AMERICAN UNIVERSITY OF BEIRUT

DEVELOPMENT OF AN EARLY MOBILITY PROTOCOL IN CRITICALLY ILL PATIENTS

by
AMALI ISSAM SAAB

A project
submitted in partial fulfillment of the requirements
for the degree of Master of Science in Nursing in Adult Care
to the Rafic Hariri School of Nursing
of the Faculty of Medicine

at the American University of Beirut

Beirut, Lebanon
September, 2014

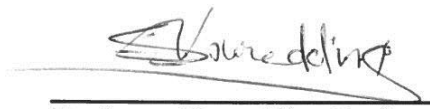
AMERICAN UNIVERSITY OF BEIRUT

DEVELOPMENT OF AN EARLY MOBILITY PROTOCOL IN CRITICALLY ILL PATIENTS

by

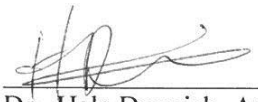
AMALI ISSAM SAAB

Approved by:



Dr. Samar Noureddine, Professor — First Reader

Hariri School of Nursing



Dr. Hala Darwish, Assistant Professor — Second Reader

Date of project presentation: September 17, 2014

AMERICAN UNIVERSITY OF BEIRUT

PROJECT RELEASE FORM

Student Name: Saab Amali Issam

Last First Middle

◯ Master's Thesis ◯ Master's Project ◯ Doctoral Dissertation

☑ I authorize the American University of Beirut to: (a) reproduce hard or electronic copies of my thesis, dissertation, or project; (b) include such copies in the archives and digital repositories of the University; and (c) make freely available such copies to third parties for research or educational purposes.

☐ I authorize the American University of Beirut, **three years after the date of submitting my thesis, dissertation, or project,** to: (a) reproduce hard or electronic copies of it; (b) include such copies in the archives and digital repositories of the University; and (c) make freely available such copies to third parties for research or educational purposes.

Amali Saab 29/9/2014

Signature Date

This form is signed when submitting the thesis, dissertation, or project to the University Libraries

ACKNOWLEDGMENTS

I would like to express my gratitude towards my parents and siblings for their endless support. I want to thank Ms Samar Noureddine and Ms Hala Darwish for their help in this project.

AN ABSTRACT OF THE PROJECT OF

Amali Issam Saab for Master of Science

Major: Nursing

Title: Development of an Early Mobility Protocol in Critically Ill Patients

This project describes the background and the significance of starting early mobility in critically ill patients. A literature review of the complications of immobility, the barriers to its early implementation, the clinical outcomes associated with early mobility in critical illness and examples of available early mobility protocols has been conducted. Development of the suggested early mobility protocol was then described in line with the conducted literature review and the American University of Beirut. Finally , a plan for implementation and evaluation of the developed protocol was proposed taking into account the importance of multidisciplinary coordination and team work for creating a culture that supports early mobility in this patient population.

CONTENTS

ILLUSTRATIONS

Figure

LIST OF TABLES

Table

CHAPTER ONE

INTRODUCTION AND SIGNIFICANCE OF EARLY MOBILITY

Caring for the critically ill adult is a process that demands resources, a specialized clinical team and real-time monitoring so that life-sustaining interventions can be delivered. It has been recently realized that the organizational structure and processes of care in an intensive care unit (ICU) have a direct impact on the clinical outcomes of patients and serve as a basis for improvement in care. Conditions under which provision of patient care happens are referred to as organizational structure, whereas activities involving patient care are the processes of care (Checkley et al., 2014).

Mobility is an essential nursing activity that mandates knowledge and skill for its effective application to critically ill patients (Vollman, 2010). Strict bed rest and heavy sedation often constitute part of the management of critically ill patients in intensive care units (King, 2012; Needham, 2008). These interventions are undertaken because patients are often hemodynamically unstable, mechanically ventilated and hypercatabolic, so one aim of management is to rest the body till organ function gets restored and prevent fighting the mechanical ventilator so optimum oxygenation is obtained. However, this approach makes patients more prone to develop complications related to immobility, such as muscle weakness, atelectasis, thromboembolic disease, pressure ulcers and joint contractures (Brower, 2009). In order to circumvent such complications, promoting the activity of critically ill patients, many of whom receive

mechanical ventilation, is done through the use of progressive mobility protocols. A collaborative, multidisciplinary approach is fostered among nurses, physicians, physical, occupational and respiratory therapists by the utilization of progressive mobility protocols, in order to start early mobility for critically ill patients (King, 2012).

With the increase in the survival and recovery rates of critically ill patients, the long-term patient outcomes that accompany this recovery must be evaluated and attention must be paid to interventions that aim to ameliorate these outcomes. Survivors of critical illness experience a decrease in their health-related quality of life, a decline in their physical and cognitive function, as well as psychological illness. The loss of physical function during critical illness may be one of the contributing factors to these changes. Rehabilitation of critically ill patients has been directed towards the post-acute period and following their discharge home. Nevertheless, the safety, feasibility and benefits of involvement of critically ill patients in rehabilitation activities early in the course of their illness has been an important finding that recent data showed (Goddard & Cuthbertson, 2012).

A. Background

Early mobility is not a new concept. During World War II, ambulating hospitalized patients was initiated as an attempt to enable soldiers to participate again in the battles. In addition, there is a powerful historical precedent for early mobility of critically ill patients. Thomas Petty is an intensive care physician who compared medical care in the intensive care unit nowadays with that of 1964 in a vivid manner (Needham, 2008). In an editorial published in Chest in 1998, he discussed certain aspects of current critical care practices that prevented him from seeing a mechanically

ventilated patient seated as he used to see in the past. He also pinpointed how these practices can result in undesirable outcomes for patients, such as complications from immobility and delirium. Part of what he described is shown by the following statements:

'But what I see these days are paralyzed, sedated patients, lying without motion, appearing to be dead except for the monitors that tell me otherwise. Why this syndrome of sedation and paralysis has emerged baffles me, because this was not the case in the past...

'When we first started our unit in 1964, patients who required mechanical ventilation were awake and alert and often sitting in a chair eating food, which was made possible by the use of a tracheostomy early in the patient 's course, where the predicted need for mechanical ventilation would be for more than a few days …. My concern is not only about the complications that result, i.e., critical care neuropathy, pulmonary emboli from immobilization and sepsis from bacterial invasion of the atrophic GI tract, but also clouded sensorium that often result in what has been termed as intensive care delirium' ...(Petty, 1998, pp.360, 361).

