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# Does Early Mobility Lead to Decreased Ventilator Days?

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DOES EARLY MOBILITY

LEAD TO DECRASED VENTILATOR DAYS?

by

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## Abstract

It is well documented that bedrest has adverse outcomes for hospitalized patients. This is especially true for critically ill patients due to life support measures, invasive catheters, and mechanical ventilation. Consequences associated with bedrest in critical care patients include venous thromboembolism, ventilator associated pneumonia, pressure ulcer development, and muscle weakness. Respiratory muscle weakness is associated with prolonged ventilator support and delayed extubation. The Awakening and Breathing Coordination, Delirium Monitoring and Management, and Early Mobility (ABCDE) bundle uses evidence based practice to prevent and treat ICU acquired delirium and weakness. The bundle aims to do this by standardizing care processes in collaboration with the ICU team to promote early mobility in ventilated patients. The purpose of this research study was to determine if the implementation of an early mobility protocol decreased the number of ventilator days for patients who receive mechanical ventilation. A retrospective chart review was conducted at a 16 bed ICU. Group A included 30 subjects ($n=30$) who were treated pre implementation of the ABCDE bundle and Group B included 39 ($n=39$) subjects who were treated post implementation of the ABCDE bundle. There were less average ventilator days found in Group A in comparison to Group B. Additionally, there was a significant difference found in the ICU length of stay pre implementation ($M=9.4$, $SD=4.4$) and post implementation ($M=5.7$, $SD=2.6$) of the ABCDE bundle for early mobility, $t\ (65) = 4.3$, $p = 0.00005$. The APRN can use the evidence in the ABCDE bundle to guide care to critically ill patients that are mechanically ventilated. Utilizing the ABCDE bundle additionally allows the APRN to be instrumental in improving patient outcomes through interdisciplinary collaboration.

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## Background/Statement of the Problem

Patients admitted to an Intensive Care Unit (ICU) are often confined to bedrest. Multiple life sustaining catheters, monitors, sedative medications, impaired levels of consciousness, sleep disturbances, electrolyte imbalances, and hemodynamic instability are all factors that contribute to limited mobilization (Adler & Malone, 2012). Consequences associated with bedrest in critical care patients include venous thromboembolism, ventilator associated pneumonia, urinary stasis, pulmonary insufficiency, pressure ulcer development, decreased gastric motility/constipation, orthostasis, and muscle weakness (Makic, 2015). Weakened muscles generate an increased oxygen demand, and both respiratory and limb muscle strength are altered after one week of mechanical ventilation. Furthermore, respiratory muscle weakness is associated with prolonged ventilator support and delayed extubation (Perme & Chandrashekar, 2009).

The Awakening and Breathing Coordination, Delirium Monitoring and Management, and Early Mobility (ABCDE) bundle incorporates the best evidence related to delirium, immobility, sedation/analgesia, and ventilator management in the ICU. The evidence-based pharmacologic and nonpharmacological interventions are tailored into a bundle that can be used in everyday practice (Balas et al., 2012). The three main principles in the foundation of the ABCDE bundle include improving communication among members of the ICU team, standardizing care processes, and breaking the cycle of over sedation and prolonged mechanical ventilation that can lead to delirium and weakness (Balas et al).

Patients are candidates for mobilization when they meet certain criteria and do not have any of the contraindications listed in the protocol. Exclusion criteria for mobilization include a Richmond Agitation-Sedation Scale score of less than negative three, an oxygen saturation of less than 88% for greater than five minutes, an FIO2 greater than 60%, a positive end-expiratory pressure (PEEP) greater than 10, any increases in vasopressor infusion, active myocardial ischemia, arrhythmias requiring administration of a new antiarrhythmic agent, therapies that restrict mobility such as an open-abdomen, and injuries in which mobility is contraindicated as with an unstable fracture (Balas et al., 2012). The patient's readiness for mobility is determined by an interdisciplinary team that consists of a physical therapist who assesses physical ability, a nurse who assesses physiological stability, and a respiratory therapist who assesses and maintains the patient's airway. The critical care physician confirms that there are no clinical contraindications for early mobility present. Each patient is assessed upon admission to the ICU; those who qualify begin the protocol immediately and those who do not are reassessed daily (Balas et al.).

The purpose of this research study was to determine if the implementation of an early mobility protocol decreased the number of ventilator days for patients who receive mechanical ventilation. The ABCDE bundle is applicable to mechanically ventilated critical and intermediate level patients. This study occurred at a community hospital with a 16 bed medical ICU and involved a retrospective chart review pre and post implementation of the ABCDE bundle.

Next, the review of the literature will be presented.

## Literature Review

A comprehensive literature review was completed utilizing search engines CINAHL, Pub Med, EBSCO and OVID databases. The following key words were searched: mechanical ventilation; ABCDE bundle; mobility; bed rest; immobility; critical care; bedrest and critical care; immobility and critical care; and Intensive Care Unit (ICU). No specific time period was used for the literature search.

### Consequences of Bedrest

Documentation of the effects of bedrest go back as early as 1947 when R.A.J. Asher wrote an article in the British Medical Journal titled *The Dangers of Going to Bed*. The author placed beds and graves in the same category and described the major hazards of bed on the different parts of the body. In this early work, Asher (1947) noted that adverse pulmonary functioning, which occurs during prolonged bedrest, was related to the absence of exercise and diminished respiratory excursion.  The author discussed that the collection of bronchial secretions stagnating in the lung bases could encourage the development of hypostatic pneumonia. Bed sores, thrombosis and thrombo-embolism, weakening and wasting of the skeletal musculature, calcium draining from the bones causing osteoporosis, retention of urine, dyspepsia's and heartburn, constipation, ataxic disease, and mental status changes are all consequences of bedrest (Adler).

Allen, Glasziou, and Del Mar (1999) systematically searched MEDLINE and the Cochrane library for randomized controlled trials of bedrest versus early mobilization for any medical condition, including medical procedures. Studies were only included if the aim was to examine the main differences in the amount of bedrest prescribed. Study groups had to be living in the same environment and had to be receiving the same treatments (drug administration, surgical intervention, or active physical therapy), other than bedrest. The authors found 39 studies that investigated bed rest usage in 15 different conditions, which included a total of 5777 patients. In the 24 studies investigating bedrest usage following a medical procedure, no patient outcome showed significant improvement and in fact eight demonstrated a significant decline following some procedures, including lumbar puncture, spinal anesthesia, radiculography, and cardiac catheterization (Allen et al.). There were 15 studies that investigated bedrest as a primary treatment and investigators found that no patient outcome improved significantly. Nine of the studies actually showed significant decline for some conditions such as acute low back pain, labor, proteinuric hypertension during pregnancy, myocardial infarction, and acute infectious hepatitis. The researchers stated that there should be no assumption of efficacy with bedrest and further studies need to be done to establish evidence for the benefit or harm of bedrest as a treatment (Allen et al.).

Bedrest is often prescribed to patients who are critically ill. Many other clinical conditions such as acute flares of rheumatoid arthritis, cavitary tuberculosis, acute myocardial infarction, and acute lower back pain are also prescribed bedrest (Brower, 2009). Historically, it has been assumed that bedrest is beneficial for preventing complications, conserving scarce metabolic resources, and for providing patient comfort (Brower). Brower noted that many studies which investigated bedrest as prevention management for complications and treatments of specific diseases failed to demonstrate beneficial effects and could cause several complications that may delay or prevent recovery from critical illness. Critically ill patients frequently remain on bedrest for many days to weeks and many survivors of critical illness complain of muscle weakness for months to years after hospital discharge (Brower). Factors that contribute to weakening of skeletal muscles include sepsis-induced vascular and metabolic derangements, malnutrition, neuropathy, myopathy, pharmacologic doses of corticosteroids, and prolonged inactivity (Brower).

