**THE PLACE OF PHYSICAL THERAPY IN THE MANAGEMENT OF CRITICALLY ILL PATIENTS**

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***Abstract***

*Critical illness can last from hours to months, depending on the underlying pathophysiology and response to treatment. Physiotherapists are positioned as very important member of the multidisciplinary team that will ensure optimal outcome for intensive care unit (ICU) patients. The most common techniques used by physiotherapists in the management of critically ill patients include positioning/support, soft tissue mobilization such as stroking, effleurage, kneading or tactile stimulation, passive mobilization, manual hyperinflation, percussion, vibrations, suctioning, coughing, and various breathing/functional exercises, stretching and the use of thrombo-embolitic deterrent (TED) stockings also known as compressive stockings. Some physiotherapists routinely treat most ICU patients with a combination of these techniques regardless of the patient’s underlying pathophysiologic condition, with the intention of preventing complications, whereas other physiotherapists use such techniques selectively when they are specifically indicated. Recently, attention now focused on early physical activity/ movement while patient is still in the ICU or high dependent unit (HDU). Several important areas for physiotherapy in critical illness include: physical deconditioning, neuromuscular and musculoskeletal complications; prevention and treatment of respiratory conditions; and emotional problems and communication. However, many problems including deconditioning, muscle weakness, joint stiffness, retained airway secretions, atelectasis and avoidance of intubation and weaning failure have been identiﬁed as evidence-based targets for physiotherapy. Therefore, physiotherapists working in ICU should have the necessary knowledge and skills to understand normal integrated physiology and anatomy and to use clinical reasoning to execute holistic assessments and effective physiotherapy techniques.*

***Keywords:***Physiotherapy, critical illness and intensive care unit

**Introduction**

Physiotherapy is an integral part of the management of critically ill patients in Intensive Care Unit (ICU) in most hospitals in both developing and developed countries. Physiotherapists are positioned as very important member of the multidisciplinary team that will ensure optimal outcome for ICU patients. They work closely with the ICU team to make a weaning plan and however, mortality, morbidity and health-related quality of life have been identified as outcomes that should be used to evaluate the quality of care provided to critically ill patients (Shellekens, Van-Hees & Doorduin, 2016).

Critical illness can last from hours to months, depending on the underlying pathophysiology and response to treatment. It carries high morbidity and mortality rates, and the associated care is a major determinant of healthcare costs. The evolution of intensive care medicine and integrated team management has greatly improved the survival of critically ill patients (Eisner, Thompson, Hudson, Luce, Hayden, Schoenfeld & Matthay, 2001). In view of the high costs associated with ICU, every attempt should continue to be made to prevent complications and appropriately treat the primary underlying pathophysiology to minimize length of stay in ICU. There are common complications particularly associated with a prolonged ICU stay, which include deconditioning, muscle weakness, dyspnea, depression / anxiety, and reduced health-related quality of life (Combes, Costa, Trouillet, Baudot, Mokhtari, Gibert & Chastre, 2003). These patients may develop muscle weakness leading to impaired mobility as a result of high acuity, Mechanical Ventilation (MV), sedation and decreased level of consciousness. Specific physical complications of critical illness, recently labeled ICU-acquired weakness (ICU-AW) includes polymyopathy and polyneuropathy, which contribute significantly to impaired mobility in ICU patients. The impact on the patient may include functional decline, associated neuromuscular/musculoskeletal weakness, impaired coordination, prolonged hospital stay and delayed physical recovery even after hospital discharge. Once the patient has left the ICU or High Dependent Unit (HDU), ongoing complications can persist and these can include a decline in activities of daily living and decreased independence, psychosocial concerns such as anxiety, depression and sleep disturbance (Shellekens et al., 2016).