Another historical evidence demonstrating that early mobility is not a new concept in critically ill patients is a photo-illustrated report that the University of Colorado published in 1972 depicting the ambulation of a mechanically ventilated patient recuperating from respiratory failure and a publication by Geisinger Medical Center in Danville, Pennsylvania in 1975 (Needham , 2008). Burns and Jones, from Geisinger Medical Center described in that report the experience they had over their past three years with the utilization of a device that has been made from commercially available parts to get over the difficulties encountered during early ambulation of

patients with respiratory failure who needed mechanical ventilation for weeks or months. They highlighted the consequences of keeping this population of patients resting in bed or lying on a chair and mentioned the benefits early ambulation could provide them. Moreover, they included a photo of the used device and expressed that patients highly accepted ambulation. According to them, this device consisted of a stable –wheeled walker that has an armrest and seat, a respirator, a source of oxygen, a pole for hanging of intravenous solutions, and a support for the respirator at tracheostomy level. This device of cumbersome appearance was easily mobilized and used with the presence of one nurse only (Burns & Jones, 1975).

B. Significance

Despite the availability of evidence on the positive impact of early mobility programs on clinical outcomes, there are many intensive care units that do not have these programs in their processes of care due to certain barriers (Dang, 2013).

The respiratory care unit (RCU) at the American University of Beirut Medical Center (AUBMC) is an eight-bed unit that admits a variety of patient populations, including patients mechanically ventilated presenting for weaning and patients requiring pulmonary toileting. The average length of stay in RCU is 15 days (S. Jamous, personal communication, May 15, 2014). The registered nurses conduct functional level screening by determining the level of assistance a patient needs in turning in bed, activities of daily living and ambulation and document that in the nursing database. If the level of assistance is classified as moderate or heavy, this indicates the need for physical therapy consultation. The nurse informs the physician about that and documents in the multidisciplinary note the need for physical therapy consultation. It is

the physician who finally requests physiotherapy consultation. Regular care of a mechanically ventilated patient usually includes bed rest with positioning every 2 hours. Upon the physical therapist's assessment of the patient, range of motion exercises are done. Ambulation of a mechanically ventilated patient is not part of routine care, which results in patients being treated as bedridden, which is taxing on the nursing staff and delaying patients' resumption of functionality and independence that can facilitate their discharge and transition to home care. Many studies (Morris et al., 2008; Needham et al., 2010) suggest that early mobilization plays a role in shortening the length of stay in the intensive care unit and in the hospital. Taking that into account, development of an early mobility protocol that guides early mobilization in RCU is of paramount significance.

This project aims to explore the available literature on the consequences of immobility and bed rest, barriers to early mobility of critically ill patients and the impact of implementing early mobility on various patient outcomes. An early mobility protocol is then developed and proposed. Finally a plan for implementation and evaluation of the suggested early mobility protocol is discussed.

CHAPTER TWO

LITERATURE REVIEW

This chapter shall present a review of the adverse effects of immobility in critically ill adults, factors that hinder the implementation and evidence on outcomes associated with mobility programs, in addition to a review of available mobility protocols.

A. Complications of Immobility in Critically Ill Patients

The complications of immobility and bed rest in critically ill patients are numerous and various. These include muscle atrophy and weakness, systemic inflammation, atelectasis, insulin resistance, microvascular dysfunction including thromboembolic disease, joint contractures and pressure ulcers (Brower, 2009).

1. Muscle Atrophy and Weakness

Development of skeletal muscle weakness is common in patients admitted into the intensive care unit. Various ICU –related conditions, such as prolonged bed rest, physical inactivity, pharmacological side effects, altered nutritional status and neuropathic changes contribute to muscle weakness and atrophy (Chambers, Moylan & Reid, 2009). According to Morris (2007), reviews of the influence of inactivity on muscle strength showed that a drop of 1% to 1.5% of skeletal muscle strength may happen for each day of strict bed rest. Moreover, data from studies of animals with casts and studies of patients having limbs immobilized with casts showed that the

decrease of muscular strength per day may be even higher, with predictions that this reduction may reach up to 5 % or 6% daily (Morris, 2007).

2. Systemic Inflammation

Empirical evidence demonstrated that exercise of muscles can alleviate systemic inflammation. Patients confined to bed rest lose the benefits of exercising. As many studies showed, exercise induces the release of several anti-inflammatory cytokines. The most dramatic rise is in the levels of IL-6. Exercise –induced IL-6 plays an anti-inflammatory role by inhibiting tumor necrosis factor - alpha and IL-1, which possess inflammatory properties. Besides, blocking the receptors of IL-1 is another function of IL-6 (Brower, 2009). With inflammation being promoted by the inactivity of the critically ill, this will increase the risk for systemic inflammatory response syndrome that may escalate into sepsis in case of concomitant infection.

3. Atelectasis

A complication of bed rest in critically ill patients is atelectasis. Chest radiographs of many critically ill patients done within 48 hours of lying supine show partial or complete atelectasis of the left lower lobe. This may be attributed to the shift of the diaphragm towards the anterior while lying supine, and to the shift of the heart towards the posterior due to the effect of the gravitational force. In addition, atelectasis affects other dependent lung regions as frequently shown by computer tomography images. Atelectasis results in elevated pulmonary vascular resistance and increased susceptibility to have pneumonia. Intrapulmonary shunt results from atelectasis too,

raising the requirements for supplemental oxygen and making patients more prone to have oxygen toxicity, especially those affected with acute lung injury (Brower, 2009).

4. Insulin Resistance

There is a link between leading a sedentary lifestyle and diabetes mellitus type 2. According to Mizock and to McCowen and colleagues, insulin resistance occurs in critically ill patients with no prior history of diabetes mellitus (as cited in Brower, 2009). It has been even shown that healthy volunteers developed insulin resistance secondary to bed rest. Hamburg et al.(2007) conducted a study in which twenty healthy subjects had their insulin sensitivity measured by glucose tolerance test at baseline and throughout five days of bed rest, and found a 67% increase in the insulin response to glucose loading associated with bed rest ($p < 0.001$). These findings suggest an association between physical inactivity and insulin resistance even during a short-term period (Hamburg et al., 2007). Insulin resistance may progress to type 2 diabetes, putting the critically ill patients at risk for increased morbidity and mortality.

5. Microvascular Dysfunction

Another variable measured by Hamburg et al., in the same study mentioned above was vascular function by ultrasound and venous occlusion by plethysmography at baseline and during five days of bed rest. Impaired microvascular function resulted from bed rest as shown by a significant decrease of reactive hyperemia in both the upper and lower extremities of the healthy volunteers (Hamburg et al., 2007).The relevance of these findings done in healthy people to critically ill adults is not yet known. However, some complications observed frequently in critically ill patients may result from

vascular dysfunction. These include lactic acidosis, multiple organ dysfunction, gastrointestinal bleeding, skin ulcers and intestinal ischemia (Brower, 2009).

Bed rest is a significant risk factor for the development of thromboembolic disease.

Sustained inactivity from bed rest triggers venous stasis, which promotes the occurrence of thrombosis due to the sluggish blood flow. Besides, prolonged contact of the limbs with the bed compresses the veins. This in turn may also promote venous stasis and may contribute to the damage of the vascular endothelium (Brower, 2009).

