Continuous Lateral Rotation Therapy Training to Promote Adherence to Evidence-based Practice Guideline in a Medical Intensive Care Unit

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Abstract

Background: Patients who experience immobility in a critical care setting are at risk for developing skin breakdown. Hospital acquired pressure injuries (HAPI) contribute to health care problems worldwide. Literature supports continuous lateral rotation therapy (CLRT) that redistributes pressure as an efficient means to reduce HAPI and provide mobility for patients who are critically ill or have unstable conditions. **Purpose:** To design and implement an educational intervention that enhanced nursing staff perceptions in the evidence-based practice of CLRT in the medical intensive care setting. **Method:** A hands-on, face-to-face, educational intervention was conducted in the MICU of an academic medical center. Effectiveness was evaluated in a quantitative pre and post evaluation. **Results:** Sixty-seven nursing staff participated in the project. Results showed a positive trend toward increased adherence in CLRT initiation, mode used during therapy, or maintaining every 2-hour turn regimen pre and post training. Statistical significance was noted in staff confidence level ($p < .000$), in using CLRT in current practice for patients who could not be turned due to hemodynamic instability ($p < .000$), and staff experience with implementing or preparing the bed for CLRT use ($p < .005$). In reviewing post training data from the EHR, none of the patients who met inclusion criteria and received CLRT were noted to have documentation indicating presence of HAPI.

Conclusion: EBP education and hands-on training may contribute to increased staff adherence to new practices that involve new technologies. EBP education and clinical application of CLRT could leverage the nurse to optimize quality of care.

Keywords: *("continuous lateral rotation" OR "kinetic therapy") AND ("hospital acquired pressure ulcer" OR "hospital acquired pressure injury" OR pressure ulcer) AND ICU.*

Continuous Lateral Rotation Therapy Training to Promote Adherence to Evidence Based Practice Guideline in a Medical Intensive Care Unit

Hospital acquired pressure injuries (HAPI) contribute to health care problems worldwide (Coleman et al., 2014). The Agency of Healthcare Research and Quality (AHRQ) estimates 2.5 million hospitalized patients will develop pressure injuries each year and 60,000 patients will die from HAPI related complications (AHRQ, 2014). Pressure injuries cost over 11 billion dollars per year in the U.S. with individual patient care cost ranging from $20,900- $151,700 per pressure injury (AHRQ, 2014). In addition to direct costs, estimated litigation for more than 17,000 lawsuits filed annually may cost an average of $250,000 per case (AHRQ, 2019). The Centers for Medicare and Medicaid Services (CMS) and the Joint Commission consider HAPI to be preventable and an indicator of patient safety and quality of care (CMS, 2019). CMS classifies Stage 3 and Stage 4 HAPIs as "never events" and as of 2008 announced it would no longer pay for costs incurred for hospital-acquired pressure injuries that were not present on admission (CMS,2019). The National Database of Nursing Quality Indicators (NDNQI) is the largest national database of nursing quality data. The NDNQI incorporates data from approximately 2,000 participating hospitals and highlights the impact nurses have on quality of care. At the unit level, nurse-sensitive indicators may reflect the structure, process, and patient outcomes of nursing care (NDNQI, Press Ganey, 2019). The NDNQI tracks a broad range of outcomes that reflect the quality of nursing services, including HAPI (NDNQI, Press Ganey, 2019).

The National Pressure Ulcer Advisory Panel (NPUAP), (2014) is an independent professional national organization whose mission seeks to improve patient outcomes in pressure injury prevention and treatment through education, and public policy (NPUAP, 2014). The NPUAP is the leading voice in clarifying current understanding of definitions for pressure

injuries (PI) and staging (Edsberg et al., 2016). The NPUAP defines PI as any local damage to the skin and underlying soft tissue usually over a boney prominence or under a medical or other device (NPUAP, 2014). Examples of boney prominences include the sacrum, trochanter, ischium, or heel. PI may appear and remain as intact skin or develop into an open injury (Edsberg et al., 2016).

According to the Society for Critical Care Medicine and Critical Care Statistics (SCCM, 2018) approximately 5 million patients are treated in intensive care units (ICU) across the U.S. Many will receive interdisciplinary management for injury or illness while needing invasive support and monitoring (SCCM, 2018). In the adult ICU population a pressure injury can be an added complication in patients who are already physiologically compromised (Jochem & Weigand, 2014). Patients who have illness or injuries that confine them to a bed, have incontinence or other factors which result in prolonged exposure of skin to moisture, or that impair their ability to care for themselves are at risk for developing a pressure injury (de Almeida Medeiros et al., 2018). Literature findings show that pressure injury development in the ICU is correlated with older age, prolonged ICU stay, diabetes mellitus, cardiovascular disease, hypotension, mechanical ventilation greater than 72 hours, use of vasopressor agents, and decreased mobility and activity (Cox et al., 2018). Pressure injuries may also contribute to pain, increased hospital length of stay, sepsis, additional procedures, inability to return to full functioning, and increased mortality (Stafford & Brower, 2012).

Early mobility interventions that effectively mobilize patients in the ICU are proven to significantly decrease HAPI and length of stay (Azuh et al., 2016). CLRT provides a slow rotation cycle that redistributes pressure in high risk critically ill individuals (Prevention and Treatment of Pressure Ulcers, 2014). Data demonstrates that CLRT use is an efficient way to

provide mobility for those patients who are critically ill or have unstable conditions (Swadener-Culpepper, 2010). Critically ill patients who have difficulty with manual turning may better tolerate slow incremental turns (Brindle CT et al., 2013). Vollman (2012) recommends that the nurse consider initiating CLRT to train the patient's body to better tolerate side-side movement.

Framework

The model used for implementation of this scholarly project is the Iowa Model of Evidenced-Based Practice (EBP) (Buckwalter et al., 2017) The Iowa Model of EBP was developed by Marita G. Titler who described the importance of transforming knowledge to guide implementation of research into clinical practice (Buckwalter et al., 2017). The Iowa Model is a widely used framework for the implementation of evidence-based practice (EBP). This model advocates a focus on knowledge and problem-focused triggers, enabling staff to question current nursing practices and improve patient care using current research findings (Titler et al., 2001). It provides a foundation for quality that encourages nurses to be leaders in seeking answers to difficult questions while providing a means for creating systematic process change through evaluating practice change (Sandström et al., 2011).

Nurses have a unique opportunity to position themselves to implement best evidence into clinical practice. When nurses make clinical decisions, their sources should not be based purely on experience but, on EBP (Hanrahan et al., 2015). When nurses become EBP champions, they empower the team to overcome barriers, develop new skills, and employ safer, more consistent, cost-effective care for their patients and their coworkers (White & Spruce, 2015).

The Iowa Model for EBP endorses the use of research evidence into the practice setting, by first identifying the clinical or patient issues (Buckwalter et al., 2017). Once the question and purpose are determined to be a priority for the organization, the model promotes the

forming of a team (Titler et al., 2008). As the evidence is appraised and synthesized it is important to determine if there is sufficient, quality evidence to promote practice changes (Titler, 2008). When there is not enough evidence the model encourages conducting research with a goal for determining practice alternatives based on evidence (Buckwalter et al., 2017). With the adoption of evidence into practice, the model highlights the importance of sustainment of process and dissemination of results. The Iowa Model of EBP has several feedback loops promoting a cyclical approach for continuous learning and promotion of change through evidence (Buckwalter et al., 2017).

This project incorporated the Iowa Model of EBP by integrating research and other science into the practice setting through the process of DNP student inquiry, asking difficult questions and seeking answers to pressure injury in the MICU. This project examined scientific literature to guide the clinical practice of using CLRT in the intensive care setting. The training of staff in implementing CLRT on the unit provided a means for systematic change and a foundation for improved quality. The design of this project incorporated the formation of a team of key stakeholders for staff and leadership engagement of the unit to include, the Clinical Nurse Specialists (CNSs), the Wound Care Nurse Manager, unit nurse educators, the Hill-Rom educator, unit skin care champions, and informal nurse leaders. The assessment of the outcome measurements provided an opportunity to evaluate practice change and to assess practice alternatives. Utilization of train-the-trainer model, development of an algorithm to guide the use of CLRT, and the development of an EBP educational handout was included with the goal of sustaining the practice (Figure 5, Figure 6).

Clinical Question

Does face-to-face education and hands-on training regarding the use of CLRT promote adherence to evidenced-based practice (EBP) guidelines in a medical intensive care unit in an academic medical center?

Review of Literature

For this scholarly practice project two separate reviews of literature were conducted. The first was conducted from April-May 2019. Articles explaining etiology, identification, risk factors, prevention and management, education of hospital acquired pressure ulcer/injury, deep tissue pressure injury in the ICU were included. For the initial review of literature, a combination of key search terms and medical subject headings (MeSH) were included: *deep tissue pressure injury, deep tissue pressure ulcer, deep tissue pressure injury AND (identification OR prevention OR treatment OR education) pressure injury or pressure ulcer) AND ICU*. A search strategy was developed and assisted by a research librarian on two separate occasions allowing for a comprehensive search. Inclusion criteria included relevant articles in English, adult > 18years of age, and published 5 years or less (2014-2019), to correspond with the most current data available from the NPUAP 2014 *Clinical Practice Guidelines* ("NPUAP Pressure Injury Stages | The National Pressure Ulcer Advisory Panel - NPUAP," 2014.).

A systematic literature review was performed using the databases of PubMed MEDLINE, and EBSCOHost (CINAHL) were queried and examined for potential sources. The following key words and combination search terms were used: optimal turning, repositioning frequency, kinetic therapy, lateral rotation, pressure redistribution, and nurse adherence to prevention of HAPI were included. This process was assisted by a research librarian using MeSH terms of *("continuous lateral rotation" OR "kinetic therapy") AND ("hospital acquired pressure ulcer"*

OR "hospital acquired pressure injury" OR pressure ulcer) AND ICU. Inclusion criteria included all articles in English with studies from the past 10 years were considered this allowed for a comprehensive understanding of the subject matter.

The electronic databases searched were PubMed, Cochrane, and Web of Science. A total of 40 hours was spent in search of gray literature including ancestry search, white papers, Clinical Practice Guidelines, and factsheets from NPUAP, AHRQ, NDNQI, and SCCM. Any article with an abstract in English was reviewed. All articles that only focused on ER, OR, children or the pediatric population, and those that were not published in English were excluded.

Final articles chosen for this scholarly project included those that investigated risk factors of the ICU patient, early identification and prevention, optimal turning frequency, and explored the benefits or risks of lateral/kinetic therapy in association with pressure injury prevention.

Following the search strategies, the databases identified a total of 318 articles. Through the systematic literature search the preceding number of records were found in the following databases PubMed (n=61), CINAHL (n=80), WOS (n=121), Cochrane (n=31) with an additional 25 records identified through grey literature. This included hand searched ancestry and descendant resources, conference abstracts, presentations, white papers, fact sheets, policies and procedures and clinical practice guidelines. Duplicate publications were checked and removed. Titles were reviewed for relevance excluding 201 non-relevant articles. Abstracts with relevant information were advanced to the next stage resulting in 117 potentially relevant articles. Sorting of the abstracts for relevant outcome information while considering inclusion criteria for published year, in-patient adult population, research method design, and ICU/critical care setting resulted in an exclusion of 78 additional articles. Thirty-nine articles proceeding to

the next stage were obtained in full text through the Health Sciences Library. The full articles were reviewed, and relevance based on prior inclusion and exclusion criteria resulted in an additional exclusion of 19 articles, leaving 20 articles identified and selected as pertinent to the project topic (*Figure 1*).

Literature Review Results and Summary

The 20 relevant articles yielded two randomized control trials, one nonrandomized clinical trial, one systematic review, one case-control, one cohort, two feasibility studies, one retrospective descriptive study, four quasi-experimental pre/post intervention studies, two scoping reviews, and five gray literature articles. The gray literature search retrieved five articles of relevance. In 2017, Cox and colleagues, conducted a survey investigating nurse perception of PI prevention highlighting the correlation between the number of years of critical care nursing experience and the perception of pressure injury (PI) prevention. Edsberg and colleagues in (2016), discussed the *NPUAP Interdisciplinary Consensus* of 2016 highlighting the revision of definitions and terminology for the staging system. The NDNQI (2019) published an educational fact sheet illustrating pressure injuries with staging. The NPUAP (2017) wrote a position statement clarifying the changes in definitions and staging with supporting references. The NPUAP/EPUAP/PPPIA *Clinical Practice Guidelines* (2014) for pressure injuries is a comprehensive book of over 300 pages providing recommendations in prevention and treatment of pressure injuries.

Early identification and prevention

The following three studies investigated interventions for identification and prevention of PIs. A systematic review conducted by Shi, Dumville, & Cullum, (2019) identified longitudinal studies to evaluate models for predicting PIs using database search and

finding relevant articles from the year of 1996 through 2017. The purpose of the review was to determine the performance of these models and to evaluate clinical impact on reducing pressure injury incidence. The authors concluded that 22 empirically derived prognostic models are available and that only 7 that were externally validated. This article revealed that risk assessment scales are an aid to clinical judgement but, only 27-32% routinely apply the predictive PI models (Shi, Dumville, & Cullum, 2019).

A two-arm cluster randomized control trial performed by Tayyib et al., (2015) sought to test the effectiveness of a pressure injury prevention bundle in reducing the incidence of PIs in critically ill patients. The study was conducted in a Saudi Arabian ICU. The intervention group received PI prevention bundle based on NPUAP guidelines and the control group received standard skin care. The intervention group showed a statistically significant reduction for Stage 1 ($p < 0.002$) and Stage 2 ($p < 0.026$) PI development. This article highlighted the potential strength and limitation of only using a bundle approach to PI prevention.

In a nonrandomized clinical trial, Okhovati et al., (2019) studied the effect of an ICU nurses' empowerment program on their ability to diagnosis pressure injury staging. The intervention group (n=40) participants received an in-hospital workshop and 10-days of social network teaching modules. The control group received standard training. The intervention group demonstrated a recall of the diagnostic stages that included Stage I ($p = 0.054$), Stage II ($p < 0.02$), IV ($p < 0.02$) unstageable ($p < 0.001$), deep tissue pressure injury (DTPI) ($p < 0.001$). The control group results noted a statistical significance in the clinician's ability to identify Stage I ($p < 0.001$), and Stage III ($p < 0.001$), DTPI ($p < 0.04$) but, not Stage II ($p < 0.255$), This article highlighted the importance of training as a contributor to appropriate staging and early detection.

Padula and colleagues (2015) conducted a quasi-experimental, observation cohort study to determine the correlation between HAPI incidence rates & adoption of QI. The study investigated 55 University Health System Consortium hospital medical centers from 2007-2012. It concluded that 96% used quality improvement interventions. The most effective interventions identified for reducing PI were leadership initiatives, visual tools, PI staging, skin care, and nutrition. The author recommended that all these interventions be used as part of a QI bundle for preventing HAPI.

Risk factors of the ICU Patient

The following three articles investigated risk factors associated with PI in the ICU patient. Cox and colleagues (2018), performed a descriptive analysis to examine pressure injury risk factors in critical care patients. The purpose of this study was to describe risk factors associated with PI development in medical-surgical ICU and to determine congruence with risk factors proposed by the NPUAP on unavoidable PIs. The most frequent risk factors identified in the study were immobility, septic shock, vasopressors, head of bed > 30^0, sedation, and mechanical ventilation >72-hours. The most common body location for a PI noted in the findings was the sacrum, and the most common PI stage was DTPI. This study provides important insight in terms of key factors to consider when integrating prevention and intervention methods.

A retrospective case control study by de Almeida Medeiros et al., (2018) and colleagues evaluated predictors of PI risk in adult intensive care patients (n=180). The purpose was to evaluate the predictive power of risk factors for PIs in adult ICU patients. Data analysis showed the strongest predictive risk factors were previous history of PI, comorbidities (renal, cardiovascular, diabetes), prolonged ICU stay, friction, dehydration, and elevated skin temperature(de Almeida Medeiros et al., 2018).

Optimal turning frequency

The following 4 articles investigated optimal turning frequency. Darvall, and colleagues (2018)**,** investigated the impact of a change in turn frequency for critically ill patients from every 5-hours to 3-hours in an ICU of a metropolitan tertiary referral hospital. This pre–post intervention evaluation study, compared a 6-month period during which patient turns were every 5-hours with a 6-month period during which turns were every 3-hours. Thirty-eight pre-intervention patients (3.5%) and 23 post-intervention patients (2.0%) developed a pressure injury ($p < 0.028$). The incidence of pressure injuries was markedly reduced in the post-intervention period from 36 PI to eight PI ($p < 0.001$). For mechanically ventilated patients, the adjusted odds ratio for developing a pressure injury in the post-intervention period was 0.22 (95% CI, 0.06–0.85) ($p < 0.029$). After adjusting for Acute Physiology and Chronic Health Evaluation (APACHE) III score, duration of intubation and age, the odds ratio for developing a pressure injury in the post-intervention period was 0.51 (95% CI, 0.27-0.97) ($p < 0.041$). A change in turn frequency from every 5-hours to 3-hours was associated with a halved incidence of pressure injuries. The study concluded that critically ill patients benefit from more frequent turns.

