Spring 3-24-2021

Implementing Interdisciplinary Team Rounding to Reduce External Ventricular Drain-Associated Infections

Laura Reiter
University of St. Augustine for Health Sciences, l.reiter@usa.edu

DOI: https://doi.org/10.46409/sr.SDUZ4650

Implementing Interdisciplinary Team Rounding to Reduce External Ventricular Drain-Associated Infections

Laura A. Reiter MSN, RN, CCRN, CNRN

School of Nursing, University of St. Augustine for Health Sciences

This Manuscript Partially Fulfills the Requirements for the

Doctor of Nursing Practice Program and is Approved by:

Jennifer Mensik Kennedy, PhD, RN, NEA-BC, FAAN

Ellen M. Harvey DNP, RN, ACNS-BC, CCRN, TCRN, FCCM

Approved: March 24, 2021

Abstract

Practice Problem

External ventricular drains (EVD) are a common intervention in critical care areas for the management of hydrocephalus. The most common complication of this life saving intervention is infection, which negatively impacts patient outcomes and overall healthcare costs.

PICOT

The PICOT question that guided this project was: For patients with an EVD, what is the effect of interdisciplinary team rounding compared with the current practice of informal rounding, on compliance with an EVD care bundle and EVD-associated infections over two months?

Evidence

Current evidence shows that IDT rounding improves compliance with evidence-based practice and reduces hospital-associated infection rates.

Intervention

This paper describes how IDT rounding was implemented in four critical care units at a level I trauma center located in Southwest Virginia.

Outcome

The implementation of this rounding process has resulted in zero infections at the practice site for the duration of the intervention and for a total of eight months to date.

Conclusion

Despite a smaller than anticipated sample size, the paper shows both clinical significance and anecdotal evidence to support this intervention as a successful part of a multifaceted approach to infection prevention.

Implementing Interdisciplinary Team Rounding to Reduce External Ventricular Drain-Associated Infections

External ventricular drains (EVDs) are a common intervention in critical care areas for the management of acute hydrocephalus in patients suffering from a disruption in cerebrospinal fluid (CSF) circulation or reabsorption within the ventricular system (Dorresteijn et al., 2020). Placement of an EVD is considered a life-saving intervention but is also fraught with potential complications, the most common being EVD-associated infection (Fried et al., 2016). Practice variation in EVD management may place patients at an increased risk for EVD-associated infection when evidence-based care is not consistently delivered (Thien et al., 2020). This DNP project focused on the implementation of interdisciplinary team rounding to reduce practice variation for patients with EVDs and to reduce EVD-associated infections.

Significance of the Practice Problem

The most common indications for an EVD are management of traumatic brain injury, intraventricular hemorrhage, subarachnoid hemorrhage, meningitis, genetic disorders, infection, and tumors (Muralidharan, 2015; Humphrey, 2018; Chau et al., 2019). Placement of an EVD catheter is a surgical procedure that is performed in the operating room, emergency department, or critical care unit. The EVD enables drainage of CSF and monitoring of intracranial pressure. Once the EVD catheter is inserted, maintenance of the EVD and monitoring for EVD-related complications becomes the responsibility of the critical care nurse (Muralidharan, 2015).

External ventricular drain-associated infections are one of the most common complications of EVD catheter placement (Humphreys et al., 2017; Hersh et al., 2019). Despite a lack of global statistics for infection rates, these infections are prevalent in the United States. Two recent studies found overall infection rates to be between 9.9% and 36% (dos Santos et al., 2017; Hersh et al., 2019). A meta-analysis conducted by Ramanan et al. (2015) found the pooled incidence rate to be 11.4 per 1,000 catheter days. A national or local surveillance system for EVD-associated CSF infections does not exist, which limits comparison data. A high-level data analysis of infections at the practice site between July 2019 and May 2020, revealed a total of 137 EVDs with 33 CSF cultures positive for at least one pathogen.

External ventricular drain-associated infections have a negative impact on overall healthcare cost and patient outcomes. Direct treatment costs per infection were estimated to be as high as $50,000 per case (Phan et al., 2016). Hersh et al. (2019) found that the total healthcare costs for patients who developed an EVD-associated infection increased by almost $85,000. Patients who developed an EVD-associated infection also had significantly more concurrent hospital-acquired infections, with associated costs per hospital-acquired infection ranging from $4,694-$94,879 depending on the type of infection (Hagel et al., 2014; AHRQ, 2017). These patients also experienced a longer critical care unit stay, prolonged overall hospital stay, and mortality was reported as high as 40.8% (Hagel et al., 2014; Sam et al., 2018; Hersh et al., 2019). These negative consequences demonstrate the need for standardization of, and compliance with, evidence-based infection prevention strategies.

PICOT Question

The PICOT question that formed the basis of this project is: For patients with an external ventricular drain (EVD), what is the effect of interdisciplinary team rounding compared with the current practice of informal rounding, on compliance with an EVD care bundle and EVD-associated cerebrospinal fluid infections over two months?

Population

External ventricular drains (EVD) are commonly used in critical care units in the treatment of adults, children, and neonates suffering from conditions causing hydrocephalus, a dangerous increase in cerebrospinal fluid that can lead to increased intracranial pressure, brain tissue damage, and even death (Chau et al., 2019). In the practice setting, patients with EVDs are cared for in designated adult and pediatric intensive care units. The practice site policy for the insertion, management, and removal of external ventricular drains is applicable to both adults and pediatric patients. The population for this project included adult and pediatric patients with EVDs, excluding neonates.

Intervention

Despite the severe consequences of EVD-related infection, inconsistencies remain in standard practice for the placement and maintenance of these drains (Hepburn-Smith et al., 2016). One strategy for eliminating inconsistency in practice is the implementation of evidence-based care bundles. In 2012, the Institute of Health developed the concept of care bundles to improve critical care processes and outcomes (Institute for Healthcare Improvement, 2012). A care bundle is a set of interventions that are based upon evidence and, when performed together, have been proven to improve patient outcomes (Institute for Healthcare Improvement, 2021).

Care bundles have been documented in the literature to reduce EVD-associated infection rates successfully and to reduce variability in practice related to placement and maintenance (Champey et al., 2018; Yaney & Hasan, 2019; Talibi et al., 2020). Once evidence-based standards have been developed, interdisciplinary team rounding has been found to improve compliance with the standards and sustain associated positive patient outcomes (Hill et al., 2012; Fisher et al., 2016; Chan et al., 2020; Snyder et al., 2020). The intervention for this project was the implementation of EVD interdisciplinary team rounding to ensure that evidence-based strategies for placement and maintenance of EVDs were maintained and to reduce the risk of EVD-associated infection.

Comparison

The project intervention was compared to the current practice of informal rounding for patients with an EVD. Prior to the intervention, neurosurgery physicians and residents conducted informal rounds on all neurosurgery patients located on the designated units. These rounds occurred at various times throughout the day, and often, bedside nurses did not participate. Interdisciplinary rounds allow different care team members to address specifics in the patient's plan of care and patient care concerns (Hermon et al., 2015). Interdisciplinary rounding also assures that compliance with evidence-based care is monitored, and necessary education and correction provided when needed (De Cristifano et al., 2016; McBeth et al., 2018; Ormsby et al., 2020; Snyder et al., 2020).

Outcome

At the practice setting, EVD-associated infections are identified when CSF samples are obtained from the EVD drainage system and sent to the laboratory for evaluation.

The institution's criteria for an EVD infection follows the Centers for Disease Control and Prevention (CDC; 2020) recommendations for device-related infections and meningitis/ventriculitis criteria and is defined as the presence of at least one identifiable pathogen from a CSF culture obtained from an EVD (Centers for Disease Control and Prevention, 2020). Cerebrospinal fluid culture results are available as part of the electronic health record for all patients with an EVD who have had CSF cultures ordered, obtained, and analyzed. The desired outcome of the project was a reduction of EVD-associated infections. Infections were measured by obtaining CSF culture data from the electronic health record (EHR) for all patients with an EVD who had CSF cultures ordered, collected, and resulted. Metrics for the project were defined and established using benchmarking and CDC guidelines.

Timeline

Vigilant monitoring of EVD insertion and maintenance practices is imperative for reducing EVD-associated infection and sustaining desired outcomes (Hepburn-Smith et al., 2016; Hersh et al., 2019). Interdisciplinary rounding has been shown to be effective in maintaining evidence-based practice change (Fisher et al., 2016; Hepburn-Smith et al., 2016). Compliance with evidence-based care practices and EVD-associated infection rates was measured during a two-month intervention period to provide evidence supporting targeted rounding as beneficial in reducing EVD-associated infections.

Change Theory and Evidence-Based Practice Framework

Change in healthcare is inevitable as nursing research continues to provide new evidence to guide changes in practice. When implementing evidence-based practice change, change theory and process improvement frameworks provide structure and guidance to determine how the implementation will occur and what might influence the success or failure of the change. Lewin's change theory and Six Sigma's Define, Measure, Analyze, Improve, and Control (DMAIC) process improvement model were both used to provide the framework for successful implementation of this evidence-based practice project.

Change Theory

Change occurs at a rapid pace in the hospital setting and is influenced by many factors. Lewin's change theory (1951) provided a framework to understand how human behavior influences the adoption of change and to facilitate successful adoption of interdisciplinary rounding at the practice site. To gain support for the change, physicians and nurses who care for patients with EVDs were made aware of pre-intervention infection rates and their role in prevention was emphasized by the DNP student and neurotrauma CNS. External ventricular drain associated infections were added to an existing infection control dashboard by the infection preventionist to establish transparency of data. This dashboard included total number of drains inserted, infections, total drain days, and the total rate of infections. Raising awareness of the problem and the consequences of continuing with the status quo was described by Lewin as unfreezing (Lewin, 1951). In Lewin's refreezing stage of change, once the change has been implemented and has become part of the current practice, it must be sustained over time (Spear, 2016). Once interdisciplinary rounding is adopted as part of the daily routine, the change will be sustained by providing monthly updates to providers and staff describing progress toward the goal of reduced EVD-associated infections. Incorporating infection rates and compliance with evidence-based care into existing quality dashboards provides easy access to a visual representation of progress. The final key component for sustaining change is the involvement of an engaged leadership team and unit champions who monitor ongoing compliance with the process, address any drift in practice, and celebrate the positive impact that rounding has on infection rates and overall patient outcomes.

Evidence-Based Practice Framework

Six Sigma's DMAIC model is the performance improvement model most commonly adopted by the practice setting and provided the framework for developing a systematic approach to reducing EVD-associated infections. The problem identified was an increase in EVD-associated infections due to practice variation. See Table 1 for the project charter developed by the DNP student to describe the problem, define the project goal, and identify the project's scope, milestones, and benefits. Baseline information regarding EVD-associated infections was collected by the infection preventionist and revealed that infections had significantly increased from the prior year. In the analysis of possible causes of this increase in infections, a cause and effect diagram was developed by the DNP student. See Figure 1 for a copy of the cause and effect diagram. This tool highlighted a gap in oversight of staff compliance with evidence-based care. Improvement strategies focused on developing an evidence-based process to ensure that physicians and nurses were compliant with evidence-based care for patients with EVDs.

Evidence Search Strategy

A comprehensive search of the literature was conducted to find evidence to support the project PICOT question. The following databases were included in the search: PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), and Medical Literature Analysis and Retrieval System Online (Ovid MEDLINE). The keywords used in the search included: rounding, critical care, intensive care unit, device-related infection, infection rate, care bundle, protocol, compliance, and adherence.