6. Joint Contractures

Skeletal joints experience loss of range of motion when not exposed to normal mobility and stress. Joint contracture is a complication that most ICU staff is aware of and thus takes measures to prevent its occurrence, such as range of motion exercises. Nonetheless, the frequency of functionally significant contractures following prolonged inactivity throughout critical illness is documented only in few studies (Brower, 2009). A recent retrospective study by Clavet and colleagues (2008), documented the incidence of joint contractures in patients who stayed in an intensive care setting for at least two weeks. A chart review on the presence of joint contractures in the ankles, knees, hips, elbows and shoulders in patients admitted to an ICU was conducted for a two-year period. The investigators found that a functionally significant contracture of a major joint affected more than one-third of patients at their transfer from ICU, and that at the time of discharge home most of these contractures were still present (Clavet, Hébert, Fergusson, Doucette, & Trudel, 2008). Persisting joint contractures along with muscle weakness may contribute to decreased physical function in patients discharged home

after surviving critical illness. Moreover, reconditioning of the weakened muscles may be hindered by persistent joint contractures (Brower, 2009).

7. Pressure ulcers

Skin breakdown usually happens at points of pressure between the bed and the skin. Good nursing care that incorporates frequent positioning is an effective method to prevent skin ulcers by relieving pressure over certain points of contact. Contributing factors to the development of skin ulcers include not only unrelieved pressure but also humidity, malnutrition, shear force to the points of contact and impaired microcirculation. In critically ill patients, however, poor nutrition, prolonged bed rest, and impaired microcirculation are the main factors that make them particularly prone to have skin breakdown (Brower, 2009).

The above review shows the adverse outcomes associated with immobilizing critically ill patients for long periods of time, which translate into prolonged length of stay and increase health care costs.

B. Barriers to Early Mobility in Critically Ill Patients

Despite the potential benefits early mobility may offer, there are some barriers to its implementation in critically ill patients. These include safety concerns, cost barriers, obesity, time restraints as well as reluctance of personnel to create a mobility culture.

1. Safety concerns.

Prolonged immobilization results from the common viewpoint that critically ill patients are too sick to sustain vigorous activity in the early stage of their illness (Bailey

et al., 2007). ICU caregivers have concerns that early ICU mobility for certain patient situations may result in the death of a patient because of unintentional endotracheal tube removal. Also they are afraid that further decline in already marginal oxygenation or hemodynamic parameters may happen because of passive movement. Moreover, sometimes the ICU staff considers wakefulness and movement as competing themes with control of pain and discomfort. Some caregivers even regard active patient mobility as a potential hazard to the pulmonary or cardiac systems whereby activity may result in preventable death through refractory hypoxemia or dysrhythmia generation (Morris, 2007). The focus of healthcare providers in caring for ICU patients who have severe disruptions in their physiologic equilibrium is to treat organ systems, which is crucial for survival (Lipshutz & Gropper, 2013). Safety concerns relate to lines used in critically ill patients, as well as sedation and delirium often experienced by these patients.

Critically ill patients in the ICU often possess numerous indwelling lines and tubes, which may include central venous lines, arterial lines, endotracheal tubes, urinary catheters, extracorporeal membrane oxygenator cannulae and left ventricular assist devices (Lipshutz & Gropper, 2013). It may be even hard to place new vascular access devices in patients with prolonged ICU stays, persistent coagulopathy or previous ICU stays that mandated vascular interventions. Thus, fear of dislodgement of indwelling devices comes at the expense of mobilizing such patients. Besides, in order to keep adequate flows in femoral dialysis catheters, the mobility of the hip of patients needing continuous renal replacement therapies or hemodialysis may be restricted (Morris, 2007).

The practice of sedating ICU patients is considered a barrier to early mobility (Lipshutz & Gropper, 2013; Morris, 2007). Sedation renders patients too drowsy to participate in physical therapy (Lipshutz& Gropper, 2013). Besides, caregivers aim to keep patients in the ICU pain free and calm. It is often hard to accomplish this goal of pain management and sedation and simultaneously maintain clear mentation especially in the early phase of their ICU stay. Utilization of protocols that involve daily awakening is an approach that numerous hospitals have adopted to address this aspect of ICU care (Morris, 2007). Furthermore, ICU delirium may restrict the ability of critically ill patients to get engaged in higher levels of activity such as ambulation (Fan, 2010), since this may cause the patient to fall.

2. Cost of needed resources.

Justification of positions for physiotherapists dedicated to the ICU is hard in view of lack of efficacy and safety data**.** Thus, hospital administrators may not agree to hire people for this purpose. Moreover, despite the lack of enough evidence to support ICU specialty beds, there seems to be more widespread acceptance by administrators of the use of these beds than investments in human labor to promote ICU mobility. The absence of literature that supports the effect of human labor in this area on patient outcomes may contribute to this reluctance. Furthermore, data that support the utilization of mobility aids are scarce, especially any data showing reduction in morbidity or mortality. Therefore, hospital administrators show unwillingness to cover for their prices. Mobility aids include specialty chairs, walkers, tilt tables, and portable mechanical ventilators (Morris, 2007).

3. Obesity

Obesity (body mass index greater than 30 kg/m^2) may be viewed as a potential impediment to early mobility implementation (Morris, 2007; Pohlman et al., 2010). Common sense mandates that more human resources are required to meet the ICU mobility needs of morbidly obese patients than those needed for patients who have normal body mass index (Morris, 2007). It is worth noting that obese patients maybe the ones in most need for early mobility to prevent complications to which they are more vulnerable, such as pulmonary problems!

4. Time constraints

Time may be an element in the minimization of attention to the mobility needs of ICU patients, considering the complex equipment used and the need for more than one person to coordinate moving a critically ill patient. Hospital staff achieve patient goals as per the priorities hospital administrators set for their institutions. With administrators, lawyers and insurance carriers requiring more documentation of care, staff set priorities of care accordingly. Lack of turning does not imply lack of care but rather it may suggest that priority was given to other activities rather than to mobility care (Morris, 2007).

5. Reluctance to create a mobility culture in the ICU

Knowledge, skills and motivation are needed to transform ICU culture into one that stresses the importance of mobility. The inability to view the immediate detriments of failing to mobilize ICU patients is a reason that mobility is assigned a low priority**,** performed less frequently or inconsistently in this patient population. Long-term

outcomes of ICU patients must be taken into account in order to highlight the need for implementing early mobility. Teams must be able to work together, choose the proper timing, and coordinate their efforts in order to achieve that. Champions that possess leadership abilities are needed to convince frontline workers and physicians who are unwilling to promote early mobility in the intensive care unit (Clemmer, 2014).

