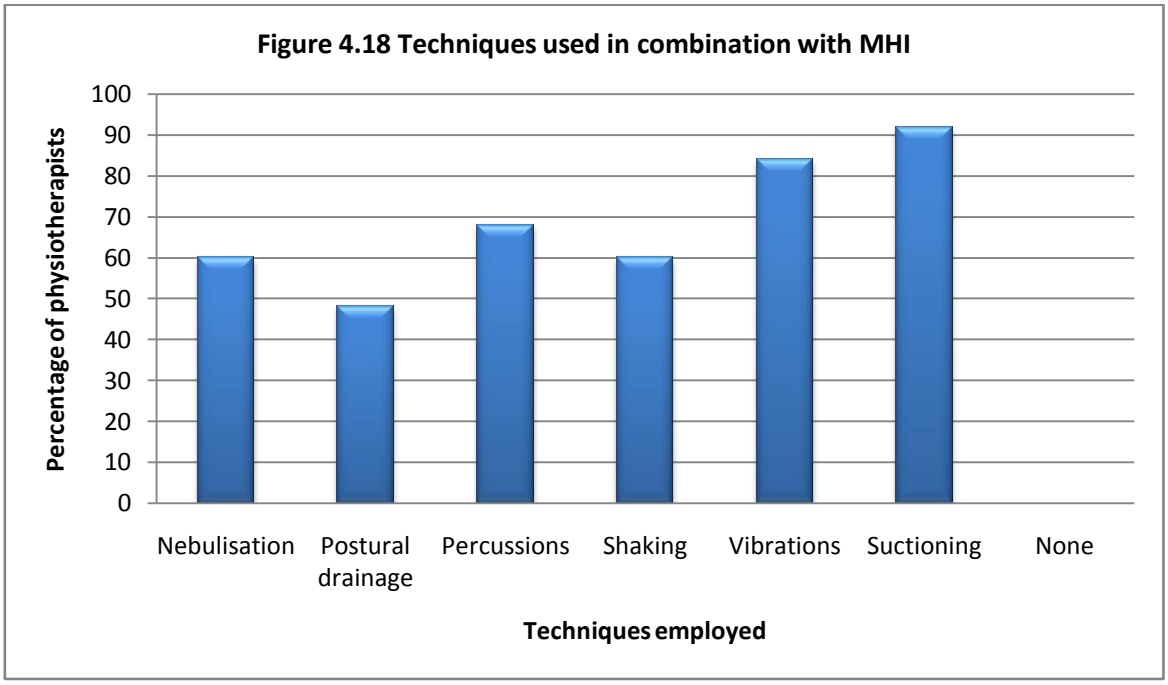


Figure 4.18: Techniques Used in Combination with MHI

The majority of respondents (91%) used suctioning in combination with MHI. Eighty-four percent of physiotherapists used vibrations in combination with MHI and the least commonly used technique in combination with MHI was postural drainage (49%).

4.4 CORRELATION OF DATA VARIABLES

The Chi-squared test of independence was used to determine significance between variables. The variables analysed were whether being male or female; having a postgraduate degree; the number years practiced as a physiotherapist; knowledge of the use of MHI or the working environment had an influence on whether physiotherapists utilised MHI in the treatment of patients.

Male physiotherapists were found to use MHI more than female physiotherapists; the results were significant with a p-value of 0.02. The physiotherapist's knowledge of the use of MHI was compared to their use of MHI. This was done by relating their use of MHI to the 14 questions asked about whether MHI should be used as a precaution, contra-indication or neither to treatment when a patient has a specific type of pathology. The results were

significant on five out of the 14 questions. These questions related to when MHI should be used and resulted in a) if a patient has high peak airway pressure ($p = 0.02$), b) raised intracranial pressure ($p = 0.02$), c) lung bullae ($p = 0.01$), d) pulmonary oedema ($p = 0.04$), or e) flail rib segment ($p = 0.03$). The data reflected that knowledge of MHI did play a role in determining whether to use a PEEP valve ($p=0.04$) or a manometer ($p=0.03$) in a MHI circuit.

Further comparisons were made between where a physiotherapist graduated and their use of MHI ($p=0.98$); their working environment (government or private) and their use of MHI ($p=0.32$); their clinical experience and their use of MHI ($p=0.71$) or whether having a postgraduate degree would influence their use of MHI ($p=0.29$). The results also reflected that clinical experience played no role in whether to use a PEEP valve ($p=0.07$) or manometer ($p=0.13$). None of those results were deemed significant and will not be discussed further.

A discussion of the results described in this chapter is provided in chapter 5.

CHAPTER 5

5. DISCUSSION

Comparisons will be made between results obtained from the current study and those published in the literature by fellow researchers.