Pickham and colleagues (2018), published a secondary descriptive study investigating two ICUs at an academic medical center among consecutive ICU patients. Patients wore sensors on admission that recorded position data. The sensors were not detectable to staff and the measures of turning frequency, degree of turn and tissue pressure relief were recorded. The investigators found turning frequency, turn magnitude, and tissue depressurization time suboptimal. This study emphasized opportunities for improvement in patient positioning for PI prevention.

Moore and colleagues (2011) conducted a randomized control trial, to compare incidence of PI among older persons while using two different repositioning regimens. The experimental group were repositioned every three hours at night using a 30^0 tilt. The control group received routine care of 6-hour turns using a 90^0 -lateral turn. The results of the study revealed a significant decrease in HAPI with the experimental group developing three PIs and the experimental group developing 13 PIs ($p < 0.035$).

In two different scoping reviews Krapfl et al., (2017) and Chew et al., (2018), examined articles related to repositioning, incremental turning, and HAPI prevention. Krapfl et al., (2017) reviewed articles published within the last ten years 2006 through 2016 and concluded that despite the limited evidence, incremental positioning and/or weight shifts are recommended as an intervention in critical care patients deemed too unstable to turn. The author concluded further research is needed to examine whether incremental positioning and/ or weight shifts are effective in reducing pressure injuries in critical care patients. Chew et al., (2018) evaluated articles published between the year 2000 through 2016. The author investigated the frequency of turning in bedridden patients to prevent HAPI. It was concluded after reviewing available studies on turning frequencies of adult bed-bound patients' that further exploration to improve the outdated guidelines surrounding pressure injury prevention is needed.

Skin pressure and CLRT

Oomens, and colleagues (2016), investigated internal tissue strains in individuals lying in a supine position during lateral turning. The outcome of the study showed tilting to have significant positive influence on reducing internal strains of the sacrum with the optimal tilting angle between 20^0-30^0 degrees. This study pointed to the ideal angle and its potential to reducing strain forces in the sacral area.

Behrendt, and colleagues (2014) conducted a prospective controlled study that looked at the use of continuous bedside pressure mapping (CBPM) to off-load areas of high pressure and prevent HAPI. The results revealed HAPIs developed in two of 213 patients in the CBPM group (0.9%;) and both PIs were a stage II. Compared with 10 of 209 in the control group (4.8%;) and all were a stage II ($p < 0.02$). These results showed that significantly fewer HAPIs occurred in the CBPM group than the control group, indicating the effectiveness of real-time visual feedback in repositioning of patients to prevent the formation of new HAPIs. This article supported the concept using technology to assist with pressure redistribution in the prevention of HAPI.

Lippoldt et al., (2014) conducted a prospective randomized crossover trial with 20 healthy volunteers. Interface pressures were measured using a pressure mapping device while in a supine position at 0, 10°, 30°, and 45° elevation and in the reverse Trendelenburg position at 10° and 30°. The results of the study showed that peak sacral interface pressures increased significantly only at 45^0 of backrest elevation ($p < 0.001$). A mattress system with low-air-loss technology significantly reduced peak interface pressures at all angles ($p < .001$). The reverse Trendelenburg position led to lower peak pressures for all positions ($p < 0.01$). The study suggested the Trendelenburg position and a mattress system with low-air-loss technology could be additional useful tools to help prevent skin breakdown at the sacrum.

Supriadi and colleagues (2014) investigated relationships between peak interface pressure (PIP) and peak pressure gradient (PPG) for predicting PI. The authors designed a prospective cohort study and measured interface pressures at the sacrum of 87 ICU patients from two different hospitals located in Indonesia. Participants underwent a tilting intervention on air and foam pressure redistributing mattresses. PIP of greater than 50.0 mm Hg and PPG of greater than 8.0 mm Hg were identified as predictors for pressure injury. The PIP was 66.2 mmHg and

PPG were 12.1 mmHg for a pressure injury compared to without a pressure injury ($p < .01$). The conclusion was that PIP and PPG were significantly higher with PI than without PI. Also, PIP with PPG had a very strong relationship to predict PI development. The investigators also reported that tilting left, and right is an effective intervention at reducing interface pressures on the sacrum.

Peterson and colleagues (2013) performed a descriptive, observational study, collecting data at a tertiary care. Twenty-three participants from intensive care and intermediate care units participated in the study. Interface pressure measurements using a pressure mapping system were used. The sensors were placed beneath the patient, spanning from the lower back to mid-thigh to ensure data collection of the peri-sacral area. The study found peak interface pressures and specific areas of at-risk skin were susceptible to significant changes upon patient repositioning. Bedridden patients at risk for PI formation exhibited high skin to bed interface pressures and specific skin areas that are likely always at risk. The study concluded that there are opportunities to raise healthcare provider awareness of the actual lack of tissue relieving effectiveness of their repositioning interventions. The authors also concluded that the decreased awareness may partially explain why PI mitigation strategies are not always successful and repositioning practice itself needs improvement.

Nam Ho and colleagues (2016), examined pressure relieving effects of CLRT at common PI anatomical body sites. Interface pressures and time were measured, and comfort was evaluated at 0^0, 15^0, 30^0, and 45^0 - degree angles. The study found peak pressures were significantly reduced at different angles. The effective angles for pressure relief at the common pressure injury sites were 30° at the occiput, 15° at the left scapula, 45° at the right scapula, 45° at the sacrum, 15° at the right heel, and 30° at the left heel. The study also found that there was

an increase in reported induced discomfort at angles greater than 30^0. The study concluded that CLRT can effectively relieve pressure at common PI body sites.

Anderson and colleagues (2016), conducted a study in a nursing clinical education center of a large academic tertiary medical center. The study investigated the differences in skin interface pressures, skin integrity or perceived discomfort with beds equipped with pressure mapping devices in 10 healthy adults. The study was conducted using 3 different scenarios: CLRT rotating left and right 40^0, CLRT with the use of manual wedge, and manual wedge with no CLRT. The study concluded that CLRT demonstrated a significant ($p < 0.012$) decrease in interfaced pressures over time at the ischial tuberosities when compared to use of manual wedge with or without CLRT. The authors concluded that CLRT may be beneficial in decreasing the amount of pressure applied to capillary beds at the ischial tuberosities.

Simonis et al., (2012) conducted a prospective randomized open-label trial in a cardiac-care ICU of a single University Hospital. The aim of the study was to compare kinetic therapy (KT) using oscillating beds with standard care (SC) in cardiogenic shock patients. Forty-five patients were randomized to KT and 44 to SC. All patients required at least 1 inotropic agent and 1 vasopressor for circulatory assistance. The study results demonstrated a significant decrease in pneumonia by 60% ($p < 0.001$) and a decrease in PI by 50% ($p < 0.001$) with the use of KT.

Discussion

PIs are not a new medical problem. The review of literature highlighted that immobility for critically patients places them at risk for PI development (Cox et al., 2018). When patients stay in one position without moving, they can experience a reduction in blood circulation. This reduction in blood circulation can result as a pressure injury (“NPUAP Pressure

Injury Stages | The National Pressure Ulcer Advisory Panel - NPUAP," 2014). When there is a loss of mobility, pressure of gravity on the body against a surface may prevent blood to flow through an area where a bone is pressing down against the skin resulting in an internal tissue break down (Bergstrom et al., 2013).

PIs develop and present in stages. The NPUAP/EPUAP classification system describes and defines the following different stages of pressure injury (*NPUAP Pressure Injury Stages | The National Pressure Ulcer Advisory Panel—NPUAP*, n.d.). Stage I, is a persistent non-blanchable redness on the skin that may feel warmer or cooler, firmer or softer compared to adjacent tissue. There may or may not be pain associated with the redness. If unrelieved it can progress to Stage II. In this stage, the skin may have a partial thickness loss of dermis showing a red pink wound usually without slough or bruising. This stage could also present with intact skin or open/ruptured serum filled blister. Stage II is distinguishable from skin tears, tape burns, perineal dermatitis, maceration or excoriation. If bruising is assessed, deep tissue pressure injury is suspected. Without active treatment, the wound may progress to Stage III, with full thickness tissue loss and subcutaneous fat visible. Slough may be present, and the wound may have undermining or tunneling. In Stage IV, there is full thickness tissue loss with exposed bone, tendon, or muscle. Slough or eschar may be present with undermining and tunneling. Deep tissue pressure injury may present as a purple or maroon localized area of intact skin or a blood-filled blister. This area may present as painful, firm, mushy, boggy, warmer or cooler as compared to adjacent tissue ("NPUAP Pressure Injury Stages | The National Pressure Ulcer Advisory Panel - NPUAP," 2014).

Frequent repositioning which allows for effective pressure redistribution is a vital step to preventing PIs ("NPUAP Pressure Injury Stages | The National Pressure Ulcer Advisory Panel

- NPUAP," 2014). Nurses have long been taught the importance of turning patients every two hours (Black et al., 2011). This standard is considered a best practice for good nursing care despite the optimal frequency of turning for the ICU patient being unclear (Cooper et al., 2013). The healthcare staff at hospitals go to great lengths to prevent patients from developing PIs. Many times, nursing staff are at the forefront of that training. Nurses receive special training in pressure injury prevention, emphasizing principles in risk and skin assessment, methods for preventing dry skin, minimizing moisture, ensuring the appropriate support surfaces are utilized, monitoring nutrition status, and regularly turning and repositioning patients (Anderson et al., 2015).

Turning is considered an essential intervention to prevent complications of immobility and to prevent PI development (Makic et al., 2014). Integrating optimal repositioning intervals for patients who are critically ill continues to be a challenge (Chew et al., 2018; Krapfl et al., 2017; Peterson et al., 2013). However, several researchers suggest turning and repositioning contribute to significant decreases in PI (Moore et al., 2011; Darvall et al., 2018).

Additionally, studies that explore interface pressures found that when patients receive repositioning with effective offloading of pressure, there is a decrease in PI (Behrendt et al., 2014; Lippoldt et al., 2014; Peterson et al., 2013). However, there are limitations in their design method such as using healthy adults (Anderson et al., 2016; Lippoldt et al., 2014; Nam Ho et al., 2016). Krapfl et al., (2017) cited that despite the limited evidence, science points to the benefits of incremental positioning and/or frequent weight shifts as an intervention in critical care patients who are too unstable to turn. It is suggested that additional research examine whether incremental positioning and/ or weight shifts are effective in reducing pressure injuries in critical care patients (Krapfl et al., 2017; Chew et al., 2016).

As cited by several authors, optimal repositioning intervals for patients who are critically ill continues to be a challenge (Chew et al., 2018; Krapfl et al., 2017; Peterson et al., 2013). Adherence to PI prevention bundles with consistent turning practices remains a challenge (Bergstrom et al., 2013). Patients who present with hemodynamic instability may not tolerate efficient off-loading(Cox et al., 2018). Therefore, the use of CLRT when used as an adjunct to two-hour turns as noted by Nam Ho et al., (2016), may be a benefit to nursing staff and aid in a more consistent routine of pressure redistribution for the patient in the critical care setting.

Background

The challenges to PI prevention noted in the aforementioned studies exist in the practice site serving as the setting for this DNP Scholarly Practice project. Several challenges in meeting turning standards have been reported by nursing staff on the unit. These barriers to consistent repositioning have been identified as patient hemodynamic instability, obese patients, lack of turning equipment, and lack of available peer assistance to aid in turning. Through a recent survey of 20 registered nurses from the MICU, 40% reported they were not aware of the existing standard work for turning a hemodynamically unstable patient. While 90% of those surveyed reported attempting to weight shift patients who are hemodynamically unstable, none of the nursing staff surveyed reported using CLRT. A review of data regarding unit HAPI, revealed that 38.5% were located on the posterior sacral, buttocks, or ischium thus, theoretically amendable to improved turning strategies.

Methods

The purpose of this project was to promote the registered nurse (RNs) and patient care technician's (PCTs) adherence to evidenced-based practice (EBP) through training of continuous lateral rotation therapy (CLRT) in the medical intensive care unit (MICU). Prior to

implementation of the project, key stakeholders were consulted. In collaboration with the key stakeholder, the CLRT educational plan and training strategy was designed. The face-to-face educational intervention and hands-on training to use CLRT technology was introduced as an adjunct to turning patients every two hours.

The educational pre-training assessments were collected from nursing staff immediately prior to training and post-assessments were obtained after the unit's go-live date of CLRT. Additional post-data was collected on the unit from the hospital beds' Graphical Caregiver Interface data repository and from the patient's EHR. Adherence to the CLRT guidelines was evaluated using data collected from the beds' Graphical Caregiver Interface. Indications and contraindications for CLRT were verified using the HER.

Design

This project followed an EBP framework and incorporated a quantitative, pre/post intervention analysis.

Setting

The project was conducted in a 28-bed inpatient MICU at an academic medical center located in the southeastern U.S. The MICU is a 28-bed unit divided among two physically distinct yet adjacent locations within a medical center.

Description of the Sample

A convenience sampling method of RN and PCT team members, who are employed at the MICU were invited through an email communication to participate in the project. Approximately 100 RN and 22 PCT team members were employed in the MICU at the time of the project.

Protection of Human Subjects

Social and Behavioral Sciences (SBS) Institutional Review Board (IRB) approval was obtained prior to the start of the project and it was determined to be IRB exempted (*Figure 3*). Permission was granted to conduct the project by the unit's nurse manager (*Figure 2*). The project lead completed all required training through the Collaborative Institutional Training Initiative (CITI; *Figure 8*). All participant data was de-identified and not linked to any one person. All participants were given the opportunity to ask questions and seek clarification prior to completing the assessments. All participants were provided contact information of project lead. Participants were informed of their rights to refuse to participate or withdraw from the project at any time. De-identified data was stored in a secured location in a locked file. All IRB and institutional policies were adhered to throughout the project. Data was only available to individuals directly involved in the project to include the DNP student, statistician, academic advisor, and practice mentors.

Procedures

Throughout this project, the project lead collaborated with several stakeholders and unit champions including the unit's Clinical Nurse Specialists (CNS)s, the Wound/Ostomy Care Nurse Manager, unit and hospital educators, unit champions, and the Hill-Rom bed representatives. Prior to implementation, several meetings were held to focus on project planning elements such as the impact of training and implementation on staff workload and workflow.

Prior to the start of the educational sessions, a "train the trainer day" was facilitated in partnership with the unit's stakeholders. An email invitation was extended to the unit's stakeholders and champions encouraging them to attend the training. Over the course of one week 13 individuals attended and received CLRT hands-on training with the project lead and the Hill-Rom bed representative. During the 'train the trainer' sessions, opportunities arose for

open discussion about the planned project. Discussion topics centered on critique and clarification of the unit's CLRT algorithm, CLRT implementation, flow of training, and assistance with reinforcing support to nursing staff during the shift.

Following the train-the trainer week, promotion of EBP through CLRT training was extended to the RN and PCT staff team members through email invitation. In addition, flyers announcing dates and times of upcoming training sessions were displayed throughout the unit using standard unit communication mechanisms.

All staff team members were invited to complete a demographic and CLRT questionnaire immediately prior to training. One month after the training, the identical CLRT questionnaire was offered as a post-assessment to those who attended the training. To evaluate the frequency of and adherence to the CLRT algorithm pre and post CLRT training, data from the unit's Progressa® beds was collected over a 2-week period prior to the training and 2-weeks after the training. In addition, the EHR was analyzed during this same time to determine if patients met the criteria for CLRT implementation and if CLRT use is documented.

Training

The training of team members consisted of face-to-face training with a return demonstration of CLRT using the unit bed. Each training session lasted approximately 20 minutes and was facilitated over a 3-week period with the goal of training as many RNs and PCTs team members who were available and willing to train. During each teaching session a CLRT skill check list was used (*figure* 9). This ensured each team member received the same CLRT algorithm training and established the same return demonstration of skill. Training was offered in a convenient location near the MICU unit, and during various work hours to facilitate attendance. To accommodate staff, training was offered during day, night, and weekend shifts.

An EBP educational handout along with the unit's algorithm for the use of CLRT on the unit was reviewed with participants and offered as a take-a-way following the training.

The start date for adherence to CLRT algorithm was set by the unit's stakeholders and verbally communicated to all staff at the time of training and was displayed on flyers throughout the unit. Additionally, a CLRT resource binder was designed and distributed to the unit for reference and to promote sustainability of the initiative.

Similar training strategies were used by (Reynolds et al., 2016), showing improved knowledge and adherence by nursing staff when a bundle of strategies for implementation methods were used. Reynolds et al., (2016) saw sustainable results in project implementation when several approaches such as consulting with local leaders, conducting educational outreach and distributing educational material were implemented. Powell et al., (2015), and colleagues also identified successful strategies for implementing change. Suggesting the importance of providing staff with interactive 1-1 problem solving opportunities along with interpersonal supportive training made it easier for staff to learn about innovation.

Measure

The project pre and post assessment questionnaire was developed by the project lead in consultation with key stakeholders. The questionnaire that was distributed to staff who volunteered to participant in the project assessment, consisted of a Likert scale questionnaire consisting of 6 demographic questions and 8 questions specific to CLRT. Demographic questions included age, gender, employment status, level of education, healthcare licensure, and years of healthcare experience. The CLRT questions included; previous training in CLRT, interest in learning about CLRT, current confidence in implementing CLRT, current number of times implementing CLRT on the unit, the number of hemodynamically unstable patients cared

for in a week, use of CLRT when caring for hemodynamically unstable patients, how likely to use CLRT in current practice, barriers to turning and using CLRT on the unit. (Figure 7).