As seen, there are many barriers that must be overcome so that early mobility may be implemented in critically ill patients. The section below reviews the evidence for the benefits of early mobility of critically ill patients.

C. Clinical Outcomes Associated with Early Mobility

Recently, there is a growing body of literature providing preliminary evidence of the positive impact of early mobility on critically ill patients' outcomes. However, there is no uniformity in the approach used to deliver mobility interventions across these studies. Besides, few of these studies are randomized controlled trials. Moreover, studies pertinent to the safety, feasibility and outcomes of early mobilization in the critically ill are characterized by the presence of sample exclusion criteria that are extensive (Lipshutz & Gropper, 2013). This may limit the generalizability of the findings and subsequently the feasibility of applying the tested mobility interventions in all critically ill patients.

A systematic review on the functional outcomes and safety of mobilization models in critically ill patients was published by Adler and Malone in 2012, who concluded that the body of evidence on mobilization of critically ill patients is limited. This systematic review included 15 studies of both prospective and retrospective designs. Three of the fifteen studies used randomization (Burtin, et al., 2009, Chiang,

Wang, C.P. Wu, H.D. Wu, & Y.T. Wu, 2006, & Schweickert et al., 2009), with one of these taking place in a post intensive care unit (Chiang et al.,2006). The authors stated that the strength of the evidence is limited by the inclusion of only 171 patients in the reviewed randomized controlled trials. Besides, a variety of interventions for starting early mobility is noted across the studies, such as utilization of a mobility team and a mobility protocol to guide mobilization in one study (Morris et al., 2008), use of a quality improvement process that involves staffing and cultural changes in ICU practice in another (e.g. Needham, et al., 2010) and the use of technologies such as cycle ergometry added to physiotherapy interventions in others (e.g. Burtin et al., 2009). Overall, the findings of the reviewed studies suggested that it is safe and feasible to implement physical therapy and mobilization early in the ICU setting. Transient oxygen desaturation for less than three minutes was the most frequently cited adverse event. Improved functional mobility following early and progressive physiotherapy/ occupational therapy in the intensive care setting was supported by the review by Adler and Malone (2012). However, it was noted that there was no uniformity in the measurement of this outcome. Functional mobility was measured with various instruments, such as the functional independence measure, the Barthel Index and the Functional Status Score in the ICU (FSS-ICU). Besides, some tools used to measure functional outcomes in some studies such as FSS-ICU require further psychometric testing as they were not reported to be tested in the ICU.

In the reviewed studies, measuring muscle strength as an outcome was not frequently done, despite the knowledge about the effects of bed rest in critical illness on the muscles. The researchers who measured the influence of early mobility on muscle strength (Burtin et al., 2009; Schweickert et al., 2009), reported no difference noted at

the time of transfer out of the ICU, but Burtin et al., in 2009 found improvement in quadriceps muscle strength at the time of discharge from the hospital (Adler & Malone, 2012).This finding suggests that the significance of early mobility maybe evident when considering long term outcomes, such as after hospital discharge rather than more short term outcomes. Finally, quality of life and patient symptoms were measured only in the study by Burtin et al. (2009), who reported amelioration of physical functioning domain of the SF-36 (Adler & Malone, 2012).

Among the studies reviewed by Adler and Malone (2012), the only study that looked into the potential cost savings of early mobility in critically ill patients was a study conducted by Morris et al., in 2008**.** This prospective cohort study of 330 patients was conducted in the medical ICUs of a university hospital to compare the respiratory outcomes of patients who received physical therapy based on a mobility protocol performed by a mobility team (n = 165) to those who received usual care (n= 165). Usual care included physical therapy, yet its delivery was irregular and infrequent. A physician's patient specific order was required for initiating physical therapy. The bedside nurse then performs passive range of motion for the patient. Besides, positioning is done every two hours for an unconscious patient. Mobility therapy is also part of usual care for eligible patients, but its availability is restricted to five days a week .The Mobility Team included a critical care nurse that was free of direct bedside care responsibilities, a nursing assistant and a physical therapist and was responsible for delivering the mobility protocol seven days a week. The protocol's automatic physician's order activates physical therapy administration to the patient in the Protocol group. Transferring the patient from ICU to a regular bed was the ending of delivery of protocol interventions in this study. The two groups were similar in baseline

characteristics. (Morris et al., 2008). The proportion of patients who survived to hospital discharge was the primary outcome of this study. Days until first out of bed, ventilator days, and length of stay (LOS) in ICU and in the hospital among survivors were secondary outcomes. Definition of the first day out of bed was when the foot of the patient touched the floor for the first time. Ventilator day was defined as a portion of any calendar day in which the patient needed a mechanical ventilator. Results of this study showed that at least one physical therapy session was administered to more patients in the Protocol group than in the Usual Care group (116 out of 145 (80%) vs. 64 out of 135 (47.4 %), respectively and $p \leq 0.001$). Among those who were administered at least one physical therapy session, 8 out of the 64 patients in the Usual Care group (12.5%) had their physical therapy started in the ICU setting compared to 106 out of the 116 patients in the Protocol group (91.4%), $p \leq 0.01$. In addition, more sessions were delivered to the Protocol group patients than the Usual Care group (5.5 sessions vs. 4.1, p=0.037). It took five days for Protocol patients to be first out of bed compared to 11.3 days for the Usual Care group ($p \leq 0.01$). No significant difference was noted in the mean number of ventilator days between both groups (10.2 vs. 8.8, p= 0.163). The adjusted ICU LOS was 6.9 days in the Usual Care group compared to 5.5 days in the Protocol group , p=0.027. Also, the adjusted hospital LOS was 14.5 days in the Usual Care group compared to 11.2 days in the Protocol group, p=0.006. The findings of this study suggest that the utilization of a protocol by a Mobility Team was associated with a higher proportion of patients receiving physical therapy, start of physical therapy prior to transfer from ICU, fewer days needed to be out of bed, and shorter duration of stay in the ICU as well as in the hospital. The utilization of the mobility team and mobility protocol appeared to be cost-effective. The Protocol group

total direct inpatient costs including the salaries of the Mobility Team were 6,805,082 dollars compared to 7,309,871 dollars for the Usual Care group. The average cost for each patient in the Protocol group was 41,142 dollars and in the Usual Care group 44,302 dollars, p=0.262 (Morris et al., 2008).

