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Improving compliance with the VitalGo Total Lift Bed to improve patient outcomes: A quality improvement study

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By

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Abstract

Background: Immobilization is frequently encountered in critically ill adult patients within the intensive care unit (ICU) leading to numerous, detrimental effects including increased hospital and ICU length of stay, increased ventilator days, and increased mortality. One measure to increase early mobility of critically ill patients at the University of Kentucky Chandler Medical Center (UKMC) is implementing the VitalGo Total Lift Bed (TLB). The TLB vertically tilts a secured patient upright from zero to 82 degrees, allowing immobile patients to benefit from early weight bearing therapy and early, progressive mobility in the confines of the bed. Despite implementation of the TLB, a discrepancy exists because the TLB protocol orders are placed for the patient however nursing does not adhere to the TLB protocol.

Objectives: The objectives were to examine adherence to the TLB protocol in the acute care, progressive care, and intensive care units at UKMC before and after a formal educational intervention; to examine the change in nursing knowledge of the TLB protocol before and after an educational intervention; and to identify associations between utilization of the TLB protocol and mobility, hospital length of stay, ICU length of stay, and ventilator days.

Methods: A 6-month retrospective chart review was performed on patients receiving TLB therapy from January 1, 2019 through June 30, 2019. One electronic medical record was analyzed. Formal education via a web-based training module was administered to registered nurses in July 2019. After the WBT intervention was completed, a 6-month post-intervention chart review was completed from August 13, 2019 to February 13, 2020. Three electronic medical records were analyzed.

Results: There was a statistically significant increase in nursing knowledge before and after an educational intervention (61.08% and 80.18%, respectively; $p<0.01$), indicating the educational

intervention was successful in increasing nursing knowledge. Due to the small sample size yielded in the chart review, it was not possible to quantitatively analyze the data for associations of adherence to the TLB protocol with mobility, ICU LOS, hospital LOS, ventilator days. **Conclusion:** This project demonstrated that there is a need for further education on mobility devices for nurses and other healthcare providers. Nurses and other members of the multidisciplinary team have the opportunity to benefit from education on early mobility devices as it pertains to their role in caring for patients and ultimately improving patient outcomes.

Key words: Early mobilization, verticalization, tilting, mobility

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Introduction

Critically ill patients admitted to the intensive care unit (ICU) have traditionally been placed on bed rest due to the complexity of their medical conditions (Clark, Lowman, Griffin, Matthews, & Reiff, 2013). Immobilization is frequently encountered in critically ill adult patients within the ICU leading to numerous detrimental effects, including increased hospital and ICU length of stay (LOS), increased ventilator days (Toccolini et al., 2015), and increased mortality (Hashem et al, 2016; Jolley et al, 2014, Rocca et al., 2016). Recent efforts to accomplish early mobilization for even the most critical patients within the ICU setting have been a priority. Early mobility protocols and guidelines, as well as in-bed mobilization devices, including robotic stepping and vertical tilting capabilities, have been implemented to decrease patient immobilization and thus improve patient outcomes.

Background

Review of the Literature

The traditional standard of care for the critically ill patient has been strict bed rest and heavy sedation to facilitate healing and restoration of health. Additionally, mobilizing critically ill patients has historically been viewed as an unsafe, complex task given the number of invasive lines, catheters, tubes, and monitoring devices involved in treatment; therefore, these patients were typically placed on bedrest (Perme & Chandrashekar, 2009). As a result, immobilization has been frequently encountered in critically ill adult patients. Historically, the detrimental effects of immobility on patient outcomes were considered unfortunate complications to being in the hospital and were believed to be secondary to the benefits thought to be preserving life.

However, recent research has shown that awake and mobile patients had better patient outcomes and that mobilizing them could be done safely despite previous misconceptions (Perme & Chandrashekar, 2009). Several studies in more recent years have found that immobility and prolonged bed rest can actually cause more harm to the patient, with the potential to lead to significant cardiovascular, respiratory, musculoskeletal, hematological, skin integrity, and cognitive complications in the already critically ill patient (Rocca et al., 2016; Toccolini et al., 2015). Immobilization can also lead to numerous harmful effects on patient outcomes, including increased hospital and ICU LOS, increased duration of mechanical ventilation (Toccolini et al., 2015), and increased mortality (Clark et al., 2013; Hashem et al, 2016; Jolley et al, 2014; Rocca et al., 2016). In addition, immobilization also leads to muscle weakness, affecting up to 60% of adult ICU patients (Toccolini et al., 2015).