Additionally, a data collection instrument was designed for the clinical setting to obtain CLRT algorithm adherence data. The instrument was used to record data collected from the unit beds and EHR. The instrument included patient's age, gender, diagnosis, mechanical ventilator use, Braden score, algorithm inclusion criteria, CLRT initiation when inclusion criteria met, total number of hours patient received CLRT during their admission, minimum mode selection, custom mode selection, custom mode with moderate or maximum inflation use, turning/repositioning every 2 hours, presence of pressure injury present upon admission (POA), and presence of hospital acquired pressure injury (HAPI).

Data Analysis

The statistical analysis of the data was conducted using the statistical software package SPSS® version 25. Descriptive data were reported as mean, standard deviation and percentages as appropriate. A paired t-test was used to analyze changes in scores from pre-assessment to post intervention for the measures of CLRT confidence, experience, current use, and how likely to use CLRT in current practice. To identify differences in pre and post patient demographic data extracted from the unit beds and EHR, an independent t-test was used for analysis. To determine CLRT algorithm adherence, the differences between groups were analyzed using the Chi square test of independence with the Fisher's exact test. A two-sided p value of $<.05$ was used to establish statistical significance.

Results

Demographics

Out of a total of 122 nursing staff team members, 67 (55%) attended training for CLRT. Of those who attended training, (79%) were RNs and (21%) were PCTs. The majority were female (87%), less than < 35 years of age (75%), employed full-time (87%), held a Bachelor Degree (BSN) as the highest degree (70%), and reported having 6 years or less in healthcare experience (66%) (Table 6).

CLRT pre-training questionnaire

Of the 67 team members who attended training, all were surveyed about their CLRT experiences prior to training; 52(78%) reported no previous training in CLRT, and 15 (22%) reported on-the-job-training on the unit or another unit in CLRT. When inquired about their level of interest in learning about CLRT 33 (49%) reported they were very interested, and 20 (30%) reported they were extremely interested. Forty-two (63%) reported no current experience in implementing or preparing the beds for CLRT use, and 44 (66%) reported they do not use CLRT in current practice when caring for a hemodynamically unstable patient. In a combined analysis of two response options, 43 (64%) said they had either no confidence or they were not so confident in activating or implementing the CLRT option currently on the unit. Sixty (90%) reported they are likely or very likely to use CLRT after training.

CLRT post-training questionnaire

Comparison means analysis using a paired t-test was performed on the assessment data from the 28 team members who returned post-training questionnaires. Four questions were directly selected for analysis based on their relevance to post training assessment. When staff was asked about their confidence level for initiating CLRT 4 participants (14%) before receiving

training and 19 participants (68%) post-training reported they were very or extremely confident in activating the CLRT option. When asked of their experience in implementing or preparing for CLRT before training, 21 participants (75%) reported no previous experience and 3 participants (11%) said they have used CLRT 1-2 times. Post training 5 participants (18%) reported no previous experience in implementing CLRT and 17 participants (61%) said they have used CLRT 1-2 times. When asked if they used CLRT in their current practice when caring for a hemodynamically unstable patient, 19 participants (68%) reported "no" pre-training and 3 participants (11%) reported "no" post training. The last question asked if they were likely to use CLRT after training or the post questionnaire read "now that you have received training," with the 2 most common answers being likely and very likely. Pre-training 25 participants (89%) and post-training 27 participants (97%) reported likely or very likely. (Table 7).

CLRT pre and post questionnaire analysis

In the analysis of pre versus post assessment questionnaire responses, three of the four selected questions demonstrated statistically significant differences. There was a statistically significant improvement in confidence in activating CLRT, $t(27)= -7.28$, $p = .000$. Additionally, there was a statistically significant improvement in the self-reported staff experience in implementing or preparing for CLRT, $t(27)= -3.02$, $p = .005$. Lastly, with respect to current CLRT use in hemodynamically unstable patients there was statistically significant improvement, $t(27)= -6.00$, $p = .000$. Interestingly, the one question that did not demonstrate statistical significance dealt with the likely hood of using CLRT after training, $t(27)= -.493$, $p = 0.626$. (Table 7).

Demographic comparison of CLRT patients

In determining CLRT algorithm adherence on the unit, an observational review of the data repositories within the unit's beds and EHRs was conducted. With use of a data collection instrument the Graphical Caregiver Interface located on the unit beds and EHRs were reviewed routinely over a 2-week period pre-and post-training. During the pre-training phase of the project 79 individual EHRs and beds were reviewed. During this time there was 13 patients admitted to the unit who met inclusion criteria based on the unit's CLRT algorithm and 2 patients (15%) received CLRT during their admission. During the post-training phase, the same process was utilized as the pre-training with 84 individual EHRs reviewed resulting in 18 patients meeting inclusion criteria and 7 (39%) patients received CLRT.

The demographics of the patients who met inclusion criteria pre and post training were compared using descriptive statistics and an independent t-test analysis was performed to determine significant differences between the 2 patient populations. In the pre-training cohort, the 13 patients who met inclusion criteria were predominantly male (69%), and < 44 years of age (54%). Range of diagnoses included 7 (54%) respiratory related, 2 (15%) substance abuse related, 3(23 %) shock, and 1(8%) neuromuscular. Twelve (92%) were mechanical ventilated, and 7(54%) had a Braden score <12. In the 2 patients who received CLRT, 1 patient received CLRT <3 hours; and 1 patient received CLRT > 3 hours. Both patients received the CLRT with a custom mode. There was no other observed mode used. From EHR documentation the majority were consistently turned and repositioned 10 (77%), and there was no documentation indicating a pressure injury upon admission or a HAPI associated with a patient receiving CLRT.

In the post-training cohort, the 18 patients who met inclusion criteria were predominately males (67%), and > 45 years of age (89%). Range of diagnoses included 8 (44%)

respiratory related, 2 (11%) substance abuse related, 4 (22%) shock, 3 (11%) GI related. Seventeen patients (94%) were mechanically ventilated; 9 patients (50%) had a Braden score <12. In those patients who received CLRT, 4 patients (22%) received CLRT <3 hours, 3 patients (17%) received CLRT > 3 hours. One patient received the minimum mode, and 6 patients received a custom mode. There was no other observed mode used. Nine (50%) were consistently turned and repositioned and there was no documentation of pressure injury upon admission or development of HAPI while receiving CLRT.

Independent t-test analysis revealed no significant difference between the patient demographics except in age. There was a significant difference in age showing the patients who met inclusion criteria post-training were statistically significantly older $t(22.62)= -2.42$, $p = .024$. (Table 8).

Adherence

In determining adherence 3 comparison criteria were used based on the CLRT algorithm: 1) Patient met inclusion criteria; was CLRT utilized? 2) Patient met inclusion criteria and CLRT initiated; was minimum or custom mode used during CLRT therapy? and 3) Patient met the inclusion criteria and CLRT initiated; were every 2-hour turns maintained?

Comparisons were made using the exact chi square between the patients who met inclusion criteria and the 3 adherence measures. Analysis showed 2 patients (15%) pre-training and 7 patients (39%) post-training received CLRT, $\chi^2(1, N=31) = 2.02$, $p = .237$. Of those who met inclusion criteria and CLRT initiated there were no patients who received minimum mode pre-training and 1 patient (14%) received minimum mode post-training, $\chi^2(1, N=31) = .057$, $p = 1.0$. For those patients who met inclusion criteria and CLRT was initiated there were 2 patients (100%) pre-training, and 6 patients (86%) post-training who received a custom mode during

CLRT, $\chi^2(1, N=31) = 2.83$, $p = .191$. Thirdly, for those patients who met inclusion criteria and had CLRT initiated the patients before training 2(100%) and 7 (100%) post training had documentation in the EHR they were turned or repositioned every 2 hours, $\chi^2(1, N=31) = .385$, $p=0.696$ (Table 9).

Discussion

The purpose of this project was to promote staff adherence to EBP of CLRT. This project addressed a gap in staff knowledge related to evidenced-based use for CLRT in the practice setting as a strategy for prevention of HAPI. This project suggests that educating and training staff to implement EBP promotes practice change with a positive trend towards increased adherence and a clear improvement in confidence with CLRT.

When the demographics of patients who met inclusion, criteria were compared pre- and post-training, only age was a significant factor, with post-training patients being slightly older. While there was an increase in frequency of implementation of the CLRT algorithm in the post-training cohort of patients and these patients experienced longer durations of CLRT in terms of hours the results did not yield a statistically significant use of CLRT among staff (Table 8, Table 9). In addition, the findings did not show statically significant staff adherence to the guideline in terms of CLRT mode, or turning frequency with the use of CLRT. (Table 9). This was not surprising given the limited sample sizes.

In assessing the post staff surveys the results do not demonstrate a statically significant improvement in the likelihood of use of the therapy in hemodynamically unstable patients. Yet there is a positive trend of improvement (89%-97%). A possible reason for this is that with a convenience sampling, a natural bias exists and therefore often skews data rendering it difficult to create a statistically significant change (Table 7). Despite a small return rate of post

surveys, an interesting finding in this project was the statistically significant differences between the pre- and post-questionnaires in the areas of staff experience, staff confidence, and their self-reported current use of CLRT. The significant results showed how EBP training can benefit staff. This reflects the potential for systematic change and a foundation for improved quality.

This project does not reconcile the question of whether CLRT will improve patient outcomes in an ICU setting. This project does reflect the fluctuation of patient demographics in the ICU setting from one week to the next and how those who may benefit from CLRT will be dependent on multiple patient factors. This project suggests challenges of implementing and adopting new technologies. This is particularly true for newly graduated nurses transitioning from orientation who are often overwhelmed by change. While significant staff adherence to CLRT was not apparent in the outcome data continued strategies for supportive implementation and training is needed to yield clinical relevance.

Strengths and Limitations

Strengths: This project involves engaging stakeholders in the process including the unit CNSs, the WOC nurse manager and unit wound care nurses, the unit nurse educator, and unit champions. The use of bed data technology as a data repository instrument aided in reducing human error in data collection. Train-the-trainer method was offered to project champions with a goal of increasing potential sustainability of the project. Furthermore, the study intervention is based on EBP and *Clinical Practice Guidelines* as recommended by the NPUAP emphasizing the scientific underpinnings of the project (NPUAP *CPG*, 2014). Additionally, a unit educational binder was developed for staff, allowing for training of new staff members, thus adding to sustainability.

Limitations: Since training was voluntary, not all staff were trained, and this probably affected adherence data and CLRT utilization outcome. Despite the benefits, the bed data repository technology was limited and at times was difficult to determine sequence of the therapy mode used by the staff thus hampering data collection.

Implications for Practice

Guidelines that are available on PI prevention do not specify the exact optimal frequency of turning but, encourages the clinician to assess the risk of PI with consideration of the individual (*NPUAP Pressure Injury Stages | The National Pressure Ulcer Advisory Panel—NPUAP*, n.d.). Although studies demonstrate immobility is a major risk factor PI, PI is multifaceted with no single risk factor that explains its development (Cox et al., 2018). The approach has been to create bundles for prevention and intervention (Padula, Makic, Wald et al., 2015). In spite of these efforts, severe PIs in the U.S. have not decreased significantly (Kayser et al., 2019). Literature shows there is a high incidence of HAPI occurring over boney prominences with the highest percentage occurring on the sacrum area in this population and it is important that interventions address consistent off-loading during times of low perfusion states whenever possible (Kirkland, 2017).

However, not all nurses have the same training, educational exposure or understanding of their unique patient population and their specific risks for developing PIs. Some teams may not realize that patients who simply cannot weight shift themselves are two times greater for developing a PI Kayser et al., (2019), and under certain conditions simply being a patient in the ICU indicates a 3-fold increased chance of developing pressure injuries (de Almeida Medeiros et al., 2018). Therefore, it is important for teams to receive ongoing training in EBP prevention of HAPI and consider newer technologies that can facilitate off-loading.

Products of the Scholarly Project

After completion of this scholarly project, the findings will be disseminated. A copy of the project proceedings will be submitted to the scholarly project repository. An abstract will be submitted to the state Association of Clinical Nurse Specialists, state Association of DNPs, with a poster submission to the state Nurses Association Conference.

Conclusion

When patient care incorporates EBP, the quality of care can be improved. Incorporating CLRT and its clinical application into the ICU setting could aid the nurse in providing improved safety and quality of care. Through this project EBP training in CLRT fostered staff awareness. The emphasis of evidence-based practice training contributed to positive nurse perception in current use of CLRT on the unit. This project demonstrates the value of EBP training to increase confidence and use of CLRT regarding pressure redistribution for the ICU patient.

The training method used in this project provided nursing staff an opportunity to ask questions and to practice their skill in preparing and correctly programing the beds for CLRT. The training underscored the importance of patient safety, the unit's algorithm for CLRT initiation and electronic health record documentation. The central location and frequency of the times that the trainings were offered provided a convenience for staff to attend. After training of staff CLRT initiation for patients who met inclusion criteria based on the unit's algorithm increased in frequency. Self-reported nurse perceptions did improve in the areas of confidence, experience, and current CLRT use on the unit.

The challenges in this project of staff adherence may be attributed to introducing new technology. As with learning any new skill consistency and practice provides opportunity for improved adherence. In addition, having a good support system in place to help strengthen

nursing staff proficiency is pertinent to team success. In this project training was voluntary and therefore, not all staff were trained. Sixty-six percent of nursing staff who attended training self-reported 0-6 years healthcare experience. These facts could be attributed to staff adherence. Training all nursing staff team members, providing ongoing support in EBP of CLRT, and offering bedside nurse support is recommended.

The data collection and monitoring provided insights that the staff and organizational stakeholders can use to enhance future adherence to CLRT. Assessing ongoing challenges and barriers to the patients and staff will be required to sustain and maintain these practices with the goal of continuing to increase adherence to the EBP guidelines and ultimately decreasing untoward complications of HAPI in the vulnerable ICU population.

References

AHRQ-Agency for Healthcare Research and Quality (2013). Retrieved from http://effectivehealthcare.ahrq.gov/ index. cfm/search-for-guides-reviews-and-reports/?productid=1490&pageaction=display product

2014 Prevention and Treatment of Pressure Ulcers: Clinical Practice Guideline | The National Pressure Ulcer Advisory Panel - NPUAP. (n.d.). Retrieved June 24, 2019, from https://www.npuap.org/resources/educational-and-clinical-resources/prevention-and-treatment-of-pressure-ulcers-clinical-practice-guideline/

Anderson, M., Finch Guthrie, P., Kraft, W., Reicks, P., Skay, C., & Beal, A. L. (2015). Universal Pressure Ulcer Prevention Bundle with WOC Nurse Support. Journal of Wound, Ostomy, and Continence Nursing: Official Publication of The Wound, Ostomy and Continence Nurses Society, 42(3), 217–225. https://doi.org/10.1097/WON.0000000000000109

Anderson, Robert, Kleiber, C., Greiner, J., Comried, L., & Zimmerman, M. (2016). Interface pressure redistribution on skin during continuous lateral rotation therapy: A feasibility study. Heart & Lung: The Journal of Critical Care, 45(3), 237–243. https://doi.org/10.1016/j.hrtlng.2016.02.003

Azuh, O., Gammon, H., Burmeister, C., Frega, D., Nerenz, D., DiGiovine, B., & Siddiqui, A. (2016). Benefits of Early Active Mobility in the Medical Intensive Care Unit: A Pilot Study. The American Journal of Medicine, 129(8), 866-871.e1. https://doi.org/10.1016/j.amjmed.2016.03.032

Behrendt, R., Ghaznavi, A. M., Mahan, M., Craft, S., & Siddiqui, A. (2014). Continuous bedside pressure mapping and rates of hospital-associated pressure ulcers in a medical intensive care unit. American Journal of Critical Care: An Official Publication, American

Association of Critical-Care Nurses, 23(2), 127–133. https://doi.org/10.4037/ajcc2014192

Bergstrom, N., Horn, S. D., Rapp, M. P., Stern, A., Barrett, R., & Watkiss, M. (2013). Turning for Ulcer ReductioN: A Multisite Randomized Clinical Trial in Nursing Homes. Journal of the American Geriatrics Society, 61(10), 1705–1713. https://doi.org/10.1111/jgs.12440

Black, J. M., Edsberg, L. E., Baharestani, M. M., Langemo, D., Goldberg, M., McNichol, L., & Cuddigan, J. (2011). Pressure ulcers: Avoidable or unavoidable? Results of the National Pressure Ulcer Advisory Panel Consensus Conference. Ostomy Wound Management, 57(2), 24–30.