Kayambu, Boots and Paratz (2013) did another systematic review of exercise in critically ill patients that included ten randomized controlled trials (RCTs) and five reviews. The interventions tested included a combination of active and passive range of motion exercises, early mobility, limb strengthening, diaphragmatic exercises, gait training, as well as electrical muscle stimulation. They concluded that physical therapy in the ICU seems to have positive impact on quality of life, length of stay and mobility outcomes. The meta-analysis showed amelioration of quality of life (mean effect size g = 0.4 ,95% confidence interval CI [0.08 , 0.71]), peripheral muscle strength (g = 0.27,95% CI [0.02 , 0.52]), respiratory muscle strength (g = 0.51, 95% CI [0.12, 0.89]) and physical function (g = 0.46 , 95% CI [0.13,0.78]), increasing days without ventilatory support (g = 0.38, 95% CI [0.16, 0.59]), reduced LOS in the hospital (g = -0.34, 95% CI [-0.53,-0.15]) and the ICU (g = -0.34, 95% CI[-0.51,-0.18]). The authors highlighted the need to perform more controlled trials with higher quality and bigger sample sizes to provide stronger evidence for these associations. They also proposed the performance of studies exploring the ideal dose and timing of exercising, the influence of exercise on certain conditions and the mode of action of certain interventions (Kayambu et al., 2013).

Furthermore, Calvo –Ayala, Khan, Farber, Wesley Ely, and Boustani (2013), conducted a systematic review of 14 randomized controlled trials on the efficacy of interventions directed towards physical functioning (PF) in ICU survivors to specify

effective interventions for the amelioration of long –term PF in this patient population. The interventions included nurse-led follow up and rehabilitation, absence of sedation during mechanical ventilation, parenteral nutrition, spontaneous breathing trials, early tracheotomy and exercise/physical therapy. A variety of outcome measures were used. Specifically the 6 minute walk test, activity of daily living scale, SF-36 physical function scale, Medical Research Council and Rivermead Mobility Index. Efficacy on PF in ICU survivors could not be shown in nine studies. Yet there was a positive impact from early physical exercise and physiotherapy based interventions on long term physical function (measured at 2 to 12 months after discharge). They concluded that the only effective intervention to enhance PF in critically ill patients is exercise/physiotherapy and that it may be more beneficial if implemented early on. They also indicated the need for further research comparing interventions of various types and duration (Calvo-Ayala et al., 2013).

As seen, research on early mobilization in critically ill patients is limited. Yet the available evidence points out that starting early mobility in the ICU is associated with positive outcomes.

D. Examples of mobility protocols

Hopkins and Spuhler (2009), Kubo(2008) as well as Perme and Chandrasekhar (2009) stated that progressive mobility protocols grant nurses and interdisciplinary team members a roadmap for escalating patient movement by applying a series of progressive steps from passive range of motion (ROM) till independent ambulation as medical stability improves (as cited in King,2012). They also stressed that utilization of mobility

protocol for eligible patients must continue till a patient can ambulate independently or is discharged from the hospital (as cited in King, 2012).

The following described protocols serve as an example for the variety of mobility protocols in the literature. In the study by Morris et al., (2008), the protocol that was utilized consists of four levels. The focus of mobility as a patient advances into higher levels was performance of functional activities that include transfer to the edge of the bed, safe movements to and from bed, chair or commode , seated balance exercises, pre-gait standing activities and ambulation. Eligibility criteria included being 18 years or older, being intubated within 48 hours and on mechanical ventilation, and still within 72 hours of admission into a medical intensive care unit. Exclusion criteria included incapability to walk without aid before the acute critical illness except for people who need canes or walkers, preadmission impairment in cognitive status, immunocompromised status before acute critical illness (taking more than 20 mg per day of prednisone for a period of two weeks), neuromuscular disease that may interfere with weaning (Guillan- Barre, amyotrophic lateral sclerosis, myasthenia gravis),body mass index above 45 kg/m^2, fracture of the hip, acute stroke, unstable cervical spine or pathologic fracture, and cancer therapy within the last six months, duration of mechanical ventilation above 48 hours prior to transfer from another outside facility, and hospitalization within one month before being admitted.

Level I of the protocol includes administration of passive range of motion (PROM) by the Mobility Team nursing assistant thrice a day to all upper and lower extremity joints in patients when unconscious and positioning every two hours. PROM was repeated at least five times for each joint. Level II of the protocol includes all activities in level I in addition to active resistance physiotherapy and putting the patient

in the sitting position for a minimum of 20 minutes three times per day. Moving the patient into level II, which involves starting participation in physiotherapy, occurs after the assessment shows the patient alert enough to do that. Three out of five commands must be properly followed in order to deem the patient alert enough for engagement in physical therapy. (Morris et al., 2008). These commands according to De Jonghe et al. are: "Open (close) your eyes", "Look at me", "Open your mouth and put out your tongue", "Nod your head" and "Raise your eyebrows when I have counted up to 5'' (as cited in Morris et al., 2008). Involvement of the patient in active –assistive and active range of motion exercises increases as the alertness of the patient and the capacity to advance improves. Limb strength during an effort determines the progress into levels III and IV of the protocol. A patient must score 3 out of 5 on the Medical Research Council Strength in biceps to move from level II to III and a score of 3 out of 5 in quadriceps to transition from level III to IV. Level III includes all activities in levels II and seating the patient on the edge of the bed. Level IV consists of all activities included in the previous level in addition to active transfer out of bed like to a chair. A characteristic goal of the levels of this protocol is to have the ability to repeat each of the exercises five times. No usage of weights was incorporated into the protocol (Morris et al., 2008).

The other described protocol published in 2007 was developed by Rosemary Timmerman, who was that year a Masters student at the Duquesne University in Pittsburgh and a clinical nurse educator at the adult critical care unit Providence Alaska Medical Center. According to this protocol, being deconditioned by more than three days, needing orthostatic training to the upright position or readiness for weaning from mechanical ventilation makes a patient candidate for progressive mobility. Physiologic stability and absence of femoral arterial lines are other inclusion criteria that must be

present in a patient for early mobility to happen. Any cardiovascular, neurologic or respiratory instability excludes the patient from progressive mobility. A list of conditions is listed under cardiovascular, neurologic and respiratory instability in the protocol to help the nurse judge that this patient cannot be currently mobilized. Steps of the protocol include positioning every two hours while on bed rest and passive range of motion twice daily for patients who are not able to participate in their care and maintenance of head of bed (HOB) at an angle above 30 degrees for a mechanically ventilated patient if no contraindications exist. In addition, the protocol provides a structure for progressive mobilization such that progressive mobilization must be done twice or thrice daily and tolerance to activity must be assessed to advance into the next step on a shift basis. The activities incorporated into this protocol for progressive mobilization include elevation of HOB 45 degrees, then configuration of the bed into partial chair position, when the patient can adjust to posture changes keeping this configuration for 1 to 2 hours. Configuration of bed into full chair position described as HOB elevated to 65 degrees and legs in dependent position is the next step. Then dangling with help to make the feet of the patient touch the floor if possible but keeping the torso supported is done when the patient is conscious and can obey commands. When the patient becomes capable of lifting his leg against gravity, standing at bedside with assistance is done. Helping a patient take one to two small steps to facilitate his/her transfer into a chair follows. The next step is to assist the patient to walk when the patient possesses strength and equilibrium, providing walker if needed. The last step is promoting independent ambulation. All these steps of the protocol are executed by the nurse .Physical therapy consultation is considered when patient is capable of following simple commands .During multidisciplinary rounds, the status of each patient is

reviewed , the plan for mobility progression is set, and patients stable enough to be enrolled in the protocol are identified. Timmerman states that although these interventions are not revolutionary, the protocol may assist patients to regain their power or functional abilities because of the constant evaluation of patients by nurses and the structure it provides to guide nurses in the mobilization process. (Timmerman, 2007).