Given the deleterious effects of immobilization, early mobility protocols and guidelines have been implemented in attempt to offset patient immobilization and improve patient outcomes. Designated early mobilization protocols in critically ill patients have led to many significant improvements in patient outcomes, one of which is a decrease in hospital LOS of 20-33% (Morris et al., 2008; Klein, Mulkey, Bena, & Albert, 2015). Additionally, early mobilization protocols have been associated with statistically significant reductions (20-36%) in ICU LOS (Morris et al., 2008; Klein et al., 2015; Lai et al., 2016). The possibility of bias exists in some of these studies, limiting the significance of findings, since blinding was not performed (Morris et al., 2008; Lai et al., 2016). While early mobilization protocols have decreased both hospital and ICU LOS, they have also been associated with significant decreases in mechanical ventilator days (Lai et al., 2016; Clark et al., 2013). Although results were significant in these studies, generalizability was compromised as they were performed in single facility settings,

limiting the extent that these findings can be applied in other settings (Klein et al., 2015; Lai et al., 2016; Clark et al., 2013). Finally, implementation of early mobility protocols have been successful in increasing earlier mobility via improved mobility scores (Morris et al., 2008; Klein et al., 2015).

Verticalization and Tilt Table Therapy

While the benefits of early mobility protocols are evident, mobilization of critically ill patients presents many barriers, including complexity, patient instability, presence of invasive lines and tubes, sedation levels, debility level, and limited staff availability. Furthermore, some patients are confined to their beds, limiting their ability to partake in early mobilization efforts out of bed. Even exercises that can be performed in bed do not counteract the adverse effects of bed rest (Perme & Chandrashekar, 2009). Verticalization or tilting immobile patients within the confines of their hospital beds is another means in which recent initiatives have been directed. Verticalization bypasses the adverse effects of bed rest and increases hemodynamic tone by shifting intravascular fluid away from the thoracic cavity and into the lower limbs, a phenomenon only achieved while standing (Perme & Chandrashekar, 2009; Toccolini et al., 2015). As a result, in-bed mobilization devices, including robotic stepping and vertical tilting capabilities, have been implemented to combat patient immobilization and thus improve patient outcomes, especially mobility and strength, level of consciousness, and pulmonary parameters.

Mobility and Strength

Two separate studies were performed evaluating the effect of tilt table therapy on mobility and strength. The first team of researchers performed a randomized controlled trial (RCT) at a single-center surgical ICU, and they found that while daily passive tilting via a tilt table did not have significant improvements on muscle strength compared to standard

rehabilitation (p=0.555), their results suggested faster muscle strength recovery within the tilt group (Rho=0.32, P= 0.015; Sarfati et al., 2018). In the second study, Solopova, Tihonova, Grsihin, and Ivanenko (2011) also evaluated the effects that early motor rehabilitation with utilization of a tilt table and functional electrical stimulation (FES) had on lower extremity motor function. They found that rehabilitation with the tilt table and FES therapy demonstrated a significantly greater increase in muscle strength and influenced mobility recovery when compared to the control group (Solopova et al., 2018). In addition, because the tilt therapy allowed for early verticalization and increased weight-bearing, more patients in the tilt therapy group were able to independently ambulate by the end of treatment (Solopova et al., 2018). Both studies were performed at single-center locations and had small sample sizes, jeopardizing the external validity of the results (Solopova et al., 2018; Sarfata et al., 2018).

Level of Consciousness (LOC)

Three studies were performed evaluating the effect of tilt table therapy on LOC. In an RCT evaluating the effectiveness of tilt table therapy with or without stepping device on LOC in minimally conscious or vegetative state patients, Krewer, Luther, Koenig, and Müller (2015) found that conventional tilt table therapy yielded a greater increase in the Coma Recovery Scale-Revised (CRS-R) from baseline to week 6 when compared to tilt table therapy with stepping device (Erigo; U-test; U=122.0, z=-2.824, p=0.005, r=-0.42). Another study performed in a general adult ICU also showed that after daily passive tilting, there were significant improvements in the Glascow Coma Scale of mechanically ventilated patients from the first to last day of the intervention [30 degree tilt (p=0.019), 45 degrees (p=0.003), and 60 degrees (p=0.007)], suggesting that tilt table therapy may lead to improved LOC (Toccolini et al., 2015). In a third RCT performed in a Neurology ICU in Italy, Frazzitta et al. (2016) compared the

effects of conventional physiotherapy care to a tilt table with a stepping device on neurological outcomes. This study showed that the group of patients treated with the tilt table with stepping device saw a greater improvement in their neurologic scores than those who received standard physiotherapy (p=0.006; Frazzitta et al., 2016). While all results were significant in determining that tilt table therapy increases LOC, limitations of all of these studies included limited external validity due to single-center studies and small sample sizes (Krewer et al., 2015; Toccolini et al., 2015; Frazzitta et al., 2016).

Pulmonary

One team of researchers investigated the effect of passive tilting on ventilated patients' gas exchange and ventilatory parameters, including tidal volume (Vt) and minute ventilation (Ve). They found that when standing with the assistance of the tilt table, there was a significant change in Ve (P<0.001), respiratory rate (P<0.001), and Vt (P=0.16) without significant changes to gas exchange parameters (PaO2 and PaCO2; Chang, Boots, Hodges, Thomas, & Paratz, 2004). While there were no statistically significant adverse changes in gas exchange with passive tilting, the transient increase in ventilatory parameters may suggest that tilt table therapy is effective in increasing ventilation and assisting in the prevention of pulmonary complications (Chang et al., 2004).