Brindle CT, Malhotra R, O'Rrourke S, Currie L, Chadwik D, Falls P, Adams C, Swenson J, Tuason D, Watson S, & Creehan S. (2013). Turning and Repositioning the Critically Ill Patient with Hemodynamic Instability: A Literature Review and Consensus Recommendations. Journal of Wound, Ostomy & Continence Nursing, 40(3), 254–267. c8h. https://doi.org/10.1097/WON.0b013e318290448f

Buckwalter, K. C., Cullen, L., Hanrahan, K., Kleiber, C., McCarthy, A. M., Rakel, B., Steelman, V., Tripp-Reimer, T., & Tucker, S. (2017). Iowa Model of Evidence-Based Practice: Revisions and Validation. Worldviews on Evidence-Based Nursing, 14(3), 175–182. https://doi.org/10.1111/wvn.12223

Coleman, S., Nixon, J., Keen, J., Wilson, L., McGinnis, E., Dealey, C., Stubbs, N., Farrin, A., Dowding, D., Schols, J. M. G. A., Cuddigan, J., Berlowitz, D., Jude, E., Vowden, P., Schoonhoven, L., Bader, D. L., Gefen, A., Oomens, C. W. J., & Nelson, E. A. (2014). A new pressure ulcer conceptual framework. Journal of Advanced Nursing, 70(10), 2222–2234. https://doi.org/10.1111/jan.12405

Cooper, K. L. (2013). Evidence-based prevention of pressure ulcers in the intensive care unit. Critical Care Nurse, 33(6), 57–66. https://doi.org/10.4037/ccn2013985

Cox, J. (2017). Pressure Injuries in Critical Care: A Survey of Critical Care Nurses. Critical Care Nurse, 37(5), 46–56. https://doi.org/10.4037/ccn2017928

Cox, J., Roche, S., & Murphy, V. (2018). Pressure Injury Risk Factors in Critical Care Patients: A Descriptive Analysis. Advances in Skin & Wound Care, 31(7), 328–334. https://doi.org/10.1097/01.ASW.0000534699.50162.4e

Darvall, J. N., Mesfin, L., & Gorelik, A. (2018). Increasing frequency of critically ill patient turns is associated with a reduction in pressure injuries. Critical Care and Resuscitation: Journal of the Australasian Academy of Critical Care Medicine, 20(3), 217–222.

de Almeida Medeiros, A. B., da Conceicao Dias Fernandes, M. I., de Sa Tinoco, J. D., Cossi, M. S., de Oliveira Lopes, M. V., & de Carvalho Lira, A. L. B. (2018). Predictors of pressure ulcer risk in adult intensive care patients: A retrospective case-control study. Intensive & Critical Care Nursing, 45(Journal Article), 6–10.

Edsberg, L. E., Black, J. M., Goldberg, M., McNichol, L., Moore, L., & Sieggreen, M. (2016a). Revised National Pressure Ulcer Advisory Panel Pressure Injury Staging System: Revised Pressure Injury Staging System. Journal of Wound, Ostomy and Continence Nursing, 43(6), 585–597. https://doi.org/10.1097/WON.0000000000000281

Edsberg, L. E., Black, J. M., Goldberg, M., McNichol, L., Moore, L., & Sieggreen, M. (2016b). Revised National Pressure Ulcer Advisory Panel Pressure Injury Staging System. Journal of Wound, Ostomy, and Continence Nursing, 43(6), 585–597. https://doi.org/10.1097/WON.0000000000000281

Estilo, M. E., Angeles, A., Perez, T., Hernandez, M., & Valdez, M. (2012). Pressure ulcers in the intensive care unit: New perspectives on an old problem. Critical Care Nurse, 32(3), 65–70. https://doi.org/10.4037/ccn2012637

Hanrahan, K., Wagner, M., Matthews, G., Stewart, S., Dawson, C., Greiner, J., Pottinger, J., Vernon-Levett, P., Herold, D., Hottel, R., Cullen, L., Tucker, S., & Williamson, A. (2015). Sacred Cow Gone to Pasture: A Systematic Evaluation and Integration of Evidence-Based Practice. Worldviews on Evidence-Based Nursing, 12(1), 3–11. https://doi.org/10.1111/wvn.12072

Jochem, K., & Weigand, L. (2014). Using a Bundle Approach to Reduce Pressure Ulcers in an Icu. American Journal of Safe Patient Handling & Movement, 4(1), 15–20.

Kayser, S. A., VanGilder, C. A., & Lachenbruch, C. (2019). Predictors of superficial and severe hospital-acquired pressure injuries: A cross-sectional study using the International Pressure Ulcer Prevalence (TM) survey. International Journal of Nursing Studies, 89, 46–52. https://doi.org/10.1016/j.ijnurstu.2018.09.003

Krapfl, L. A., Langin, J., Pike, C. A., & Pezzella, P. (2017). Does Incremental Positioning (Weight Shifts) Reduce Pressure Injuries in Critical Care Patients? Journal of Wound, Ostomy, and Continence Nursing: Official Publication of The Wound, Ostomy and Continence Nurses Society, 44(4), 319–323. https://doi.org/10.1097/WON.0000000000000340

Makic, M. B. F., Rauen, C., Watson, R., & Poteet, A. W. (2014). Examining the Evidence to Guide Practice: Challenging Practice Habits. Critical Care Nurse, 34(2), 28–45. https://doi.org/10.4037/ccn2014262

Nam Ho, D., Deog Young, K. I. M., Jung-Hoon, K. I. M., Jong, H. C., So Young, J. O. O., NA, K. K., & Baek, Y. S. (2016). Effects of a continuous lateral turning device on pressure relief. Journal of Physical Therapy Science, 28(2), 460–466.

NDNQI - National Database of Nursing Quality Indicators. (n.d.). Retrieved April 27, 2019, from http://www.pressganey.com/solutions/clinical-excellence/nursing-quality

NPUAP Pressure Injury Stages | The National Pressure Ulcer Advisory Panel—NPUAP. (n.d.). Retrieved March 14, 2019, from https://www.npuap.org/resources/educational-and-clinical-resources/npuap-pressure-injury-stages/

Okhovati, S., Esmaeili, M., & Shariat, E. (2019). Effect of Intensive Care Unit Nurses' Empowerment Program on Ability in Visual Differential Diagnosis of Pressure Ulcer Classification. Critical Care Nursing Quarterly, 42(1), 89–95. c8h. https://doi.org/10.1097/CNQ.0000000000000242

Oomens, C. W. J., Broek, M., Hemmes, B., & Bader, D. L. (2016). How does lateral tilting affect the internal strains in the sacral region of bed ridden patients? - A contribution to pressure ulcer prevention. Clinical Biomechanics (Bristol, Avon), 35, 7–13. https://doi.org/10.1016/j.clinbiomech.2016.03.009

Padula, W. V., Makic, M. B. F., Wald, H. L., Campbell, J. D., Nair, K. V., Mishra, M. K., & Valuck, R. J. (2015). Hospital-Acquired Pressure Ulcers at Academic Medical Centers in the United States, 2008-2012: Tracking Changes Since the CMS Nonpayment Policy. Joint Commission Journal on Quality & Patient Safety, 41(6), 257–263.

Pickham, D., Berte, N., Pihulic, M., Valdez, A., Mayer, B., & Desai, M. (2018). Effect of a wearable patient sensor on care delivery for preventing pressure injuries in acutely ill

adults: A pragmatic randomized clinical trial (LS-HAPI study). International Journal of Nursing Studies, 80(Journal Article), 12–19.

Powell, B. J., Waltz, T. J., Chinman, M. J., Damschroder, L. J., Smith, J. L., Matthieu, M. M., Proctor, E. K., & Kirchner, J. E. (2015). A refined compilation of implementation strategies: Results from the Expert Recommendations for Implementing Change (ERIC) project. Implementation Science, 10(1), 21. https://doi.org/10.1186/s13012-015-0209-1

Reynolds, S. S., Murray, L. L., McLennon, S. M., Ebright, P. R., & Bakas, T. (2016, October 26). Implementation Strategies to Improve Knowledge and Adherence to Spinal Cord Injury Guidelines. Rehabilitation Nursing. https://doi.org/10.1002/rnj.304

Sandström, B., Borglin, G., Nilsson, R., & Willman, A. (2011). Promoting the Implementation of Evidence-Based Practice: A Literature Review Focusing on the Role of Nursing Leadership. Worldviews on Evidence-Based Nursing, 8(4), 212–223. https://doi.org/10.1111/j.1741-6787.2011.00216.x

Shi, C., Dumville, J. C., & Cullum, N. (2019). Evaluating the development and validation of empirically derived prognostic models for pressure ulcer risk assessment: A systematic review. International Journal of Nursing Studies, 89, 88–103. c8h. https://doi.org/10.1016/j.ijnurstu.2018.08.005

Simonis, G., Steiding, K., Schaefer, K., Rauwolf, T., & Strasser, R. H. (2012). A prospective, randomized trial of continuous lateral rotation (“kinetic therapy”) in patients with cardiogenic shock. Clinical Research in Cardiology, 101(12), 955–962. https://doi.org/10.1007/s00392-012-0484-7

Swadener-Culpepper, L. (2010). Continuous Lateral Rotation Therapy. Critical Care Nurse, 30(2), S5–S7. https://doi.org/10.4037/ccn2010766

Tayyib, N., Coyer, F., & Lewis, P. A. (2015). A Two-Arm Cluster Randomized Control Trial to Determine the Effectiveness of a Pressure Ulcer Prevention Bundle for Critically Ill Patients. Journal of Nursing Scholarship, 47(3), 237–247. https://doi.org/10.1111/jnu.12136

Titler, M. G. (2008). The Evidence for Evidence-Based Practice Implementation. In R. G. Hughes (Ed.), Patient Safety and Quality: An Evidence-Based Handbook for Nurses. Agency for Healthcare Research and Quality (US). http://www.ncbi.nlm.nih.gov/books/NBK2659/

Vollman, K. M. (2012). Ask the Experts. Hemodynamic Instability: Is It Really a Barrier to Turning Critically Ill Patients? Critical Care Nurse, 32(1), 70–75. c8h. https://doi.org/10.4037/ccn2012765

White, S., & Spruce, L. (2015). Perioperative Nursing Leaders Implement Clinical Practice Guidelines Using the Iowa Model of Evidence-Based Practice. AORN Journal, 102(1), 50–59. https://doi.org/10.1016/j.aorn.2015.04.001

Table 1

Summaries of Articles Investigating Early Identification and Prevention

Reference	Design Purpose	Subjects & Setting	Intervention: Control/Comparison	Outcomes	Level of Evidence Limitations
Okhovati, S., Esmaeili, M., Shariat, E. 2019	Nonrandomized clinical trial Purpose: To examine the effect of ICU nurses' empowerment program on their ability in differential diagnosis of pressure ulcer staging Intervention group (n=40) Control: (n=40) participants	Convenience sampling, Nurses working in ICUs of 2 selected hospitals w/ Shahid Beheshti U. of Medical Sciences Inclusion nurse > 6 months of experience in the ICU. Exclusion: failure to attend	Intervention: 4-hour in hospital workshop & 10-day social network group led by researcher who uploaded 3 pictures of different stages of pressure ulcer and members of the group identified stages of PU w/ criteria. Correct answer was posted next day. One hospital designated intervention & other hospital designated control group. Using the same method for identifying and staging PIs. Pre/post test	Intervention group: Stage I (p=0.054) Stat. Sig for identifying Stage II(p=0.02), IV (p=0.02) unstageable (p=0.001), DTPI(p=0.001) Control group: Stat. Sig. for identifying. Stage I, III, DTPI Empowerment program	LOE: III Conducted in Iran. Prevalence/incidence rate or stage was not identified pre-intervention in the ICUs failed to provide significant assistance to nurses in identifying stage III
(Tayyib et al., 2015) Saudi Arabia	"A Two-Arm Cluster Randomized Control Trial to Determine the Effectiveness of a Pressure Ulcer Prevention Bundle for Critically Ill Patients"	Two-arm cluster randomized experimental control trial Purpose To test the effectiveness of a pressure ulcer (PU) prevention bundle in reducing the incidence of PUs in critically ill patients	Oct. 2013- Feb. 2014 in 2 Saudi Arabian hospital ICU. Clinical variables, PU presence, staging. Followed every two days: max. of 28 days. n=140	Intervention group: received PU prevention bundle, Control group: received standard skin care as per the local ICU policies. Bundle based on: EPUAP & NPUAP, 2009 guidelines for risk assessment, skin assessment, skin care, nutrition, repositioning, support surface, education, training, and care of medical device	LOE: I Bundle approach and standardized nursing language had a positive impact. Stat Sig. PU incidence Severity Total PUs per patient.
Shi et al., 2019	Systematic review Purpose: to identify and describe empirically derived models for predicting pressure ulcer risk, to assess performance and evaluate clinical impact	Data base search up to Feb. 2017 identifying longitudinal studies that developed models for predicting PUs. Two reviewers conducted ea. Study selection	Inclusion: all settings prospective or retrospective, before & after studies randomized & nonrandomized. Exclusion: case-control, cross-sectional, case series, case reports, reviews, qualitative studies, comments & animal studies.	Reported on 24 studies, recommend: develop quality models using predictors for prevention, only 27-32% of nurses routinely applied prediction models, there is uncertainty about their value	LOE: I potentially may have missed eligible studies, did not examine heuristic tools used in studies, did not focus on information sources of the studies

Table 1 ***(continued)***

Summaries of Articles Investigating Early Identification and Prevention

Reference	Design Purpose	Subjects & Setting	Intervention: Control/Comparison	Outcomes	Level of Evidence Limitations
Padula, et al., 2015	Quasi experimental, observation cohort Purpose: determine correlation b/w HAPU incidence rates & adoption of QI interventions	55 academic medical centers were surveyed b/w Sept '07-Feb.'12. # 5,208 PU cases were analyzed. Inpatient data from University Health System Consortium (UHC). Used a survey instrument to characterize QI interventions,	No intervention/control Comparison was b/w patient & hospital characteristics, QI interventions and HAPU rates	96% used QI interventions, 5 QI interventions for reducing PU: Leadership initiatives, develop visual tools, PU staging, skin care, & nutrition all can be used as part of a QI bundle for preventing HAPU	LOE: IV Possible Recall bias Response bias limited to hospitals that observed positive effects following QI, possible transcription errors in coding in UHC data

Table 2

Summaries of Articles Investigating Risk Factors of the ICU Patient

Reference	Design Purpose	Subjects & Setting	Intervention Control/Comparison	Outcomes	Level of Evidence Limitations
Cox, J., Roche, S., Murphy, V. 2018	Retrospective, descriptive. Purpose: To describe risk factors assoc. w/ PI development in medical-surgical ICU & to determine congruence w/ risk factors proposed by the NPUAP on unavoidable PIs.	Acute care teaching medical center, MSICU during 2013-2016 (n=57) adult >18yrs, LOS> 24hrs., & acquired PI during their admission, data from EHR	Data extracted for intrinsic and extrinsic variables, demographics, LOS, days in MSICU when PI emerged, location/stage, Braden mobility & friction/shear at ADM & 24hrs before appearance of PI	Most freq. factors; immobility, septic shock, vasopressors, HOB>30, sedation, MV>72hrs, Location: sacrum, Stage: DTPI PI HD: 7.5 days	LOE: IV
Medeiros, A., et. al., 2017 Brazil	Retrospective case-control Purpose: to evaluate the predictive power of risk factors for PUs in adult ICU Pts.	Large university hospital in N.E. Brazil. Adult, >18yrs, admitted to ICU, presence of at least 1 PU from stage 1. n=180 Pts. (90 cases & 90 controls), data collected: 1st semester of 2016	Cases: Pts w/ PU at time of data collection. Control: Pts w/o PUs. Primary source of data: direct interaction w/ Pt (physical exam), 2ndary source: clinical records. Pts were classified as case or control and delegated data collection to another researcher. Characteristics were compared b/w cases and controls	Data analysis: stat. sig. strongest predictive risk factors: 1. previous Hx of PU, 2. Tx for comorbidities (renal, cardiovascular, diabetes), 3. prolonged ICU stay, 4. Friction, 5. Dehydration 6. elevated skin temperature.	LOE: III Limitations: Unmatched case and control groups, convenience sampling method

Table 3

Summaries of Articles Investigating Optimal Turning frequency

Reference	Design Purpose	Subjects & Setting	Intervention Control/Comparison	Outcomes	Level of Evidence Limitations
Chew, Thiara, Lopez, & Shorey, (2018)	Scoping review (CINAHL, PubMed, Cochrane Library, ScienceDirect, PsycINFO, Scopus, Pro-Quest, and Web of Science) to identify articles published from 2000 to 2016.	Prevention of hospital-acquired pressure ulcers related to the frequency of turning or repositioning of bed-bound patients.	No intervention or Control	In total, 911 articles were identified, of which 10 were eligible. Of the eligible articles, 8 studies could not reach a conclusion on the effective frequency of turning and duration for repositioning patients to prevent the development of pressure ulcers.	N/A
Darvall et al., (2018)	Pre-Post Intervention evaluation study Purpose: To determine the impact of changing from 5-hourly to 3-hourly turns on PI incidence in critically ill patients.	ICU setting Collected data: (1 July 2015 - 31 December 2015) and compared with (1 February 2016 - 31 August 2016).	Compared change in turn frequency: a 6-month period in which patient turns were 5-hourly (1 July 2015 - 31 December 2015) with a 6-month period during which turns were 3-hourly (1 February 2016 - 31 August 2016). These periods were separated by a 3-week wash-in period. Preintervention (N=1094) admitted Post-intervention (N=1165) admitted	Thirty-eight pre-intervention patients (3.5%) and 23 post-intervention patients (2.0%) developed a pressure injury (P =0.028). The incidence of decubitus injuries was markedly reduced in the post-intervention period (36 v 8 injuries, ($p <$ 0.001).	LOE: IV
(Krapfl et al., 2017)	Evidence-based report reviews if incremental positioning and/or weight shifts reduce HAPI sacral/buttocks pressure injuries in critical care patients deemed too unstable to turn.	scoping review of the literature studies related to repositioning and hospital-acquired pressure injuries in high-risk, critical care patients.	No intervention or Control	Further research is needed to examine whether incremental positioning and/ or weight shifts are effective in reducing pressure injuries in critical care patients.	N/A
(Pickham et al., 2018)	Two arm RCT Pilot study Purpose: To evaluate optimal patient turning. Quantifying a wearable Pt sensor to determine if this is effective in reducing HAPIs	1812 Patients from 2 ICUs/randomly will be assigned CA, USA	All subjects will receive a wearable Pt sensor that will detect patient movement and positioning/info will be relayed to central server.	Study is ongoing	LOE I