The majority of practicing ICU physiotherapists in South Africa did not use MHI when treating ventilated patients according to the results of this survey. This is in contrast to the results reported by Hodgson, Carroll and Denehy (1999) on a survey of Australian teaching hospitals that showed 91% of senior physiotherapists used MHI as treatment technique in ICU. Similar results were reported by King and Morrell (1992) on a survey of UK physiotherapists that showed that 89% of senior physiotherapists used MHI as a physiotherapy treatment technique in ICU. Jones, Hutchinson and Teik (1992) conducted a survey investigating current physiotherapy work practices in ICUs in Australia, the UK and Hong Kong. The survey was questionnaire based and the three countries that were selected were done so as they had similar curricula for physiotherapy training. In Australia 34 hospitals with ICUs in capital cities were selected; in the UK 33 hospitals with ICUs and a physiotherapy training school were selected, and in Hong Kong all 12 of the hospitals with ICUs were selected. The authors reported similar frequencies regarding the use of MHI for the Australian physiotherapists (92%) but contrasted somewhat to the UK physiotherapists as less used MHI (53%). Paulus et al., (2009) conducted a survey into current practice and knowledge on MHI in intubated and mechanically ventilated patients among ICU nurses in the Netherlands. Their study concluded that MHI was practised in 96% of the ICUs. As shown above MHI is widely used as treatment technique in surveys conducted in other countries in comparison to South Africa. The result of the current survey is against the trend when compared to the UK, Dutch and Australian surveys. A possible explanation for this finding could be the fact that a large number of participants felt that they had not been adequately trained in performing the technique. Some felt that even though they had been adequately trained to perform the technique, they did not feel confident enough to use it on their own.

The current survey revealed that the majority of physiotherapists were in agreement on the benefits of using MHI. Eighty four percent agreed that it is effective as a means of secretion clearance and most believed it improves lung volumes, with only a small number indicating that it is of no benefit at all. These figures are similar to those obtained by Hodgson, Carroll and Denehy (1999). Considering that there is agreement amongst the South African

physiotherapists on the benefits of MHI, it is reasonable to expect that there would be more physiotherapists who use it as a treatment technique in the management of their ICU patients. A factor that could have an influence on the use of MHI is the reported lack of availability of MHI equipment in South African ICUs. The lack of availability could be due to the poor state of finances faced by the government health care facilities in South Africa, and this could have an impact on the type of equipment ordered for an ICU (Coovadia, Jewkes, Barron, Sanders, McIntyre 2009).

A small number of respondents indicated that they always had access to a manometer and a PEEP valve to use with a MHI circuit in their unit. The importance of the use of a manometer in a MHI circuit to monitor airway pressures delivered to the patient during physiotherapy treatment is emphasized in the literature (Gosselink et al., 2008; Redfern, Ellis, Holmes 2001; Denehy 1999). Therefore it is reasonable to deduce that if physiotherapists were well versed with the literature on the correct equipment needed to perform MHI, they could be detracted from using the technique due to the lack of suitable equipment to perform MHI safely in their ICUs. This argument is supported by the fact that results from the current study showed that knowledge did play a significant role in determining whether to use a MHI circuit and include a PEEP valve or manometer.

The majority of physiotherapists in South Africa who utilised MHI were unsure of the brand of MHI circuit that they used. This is in stark contrast to the Dutch survey by Paulus et al., (2009) where all of the respondents were sure of the circuit name that they used to perform MHI. The small number of South African physiotherapists, who were certain about the type of circuit they used, indicated that they used the Laerdal MHI circuit. The results from the current survey differs from the survey by Hodgson, Carroll and Denehy (1999), in that their study showed that the Magill MHI circuit was used 59% of the time and the Laerdal 55% of the time. The percentage of physiotherapists who used the Laerdal circuit in the current study is similar to the percentage of those who used the Laerdal circuit in Hong Kong, whose physiotherapists made minimal use of MHI as well, as reported by Jones, Hutchinson and Teik (1992). Reasons for using different circuits were not explored in the current study and are a limitation of the survey. As the researcher is a practicing physiotherapist in an ICU in South Africa, it is known that physiotherapists are generally not consulted by the sister in charge of the ICU or the ICU consultant regarding the type of MHI circuits purchased for the unit. The MHI circuit that is available in the ICU at the time is the one that is employed to perform MHI, and these circuits are acquired via the hospitals procurement process which the physiotherapist has very little role in. If the physiotherapist did play a role in selecting the type of MHI circuit procured for the ICU, the circuit of choice should be the Mapleson–C MHI circuit. This circuit is seen to be slightly superior in performance compared to the Laerdal MHI circuit which is most commonly used by South

African physiotherapists. Studies have indicated that using the Mapelson–C MHI circuit results in a) increased PIP, b) increased PEFR, c) reduced I:E ratio, d) increased PEEP and e) greater TV which improves mucus clearance and re-expansion of atelectatic alveoli when compared to the Laerdal MHI circuit (Hodgson et al., 2007; Ntoumenopoulus 2005; Savian, Chan, Paratz 2005; Maxwell & Ellis 2004; Maxwell & Ellis 2003; Maxwell, Crosbie, Ellis 2001; McCarren & Chow Moi 1996).