The search in PubMed resulted in a total of 74 articles. Boolean operators and truncation were used by the DNP student to obtain a more inclusive search. Examples include: *critical care* OR *intensive care unit* AND *round**, *external ventricular device-related infection* OR *infection rate*, *compliance* OR *adherence*, *care bundle* OR *protocol*. The search in CINAHL resulted in a total of 17 articles. The terms *rounding, care bundle,* and *compliance* were further defined by using the Boolean operator OR: *rounding* OR *hourly rounding* OR *standardized hourly rounding*, *bundles* OR *bundle of care* OR *protocols*, *compliance* OR *adherence*. In addition to the original key words, Boolean operators and truncation were used to expand the search in Ovid

MEDLINE: *critical care* OR *intensive care unit,* and *round**. This search resulted in 88 total articles.

Evidence Search Results

A total of 179 results were screened by the student to verify that they included rounding in the critical care or ICU setting, care bundle or protocol compliance, and device-related infection or infection rates. Articles were excluded if they were published before 2015, were not peer-reviewed, or were written in a language other than English. After the student reviewed article titles and abstracts for relevance and applied inclusion and exclusion criteria, 25 articles remained. The student identified an additional four articles during the review of bibliographies. Two of the four articles were published in 2012 and 2013 and were included in the review as they were relevant to the topic. See Figure 2 for a Prisma Diagram depicting inclusion and exclusion of records. Of the remaining 29 articles, 15 were chosen by the student for the critical appraisal. See Appendix A for a summary of the primary resources.

The student used the Johns Hopkins Nursing Evidence-Based Practice Level and Quality Guide to evaluate each of the 15 remaining articles for level and quality (Dang & Dearholt, 2017). No Level I randomized controlled trials were found, but five of the articles were quasi-experimental and considered Level II evidence. Three articles were non-experimental in nature or Level III evidence and the remaining seven were quality improvement studies or Level V evidence. All of the Level II and III studies were found to be of good quality, with detailed descriptions of data interpretation and evident connection to relevant literature (Dang & Dearholt, 2017). Only two quality improvement articles were low quality as they lacked the necessary transparency, diligence, and insightful interpretation necessary for good quality evidence (Dang & Dearholt, 2017). See Appendix B for a table that includes the level and quality of evidence for each of the 15 final articles.

Themes from the Evidence

A synthesis of the thirteen articles considered to be of good quality conducted by the student revealed rounding to be an effective intervention in both improving compliance with an evidence-based care bundle and reducing device-related hospital-acquired infections. See Appendix C for a table describing the effect of rounding on reducing infections and improving bundle compliance. Rounding effect on bundle compliance was statistically significant in eight of the thirteen studies: three of the five Level II studies, one of three Level III studies, and four of five level V studies. Four of the remaining studies revealed improvements in compliance, although the results were not statistically significant. One study did not report the effect on compliance. The effect of rounding on infections was statistically significant in nine of the studies: four of the five Level II studies, one of the four Level III studies, and four of the five Level V quality improvement studies. Two of the remaining studies described improvements to be clinically relevant but not statistically significant, and two of the studies did not report the effect of rounding on infections.

Several themes emerged from the synthesis of the literature relating to rounding as an intervention to improve compliance with evidence-based care bundles and to reduce device-related hospital-acquired infections: frequency of rounds, in-the-moment feedback and education, reporting outcomes to participating units and staff, and trained professionals conducting the rounds. See Appendix D for a table depicting common themes found in the literature. Five of the thirteen articles showed that rounding significantly improved bundle compliance and infection rates, and included each of the identified themes as relevant to program success.

Frequency of Rounds

Interdisciplinary rounding is a practice that has become common in the critical care area, and incorporating a process for monitoring care bundle compliance is easily adopted into the existing process (Rawat et al., 2017). Interdisciplinary team rounding provides a systematic approach to rounding and can foster an atmosphere of ongoing awareness of the bundle as a relevant tool for improving patient outcomes (Hermon et al., 2015; Khan et al., 2016; Rawat et al., 2017; Snyder et al., 2020). Interdisciplinary rounding also provides the opportunity for feedback that is meaningful for motivating performance and improving deficiencies (Rawat et al., 2017; Snyder et al., 2020).

Real-Time Feedback and Education

Providing real-time feedback and in-the-moment education during rounding was another common theme. Regular feedback provides the opportunity for immediate correction of noncompliance and education to facilitate standardized and consistent evidence-based practice (Khan et al., 2016; Su et al., 2017; Snyder et al., 2020). Providing feedback in a non-punitive manner facilitates ongoing staff engagement and improves overall compliance with best practices (McBeth et al., 2018).

Reporting Outcomes to Participating Units and Staff

Reporting outcomes to participating units and staff was identified in the literature as a way to engage staff in ongoing practice improvement by highlighting progress toward a goal or impact on patient outcomes (Hermon et al., 2015; Rawat et al., 2017; Snyder et al., 2020). Linking an intervention directly to a patient outcome helps staff to appreciate their role in providing evidence-based care to patients and positively impacting patient outcomes (Wilder et al., 2016). Snyder et al. (2020) found that developing a Harm Prevention Dashboard provided frontline staff the ability to see compliance and outcome trends daily and to facilitated a more proactive response to data.

Rounding Led By Trained Professionals

The final theme highlighted in the evidence was the value of having an individual or interdisciplinary team who is specifically trained to conduct the rounds. MacBeth et al. (2018) found that despite the implementation of an evidence-based care bundle, infection rates remained below target, and it was not until a trained group began rounding for compliance and providing in-the-moment corrections that outcomes improved. By enlisting an individual or group trained on what constitutes bundle compliance, education and immediate corrections will be consistent and support a standardized approach to data collection (Hermon et al., 2015; Khan et al., 2016). Khan et al. (2016) found training essential to be able to identify barriers to compliance during rounding and to be able to respond appropriately. A trained rounding group may also address overall gaps in education and facilitate the celebration of compliance successes (Rawat et al., 2017).

Practice Recommendations

While no randomized controlled trials were found in the literature search, the level II, III, and V research clearly demonstrates a positive effect of interdisciplinary rounding to monitor compliance with care bundles on the incidence of hospital-acquired infection. Frienen (2017) explained that by relying only on RCTs to make healthcare decisions, a wealth of applicable evidence is missed: “An approach that uses all appropriate evidence types and builds on the existing evidence base using proven best practices is the one most likely to result in clinical and public health action that will save lives" (para. 14). Recommendations for this project were obtained by the student through a synthesis of all good quality Level II, III, and V evidence.

Real-time Feedback and Education Provided by Trained Professionals

Monitoring compliance with evidence-based interventions as part of a care bundle is not enough to significantly reduce infections. Khan et al. (2016) implemented chart reviews to monitor compliance with a ventilator-associated pneumonia (VAP) care bundle and found that despite 97% bundle compliance, infection rates were unchanged. When compliance was measured by trained individuals conducting direct observations and providing in-the-moment correction and education to staff compliance rates remained at 97%, and infections were significantly reduced from 6.3 to 1.8 per 1000 ventilator days (Khan et al., 2016). Hermon et al. (2015), found that when expert members of a rounding team provided regular feedback to staff, bundle compliance improved to 100% and central-line-associated bloodstream infection rates were zero for 45 months. In addition to providing the opportunity for real-time feedback, education, and early detection of potential problems, rounding conducted by engaged and knowledgeable team members offers the opportunity to reinforce best practice and further engage staff through non-punitive corrections and positive reinforcement (De Cristifano et al., 2016; McBeth et al., 2018; Ormsby et al., 2020; Snyder et al., 2020).

Rounding Checklist

Ormsby et al. (2020) used a checklist to reduce variability in rounding and reported increased overall reliability from 43% to 78%. De Cristifano et al. (2016) found that rounding improved bundle compliance, but it was not until a checklist was added to standardize the rounding process that VAP rates significantly improved from 6.43 to 2.38 per 1000 ventilator days ($p < 0.5$). A checklist to standardize rounding also improves communication among the care team and supports the ongoing discussion of best practice and care standards (Hulyalkar et al., 2017). Based on the best evidence, interdisciplinary team rounding by trained professionals using a checklist to monitor bundle compliance and provide real-time education and feedback to staff was conducted for patients with EVDs in participating units.

Project Setting

This project was conducted by the DNP student in the intensive care units that care for patients with EVDs within a 703-bed, level 1 trauma center located in Southwest Virginia. This facility is the flagship hospital for a not-for-profit healthcare organization based in Roanoke, Virginia which serves nearly one million patients across Virginia and West Virginia and it has received four consecutive Magnet designations. Magnet designation recognizes hospitals for quality outcomes and nursing excellence. Nurses who work in a magnet hospital are empowered to lead change and to foster innovation through evidence-based practice and professional collaboration (American Nurses Association, n.d.).

Organizational Culture

The mission and vision for the organization include a commitment to improving the health of the community by providing cost-efficient, best quality patient care. Prevention of hospital-associated infections is one of the many focus areas for quality improvement efforts across the facility.

In May of 2020, a nurse leader identified three EVD-associated infections within one month and determining that this was a patient safety concern, submitted an electronic event report. As part of the internal review of this adverse event, a deep dive was conducted by an infection preventionist to identify any commonalities among the cases. The deep dive results, reviewed by the neurotrauma clinical nurse specialist (CNS), identified practice variation as a probable contributor.

Organizational Support

Organizational support for the project was initially provided by the unit director of the reporting unit and the neurotrauma CNS, who convened a multi-disciplinary team to address the problem of practice variation. The team included the chief neurosurgeon, chief neurosurgery resident, senior nursing director, several nursing unit leaders, neurotrauma CNS, a bedside nurse, the director of quality, an infection preventionist, and a pharmacist. This group supported the DNP project as part of a multi-faceted approach to reducing infections.

Stakeholders

A stakeholder analysis matrix was developed by the student to identify project stakeholders as found in Appendix E. The chief neurosurgeon and nurse leaders possess the power to approve change and ensure adoption and compliance among their team. The quality director, infection preventionist, and pharmacist, while having a moderate influence on the project, provided a wealth of experience, expertise, and influence to support the project.

Strength, Weakness, Opportunity, and Threat Analysis

A strength, weakness, opportunity, and threat (SWOT) analysis was conducted to identify the internal strengths and weaknesses and external opportunities and threats that might impact the facility's readiness to implement the proposed change. See Figure 3 for the SWOT diagram. The internal strengths were an engaged leadership team, both neurosurgery and nursing, and a neurotrauma CNS with extensive experience in systematic adoption of change initiatives. Internal weaknesses included a large number of nurses with less than three years of experience, inconsistencies in provider ordering and care practices for patients with EVDs, and no surveillance. External opportunities included establishing surveillance of EVD-associated infections to monitor outcomes, using innovative data collection tools, and optimizing nursing documentation in the electronic medical record. External threats included increased workload for both physicians and nurses, and unexpected patient care emergencies.

Project Overview

The setting for this evidence-based practice project was critical care units that care for patients with EVDs. The project's short term goals were to improve compliance with evidence-based care and to reduce EVD-associated infections by implementing a targeted rounding process. The long term aim of the project is to maintain improvements through constant surveillance and ongoing communication. The vision of the project aligns with the organization's mission and vision and will further enhance infection surveillance and ongoing efforts to mitigate patient harm and reduce health care costs associated with hospital-associated infections.