Table 4

Summaries of Articles Investigating Skin Pressure and CLRT

Reference	Design Purpose	Subjects & Setting	Intervention: Control/Comparison	Outcomes	Level of Evidence Limitations
R. Anderson, Kleiber, Greiner, Comried, & Zimmerman, (2016)	Feasibility study Purpose: To determine if there are differences in skin interface pressures, skin integrity, or perceived discomfort across three positioning scenarios.	10 healthy participants evaluated in simulation lab in a nurse clinical education center in July 2013	A Hill-Rom Total Care SpOrt (®) bed was equipped with a pressure mapping device. Ten healthy volunteers were placed in each positioning scenario for 30 minutes; interface pressures were recorded.	CLRT alone demonstrated statistically lower interface pressures on ischial tuberosities ($p < 0.05$) as compared to the scenarios with static wedge. Higher pressures were noted on the heels in CLRT alone ($p < 0.05$). One subject noted pain with CLRT. No erythema or breakdown noted.	LOE: IV
(Behrendt et al., 2014)	Retrospective cohort study Purpose: To test Real-time continuous bedside pressure mapping (CBPM)	Patients admitted to the MICU based during January and February 2011 were included in the CBPM cohort group	Continuous bedside pressure mapping systems were placed on 20 beds in MICU (N=307) patients placed on beds with a CBPM system (N=320) historical controls placed on the same beds without the CBPM system	1 (0.3 %) CBPM cohort developed a pressure ulcer compared with 16 (5%) patients in the historical cohort (P = 0.001). Survey of the MICU: 90% of respondents reported that the CBPM contributed to improved pressure detection and relief,	LOE: IV
NAM HO et al., (2016)	One group repeated measure design. Purpose to examine the pressure-relieving effects of a continuous lateral turning device on common pressure ulcer sites	Twenty-four healthy adults participated	Continuous lateral turning pressure-relieving device for immobile and/or elderly people. Interface pressure and time were measured, and comfort grade was evaluated during sessions of continuous lateral turning at 0°, 15°, 30°, and 45°.	Peak pressures were sig. reduced. effective angles for pressure relief at the common pressure ulcer sites were 30° at the occiput, 15° at the left scapula, 45° at the right scapula, 45° at the sacrum, 15° at the right heel, and 30° at the left heel. , angles greater than 30° induced discomfort	LOE: IV
(Oomens et al., 2016)	Parameter Study Purpose: To determine the internal strains in individuals lying in a supine position and during tilting.	14 volunteers of different BMI were used to construct the model	MRI images of sacral area of volunteers were used to create a model and simulations were performed to analyze strain pressures	Highest strain is found in muscle and fat. Peak strains vary with tilting angle. Minimal surface area of strain was found at 20^0-30^0	LOE: IV

Table 4 *(continued)*

Summaries of Articles Investigating Skin Pressure and CLRT

Reference	Design Purpose	Subjects & Setting	Intervention: Control/Comparison	Outcomes	Level of Evidence Limitations
(Simonis et al., 2012)	A retrospective analysis Purpose: To compares KT with standard care in patients with cardiogenic shock.	(N=133) patients with cardiogenic shock admitted to 1 academic heart center was performed	68 patients with KT were compared with 65 patients with SC. Patients with standard care (SC, turning every 2 h by the staff) were compared with kinetic therapy (KT, using oscillating air-flotation beds).	Length of ventilator therapy was 11 days in KT and 18 days in SC (p=0.048). Pneumonia occurred in KT vs. in SC (p<0.001); pressure ulcers reduced by 50% (p<0.001). LOS: SC vs. in KT, p=0.009)	LOE: IV

Table 5

Summary of Gray Literature

Reference	Summary of Relevant Material
(Cox, 2017) Survey article of critical care nurses	Critical care nursing perception of PI prevention • CC nurses think PI prevention is important aspect of care • # of years as a CC nurse correlates with difference in perception of PI prevention risks, effectiveness of Tx, & factors for unavoidable PI.
(Edsberg et al., 2016b) NPUAP staging system Article	Interdisciplinary Consensus held in 2016 • Revised staging system definitions • Revised definition of PU to PI • Definition describes the extent of tissue loss present & anatomical features in the stage of injury.
(*NDNQI - National Database of Nursing Quality Indicators*, n.d.) 2019 Practice statements	Fact sheet on pressure injuries and staging • DTPI results from prolonged pressure & shearing forces • DTPI should be off-loaded as soon as it is discovered
(*NPUAP Pressure Injury Stages | The National Pressure Ulcer Advisory Panel—NPUAP*, n.d.) 2017 Article	NPUAP Position statement on staging- 2017 clarification • PI does not mean HC provider caused the injury • Stages use Arabic numerals and does not imply progression or reverse staging
CPG NPUAP/EPUAP/PPPIA 2014 Book	Prevention and treatment of PUs CPG • Etiology of PI • Intervention & prevention • Treatment

Note. CPG-Clinical Practice Guidelines
NDNQI-National Database of Nursing Quality Indicators
NPUAP/EPUAP/PPPIA-National Pressure Ulcer Advisory Panel/European Pressure Ulcer Advisory Panel/Pan Pacific Pressure Injury Alliance

Table 6

Demographics of Nursing Staff Participating in CLRT Training

Characteristics	n=67	%
Age Range		
18-24	17	25.4
25-34	33	49.3
35-44	10	14.9
45-54	4	6.0
55-64	3	4.5
Gender		
Male	9	13.4
Female	58	86.6
Licensure		
RN	53	79.1
PCT	14	20.9
Employment Status		
Full-Time	58	86.6
Part-Time	9	13.4
Education		
High School	1	1.5
Associate Degree	11	16.4
Bachelor's Degree	47	70.1
Master's Degree	4	6.0
Some College no Degree	4	6.0
Healthcare Experience Years		
0-3	28	41.8
4-6	16	24.0
7-10	9	13.4
11-15	7	10.4
>15	7	10.4

Note. RN=Registered Nurse; PCT=Patient Care Technician

Table 7

Paired t-test results of Pre and Post Continuous Lateral Rotation Therapy Training on Nursing Staff Perception

	Pre-Training (n=28)	Post-Training (n=28)	Paired T-test p value
	N (%)	N (%)	
How confident are you currently in activating the CLRT option? (Very or Extremely)	4(14.3) *	19(68.0) *	<.000
What is your experience in implementing or preparing for CLRT? (No previous experience) (1-2 Times)	21(75.0) 3(11.0)	5(18) 17(61.0	<.005 <.005
Do you Use CLRT in Current practice when caring for hemodynamically unstable patients? (No)	19(68.0)	3(11.0)	<.000
How likely are you to use it after training or now that you have received training? (Very Likely or Likely)	25(89.3) *	27(97.0) *	0.626

Note. * The two options were combined for analysis

Table 8

Comparison of Patient Demographics of those who met inclusion criteria for CLRT pre-and post-training

	Pre-Training (n=13) N (%)	Post-Training (n=18) N (%)
Gender	Male 9 (69.0) Female 4 (31.0)	Male 12(67.0) Female 6 (33.0)
Age	<44Yrs 9(54.0) >45 Yrs. 6(46.0)	<44Yrs 2(11.0) >45 Yrs. 16(89.0)
Diagnosis	Respiratory 7(54); Substance Abuse 2(15.4); Shock 3(23.0); Neuro.1(7.7)	Respiratory 8(44.4); Substance Abuse 2(11.0); Shock 4(22.0); GI 3(11.0)
Mechanical Ventilation	Yes 12(92.0)	Yes 17(94.0)
Braden Score	< 12 7(54.0)	<12 9(50.0)
CLRT Initiated	No 11(85.0)	No 11(61.0)
Total hrs. Pt. Received CLRT	0 Hrs. 11(85); <3 Hrs.1(7.7); > 3 Hrs.1(7.7)	0 Hrs. 11(61);< 3Hrs 4(22.0); >3 Hrs 3(17.0)
Minimum Mode	None	1(6.0)
Custom Mode	2(15.4)	6(33.3)
Other Mode	0	0
Patient Turned	Yes-10(77.0) Inconsistent 3(23.0)	Yes-9(50.0) Inconsistent 9(50.0)
PI POA	0	0
HAPI	0	0

Note. PI POA= Pressure injury present on admission; HAPI=hospital acquired pressure injury

Table 9

Chi-Square statistics for Continuous Lateral Rotation Therapy Nursing Staff Adherence Pre-Training (n=13) and Post-Training (n=18)

	Adherence		
	Pre-training N (%)	Post-training N (%)	Chi-square χ^2; *df* (*p*)
CLRT Initiated	2(15.4)	7(39.0)	2.02; 1 (.237)
Maintains Q2 Turns	2(100)	7(100)	.385; 1(.696)
Minimum Mode	0	1(14.0)	.057; 1 (1.0)
Custom Mode	2(100)	6(86.0)	2.83; 1 (.191)

Note. [a] Q2= every 2 hours. [b] Statistical significance is $p < .05$

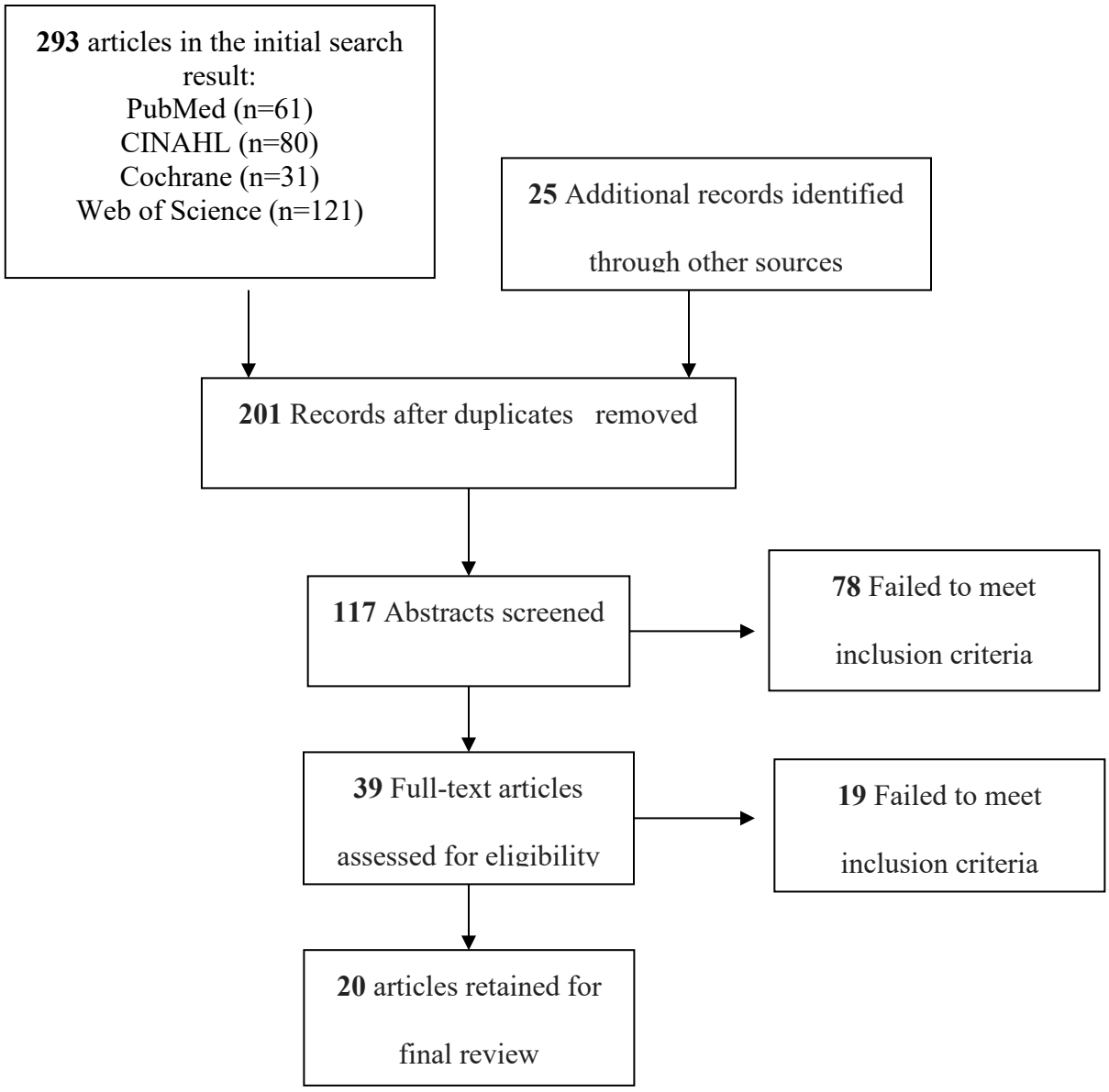
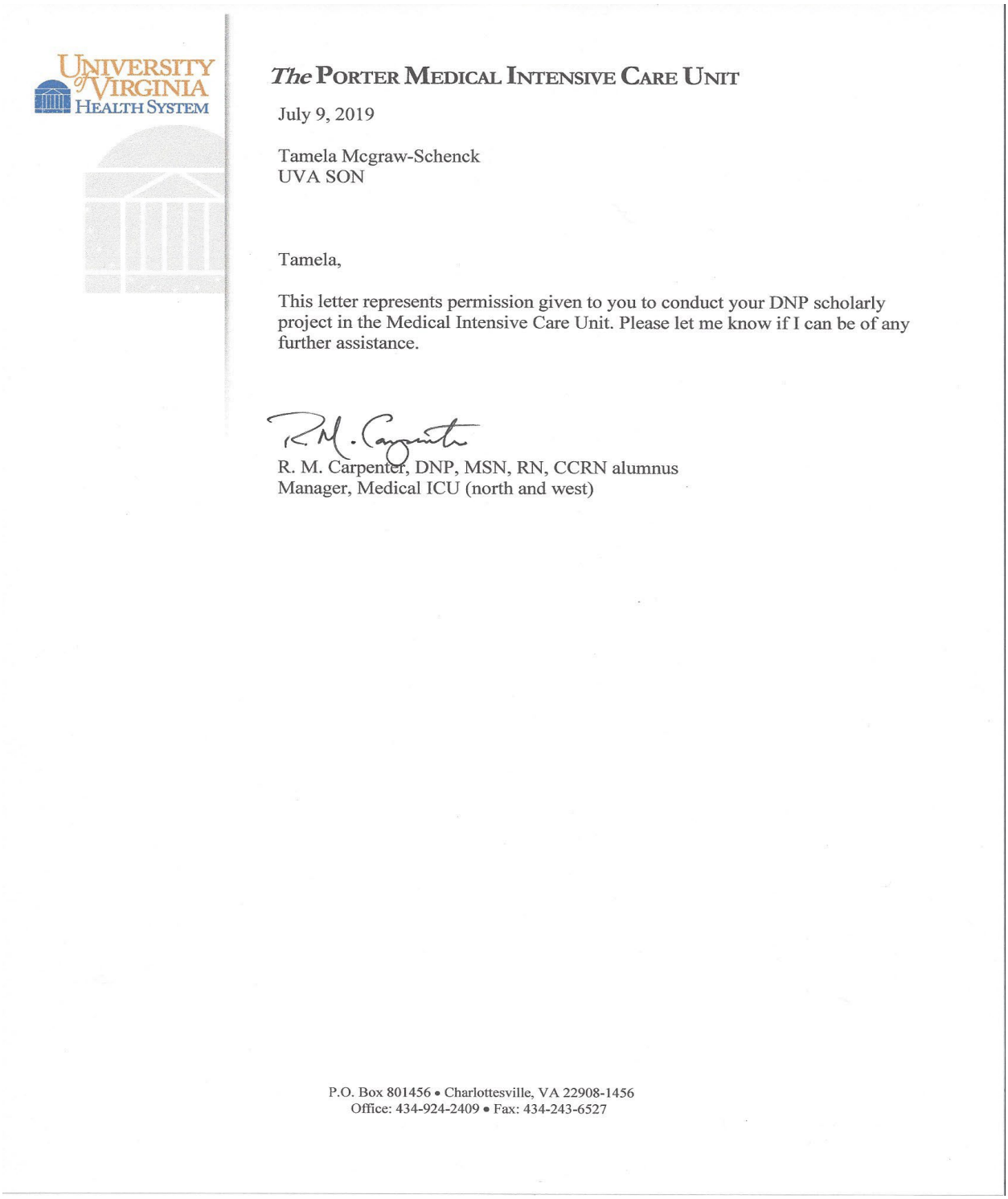


*Figure 1***.** Literature Selection Flow Chart



UNIVERSITY of VIRGINIA HEALTH SYSTEM

The PORTER MEDICAL INTENSIVE CARE UNIT

July 9, 2019

Tamela Mcgraw-Schenck
UVA SON

Tamela,

This letter represents permission given to you to conduct your DNP scholarly project in the Medical Intensive Care Unit. Please let me know if I can be of any further assistance.