Barriers to Tilt Table Therapy

While evidence supports early mobilization efforts with tilt table therapy to improve patient outcomes, one potential barrier to its successful implementation is that caregivers and providers may hesitate to adopt and adhere to the tilt table protocols. The traditional view was for ICU patients to remain on bed rest until discharged from the ICU, for fear of harming the patients or dislodging invasive tubes and lines while mobilizing, especially for patients being

mechanically ventilated (Arnold, Combs, Gach, & Labreche, 2015). Despite these fears, evidence has shown that it is safe, feasible, and a generally well-tolerated method of mobilization, even for critically ill patients to be mobilized with tilt table therapy (Rocca et al., 2016; Sarfati et al., 2018; Frazzitta et al., 2016; Arnold et al., 2015).

Effectiveness of Web-Based Training Education

Because recent studies confirmed the safety and benefits of tilt table therapy on patient outcomes, UKMC implemented use of the TLB, a tilt table bed, and an associated protocol for use in the inpatient population. However, there was only a nursing practice guideline released for nurses to reference when the TLB was first implemented. There is a discrepancy between the TLB protocol being ordered for the patient and appropriate use of the protocol. This discrepancy is believed to be the result of not effectively educating bedside nursing staff on the TLB and the TLB protocol.

Effectively delivered education can bridge the gap between current and evidence-based practice, which influences providers' knowledge and thus patient outcomes (Maloney et al., 2011). Web-based training (WBT) is a technological approach to distance learning that allows learners to access educational materials via computer, intranet, or internet at their own pace and at whatever time is convenient to them. Education delivered in the traditional face-to-face manner presents many barriers, including, but not limited to time constraints, access, and cost (Schoo, Stagnitti, Mercer, & Dunbar, 2005; Curran, Fleet, & Kirby, 2006). With emerging digital technological advances, WBTs provide an alternative learning method for healthcare professionals that not only eliminates these potential barriers, but also has the advantage of being more convenient, accessible, flexible, feasible, and time-saving (Álvarez-Nieto et al., 2018; Forbat, Robinson, & Bilton-Simek, 2018; Wu, Chan, Shing Tan, & Wang, 2018). In addition,

evidence from a systematic review supports that WBTs are just as effective, if not superior, to traditional learning at increasing nursing knowledge and acquisition of skills, further reinforcing WBTs as an effective educational alternative (George et al., 2014).

Purpose

There have been recent efforts to increase early mobilization and verticalization of patients within the ICU setting to offset the detrimental effects of immobility. Tilting or verticalization of immobile patients has shown to decrease the adverse effects of immobilization, increasing weight-bearing, ventilation, and level of consciousness (Sarfati et al., 2018). One measure to increase early mobility of critically ill patients at the University of Kentucky Chandler Medical Center (UKMC) is the VitalGo Total Lift Bed (TLB), which vertically tilts a secured patient upright from zero to 82 degrees, allowing even immobile patients to benefit from early weight bearing therapy and early, progressive mobility in the confines of the bed (Sarfati et al., 2018).

Despite implementation of the TLB and its evidence-based benefits, a discrepancy exists between the TLB protocol orders being placed for the patient and nursing adherence with the TLB protocol- lifting the patient with the specified frequency per day and complying with the appropriate documentation. Therefore, patients are not receiving the intended benefits from the TLB therapy. Upon initiation of the TLB at UKMC, a nursing guideline was developed addressing the lifting procedure, indications, contraindications, goals of therapy, care of the patient during tilting, and documentation requirements. However, no formal education was provided to bedside nurses caring for patients on the TLB, resulting in limited compliance with the TLB protocol and, ultimately, no improvement in patient clinical outcomes.

Despite the evidence that supports the benefits of tilt table therapy for critically ill

patients, there has been little research examining its effects on certain outcomes. While multiple studies have demonstrated that verticalization and tilt table therapy have improved patient strength, mobility, and LOC, there are limited studies evaluating the effect of tilt table therapy on ICU LOS, hospital LOS, and ventilator days.

Therefore, the specific aims of this project were to:

1. Examine any change in the adherence to the TLB protocol before and after an educational intervention
2. Examine any change in nursing knowledge regarding the TLB protocol before and after an educational intervention
3. Examine any change in mobilization at the start of TLB use, at the end of TLB use, and at the time of hospital discharge
4. Identify the associations between use of the TLB protocol and hospital LOS, ICU LOS, and ventilator days.