Unintended Consequences and Risk

Unintended consequences of the project were viewed as positive rather than negative. Members of the neurosurgical physician team conducted informal rounding several times a day on patients with EVDs prior to implementation of interdisciplinary rounds. These rounds often happened unannounced due to a vigorous surgery schedule and conflicting patient priorities. As a result, nurse participation in rounding was inconsistent and opportunities for collaboration, to clarify the plan of care, and to update the providers on changes in patient condition often occurred via phone contact rather than in person. During the intervention period, providers and nurses reported improved communication between providers and nurses and found that the rounds provided opportunities more conducive to information sharing. A potential risk of the project was a lack of accountability for participating in rounds. Having engaged and supportive leadership from the physician group and the nursing group was a critical factor in addressing this risk; physician and nurse leaders established expectations and consequences to support staff participation in rounds.

Project Plan

To validate the importance of this evidence-based practice change, unit directors on participating units provided an overview of the problem and practice change recommendation to their staff. A clear description of the problem and a convincing argument for the change are necessary to strengthen driving forces and help individuals recognize that change is needed (Spear, 2016). The presentation included information on EVD-associated infections both over the previous year and current year-to-date, the role of evidence-based practice in preventing infections, and the evidence supporting targeted rounding as a measure to improve consistency and compliance with evidence-based practice. Prior to implementation, the DNP student trained unit champions, previously identified by nursing unit leaders, on the rounding process and strategies to correct deficiencies discovered during rounding. A core group of unit champions is essential for effectively engaging and motivating their peers to support the change. Shaw et al. (2012) describe the core behaviors of a champion: “actively and enthusiastically promoting a new innovation, making connections between different people in the organization…and navigating the political environment inside the organization” (p.676). Project champions are also instrumental in fostering collaboration between the physician group and bedside nurses (Miech et al., 2018). Before the project start date, unit champions engaged staff by emailing reminders about the project and responding to questions.

Intervention

Interdisciplinary rounding occurred weekly and included all patients with EVDs on participating units. The interdisciplinary rounding team included the following members: neurosurgery advanced clinical practitioner (ACP), neurotrauma CNS, unit champions, unit leaders, primary RNs, DNP student, and infection control and quality department representatives. Every Monday morning patients with an EVD were identified by the DNP student who then contacted the rounding team. The rounding team assembled on the unit that historically had the highest number of patients with an EVD. A rounding checklist was used by the DNP student to record rounding compliance and compliance with evidence-based practices for each patient. See Appendix F for a copy of the rounding checklist. The rounding checklist provided structure for initiating conversation and interactions that focused on influencing behaviors during rounds (Ormsby et al., 2020). In-the-moment education, corrections, and praise were provided by members of the rounding team for each rounding opportunity and a plan verbalized for any necessary corrections. Upon completion of rounding on each unit, rounding compliance was documented by the DNP student prior to moving to the next unit. Demographic information was also collected by the student for each patient who had an EVD during the intervention period and included age, duration of the EVD, and indication for the drain.

The primary outcome measure for the project was EVD-associated infection rates. The goal was a 50% decrease in infection rates when the infection rates during the intervention period were compared to the infection rates during the same time period from the previous year. Infection surveillance data was collected by an infection preventionist, and from this data infections per 1,000 line days was calculated. Based on the infection criteria described in Table 2, patients with an EVD in place less than two days before the infection event were excluded from data evaluation. An infection control dashboard was developed by the infection preventionist and includes the following information: the number of EVDs inserted, infections, drain days, and EVD-associated infection rates. External ventricular drain-associated infection rates were compared between the intervention period, November and December 2020, and the same period in 2019.

Process measures included compliance with rounding, compliance with the rounding checklist items, and documentation compliance. Compliance with the EVD bundle elements was measured in two ways: (1) during rounding where compliance was visualized and (2) by reviewing documentation of bundle elements. Furuya et al. (2011) reported a bundle adherence rate of ≥ 95% to be effective in reducing central line-associated infection rates and this was used as the target for compliance. For visualizing compliance, the DNP student or neurotrauma CNS collected data during rounding using a checklist. To evaluate compliance with documentation, the DNP student reviewed documentation in the electronic health record during weekly chart review: completion of the insertion checklist, administration of a prophylactic antibiotic, dressing assessment and change date, presence of label and red caps on EVD tubing, bag change, line flushing, and CSF sampling. Compliance was measured by comparing the number of possible documentation opportunities to the actual number of times that compliance was achieved (Labeau, 2020).

All collected data was entered into an Excel spreadsheet that was stored in a shared-drive folder only accessible to the DNP student, student preceptor, and biostatistician for data evaluation purposes only. To further protect data integrity and to assure the safety of patient protected health information, the DNP project proposal was submitted by the student to the practice site's Institutional Review Board and a determination was made that the DNP project did not meet the requirements necessary to be deemed research. This approval letter was forwarded to the Evidence-Based Practice Review Council at the University of St. Augustine for Health Sciences along with the project proposal for final approval to ensure that all the requirements of a DNP scholarly project were met. See Appendix G and H respectively for the project plan and letter.

Barriers and Facilitators

Barriers to the successful adoption of this intervention primarily arose from the impact that COVID-19 had on delaying system-wide approval processes for non-Covid related requests. The policy for insertion, maintenance, and removal of EVDs was updated based upon current evidence, but the approval of the policy did not occur until after the project start date. The delay in approval for the updated policy prevented participating nurses from being educated on the evidence-based practice changes and as a result, delayed the process of validating nurses on competencies related to the changes until after the project intervention period ended.

Facilitators of the intervention included having an engaged and supportive project team and support from physician and nurse leaders for implementing the rounding process despite the barriers noted. Rounding began as scheduled and opportunities to educate staff and identify opportunities for improved compliance with evidence-base practice occurred as planned. Another facilitator of the intervention was the limited additional budgetary requirements for implementing daily rounding as depicted in Table 3.

Evaluation Results

Lewin’s change theory provided a framework for implementing and evaluating the effect of interdisciplinary rounding on EVD-associated infections and compliance with elements of the EVD bundle. Once the status quo has been unfrozen in the first stage of change, the change happens, and evaluation of what was successful and what was not successful occurs (Spear, 2016). See Table 4 for the evaluation plan used by the student to measure the impact that targeted rounding had on EVD-associated infections and compliance with elements of the EVD bundle. Due to an unexpected decrease in the anticipated sample size, data analysis was limited to descriptive statistics. Frequencies and means were used to describe compliance with rounding, rounding checklist items, and documentation.

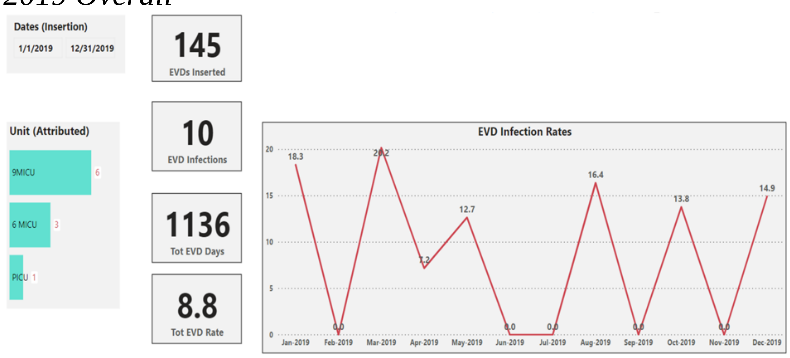
Primary Outcome: EVD-associated infections

The primary project outcome of this project was a reduction of EVD-associated infections by at least 50%. As depicted in the dashboard shown in Figure 4, for the pre-intervention period, November and December 2019, the infection rates were zero and 14.9 respectively. During the intervention period there were zero infections for both months.

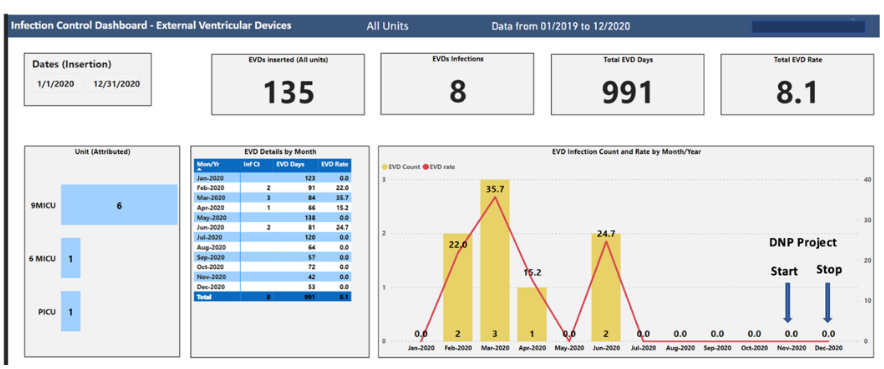
Figure 4

Infection Control Dashboard

2019 Overall



2020 Overall



Process Measures: Compliance with Rounding, Checklist Items, Documentation

During the nine-week intervention period there was a total of 9 unique patients located on two of the four participating units during the 9-week intervention period; 4 on Unit 1 and 5 on Unit 2. There were no patients with an EVD on any unit for weeks 3, 5, 8, or 9. There was a total of 13 possible rounding opportunities and the goal for rounds completed was ≥ 75%. Rounding occurred for 100% (n=13) of the rounding opportunities. As depicted in Table 5, all members of the rounding team participated in rounding at least 75% of the time with neurosurgery ACPs and infection control attending 100% of the rounds. Nursing unit directors did not participate in the rounds but between the primary nurse and unit champion, a unit representative participated in rounding for each patient on each unit. The intervention period occurred during the COVID-19 pandemic when staffing across the entire system was negatively impacted.

Table 5

Rounding Compliance: Participants

	Percentage	Frequency
Neurosurgery	100%	13
Infection Control	100%	13
Quality	84.62%	11
DNP Student	92.31%	12
Primary RN	84.62%	11
Unit Champion	76.92%	10
Neurotrauma CNS	7.69%	1
Unit Director	0	0

There were 11 total drains evaluated during the rounding period for 10 total patients; one patient had a drain on each side of the head. Compliance in all but one measure was below the goal of ≥95%, catheter in a question mark pattern 81.82% (n=9); dead end caps present 81.82%

(n=9); labels on tubing 63.64% (n=7); dressing intact and per protocol 36.36% (n=4). There were zero patients with indication of a CSF leak. The small sample size and short intervention period resulted in a maximum of 11 different nurses participating in the in-the-moment education at the bedside and none participated in rounding more than one time. Compliance for all checklist items is depicted in Table 6.

Table 6

Rounding Checklist Compliance

	Percent compliant	Frequency
Catheter in ? Pattern	81.82%	9
Dressing intact and per protocol	36.36%	4
Labels on tubing	63.64%	7
Dead end caps on system	81.82%	9

There were 140 documentation opportunities. Dressing assessment was the only measure documented >95% of the time, 97.14% (n=136). Dressing change documentation was the least documented measure, 7.14% (n=10). At the time of the intervention, nurses had not yet received training and skills validation for the new dressing change protocol and providers were responsible for dressing changes. Those measures that reflected manipulation of the insertion site or disruption in the closed EVD drainage system were the least documented items: CSF sample 0%, bag change 1.43% (n=2), and line flushed 1.43% (n=2). Compliance with documentation of bundle elements is depicted in Table 7 and compliance with measures reflecting manipulation of the drainage system are depicted in Table 8.