**Roles of Physiotherapist in the Management of Critically Ill Patients**

The role of physiotherapist in ICU, as stated by Stiller (2013) includes positioning, percussion, vibration, manual hyperinflation, coughing, tracheal suctioning, and breathing / limb exercises. However, the precise role that physiotherapist play in the ICU varies considerably from one unit to the other, depending on factors such as the country in which the ICU is located, local tradition, staffing levels, training, and expertise. In some ICUs, physiotherapists assess all patients, whereas in other, patients are seen only after referral from other medical professionals. The most common techniques used by physiotherapists in the management of critically ill patients include positioning/support (to prevent decubitus ulcer), soft tissue mobilization such as stroking, effleurage, kneading or tactile stimulation (to relax spastic muscles, reduce oedema, enhance blood supply to the muscles and stimulate weak muscles), passive mobilization (to prevent hypertonicity and maintain joint range of motion), manual hyperinflation, percussion, vibrations, suctioning, coughing, and various breathing/functional exercises (to salvage pulmonary and musculoskeletal systems), stretching (to prevent contracture) and the use of Thrombo-Embolitic Deterrent (TED) stockings also known as compressive stockings (to facilitate venous return and reduce the chances of pedal oedema and Deep Venous Thrombosis (DVT) occurrence) (Stiller, 2013; Jones, Hutchinson & Oh, 2002). Some physiotherapists routinely treat most ICU patients with a combination of these techniques regardless of the patient’s underlying pathophysiologic condition, with the intention of preventing complications, whereas other physiotherapists use such techniques selectively when they believe they are specifically indicated. Recently, attention now focused on early physical activity/ movement while patient is still in the ICU/HDU. However, there is sufficient evidence to demonstrate the feasibility and safety of physiotherapeutic interventions in the management of these individuals to enhance cardiorespiratory, neuromuscular and musculoskeletal functions thereby preventing associated complications such as decubitus ulcer, contractures, disuse muscular atrophy, alterated ventilation/perfusion, postural hypotension, DVT and so on (Shellekens et al., 2016). Physiotherapist assessment prior to treatment should determine the underlying problem amenable to physiotherapy and which, if any, intervention(s) are appropriate and most importantly, appropriate monitoring of vital functions should be used and acted upon to help ensure that physiotherapy interventions are both therapeutic and safe.

In ICU setting, the prescription of exercise is mostly based on clinical condition and response to treatment. The risk of moving a critically ill patient should be weighed against the risks entailed by immobility and recumbency. No adverse effects of physical activity on the inﬂammatory status of critically ill patients have been demonstrated (Winkelman, Higgins, Chen & Levine, 2007).

Critically ill patients may experience feelings of anxiety, alienation and panic, particularly if nursed in an ICU or HDU. Those on mechanical ventilation may experience additional distress from the endotracheal tube. These emotions may lead to post-traumatic stress disorder in some patients after discharge. Anxiety also adversely affects recovery if not assessed and treated. Promoting a restful environment conducive for relaxation and sleep is a daily challenge in critical care (Moser, Chung, McKinley, Riegel, An, Cherrington, & Garvin, 2003). Physiotherapists can make a valuable contribution to the psychological well-being and education of the critically ill patient. Relaxation interventions can reduce anxiety and panic, promote sleep, and in turn, reduce the severity of pain and dyspnea. The physiotherapists’ role in the ICU can therefore be separated into two key areas i.e., respiratory physiotherapy and general rehabilitation.

1. **Respiratory physiotherapy for critically ill patients**

Respiratory dysfunction is one of the most common causes of critical illness necessitating ICU admission. Failure of either of the two primary components of the respiratory system (i.e., the gas-exchange membrane and the ventilatory pump) can result in a need for mechanical ventilation to maintain adequate gas exchange and the work of breathing. The aims of physiotherapy in respiratory dysfunction are to improve global / regional ventilation and lung compliance, to reduce airway resistance / the work of breathing, and to clear airway secretions (Thomas, Kreizman, Melchiorre & Ragnarsson, 2002).

Every day our lungs produce 100mls of fluid called sputum. Sputum traps the dirt particles that we breathe in. This is normally coughed and cleared during the day, to clean the lungs/respiratory pathways. Patients in ICU may require mechanical ventilation to help their breathing. This is necessary for quick healing/recovery as well as reducing the stress of coughing and clearing the daily sputum load. However this can be made worse if the patient has pneumonia or chest infection, as more sputum will be produced. Physiotherapists help patients clear this excess sputum, thereby reducing the chance of chest infections through physiotherapeutic techniques.