As noted above, early mobility protocols provide guidance in terms of when to introduce early mobility and to which ICU patients. The steps moving patients from one level of activity to another are outlined and the criteria for evaluating the patient's readiness to progress are described. Chapter III proposes an early mobility protocol based on the literature and in line with the context at the AUBMC.

CHAPTER THREE

PROPOSED EARLY MOBILITY PROTOCOL

Early mobility is not just the attainment of prehospital ambulation status. It is starting a mobility program when the patient is minimally capable of participation in his/her treatment process, is hemodynamically stable and is dependent on acceptable oxygen levels (Dang, 2013).Fraction of inspired oxygen (FiO_2) less than or equal 0.6 is one of the respiratory criteria a patient must satisfy for activity to be started early (Bailey et al., 2007). Based on the literature review described in chapter 2 of available mobility protocols, the following early mobility protocol has been designed, including eligibility criteria, when to initiate and discontinue mobility, and the levels through which patients progress. The protocol progresses into four levels as adapted from Morris et al., (2008).On day of admission into the unit, all patients are placed in level I of the protocol, thereafter progressive mobilization is assessed on daily basis in multidisciplinary rounds.

Eligibility Criteria:

Previous level of function**,** neurologic, respiratory and circulatory criteria are used to determine eligibility of patient for activation of early progressive mobility protocol. If patients do not satisfy the functional level and neurologic criteria, progression of activity from one level to the other is not possible and patients remain in level I of protocol.

Previous Level of Function: Baseline functional independence (Schweickert et al., 2009).

Neurologic Criteria: Follows commands and is cooperative **(**Thomsen, Snow, Rodriguez, & Hopkins, 2008)

Respiratory Criteria: FiO_2 less than or equal 0.6 and positive end-expiratory pressure less than or equal 10 (Thomsen et al., 2008)

Circulatory Criteria: Mean arterial blood pressure between 60 and 110 mmHg (Perme & Chandrashekar, 2009)

No new nor increase in vasopressor dose in the last two hours (Korupolu, Gifford & Needham, 2009).

Contraindications for activation of early mobility protocol

1) Neuromuscular disease that may impair weaning (amyotrophic lateral sclerosis, Guillain – Barré syndrome, myasthenia gravis)(Morris et al.,2008).
2) Acute stroke (Morris et al., 2008) or evidence of increased intracranial pressure (Pohlman et al., 2010).
3) Hip fracture
4) Unstable cervical spine or pathologic fracture
5) Cognitive impairment before acute critical illness (Morris et al., 2008).
6) Heart rate less than 40 or more than 130 beats per minute
7) Respiratory rate less than 5 or more than 40 breaths per minute
8) Pulse oximetry less than 88%
9) Active myocardial ischemia (Pohlman et al., 2010,p.2094)
10) Active gastrointestinal bleeding (Pohlman et al., 2010)

Progressive Mobility Protocol Levels

The levels of activity per protocol are described next.

Level I: Therapy consists of passive range of motion (PROM) three times per day and positioning every two hours. An unconscious patient remains in level I until regaining consciousness. Then he/she is progressed into level II.

Level II: In addition to PROM three times a day and positioning every two hours, activity resistance physiotherapy is initiated by the physical therapist whereby the patient is asked to move his/her extremity against gravity. Also, the patient is placed in sitting position for at least 20 minutes three times per day. When the patient can move arm against gravity by observing him/her after asking him to do that, he/she is advanced into level III.

Level III: All activities done in level II plus sitting on the edge of the bed.

When the patient can move his/her leg against gravity, he/she advances into level IV. (Morris et al., 2008)

Level IV: consists of all the activities in level III plus active transfer of the patient out of bed such as to chair for at least twenty minutes a day and ambulation (Morris et al., 2008).Assistance in transfer out of bed and in ambulation is provided as appropriate with duration of all these sessions ranging between fifteen minutes to forty five minutes daily as per tolerance of patient once or twice if needed (Perme &Chandrashekar, 2009) .Achieving independent ambulation is the final step to be reached in the protocol (King , 2012).

For a patient with a mechanical ventilator, a doctor, a registered nurse, a nursing assistant, a physiotherapist and a respiratory therapist must be present for ambulation of

the patient. Elevating FiO2 by 0.2 may be a consideration in intubated patients during activity (Thomsen, et al., 2008).

Assess changes in respiratory rate, pulse oximetry, heart rate and blood pressure during activity and attend to complaints of fatigue verbalized by patient (Perme & Chandrashekar, 2009).

Moving a patient from one mobility level to another is done on daily basis based on mobility assessment findings during multidisciplinary rounds.

If mobility session is terminated, reevaluation of the patient is done the next day for reinitiation of the protocol at appropriate level if eligible (Morris et al., 2008). Documentation of mobility level and assessment parameters to evaluate the progress as well as the response of the patient to activity can be performed using the form shown below

Mobility Assessment Sheet

Name of patient: Age: Gender:

Level reached in the protocol	Activities done	Activity tolerated yes or no

Assessment parameters (filled by nurse)	Before activity	After starting activity
Level of consciousness		
Respiratory rate		
Pulse oximetry		
Heart rate		
Blood pressure		

Figure 1: Mobility Assessment Sheet

Criteria for Terminating a Mobility Session.

A mobility session is ended in case of any of the following:

1) Oxygen saturation less than 88% on supplemental oxygen throughout activity, unless the physician indicates otherwise (Perme & Chandrashekar, 2009, p. 218)
2) Hypotension (Perme & Chandrashekar, 2009) with more than 20% decrease in systolic blood pressure or diastolic blood pressure (Adler & Malone,

2012), accompanied by dizziness, fainting and/or excessive sweating (Perme & Chandrashekar, 2009).

3) Arrhythmia (Perme & Chandrashekar, 2009).
4) Heart rate less than 40 beats per minute
5) Heart rate greater than 130 beats per minute. (Adler & Malone, 2012; Pohlman et al., 2010)
6) Respiratory distress.
7) Profound fatigue.
8) Severe chest pain.
9) Excessively pale or flushed skin.
10) Request of patient to stop. (Perme & Chandrashekar, 2009)
11) Patient distress evidenced by nonverbal cues, gestures or by becoming physically combative (Pohlman et al., 2010, p.2094)

For implementation of this protocol we propose having a team that includes one full time physical therapist dedicated to the ICU and RCU, in addition to an orderly to help in patient ambulation. The registered nurses responsible for the patients shall participate in mobility assessment and implementation of the protocol.