This study revealed that there was no standardised agreement among physiotherapists who worked in ICU relating to a) the number of MHI breaths delivered per set during patient treatment; b) at what ventilator PEEP setting a PEEP valve should be included in a MHI circuit and, c) what the maximum safe airway pressure is when delivering MHI. The majority of respondents used 5 – 6 MHI breaths per set, whereas others used 3-4 and 7-8 MHI breaths per set respectively. The current uncertainty amongst the South African physiotherapy population on the number of MHI breaths to administer per set is in agreement to what was found in the Australian survey by Hodgson, Carroll and Denehy (1999). Furthermore there was no consensus by the South African physiotherapy population regarding the correct use of a PEEP valve in a MHI circuit. The confusion was regarding the decision on when to use a PEEP valve in a MHI circuit according to the PEEP setting set on a ventilator. Alarmingly 12% stated that they did not even know what a PEEP valve was. The findings in the Australian survey by Hodgson et al., 1999, showed that 66% of Australian physiotherapists would include a PEEP valve in their MHI circuit, irrespective of the PEEP ventilator setting.

Further uncertainty was evident amongst the South African physiotherapy population when asked to indicate the maximum safe airway pressure. Only 34% of South African physiotherapists correctly stated that it was 40 cmH_2O (Redfern, Ellis, Holmes 2007; Maxwell & Ellis 2007) and only 47% would include a manometer in the MHI circuit to monitor airway pressures. The literature reflects the fact that there is no standardised treatment regime for selecting MHI breaths per set, including a PEEP valve and manometer or techniques that should be used in conjunction with MHI (Paulus et al., 2009; Hodgson, Carroll, Denehy 1999; Robson 1998). It was encouraging to find from the current survey, that 68% of South African physiotherapists who utilised MHI, performed four out of the five phases of MHI in their application of the technique. These phases are slow inspiration, inspiratory hold, quick release, and inflation without inspiratory hold. The phase of MHI that was least included in their application of the technique was the use of a manometer (47%). The majority of South African physiotherapists used suctioning and vibrations as an adjunct to MHI treatment and this is in line with current international practice as reported in the literature by Berney, Haines, Denehy (2012); Berti, Tonon, Ronchi, Berti, Stefano, Gut (2012) and Gosselink et al., (2008).

Working environment (government or private health care), clinical experience, institution where physiotherapy degree was completed and postgraduate studies did not play a significant role in influencing South African physiotherapists' use of MHI. None of these factors were deemed significant in either selecting to use a PEEP valve or manometer. What is interesting is the fact that only two out of the 66 respondents held a postgraduate degree in cardiopulmonary physiotherapy. The Australian (Hodgson, Carroll, Denehy 1999) and UK (Jones, Hutchinson, Teik 1992) surveys showed that senior physiotherapists or physiotherapists with post graduate education predominantly worked in, or oversaw the ICU in that particular country. In a study by Norrenburg et al., (2000) on the profile and role of ICU physiotherapists in 17 different European countries, it was shown that specialization by physiotherapists is a common practice. The study revealed that 29% had a specific postgraduate specialization in ICU therapy, and 43% had a postgraduate specialization in respiratory therapy. Post graduate specialization was especially common in the UK (71% intensive care therapy, 82% respiratory therapy). This shows that in the Australian, European and UK ICUs there is emphasis on post graduate education and clinical experience among physiotherapists. The current survey reveals that this is not the case in South Africa as only four percent of the physiotherapists had a postgraduate education in cardiopulmonary physiotherapy. The vast majority of physiotherapists working in ICU had between one and five years clinical experience. This is a disappointing figure considering the specialised skill (Norrenburg et al., 2000; Jones, Hutchinson, Teik 1992) that is needed to treat patients in an ICU. Had the current questionnaire had a higher response rate, as in the UK survey (Jones, Hutchinson, Teik 1992) and the Australia survey (Hodgson, Carroll, Denehy 1999), perhaps the results would have been different. Interestingly in the Hong Kong survey by Jones, Hutchinson, Teik (1992), it was found that half of the ICUs were assigned physiotherapists with only one to two years clinical experience. None of the units had ongoing chest physiotherapy research and their utilisation of MHI was low. This figure is similar to the one obtained from the current survey on the use of MHI and clinical experience. Therefore it could be argued that the lack of clinical experience and postgraduate education of physiotherapists in South Africa could play a role in influencing their decision making regarding the use of MHI as part of the cardiopulmonary management of their patients.

Physiotherapists in South Africa who used MHI had greater knowledge on the pathological conditions related to when MHI should be used or not, as opposed to the physiotherapists who did not use MHI. These results were significant on five out of the 14 questions. The following conditions are a contraindication to treatment with MHI: a) if a patient has high peak airway pressure, b) lung bullae, or c) pulmonary oedema, and a precaution to treatment if the patient has d) raised intracranial pressure, or e) flail rib segment. The

physiotherapists, who could identify whether the condition was a contraindication or precaution to treatment with MHI, were the ones who were practicing the MHI technique in ICU. This again emphasizes the fact that post graduate education and specialisation in the field of cardiopulmonary physiotherapy, does have an influence on the use of MHI, as the physiotherapists would have more confidence in selecting to use the technique if they had a greater understanding of which conditions its indicated or contraindicated for.