**Chest management techniques (Chest Physiotherapy**)

Chest Physiotherapy (CPT) also known as pulmonary hygiene is a technique used by physiotherapist to mobilize or loose secretion from the lung(s) and respiratory tract. It is a means of clearing the lung(s) of accumulated mucus. It uses gravity and physical therapy to help move secretions out of the lung(s) and stimulate coughing. CPT is basically used for patients with increased amount of mucus / thick secretions, those with weak respiratory muscles or individuals with ineffective coughing. Chest Physiotherapy consist of the following

1. Breathing exercises {Active Cycle of Breathing Technique (ACBT)}
2. Postural drainage
3. Coughing
4. Chest percussion
5. Chest vibration
6. Positioning
7. Spirometry

Intensive care patient often need help to get their lungs work properly. The physiotherapists will observe their breathing pattern, depth of breath and whether or not they have any phlegm to clear. The patients may be encouraged to participate in some exercises to help their breathing whilst they are not so active. This is aimed at increasing the volume of air entering their lungs, maintenance of lung muscle strength, and enhancing effective coughing (Keynes, 2011). Early activity such as sitting, standing or walking promotes deep breathing and coughing in these patients and therefore should be encouraged.

The chest management exercises use the Active Cycle of Breathing Technique (ACBT). The ACBT is a simple pattern of breathing designed to loosen and clear phlegm and improve patients breathing. The ACBT is a group of techniques which use breathing exercises performed actively by the patient to improve the effectiveness of cough, loosen /clear secretions and improve ventilation (Celik & Kanan, 2006).

Active Cycle of Breathing Technique (ACBT) consists of three main phases:

1. Breathing Control
2. Thoracic Expansion Exercises (Deep Breathing Exercises)
3. Huffing or Forced Expiratory Technique (F.E.T).

However, a manual technique (MT) or positive pressure can be added if indicated, to create a more complex cycle to help improve removal of secretions from the lungs. It is important to constantly assess for dizziness or increased shortness of breath throughout ACBT. If patient feels dizzy during deep breathing, decrease the number of deep breaths taken during each cycle and return to normal breathing to reduce dizziness (McKoy, Saldanha, Odelola & Robinson, 2012).

* **Breathing control**

This is normal gentle breathing using the lower chest, with relaxation of the upper chest and shoulders. It helps patient’s relaxation between deep breathing and huffing (Keynes, 2011). Breathing control has been referred to as diaphragmatic breathing, or gentle breathing using the lower chest. During breathing control, the upper chest and shoulders are relaxed while breathing is done at a relatively normal tidal volume and rate. The patient feels swelling around the waist during inspiration, associated with the descending diaphragm displacing abdominal contents. The swelling subsides with exhalation. Breathing control is used to relax the airways and relieve the symptoms of wheezing and tightness which normally occur after coughing or breathlessness (Harden, Cross, Broad, Quint, Ritson & Thomas, 2008). Breathing should be performed gently through the nose using as little effort as possible. If it is necessary to breath out through the mouth this should be done with ‘pursed lips breathing’. Eye closure while performing breathing control can be beneficial in helping to promote relaxation and if properly done will also help in relieving any other tension that may be present (McKoy et al., 2012). The length of time spent performing breathing control is dependent on how breathless a patient is.

* **Thoracic Expansion Exercises(Deep breathing exercises)**

These are slow deep breaths, followed by a three (3) seconds breath hold if patients can, with a relaxed breath out, however 3-4 deep breaths are enough (Keynes, 2011). Deep breathing is used to get air behind the sputum stuck to mobilize it toward larger airways and toward the mouth. Note the following steps:

1. Relax the upper chest.
2. Breathe in slowly and deeply.
3. Breathe out gently until lungs are empty – don’t force the air out.
4. Repeat 3 – 4 times,
5. At the end of the breath in, hold the air in the lungs for 3 seconds (this is known as an inspiratory hold) followed by a relaxed breath out (Harden et al., 2008).

Note: if the patient feels light headed then revert back to the breathing control portion of the ACBT cycle.

Instruction to patient

1. Relax your shoulders.
2. Place both hands on either side of ribs.
3. Breathe in deeply feeling as your ribs expand.
4. Breathe out gently as far as you can go without stopping midway until your lungs feel empty.

NB: If done properly, it will stimulate coughing at end range

Deep breathing / thoracic expansion is usually repeated 4 times (McKoy et al., 2012).