Table 7

Documentation Compliance

	Percentage	Frequency
Dead end caps on system documented	20%	28
Dressing assessment documented	97.14%	136
Dressing Change documented	7.14%	10
Labels on tubing documented	33.57%	47

Table 8

Documentation of Manipulation of the EVD and Drainage System

	Percentage	Frequency
CSF sample documented	0%	0
Bag change documented	1.43%	2
Line flush documented	1.43%	2

Impact

As part of a multifaceted approach to reducing EVD-associated infection, the policy for insertion, maintenance, and removal of EVDs was updated to reflect current evidence. This update was completed by members of the multi-disciplinary team initially established in response to the increase in infections and included the DNP student. The impact of the COVID-19 pandemic on hospital operations resulted in an unanticipated delay in policy approval. As a result, nurses did not receive education and competency validation related to the policy changes prior to the implementation of interdisciplinary rounding. Despite this limitation, anecdotal feedback from staff revealed that rounding was perceived as being more supportive and less punitive than previous rounding experiences and nurses were engaged, asking questions, and open to feedback regarding practice deficiencies. As found in the literature, each rounding episode provided the opportunity to educate nurses on new practice changes, to discuss barriers to compliance, to collaborate with providers to address patient care concerns, and to have questions answered in the moment (Anderson et al., 2015; De Cristofano et al., 2016).

Compliance with practice change and documentation observed during rounding and chart review did not show significant improvement over the two-month intervention period. This may be explained by nurses not having received training on policy updates prior to implementation of rounding. Only one measure met the >95% compliance goal; documentation of dressing assessment. Dressing assessment was part of policy and procedure prior to the evidence-based update and was not a change in practice. Practice changes were discussed during rounding by the rounding team members but the small number of rounding opportunities resulted in fewer chances for bedside nurses to participate in more than one round during the two-month intervention period.

Weekly rounding occurred 100% of the time. As several studies have shown, having an engaged and supportive interprofessional team and support from physician and nurse leaders is instrumental in successful completion of weekly rounds (Zavalkoff et al., 2015; Snyder et al., 2020). Rounding began as scheduled and opportunities to educate staff and identify opportunities for improved compliance with evidence-base practice occurred as planned. As found in the literature, the rounding team increased awareness of infection prevention practices through immediate non-punitive correction and collaborative conversations to identify any barriers (Snyder et al., 2020).

There were no infections reported during the intervention period, however, infection rates dropped to zero four months prior to the intervention. It can be difficult, in practice improvement projects, to identify the exact reason for decreasing infections rates. Several early initiatives to reduce practice variation may have contributed to the infection rate of zero. First, the development of a multi-disciplinary EVD team to address increased infections may have increased overall awareness of the problem resulting in extra attention to the care of patients with

EVDs. Second, this group recommended that any practice involving manipulation of the EVD drain or drainage system be conducted by neurosurgery providers until all appropriate nurses were trained in evidence-based practices identified in the updated policy. And third, in educating participating units about the DNP project, further attention to infection prevention and limited manipulation of the EVD may have occurred despite nurses not having formal education and training related to the policy changes.

Based upon the absence of EVD-associated infections and the overwhelmingly positive feedback received about the rounding process, the chair of neurosurgery recommended that interdisciplinary rounding continue after the DNP project intervention period ended. As nurses complete training and skills validation on policy changes, the data collected during the DNP project will form a baseline for ongoing data collection and monitoring of compliance.

Dissemination Plan

Dissemination of the results of this evidence-based project is a critical component of the re-freezing phase of change. If rounding is not adopted into unit culture, if ongoing compliance with evidence-based practices is not monitored, the impact on EVD-associated infections is not sustainable. Several processes have been developed by the DNP student and multi-disciplinary team to facilitate ongoing monitoring and dissemination of process and outcome measures. The rounding checklist has been added to a digital rounding platform by members of the nursing informatics team to facilitate efficient documentation, analysis, and dissemination of compliance results. The infection control department has added surveillance of EVD-associated infections to existing surveillance processes for other hospital-associated infections such as catheter-associated urinary tract infections and central line-associated bloodstream infections. An electronic deep dive form was developed by the infection preventionist and if an infection occurs, the infection preventionist, quality facilitator, and neurotrauma CNS will conduct a structured deep dive to identify contributing factors. This information will be shared with the interdisciplinary team, unit directors, and unit champions as part of a structured monthly communication emailed by the neurotrauma CNS. Existing quality dashboards provide another opportunity for improving visibility and ongoing monitoring of hospital and drain-associated infections; EVDs have been added to this platform.

Bedside nurses directly impact infection prevention by practicing and assuring compliance with evidence-based practice. Ongoing surveillance and transparency of outcome data allows nurses to maintain a connection to infection prevention efforts. Nurse leaders on participating units receive monthly surveillance and compliance reports from infection control and distribute this information to nursing staff according to unit-specific processes. Continuing to share this information with nurses provides a means for celebrating ongoing outcome success and for early identification and correction of practice drift. Sharing outcome data and providing ongoing feedback to staff has been shown to improve compliance with evidence-based practice and to reduce infection. Hermon et al. (2015) found that adherence to bundle interventions improved to 100% within a 6 month period after providing monthly feedback to staff regarding compliance with statistically significant reductions of infection rates ($p < 0.05$).

Project results have been shared with the organization's shared governance quality council by the DNP student and neurotrauma CNS to highlight the impact of interdisciplinary teamwork on reducing infections. The Nursing Research and EBP Council develops and distributes the organization's internal peer-reviewed research journal. A project summary was submitted to the journal by the DNP student for further dissemination of project success. Prior to submitting abstracts to external sources for publication and conference presentations, members of the Nursing Research and EBP council will provide peer-review to ensure that submissions meet professional writing expectations.

This evidence-based project's focus is especially relevant to nurses and nursing leaders who provide care for neuroscience patients with EVDs. While statistical analysis was not possible due to unanticipated limitations, anecdotal evidence and clinical significance provides useful information for other organizations seeking to address EVD-associated infections. Abstracts for publication will be submitted to the following journals to ensure that relevant information is disseminated: Journal of Neuroscience Nursing, American Journal of Critical Care, and the Journal for Healthcare Quality. Professional nursing organizations provide another venue for sharing knowledge. Thus, abstracts will be submitted to the following organizations for potential poster presentations: American Association of Neuroscience Nurses, American Association of Critical Care Nurses, and the Virginia Nurses Association.

Conclusion

External ventricular drains are a life-saving intervention for the management of increased intracranial pressure and acute hydrocephalus. Infection is the most common complication of external ventricular drains and can have a significant negative impact on patient outcomes (Hagel et al., 2014; Sam et al., 2018; Hersh et al., 2019). An increase in EVD-associated infections at the project site led to a comprehensive review of the literature in search of evidence-based strategies to address this problem. The literature supports the implementation of interdisciplinary rounding as an effective strategy to improve compliance with evidence-based care and to reduce hospital-associated infection. The focus of this evidence-based practice project was implementation of interdisciplinary team rounding for all patients with an EVD. Evaluation of both outcome and process measures provides baseline data for ongoing efforts to prevent infections and validate this intervention as a successful strategy for reducing EVD-associated infection in patients with EVDs at this level 1 trauma center.

References

AHRQ. Agency for Healthcare Research and Quality. (2017). *Estimating the additional hospital inpatient cost and mortality associated with selected hospital-acquired conditions.* https://www.ahrq.gov/hai/pfp/haccost2017-results.html

American Nurses Association. (n.d.). *Why become Magnet?* https://www.nursingworld.org/organizational-programs/magnet/about-magnet/why-become-magnet/

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 & Continence Nursing*, *42*(3), 217–225. https://doi.org/10.1097/WON.0000000000000109

Centers for Disease Control and Prevention. (2020). *CDC/NHSN surveillance definitions for specific types of infections*. https://www.cdc.gov/nhsn/PDFs/pscManual/17pscNosInfDef_current.pdf

Champey, J., Mourey, C., Francony, G., Pavese, P., Gay, E., Gergele, L., Manet, R., Velly, L., Bruder, N., & Payne, J. (2018). Strategies to reduce external ventricular drain-related infections: a multicenter retrospective study. *Journal of Neurosurgery*, *130*(6), 1789-2097. https://doi.org/10.3171/2018.1.JNS172486

Chan, A., Wren, F., Krechmery, K., Cohen, T., Shen, T., Dong, E., Imai, T., Yaung, J., Dhillon, A., Woodward, E., Kumaresan, S., D'Attellis, N., Beckett, M., Krom, Z., Lupera, A., Olay, C., Cohen, K., Fellin, R., Drucker, C., & Nurok, M. (2020). Core measure rounds to increase compliance in a busy ICU. *Critical Care Medicine*, *48*(1), 649. https://doi.org/10.1097/01.ccm.0000645296.96359.85

Chau, C., Craven, C., Rubiano, A., Adams, H., Tulu, S., Czosnyka, M., Servadei, F., Ercole, A., Hutchinson, P., & Kolias, A. (2019). The evolution of the role of external ventricular drainage in traumatic brain injury. *Journal of Clinical Medicine*, *8*(9), 1-23. https://doi.org/10.3390/jcm8091422

Dang, D., & Dearholt, S. (2017). *Johns Hopkins nursing evidence-based practice: model and guidelines*. (3rd ed). Sigma Theta Tau International

De Cristofano, A., Peuchot, V., Canepari, A., Franco, V., Perez, A., & Eulmesekian, P. (2016). Implementation of a ventilator-associated pneumonia prevention bundle in a single PICU. *Pediatric Critical Care Medicine*, *17(*5), 451–456. https://doi.org/10.1097/PCC.0000000000000714

Dorresteijn, K., Brouwer, M., Jellema, K., & van de Beek., D. (2020). Bacterial external ventricular catheter-associated infection. *Expert Review of Anti-Infective Therapy*, *18*(3), 219-229. https://doi.org/10.1080/14787210.2020.1717949

dos Santos, S., Lima, T., Lunardi, L., & Stefani, M. (2017). External ventricular drain-related infection in spontaneous intracerebral hemorrhage. *World Neurosurgery*, *99,* 580-583. https://doi.org/10.1016/j.wneu.2016.12.071

Fisher, K., Grosh, A., & Felty, V. (2016). Using nurse-led rounds to improve quality measures related to HAPUs. *Nursing2016*, *46*(11), 63-68. https://doi.org/10.1097/01.NURSE.0000494657.67378.00

Fried, H., Nathan, B., Rowe, A., Zabramski, J., Andaluz, N., Bhimraj, A., Guanci, M., Seder, D., & Singh, J. (2016). The insertion and management of external ventricular drains: An evidence-based consensus statement. *Neurocritical Care*, *24,* 61-81. https://doi.org/10.1007/s12028-015-0224-8

Frieden, T. (2017, August 2). *Why the 'gold standard' of medical research is no longer enough*. https://www.statnews.com/2017/08/02/randomized-controlled-trials-medical-research/

Furuya, E., Dick, A., Perencevich, E., Pogorzelska, M., Goldmann, D., Stone, P. (2011). Central line bundle implementation in US intensive care units and impact on bloodstream infections. *PLoS One*, *6*, 1–6. https://doi.org/10.1371/journal.pone.0015452

Hagel, S., Bruns, T., Pletz, M., Engel, C., Kalff, R., & Ewald, C. (2014). External ventricular drain infections: Risk factors and outcome. *Interdisciplinary Perspectives on Infectious Diseases*, *214*, 1-6. https://doi.org/10.1155/2014/708531

Hepburn-Smith, M., Dynkevich, I., Spektor, M., Lord, A., Czeisler, B., Lewis, A. (2016). Establishment of an external ventricular drain best practice guideline: The quest for a comprehensive, universal standard for external ventricular drain care. *Journal of Neuroscience Nursing*, *48*(1), 54-65. https://doi.org/10.1097/JNN.0000000000000174