A comparison between the current survey and that of the Dutch (Paulus et al., 2009) and Australian (Hodgson, Carroll, Denehy 1999) surveys showed that, the South African and Australian physiotherapists and the Dutch ICU nurses generally agreed as to which conditions related to precautions and contraindications for the use of MHI. There was a consensus of 80% or more physiotherapists in the Australian and South African survey that agreed that an undrained pneumothorax/haemothorax is a contraindication to treatment (Hodgson et al., 2007; Paratz, Lipman, McAuliffe 2002; Denehy 1999). Only 58% of the Dutch nurses agreed that it should be a contraindication to MHI treatment. Regarding the remaining conditions namely unstable cardiovascular system; raised ICP; haemoptysis; pulmonary oedema; high peak airway pressure; PEEP greater than 15 cmH_2O, the South African and Australian physiotherapists and Dutch nurses generally agreed that they constituted contraindications or precautions to MHI. These findings are within the norm for accepted contraindications and precautions to MHI according to recent clinical trials that investigated MHI (Berti et al., 2012; Lemes, Zin, Guimaraes 2009; Paulus et al., 2009; Maxwell & Ellis 2007; Hodgson et al., 2007). There were certain conditions asked in the current survey that were not covered in the Australian and Dutch surveys. The current survey revealed that there was general confusion as to whether these conditions should be classified as a contraindication, precaution or neither to treatment with MHI. These conditions were 1) lung abscess; 2) rib fracture; 3) multiple rib fractures and 4) flail rib segment.

5.1 LIMITATIONS OF THE CURRENT STUDY

The study was limited by the poor response rate from the South African ICU physiotherapy population. This could be due to the fact that it was a postal survey which has been shown in previous studies (Norrenberg & Vincent 2000; King & Morrel 1992) to have a poor response rate. Another limitation was the fact that private hospital ICU physiotherapy services are not run by a physiotherapy department, but by more than one privately owned physiotherapy practice. This made it extremely difficult to contact the physiotherapists working in a private ICU setting and obtain data on them. This in itself creates a potential problem as there is no supervision of privately practicing physiotherapists regarding their knowledge and current best practice guidelines for treatment techniques in ICU. Therefore

it remains the sole responsibility of the privately practicing physiotherapist to continually educate themselves regarding the use of MHI.

5.2 RECOMMENDATIONS FOR FUTURE RESEARCH

- Interviews should be held with the sisters that work in the ICUs regarding their opinions on the benefits of MHI. If their opinions are generally negative regarding the benefits and use of MHI, it could influence the procurement of MHI equipment as ICU sisters are involved in the procurement of equipment for the ICUs that they work in.

- Future surveys of this nature should be done by telephonic interview or electronically (internet-based) to increase response rate.

- The lecturers at the various universities that offer a physiotherapy degree should be interviewed to ascertain the emphasis placed on coursework and clinical experience with regards to the use of MHI. This could offer baseline information about what skills the undergraduate physiotherapist is obtaining with regards to MHI and could provide insight into why MHI is not a commonly used modality by South African physiotherapists.

- Awareness of the evidence-based benefits of the use of MHI as part of physiotherapy management of critically ill patients in ICU should be raised among physiotherapists. This could be done in the form of workshop presentations in order to allow physiotherapists to not only enhance their theoretical knowledge but also to practice MHI under supervision of the presenter (experienced in MHI).

- Ongoing research should be focused at establishing best practice guidelines for the use of MHI in relation to number of MHI breaths delivered per set during a treatment session to gain optimal patient outcomes.

CHAPTER 6

6. CONCLUSION

The survey of 67 physiotherapists, in 2012, working in adult ICUs of South Africa, indicated that MHI is not a widely used treatment technique. The study indicated that the under utilisation of MHI in ICUs could be due to a number of factors. These factors being 1) lack of equipment (MHI circuits, manometers, PEEP valves); 2) inadequate knowledge on the conditions treated by MHI; 3) the perceived lack of initiative by physiotherapists to part-take in available post graduate education and training in the field of cardiopulmonary physiotherapy and 4) limited clinical experience by the physiotherapists working in ICU. The factors that do not seem to influence whether MHI is used as a treatment technique are 1) the university where undergraduate degree was obtained and 2) the area of employment (government, private or both).

There is a general consensus regarding the benefits, contraindications and precautions regarding the use of MHI. This has been shown to be in line with current studies conducted in other countries. The survey does show that there is a need for the development of guidelines pertaining to the use of MHI, as there is confusion regarding the exact delivery of MHI. ‘Exact delivery’, meaning number of breathes per set, maximum safe airway pressure, inclusion of PEEP valve and manometer in the treatment of a patient with MHI. These findings support previously published recommendations that there are still parameters for which guidelines are needed.