R. M. Carpenter, DNP, MSN, RN, CCRN alumnus
Manager, Medical ICU (north and west)

P.O. Box 801456 • Charlottesville, VA 22908-1456
Office: 434-924-2409 • Fax: 434-243-6527

Figure 2. Unit Permission Letter for Scholarly Project

FOR IRB-HSR OFFICE USE ONLY
UVA IRB-HSR Study Tracking # 21755_
Project is determined to NOT meet the criteria of Research with Human Subjects or a Clinical Investigation and therefore is not subject to IRB-HSR Review.
All project team personnel are required to follow all requirements described in this form and follow:
•*Procurement requirements if participants will be compensated for their time*
•*UVA Information Security policies to protect the data: See Appendix B: Privacy Plan.*

Pick One
No health information/specimens are to be collected or used for this project (nurses)
Health information/specimens to be collected or used for this project meet the criteria of Deidentified under HIPAA (No identifiers as noted in Appendix A may be collected/ used.) (Reports regarding patients)
Health information collected meets the criteria of identifiable
Health Information meets the criteria of Limited Dataset.
HIPAA Data Use Agreement is required to share data outside of UVA.
Data/Specimens used in this project are coded:
Check if applicable
Your project was determined to be QI-Improvement Project. If you decide to publish results of this project you must describe the project in the publication as QI and NOT as research.
IF SENDING OR RECEIVING DATA/SPECIMENS
Provide this signed form to School of Medicine Office of Grants and Contracts and/or Medical Center Procurement if your project has external funding or plans to share data/specimens outside of UVA.
Contact the IRB if anything concerning this project changes that might affect the non-human subject determination.
Project is determined to be Human Subjects Research or a Clinical Investigation and must be submitted to the IRB-HSR for review and approval prior to implementation. Please go the Protocol Builder to create your submission. https://www.irb.virginia.edu/
Name of IRB Staff: **_** Karen Mills ***Date:*** **07-26-19 _**

Figure 3. IRB Approval

Dear Nursing Staff,

My name is Tamela McGraw-Schenck I am a Doctor of Nursing Practice student at the University of Virginia School of Nursing. In Fall 2019 I will be implementing a project to train nursing staff using the rotational mode on the ICU beds as an option to implement continuous lateral rotation therapy (CLRT) for patients. This study is projected to be open from September through November.

This is a voluntary project that consists of completing a brief demographic questionnaire which was mailed out to RN and PCT staff before the training. After completing the questionnaire, you will receive information on the dates, times, and location of the training.

The training sessions will consist of face-face training with your return demonstration of CLRT with use a unit bed. You will also be provided an EBP educational handout after the in-person training.

The various times of the training sessions was offered over a 3-week period. The training was in a designated area near the MICU. Each training session will take approximately 20 minutes. You may attend at your convenience.

Thank you for your consideration in participating in this study.

Sincerely,

Tamela McGraw, MSN, RN,

DNP student,

University of Virginia School of Nursing

Figure 4. Initial Email Introducing the Proposed Scholar Project Information

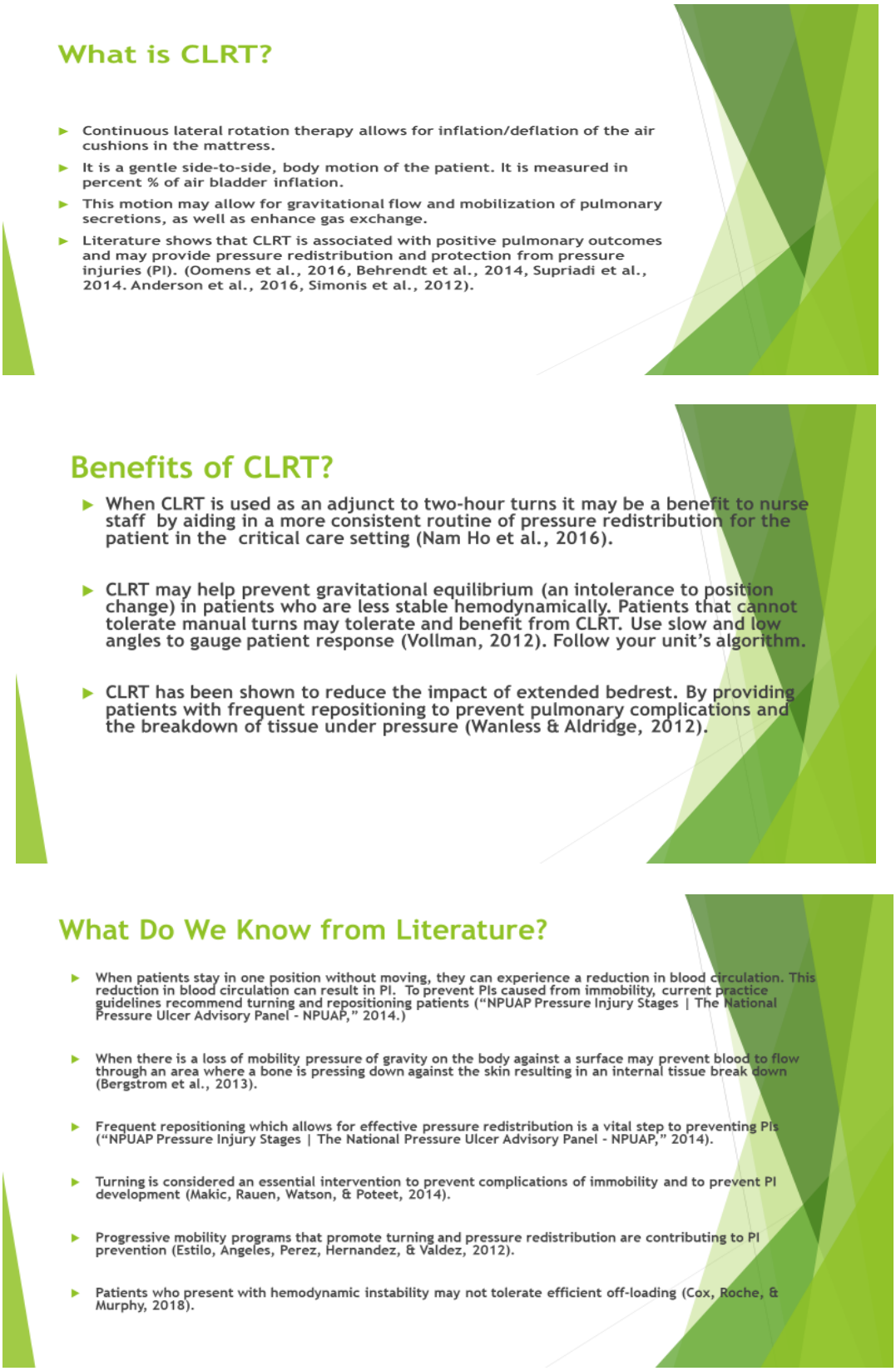


Figure 5. Educational Handout

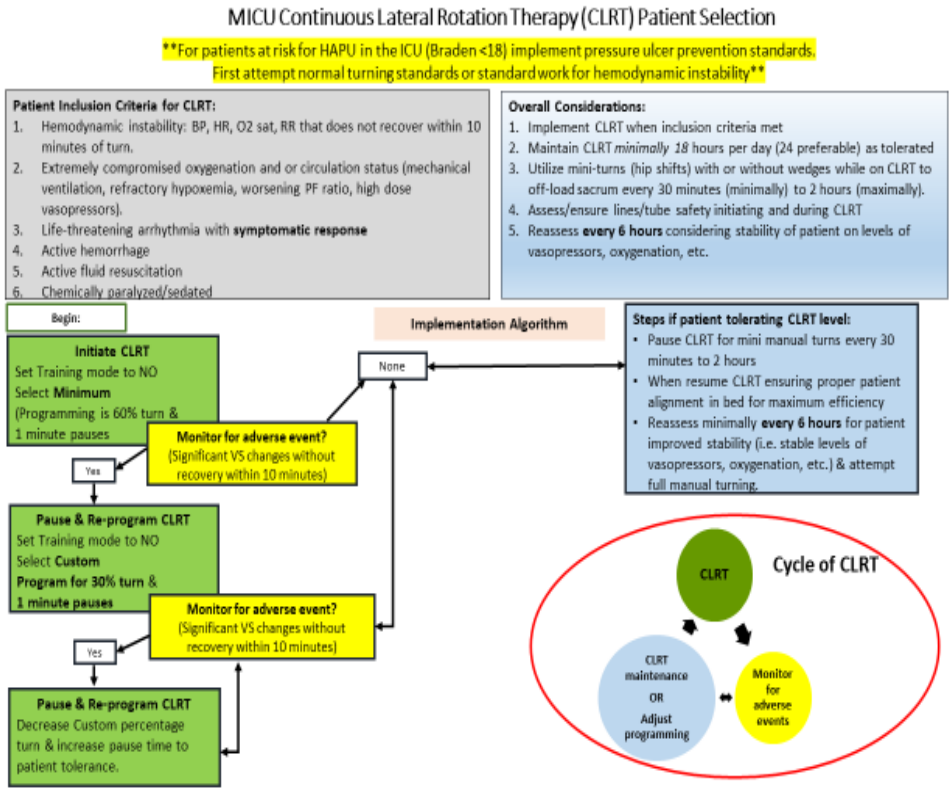


Figure 6. MICU CLRT Algorithm

Demographic Questionnaire

1. What is your gender? (M, F)
2. What is your age? (18-24, 25-34, 35-44, 45-54, 55-or older?)
3. Which of the following categories best describe your employment? (FT, PT?)
4. What is the highest level of education completed? (HS, Associate degree, Bachelor's degree, Master's degree, DNP, Some college, Other)
5. What is your healthcare licensure? (RN, PCT?)
6. Years of healthcare experience? (0-3, 4-6, 7-10, 11-15, >15?)
7. Have you ever received training in continuous lateral rotation therapy on the MICU or on another unit? (None, On the job training on the MICU, On the job training on another unit, classroom/in-service, other?)
8. Are you interested in learning about CLRT? (Extremely interested, very interested, somewhat interested, not so interested, not at all interested?)
9. How confident are you currently in activating the CLRT option through the Progressa Beds on the unit? Extremely confident, very confident, somewhat confident, not so confident, not all confident?)
10. What is your experience in implementing or preparing the bed for CLRT use on the MICU? (None, 1-2 times, 2-3 times, 3-4 times, > than 4 times?)
11. How often in a week do you care for a patient who is hemodynamically unstable on the unit? (0-1, 1-2, 2-3, > 3?)
12. When you are caring for a patient who is hemodynamically unstable and cannot tolerate manual repositioning do you use CLRT in your current practice? (Y, N?)
13. If you receive training in CLRT (or now that you have received training in CLRT) how likely would you use it for your patients who are hemodynamically unstable in the MICU? (very likely, likely, somewhat likely, neither likely nor unlikely, unlikely, very unlikely?)
14. In your opinion what are the greatest barriers on the MICU to consistent patient repositioning? (hemodynamic instability, obese patient, lack of turning equipment, lack of available peer staff, all the above?)

Figure 7. Questionnaire

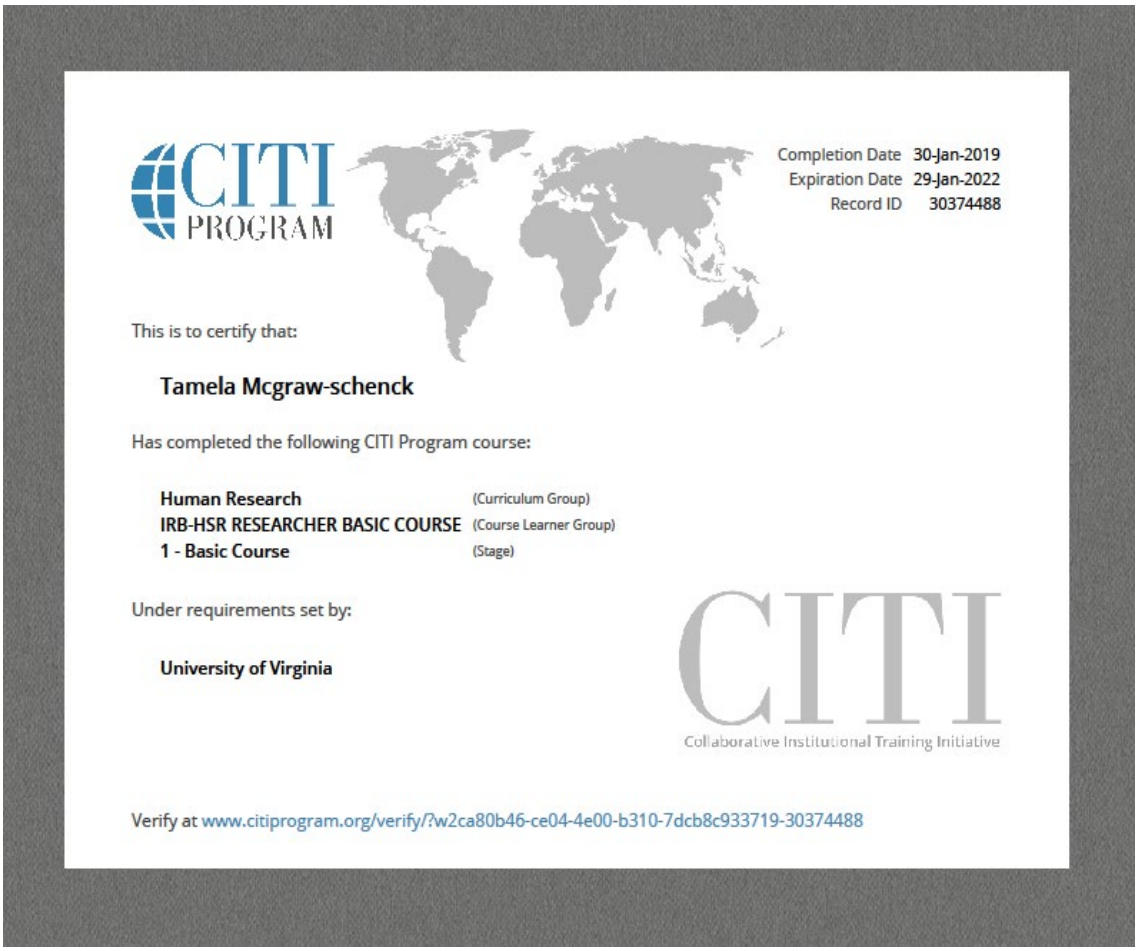


Figure 8. CITI Training

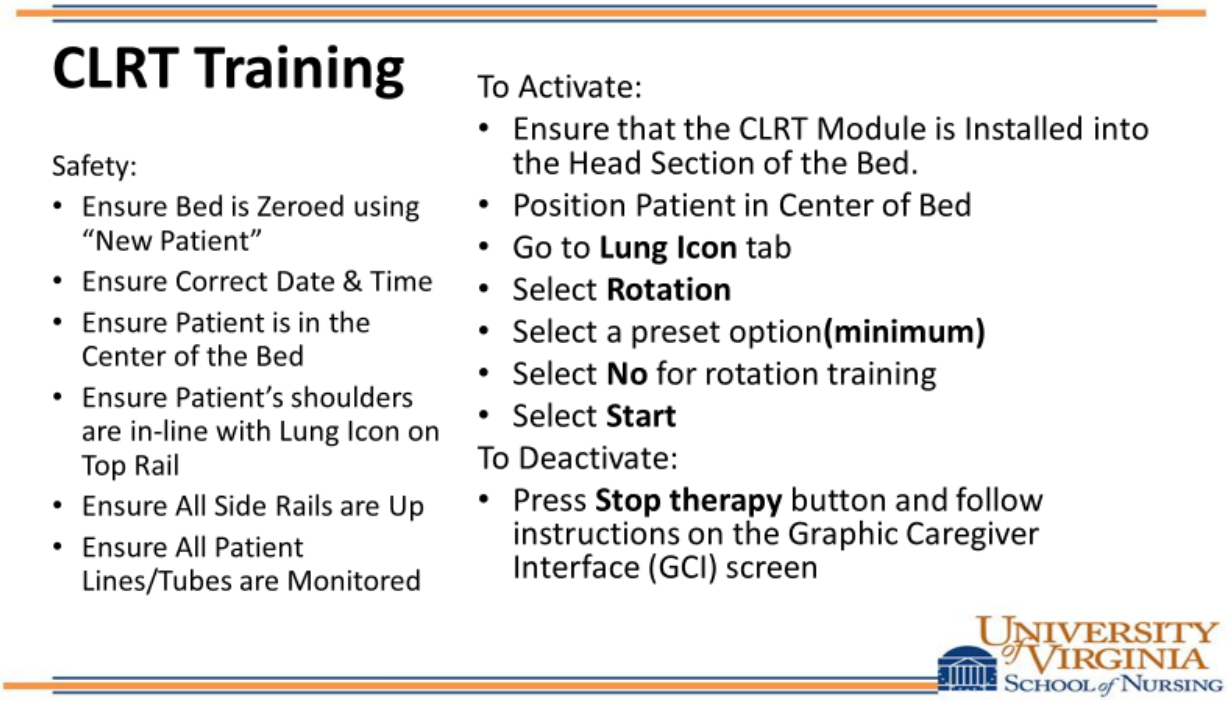


Figure 9. CLRT training

Appendix A

Definition of Terms

Adherence was determined in this project by 3 requirements that are in alignment with the unit's algorithm inclusion criteria. If the patient met inclusion criteria did the trained team members initiated CLRT, did they maintain turning the patient every 2 hours, and was minimum or custom mode utilized on the unit's bed when implementing CLRT?