Hermon, A., Pain, T., Beckett, P., Jerrett, H., Llewellyn, N., Lawrence, P., & Szakmany, T. (2015). Improving compliance with central venous catheter care bundles using electronic records. *Nursing in Critical Care*, *20*(4), 196–203. https://doi.org/10.1111/nicc.12186

Hersh, R., Yaeger, K., Neifert, S., Kim, J., Dangayach, N., & Weiss, N. (2019). Patterns of health care costs due to external ventricular drain infections. *World Neurosurgery*, *128*, E31-E37. https://doi.org/10.1016/j.wneu.2019.03.197

Hill, M., Baker, G., Carter, D., Henman, L., Marchall, K., Mohm, K., & Moody, E. (2012). A multidisciplinary approach to end external ventricular drain infections in the neurocritical care unit. *Journal of Neuroscience Nursing*, *44*(4), 188-193. https://doi.org/10.1097/JNN.0b013e3182527672

Hulyalkar, M., Gleich, S., Kashyap, R., Barwise, A., Kaur, H., Dong, Y., Fan, L., Murthy, S., Arteaga, G., Tripathi, S., Gleich, S. J., & Arteaga, G. M. (2017). Design and α-testing of an electronic rounding tool (CERTAINp) to improve process of care in pediatric intensive care unit. *Journal of Clinical Monitoring & Computing*, *31*(6), 1313–1320. https://doi.org/10.1007/s10877-016-9946-1

Humphrey, E. (2018). Caring for neurosurgical patients with external ventricular drains. *Nursing Times*, *114*(4), 52-56. https://www.nursingtimes.net/clinical-archive/neurology/caring-for-neurosurgical-patients-with-external-ventricular-drains-26-03-2018/

Institute for Healthcare Improvement. (2021). *Evidence-based care bundles.* http://www.ihi.org/Topics/Bundles/Pages/default.aspx

Institute for Healthcare Improvement. (2012). *Using care bundles to improve health care quality*. http://www.ihi.org/resources/Pages/IHIWhitePapers/UsingCareBundles.aspx

Khan, R., Al-Dorzi, H. M., Al-Attas, K., Ahmed, F. W., Marini, A. M., Mundekkadan, S., Balkhy, H. H., Tannous, J., Almesnad, A., Mannion, D., Tamim, H. M., & Arabi, Y. M. (2016). The impact of implementing multifaceted interventions on the prevention of ventilator-associated pneumonia. *American Journal of Infection Control*, *44*(3), 320–326. https://doi.org/10.1016/j.ajic.2015.09.025

Labeau, S. (2020). Recommendation and protocol compliance: "Yes, I do" may not be true; the complexity of measuring provider adherence. Intensive and Critical Care Nursing, 60(2020), 1-4. https://doi.org/10.1016/j.iccn.2020.102890

Lewin, K. C. (1951). *Field theory in social science*. Harper & Row.

McBeth, C. L., Montes, R. S., Powne, A., North, S. E., & Natale, J. E. (2018). Interprofessional approach to the sustained reduction in ventilator-associated pneumonia in a pediatric intensive care unit. *Critical Care Nurse*, *38*(6), 36–45. https://doi.org/10.4037/ccn2018121

Miech, E., Rattray, N., Flanagan, M., Damschroder, L., Schmid, A., & Damush, T. (2018). Inside help: An integrative review of champions in healthcare-related implementations. *SAGE Open Medicine*, *6*, 1-11. https://0b32od887-mp03-y-https-journals-sagepub-com.prx-usa.lirn.net/doi/10.1177/2050312118773261

Mendez, M. P., Lazar, M. H., Digiovine, B., Schuldt, S., Behrendt, R., Peters, M., & Jennings, J. H. (2013). Dedicated multidisciplinary ventilator bundle team and compliance with sedation vacation.. *American Journal of Critical Care*, *22(*1), 54–60. https://doi.org/10.4037/ajcc2013873

Muralidharan, R. (2015). External ventricular drains: Management and complications. *SNI: Neurosciences Nursing*, *6*(6), S271-S274. https://doi.org/10.4103/2152-7806.157620

Nassikas, N. J., Monteiro, J. F. G., Pashnik, B., Lynch, J., Carino, G., & Levinson, A. T. (2020). Intensive care unit rounding checklists to reduce catheter-associated urinary tract infections. *Infection Control and Hospital Epidemiology*, *41*(6), 680–683. https://doi.org/10.1017/ice.2020.43

Ormsby, J. A., Cronin, J., Carpenter, J., Graham, D. A., Potter-Bynoe, G., Vaughan, A. M., Weir, L., Flaherty, K. A., Chandonnet, C. J., Priebe, G. P., & Sandora, T. J. (2020). Central venous catheter bundle adherence: Kamishibai card (K-card) rounding for central-line-associated bloodstream infection (CLABSI) prevention. *Infection Control and Hospital Epidemiology*, 41(9), 1058-1063. https://doi.org/10.1017/ice.2020.235

Phan, K., Schultz, K., Halcrow, S., Fuller, J., McDowell, D., Mews, P., & Rao, P. (2016). External ventricular drain infections at the Canberra Hospital: A retrospective study.

Journal of Clinical Neuroscience, *32*(2016), 95-98. https://doi.org/10.1016/j.jocn.2016.03.019

Ramanan, M., Lipman, J., Shorr, A., & Shankar, A. (2015). A meta-analysis of ventriculostomy-associated cerebrospinal fluid infection. *BMS Infectious Diseases*, *3*, 1-12. https://doi.org/10.1186/s12879-014-0712-z

Rawat, N., Yang, T., Ali, K. J., Catanzaro, M., Cohen, M. D., Farley, D. O., Lubomski, L. H., Thompson, D. A., Winters, B. D., Cosgrove, S. E., Klompas, M., Speck, K. A., & Berenholtz, S. M. (2017). Two-state collaborative study of a multifaceted intervention to decrease ventilator-associated events. *Critical Care Medicine*, *45*(7), 1208–1215. https://doi.org/10.1097/CCM.0000000000002463

Riley, B., & Harris, J. (2020). Influences and determinants of quality improvement projects. In J. L. Harris, L. Roussel, C., Dearman, & P. L. Thomas (Eds.), *Project planning and management. A guide for nurses and interprofessional teams* (3rd ed., 23-38). Jones & Bartlett Learning.

Sam, J., Lim, C., Sharda, P., & Wahab, N. (2018). The organisms and factors affecting outcomes of external ventricular drainage catheter-related ventriculitis: A Penang experience. *Asian Journal of Neurosurgery*, *13*(2), 250-257. https://dx.doi.org/10.4103%2Fajns.AJNS_150_16

Shaw, E., Howard, J., West, D., Crabtree, B., Nease, D., Tutt, B., & Nutting, P. (2012). The role of the champion in primary care change efforts: From the State Networks of Colorado Ambulatory Practices and Partners (SNOCAP). *Journal of the American Board of Family Medicine*, *25*(5), 676-685. https://doi.org/10.3122/jabfm.2012.05.110281

Snyder, M. D., Priestley, M. A., Weiss, M., Hoegg, C. L., Plachter, N., Ardire, S., & Thompson, A. (2020). Preventing catheter-associated urinary tract infections in the pediatric intensive care unit. *Critical Care Nurse*, *40*(1), e12–e17. https://doi.org/10.4037/ccn2020438

Spear, M. (2016). How to facilitate change. *Plastic Surgical Nursing*, *36*(2), 58-61. https://doi.org/ 10.1097/PSN.0000000000000139

Su, K.-C., Kou, Y. R., Lin, F.-C., Wu, C.-H., Feng, J.-Y., Huang, S.-F., Shiung, T.-F., Chung, K.-C., Tung, Y.-H., Yang, K.-Y., & Chang, S.-C. (2017). A simplified prevention bundle with dual hand hygiene audit reduces early-onset ventilator-associated pneumonia in cardiovascular surgery units: An interrupted time-series analysis. *PloS One*, *12*(8), e0182252. https://doi.org/10.1371/journal.pone.0182252

Talibi, S., Silva, A., Afshari, F., Hodson, J., Roberts, S., Oppenheim, B., Flint, G., & Chelvarajah, R. (2020). The implementation of an external ventricular drain care bundle to reduce infection rates. *British Journal of Neurosurgery*, *34*(2), 181-186. https://doi.org/10.1080/02688697.2020.1725436

Thien, A., Soh, S., Lock, C., Han, J., Chen, M., Srivatsava, S., Rao, J., Ang, B., Seow, W., & Keong, N. (2019). The National Neuroscience Institute External Ventricular Drain Study: A pragmatic multisite risk-stratification pathway to reduce ventriculostomy-related infection. *World Neurosurgery*, *135*, e126-e136. https://doi.org/10.1016/j.wneu.2019.11.070

Wilder, K. A., Wall, B., Haggard, D., & Epperson, T. (2016). CLABSI Reduction Strategy: A systematic central line quality improvement initiative integrating line-rounding principles and a team approach. *Advances in Neonatal Care*, *16*(3), 170–177. https://doi.org/10.1097/ANC.0000000000000259

Yaney, E., & Hasan, U. (2019). Implementation of external ventricular drain insertion and maintenance protocol checklist to reduce infections in the pediatric population. American *Journal of Infection Control*, *47*(6), S43-S44. https://doi.org/10.1016/j.ajic.2019.04.106

Zavalkoff, S., Korah, N., & Quach, C. (2015). Presence of a physician safety champion is associated with a reduction in urinary catheter utilization in the pediatric intensive care unit. *Plos One*, 10(12), e0144222. https://doi.org/10.1371/journal.pone.0144222

Table 1

Project Charter

Project Charter	
Project Name	Implementation of interdisciplinary team rounding to improve EVD bundle compliance and reduce EVD-associated infections
Problem Statement	In May 2020 three EVD-associated infections were discovered on one unit that cares for patients with an EVD. Practice variation was found to be a common factor in all of the cases. EVD-associated infection surveillance is not current practice. Variation in practice increases risk of patient harm.
Project Goal	Implement interdisciplinary team rounding to ensure compliance with evidence-based practice and to reduce overall EVD-associated infection rate 50% over a two month period by January 2021. Infection rates near zero have been reported in the literature for studies conducted for greater than one year. With a shorter implementation period the short term goal is a 50% reduction with a long term goal of zero infections.
Benefits/ROI	Decrease patient risk of hospital-associated infection (HAI) Reduced healthcare costs Improve interprofessional collaboration
Project Team	Project Champions and nurse leaders from units that care for patients with EVDs, Neurosurgery Chief and residents, neurotrauma CNS, DNP student, infection preventionist, pharmacist, representative from quality department
Project Scope	To reduce EVD-associated infection rates on adult and pediatric critical units that care for patients with an EVD by January 2021
Project Milestones	Project approvals, present project to participating units, and train project champions by end of October 2020 Implement Quality rounding November 2020 Data collection and monthly reporting November 2020-January 2021

Table 2

EVD-Associated Infection Criteria

Admit Date	**Gender & Age**
Discharge Date	Infection Unit
InfectionType	Location of Insertion
Event Date[1]	Inserting Provider
EVD Catheter(s) inplace during encounter	
CSF Cultures –	
Element	**Element Met**

Patient meets criteria for EVD-associated infections due to the following:

1. Patient had EVD that had been in place for >2 days on the date of event or EVD was removed <2 days on date of event.
2. Patient has at least one of the following:
   - *I.* Patient has organism(s) identified from cerebrospinal fluid (CSF) by a culture or non-culture based microbiologic testing method, which is performed for purposes of clinical diagnosis or treatment, for example, not Active Surveillance Culture/Testing (ASC/AST).
   - *II.* Patient has at least two of the following:
     - *a. Fever >38°C*
     - *b. Headache*
     - *c. Meningeal sign(s)**
     - *d. Cranial nerve sign(s)**