Theoretical Framework

Graham's Ottawa Model of Research Use was the planned change model that assisted in this implementation strategy and helped guide the process of transforming research into practice (Graham & Logan, 2004). The model focuses on six specific steps that aid in implementation of the change: setting the stage, specifying the intervention, assessing the innovation (including potential adopters and the environment for barriers and facilitators), selecting and monitoring the knowledge translation strategies, monitoring the adoption of the change, and evaluating outcomes of the implementation. One premise of the Ottawa Model of Research Use is that there is a dynamic and interactive relationship between research and transforming evidence into knowledge. Research and transforming evidence into knowledge are also affected by external

forces such as society and the healthcare setting (NCCMT, 2010). Furthermore, because health outcomes are the priority in evidence-based practice, emphasis on patients and how they are affected is a central component of the implementation of a practice change (NCCMT, 2010).

Agency Description

Setting

The University of Kentucky Chandler Medical Center (UKMC) is a 945-bed academic teaching hospital and level-one trauma center hospital located in Lexington, Kentucky. There are eight ICUs with a cumulative 124 ICU beds in the hospital. The ICU nurses provide the vast majority of their ICU patient care in either 1:1 or 1:2 nurse-to-patient ratios. At the end of fiscal year 2019, there were a total of 776 registered nurses who were employed in acute, progressive, and ICU areas. Each patient is chiefly managed by their primary admitting service, consisting of various combinations of attending physicians, resident physicians, nurse practitioners, and physician assistants. Patient care is also provided by other healthcare professionals on the multidisciplinary team, including nursing care technicians, physical therapists, and respiratory therapists. The patient population within this hospital varies, but includes neurological, neurosurgical, trauma, surgical, cardiovascular and thoracic, and medicine patient populations. UKMC also has a full emergency department and children's hospital; however, these areas of the hospital were excluded from this study.

Target Population

Candidates eligible for the pre-intervention chart review portion of the study selection included any adult patient 18 years and older admitted to any ICU, progressive, or acute care floor at UKMC who had an order placed for the VitalGo TLB between January 1, 2019 and June 30, 2019 (see Table 1). Inclusion criteria for the prospective chart review portion of the study

was the same as the pre-intervention portion, except it included patients who had an order for the VitalGo between August 13, 2019 and February 13, 2020, which was after bedside nurses completed a formal, web-based training module. This study excluded inpatients receiving hospice or comfort only care and any patients for whom use of the TLB was contraindicated. The target population of nurses to receive the web-based training module on the TLB included dayshift and nightshift bedside registered nurses employed in any of UKMC's ICUs, PCUs, or acute care floors. Emergency department, pediatric, and neonatal nurses were excluded.

Congruence with Organizational Values

One of UKMC's recent organizational goals supports growth in complex care, including increased collaboration among the multidisciplinary team and development of new models of care. This project is congruent with that goal and with UKMC's strategic plan. The TLB represents a new model of care to promote early mobilization, and implementation of this protocol will require multidisciplinary collaboration. Congruent to UKMC's mission and vision, implementation of this project provided commitment to research, education and advancement of clinical care in order to optimize patient outcomes.

Description of Stakeholders

Patients at UKMC have the potential to glean the most benefit from increased nursing adherence to the TLB protocol, as it has the potential to directly impact patient outcomes. Bedside nursing staff at UKMC are also essential stakeholders in this project, as they were the target of the educational interventions. Additionally, bedside nurses were essential as they could recommend the TLB use to providers, tilted the patients, and were responsible for documenting each patient tilt for the manual chart review. Physical therapists are stakeholders in this study, as they assist in mobilizing patients at UKMC within the ICU. Their role in this study is to

collaborate with providers regarding the appropriateness of TLB therapy for patients on a case-by-case basis. Finally, UKMC's providers were instrumental to this project as they placed the order for the TLB and collaborated with physical therapists to determine which patients were appropriate for TLB therapy.

Project Design and Methods

Description of Evidence-based Intervention

An optional pretest (Figure 1) was available for all ICU, PCU, and acute care registered nurses to take to determine baseline level of knowledge regarding the TLB and TLB protocol. Formal education on the TLB in the form of a WBT module was implemented for registered nurses to review and complete. Dissemination of a web-based educational intervention included detailed information on the TLB policy, goals of TLB use, nursing role in use of the TLB, indications and contraindications of the TLB, tilting procedure, and appropriate documentation regarding TLB use (including documenting the degrees tilted, pounds of weight bearing, duration of tilt, and patient tolerance). The WBT took approximately twenty minutes to complete and nurses knew ahead of time of the time commitment. An optional posttest was available for all registered nurses to take after completing the WBT. The pretest and posttest were identical and comprised of six multiple choice questions pertaining to the TLB and TLB protocol. Each pretest and posttest took approximately three minutes to complete.

IRB Approval

IRB approval was obtained prior to implementation through the University of Kentucky. A waiver for the informed consent process was obtained since there was no more than minimal risk to the patients who participated in the pretest and posttest. Informed consent was obtained

for the nursing portion of the study via a cover letter distributed along with the pretests and posttests.