Bedrest has several detrimental effects on the cardiovascular system. Alterations in heart rate, orthostatic instability, coagulopathy, and red blood cell (RBC) dynamics can cause both short-term and long-term pathologies in cardiac and blood vessel tissues (Winkelman, 2009). These tissue changes can lead to functional changes that can increase the need for rehabilitation interventions in patients who have had a prolonged critical illness. Critical illness increases the risk for venous thromboembolic events (VTE) through vessel trauma with cannulation, disease related inflammation, circulatory instability, and activation of pathways that increase coagulation. Reduced oxygen carrying capacity through reduced RBC size and number contribute to a sensation of dyspnea or impaired activity intolerance and may be a factor in dysfunction from fatigue after discharge from the ICU (Winkelman). Atelectasis and aspiration are related to supine positioning and patients are at greatest risk when the backrest elevation is less than 30 degrees. A supine position of less than 45 degrees is associated with decreased lung volumes and increased airway resistance when compared to a head up position (Winkelman).

Other effects of bedrest include skin breakdown and delayed wound healing (Winkelman, 2009). Cognitive changes may also result from bedrest and mainly occur due to altered work-rest cues and altered social interaction. Molecular and systematic changes lead to functional impairment and inability to return to activities of daily living reducing quality of life. Elderly clients (or patients), in particular, are at a greater risk for adverse effects related to bedrest because of age-related changes in muscle (Winkelman).

**Benefits of Early Mobility in Hospitalized Adults**

Brown, Friedkin, and Inouye (2004) conducted a study to estimate different levels of mobility in a hospitalized older cohort. They aimed to measure the degree and rate of adverse outcomes associated with different mobility levels and to examine the physician activity orders and documented reasons for bedrest in the lowest mobility group. Initial data collection was conducted from November 1989 to July 1991 as part of a prospective cohort study. Potential participants were patients aged 70 and older consecutively admitted to the medicine service at Yale-New Haven Hospital, an 800-bed teaching hospital. Of the 525 subjects enrolled, patients with a length of stay of two nights or less were further excluded because of insufficient time to develop the effects of low mobility, as were those whose disposition was unknown.

The final cohort for the study included 498 patients. Detailed nursing observations were available regarding degrees of assistance and the number of times patients transferred and ambulated during the previous 24-hour period. An empiric scoring system was developed assigning points from 0 to 12 for increasing levels of mobility. Bedrest was assigned a score of 0, transferring from bed to chair once was assigned a score of 2, transferring two or more times received a score of 4, and ambulation once with total assistance was assigned a score of 6. Two or more times with total assistance was assigned a score of 8, two or more times with partial assistance received a score of 10, and independent ambulation two or more times a day received a score of 12. Low and intermediate levels of mobility were common, accounting for 80 (16%) and 157 (32%) of patients in the study respectively. The remaining 261 (52%) of patients had high mobility levels. Bedrest was noted for 14% of nursing observations and was present at some point during hospitalization for 33% of patients. Of the 474 patients not requiring total assistance with basic ADLs at their admission interview, 135 (29%) experienced a new decline in nonmobility ADLs at discharge, with 14% declining in one ADL, 7% declining in two ADLs, and 8% declining in three or more ADLs at discharge. Of the 434 patients who survived the hospitalization and were not admitted from an institution, 55 (13%) were newly discharged to an institutional setting and 107 (22%) died or were newly discharged to an institution. New institutionalization was defined as placement of a surviving community dwelling person in a nursing home or a rehabilitation center at discharge and the combined outcome of death and new institutionalization was included to avoid potential interferential errors that might arise because patients who die can no longer be discharged to an institution. The study demonstrated that low mobility and bedrest were common in hospitalized older patients and are important predictors of adverse outcomes (Brown et al.).

Drolet, DeJuilio, Harkless, Henricks, Kamin, Leddy, Lloyd, Waters, and Williams (2013) conducted a research study to determine the effectiveness of a nurse-driven mobility protocol to increase the percentage of patients ambulating during the first 72 hours of their hospital stay. A quasi-experimental design was used before and after intervention. The study took place in a 16-bed adult medical/surgical intensive care unit (ICU) and a 26-bed adult intermediate care unit (IMCU) at a large community hospital (Drolet et al.). A multidisciplinary team developed and implemented a mobility order set with an algorithm to guide nursing assessment of mobility potential that was based on assessments of the nurse in consultation with physical or occupational therapists when appropriate. Three months of data (January–March, 2010) were collected before implementation of the mobility protocol and six months of data (March-August, 2011) were collected post implementation to evaluate the impact of the initiative. The researchers compared the frequency of ambulation for patients admitted to the ICU and IMCU, or who were transferred from the ICU to the IMCU, during these time periods to evaluate the impact of the initiative. Retrospective and prospective chart reviews were done to evaluate the effectiveness of the protocol. Patients that were included in the study were 18 years of age and older and were hospitalized 72 hours or longer. Data were collected for 193 ICU patients and 349 IMCU patients during the three month pre implementation period and for 426 ICU patients and 358 IMCU patients during the six month post implementation period.

In the three months prior to implementation of the initiative, 6.2% (12 of 193) of the ICU patients and 15.5% (54 of 349) of the IMCU patients ambulated during the first 72 hours of their hospitalization. During the six months post implementation of the initiative those rates rose to 20.2% (86 of 426) and 71.8% (257 of 358). The researchers concluded that with a nurse-driven mobility protocol, the rate of patient ambulation in an adult ICU and IMCU increased during the first 72 hours of a hospital stay, (Drolet et al.).

**Early Mobilization in Intensive Care Units**

**Background**. Early mobilization of critically ill patients receiving mechanical ventilation is an advanced physical therapy practice and requires education and specialized skills in specific areas that affect the clinical decision making as well as the treatment for such patients (Perme & Chandrashekar, 2009). The purpose of an early mobility and walking program is to provide guidelines that can assist clinicians who work with mechanically ventilated patients. The program facilitates the development of a treatment plan that focuses on individualized functional capability and progressive mobilization. The physical therapist evaluates the patient to develop appropriate goals and plan of care for mobility and the patient's physician and the nurse should be available to assist in the decision making related to ongoing medical issues (Perme & Chandrashekar).

Once a patient is evaluated by a physical therapist, he/she is placed in one of the early mobility and walking programs' four phases according to their mobility level (Pereme &Chandrashekar). Phase one includes patients who are restricted to bedrest because of their inability to bear weight so activities such as turning and sitting on the side of the bed and standing are encouraged as the patient tolerates. Phase two is when patients progress to transfer to a walker, prewalking activities, and walking reeducation in the room because of their weakness and limited stamina. Phase three advances patients who are ready to start a progressive walking program outside of the room to improve endurance and phase four describes the care of patients that have been transferred out of the ICU. Early mobility in the ICU can lead to minimizing complications of bedrest, promoting improved function for patients, promoting weaning from ventilator support, reducing hospital length of stay, reducing overall hospital cost, and improving patients' quality of life (Perme & Chandrashekar).