   AND at least one of the follwing:
     - *a. Increased white cells, elevated protein, and decreased glucose in CSF (per reporting laboratory's reference range).*
     - *b. Organism(s) seen on Gram stain of CSF.*
     - *c. Organism(s) identified from blood by a culture or non-culture based microbiologic testing method, which is performed for purposes of clinical diagnosis or treatment, for example, not Active Surveillance Culture/Testing (ASC/AST)*
     - *d. Diagnostic single antibody titer (IgM) or 4-fold increase in paired sera (IgG) for organism.*
   - III. Patient ≤1 year of age has at least two of the following:
     - i. (elements of 'I' alone may not be used to meet the two required elements)
       - *a. Fever (>38.0°C)*
       - *b. Hypothermia (<36.0°C)*
       - *c. Apnea**
       - *d. Bradycardia**
       - *e. Irritability**
     - ii. Meningeal signs*
     - iii. Cranial nerve signs*

AND at least one of the following:

- *a. Increased white cells, elevated protein, and decreased glucose in CSF (per reporting laboratory's reference range).*
  ☐b. Organism(s) seen on Gram stain of CSF
- *b. Organism(s) seen on Gram stain of CSF.*
- *c. Organism(s) identified from blood by a culture or non-culture based microbiologic testing method, which is performed for purposes of clinical diagnosis or treatment, for example, not Active Surveillance Culture/Testing (ASC/AST).*
- *d. Diagnostic single antibody titer (IgM) or 4-fold increase in paired sera (IgG) for organism.*

Date of Event: Date first element of the criteria was met
Day: Calendar Days

Table 3

Project Budget

Expenses		Revenue
Staff orientation to project occurs as part of existing monthly staff meetings (time is already captured in unit budget for necessary non-prodctive hours)		Savings per EVD-associated infection estimeted $7,028/occurance (Hersh et al., 2019) Goal= reduce current EVD-related infection by 50%= Goal ≤ 5.9
Paper and printing supplies	~$20	**Infection rate 11.8 x $7,028 ($82,930) - Infection rate 5.9 X $7,028 ($41,465)**
Total Revenue >$41,400		

Table 4

Evaluation Plan

MEASURES	CATEGORIES: OUTCOME	CATEGORIES: PROCESS	TIME for DATA COLLECTION: Baseline	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Rate of EVD-associated Infections on adult and pediatric critical care units that care for patients with EVDs Denominator is total # of drain days within the intervention period. Numerator is the total # of infections within the intervention period. Result is multiplied by 1,000.	X		X				X				X
Percentage of Rounds Completed Add the number of completed rounds each week and divide by the total number of possible rounding opportunities		X		X	X	X	X	X	X	X	X
Percent Compliance (visualization) with: Catheter in ? pattern under dressing Dressing intact and per protocol Tubing labeled Dead end caps on tubing CSF leak from site, ear, nose, mouth Number of times compliant divided by total number of opportunities for each individual element		X		X	X	X	X	X	X	X	X
Percent Compliance (documentation) with of elements of EVD care bundle: Insertion checklist, abx pior to insertion, dressing assessment and change, presence of tubing label and dead end caps, bag change, line flushing and CSF sampling. Number of times compliant divided by total number of opportunities for each individual element		X		X	X	X	X	X	X	X	X
Patient age and duration of EVD Described as mean				X	X	X	X	X	X	X	X
Indication for EVD Described using Frequency Distribution and represented as a percentage				X	X	X	X	X	X	X	X

MEASURES	Descriptive Statistices: Frequency	Descriptive Statistices: Other	BASELINE: Values	GOAL: Baseline	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 8
Rate of EVD-associated Infections on adult and pediatric critical care units that care for patients with EVDs		X	11.8										≤ 5.9
Percentage of Rounds Completed	X		N/A		≥ 75%	≥ 75%	≥ 75%	≥ 75%	≥ 75%	≥ 75%	≥ 75%	≥ 75%	≥ 75%
Percent Compliance (visualization)	X		N/A		≥ 95%	≥ 95%	≥ 95%	≥ 95%	≥ 95%	≥ 95%	≥ 95%	≥ 95%	≥ 95%
Percent Compliance (documentation)	X		N/A		≥ 95%	≥ 95%	≥ 95%	≥ 95%	≥ 95%	≥ 95%	≥ 95%	≥ 95%	≥ 95%
Patient age and duration of EVD	X		N/A										
Indication for EVD	X		N/A										

Figure 1

Cause and Effect Diagram

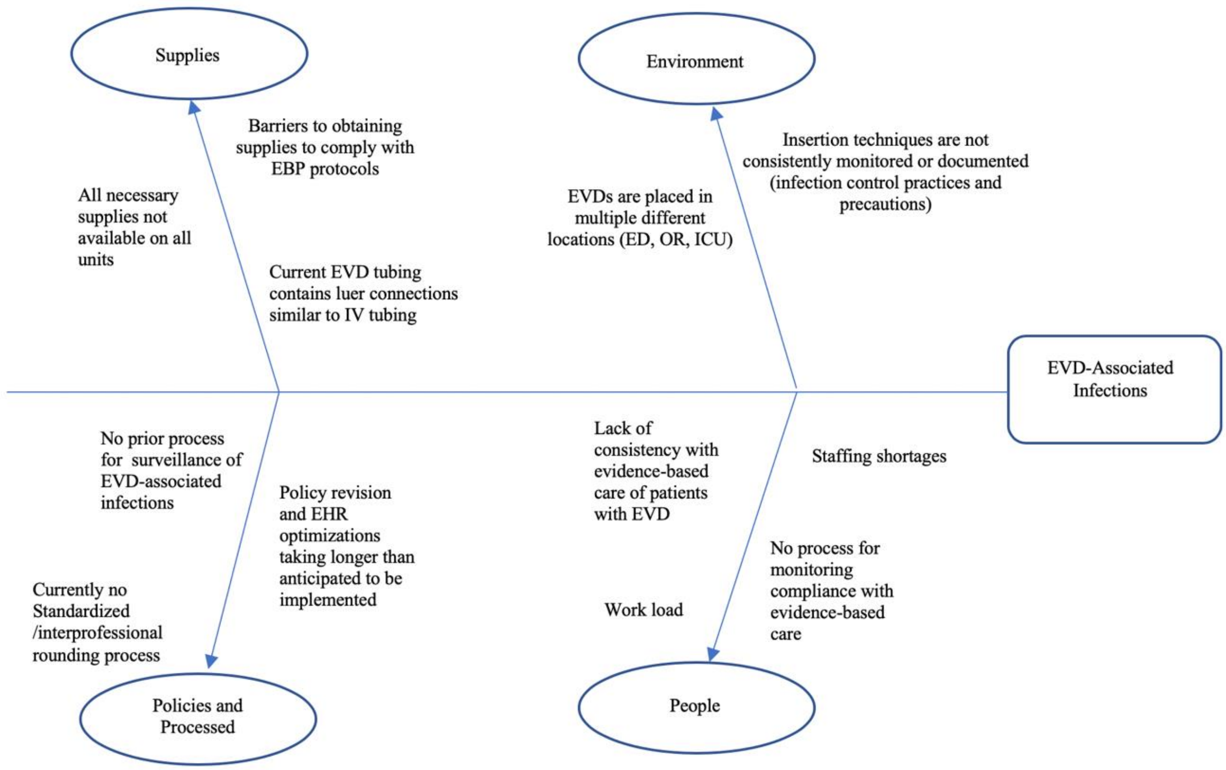


Figure 2

Prisma Diagram

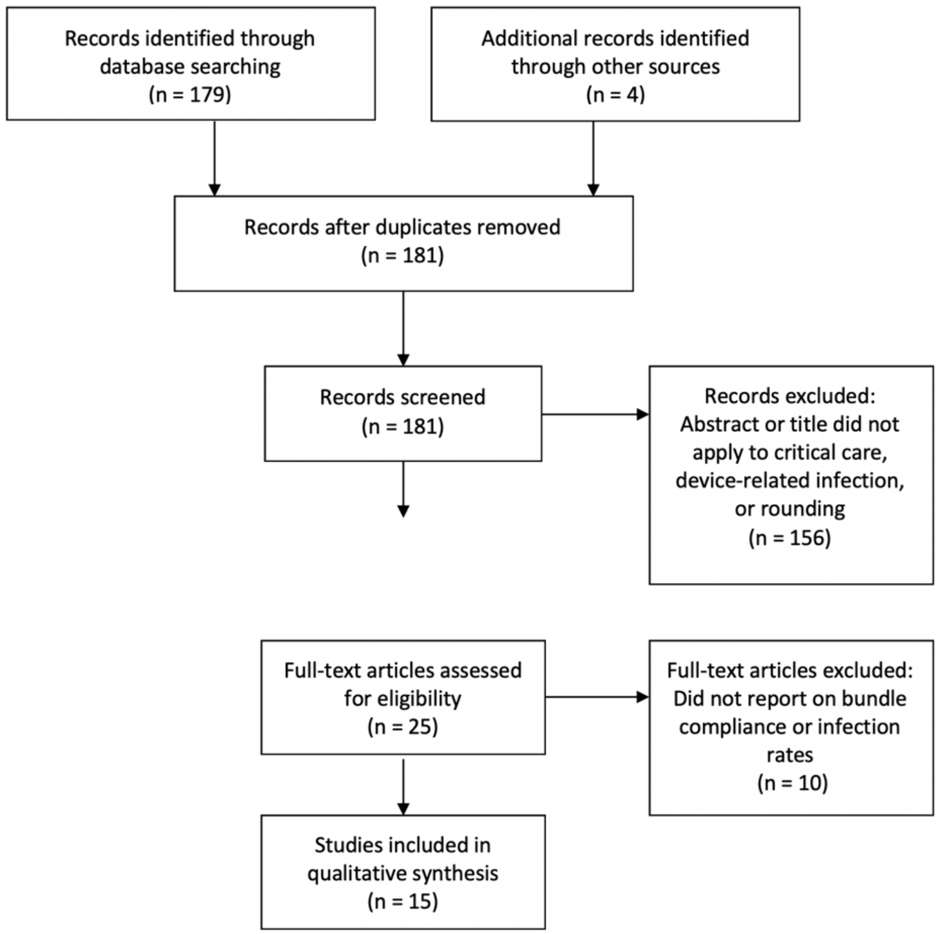


Figure 3

SWOT Analysis

Strengths What do you do well? What unique resources can you draw on? What do others see as your strengths?	**Weaknesses** What could you improve? Where do you have fewer resources than others? What are others likely to see as weaknesses?
*Neurosurgery Chief is engaged and supportive of collaboration and evidence-based initiatives for improving patient outcomes *Trauma CNS has extensive experience in EBP *Leadership support	*Lack of consistent interprofessional rounding process for neurosurgery team *Inconsistencies in care practice and provider orders for patient with EVDs *No surveillance for EVD-associated infections *Large number of nurses with less than 3 years of critical care experience
Opportunities What opportunities are open to you? What trends could you take advantage of? How can you turn your strengths into opportunities?	**Threats** What threats could harm you? What is your competition doing? What threats do your weaknesses expose you to?
*Establishing surveillance of EVD-associated infections based upon existing structure for surveillance of other hospital-acquired infections *Using innovative electronic data collection to facilitate data collection and reporting *Optimize nursing documentation in Electronic Health Record	*Work load *Staffing *Patient care emergencies