Hiring a team for starting early mobility can be justified in terms of the potential cost savings introducing early rehabilitation in the ICU may generate. A financial model developed by Lord et al., 2013 utilizing data from existing publications and actual experience with an early rehabilitation program in the Johns Hopkins Medical ICU projects that net financial savings for U.S. hospitals can be generated through investing in an ICU early rehabilitation program . A projected financial analysis of the Johns Hopkins Medical ICU rehabilitation program with 900 admissions per year and actual shortening of the length of stay in the ICU by 22% and in the floor by 19% generated net cost savings of 817, 836 US dollars (Lord et al., 2013).

CHAPTER FOUR

IMPLEMENTATION AND EVALUATION

The process of incorporating early mobility protocol into practice mandates the cooperation of all members of the multidisciplinary team including physicians, physiotherapists, respiratory therapists, and nurses of all levels.

First a task force consisting of representatives from the different members of the healthcare team, including an intensive care physician, a nurse, critical care clinical nurse specialist, physical therapist and respiratory therapist, is formed. The purpose of this task force is to review the proposed protocol, revise it as needed, and make the implementation process smooth. Meetings with administration to gain their support of this process are to be held after they receive a proposal including description of the protocol, related empirical evidence, and cost analysis based on the literature. Following administrative approval, revision of the proposed early mobility protocol is to be performed if further modifications are deemed necessary. After finalizing the early mobility protocol development, education for the various specialties will be provided in the form of sessions that explain the complications of immobility in critical illness, the strategies used to overcome barriers to its implementation and the evidence supporting the benefits of initiating early mobility and of utilizing mobility protocols. During the sessions healthcare professionals are granted the chance to voice their concerns pertinent to implementation of progressive mobility protocol in critically ill patients. The protocol is presented next. Demonstration and back demonstration are used to show how a patient on mechanical ventilation can be safely mobilized and transferred out of bed.

Once education is over, implementation follows. The mobility team is designated and the documentation forms prepared. The protocol is pilot tested on few patients and barriers to and/or problems in implementation are identified and rectified. Then the final version is implemented.

Evaluating outcomes of starting early mobility in eligible critically ill patients in RCU is done through measuring the output, outcomes and impact of protocol implementation. The output is measured by noting the number of eligible patients on whom the protocol is implemented, i.e. compliance with the protocol. The outcomes are length of stay, benefits of activity measured by functional ability and complications of immobility of patients started on early mobility and comparing them with those prior to starting implementation of the protocol. A retrospective medical record review can be done over one year period. Assessment of functional level is conducted through monitoring the number of patients regaining ability to ambulate in addition to length of stay in ICU and in the hospital, and length of time on mechanical ventilation. Furthermore, the incidence of VAP and of pressure ulcers is noted.

Besides, process evaluation is done by monitoring any adverse events happening during mobility sessions and reporting them to identify areas for improvement. Staffing concerns if noted are to be addressed with the administration as appropriate. Satisfaction of the staff and compliance with the protocol are examined and the findings used to modify the protocol if needed. Then six months after implementation a prospective study is done looking at length of stay, ventilator and ICU days, in addition to complications that were studied pre implementation and compared with the post-implementation data.

	Pre –implementation of early mobility protocol	Post – implementation
Average LOS in RCU		
Length of time on MV in RCU		
Incidence of pressure ulcers		
Incidence of VAP		
Number of patients eligible for mobility therapy regaining ability to ambulate		

Table 1:.Evaluation of outcomes pre-implementation and post –implementation

Impact evaluation is also done one year after discharge for patients, whereby functional ability, readmission rate and quality of life are measured. Functional ability can be assessed by using the the ICU Mobility Scale (IMS) to standardize the measurement and reporting of a patient's highest mobilization level achieved in the intensive care setting (Hodgson et al., 2014). It is a simple scale consisted of eleven items that describe in details mobility milestones and the level of assistance the patient required for achieving the specified milestone. It can be easily completed by nurses and physical therapists with strong inter-rater reliability. (Hodgson et al., 2014).In addition, cost analysis in terms of staffing required for protocol implementation versus length of stay and quality of life years is done to validate the worth of the proposed protocol.

As seen, establishment of a culture that promotes early mobility is a challenging process that needs the concerted efforts of all healthcare members in the

critical care area including RCU. The critical care clinical nurse specialist can play an important role in fostering such culture. Educating nursing staff, patients, families and physicians about the significance of evidence –based practices, the positive impact of implementing early mobility in the ICU, and the expectations of practices in this setting is one role the clinical nurse specialist can perform (Dang, 2013).Other roles include doing necessary system changes to implement early mobility such as the development of a standard protocol and conducting further research pertinent to this subject (Dang, 2013). The benefits of using a progressive mobility protocol include: providing clear guidelines and assessment parameters for nurses to promote patient -out -of bed mobility in the intensive care unit (King, 2012), making nurses view mobility as a core component of nursing care, and enabling them to play a proactive role in the start of mobilization for the patient, in addition to facilitation of integration of mobility into multidisciplinary rounds (Timmerman, 2007). This integration allows healthcare professionals to plan for the mobility needs of the patient and make sure that progression of activities in a stepwise fashion happens with improvements in physiologic stability (Timmerman, 2007).

References

Adler, J. & Malone, D. (2012). Early mobilization in the intensive care unit: a systematic review. *Cardiopulmonary Physical Therapy Journal*, *23*(1), 5-13.

Bailey, P., Thomsen, G. E., Spuhler, V. J., Blair, R., Jewkes, J., Bezdjian, L., ... Hopkins, R. O. (2007). Early activity is feasible and safe in respiratory failure patients. *Critical Care Medicine, 35*(1), 139-145. doi: 10.1097/01.CCM.0000251130.69568.87

Brower, R. G. (2009). Consequences of bed rest. *Critical Care Medicine, 37* (Suppl.10), S422-S428. doi: 10.1097/CCM.0b013e3181b6e30a

Burns, J. R., & Jones, F. L. (1975). Early ambulation of patients requiring ventilatory assistance. *Chest, 68* (4), 608.Retrieved from http://journal.publications.chestnet.org/

Burtin, C., Clerckx, B., Robbeets, C., Ferdinande, P., Langer, D., Troosters, T., …Gosselink, R. (2009).Early exercise in critically ill patients enhances short-term functional recovery.*Critical Care Medicine, 37* (9), 2499-2505.doi: 10.1097/CCM.0b013e3181a38937

Calvo-Ayala, E., Khan, B.A., Farber, M.O., Wesley Ely, E.,& Boustani, M.A.(2013). Interventions to improve the physical function of ICU survivors: a systematic review, *Chest, 144*(5), 1469-1480. doi: 10.1378/chest.13-0779