Continuous lateral rotation therapy is a continuous, slow rotation cycle that redistributes pressure in high risk critically ill individuals. The degree of rotation can be adjusted to the individual's tolerance ("Prevention and Treatment of Pressure Ulcers," 2014).

Hospital acquired pressure injury a pressure injury that occurs after the admission to a facility (*2014 Prevention and Treatment of Pressure Ulcers*, n.d.)

NPUAP Clinical Practice Guidelines the National Pressure Ulcer Advisory Panel Clinical Practice Guidelines-recommends and summarizes supporting evidence for pressure injury prevention and treatment using expert guidance ("Prevention and Treatment of Pressure Ulcers," 2014).

Pressure redistribution is defined as the ability of a support surface on which an individual is placed to distribute load over the contact areas of the human body, thereby reducing the load on areas in contact with the support surface ("Prevention and Treatment of Pressure Ulcers," 2014.).

Pressure injury a pressure injury that is a localized injury to the skin and/or underlying tissue, usually over a boney prominence resulting from sustained pressure (including pressure associated with shear) (" Prevention and Treatment of Pressure Ulcers," 2014).

Appendix B

DRAFT MANUSCRIPT

Promoting Evidence Based Practice Training of Continuous Lateral Rotation Therapy in a Medical Intensive Care Unit

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Work performed at the University of Virginia Medical Center, No financial disclosures.

ABSTRACT

Background: Patients who experience immobility in a critical care setting are at risk for developing skin breakdown. Hospital acquired pressure injuries (HAPI) contribute to health care problems worldwide. Literature supports continuous lateral rotation therapy (CLRT) that redistributes pressure as an efficient means to reduce HAPI and provide mobility for patients who are critically ill or have unstable conditions.

Purpose: To design and implement an educational intervention that enhanced nursing staff perceptions in the evidence-based practice of CLRT in the medical intensive care setting.

Method: A hands-on, face-to-face, educational intervention was conducted in the MICU of an academic medical center. Effectiveness was evaluated in a quantitative pre and post evaluation.

Results: Sixty-seven nursing staff participated in the project. Results showed a positive trend toward increased adherence in CLRT initiation, mode used during therapy, or maintaining every 2-hour turn regimen pre and post training. Statistical significance was noted in staff confidence level ($p < .000$), in using CLRT in current practice for patients who could not be turned due to hemodynamic instability ($p < .000$), and staff experience with implementing or preparing the bed for CLRT use ($p < .005$). In reviewing post training data from the EHR, none of the patients who met inclusion criteria and received CLRT were noted to have documentation indicating presence of HAPI.

Conclusion: EBP education and hands-on training may contribute to increased staff adherence to new practices that involve new technologies. EBP education and clinical application of CLRT could leverage the nurse to optimize quality of care.

Keywords: *("continuous lateral rotation" OR "kinetic therapy") AND ("hospital acquired pressure ulcer" OR "hospital acquired pressure injury" OR pressure ulcer) AND ICU*.

BACKGROUND

Hospital acquired pressure injuries (HAPI) contribute to health care problems worldwide.[1- 5] The National Pressure Injury Advisory Panel (NPIAP) is the leading voice in clarifying current understanding of definitions for pressure injuries (PI) and staging.[1-2] PI is defined as any local damage to the skin and underlying soft tissue usually over a boney prominence or under a medical or other device.[1] Examples of boney prominences include the sacrum, trochanter, ischium, or heel. PI may appear and remain as intact skin or develop into an open injury.[1-2] Pressure injuries may also contribute to pain, increased hospital length of stay, sepsis, additional procedures, inability to return to full functioning, and increased mortality.[3]

The Agency of Healthcare Research and Quality (AHRQ) estimates 2.5 million hospitalized patients will develop pressure injuries each year and 60,000 patients will die from HAPI related complications.[1,4] The Centers for Medicare and Medicaid Services (CMS) and the Joint Commission consider HAPI to be preventable and an indicator of patient safety and quality of care.[5] They classify Stage 3 and Stage 4 HAPIs as "never events" and as of 2008 announced it would no longer pay for costs incurred for hospital-acquired pressure injuries that were not present on admission.[5]

According to the Society for Critical Care Medicine over 5 million patients are treated in our intensive care units (ICU) across the U.S.[6] Many patients who are admitted to the ICU will have illnesses that will prevent and limit their mobility with potential weakness and loss of function.[7] Patients who experience immobility in a critical care setting have increased risk factors for developing skin breakdown.[1, 8] According to the NPIAP immobility is a major risk factor for developing a pressure injury and frequent repositioning with effective pressure redistribution are among the recommendations of the NPIAP Clinical Practice Guidelines.[1] Early

mobility programs that implement interventions to effectively mobilize patients in the critical care setting are proven to significantly decrease complications such as HAPI.[9, 10] In the critical care setting it is important for nursing staff to assess and manage patient mobility.[10] Clinical evidence supports the importance of progressive mobility with implementation of head of bed elevation, manual turning, passive and active range of motion, chair position, ambulation, and continuous lateral rotation therapy.[9]

Continuous lateral rotation therapy (CLRT) provides a slow rotation cycle that redistributes pressure in high risk critically ill individuals.[1, 9-10] Literature supports the use of CLRT as an efficient way to provide mobility for patients who are critically ill or have hemodynamically unstable conditions [1, 9-10]. Critically ill patients who demonstrate signs of decompensation with manual turning may better tolerate slow incremental turns that CLRT can provide, while protecting vulnerable skin.[9-10] Studies support recommending that the nurse consider initiating CLRT to train the patient's body to better tolerate side-side movement.[9-10]

FRAMEWORK

The educational intervention used in this project was guided by the Iowa Model of EBP to Promote Quality of Care.[11] This project integrated research and other science into the practice setting through the process of inquiry and asking difficult questions and seeking answers to pressure injury on the MICU. This project examined scientific literature to guide the clinical practice of using CLRT in the intensive care setting. The design of this project incorporated the formation of a team of key stakeholders for staff and leadership engagement of the unit to include, the Clinical Nurse Specialists (CNSs), the Wound Care Nurse Manager, unit nurse educators, a bed-manufacturer, education representative, unit skin care champions, and informal

nurse leaders. The training of staff in implementing CLRT on the unit provided a means for systematic change and a foundation for improved quality

CLINICAL PROBLEM

Maintaining awareness, by educating and supporting nursing staff in the importance of mobility interventions and pressure injury prevention were ongoing efforts of the leadership staff for the healthcare facility. With the continuous model for improvement many evidenced-based nursing interventions were implemented into standards of care throughout the facility. Part of these ongoing efforts included identifying any gaps in training or nursing staff knowledge.

One element of the unit's standard work included the implementation of CLRT to aid in the patient better tolerating side-side movement. A returned questionnaire from 20 registered nurses on the unit revealed 80% having at least one patient weekly who was hemodynamically unstable, and 40% reported they were not aware of the unit's existing standard work for turning a hemodynamically unstable patient. Of those surveyed 90% of nursing staff reported attempting to weight shift patients who are hemodynamically unstable, and none of the nursing staff surveyed reported using CLRT. Moreover, the certified wound and ostomy nurses found in their interaction with nursing staff there was a general lack of knowledge regarding the impact of CLRT on pressure prevention in the MICU. In addition, nursing staff expressed several challenges in meeting turning standards on the unit and identified barriers to consistent repositioning with patient hemodynamic instability, obese patients, and lack of available peer assistance to aid in turning.

Project Purpose

Although each bed on the unit had the capability of CLRT, previously no training specific to the evidence-based literature of CLRT prepared nursing staff to utilize this available

technology for their patient population. The initiative to train nursing staff to utilize CLRT for the hemodynamically unstable patient was supported by the clinical practice leaders, and management team. The purpose of this project was to design and implement an educational intervention that enhanced nursing staff perceptions in the evidence-based practice of CLRT in the medical intensive care setting. The project question asked: Does face-to-face education and hands-on training regarding the use of CLRT promote adherence to evidenced-based practice (EBP) guidelines in a medical intensive care unit in an academic medical center?

Literature Review

HAPI risk factors for the ICU patient are complex and require a multifaceted approach to prevention.[12-15] Although the optimal frequency of turning for the ICU patient is unclear, turning patients every two hours is considered a best practice for good nursing care. [12, 15-17] Studies that investigated optimal turning frequency concluded critically ill patients benefit from more frequent turns.[12, 17-18] Turning is considered an essential intervention to prevent complications of immobility contributing to significant decreases in PI.[17-19] Interventions that target progressive mobility make patients less susceptible to PI and may affect prevention of HAPI. [7, 9-10, 20-- 21]

Additionally, studies that explore interface pressures found that patients who receive repositioning with effective offloading experience decreased peak pressures that can contribute to PI development. [21-22] However, there are limitations in the design method such as using healthy adults or small sample sizes.[21-23] Despite the limited evidence, science points to the benefits of incremental positioning and/or frequent weight shifts as an intervention in critical care patients who are too unstable to turn [9-10, 12, 18-20, 23] It is suggested that additional research examine whether incremental positioning and/ or weight shifts are effective in reducing pressure injuries in critical care patients.[12-24] Patients who present with hemodynamic instability may not

tolerate efficient off-loading and therefore technology that allows easier turning or more frequent off-loading of pressure may be a benefit to nurse and patient.[9-10,] CLRT has the potential for off-loading areas of high pressure for immobile critically ill patients or those with unstable conditions.[1, 9-10, 22-24] Therefore, the use of CLRT when used as an adjunct to two-hour turns may be a benefit to nursing staff and aid in a more consistent routine of pressure redistribution for the patient in the critical care setting.

METHODS

The project was reviewed by Institutional Review Board and approval was obtained prior to the start of the project

The project was conducted in a 28-bed inpatient MICU at an academic medical center located in the southeastern U.S. A convenience sampling method of RN and nursing assistant team members, who are employed at the MICU were invited through an email communication to participate in the project.

Prior to the start of the hands-on, face to face educational sessions, a "train the trainer day" was facilitated in partnership with the unit's stakeholders. Thirteen individuals attended and received CLRT training with the project lead and the bed-manufacturer education representative. Following the train-the trainer week, promotion of EBP through CLRT training was extended to the RN and PCT staff team members using standard unit communication mechanisms.

All staff team members were invited to complete a demographic and CLRT questionnaire immediately prior to training. One month after the training, the identical CLRT questionnaire was offered as a post-assessment to those who attended the training. To evaluate the frequency of and adherence to the CLRT algorithm pre and post CLRT training, data from the repository within each of the unit's beds was collected over a 2-week period prior to the training and 2-

weeks after the training. In addition, the EHR was analyzed during this same time to determine if patients met the criteria for CLRT implementation and if CLRT use was documented.

Education Intervention

The training of team members consisted of face-to-face training with a return demonstration of CLRT using the unit bed. Each training session lasted approximately 20 minutes and was facilitated over a 3-week period with the goal of training as many RNs and PCTs team members as possible. During each teaching session a CLRT skill check list was used. This ensured each team member received the same CLRT algorithm training and established the same return demonstration of skill. Training was offered in a convenient location near the MICU unit, and during various work hours to facilitate attendance. To accommodate staff, training was offered during day, night, and weekend shifts. An EBP educational handout along with the unit's algorithm for the use of CLRT on the unit was reviewed with participants and offered as a take-a-way following the training. Additionally, a CLRT resource binder was designed and distributed to the unit for reference and to promote sustainability of the initiative.

Measures

The project pre and post assessment questionnaire was developed by the project lead in consultation with key stakeholders. The questionnaire that was distributed to staff who volunteered to participant in the project assessment, consisted of a Likert scale questionnaire consisting of 6 demographic questions and 8 questions specific to CLRT. (see Figure 1) Additionally, a data collection instrument was designed for the clinical setting to obtain CLRT algorithm adherence data. The instrument was used to record data collected from the unit beds and EHR.

Data Analysis

The statistical analysis of the data was conducted using the statistical software package SPSS® version 25. Descriptive data were reported as mean, standard deviation and percentages as appropriate. A paired t-test was used to analyze changes in scores from pre-assessment to post intervention for the measures of CLRT confidence, experience, current use, and how likely to use CLRT in current practice. To identify differences in pre and post patient demographic data extracted from the unit beds and EHR, an independent t-test was used for analysis. To determine CLRT algorithm adherence, the differences between groups were analyzed using the Chi square test of independence with the Fisher's exact test. A two-sided *p* value of <.05 was used to establish statistical significance.

RESULTS

A total of 55% (n = 67) clinicians attended training, including 79% (n = 53) nurses and 21% (n = 14) nursing assistants. Of those who participated in the project 70% (n = 47) held a bachelor's degree (BSN) as the highest level of education, and 66% (n = 44) reported having 6 years or less in healthcare experience. Perceived confidence level 64% (n = 43) participants reported they had either no confidence or they were not so confident in activating or implementing the CLRT option currently on the unit. Previous experience in implementing or preparing the beds for CLRT 63% (n = 42) participants reported no experience in implementing or preparing the beds. Current use of CLRT in current practice 66% (n = 44) participants reported they do not use CLRT in current practice when caring for a hemodynamically unstable patient and 90% (n = 60) reported they are likely or very likely to use CLRT after training. Demographic data for the sample are illustrated in Table 1.

Staff were surveyed immediately prior to training and approximately 1 month after CLRT implementation on the unit. Comparison means analysis using a paired t-test was performed on

the assessment data from the 28 team members who returned post-training questionnaires. Four questions were directly selected for analysis based on their relevance to post training assessment. In the analysis of pre versus post assessment questionnaire responses, three of the four selected questions demonstrated statistically significant differences. There was a statistically significant improvement in confidence in activating CLRT, t (27) = -7.28, p = .000. Additionally, there was a statistically significant improvement in the self-reported staff experience in implementing or preparing for CLRT, t (27) = -3.02, p = .005. Lastly, with respect to current CLRT use in hemodynamically unstable patients there was statistically significant improvement, t (27) = -6.00, p = .000. Interestingly, the one question that did not demonstrate statistical significance dealt with the likelihood of using CLRT after training, t (27) = -.493, p = 0.626. (see Table 2).

In determining CLRT algorithm adherence on the unit, an observational review of the data repositories within the unit's beds and EHRs was conducted. With use of a data collection repository located on the unit beds and EHRs, compliance was reviewed routinely over a 2-week period pre-and post-training. During the pre-training phase of the project 79 individual EHRs and beds were reviewed. During this time there was 13 patients admitted to the unit who met inclusion criteria based on the unit's CLRT algorithm and 2 patients (15%) received CLRT during their admission. During the post-training phase, the same process was utilized as the pre-training with 84 individual EHRs reviewed resulting in 18 patients meeting inclusion criteria and 7 (39%) patients received CLRT.

The demographics of the patients who met inclusion criteria pre and post training were compared using descriptive statistics and an independent t-test analysis was performed to determine significant differences between the 2 patient populations. In the pre-training cohort, the 13 patients who met inclusion criteria were predominantly male (69%), and < 44 years of age

(54%). Range of diagnoses included 7 (54%) respiratory related, 2 (15%) substance abuse related, 3(23 %) shock, and 1(8%) neuromuscular. Twelve (92%) were mechanical ventilated, and 7(54%) had a Braden score <12. In the 2 patients who received CLRT, 1 patient received CLRT <3 hours; and 1 patient received CLRT > 3 hours. Both patients received the CLRT with a custom mode. There was no other observed mode used. From EHR documentation the majority were consistently turned and repositioned 10 (77%), and there was no documentation indicating a pressure injury upon admission or a HAPI associated with a patient receiving CLRT.

In the post-training cohort, the 18 patients who met inclusion criteria were predominately males (67%), and > 45 years of age (89%). Range of diagnoses included 8 (44%) respiratory related, 2 (11%) substance abuse related, 4 (22%) shock, 3 (11%) GI related. Seventeen patients (94%) were mechanically ventilated; 9 patients (50%) had a Braden score <12. In those patients who received CLRT, 4 patients (22%) received CLRT <3 hours, 3 patients (17%) received CLRT > 3 hours. One patient received the minimum mode, and 6 patients received a custom mode. There was no other observed mode used. Nine (50%) were consistently turned and repositioned and there was no documentation of pressure injury upon admission or development of HAPI while receiving CLRT. (see Figure 2)

Independent t-test analysis revealed no significant difference between the patient demographics except in age. There was a significant difference in age showing the patients who met inclusion criteria post-training were statistically significantly older $t(22.62) = -2.42$, $p = .024$.