Procedure

A six-month retrospective chart review was completed on one patient who received TLB therapy from January 1, 2019 through June 30, 2019. Demographic data collected included age, gender, body mass index (BMI), and ethnicity. Additional data collected included albumin level, daily progression of mobility scores, ICU LOS, hospital LOS, ventilator days (if applicable), admitting diagnosis, and comorbidities. Regarding adherence to the TLB protocol, additional data regarding number of tilts completed per day, maximum angle of each tilt, duration of each tilt, and vital signs were also collected for each patient.

An optional pretest (Figure 1) was sent to all ICU, PCU, and acute care UKMC nurses to determine their baseline level of knowledge regarding the TLB and TLB protocol. A total of 174 nurses, which was a 22% response rate, completed the pretest. The pretest did not have any identifying information regarding the nurse. The pretests concluded before implementing formal education in July 2019.

Formal education via a WBT module was provided to registered nurses in July 2019. After formal education was provided to nurses, an optional posttest with the identical questions as the pretest (Figure 1) was sent to nurses to determine their level of knowledge. A total of 148 nurses (19% response rate) completed the posttest. After the WBT intervention was completed, a six-month post-intervention chart review was completed on three patients from August 13, 2019 until February 13, 2020. The same patient data was collected on this post-intervention group as was collected on the pre-intervention group.

Measures and Instruments

The primary outcome assessed was progression of patient mobility at the start of TLB use (T0), the end of TLB use (T1), and the time of hospital discharge (T2). Mobility was assessed by utilizing the UK HealthCare Mobility Scale, an evidence-based, ordinal mobility scale ranging from 0 to 5 that can be utilized for patients in the ICU, PCU, and acute care settings and is further outlined within the nursing care guideline #gNU-51 and in Table 2. The UK HealthCare Mobility Scale is an evidence-based, ordinal scale ranging from one to five (one being most immobile, while five is most mobile) that is utilized in all patient care areas to assess patient mobility level. The reliability, construct and predictive validity of this mobility scale supports the use in measuring daily mobility level (Tipping et al., 2016). Secondary outcomes included ICU LOS, hospital LOS, and ventilator days. Additional data obtained from the electronic medical records included age, gender, BMI, albumin level, admitting diagnosis, and comorbidities. The Charlson Comorbidity Index was used to predict a patient's ten year mortality rate based upon the range of comorbidities that were present. Demographic and clinical data were manually extracted from UKMC's electronic medical record, Sunrise Clinical Manager (SCM), by UKMC's CCTS personnel.

Nursing adherence to the TLB protocol was determined by assessing if the patient received the ordered number of tilts per day and if the maximum degrees tilted, the duration of the tilt, and vital signs were documented in SCM within the TLB parameters (see Figure 2). To be considered "adherent" to the TLB protocol, the patient needed to meet all of these criteria.

The pretest and posttest each consisted of the same six multiple choice questions listed in Figure 1. The selected test questions were a complete and representative sample of the content

and skills to be learned from the formal education intervention, supporting the instrument's content validity.

Data Analysis

Data analysis was conducted utilizing SPSS. An alpha level of 0.05 was utilized to determine all statistical tests' significance. Descriptive statistics, including means and standard deviations, were used to present and summarize subject demographic characteristics and quantitative data. Inferential statistics were utilized to compare mean mobility scores (at T0 and T2), ICU LOS, hospital LOS, and ventilator days before and after formal education with WBT. The Chi-Square test of association was used to compare nursing knowledge before and after the educational intervention.

Results

Demographic characteristics and information, including age, gender, ethnicity, BMI, comorbidities, admitting diagnoses, and albumin are summarized in Table 3 for every patient included within this study. One patient met the criteria for the pre-intervention group and three patients were included in the post-intervention group. The pre-intervention and post-intervention groups were well matched in age, BMI, comorbidities, ethnicity, and albumin level. However, because of the small sample size and only one patient was included in the pre-intervention group, it was not possible to perform statistical analysis for between group differences.

During the course of this study, an unforeseen incident occurred while a patient was receiving TLB therapy, which led to a temporary, hospital-wide suspension of its use at UKMC. After the TLB suspension, patients instead were ordered the MOTOmed® Letto2 and, later, the MOTOmed Viva2 bike to assist in early mobility efforts. Because of the suspension of the TLB, it is difficult to discern if more patients would have been included in this study or not.

Nursing Knowledge

Table 6 reports the nursing knowledge outcome variables assessed before and after implementation of the educational intervention. A total of 174 nurses completed the voluntary, anonymous pretest (a response rate of 22.4%) and 148 nurses completed the posttest (a 19.1% response rate). Individual questions as well as overall test scores were evaluated before and after the educational intervention. The overall test scores of the pretest and posttest, respectively, were 61.08% and 80.18% ($p<0.001$). The three individual questions that scored the lowest on the pre-test (#3, #4, and #5) all had statistically significant increases in scores after the educational intervention ($p<0.001$). This indicates there was a gap in knowledge and an opportunity for education in these areas prior to implementation of the WBT.