This survey showed that South African physiotherapy practice is not similar to international physiotherapy practice with regards to the use of MHI as part of patient management in ICU. The reasons for this conclusion include the relative inexperience of physiotherapists who work in ICU, their resultant lack of confidence in the use of MHI and lack of availability of MHI equipment in the ICUs that they work in daily.

REFERENCES

Berney S, 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* 7(2): 100-108

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

Berney S, Haines K, Denehy L. 2012. Physiotherapy in Critical Care in Australia. *Cardiopulmonary Physical Therapy Journal* 23(1): 19-25

Bersten AD and Soni N. 2009. Oh's Intensive Care Manual 6th edition

Berti J, Tonon E, Ronchi C, Berti H, Stefano L, Gut A, Padovani C, Ferreira A. 2012. Manual Hyperinflation combined with expiratory rib cage compression for reduction of length of ICU stay in critically ill patients on mechanical ventilation. *Jornal Brasileiro de Pneumologia* 38(4): 477-486

Blattner C, Guaragna JC, Saadi E. 2008. Oxygenation and static compliance is improved immediately after early manual hyperinflation following myocardial revascularisation: a randomised controlled trial. *Australian Journal of Physiotherapy* 54: 173-178

Choi JS, Jones A. 2005. Effects of manual hyperinflation and suctioning on respiratory mechanics in mechanically ventilated patients. *Australian Journal of Physiotherapy* 51: 25-30

Coovadia H, Jewkes R, Barron P, Sanders D, McIntyre D. 2009. The health and health system of South Africa: historical roots of current public health challenges. *Lancet* 374: 817–834

Denehy L. 1999. The use of manual hyperinflation in airway clearance. *European Respiratory Journal* 14: 958-965

Gosselink R, Bott J, Johnson M, Dean E, Nava S, Norrenburg M, Schonhofer B, Stiller K, van de Leur H, Vincent J. 2008. Physiotherapy for adult patients with critical illness: recommendations of the European Respiratory Society and European Society of Intensive Care Medicine Task Force on Physiotherapy for Critically Ill Patients. *Intensive Care Medicine* 34: 1188-1199

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

Hodgson C, Denehy L, Ntoumenopoulus G, Santaamaria J, Carroll S. 2000. An investigation of the early effects of manual lung hyperinflation in critically ill patients. *Anaesthesia and Intensive Care* 28: 255-261

Hodgson C, Ntoumenopoulos G, Dawson H, Paratz J. 2007. The Mapleson C circuit clears more secretions than the Laerdal circuit during manual hyperinflation in mechanically-ventilated patients: a randomised cross-over trial. *Australian Journal of Physiotherapy* 53: 33-38

Jones AYM, Hutchinson RC, Oh TE. 1992. Chest physiotherapy practice in intensive care units in Australia the UK and Hong Kong. *Physiotherapy Theory and Practice* 8: 39-47

Kim C, Iglesias A, Rodriguez C. 1985. Mucus transport by two-phase gas-liquid flow mechanism during periodic flow. *American Review of Respiratory Disease* 131: A373

King D, Morrell A. 1992. A survey on manual hyperinflation as physiotherapy technique in intensive care units. *Physiotherapy* 78: 747-750

Kollef H. 2012. Prevention of ventilator-associated pneumonia or ventilator-associated complications: A worthy, yet challenging, goal. *Critical Care Medicine* 40: 1271-1277

Kumar Jithendra A, Arun GM, Daphne P. 2007. Role of physiotherapists in intensive care units of India: A multicenter survey. *Indian Journal of Critical Care Medicine* 11(4):198-203

Lemes DA, Zin WA, Guimaraes FS. 2009. Hyperinflation using pressure support ventilation improves secretion clearance and respiratory mechanics in ventilated patients with pulmonary infection: a randomised crossover trial. *Australian Journal of Physiotherapy* 55: 249-254

Maa SH, Hung TJ, Hsu KH, Hsieh YI, Wang KY, Wang CH, Lin HC. 2005. Manual hyperinflation improves alveolar recruitment in difficult-to-wean patients. *Chest* 128: 2714-2721

Maxwell LJ, Crosbie J, Ellis E. 2001. A new system for examining pattern of ventilation. *Australian Journal of Physiotherapy* 47: 271

Maxwell LJ, Ellis ER. 2003. The effect of circuit type, volume delivered and “rapid release” on flow rates during manual hyperinflation. *Australian Journal of Physiotherapy* 49: 31-49

Maxwell LJ, Ellis ER. 2004. The effect on expiratory flow rate of maintaining bag compression during manual hyperinflation. *Australian Journal of Physiotherapy* 50: 47-49

Maxwell LJ, Ellis ER. 2007. Pattern of ventilation during manual hyperinflation performed by physiotherapists. *Anaesthesia* 62: 27-33