* **Huffing or Forced Expiratory Technique (FET)**

This is a medium sized breath in, followed by a fast breath out through an open mouth, using the muscles of the chest and stomach to force the breath out (Imagine a patient steaming up his glasses to clean them or blowing a tissue paper held out in front of him). This will move phlegm along the airways to a point where patients can cough them out. Huffing is a less tiring way of clearing patients’ secretions than coughing (Keynes, 2011).

A huff is exhaling through an open mouth and throat instead of coughing. Huffing moves sputum from the small airways to the larger airways, from where they are removed by coughing. Coughing alone does not remove sputum from small airways. The following are the steps involved:

1. Take a small-medium sized breath in.
2. Squeeze the breath out by contracting the abdominal muscles while keeping mouth and throat open to perform a huff. This helps with the removal of sputum from the lower reach of the lungs.
3. To remove sputum in the higher portions of the lungs take a large breath in.
4. Squeeze the air out as above to perform a huff.
5. Cough and expectorate any sputum. If no sputum is produced with 1 or 2 coughs, stop coughing and return to breathing control,.

Note; allow breathing to settle with breathing control and then repeat the cycle until chest is clinically clear (Harden et al., 2008).

**Procedure of ACBT**

ACBT can be performed in sitting, lying or side-lying positions. Initially patients should start in a lying position until they are comfortable and confident to try different positions. Extensive evidence supports its effectiveness in sitting or gravity assisted positions. A minimum of ten minutes in each productive position is recommended. The ACBT may be performed with or without an assistant providing vibration, percussion and shaking.

**Breathing control**

**20-30 seconds**

**3-4 deep breaths**

**Breathing control**

**3-4 deep breaths**

**Breathing control**

**Huffing followed by cough if needed**

(Quinn, 2011)

Fig. 1: Active cycle of breathing

This method of breathing however can be performed in whatever position the patients is most comfortable, or seems to clear most phlegm with the help of gravity. It is often beneﬁcial to ‘hold’ for three seconds at the end of one or all the deep breath. Physiotherapists can gently provide some vibrations with their hands to patients’ chest while they breathe out. Depending on the chronicity of the respiratory condition, 10 minutes will be long enough to ventilate patients’ lungs and clear any phlegm and should be repeated 4-5 times a day for about 20 minutes. These exercises might be difficult at the beginning, but with practice they become easier as patients’ muscles become stronger.

* **Postural Drainage and Body Position**

Postural drainage is a technique in which positions are assumed to facilitate the removal of secretions from the bronchial airways using the gravitational effect. It is also known as airway clearance. During postural drainage the patient’s body is positioned so that the trachea is inclined downward and below the affected lung area thereby employing gravity to drain excess mucous secretion from the lung. Postural drainage is facilitated with manual therapy such as percussion, vibration or shaking. When carrying out postural drainage the patient should be positioned such that the part of the lung to be drained is uppermost. There are different drainage positions for different segments of the lung. However, these positions can be modified depending on the patient’s condition and the location that need therapy most.

Positioning in this context describes the use of body position as a specific treatment technique. Positioning for ICU patients can be used with the physiologic aims of optimizing oxygen transport through its effects of improving ventilation / perfusion matching, increasing lung volumes, reducing the work of breathing, minimizing the work of the heart, and enhancing mucociliary clearance (Stiller, 2000).

* **Coughing**

This should follow 2-3 huffs or a deep breath in. Here, the patient does not cough unless secretions are ready to be cleared. Coughing is an effective way of removing secretions and it should be done with minimum effort.

How to cough effectively:

1. Take a slow relaxed deep breath in.

2. Hold the breath for a second – to allow pressure to increase in the lungs.

3. Then force the air out. You will feel the abdominal muscles tighten to provide the force to expel the air. Try to avoid a coughing ’ﬁt’ by allowing one or two coughs on the breath out.

* **Percussion (Clapping with cupped Hand)**

Percussion is a technique that increases the clearance of airway secretions by the transmission of an energy wave through the chest wall. Percussion can be performed manually by clapping the chest wall over the affected area of the lung(s) to be drained, using cupped hands.