Early mobility in the ICU is the initiation of a mobility program when the patient is minimally able to participate with therapy, hemodynamically stable, and receiving acceptable levels of oxygen (Dang, 2013). A mobility program sets parameters on initiation of early mobility and requires an interdisciplinary model and team to ensure and optimize safety, timing, and duration. Prolonged immobility leads to neuromuscular weakness including disuse atrophy, decrease in strength, and functional denervation. One week of bedrest decreases muscle strength by 20%. Research suggests high intensity exercises done in bed do not counteract the effects of bedrest such as muscle weakness. Early mobility in the ICU is impacted by the use of sedatives, narcotics, and/or paralytics that can increase profound weakness, prolong the duration of mechanical ventilation, and prolong ICU and hospital length of stay (Dang).

One of the most challenging parts of rethinking critical care is thought to be improving mobility because it involves the greatest shift in culture and daily processes (Bassett et al., 2015). Significantly reducing sedation and analgesics allows the patient to be alert and interactive, thus increasing patient activity and decreasing the length of time on the ventilator, days in ICU and hospital length of stay, and most importantly, patient mortality. The Institute for Healthcare Improvement's Rethinking Critical Care (IHI-RCC) in-person seminars were designed to replicate powerful changes proven in other health care settings and were established to reduce harm of critically ill patients by decreasing sedation, increasing monitoring and management of delirium, and increasing patient mobility. The IHI in March 2011 held a live case study where participants saw newly published evidence put into action at Intermountain Healthcare in Salt Lake City. Faculty described their practices for titration of sedation and pain management, delirium monitoring, liberation from mechanical ventilation, and early mobility for critically ill patients (Bassett et al.). Following the live case study, IHI developed a two day seminar, run five times that included follow-up through an active listserve that connected participants with faculty for ongoing learning and troubleshooting. Bassett et al. provided case studies of a convenience sample consisting of five hospitals/health systems that attended the live case study and/or the first seminar held in November 2011. The convenience sample was chosen in advance of determination of their clinical outcomes and their enthusiasm of the process of culture change.

The IHI-RCC faculty noted that key barriers at the outset of the project were perceived lack of resources and equipment, fear of patients off sedation, and the belief that perfect protocols were needed to start the implementation process. Some of the common challenges described in making this culture change included a lack of leadership, lack of understanding regarding the clinical evidence, and lack of prioritization of these challenges to align necessary improvement resources (Bassett et al., 2015). Qualitative descriptions of the changes tested at each of the five case study sites included improvements in teamwork, processes, and reliability of daily work. Improvements in ICU length of stay and days on the ventilator between pre and post implementation periods varied from slight to substantial. In conclusion, the designers suggested that changing practices in critical care requires an interdisciplinary approach addressing cultural, psychological, and practical issues. Key lessons were (1) the importance of testing changes on a small scale, (2) feeding back data regularly and providing sufficient education, and (3) building will through seeing the work in action (Bassett et al.).

**Evidence of Mobilization of ICU Patients.** Brahmbhatt, Murugan, and Milbrandt (2010) conducted an opened label randomized clinical trial at two university hospitals with patients receiving sedation and mechanical ventilation. Participants included 104 mechanically ventilated patients in the ICU who received mechanical ventilation for less than 72 hours, were functionally independent prior to hospitalization, and were expected to continue in the study at least 24 hours after enrollment. The patients were randomized to receive both early exercise and mobilization (physical and occupational therapy) during periods of daily interruption of sedation (intervention; n=49) or interruption in sedation with therapy as ordered by the primary care team (control; n=55). The primary endpoint was return to independent functional status at hospital discharge defined as the ability to perform six activities of daily living and walk independently. The return to independent functional status at hospital discharge occurred in 29 (59%) patients in the intervention group compared with 19 (35%) patients in the control group (p=0.02; odds ratio 2.7 [95% CI 1.2-6.1]). Patients in the intervention group had shorter duration of delirium (median 2.0 days, IQR 0.0-6.0 vs 4.0 days, 2.0-8.0; p=0.02), and more ventilator free days (23.5 days, 7.4-25.6 vs 21.1 days, 0.0-23.8; p=0.05) during the 28-day follow-up period than did the control. Discontinuation of therapy occurred in 19 (4%) of all sessions and one serious adverse event occurred in the 498 therapy sessions that consisted of a desaturation to less than 80%. The researchers concluded that a strategy for whole body rehabilitation consisting of physical and occupational therapy in the earliest days of critical illness and interruptions of sedation was safe, well tolerated and resulted in better functional outcomes at hospital discharge, a shorter duration of delirium, and more ventilator-free days compared with standard care (Brahmbhatt et al.).

Mortality from critical illness is declining and the number of ICU survivors are growing. These ICU survivors commonly experience neuromuscular weakness that may be severe and prolonged particularly in mechanically ventilated patients that are often heavily sedated and on bedrest (Needham et al., 2010). Immobility plays an important role in the development of neuromuscular weakness and also contributes to the development of atelectasis, insulin resistance, and joint contractures. Needham et al. conducted a seven-month prospective before/after quality improvement project to 1) reduce deep sedation and delirium to permit mobilization, 2) increase the frequency of rehabilitation consultation and treatments to improve patients' functional mobility, and 3) evaluate effects on length of stay. The study took place at a 16-bed MICU in an academic hospital. The participants included 57 patients who were mechanically ventilated four days or longer. The intervention used was a multidisciplinary team focused on reducing heavy sedation and increasing MICU staffing to include fulltime physical and occupational therapists with new consultation guidelines. The main outcomes measured were sedation and delirium status, rehabilitation treatments, and functional mobility.

Post implementation of the quality improvement project demonstrated a marked decrease in benzodiazepine use. Patients additionally showed an increase in alertness and decreased delirium (MICU days alert [67% vs 30%, $P<.001$] and not delirious [53% vs 21%, $P=.003$]). There was a greater median number of rehabilitation treatments per patient (7 vs 1, $P<.001$) with a higher level of functional mobility, 78% VS 56%, $P=.03$) and a decrease in ICU length of stay by 2.1 (95% confidence interval: 0.4-3.8) and hospital length of stay by 3.1 (0.3-5.9) days. The researchers proposed that by using a quality improvement process in the ICU, physical rehabilitation and functional mobility were improved and delirium and length of stay decreased (Needham et al.).

Adler and Malone (2012) conducted a systematic review to evaluate the literature related to mobilization of the critically ill patient with an emphasis on functional outcomes and patient safety. Studies in the review included randomized and non-randomized clinical trials, prospective and retrospective analyses, and case series in peer reviewed journals. Fifteen studies met inclusion criteria and were reviewed. Inclusion criteria included prospective randomized trials, prospective cohort studies, retrospective analyses, and case series. The inclusion was further limited to articles that focused on adults and were published in English between January 1, 2000 and June 1, 2011. Studies were excluded if they were review articles, only studied nonmobility interventions, and/or described programs or protocols designed to promote early mobilization. Sackett's level of Evidence were used to rate the strength of the research process. The research was ranked from strongest to weakest using a five point scale.

According to Sackett's Level of Evidence, nine studies were level four evidence, one study was level three evidence, four studies were level two evidence, and one study was level one evidence. Ten studies pertained to functional outcomes and 10 studies pertained to functional outcomes with five of the studies fitting into both categories. This review found a limited number of studies examining the mobilization of critically ill patients in the intensive care unit. The three randomized control trials included a total of 171 patients limiting the strength of evidence. The literature reviewed supported improvements in functional mobility following early and progressive physical therapy/occupational therapy in the ICU but the measurement of this outcome was not uniform across the literature. Variability of outcome measurements included achievement of mobility milestones, Functional Independence Score (FIM), Functional Status Score in the ICU (FSS-ICU), and the Barthel Index. Mobility milestones, such as: out-of-bed transfers, a return to mobility baseline, greater unassisted walking and increased six minute walk test (6MWT), were accomplished earlier in the intervention group than the comparison group in four of the studies. In fact, one of these four studies found that over 59% of patients in the intervention group achieved functional independence compared to only 35% in the control group (Adler & Malone).