McCarren B, Chow Moi C. 1996. Manual hyperinflation a description of the technique. *Australian Journal of Physiotherapy* 42(3): 203-208

Norrenburg M, Vincent JL. 2000. A profile of European intensive care unit physiotherapists. *Intensive Care Medicine* 26: 988-994

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

Ntoumenopoulos G, Presneill JJ, McElholum MJ, Cade JF. 2002. Chest physiotherapy for the prevention of ventilator-associated pneumonia. *Intensive Care Medicine* 28: 850-856

Ntoumenopoulus G. 2005. Indications for manual hyperinflation (MHI) in the mechanically ventilated patient with chronic obstructive pulmonary disease. *Chronic Respiratory Disease* 2: 199-207

Paratz J, Lipman J, McAuliffe M. 2002. Effect of manual hyperinflation on hemodynamics, gas exchange, and respiratory mechanics in ventilated patients. *Journal of Intensive Care Medicine* 17:317

Patman S, Jenkins S, Smith K. 2001. Manual hyperinflation: consistency and modification of the technique by physiotherapists. *Physiotherapy Research International* 6(2): 106-117

Patman S, Jenkins S, Stiller K. 2000. Manual hyperinflation – effects on respiratory parameters. *Physiotherapy Research International* 5(3): 157-171

Paulus F, Binnekade JM, Middelhoek P, Schultz MJ, Vroom MB. 2009. Manual hyperinflation of ventilated patients in Dutch intensive care units – A survey into current practice and knowledge. *Intensive and Critical Care Nursing* 25: 199-207

Paulus F, Veelo D, Nijs SB, Beenen LFM, Bresses P, Mol BAJM, Binnekade JM, Schultz MJ. 2011. Manual hyperinflation partly prevents reductions of functional residual capacity in cardiac surgical patients – a randomized controlled trial. *Critical Care* 15: R187

Pryor JA, Prasad SA. 2008. *Physiotherapy Essentials: Physiotherapy for Respiratory and Cardiac Problems Adults and Paediatrics*, 4th edn, Elsevier Churchill Livingstone

Redfern J, Ellis E, Holmes W. 2001. The use of a pressure manometer enhances student physiotherapists' performance during manual hyperinflation. *Australian Journal of Physiotherapy* 47: 121-131

Robson WP. 1998. To bag or not to bag? Manual hyperinflation in intensive care. *Intensive Critical Care Nursing* 14: 239-243

Rusterholz B, Ellis E. 1998. The effect of lung compliance and experience on manual hyperinflation. *Australian Journal of Physiotherapy* 44: 23-28

Savian C, Chan P, Paratz J. 2005. The effect of positive end-expiratory pressure level on peak expiratory flow during manual hyperinflation. *Anesthesia Analgesia* 100: 1112-1116

Savian C, Paratz J, Davies A. 2006. Comparison of the effectiveness of manual and ventilator hyperinflation at different levels of positive end-expiratory pressure in artificially ventilated and intubated intensive care patients. *Heart and Lung* 35(5): 1-10

Smith MCL, Ellis ER 2000. Is retained mucus a risk factor for the development of postoperative atelectasis and pneumonia? - Implications for the physiotherapist. *Physiotherapy Theory and Practice* 16: 69-80

Stiller K. 2000. Physiotherapy in Intensive Care. *Chest* 118: 1801-1813

Stiller K, Jenkins S, Grant R. 1996. Acute lobar atelectasis: A comparison of five physiotherapy regimens. *Physiotherapy Theory and Practice* 12: 197-209

Zeppos L, Patman S, Berney S, Adsett JA, Bridson JM, Paratz JD. 2007. Physiotherapy intervention in intensive care is safe: an observational study. *Australian Journal of Physiotherapy* 53: 279-283

APPENDIX 1

- **QUESTIONNAIRE**

A SURVEY TO ASSESS THE USE OF MANUAL HYPERINFLATION BY PHYSIOTHERAPISTS IN SOUTH AFRICAN INTENSIVE CARE UNITS

Answer the following questions by ticking the box or filling in your answer in the space provided.

QUESTIONNAIRE CODE: _____

SECTION A: DEMOGRAPHICS

1. Your current age:_____

2. Gender
   - ☐ Male
   - ☐ Female

3. Which institution did you graduate from?
   - ☐ University of Witwatersrand
   - ☐ University of Pretoria
   - ☐ University of Cape Town
   - ☐ Stellenbosch University
   - ☐ University of Kwazulu Natal
   - ☐ University of Free State
   - ☐ University of Western Cape
   - ☐ Other Please state: _____

4. What sector are you working in?
   - ☐ Government
   - ☐ Private
   - ☐ Both
   - ☐ Other Please state:_____

5. The type of ICU that you practice in?
   - ☐ Medical
   - ☐ Surgical
   - ☐ Cardiothoracic
   - ☐ Trauma
   - ☐ Neurological
   - ☐ General
   - ☐ Other Please state:_____