This generates some vibration, which are transmitted through the air passage. These vibrations may help in removing secretions sticking to the walls of the air passage. The hand is cupped by holding the fingers together so that the shape of the cupped hand conforms to the chest wall. The cupped hands tend to trap a cushion of air which softens the blow of the clapping. Clapping should be rapid but not painful. Clapping should not be done on bare skin, but over soft comfortable clothing or towel. Rings should be removed before clapping.

* **Vibration / Shaking**

Vibration / shaking are more difficult than clapping, but is valuable because its helps stimulate the flow of secretions. Vibrations may be applied manually by vibrating, shaking, or compressing the chest wall during expiration. Vibrations can also be performed using mechanical devices.

* **Suctioning**

Suctioning through an endotracheal or tracheostomy tube is done with the aim of removing secretions from the central airways and stimulating coughing (Stiller, 2000). Although it is clear in the clinical setting that suctioning does achieve its aim of removing secretions from the central airways, but few studies have specifically investigated this. It has been shown that suctioning can be associated with many detrimental effects, such as hypoxemia and hemodynamic instability, and tracheobronchial erosion and hemorrhage. However, the use of sedation, reassurance, preoxygenation, and optimal technique minimizes the occurrence of these side effects (Judson & Sahn, 2004). However, not all centers utilize the services of physiotherapist in this area.

1. **Rehabilitation of critically ill patients**

Rehabilitation in the ICU as defined in a position paper by the European Respiratory Society as a process to achieve optimal daily functioning and health-related quality of life of individual patients as measured by clinically and /or physiologically relevant outcome measures (Denehy & Berney, 2006). Patients in ICU can become weak very quickly, losing up to 2% of muscle daily. They can also experience joint stiffness, muscle tightness and reduced fitness—this can lead to long term disability. Rehabilitation has the potential to restore lost function but is traditionally not started until after ICU discharge in some centers, since critically ill patients are often viewed as too sick to tolerate physical activity in the early phase of their illness and their immobilization is frequently inevitably prolonged. This will enhance deconditioning and might further complicate the clinical course (De -Jonghe, Bastuji-Garin, Sharshar, Outin & Brochard, 2004).

Physiotherapists play a vital role in maintaining and improving muscle strength and joint movement. It is therefore recognized that immobility in ICU and time spent on a ventilator are detrimental to long-term patients’ outcome. A growing body of evidence suggests that the implementation of early mobility practices by physiotherapy programmes in the ICU/HDU can have long-term benefits for the patient and the healthcare system. Managing this group of patients to improve mobility needs a focus on increasing muscular strength, treating de-conditioning and maintaining muscular mass and function. The key to effecting change is to improve patient mobility through the implementation of dedicated physical activity and movement (PAM) programmes. Physical training programmes may include focusing on limb muscle training using passive and active range of movement and a progressive mobilization plan. Research has shown this approach to be effective and economical (Bailey, Thomsen, Spuhler, Blair, Jewkes, Bezdjian & Hopkins, 2007).

* **Physical activity and movement (PAM) programme**

PAM is a programme to optimize functional outcome of the critically ill patients. It comprises a range of strategies that include patient assessment followed by a series of activities designed to optimize muscle strength and functional mobility (Morris, 2007).

Keynes (2011) classified PAM programme as follows:

1. **Bed Exercises**

These exercises can be done while lying down.

For ankle pumps, point your toes down and bring them back towards you. Repeat several times on both legs.



Fig. 2: Ankle Pumps

To perform hip and knee flexions, slide your heel towards your bottom bending your knee and hip. Repeat several times on both legs.



Fig. 3: Hip and Knee Flexion

For pelvic tilts: with your knees bent, rock your pelvis back to flatten your back on the bed and then forwards. Repeat several times.



Fig. 4:Pelvic Tilts

To perform bridging exercise: with your knees bent, slowly tilt your pelvis as in the exercise above and continue to lift your bottom up off the bed and slowly lower it down. Repeat several times.



Fig. 5: Bridging

1. **Chair exercises**

These exercises are to be done while sitting down.

For toe taps and heel lifts, alternatively lift your heels and your toes off the floor. Repeat on the right and the left several times.



Fig. 6:Toe Taps and Heel Lifts

To perform knee extension, straighten out one of your legs as much as you can and hold for many seconds. Repeat on the right and the left side several times.