Nursing Adherence

Nursing adherence to the TLB protocol before and after the educational intervention is summarized in Table 5. Between nursing and Physical Therapy, the patient in the pre-intervention sample received TLB therapy for a four-day duration and was tilted once a day on average, for a total of four total tilts. Of the four documented tilts, nursing performed and documented one tilt over the course of the patient's four-day TLB treatment, for an average of 0.25 patient tilts per day. Physical Therapy performed and documented the remaining three tilts within their therapy notes. The maximum degree and duration of tilt were charted according to protocol in the one tilt nursing performed in the pre-intervention patient. However, vital signs were not charted and the patient was not tilted the minimum frequency per day. Therefore, the patient's overall care was not entirely adherent to the TLB protocol.

In the post-intervention group, the three patients were tilted eight times between nursing and Physical Therapy. Seven of the cumulative eight tilts were performed and documented by

nursing (87.5%) while Physical Therapy performed and documented the remaining tilt (12.5%). The average tilts per day performed solely by nursing averaged 1.33 among the post-intervention sample (SD=0.47). Of nursing's seven documented tilts, five (71.4%) were adherent to the TLB protocol with appropriate documentation of maximum degree, duration, and vital signs. The documentation requirements that were not fulfilled per protocol in the remaining two nursing tilts were the duration of tilt and the vital signs.

Patient Outcomes

Mobility outcomes are summarized in Table 4. Mobility of the pre-intervention patient did not change at the three measured time periods of this study; remaining at a level 2/5 at T0, T1, and T2. Overall within the post-intervention group, there was more progression in mobility, with mobility scores increasing from a level 1.67 at the beginning of TLB therapy, to a level 2 at the end of therapy, and a level 2.67 at hospital discharge. However, given the small sample sizes, these differences in mobility levels between groups has limited applicability since statistical significance could not be established.

The remaining patient outcome variables, including hospital LOS, ICU LOS, and ventilator days, are summarized in Table 4 as well. All patients within the pre-intervention and post-intervention required ICU admission and were mechanically ventilated at some point throughout their hospitalization. Unfortunately, this study was unable to determine statistical significance of these variables between the two study groups since there was only one patient in the pre-intervention group.

Discussion

The pretest and posttest results indicate that there was a gap in knowledge and a need for education on early mobility devices. Furthermore, these results reveal that the educational

intervention implemented at UKMC was successful in increasing nursing knowledge. The statistically significant increase in overall test scores after the educational intervention coupled with the volume of nurses that chose to participate in the optional pretest and posttest, demonstrate that nurses are motivated, have the desire, and are eager to learn about early mobility modalities. It is encouraging and promising that nurses have an ambition to learn. This will prove to be beneficial in future opportunities where gaps in knowledge arise, requiring educational intervention.

Because of the small patient sample sizes, the patient outcome data extracted from the chart review revealed limited information, had limited strength, and, therefore, statistical significance could not be concluded. While progression of mobility remained static in the pre-intervention group and appeared to progress throughout the three-time measurements in the post-intervention group, the sample sizes were too small to have any statistical significance and draw any conclusions.

A cost analysis was performed to determine the potential impact that early mobility devices could have on an average patient admitted to one of UKMC's ICU's. UKMC rents two early mobility devices available for use for $120 each. The average ICU LOS is 6.07 days and the ICU room and board charge is $6,428 per day. Given this information and based upon the research findings of a potential 20-36% reduction in ICU LOS that early mobility devices cause, UKMC could have a potential savings between $849,000 and $1,598,000 per year in ICU room and board costs (Morris et al., 2008; Klein et al., 2015; Lai et al., 2016). Despite the transition to MOTOmed bikes, it can be deduced that similar cost savings can be expected with the use of this device as with the TLB. However, providers and nurses would need to ensure the mobility devices are being utilized to their full potential in order to see full patient benefits and cost

savings.

A secondary finding that this study yielded was there was underutilization of early mobility devices. Given the sample sizes generated with this study, one plausible explanation is that ordering providers are unaware or lack understanding of the potential benefit that mobility devices have on patient outcomes. Since the current focus in healthcare today is steered toward preventative efforts for patients, providers educating and familiarizing themselves with early mobility interventions should be a priority.

Implications for Future Nursing Research

This project provided the initial introduction of education regarding early mobility devices to bedside nursing staff, therefore, there are multiple areas of opportunities for future studies. For example, providing educational interventions geared specifically to ordering healthcare providers regarding the indications, utility, and benefits of early mobility devices that are available, including the MOTOmed® bikes, would aid in increasing awareness. This would subsequently lead to a greater number of patients benefiting from early mobility devices' use. Since this study revealed that education was successful in increasing nursing knowledge and nurses are motivated to learn, another formal educational intervention in the form of a WBT detailing the use of the newly adopted MOTOmed® bikes should also be implemented to nurses. Additionally, it is important to empower nurses to recommend early mobility devices to an ordering provider if they see a potential benefit for their patient. Therefore, future research should also incorporate providing supplementary education reiterating nurses to prompt and recommend mobility therapies to providers.