In a study by Winkelson et al. (2012) standard care was compared with care delivered using a mobility protocol. The setting was the medical surgical ICUs at a large, urban, academic medical center. The effects of exercise on vital signs and inflammatory biomarkers and the effects of the nurse-initiated mobility protocol on outcomes were examined. A prospective, repeated measures study was used with a control period (standard care), run-in period, and intervention period with protocol care. There were three phases of the study. During the control phase, 20 patients receiving standard care were observed and recorded. During the run in phase, five new subjects were enrolled, the intervention was refined for feasibility, and research assistants (RAs) were trained in the refined protocol. During the intervention period a consistent research protocol was implemented for 55 new subjects and outcomes were measured.

Seventy-five heterogeneous subjects enrolled in the study. A concerning alteration in respiratory rate or peripheral oxygen saturation occurred in less than 5% of the exercise periods. No other adverse events occurred. Participants enrolled in the intervention period had five fewer ICU days despite higher acuity than the control group. The finding suggested that the use of a protocol with a 20 minute episode of exercise daily for two or more days reduced ICU length of stay in this study. The duration of mechanical ventilation was not different between groups (p=.07). Duration of the exercise was linked to increase Interleukin 10, an anti-inflammatory cytokine, suggesting that implementing a mobility protocol can improve inflammatory dysregulation in patients with prolonged critical illness. In conclusion, the use of a mobility protocol promoted both earlier initiation and increased progression of exercise, avoiding clinician inertia and long periods of uninterrupted bedrest. This study suggests that a limited intervention of one 20-minute period of exercise daily for two or more days can demonstrate a significant reduction in ICU length of stay (Winkelson et al.).

Li, Peng, Zhu, Zhang, & Xi (2013) conducted a systematic review to investigate the effectiveness and safety of active mobilization on improving physical function and hospital outcomes in patients undergoing mechanical ventilation for more than 24 hours. Two reviewers independently selected potential studies according to the inclusion criteria and two reviewers independently extracted data and assessed the methodologic quality of the studies (Li et al.). Studies included met the following criteria: (1) adults aged $\geq$18y, at least 60% of whom were mechanically ventilated for 24 hours or more; (2) samples of randomized control trials (RCT), quasi-randomized control trials, other comparative studies with or without concurrent controls, and case studies with 10 or more consecutive cases; (3) active mobilization was conducted in an ICU or high dependency unit (HDU) setting. Among the 17 eligible studies, seven RCT's, one quasi-RCT, one prospective cohort study, and one history controlled study were used to examine the effectiveness of active mobilization. To examine the safety of active mobilization in patients receiving mechanical ventilation for more than 24 hours, two RCTs, one prospective cohort study, and seven case studies were examined.

In the systematic review, six studies compared muscle strength in mobilization groups with that in control groups. Muscle strength included respiratory muscle force and upper and lower limb force. Four of the six studies reported improvements on maximal inspiratory pressure in the mobilization group with only one study finding a significant difference in the mobilization group compared to the control group ($p<.050$) (Li et al.). Upper limbs muscle force was assessed in four of the studies with pre-post differences within the mobility versus the control group only found in two of the four studies. The studies reviewed in this systemic review support improvements in functional status after active intervention in ICU/HDU settings, however 40% of patients were not able to walk or required two or more assistants at four days after ICU discharge.

The measurement of functional status was not uniform throughout the studies with both the 6 minute walking distance (6MWD) and Activities of Daily Living (ADL) being used to assess functional status. Nine studies reported data for mechanical ventilation concerning weaning rate, ventilator-free time, and duration of ventilation. Three trials noted a significantly shorter duration of mechanical ventilation and ventilator-free time after active mobilization intervention. Seven studies provided ICU/HDU and total hospital length of stay (LOS) data. Five of the studies indicated no significant effect from active mobilization intervention on reducing ICU/HDU and total hospital LOS. There were two nonrandomized studies that found the LOS in the ICU or hospital were significantly shorter in the mobilization group than the control group. Of the seventeen trials in the review, 10 studies reported safety profile data and there were no serious adverse events with mobilization that required life saving measures. The researchers found that active mobilization improved muscle strength, functional independence, and the ability to wean from the ventilator and may decrease the length of stay in the ICU and hospital. Further research is needed to provide more robust evidence to support the effectiveness and safety of active mobilization (Li et al.).

A randomized control trial by Dong, Yu, Sun, and Li (2014) was conducted to investigate the feasibility of early rehabilitation therapy in patients with mechanical ventilation. Participants included 60 patients with tracheal intubation or tracheostomy for more than 48 hours but less than 72 hours. The patients were randomly divided into a rehabilitation group and a control group. In the rehabilitation group, rehabilitation therapy was performed twice daily, and included heading up actively, transferring from the supine position to sitting position, sitting at the edge of the bed, sitting in the chair, transferring from sitting to standing, and ambulating at bedside. Data collected included the patient's body mass index, days to first out of bed, duration of mechanical ventilation, length of ICU stay, Acute Physiology and Chronic Health Evaluation (APACHE II) score, highest FiO2, lowest PaO2/FiO2, and hospital mortality of patients.

The results showed no significant difference in body mass index, APACHE II score, highest FiO2, lowest PaO2/FiO2, and hospital mortality between the rehabilitation group and the control group ($P>0.05$). Patients in the rehabilitation group had shorter days to first out of bed ($3.8 \pm 1.2$ d vs. $7.3 \pm 2.8$ d; $P=0.00$), duration of mechanical ventilation ($5.6 \pm 2.1$ d vs. $12.7 \pm 4.1$ d; $P=0.005$) and length of ICU stay ($12.7 \pm 4.1$ d vs. $15.2 \pm 4.5$ d; $P=0.01$) compared with the control group (Dong et al., p. 48). The researchers concluded that early rehabilitation therapy was feasible and effective in improving outcomes of patients with mechanical ventilation (Dong et al.).

A prospective, multi-center, cohort study (The Team Study Investigators, 2015) was conducted in twelve ICUs in Australia and New Zealand to investigate current mobilization practice, strength at ICU discharge, and functional recovery at six months among mechanically ventilated ICU patients. The study included 192 patients that were previously functionally independent and expected to be ventilated greater than 48 hours. The researchers measured mobilization during invasive ventilation, sedation depth using the RASS co-interventions, duration of mechanical ventilation, ICU-acquired weakness (ICUAW) at ICU discharge, mortality at day 90, and six month functional recovery including return to work (The Team Study Investigators). Information was collected during 1,288 planned early mobilization episodes in 192 patients on mechanical ventilation for the first 14 days or until extubation (whichever occurred first) and the highest level of early mobilization was recorded (The Team Study Investigators).

No mobilization occurred in 1,079 (84%) of these episodes and when mobilization did occur the maximum levels of mobilization were exercises in bed (N=94, 7%), standing at the bed side (N=11, 0.9%), or walking (N=26, 2%) (The Team Study Investigators, 2015). On day three all patients that were mobilized were mechanically ventilated via an endotracheal tube (N=10), and by day five 50% of the patients mobilized were mechanically ventilated via a tracheostomy tube (N=18) (The Team Study Investigators).