6. How many patients do you treat in your ICU per day?

Please state:_____

7. Are you doing or do you have a post-graduate qualification in cardiopulmonary physiotherapy?
   - ☐ Yes
   - ☐ No

7.1 If yes, indicate qualification below
   - ☐ Certificate
   - ☐ Diploma
   - ☐ MSc
   - ☐ Phd

8. How many years have you been qualified for?
   - ☐ 1-5
   - ☐ 6-10
   - ☐ 11-15
   - ☐ 16 +

SECTION B: KNOWLEDGE ON MANUAL HYPERINFLATION

1. Do you use manual hyperinflation in ICU?
   - ☐ Yes
   - ☐ No

   If yes, continue with question 1.1, and if no, continue with question 1.2.

1.1 If yes, where did you acquire the skill to perform MHI?
   - ☐ Undergraduate training
   - ☐ Postgraduate training
   - ☐ Senior physiotherapy colleague
   - ☐ Staff in the ICU
   - ☐ Self taught
   - ☐ Other Please state:_____

1.2 If no, indicate reasons (may tick more than one)
   - ☐ Do not know how to use MHI (have not been trained)
   - ☐ Have not been adequately trained to use MHI
   - ☐ Know how to use MHI, but do not feel confident
   - ☐ The nurses do it
   - ☐ Do not have equipment for MHI
   - ☐ Not enough research has proven it is effective
   - ☐ No clinical benefits have been observed
   - ☐ The technique is time consuming (time constraints)

2. What do you consider to be the benefits of MHI? You may tick more than one answer.
   - ☐ Increased lung volume
   - ☐ Increased lung compliance
   - ☐ Secretion clearance
   - ☐ Stimulation of a cough
   - ☐ Increased oxygen saturation
   - ☐ There are no benefits
   - ☐ Other Please state: _____

3. Would you use a manometer in the MHI circuit to monitor delivered airway pressure?
   - ☐ Yes
   - ☐ No

   If yes, continue with question 4

3.1 If no, please state why not:_____

4. What is the maximum airway pressure you feel is safe during MHI to ensure that no alveolar damage occurs?

   ☐ 20 cmH_2O
   ☐ 30 cmH_2O
   ☐ 40 cmH_2O
   ☐ 50 cmH_2O
   ☐ 60 cmH_2O
   ☐ Other Please state: _____

5. When would you use a PEEP valve in a MHI circuit?

   ☐ Always
   ☐ Only if patient is PEEP dependent less than 15cmH_2O
   ☐ Only if PEEP is above 15cmH_2O
   ☐ Never
   ☐ Other Please state: _____

6. Indicate whether you consider each of the following to be a contra-indication, precaution or neither in the use of MHI (Mark appropriate column with an X)

Condition	**Contra-indication**	**Precaution**	**Neither**
Undrained pneumothorax/ haemothorax/ pleural effusion			
Unstable cardiovascular system			
High peak airway pressure			
Raised intracranial pressure			
Haemoptysis			
Lung bullae			
Bronchospasm			
PEEP > 15 cmH_2O			
Pulmonary oedema			
Bronchopleural fistula			
Lung abscess			
Rib fracture			
Multiple rib fractures			
Flail rib segement			

7. Indicate whether the following are always available, sometimes available or never available in your work area (Mark appropriate column with X).

Equipment	Always Available	Sometimes Available	Never available
Manometer			
PEEP valve			
MHI circuit			

SECTION C: CLINICAL APPLICATION

(Continue with this section only if you treat patients using manual hyperinflation)

1. How many of the patients that you see daily would be eligible for MHI?
   Please state:_____

2. What indications do you use for MHI in your clinical setting? You may tick more than one answer.
   - ☐ Decreased lung volume/ atelectasis
   - ☐ Decreased lung compliance
   - ☐ Secretion retention
   - ☐ Stimulation of a cough
   - ☐ Decreased oxygen saturation
   - ☐ Other Please state:_____

3. Which circuit do you use to perform MHI in your clinical setting?
   - ☐ Air Viva 2
   - ☐ Mapelson B
   - ☐ Mapelson C
   - ☐ Mapelson F
   - ☐ Magill
   - ☐ Laerdal
   - ☐ Uncertain of the circuit name
   - ☐ Other Please state:_____

4. Do you use the following during MHI?

Techniques used	Yes	No
Slow Inspiration		
Inspiratory Hold		
Quick Release		
Inflation without respiratory hold		
Other Please state:		

5. What is your average duration of MHI within a treatment session?
   - ☐ <5 minutes
   - ☐ 5 -10 minutes
   - ☐ 11-15 minutes
   - ☐ 16 -20 minutes
   - ☐ >20 minutes

6. How many breaths are administered per set?
   - ☐ 1 - 2
   - ☐ 3 - 4
   - ☐ 5 - 6
   - ☐ 7 - 8
   - ☐ 9 - 10
   - ☐ Other Please state: _____

7. What other techniques do you use in combination with MHI during your treatment? (Mark one or more)
   - ☐ Nebulisation
   - ☐ Postural Drainage
   - ☐ Percussions
   - ☐ Shaking
   - ☐ Vibrations
   - ☐ Suctioning
   - ☐ None
   - ☐ Other Please state: _____

Thank you for taking the time to complete this questionnaire.