Fig. 7: Knee Extension

For knee marching, sitting on the chair, lift your knees alternatively up towards the ceiling as if you are marching on the spot. Repeat several times.



Fig. 8: Knee Marching

To perform push ups, bring your upper body forward slightly and place your hands on the arms of your chair. Push through your arms and try to lift your bottom up off the chair and slowly lower back to the start point. Repeat several times.



Fig. 9:Push Ups

* **Limb Exercises**

Limb exercises (passive, active assisted, or active resisted) may be performed on ICU patients with the aim of maintaining or improving joint range of motion, soft-tissue length, muscle strength/function, and decreasing the risk of thrombo-embolism (Stiller, 2000). These include ankle pump exercise, knee flexion and extension, hip flexion, pelvic tilts, bridging toe taps and heel lifts etc (Keynes, 2011). Limb movements performed passively by a physiotherapist, have been shown to result in significant increase in metabolic and hemodynamic variables for critically ill patients, with approximately 15% increase in oxygen consumption demonstrated.

* **Mobilization**

Mobilization has been part of the physiotherapy of acutely ill patients for several decades. Mobilization refers to physical activity sufficient to elicit acute physiological effects that enhance ventilation, central and peripheral perfusion, circulation, muscle metabolism, and alertness.

Mobilization can refer to many different activities, the exact definition of which is difficult to find. Commonly, there is a hierarchy in accepted mobilization exercises in the ICU (Stiller & Phillips, 2003) and this may include bed exercises, sitting over the edge of the bed, standing, transferring, and walking on the spot (Stiller, Phillips & Lambert, 2004). These exercise strategies reflect specificity of training for future functional tasks. Mobilizing critically ill patients requires an initial comprehensive assessment of the patient’s cardiorespiratory status. The benefits of early mobilization include reductions in length of stay in the ICU and hospital, as well as improvements in strength and functional status (Schweickert & Kress, 2011).

Mobilization techniques that may be used for intubated patients receiving mechanical ventilation in the ICU include active limb exercises, the patient actively moving or turning in bed, get out of bed via mechanical lifting machines or slide board transfers, sitting on the edge of the bed, standing, standing transfers from bed to chair, and walking. The physiologic rationale for mobilization is that it will optimize oxygen transport by enhancing, for example, alveolar ventilation and ventilation/perfusion matching. It can also provide a gravitational stimulus to maintain or restore normal fluid distribution in the body and to reduce the effects of immobility and bed rest. In the longer term, mobilization aims to optimize work capacity and functional independence and to improve cardiopulmonary fitness. However, electrical stimulation, stretching or splinting (to prevent muscle and joint stiffness) and soft tissue manipulation (massage) to keep the skin moist, reduce swelling and improve sensation have also been recommended (Stoll, Schelling, Goetz, Kilger, Bayer, Kapfhammer & Peter, 2000).

**Conclusion**

Physiotherapists are members of the interdisciplinary healthcare team for the management of critically ill patients. Several important areas for physiotherapy in critical illness include: physical deconditioning, neuromuscular and musculoskeletal complications; prevention and treatment of respiratory conditions; and emotional problems and communication. However, many problems including deconditioning, muscle weakness, joint stiffness, retained airway secretions, atelectasis and avoidance of intubation and weaning failure have been identiﬁed as evidence-based targets for physiotherapy.

**Recommendations**

Appropriately prescribed physiotherapy may improve outcomes and reduce the risks associated with intensive care, as well as minimize costs and thus, should be religiously practiced. Also, there is a need to standardize pathways for clinical decision-making and education, and deﬁne the professional proﬁle of ICU physiotherapists in more detail. In other words, physiotherapists working in ICU should have the necessary knowledge and skills to understand normal integrated physiology and anatomy and to use clinical reasoning to execute holistic assessments and effective physiotherapy techniques.

**REFERENCES**

Bailey, P., Thomsen, G.E., Spuhler, V.J., Blair, R., Jewkes, J., Bezdjian, L., Veale, K., Rodriquez, L. & Hopkins, R.O. (2007). Early activity is feasible and safe in respiratory failure patients. *Crit Care Med*, 35, 139–145.