In 94 of the 156 ICU survivors, strength was assessed at ICU discharge and 48 (52%) had ICU-acquired weakness (Medical Research Council Manuel Muscle Test Sum Score (MRC-SS) score <48/60). The MRC-SS score was higher in those patients who mobilized while mechanically ventilated (50.0 ± 11.2 versus 42.0 ± 10.8, P=0.003) (The

Team Study Investigators, 2015). In conclusion early mobilization of patients receiving mechanical ventilation was uncommon. More than 50% of patients discharged from the ICU had developed ICU-acquired weakness and 90-day mortality was high. Barriers to mobilization were reported mainly as intubation and sedation. Less than one third of survivors had returned to their previous work at six months (The Team Study Investigators).

A prospective feasibility parallel group assessor-blinded randomized clinical trial was conducted in five ICUs in Australia and New Zealand. The hospitals included tertiary teaching hospitals with a combination of mixed medical, surgical, and trauma beds (Hodgson et al., 2016). The trial took place between the dates of September 4, 2013 to October 3, 2014. Inclusion criteria for the study included patients that were expected to be invasively ventilated at least two days, were more than 18 years of age, and less than 48 hours had passed since eligibility criteria were met. Exclusion criteria included a second or subsequent ICU admission during a single hospital admission, unable to follow simple commands in English, unable to walk without assistance of another person prior to ICU admission, death was deemed inevitable by the ICU consultant, a diagnosis of dementia prior to current acute illness, bedrest orders due to a documented injury or process that precluded mobilization, and if the treating physician's opinion was that it was unsafe to mobilize the patient. In addition, daily assessments on patients were made and patients were excluded from eligibility that day if they were physiologically unstable (Hodgson et al., 2016).

Patients were randomly assigned in a 1:1 ratio to either early goal-directed mobilization (EGDM) beginning on the day of enrollment or to standard care with physiotherapy delivered as ordered by the primary care team (Hodgson et al., 2016). The EGDM protocol included active functional activities with the goal to maximize safe physical activity starting with the highest level of activity a patient can sustain and working down to maximize activity. The mobility team was defined as ICU clinical staff sufficient to provide the intervention while the EDGM team was led by physical therapy. Sedation was adjusted in the EGDM group to facilitate exercise at the highest level of activity possible using the ICU mobility scale (IMS). On the IMS scale a score of 1 or 2 indicated a very low level of mobility where an IMS score of 7-10 indicated a high level of mobility. The control group intervention did not have a protocol and all unit practice was continued with no restrictions on physical therapy or sedation practices (Hodgson et al., 2016).

The results of the study conducted by Hodgson et al. (2016) included 21 patients in the control group and 29 patients in the EGDM group for a total of 50 patients. Data that were recorded included the ICU mobility scale, strength, ventilation duration, ICU hospital and ICU length of stay as well as six month post ICU quality of life, activities of daily living, and anxiety and depression. The proportion of the amount of patients assigned to EGDM who walked in the ICU almost doubled $n$=19 [66%] compared to $n$=8 [38%]; $p$=0.05 for patients receiving standard care. There was no difference between the intervention and the control groups in total inpatient stay and there were no adverse events. Interestingly, at 6 month follow-up there were no differences between the groups for health-related quality of life, activities of daily living, return to work, or anxiety or depression. Although there was no statistical difference, Hodgson et al. concluded that

EGDM was feasible and safe and resulted in increased duration of active exercises and mobility milestones achieved while the patient was in the ICU.

## ABCDE Bundle

**Background**. Morandi, Brummel, and Ely (2011) reviewed recent evidence-based findings on the management of mechanically ventilated patients focusing on strategies that may improve neurologic and functional outcomes in critically ill patients. The researchers presented the evidence-based ABCDE bundle, an integrated and interdisciplinary approach to the management of mechanically ventilated patients. Critically ill patients often require mechanical ventilation and commonly receive sedatives such as benzodiazepines and opioids to ensure comfort and make lifesaving interventions more tolerable. Recent evidence has shown that the use of these sedative regimens can prolong mechanical ventilation, lead to delirium, and delay recovery from critical illness. Clonidine and dexmedetomidine are alpha-2 agonists that have been proposed as alternatives to GABA-agonist drugs for sedation in mechanically ventilated patients. Clonidine and dexmedtomidine work on the alpha-2 receptors to produce sedation without the effects of respiratory depression and have been shown to reduce ICU delirium and duration of mechanical ventilation. Intensive care unit-- acquired weakness affects 25-60% of critically ill patients and can prolong mechanical ventilation, hospital length of stay, and increases the likelihood of death. Choice of sedation, delirium monitoring, and early exercise and mobility can be combined to help prevent adverse consequences such as delirium and ICU acquired weakness (Morandi et al.).

In summary of the review, outcomes of critically ill patients can be improved by applying evidence-based therapies such as the ABCDE bundle to improve the management of mechanically ventilated patients. The evidence-based ABCDE bundle consists of awakening and breathing trial coordination, choice of sedatives and analgesics, daily delirium monitoring, and early exercise and mobility. The combination of therapies can increase liberation from the ventilator, increase earlier ICU and hospital discharge, increase return to normal brain function, increase independent functional status, and increase survival (Morandi et al.).

**Bundle Implementation**. Balas et al. (2013) identified facilitators and barriers to the ABCDE bundle adoption and further evaluated the extent to which bundle implementation was effective, sustainable, and conducive to dissemination. A prospective, before-after, mixed-methods study was conducted at five adult ICU's, one step-down unit, and a special care unit located in a 624 bed academic medical center. The researchers worked in collaboration with the participating institution to initiate an ABCDE bundle policy as their intervention. Over the course of an 18 month period, all ICU team members were offered the opportunity to participate in numerous multimodal educational efforts (Balas et al.). All full and part-time RNs (n=220), RTs (n=70), pharmacists (n=5), PTs (n=2), NPs (n=4), physician assistants (n=1), academic medical and/or surgical intensivists (n=17), and critical care fellows (n=9) were invited to participate in the research and implementation process. All individuals involved were 19 years or older, currently practiced in the aforementioned units, and were purposefully chosen because of their expertise and essential role in ABCDE bundle development (Balas et al.).

In order to identify facilitators and barriers to bundle adoption three focus group sessions, three online surveys, and one educational evaluation were administered. Factors that were found to facilitate bundle implementation included: 1) the performance of daily interdisciplinary rounds; 2) engagement of key implementation leaders; 3) sustained and diverse educational efforts; and 4) the bundle's quality and strength (Balas et al.). The barriers identified included: 1) intervention related issues; 2) communication and care coordination challenges; 3) knowledge deficits; 4) workload concerns; and 5) documentation burden (Balas et al.). The researchers identified clear factors that both advanced and impeded adoption of the intervention, which requires interprofessional education, coordination, and cooperation. The researchers proposed that focusing on these factors would enable a more effective and lasting implementation of the bundle and better care for critically ill patients (Balas et al.).

In another study by Balas et al. (2014), investigators evaluated the effectiveness and safety of implementing the ABCDE bundle into everyday practice. This study's design was an 18-month, prospective, cohort, before-after study conducted between November 2010 and May 2012. The setting included five adult ICU's, one step-down unit, and one oncology/hematology special care unit located in a 624 bed tertiary medical center. Two hundred ninety-six patients (146 pre- and 150 post- bundle implementation) participated in the study. Inclusion criteria was age greater than or equal to 19 years and institutional medical or surgical critical care service management. The intervention used was the ABCDE bundle. The goal of the study was to determine if implementing the ABCDE bundle would prove safe and effective if applied to every critically ill patient regardless of mechanical ventilation status. The measurement used for mechanically ventilated patients (n=187) was examining the association between bundle implementation and ventilator free days (Balas et al.). For all patients, regression models were used to quantify the relationship between ABCDE bundle implementation and the prevalence/duration of delirium and coma, early mobilization, mortality, time to discharge, and change in residence (Balas et al.).