UKMC currently utilizes the MOTOmed® Letto2 and Viva2 stationary bikes as alternative early mobility devices for inpatients. These bikes have the ability to actively or

passively train bilateral upper and lower extremities from either a chair or lying supine in a hospital bed. The Viva2, specifically, is equipped with biofeedback and training games programed to motivate patients during therapy. Performing a study evaluating the efficacy of these bikes would be beneficial as to ensure they have beneficial and comparable effects on patient outcomes as other early mobility devices.

In regard to delivering future education, nursing staff and providers could be offered supplementary interventions in addition to a WBT to enhance knowledge. Face-to-face educational sessions would allow for any unresolved questions from a WBT to be answered and addressed appropriately. Placing chart reminders or visual mobility cues at the bedside and where nurses frequently chart may help remind nurses to engage their patients in the available mobility devices.

Conducting a qualitative study to identify nurses' rationales for not engaging patients in early mobility efforts and reasons preventing nurses from documenting appropriately may provide further insight into how to address the discrepancy. This study approach might also allow for further understanding of any perceived barriers that exist for nursing or providers regarding execution and ordering of early mobility interventions. Incorporating an open-ended question within any future pretest and posttest asking for any additional educational requests may also be beneficial.

Limitations

This study had various limitations that impede the generalizability of the results. The first limitation is the small sample sizes in both the retrospective and prospective portions of the chart review. One explanation for this could be attributed to the unexpected incident that led to hospital-wide suspension of the TLB at UKMC during the course of the study. It is difficult to

discern if more patients would have been included in this study or not had it not been suspended. Small samples sizes also could have been a result from underutilization and under-recognition of available mobility devices from the provider role. The small sample sizes prevented quantitative analysis to be completed on patient outcomes and decreased external validity and strength of the evidence. In addition, this study was only completed in one hospital setting, further limiting the extent to which the results can be applied to other settings. However, this specific limitation was anticipated given this study was intentionally conducted at UKMC alone. Future studies implemented at multisite locations with larger sample sizes would help increase statistical significance of the study results. Future studies, such as a longitudinal study, would help increase the validity of the results.

In addition, the accuracy of this study's retrospective and prospective chart review was highly dependent upon the documentation skills of the nurse caring for the patient. Therefore, there is no way to distinguish whether each patient received the adequate frequency of tilts per day and it simply was not documented, or if the patient in fact did not receive the ordered number of tilts per day.

Conclusion

Research indicates that designated early mobility protocols improve patient outcomes. This project demonstrated that there is a need for education for nurses and other healthcare providers in regard to the early mobility devices. Nurses and other members of the multidisciplinary team have the opportunity to benefit from further education on mobility devices as it pertains to their role in caring for patients and ultimately improving patient outcomes dramatically.

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Tables

Table 1. Inclusion and Exclusion Criteria for the Study

Patient Inclusion Criteria: •Admission to an adult acute care, progressive care or ICU at UKMC •Order placed by a physician for the VitalGo TLB •Aged 18 years and older **Patient Exclusion Criteria:** •Receiving hospice or palliative care •Contraindications to TLB therapy: •Patients who are non-weight bearing on lower extremities •Untreated DVT •Active hemorrhage •Systolic blood pressure outside goal of 20 mmHg sustained for 10 minutes •Heart Rate >20 beats per minute outside goal sustained for 10 minutes •Intracranial pressure >20 mmHg sustained for 5 minutes if applicable
Nurse Inclusion Criteria: •Bedside adult acute care, progressive care, or ICU nurses •Dayshift and nightshifts •Employed at the University of Kentucky Chandler Medical Center **Nurse Exclusion Criteria:** •Emergency department registered nurses •Pediatric and neonatal registered nurses

Table 2. University of Kentucky Chandler Medical Center Mobility Score

Mobility Score	Description
Unable to Assess	Patient completely immobile or prone
Unable to Assess	Patient sleeping
Unable to Assess	Patient in procedural area
Unable to Assess	Patient having or recovering from procedure
1	Unable to sit supported with HOB at 45 degrees for less than 10 minutes
2	Able to sit supported with HOB at 45 degrees >10 minutes; up with lift
3	Able to sit unsupported and lift arms
4	Can stand at bedside and pivot to chair with assistance
5	Minimal Assist- Ambulates in room or hallway with assist as needed