Celik, S.A. & Kanan, N.A. (2006). Current conflict: use of isotonic sodium chloride solution on endotracheal suctioning in critically ill patients. *Dimens Crit Care Nurs*, 25(1), 11–14.

Combes A., Costa, M.A., Trouillet, J.L., Baudot, J., Mokhtari, M., Gibert, C. & Chastre J. (2003). Morbidity, mortality, and quality-of-life outcomes of patients requiring *>* or = 14 days of

De –Jonghe, B., Bastuji-Garin, S., Sharshar, T., Outin, H. & Brochard, L. (2004). Does ICU-acquired paresis lengthen weaning from mechanical ventilation? *Intensive Care Med*, 30, 1117–1121.

Denehy, L. & Berney, S. (2006). Physiotherapy in the intensive care unit. *physical therapy reviews* 2006; **11**: 49–56

Eisner, M.D., Thompson, T., Hudson, L.D., Luce, J.M., Hayden, D., Schoenfeld, D. &Matthay, M.A. (2001). Efﬁcacy of low tidal volume ventilation in patients with different clinical risk factors for acute lung injury and the acute respiratory distress syndrome. *Am J Respir Crit Care Med*, 164, 231–236.

Harden, B., Cross, J., Broad, M.A., Quint, M., Ritson, P. & Thomas, S. (2008). Respiratory Physiotherapy: An On-Call Survival Guide, 2e. London: Churchill Livingstone.

Jones, A.Y.M., Hutchinson, R.C. & Oh, T.E. (2002). Effects of bagging and percussion on total static compliance of the respiratory system. *Physiotherapy*,78, 661–666.

Judson, M.A. & Sahn, S.A. (2004). Mobilization of secretions in ICU patients. *Respir Care,* 39, 213–226.

Keynes, M. (2011). Physiotherapy and recovery from intensive care.

McKoy, N.A., Saldanha, I.J., Odelola, O.A. & Robinson, K.A. (2012). Active cycle of breathing technique for cystic fibrosis. Cochrane Database Syst Rev., 12, 12, CD007862. Mechanical ventilation. *Crit Care Med*, 31, 1373–1381

Morris, P.E. (2007). Early mobility of the ICU patient. *Crit Care Clin*, 23,1–116.

Moser, D.K., Chung, M.L., McKinley, S., Riegel, B., An, K., Cherrington, C.C. & Garvin, B.J. (2003). Critical care nursing practice regarding patient anxiety assessment and management. *Intensive Crit Care Nurs*, 19, 276–288.

Quinn, A. (2011). Physitherapy and revovery from intensive care, Milton Keynes: icusteps.org.

Schweickert, W.D. & Kress, J.P. (2011). Implementing early mobilization interventions in

mechanically ventilated patients in the ICU. *Chest*, 140, 1612‑7.

Shellekens, W.J., Van Hees, H.W. & Doorduin, J. (2016). Strategies to optimize respiratory muscle function in ICU patients. *Crit Care* , 20(1), 103.

Stiller, K., Phillips, A. & Lambert, P. (2004).The safety of mobilization and its effect on

haemodynamic and respiratory status of intensive care patients. *Physiother Theory Pract*, 20, 175–85

Stiller K. & Phillips A. (2003) Safety aspects of mobilising acutely ill inpatients.

*Physiother Theory Pract*, 19, 239–57

Stiller, K. (2000). Physiotherapy in Intensive Care towards an Evidence-Based Practice

Stiller, K. (2013). Physiotherapy in intensive care: An updated systematic review. *Chest,* 144(3), 825-47.

Stoll, C., Schelling, G., Goetz, A.E., Kilger, E., Bayer, A., Kapfhammer, H.P. & Peter, K. (2000). Health-related quality of life and post-traumatic stress disorder inpatients after cardiac surgery and intensive care treatment. *J Thorac Cardiovasc Surg,* 120, 505–512.

Thomas, D.C., Kreizman, I.J., Melchiorre, P. & Ragnarsson, K.T. (2002).Rehabilitation of the patient with chronic critical illness. *Crit Care Clin*, 18, 695–715.

Winkelman, C., Higgins, P.A., Chen, Y.J. & Levine, A.D. (2007). Cytokines in chronically critically ill patients after activity and rest. *Biol Res Nurs*, 8,261–271.