Patients in the post-implementation period spent three less days breathing with mechanical assistance than did those in the pre-implementation period (pre median 21 days [interquartile range (IQR) 0 to 25] vs. post median 24 days [IQR 7 to 26]; *p*=0.04) (Balas et al.). After adjusting for age, severity of illness, gender, comorbidity, and mechanical ventilation status, patients managed with the ABCDE bundle experienced a 50% reduction in delirium (odds ratio [OR], 0.55; 95% confidence interval [CI], 0.33-0.93; *p*=0.03), and no significant differences were noted in self-extubation or reintubation rates (Balas et al.). Patients managed with the ABCDE bundle spent three more days breathing without assistance, experienced less delirium, and were more likely to be mobilized during their ICU stay than those patients that were treated with usual care (Balas et al.).

Liu et al. (2016), conducted a retrospective study of the practices and outcomes of three Kaiser Permanente Northern California (KPNC) ICUs before and after implementing the Rethinking Critical Care (RCC) performance improvement program. The RCC bundle components include 1) improving the recognition, prevention, and management of delirium; 2) minimizing the use of sedatives and the duration of mechanical ventilation; 3) increase the frequency of mobilization and ambulation of critically ill patients; and 4) optimizing coordinated care by multidisciplinary teams. The RCC program was implemented in the first facility in October 2011 followed by implementation in July 2011 and November 2012 in the remaining two sites. The primary outcome measured was hospital mortality among first time ICU patients admitted between January 1, 2009 and August 31, 2013. Eligible populations identified within the three sites included patients 18 years or older whose hospitalization included an overnight stay, began in a KPNC hospital, and were not peripartum care. The inpatient cohort was then identified as eligible if they were a patient's first ICU admission during a hospitalization and received ICU level of care. Patients whose primary reason for hospitalization was neurosurgical observation or treatment were excluded (Liu et al., 2016). Primary outcome measure was hospital mortality among first time ICU patients admitted between January 1, 2009 and August 31, 2013. Secondary outcomes included 30-day mortality, the duration of mechanical ventilation, and the length of ICU and hospital stay.

The total sample included 24,886 first ICU admissions occurring in 19,872 patients. Mean predicted hospital mortality based on the KPNC-calibrated eSAPS3 score was 9.3% ± 11.4% with the most common reason for hospitalization being sepsis (18.1%, $n$=4,452). Mortality decreased from 12.3% to 10.9% ($p$<0.01) before and after implementation. The adjusted odds ratio for hospital mortality after implementation was 0.85 (95% CI, 0.73-0.99) and for 30 day mortality was 0.88 (95% CI, 0.80-0.97). The mean duration of mechanical ventilation and hospital stay did not demonstrate incrementally greater declines after implementation of the RCC. Implementation of the RCC was associated with changes in practice and a 12-15% reduction in the odds of short-term mortality (Liu et al., 2016).

**Barriers to Early Mobilization**

The purpose of the study by Leditschke, Green, Irvine, Bissett, & Mitchell (2012) was to identify barriers to early mobilization by studying the frequency of early mobilization. A four week prospective audit of 106 patients admitted to a mixed medical-surgical tertiary ICU (mean age 60 $\pm$ 20 years, mean APACHE II score 14.7 $\pm$ 7.8) was conducted. Outcome measures included number of patients mobilized, type of mobilization, adverse events, and reasons for inability to mobilize. The results showed patients were mobilized on 176 (54%) of 327 patient days and adverse events occurred in 2 of 176 mobilization episodes (1.1%). On 71 (47%) of the 151 patient days that mobilization did not occur, potentially avoidable factors were vascular access devices in the femoral region, timing of procedures, and agitation or reduced level of consciousness. Reasons for not mobilizing patients with unavoidable factors include respiratory instability, hemodynamic instability, neurologic instability, and medical orders to rest in bed. Reasons for inability to mobilize in potentially avoidable factors include vascular access devices in a femoral position, timing of procedures, sedation management, and early ward transfer. Interventions that may allow more patients to mobilize include: changing the site of vascular catheters, careful scheduling of procedures, and improved sedation management (Leditschke et al.).

In summary, the review of the literature supports the early exercise and mobilization of mechanically ventilated patients. The benefits of early mobilization of critically ill patients include decreased days on the ventilator, decreased ICU and hospital length of stay, decreased mortality, and improvements in strength and functional status. The implementation of the ABCDE bundle is a combination of evidence-based therapies to minimize patient sedation, decrease delirium, and mobilize mechanically ventilated patients early in order to decrease the number of days on the ventilator and prevent functional decline and delirium of critically ill patients.  The purpose of this research study is to determine if a decrease in ventilator days occurred after the implementation of early mobility in ventilated patients.

Next, the theoretical framework that guided this study will be presented.

## Theoretical Framework

The theoretical framework used to guide this research project was Rogers' Diffusion of Innovation. According to Rogers (2003), diffusion is the process in which innovation is communicated through certain channels over time among the members of a social system. Communication is a process in which participants create and share information with one another in order to reach a mutual understanding. Diffusion is a special type of communication in which the messages are about new ideas both planned and spontaneous (Rogers).

There are four main elements in the Diffusion of Innovation that define diffusion as the process by which (1) an innovation (2) is communicated through certain channels (3) over time (4) among the members of a social system (Rogers, 2003). An innovation is an idea, practice, or object that is perceived as new by an individual (Rogers).  The innovation in this research project is the implementation of the ABCDE bundle. The second element of the diffusion process is the communication channel, which is how the information or messages get from one individual to another (Rogers). When the bundle was being implemented, the communication channels that were being used were education on the hospital's Net Learning and staff education sessions done by the Nurse Educator. Time is the third element of the diffusion process and is the passage of time necessary for the innovation to be adopted (Rogers). The time between the pre and post implementation of the ABCDE bundle is the time it took for the staff to be educated on the bundle and the time it took for staff to start implementing the early exercise and mobility protocol on mechanically ventilated patients in the bundle. The last element in the diffusion process is a social system, defined as a set of interrelated units that are engaged in joint problem solving to accomplish a common goal (Rogers). In order to implement the early exercise and mobility protocol, it takes an interdisciplinary team that includes the Critical Care Doctor, Registered Nurse, Respiratory Therapist, and the Physical and Occupational Therapists. The interdisciplinary team is the social system engaging in joint problem solving to accomplish the common goal of mobilizing mechanically ventilated patients.

Rogers (2003) defined five stages in the innovation-decision process. The first stage is knowledge. Knowledge is when the individual becomes exposed to an innovation's existence and gains information and understanding on how it functions. The second stage is persuasion which occurs when an individual forms a favorable or unfavorable attitude toward the innovation. Decision is the third step and occurs when an individual engages in activities that lead to a choice of whether or not to adopt or reject the innovation. Implementation is the fourth stage and occurs when an individual puts the new idea or innovation to use. The final stage is the confirmation stage. In the confirmation stage an individual seeks reinforcement of an innovation-decision already made, but may change their previous decision if they are exposed to conflicting messages about the innovation (Rogers).

The confirmation stage was the focus of the research study. This study attempted to demonstrate whether or not the implementation of the early exercise and mobility protocol in the ABCDE bundle decreased the number of ventilator days in mechanically ventilated patients. The purpose of the ABCDE bundle is to decrease the number of days a patient is on the ventilator by decreasing sedation, monitoring and managing delirium, and mobilizing patients early. The innovation-decision already made was the implementation of the ABCDE bundle. The confirmation that the bundle is effective is if there is actually a decrease in ventilator days.