Appendix A

Summary of Primary Research Evidence

	Citation	Design/ Method	Sample/Setting	Major Variables Studied	Outcome Measurement Data Analysis	Findings	Level of Evidence	Quality of Evidence: Critical Worth to Practice
1	Anderson et al., 2015.	Quasi-experimental, pre-post-intervention design to determine if semi-weekly nurse rounding reduced hospital-acquired pressure injury and improved adherence to care bundle interventions Patient assessments, chart reviews for 5 interventions, nurse rounding logs	181 pre- 146 post- subjects Setting 3 ICUs in Minneapolis, MN	*Unit-acquired pressure injury *Adherence to bundle interventions * Semi-weekly nurse rounds	Power analysis for multiple logistic regression between groups Sample size determination used PASS 11 software Means and standard deviations to describe sample characteristics Pre-Post-subject characteristics compared with t-tests and chi-square Differences pre-post-intervention with t-test Frequencies used to evaluate nurse rounding log	Adherence to 2/5 bundle interventions improved significantly ($p<.001$) Post-intervention unit-acquired injury were reduced from 15.5% to 2.1%	**Level=II**	Semi-weekly rounds promoted in-the-moment feedback, corrections and early identification of non-adherence to care and unit-acquired injuries were reduced significantly **Limitations:** Adherence to bundle was determined by chart review only **Grade: B**
2	De Cristofano et al., 2016	Quasi-experimental uninterrupted time series study Implemented an evidence-based care bundle Implemented rounding for compliance	Pediatric ICU (PICU) in Argentina Rate of ventilator use is 40% and baseline ventilator-associated pneumonia rates were 6.3 per 1,000 ventilator days. All mechanically ventilated patients were included	Once bundle was introduced, compliance was measured in two ways: 1. Initially unplanned visits by infectionist Nov 2012-Aug 2013 2. Checklist used during daily rounds by physician to verify compliance with bundle (Sep 2013- Oct 2014) Infectionist group collected # of Vent days, admission days, % of compliance with	Process indicator: monthly % of compliance with each component of the bundle Result indicator: monthly ventilator associated pneumonia (VAP) rate every 1,000 vent days Descriptive statistics used means and standard deviations, medians and	VAP rates decreased significantly post intervention (6.34 to 2.38 per 1000 ventilator days, $p=0.0047$) Compliance reported in a table indicating	**Level= II**	Compliance improved and VAP rates decreased after daily rounding checklist process implemented during physician led rounding During rounding if an item was not being followed the opportunity to educated was observed. **Grade: B**

			713 ventilated patients over 4 years	bundle during unplanned visits phase 1 PICU members responsible for obtaining % of compliance derived from use of the checklist	interquartile ranges or proportions depending on the characteristics and distribution of variables. Analysis of monthly result indicator variability performed using control chart. Mean VAP rates compared using t- test for independent samples and $p<0.05$ considered statistically significant	overall improvement after daily rounding initiated		
3	Hermon et al., 2015.	Quasi-experimental Project	Bundle compliance measured over a 8 year period using electronic tool. Data on compliance was recorded twice a shift and data provided monthly to nursing and medical staff 500-bed district hospital in UK	*Rate of catheter-related infections *Compliance with care bundle *Number of lines	Variables that indicated compliance were tested using ANOVA. Segmented regression analysis assessed changes in infections before and after bundle.	Bundle compliance increased to 100% from 55% after feedback from rounding was consistently shared. Infection reduction statistically significant from 15.6/1000 days to 0.4/1000 days ($p<0.05$)	**Level=II**	Compliance with bundle had significant effect on the number and prevalence of infections. Electronic tool to monitor compliance with bundle successfully improved compliance and reduced infections Tool allows for regular feedback to staff on progress toward goals **Grade: B**
4	Hill et al., 2012	Quality Improvement Program Review Multi-disciplinary team developed to identify gaps in practice. To reduce infections	3-year period at Tertiary hospital with 11.3% of annual patients admitted with neurological insult.	*EVD associated infections per 1,000 drain days *Implementation of an insertion checklist *Monthly infection rounds	Not included	EVD associated infections decreased from 16 per 1,ooo EVD days to 3.2 for 2 years then zero for	**Level=V**	Rounds were performed weekly to ensure dressings were sterile and occlusive and to provide immediate feedback and education to staff. Monthly round results posted for staff to track progress to goals

		*Define criteria for EVD infection *Revise policy to standardize insertion and maintenance *Develop insertion checklist. *Weekly rounds initiated to monitor dressings * Include routine surveillance of EVD infections				over a year through reporting period		**Limitations:** Sample sizes not reported only surveillance results **Grade: C**
5	Hulyalkar et al., 2017.	Prospective pre-post-interventional study	113 patient encounters and 108 staff completed surveys pre- 114 patient encounters and 80 staff completed surveys post- Pediatric intensive care unit in Minnesota during two month period	*Direct in-person observation of team performance pre-post-implementation of a CERTAINp rounding tool. *Compliance scores= dividing # of standard care adherence data points by the # of eligible data points * compliance and staff perception of rounds collected	REDCap used to collect data. JMP software used for analysis. Shapieo-Wilk testing on continuous variables and revealed non-normal distribution. Non-parametric used to analyze continuous data. Chi-square for binary variables. Fisher exact for variables with expected count <5 in 20% of the cells. P value <0.05 statistically significant	Discussion of care guidelines during rounds improved to 97% in all points post-intervention Total compliance to checklist improved from mean 49.17 ± 16.5% pre- to 100% post	**Level=III**	Checklist based rounding tool (CERTAINp) improved discussion of standard of care guidelines and improved staff satisfaction **Limitations:** Effect on patient outcomes not determined **Grade: B**
6	Khan et al., 2016	Pre-post-interventional quality improvement project Care bundle implementation and daily	3665 ventilated patients included, 9445 monitored observations for compliance with bundle Over a 4 year span 2008-2013	*Ventilator-associated pneumonia rate *Compliance with evidence-based interventions	VAP incidence reported as cases per 1000 ventilator days Compliance for bundle elements obtained from documentation and direct observation	*Bundle compliance increased from baseline 48% to pre-VAP rounds at 90.7% to 94.2% post	**Level=V**	Compliance was monitored during daily rounds by multidisciplinary VAP team per chart review different times of the day. If component of bundle was non-compliant, staff teaching was conducted.

		rounding to assure compliance				VAP team rounding (p<0.001) *VAP rate decreased from 8.6 to 2.0 per 1000 ventilator days (p<0.001)		ICU-safety team randomly monitored compliance on almost daily-basis for redundant check. **Grade: B**
7	McBeth et al., 2018.	Pre-Post-Intervention quality improvement study	Aug 2010-June 2017 24-bed open PICU/Pediatric cardiac ICU in Northern CA	*Ventilator-associated infection rates *Compliance with care bundle *Unannounced bedside audits with just-in-time feedback/education	Compliance with bundle components reported as # correctly completed per # of observations expressed as monthly percentages averaged over a year. VAP rates reported as rate per 1000 vent days.	Compliance improved to >95% across 7-year intervention period Quarterly VAP rates fell from 7.86 to 1.16 per 1000 vent days within 2 years and to zero to date	**Level=V**	Development of a bundle with compliance monitored by unannounced bedside auditing linked with just-in-time education reduced infection rate from 7/86 to 1.16 per 1000 vent days, Bundle compliance ranged from 86-99% Just-in-time teaching with non-punitive compliance rounding Electronic audit tool used **Grade: B**
8	Mendez et al., 2013.	Retrospective before and after study	68-bed MICU in Michigan 781 patients 580 ICU rounding team 201 Dedicated rounding team 1st phase ICU rounded 2nd phase dedicated team rounded 1 year period	***Differences in Compliance with ventilator bundle between dedicated ventilator bundle team and ICU rounding team	Retrospective review of electronic database GraphPad Prism Software V 5.0 and Statistical Analysis Software version 9.2 were used for statistical analysis. Baseline characteristics compared using t-test for continuous variables or chi-square for dichotomous variables. Frequency of compliance with components was corrected for the fact that data was	Spontaneous breathing trial compliance was not significantly different p=.35 Sedation Vacation improved p<.001 Peptic ulcer prophylaxis was not significantly changed p=.50 except on the weekend p<.001	**Level=III**	Compliance in some bundle interventions was improved with dedicated rounding team. Those interventions that were improved were largely nurse-driven. **Limitations:** Not all elements showed improved compliance Not all elements could be analyzed through the electronic rounding database **Grade: B**

					collected on the same patient for all days on the ventilator. PROC GENMOD within SAS allowed for correction for repeated measures. Alpha level of < .05 considered statistically significant.			
9	Nassikas et al., 2020	Retrospective before-and-after study	Academic community hospital ICU between March 2013 and February 2017 16-bed mixed surgical, cardiac, medical ICU in Rhode Island	Rounding checklist maintained through web-based data tool (REDCap). Used during daily rounds by providers. Checklist prompted users to answer questions about care. *Checklist completion rate (# checklists completed per # of ICU patient days)	CAUTI rates defined as # CAUTI per 1,000 catheter days Analysis using SAS software A means procedure and t test were performed for descriptive and bivariate analyses to compare before-and-after end points Post intervention period 1 March 2014-Feb 2015 Post-intervention period II March 2015-February 2016 Post intervention period III March 2016-Feb 2017	Checklist completion rate was 33/6% Rate of CAUTI decreased from pre-intervention of 4.62 to Post I: 2.12 p=.2104 Post II:0.45 p=.0275 Post III: 0.96 p=0.532	**Level=III**	Use of checklist to facilitate rounding is associated with statistically significant reductions in CAUTI rates **Limitations:** Attending provider used checklist during multi-disciplinary rounds **Grade: B**
10	Ormsby, et al., 2020.	Quality improvement project (Use Kamishibai card)	2,321 K-card audits for 1,051 unique patients Implemented in 4 ICU units, 1 intermediate unit, 3 medical units, 2 oncology units, 1 cardiac unit and 3 surgical units. at a 415-bed academic pediatric hospital	*Monthly audit rounds using K-card *Adherence to bundle elements *CLABSI rates	Descriptive statistics to summarize characteristics of lines and patients. Bundle reliability calculated. Monthly and expressed as a proportion. Chi square tests used to compare change in reliability from initial to final month of intervention. CLABSI rates were displayed using statistical	Bundle reliability increased significantly (p<.001) 43% to 78% at 12 months CLABSI rate decreased from 1.35 to 1.17 although the result was not statistically	**Level=V**	Rounding using K-card facilitated standardized data collection and real-time feedback to nurses. Bundle compliance increased after implementation and CLABSI rate decreased although not significantly. **Grade: B**

					process control charts and change in rate between pre-post period assessed using Poisson regression. Stata version 13.1 software and SAS version 9.4 used for analysis	significant (p=.41)		
11	Rawat et al., 2017.	Longitudinal quasi-experimental study	56 ICUs at 38 hospitals in Maryland and Pennsylvania Oct 2012 to March 2015	*VAE(ventilator associated events) *IVAC(Infection related vent-associated complications) *VAP (probable ventilator-associated pneumonia) incidence rated per 1000 ventilator days *Compare early and late intervention periods *Compliance with 6 bundle interventions	Log-link and Poisson variance used to explore the relationship between time since intervention and rates for the quarterly numbers of events. Modeled the exposure of interest (quarter) as a continuous variable and estimated average intervention effects per quarter. Statistical software R 3.2.2 was used for analysis	Quarterly mean VAE IVAC and PVAP rates reduced significantly (p=.007, p=0.018, p=0.012) respectively VAE, IVAC< PVAP reduced over time (p=0.002, p<0.001, p<0.001) respectively Compliance with bundle increased p<0.024.	**Level=II**	Multifaceted intervention improved compliance with bundle and decreased VAE, IVAC and PVAP. Developed care bundle, training, rounding using a standard data collection tool daily. Performance data results shared on data portal and feedback provided quarterly As bundle compliance increased VAE was shown to decrease. **Grade: B**
12	Snyder et al., 2020. ,	Pre-Post-Intervention quality improvement study	55-bed PICU in a large 520 bed urban hospital in Atlanta	***Compliance with bundle interventions *targeted rounding	Compliance with bundle calculated as % of patients with catheter for whom all 5 bundle elements were met during rounding. Counted raw # of infections and infection rates # of infections divided by # of opportunities.	Bundle compliance supported by targeted rounding increased from 84-93%, infection rate went from 2/7 per1000 catheter days to zero	**Level=V**	Targeted rounding supported bundle compliance and reduced Catheter-associated infection. Change sustained X 1 year. Ease of implementation (targeted rounding) Rounds occurred once per day ~ 5 min per patient Targeted rounds included real-time training for needed improvements