Adherence

In determining adherence 3 comparison criteria were used based on the CLRT algorithm: 1) Patient met inclusion criteria; was CLRT utilized? 2) Patient met inclusion criteria and CLRT

initiated; was minimum or custom mode used during CLRT therapy? and 3) Patient met the inclusion criteria and CLRT initiated; were every 2-hour turns maintained?

Comparisons were made using the exact chi square between the patients who met inclusion criteria and the 3 adherence measures. Analysis showed 2 patients (15%) pre-training and 7 patients (39%) post-training received CLRT, $\chi^2(1, N=31) = 2.02$, $p = .237$. Of those who met inclusion criteria and CLRT initiated there were no patients who received minimum mode pre-training and 1 patient (14%) received minimum mode post-training, $\chi^2(1, N=31) = .057$, $p = 1.0$. For those patients who met inclusion criteria and CLRT was initiated there were 2 patients (100%) pre-training, and 6 patients (86%) post-training who received a custom mode during CLRT, $\chi^2(1, N=31) = 2.83$, $p = .191$. Thirdly, for those patients who met inclusion criteria and had CLRT initiated the patients before training 2(100%) and 7 (100%) post training had documentation in the EHR they were turned or repositioned every 2 hours, $\chi^2(1, N=31) = .385$, p=0.696 (see Table 3).

Discussion

. The purpose of this project was to design and implement an educational intervention that enhanced nursing staff perceptions in the evidence-based practice of CLRT in the medical intensive care setting.

This project addressed a gap in staff knowledge related to evidenced-based use for CLRT in the practice setting as a strategy for prevention of HAPI. This project suggests that educating and training staff to implement EBP promotes practice change with a positive trend towards increased adherence and a clear improvement in confidence with CLRT.

In assessing the pre-post staff questionnaires, the results do not demonstrate a statically significant improvement in the likelihood of use of the therapy in hemodynamically unstable patients. Yet there is a positive trend of improvement from (89% to 97%) (Table 2). A possible reason for this is that with a convenience sampling, a natural bias exists and therefore often skews data rendering it difficult to create a statistically significant change. Despite a small return rate of post questionnaires, an interesting finding in this project was the statistically significant differences between the pre- and post-questionnaires in the areas of staff experience, staff confidence**,** and their self-reported current use of CLRT. The significant results showed that hands-on, face-to-face EBP training can benefit staff. This reflects the potential for systematic change and a foundation for improved quality.

This project does not reconcile the question of whether CLRT will improve patient outcomes in an ICU setting. This project does reflect the fluctuation of patient demographics in the ICU setting from one week to the next and how those who may benefit from CLRT will be dependent on multiple patient factors. This project suggests challenges of implementing and adopting new technologies. This is particularly true for newly graduated nurses transitioning from orientation who are often overwhelmed by change, and more seasoned nurse who may not be as welcoming of technologies While significant staff adherence to CLRT was not apparent in the outcome data, continued strategies for supportive implementation and training is needed to yield clinical relevance.

Limitations

This EBP project had limitations. The voluntary sample could indicate that only those who were interested in learning of CLRT attended training. The small sample size due to questionnaire response rate limits the conclusions that can be drawn from the data. Since training

was voluntary, not all staff were trained, and this may have affected adherence data and CLRT utilization outcome. Despite the benefits, the bed data repository technology was limited and at times was difficult to determine sequence of the therapy mode used by the staff thus hampering data collection. The measuring tool created for this project was not tested for validity or reliability. The restriction to one medical nursing unit limits the generalizability of the project.

CONCLUSION

Guidelines that are available on PI prevention do not specify the exact optimal frequency of turning but, encourages the clinician to assess the risk of PI with consideration of the individual. [25] Although studies demonstrate immobility is a major risk factor for PI, PI is multifaceted with no single risk factor that explains its development.[15, 17] However, not all nurses have the same training, educational exposure or understanding of their unique patient population and their specific risks for developing PIs. Some teams may not realize that patients who simply cannot weight shift themselves are two times greater for developing a PI, and under certain conditions simply being a patient in the ICU indicates a 3-fold increased chance of developing pressure injuries.[16, 26] Therefore, it is important for teams to receive ongoing training in EBP prevention of HAPI and consider newer technologies that can facilitate off-loading.

When patient care incorporates EBP, the quality of care can be improved.[27] Incorporating CLRT and its clinical application into the ICU setting could aid the nurse in providing improved safety and quality of care.[9-10] Through this project EBP training in CLRT fostered staff awareness. The emphasis of evidence-based practice training contributed to positive nurse perception in current use of CLRT on the unit. This project demonstrates the value of EBP training to increase confidence and use of CLRT regarding pressure redistribution for the ICU patient.

The data collection and monitoring provided insights that the staff and organizational stakeholders can use to enhance future adherence to CLRT. Assessing ongoing challenges and barriers to the patients and staff will be required to sustain and maintain these practices with the goal of continuing to increase adherence to the EBP guidelines and ultimately decreasing untoward complications of HAPI in the vulnerable ICU population.

References

1. 2019 Guideline QRG E-Version (NPIAP) - Clinical Practice Guidelines. https://guidelinesales.com/store/ViewProduct.aspx?ID=15037164. Accessed April 9, 2020.

2. Edsberg LE, Black JM, Goldberg M, McNichol L, Moore L, Sieggreen M. Revised National Pressure Ulcer Advisory Panel Pressure Injury Staging System. *J Wound Ostomy Continence Nurs*. 2016;43(6):585-597. doi:10.1097/WON.0000000000000281

3. Stafford AB, Brower JC. Let's get comfortable: Preventing pressure ulcers. *Nurs Manag Springhouse*. 2012;43(9):10-12. doi:10.1097/01.NUMA.0000418777.69056.f7

4. Ramanathan R, Leavell P, Wolfe LG, Duane TM. Agency for Healthcare Research and Quality patient safety indicators and mortality in surgical patients. *Am Surg*. 2014;80(8):801-804.

5. Hospital-Acquired Conditions | CMS. https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/HospitalAcqCond/Hospital-Acquired_Conditions. Accessed April 11, 2020.

6. SCCM | Critical Care Statistics. Society of Critical Care Medicine (SCCM). https://sccm.org/Communications/Critical-Care-Statistics. Accessed April 23, 2019.

7. Azuh O, Gammon H, Burmeister C, et al. Benefits of Early Active Mobility in the Medical Intensive Care Unit: A Pilot Study. *Am J Med*. 2016;129(8):866-871.e1. doi:10.1016/j.amjmed.2016.03.032

8. Cox J. Pressure Injury Risk Factors in Adult Critical Care Patients: A Review of the Literature. *Ostomy Wound Manage*. 2017;63(11):30-43.

9. Brindle CT, Malhotra R, O'Rrourke S, et al. Turning and Repositioning the Critically Ill Patient with Hemodynamic Instability: A Literature Review and Consensus Recommendations. *J Wound Ostomy Continence Nurs*. 2013;40(3):254-267. doi:10.1097/WON.0b013e318290448f

10. Swadener-Culpepper L. Continuous Lateral Rotation Therapy. *Crit Care Nurse*. 2010;30(2): S5-S7. doi:10.4037/ccn2010766

11. Buckwalter KC, Cullen L, Hanrahan K, et al. Iowa Model of Evidence-Based Practice: Revisions and Validation. *Worldviews Evid Based Nurs*. 2017;14(3):175-182. doi:10.1111/wvn.12223

12. Darvall JN, Mesfin L, Gorelik A. Increasing frequency of critically ill patient turns is associated with a reduction in pressure injuries. *Crit Care Resusc J Australas Acad Crit Care Med*. 2018;20(3):217-222.

13. Smit I, Blevins C. EB91 A 3-Year Journey to Decrease Occurrence of Pressure Ulcers in an Academic Medical Intensive Care Unit. *Crit Care Nurse*. 2014;34(2): e23-e23.

14. Smit I, Harrison L, Letzkus L, Quatrara B. What Factors Are Associated with the Development of Pressure Ulcers in a Medical Intensive Care Unit? *Dimens Crit Care Nurs DCCN*. 2016;35(1):37-41. doi:10.1097/DCC.0000000000000153

15. Cox J, Roche S, Murphy V. Pressure Injury Risk Factors in Critical Care Patients: A Descriptive Analysis. *Adv Skin Wound Care*. 2018;31(7):328-334. doi:10.1097/01.ASW.0000534699.50162.4e

16. de Almeida Medeiros AB, da Conceicao Dias Fernandes MI, de Sa Tinoco JD, Cossi MS, de Oliveira Lopes MV, de Carvalho Lira ALB. Predictors of pressure ulcer risk in adult intensive care patients: A retrospective case-control study. *Intensive Crit Care Nurs*. 2018;45(Journal Article):6-10.

17. Pickham D, Ballew B, Ebong K, Shinn J, Lough ME, Mayer B. Evaluating optimal patient-turning procedures for reducing hospital-acquired pressure ulcers (LS-HAPU): study protocol for a randomized controlled trial. *Trials*. 2016;17(Journal Article):190-016-1313-1315. doi:10.1186/s13063-016-1313-5

18. Chew H-SJ, Thiara E, Lopez V, Shorey S. Turning frequency in adult bedridden patients to prevent hospital-acquired pressure ulcer: A scoping review. *Int Wound J*. 2018;15(2):225-236. doi:10.1111/iwj.12855

19. Moore Z, Cowman S. Pressure ulcer prevalence and prevention practices in care of the older person in the Republic of Ireland. *J Clin Nurs*. 2012;21(3-4):362-371. doi:10.1111/j.1365-2702.2011.03749.x

20. Dickinson S, Tschannen D, Shever LL. Can the use of an early mobility program reduce the incidence of pressure ulcers in a surgical critical care unit? *Crit Care Nurs Q*. 2013;36(1):127-140. doi:10.1097/CNQ.0b013e31827538a1

21. Peterson MJ, Gravenstein N, Schwab WK, van Oostrom JH, Caruso LJ. Patient repositioning and pressure ulcer risk-Monitoring interface pressures of at-risk patients. *J Rehabil Res Dev*. 2013;50(4):477-488. doi:10.1682/JRRD.2012.03.0040

22. Anderson R, Kleiber C, Greiner J, Comried L, Zimmerman M. Interface pressure redistribution on skin during continuous lateral rotation therapy: A feasibility study. *Heart Lung J Crit Care*. 2016;45(3):237-243. doi:10.1016/j.hrtlng.2016.02.003

23. Simonis G, Steiding K, Schaefer K, Rauwolf T, Strasser RH. A prospective, randomized trial of continuous lateral rotation ("kinetic therapy") in patients with cardiogenic shock. *Clin Res Cardiol*. 2012;101(12):955-962. doi:10.1007/s00392-012-0484-7

24. Wanless S, Aldridge M. Continuous lateral rotation therapy - a review. *Nurs Crit Care*. 2012;17(1):28-35. doi:10.1111/j.1478-5153.2011.00458.x

25. NPUAP Pressure Injury Stages | The National Pressure Ulcer Advisory Panel - NPUAP. https://www.npuap.org/resources/educational-and-clinical-resources/npuap-pressure-injury-stages/. Accessed March 14, 2019.

26. Kayser SA, VanGilder CA, Lachenbruch C. Predictors of superficial and severe hospital-acquired pressure injuries: A cross-sectional study using the International Pressure Ulcer Prevalence (TM) survey. *Int J Nurs Stud*. 2019;89:46-52. doi:10.1016/j.ijnurstu.2018.09.003

27. Padula WV. Are Evidence-based Practices Associated with Effective Prevention of Hospital-acquired Pressure Ulcers in US Academic Medical Centers? *Med Care*. 2016;54(5):512-518.

Table 1

Demographics of Nursing Staff Participating in CLRT Training

Characteristics	n=67	%
Age Range		
18-24	17	25.4
25-34	33	49.3
35-44	10	14.9
45-54	4	6.0
55-64	3	4.5
Gender		
Male	9	13.4
Female	58	86.6
Licensure		
RN	53	79.1
PCT	14	20.9
Employment Status		
Full-Time	58	86.6
Part-Time	9	13.4
Education		
High School	1	1.5
Associate Degree	11	16.4
Bachelor's Degree	47	70.1
Master's Degree	4	6.0
Some College no Degree	4	6.0
Healthcare Experience Years		
0-3	28	41.8
4-6	16	24.0
7-10	9	13.4
11-15	7	10.4
>15	7	10.4

Note. RN=Registered Nurse; PCT=Patient Care Technician

Table 2

Paired t-test results of Pre and Post Continuous Lateral Rotation Therapy Training on Nursing Staff Perception

	Pre-Training (n=28)	Post-Training (n=28)	Paired T-test p value
	N (%)	N (%)	
How confident are you currently in activating the CLRT option? (Very or Extremely)	4(14.3) *	19(68.0) *	<.000
What is your experience in implementing or preparing for CLRT? (No previous experience) (1-2 Times)	21(75.0) 3(11.0)	5(18) 17(61.0	<.005 <.005
Do you Use CLRT in Current practice when caring for hemodynamically unstable patients? (No)	19(68.0)	3(11.0)	<.000
How likely are you to use it after training or now that you have received training? (Very Likely or Likely)	25(89.3) *	27(97.0) *	0.626

Note. * The two options were combined for analysis

Table 3

Chi-Square statistics for Continuous Lateral Rotation Therapy Nursing Staff Adherence Pre-Training (n=13) and Post-Training (n=18)

	Adherence		
	Pre-training N (%)	Post-training N (%)	Chi-square χ^2; *df* (*p*)
CLRT Initiated	2(15.4)	7(39.0)	2.02; 1 (.237)
Maintains Q2 Turns	2(100)	7(100)	.385; 1(.696)
Minimum Mode	0	1(14.0)	.057; 1 (1.0)
Custom Mode	2(100)	6(86.0)	2.83; 1 (.191)

Note. [a] Q2= every 2 hours. [b] Statistical significance is $p < .05$

Figure 1: Demographic Questionnaire

1. What is your gender? (M, F)

2. What is your age? (18-24, 25-34, 35-44, 45-54, 55-or older?)

3. Which of the following categories best describe your employment? (FT, PT?)

4. What is the highest level of education completed? (HS, Associate degree, Bachelor's degree, Master's degree, DNP, Some college, Other)

5. What is your healthcare licensure? (RN, PCT?)

6. Years of healthcare experience? (0-3, 4-6, 7-10, 11-15, >15?)

7. Have you ever received training in continuous lateral rotation therapy on the MICU or on another unit? (None, On the job training on the MICU, On the job training on another unit, classroom/in-service, other?)

8. Are you interested in learning about CLRT? (Extremely interested, very interested, somewhat interested, not so interested, not at all interested?)

9. How confident are you currently in activating the CLRT option through the P Beds on the unit? Extremely confident, very confident, somewhat confident, not so confident, not all confident?)

10. What is your experience in implementing or preparing the bed for CLRT use on the MICU? (None, 1-2 times, 2-3 times, 3-4 times, > than 4 times?)

11. How often in a week do you care for a patient who is hemodynamically unstable on the unit? (0-1, 1-2, 2-3, > 3?)

12. When you are caring for a patient who is hemodynamically unstable and cannot tolerate manual repositioning do you use CLRT in your current practice? (Y, N?)

13. If you receive training in CLRT (or now that you have received training in CLRT) how likely would you use it for your patients who are hemodynamically unstable in the MICU? (very likely, likely, somewhat likely, neither likely nor unlikely, unlikely, very unlikely?)

14. In your opinion what are the greatest barriers on the MICU to consistent patient repositioning? (hemodynamic instability, obese patient, lack of turning equipment, lack of available peer staff, all the above?)

Figure 2: Demographics of Patients Who Met Inclusion Criteria for CLRT Pre-and Post-Training

	PRE-TRAINING	POST-TRAINING
	(n=13) n(%)	(n=18) n(%)
Gender	M-9(69)	M-12(67)
Age	<44Yrs 9(54); >45 Yrs. 6(46)	<44Yrs 2(11.0); >45 Yrs. 16(89.0)
Diagnosis	Respiratory 7(54.0); Sub. Abuse 2(15.4); Shock 3(23.0); Neuro.1(7.7)	Respiratory 9(50.0); Sub. Abuse 2(11.0); Shock4(22.0); GI 3(17.0)
MV	Yes 12(92.0)	Yes 17(94.0)
Braden	< 12 7(54.0)	<12 9(50.0)
CLRT Initiated	No 11(85.0)	No 11(61.0)
Total Hrs. Pt. received CLRT	0 Hrs. 11(85); <3 Hrs.; 1(7.7); > 3 Hrs.1(7.7)	0 Hrs. 11(61.0); 4(22.0) <3 Hrs; 3(17.0) > 3 Hrs.*
Minimum Mode	None	1(6.0)
Custom Mode	2(15.4)	6(33.3)
Other Mode	0	0
Pt. Turned	Yes-10(77.0); Inconsistent 3(23.0)	Yes-9(50); Inconsistent 9(50.0)
PI POA	0	0
HAPI	0	0

Note. PI POA= Pressure injury present on admission; HAPI=hospital acquired pressure injury