Next, study methods will be reviewed.

# Method

## Purpose

The purpose of this research study was to determine if the implementation of a mobility protocol on critically ill patients decreased the number of ventilator days for patients who were on mechanical ventilation.

## Research Question

Does early mobility lead to decreased ventilator days?

## Design

The design for this study included a chart audit of pre and post implementation of the early exercise and mobility protocol of the ABCDE bundle. A retrospective chart review was conducted to determine if there was a difference in the amount of ventilator days for patients who are mechanically ventilated.

## Sample

The sample included randomly selected mechanically ventilated patients separated into two groups. Group A consisted of mechanically ventilated patients prior to the implementation of the ABCDE bundle and Group B consisted of mechanically ventilated patients post implementation of the ABCDE bundle. There were 350 potential subjects reviewed with 30 patients who met the inclusion criteria in Group A and 39 patients who met the inclusion criteria in Group B. The inclusion criterion was any mechanically ventilated patient eighteen years or older admitted to the ICU. At the study site, when a patient met the inclusion criteria, a physical therapy order was placed by the critical care team and that patient was seen and treated by physical therapy. Exclusion criteria was any patient that had a RASS (Richmond Agitation-Sedation Scale) score less than or equal to negative three, an oxygen saturation less than 88% for greater than five minutes, FIO2 greater than 60%, PEEP greater than ten, increases in vasopressor infusion, active myocardial ischemia, arrhythmias requiring administration of a new antiarrhythmic agent, therapies that restrict mobility such as an open-abdomen, and injuries in which mobility is contraindicated as with an unstable fracture. The inclusion and exclusion criteria identified were part of the policy for the ABCDE protocol at the site where the study was conducted.

**Site**

The research was conducted at a 247 bed acute-care hospital in the northeastern part of the United States with a 16 bed Intensive Care Unit.

**Procedures**

Permission from the Chief Nursing Officer at the site identified was obtained. The researcher obtained IRB approval from both Lifespan IRB and Rhode Island College IRB. Randomly selected medical records of 225 potential subjects were reviewed pre implementation and 125 post implementation of the ABCDE bundle for inclusion and exclusion criteria. The researcher identified the records by using the ICD-10 (International Classification of Disease Codes) for mechanical ventilation. The ABCDE was implemented after August 1, 2012 and before August 1, 2013. The dates used for pre implementation of the ABCDE bundle were August 1, 2011- August 1, 2012. The dates used for post implementation of the ABCDE bundle were August 1, 2013- August 1, 2014.

Data reviewed in the medical records office during regular office hours at the site were entered into an excel spreadsheet (Appendix A). The patient’s medical record numbers were recorded per IRB protocol to keep track of which records were reviewed and which records required review. All data obtained was stored on an encrypted flash drive and kept in a locked locker in the nurse's break room that only the researcher had access to. All data on the excel spreadsheet was destroyed upon completion of the retrospective chart review.

**Measurement**

A data collection tool designed by the student researcher was used based on literature and clinical experience. The data was collected on an excel spreadsheet, including the following data: patient age, ventilator days, ventilator day physical therapy was ordered, ventilator day patient was first mobilized, how many days patient was mobilized on the ventilator, and ICU length of stay (appendix A). Patient was considered mobilized if there was at least a progression to chair position and patient was able to perform active range of motion (ROM).

**Data Analysis**

Data were analyzed using descriptive statistics and mean, medium, and range were compared between the variables in Group A and Group B. Additionally the study variable ICU length of stay was examined pre and post implementation of the ABCDE bundle using independent group T-test.

Next, the results will be discussed.

## Results

A total of 350 medical charts were reviewed to obtain a cohort of 69 patients who had been mechanically ventilated in an ICU. Group A included 30 subjects (n=30) who were treated pre implementation of the ABCDE bundle and Group B included 39 (n=39) subjects who were treated post implementation of the ABCDE bundle. Data collected for both Group A and Group B included age, ventilator days, ventilator day physical therapy was ordered, ventilator day patient was first mobilized, how many days patient mobilized on ventilator, and ICU length of stay. The mean, median, and range was computed for all categories of data collected and then compared between the two groups. Table 1 summarizes the data collected in both Group A and Group B.

Table 1 *Comparison between Group A and Group B*

| | Age | Ventilator Days | Ventilator Day Physical Therapy Ordered | Ventilator Day Patient First Mobilized | How Many Days Patient Mobilized on Ventilator | ICU LOS |
|---|---|---|---|---|---|---|
| **Group A (pre implementation)** | | | | | | |
| Mean | 68.3 | 5 | 0 | 0 | 0 | 9.5 |
| median | 68.5 | 3 | 0 | 0 | 0 | 9.5 |
| range (min) | 33 | 2 | 0 | 0 | 0 | 3 |
| range (max) | 90 | 15 | 2 | 0 | 0 | 18 |
| **Group B (post implementation)** | | | | | | |
| Mean | 67.7 | 4 | 0.9 | 0.5 | 0.1 | 5.7 |
| median | 66 | 4 | 0 | 0 | 0 | 5 |
| range (min) | 42 | 2 | 0 | 0 | 0 | 3 |
| range (max) | 93 | 9 | 7 | 8 | 1 | 17 |

The age range in group A was between the ages of 33 and 90 with the mean age being 68.3. The mean number of ventilator days for Group A was 5 with the range being between 2 and 15. The mean day of physical therapy being ordered for Group A was 0, indicating the order for physical therapy was not placed. The maximum range of patients who were ordered physical therapy, was on ventilator day 2; however, the average amount of days that patients were mobilized in Group A was 0, meaning that the activity did not occur in the first two days. Overall in Group A the mean ICU length of stay was 9.5 days, ranging between a minimum of three days and a maximum of 18 days.

The age range in Group B was between the ages of 42 and 93 with a mean age of 66. The mean number of ventilator days for Group B was 4 with a range of 2 to 9. The mean for day that physical therapy was ordered for Group B was 0, which indicated that the activity was not ordered and therefore did not occur. The range for when physical therapy was ordered was ventilator day 0 to ventilator day 7.

The mean day that physical therapy was ordered was found to be slightly different between the two groups (0 and 0.9) respectively. Group A had 0 maximum amount of days a patient was mobilized on a ventilator while for Group B the maximum number of days was 1. The mean length of ICU stay was 5.7 days for Group B in comparison to Group A with a mean length of stay of 9.5 days. There was a significant difference found in the ICU length of stay pre implementation ($M=9.4$, $SD=4.4$) and post implementation ($M=5.7$, $SD=2.6$) of the ABCDE bundle for early mobility, $t\ (65) =4.3$, $p = 0.00005$.

Next, the summary and conclusions will be discussed.

## Summary and Conclusions

Prolonged bedrest in hospitalized patients leads to many complications including deconditioning, impaired mobility, and increased hospital length of stay (Drolet et al., 2013). Patients in critical care units on mechanical ventilation often are physically inactive for days to weeks due to the severity of their underlying illness in combination with the sedation administered during mechanical ventilation (Schweickert & Kress, 2011). Early mobilization in mechanically ventilated patients has many benefits including improvements in strength and functional status as well as decreased hospital and ICU length of stay (Schweickert & Kress, 2011). The Awakening and Breathing Coordination, Delirium Monitoring and Management, and Early Mobility (ABCDE) bundle is an evidence based approach to minimizing sedation exposure, reducing duration of mechanical ventilation, and managing ICU delirium and weakness to improve patient outcomes (Balas et al., 2013).