There are three methods for returning the questionnaire.

1. Post
   Please place the questionnaire in the envelope and post it at the nearest available post box/office. The envelope has a prepaid stamp and the correct return address on it.

2. Fax
   Please fax the document to – 014 533 0843

3. Scan and email
   Please scan and email the document to –gianjacobs@yahoo.com

If you are experiencing any problems in completing or returning the questionnaire, do not hesitate to contact me.

Gian Jacobs
Cell: 074 179 3078
Work: 014 533 0850

APPENDIX 2

- **ETHICAL CLEARANCE CERTIFICATE**

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG
Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Mr Gian Jacobs

CLEARANCE CERTIFICATE	**M10M101112**
PROJECT	The Use of Manual Hyperinflation by Phyiotherapists in South Africa during the Treatment of Respiratory Compromised patients in Intensive Care
INVESTIGATORS	Mr Gian Jacobs.
DEPARTMENT	Department of Physiotherapy
DATE CONSIDERED	26/11/2010
DECISION OF THE COMMITTEE*	

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

DATE 26/11/2010 **CHAIRPERSON** .....
(Professor PE Cleaton-Jones)

*Guidelines for written 'informed consent' attached where applicable
cc: Supervisor : Dr H van Aswegen

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 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...

Self funded

8.7 Any other information, which may be of value to the Committee, should be provided here:

N/A

Date: 31/08/2010 **Applicant's Signature:** Gian Jacobs

WHO WILL SUPERVISE THE PROJECT? (WHERE APPLICABLE)

Name Dr H VAN ASWEGEN

Department: PHYSIOTHERAPY .

Telephone No: 011 7173702

Date 31/8/2010

Signature:

HEAD / RESEARCH COORDINATOR OF DEPARTMENT / ENTITY IN WHICH STUDY WILL BE CONDUCTED (where applicable)

Name: PROF A STEWART

Signature: AStewart

Date: 31-08-2010

Entity: PHYSIOTHERAPY DEPT

Tel No: 011 717 3718

Fax No: 011 717 3719

Email: aimee.stewart@wits.ac.za

MSWord/lain0015/HERCMedAF

PLEASE NOTE:

1 Please indicate clearly, where correspondence should be sent; failure to do this causes delays.

2 This requirement holds even if, to assist the Committee, a protocol detailing the background to the research, the design of the investigation and all procedures, is submitted with the application.

3 **If any doubt exists please contact Anisa Keshav, Wits Research Office, 10th Floor Senate House, East Campus at 011-717-1234 Fax: 011-717-1265 Email anisa.keshav@wits.ac.za**

APPENDIX 3

- **INFORMATION DOCUMENT**

INFORMATION DOCUMENT

The use of manual hyperinflation by physiotherapists in South Africa during the treatment of respiratory compromised patients in intensive care.

Fellow colleagues, my name is Gian Jacobs. I am a qualified physiotherapist, I completed my undergraduate Bsc physiotherapy degree in 2006 at the University of the Witwatersrand. I am currently doing my masters degree in physiotherapy at the University of the Witwatersrand, specialising in respirology, cardiology and cardiothoracic surgery for physiotherapists. I am doing research on the use of manual hyperinflation by physiotherapists in respiratory compromised patients in ICU in the public and private sectors in South Africa. Research performed in the UK and Australia portrays valuable information regarding the use of MHI on an international level. There is however little research done in South Africa regarding the use of MHI in the physiotherapy population.

The purpose of this survey is to gain information about physiotherapists' use of MHI in the clinical setting in South Africa. The information obtained would create a platform to compare the use of MHI by the South African physiotherapy community with the international community to determine whether South African physiotherapists perform evidence-based practice with regard to MHI.

I am inviting you to take part in my study; this will require you filling out a questionnaire and returning it to me. The information obtained will help to further the growth of our profession. To ensure confidentiality the questionnaire will be coded so that the individual physiotherapist who completes it will remain anonymous. Participation is voluntary and you may discontinue at any time, refusal to take part or discontinuing will not result in any penalty or loss of benefits. Please complete the attached questionnaire and return it to me within four weeks via fax or email or in the prepaid envelope provided.

May you require further information do not hesitate to contact me.

Gian Jacobs Bsc Physiotherapy
Cell: 0741793078
Work: 014 5330850

If you would like to lay a complaint or report a problem, please contact:

WITS research ethics office
Tel: 011 7171233
Or
HREC chairman: Professor Cleaton Jones
011 717 2301 (Mondays – Wednesdays – Fridays)