Table 3. Patient Demographic Characteristics

	Pre-Intervention	**Post-Intervention**
Age, years Mean (SD)	64	64.67 (4.0)
Gender, No. (%)		
Male	1	2
Female	0	1
Ethnicity		
Caucasian/Non-Hispanic	1	3
African American	0	0
Asian/Pacific Islander	0	0
Hispanic/Latino	0	0
Native American/Native Indian	0	0
Admitting Diagnosis		
Medical	0	2
Cardiac (nonsurgical)	0	0
Neurologic	1	0
Surgical	0	1
Comorbidities,		
Charlson Index, Mean (SD)	4	3.67 (0.58)
10yr Survival Probability, Mean (SD)	53.39%	61.42% (13.91)
Body Mass Index (BMI), Mean (SD)	33.97	29.65 (8.19)
Albumin level (g/dL), Mean (SD)	2.82	2.43 (0.33)

Table 4. Patient Outcomes Summary

	Pre-intervention (n=1)	**Post-intervention (n=3)**
Mobility **T0- at start of TLB use** **T1- at end of TLB use** **T2- at time of hospital discharge**	 2 2 2	 1.67 2 2.67
ICU Length of Stay, Mean (SD)	27.26	19.36 (11.58)
Hospital Length of Stay, Mean (SD)	29.93	25.96 (2.49)
Ventilator Days, Mean (SD)	23.88	18.22 (0.90)

Table 5. Nursing Adherence to Total Lift Bed Protocol Summary

Outcome	**Pre-intervention (n=1)**	**Post-intervention (n=7)**
Average Nursing Tilts per day	0.25	1.33 (0.47)
% of Tilts in which Nursing was Adherent to TLB Protocol	0% (0/1)	71.4% (5/7)
RN documents maximum degree of tilt	100% (1/1)	100% (7/7)
RN documents duration of tilt	100% (1/1)	85.7% (6/7)
RN documents vital signs	0% (0/1)	85.7% (6/7)

Table 6. Nursing Knowledge with Formal Education via WBT Intervention Summary

Outcome	Pre-Intervention (n=174)	Post-intervention (n=148)	*p*-Value
Nursing Knowledge, Mean % correct (SD)			
Question #1	76.44	84.46	0.07
Question #2	58.62	73.65	0.16
Question #3	44.83	77.03	< 0.001
Question #4	39.08	68.24	< 0.001
Question #5	54.6	86.49	< 0.001
Question #6	92.53	91.22	0.666
Overall Score	61.08	80.18	< 0.001

Figures

Figure 1. Formal Education Pre- and Post-test for Nurses

6-Question Multiple Choice Pre- and Post-test for Nurses

1. Which of the following parameters does NOT need documented in SCM when tilting a patient?
    a. The highest degrees tilted
    b. Number of straps utilized to tilt
    c. Patient tolerance to tilting
    d. Duration of tilt

Correct answer: B, number of straps utilized to tilt

2. To tilt the patient, which of the following locations is NOT where you would place the straps?
    a. One strap under arms
    b. One strap around lower abdomen near the hips
    c. One strap over lower extremities distal to the knees
    d. One strap over arms

Correct answer: D, one strap over arms

3. Which patient would have a contraindication to tilting?
    a. Patient with history of atrial fibrillation who is currently in atrial fibrillation with a heart rate of 90 and a blood pressure of 130/70
    b. Patient without cardiac history requiring one vasopressor to maintain blood pressure
    c. Intubated patient who is hemodynamically stable
    d. Patient with neck injury who has been cleared of mobility restrictions

Correct answer: B, patient without cardiac history requiring one vasopressor to maintain blood pressure

4. If your patient becomes short of breath and dizzy, with change in vital signs during tilting, what are your initial actions?
    a. Pause tilting and wait 5-10 minutes to assess if VS returns to near baseline/safe range
    b. Continue to tilt the patient further
    c. Call a code
    d. Abort tilting patient

Correct answer: A, pause tilting and wait 5-10 minutes to assess if VS returns to near baseline/safe range

5. After confirmed TLB order, how often should a patient be tilted?
    a. Never
    b. Once a day
    c. 3-4 times daily or as ordered per provider
    d. However many times the nurse has time to tilt the patient

Correct answer: C, 3-4 times daily or as ordered per provider

6. For further inquiry regarding use of the TLB, you can do which of the following?
    a. Consult UHS
    b. Review the Nursing Guideline #gNU-58 on PolicyWeb
    c. See attached TLB handout attached to the bed
    d. All of the above

Correct answer: D, all of the above

Figure 2. VitalGo Total Lift Bed Protocol

VitalGo TLB Protocol
Active standing order from provider for VitalGo Total Lift Bed (Standard or Bariatric) Patients are tilted a minimum of 3 times per day or as otherwise ordered by provider Prior to each tilt, baseline vital signs (HR, BP, RR, and SpO2) are obtained and documented During tilt, vital signs (HR, RR, BP, and SpO2) obtained and documented every 10 minutes Documentation within the TLB parameter in SCM of: •Each tilt performed (3 times per day or as otherwise ordered by provider) •Maximum degrees tilted •Duration of maximum tilt
**Adherence to TLB protocol will be deemed "adherent" if all above criteria are met*