The purpose of this study was to determine if the implementation of an early exercise and mobility protocol on critically ill patients decreased the amount of ventilator days for patients who were on mechanical ventilation. The study was guided by Rogers' Diffusion of Innovation. A retrospective chart review was conducted at a 247 bed acute-care hospital with a sixteen bed ICU. A randomly selected sample of mechanically ventilated patients was separated into two groups. Group A was mechanically ventilated patients pre implementation of the ABCDE bundle and Group B was post implementation of the ABCDE bundle. In Group A 225 charts were reviewed for inclusion criteria, with 125 charts reviewed in Group B. The researcher designed a data collection tool based on literature and clinical experience which included patient age, ventilator days, ventilator day physical therapy was ordered, ventilator day patient was first mobilized, how many days patient was mobilized on ventilator, and ICU length of stay.

Group A had a final sample size of 30 patients (n=30) and Group B had a final sample size of 39 patients (n=39). The median amount of ventilator days for Group A was 3 with a range from 2-15 and the median amount of ventilator days for Group B was 4 with a range from 2-9. There were less average ventilator days in the pre implementation of the bundle group than post implementation group; however the maximum range of days on the ventilator was higher in the pre implementation group at 15 compared with only nine in the post implementation group. Both groups had a median of 0 days for how many days the patient was mobilized while mechanically ventilated and both groups had a zero for day physical therapy was first ordered and day patient first mobilized on mechanical ventilation. These findings indicated that the activity, mobility, did not occur. Although the LOS results are promising, it was hypothesized that the mechanically ventilated patient would be mobilized sooner and more often after implementation of the bundle which was not supported by the data. There was a significant difference found in the ICU length of stay pre implementation (M=9.4, SD=4.4) and post implementation (M=5.7, SD=2.6) of the ABCDE bundle for early mobility, t (65) =4.3, p = 0.00005. This finding suggested that implementation of the ABCDE bundle, and therefore early mobilization, may have an impact on ICU length of stay. Specifically, these results suggest that in this sample of ventilated patients who had the ABCDE bundle implemented earlier in their ICU admission, the average length of stay was shorter than for those that did not have the ABCDE bundle implemented.

The mean day that physical therapy was ordered was found to be slightly different between the two groups (0 and 0.9) respectively. Group A had 0 maximum amount of days a patient was mobilized on a ventilator while for Group B the maximum number of days was 1. Factors that could have contributed to patients not being mobilized more after implementation of the bundle could have been physicians not placing the physical therapy order, nurses not willing to assist with mobility or deferring physical therapy due to patient condition or tests, availability of physical therapy, and patient refusal of physical therapy. If a physical therapy order was placed on a Friday then the patient would not be evaluated by physical therapy until Monday, delaying patient care as well as contributing to miss opportunities since oftentimes patients would be extubated by the time physical therapy evaluated them. An explanation for the decreased length of stay in the post implementation group could have been the other aspects in the ABCDE bundle which included decreasing sedation or interruption in sedation, spontaneous breathing trials, and delirium monitoring.

The study was limited by factors such as incomplete or missing records, limited eligibility due to the exclusion criteria, and only using a one 16 bed ICU in a single hospital. Other factors in the ABCDE bundle could have contributed to the decrease in ICU length of stay post implementation of the bundle, which further research is needed to investigate. Also using the ICD-10 code for mechanical ventilation did not differentiate between patients that were on invasive versus noninvasive mechanical ventilation and it also was not able to distinguish whether or not the patients were admitted to the ICU, Coronary Care Unit (CCU), or the Surgical Intensive Care Unit (SICU). Patients on Bipap or admitted to either the CCU or SICU were not included in the study. No attempt was made to collect demographic data such as sex, race, ethnicity, or socioeconomic status and was not reflected in the data collected.

In summary, the data did not support the implementation of an early exercise and mobility protocol on mechanically ventilated patients decreasing the amount of ventilator days. These results suggest that implementation of the ABCDE bundle, and therefore early mobilization, may have an impact on ICU length of stay. Specifically, these results suggest that when ventilated patients are mobilized earlier in their ICU admission, the average length of stay may be shorter. More research needs to be done on how to effectively implement mobility protocols and also researching barriers to mobilizing mechanically ventilated patients.

Next, recommendations and implications for advanced nursing practice will be discussed.

## Recommendations and Implications for Advanced Nursing Practice

It is well documented that bedrest has adverse outcome for hospitalized patients. This is especially true for critically ill patients due to life support measures, invasive catheters, and mechanical ventilation. Advanced Practice Registered Nurses (APRNs) have the knowledge and expertise to apply evidence based practice to avoid adverse outcomes and improve patient care. The ABCDE bundle uses evidence based practice to prevent and treat ICU acquired delirium and weakness.

The APRN can use the evidence in the ABCDE bundle to help guide care when taking care of critically ill patients that are mechanically ventilated. The APRN can use his/her training to evaluate whether or not the patient is appropriate for early mobility and if they meet any exclusion criteria. When the patient is appropriate for early mobilization the APRN can confirm that physical therapy is ordered and implemented on the first day the patient is intubated to maximize the benefit of the intervention.

The APRN can also educate the staff on the benefit of early exercise by providing education material and in-services. Education would also include the mobility levels and when patients may or may not meet criteria for early mobility. The education provided would include doctors, nurses, nursing assistants, respiratory therapists, and physical and occupational therapists. The APRN can also assist in interdisciplinary collaboration to discuss barriers and concerns regarding implementation as well as evaluation of the early exercise and mobility protocol. Future research also could be done on other aspects of the ABCDE bundle and whether or not they have effect on ventilator days such as the spontaneous awakening trial where the RN stops sedation if they meet criteria.

The APRN can assist with broadening the early mobilization to not only invasive mechanical ventilation but non-invasive mechanical ventilation. While reviewing patients' charts for inclusion criteria more patients were using non-invasive mechanical ventilation as opposed to mechanical ventilation. These patients need to be mobilized as well to help prevent weakness and deconditioning. Further research can be done on patients using non-invasive mechanical ventilation and whether or not they are being mobilized and if it contributes to ICU or hospital length of stay and improved patient outcomes.

Recommendations for practice include having an order set for mechanical ventilation that includes mobility so it brings to the attention of the Licensed Independent Practitioner (LIP) the need for physical therapy in this patient population. Also having a 'tip sheet' available during rounds with a list of interventions and orders that need to be addressed daily on every patient that includes whether or not the patient is appropriate for early mobilization would be beneficial. Other recommendations include having a physical therapist that works strictly in the ICU and can facilitate early mobilization including off shift and on the weekends. The APRN along with the inter-disciplinary team can help facilitate the need for order sets using evidence based practice to help guide and change current practice for better patient outcomes.

This study indicates that future research be conducted at other tertiary hospitals to compare their pre and post implementation of the ABCDE bundle in regards to early mobilization and impact on outcomes, including length of stay. It may also be beneficial to compare different types of ICU's (medical, surgical, cardiothoracic, or cardiac) to see if the patient population and type of illness has an effect on criteria for mobilization and weaning off the ventilator in less time.

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# Appendix A

*Data Collection Tool*

## Group A

| Patient | Age | Ventilator Days | Ventilator Day Physical Therapy Ordered | Ventilator Day Patient First Mobilized | How Many Days Patient Mobilized on Ventilator | ICU LOS |
|---|---|---|---|---|---|---|
| 1 | | | | | | |

## Group B

| Patient | Age | Ventilator Days | Ventilator Day Physical Therapy Ordered | Ventilator Day Patient First Mobilized | How Many Days Patient Mobilized on Ventilator | ICU LOS |
|---|---|---|---|---|---|---|
| 1 | | | | | | |