Chambers, M.A., Moylan, J.S., &Reid, M.B. (2009). Physical inactivity and muscle weakness in the critically ill. *Critical Care Medicine,37*(Suppl.10), S337-S346.doi: 10.1097/CCM.0b013e3181b6e974

Checkley, W., Martin,G. S., Brown,S. M. , Chang,S. Y. , Dabbagh , O. , Fremont,R. D. , ...Sevransky , J. E. (2014) . Structure, process, and annual ICU mortality across 69 centers: United States critical illness and injury trials group critical illness outcomes study. *Critical Care Medicine,42*(2), 344-356. doi: 10.1097/CCM.0b013e3182a275d7

Chiang, L.L., Wang, L.Y., Wu, C.P., Wu, H.D., &Wu, Y.T. (2006). Effects of physical training on functional status in patients with prolonged mechanical ventilation. *Physical Therapy, 86*(9), 1271-1281. doi: 10.2522/ptj.20050036

Clavet, H., Hébert, P.C., Fergusson, D., Doucette, S, & Trudel, G. (2008).Joint contracture following prolonged stay in the intensive care unit. *Canadian Medical Association Journal, 178*(6), 691-697.

Clemmer, T. P. (2014).Why the reluctance to meaningfully mobilize ventilated patients?" The answer my friend is blowin' in the wind " .*Critical Care Medicine, 42*(5), 1308-1309.doi: 10.1097/CCM.0000000000000184

Dang, S. L. (2013). ABCDEs of ICU early mobility. *Critical Care Nursing Quarterly, 36*(2), 163-168.doi: 10.1097/CNQ.0b013e318283cf45

Fan, E. (2010). What is stopping us from early mobility in the intensive care unit? *Critical Care Medicine, 38* (11), 2254-2255. doi: 10.1097/CCM.0b013e3181f8477d

Goddard,S. L. & Cuthbertson, B. H. (2012). Rehabilitation and critical illness. *Anaesthesia and Intensive Care Medicine, 13*(5), 214-216.

Hamburg, N.M., McMackin, C.J., Huang, A.L., Shenouda, S.M., Widlansky, M.E. Schulz, E.,…Vita, J.A. (2007). Physical inactivity rapidly induces insulin resistance and microvascular dysfunction in healthy volunteers. *Arteriosclerosis, Thrombosis and Vascular Biology, 27*(12), 2650-2656.doi: 10.1161/ATVBAHA.107.153288

Hodgson, C., Needham, D., Haines, K., Bailey, M., Ward,A., Harrold,M., ...Berney,S. (2014).Feasibility and inter-rater reliability of the ICU mobility scale. *Heart & Lung , 43,* 19-24.

Kayambu, G., Boots, R., & Paratz, J. (2013).Physical therapy for the critically ill in the ICU: a systematic review and meta-analysis. *Critical Care Medicine, 41*(6),1543-1554.doi: 10.1097/CCM.0b013e31827ca637

King, L. (2012). Developing a progressive mobility activity protocol. *Orthopaedic Nursing, 31* (5), 253-262.doi:10.1097/NOR.0b013e31826649f2

Korupolu, R., Gifford, J.M., & Needham, D.M. (2009). Early mobilization of critically Ill patients: reducing neuromuscular complications after intensive care, *Contemporary Critical Care, 6*(9), 1-12.

Lipshutz, A. K. M., & Gropper, M. A.(2013).Acquired neuromuscular weakness and early mobilization in the intensive care unit. *Anesthesiology, 118*(1), 202-215. Retrieved from www.anesthesiology.org.

Lord, R. K., Mayhew, C. R., Korupolu, R., Mantheiy, E.C., Friedman, M.A., Palmer, J.B., & Needham, D.M. (2013). ICU early physical rehabilitation programs: financial modeling of cost savings. *Critical Care Medicine, 41*(3), 717-724. doi: 10.1097/CCM.0b013e3182711de2

Morris, P. E. (2007). Moving our critically ill patients: mobility barriers and benefits. *Critical Care Clinics, 23,* 1-20. doi:10.1016/j.ccc.2006.11.003

Morris,P.E., Goad,A., Thompson, C., Taylor, K., Harry,B., Passmore, L.,… Haponik, E.(2008). Early intensive care unit mobility therapy in the treatment of acute

respiratory failure. *Critical Care Medicine, 36*(8), 2238–2243. doi: 10.1097/CCM.0b013e318180b90e

Needham, D. M. (2008). Mobilizing patients in the intensive care unit improving neuromuscular weakness and physical function. *Journal of the American Medical Association, 300*(14), 1685-1690. Retrieved from http:// jamanetwork.com/

Needham,D.M.,Korupolu,R., Zanni,J.M., Pradhan,P.,Colantuoni ,E.,Palmer,J.B.,… Fan, E. (2010).Early physical medicine and rehabilitation for patients with acute respiratory failure: a quality improvement project. *Archives of Physical Medicine and Rehabilitation,91*(4), 536-542.doi: 10.1016/j.apmr.2010.01.002

Perme, C., & Chandrashekar, R. (2009) .Early mobility and walking program for patients in intensive care units: creating a standard of care. *American Journal of Critical Care, 18*(3), 212-221. doi: 10.4037/ajcc2009598

Petty, T.L. (1998).Suspended life or extending death ?*Chest,114*(2), 360-361. Retrieved from http://journal.publications.chestnet.org/

Pohlman, M. C., Schweickert, W. D., Pohlman, A. S., Nigos, C., Pawlik, A. J.,Esbrook, C. L.,...Kress, J. P. (2010). Feasibility of physical and occupational therapy beginning from initiation of mechanical ventilation. *Critical Care Medicine, 38* (11), 2089-2094. doi: 10.1097/CCM.0b013e31

Schweickert, W.D., Pohlman, M.C., Pohlman, A.S., Nigos, C., Pawlik, A.J., Esbrook, C.L., …Kress, J.P. (2009). Early physical and occupational therapy in mechanically ventilated, critically ill patients: a randomized controlled trial. *Lancet, 373* , 1874-1882. doi: 10.1016/S0140-6736(09)60658-9

Timmerman, R.A. (2007).A mobility protocol for critically ill adults. *Dimensions of Critical Care Nursing,26*(5), 175-179.

Thomsen, G.E., Snow, G.L., Rodriguez, L., & Hopkins, R.O. (2008). Patients with respiratory failure increase ambulation after transfer to an intensive care unit where early activity is a priority. *Critical Care Medicine, 36*(4), 1119-1124. doi:10.1097/CCM.0b013e318168f986

Vollman, K. M. (2010). Introduction to progressive mobility. *Critical Care nurse, 30* (Suppl.2), S3-S5.doi: 10.4037/ccn2010803