								Harm prevention data review dashboard created to review compliance and outcome trends in real time **Grade: B**
13	Su et al., 2017.	Quasi-experimental study with interrupted time-series analysis	2 Cardiovascular ICUs in one medical center 1512 patients enrolled accounting for 2553 ventilator days and 68 early onset VAP events	*Unaware external audits done pre-bundle *Knowing internal audits were done post bundle implementation *Compliance with bundle *Ventilator associated pneumonia (VAP)incidences	VAP incidence (events/1000 vent days) VAP incidence was inversely correlated with bundle compliance p=0.001 SPSS software used for statistical analysis. Data presented as mean SD or 95% conference interval. ANOVA test or t-test to compare continuous variables between groups and chi square or Fisher-exact to compare categorical data. Incidence was analyzed using Poisson regressions. Changes of VAO incidence and bundle compliance used Spearman's rank test.	4 study phases: VAP significantly reduced in phase 3 by 59% (p=0.002 but rebounded in phase 4. VAP incidence inversely correlated to compliance p=0.001 and external rounding p<0.001 Minimum compliances required for significant VAP reduction were 85% and 75% for Oral care and hand hygiene	**Level=II**	Aware audits (rounding) conducted by unit-based staff improves bundle compliance and reduces VAP incidence. During rounding real-time feedback was given to ensure quality of care **Grade: B**
14	Wallace & Macy, 2016.	Quality Improvement Project	Adult Med-Surg ICU in a Baltimore hospital	*Bundle Compliance monitoring using Checklist, flip chart, and daily goal sheet *CLABSI rates	CLABSI rates per 1000 line days (#CLABSI divided by #of line days X1000) Statistical significance determined by CI 95% using Byar's method.	Infections rates dropped and have remained statistically stable 0.8/1000 line days 95% CI	**Level=V**	Electronic checklist used to round and monitor bundle compliance. Bundle compliance monitored Before Procedure: did provider perform? During procedure: did the provider?

						2011, 0.0 95% CI in 2012, .91 95% CI in 2013.		Post procedure Limitations: bundle compliance data not reported only general improvement **Grade: C**
15	Wilder et al.., 2016.	Quality Improvement Project	36-bed level IV NICU at large academic medical center.	*CLABSI rates *CLABSI infections	Direct observation for data during daily rounding process.	CLABSI rate reduced by 92% or 7 infections over 3 years $327,238.34 savings and decreased length of stay 17.6 days	**Level=V**	Line rounding audit tool developed to evaluate lines every day using an “all or nothing” principle. Rounders were to react in the moment to provide necessary feedback **Limitations:** Data for compliance not included only general description that increased compliance improved infections **Grade: B**

Legend:

1. 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 & Continence Nursing, 42*(3), 217–225. https://doi.org/10.1097/WON.0000000000000109
2. De Cristofano, A., Peuchot, V., Canepari, A., Franco, V., Perez, A., & Eulmesekian, P. (2016). Implementation of a ventilator-associated pneumonia prevention bundle in a single PICU. *Pediatric Critical Care Medicine, 17*(5), 451–456. https://doi.org/10.1097/PCC.0000000000000714
3. Hermon, A., Pain, T., Beckett, P., Jerrett, H., Llewellyn, N., Lawrence, P., & Szakmany, T. (2015). Improving compliance with central venous catheter care bundles using electronic records. *Nursing in Critical Care, 20*(4), 196–203. https://doi.org/10.1111/nicc.12186
4. Hill, M., Baker, G., Carter, D., Henman, L. J., Marshall, K., Mohn, K., & Moody, E. (2012). A multidisciplinary approach to end external ventricular drain infections in the neurocritical care unit. *Journal of Neuroscience Nursing, 44*(4), 188Y193.doi:10.1097/JNN.0b013e3182527672
5. Hulyalkar, M., Gleich, S., Kashyap, R., Barwise, A., Kaur, H., Dong, Y., Fan, L., Murthy, S., Arteaga, G., Tripathi, S., Gleich, S. J., & Arteaga, G. M. (2017). Design and α-testing of an electronic rounding tool (CERTAINp) to improve process of care in pediatric intensive care unit. *Journal of Clinical Monitoring & Computing, 31*(6), 1313–1320. https://doi.org/10.1007/s10877-016-9946-1
6. Khan, R., Al-Dorzi, H. M., Al-Attas, K., Ahmed, F. W., Marini, A. M., Mundekkadan, S., Balkhy, H. H., Tannous, J., Almesnad, A., Mannion, D., Tamim, H. M., & Arabi, Y. M. (2016). The impact of implementing multifaceted interventions on the prevention of ventilator-associated pneumonia. *American Journal of Infection Control, 44*(3), 320–326. https://doi.org/10.1016/j.ajic.2015.09.025
7. McBeth, C. L., Montes, R. S., Powne, A., North, S. E., & Natale, J. E. (2018). Interprofessional approach to the sustained reduction in ventilator-associated pneumonia in a pediatric intensive care unit. *Critical Care Nurse, 38(*6), 36–45. https://doi.org/10.4037/ccn2018121

8. Mendez, M. P., Lazar, M. H., Digiovine, B., Schuldt, S., Behrendt, R., Peters, M., & Jennings, J. H. (2013). Dedicated multidisciplinary ventilator bundle team and compliance with sedation vacation.. *American Journal of Critical Care*, *22*(1), 54–60. https://doi.org/10.4037/ajcc2013873
9. Nassikas, N. J., Monteiro, J. F. G., Pashnik, B., Lynch, J., Carino, G., & Levinson, A. T. (2020). Intensive care unit rounding checklists to reduce catheter-associated urinary tract infections. *Infection Control and Hospital Epidemiology*, *41*(6), 680–683. https://doi.org/10.1017/ice.2020.43
10. Ormsby, J. A., Cronin, J., Carpenter, J., Graham, D. A., Potter-Bynoe, G., Vaughan, A. M., Weir, L., Flaherty, K. A., Chandonnet, C. J., Priebe, G. P., & Sandora, T. J. (2020). Central venous catheter bundle adherence: Kamishibai card (K-card) rounding for central-line-associated bloodstream infection (CLABSI) prevention. *Infection Control and Hospital Epidemiology*, 1–6. https://doi.org/10.1017/ice.2020.235
11. Rawat, N., Yang, T., Ali, K. J., Catanzaro, M., Cohen, M. D., Farley, D. O., Lubomski, L. H., Thompson, D. A., Winters, B. D., Cosgrove, S. E., Klompas, M., Speck, K. A., & Berenholtz, S. M. (2017). Two-state collaborative study of a multifaceted intervention to decrease ventilator-associated events. *Critical Care Medicine*, *45*(7), 1208–1215. https://doi.org/10.1097/CCM.0000000000002463
12. Snyder, M. D., Priestley, M. A., Weiss, M., Hoegg, C. L., Plachter, N., Ardire, S., & Thompson, A. (2020). Preventing catheter-associated urinary tract infections in the pediatric intensive care unit. *Critical Care Nurse*, *40*(1), e12–e17. https://doi.org/10.4037/ccn2020438
13. Su, K.-C., Kou, Y. R., Lin, F.-C., Wu, C.-H., Feng, J.-Y., Huang, S.-F., Shiung, T.-F., Chung, K.-C., Tung, Y.-H., Yang, K.-Y., & Chang, S.-C. (2017). A simplified prevention bundle with dual hand hygiene audit reduces early-onset ventilator-associated pneumonia in cardiovascular surgery units: An interrupted time-series analysis. *PloS One*, *12*(8), e0182252. https://doi.org/10.1371/journal.pone.0182252
14. Wallace, M. C., & Macy, D. L. (2016). Reduction of central line-associated bloodstream infection rates in patients in the adult intensive care unit. *Journal of Infusion Nursing*, *39*(1), 47–55. https://doi.org/10.1097/NAN.0000000000000151
15. Wilder, K. A., Wall, B., Haggard, D., & Epperson, T. (2016). CLABSI Reduction Strategy: A systematic central line quality improvement initiative integrating line-rounding principles and a team approach. *Advances in Neonatal Care*, *16*(3), 170–177. https://doi.org/10.1097/ANC.0000000000000259

Appendix B

Levels and Quality of Evidence Synthesis Table

Key: **B=Good quality** **C=Low quality**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Level I: Randomized controlled trial (RCT) Systematic Review of RCT															
Level II: Quasi-experimental	**B**	**B**	**B**								**B**		**B**		
Level III: Non-experimental					**B**			**B**	**B**						
Level IV: Opinion of respected authorities or national expert															
Level V: Quality Improvement				**C**		**B**	**B**			**B**		**B**		**C**	**B**

Legend:

1. Anderson et al., 2015
2. De Cristofano et al., 2016
3. Hermon et al., 2015
4. Hill et al., 2012
5. Hulyalkar et al., 2017
6. Khan et al., 2016
7. McBeth et al., 2018
8. Mendez et al., 2013
9. Nassikas et al., 2020
10. Ormsby et al., 2020
11. Rawat et al., 2017
12. Snyder et al., 2020
13. Su et al., 2017
14. Wallace & Macy, 2016
15. Wilder et al., 2016

Appendix C

Outcomes Synthesis Table: Effect of quality rounding on hospital-acquired condition and evidence-based bundle compliance

= Level V Low Quality Studies	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Outcome #1 Reduce hospital-acquired condition	↓	↓	↓	↓	**NR**	↓	↓	**NR**	↓	↓	↓	↓	↓	↓	↓
Outcome #2 Improved Evidence-Based Bundle Compliance	↑	↑	↑	**NR**	↑	↑	↑	↑	↑	↑	↑	↑	↑	**NR**	**NR**

Symbol Key:

↑ = Increased and statistically significant, ↑ = Increased but not statistically significant,

↓ = Decreased and statistically significant, ↓ = Decreased but not statistically significant, NR = Not Reported

Legend:

1. Anderson et al., 2015
2. De Cristofano et al., 2016
3. Hermon et al., 2015
4. Hill et al., 2012
5. Hulyalkar et al., 2017
6. Khan et al., 2016
7. McBeth et al., 2018
8. Mendez et al., 2013
9. Nassikas et al., 2020
10. Ormsby et al., 2020
11. Rawat et al., 2017
12. Snyder et al., 2020
13. Su et al., 2017
14. Wallace & Macy, 2016
15. Wilder et al., 2016

Appendix D

Synthesis Table: Common Themes Related to Rounding

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Rounding frequency	Semi-weekly	Daily	2x/day	Weekly	Daily	Daily	Daily	Daily	Daily	10-20 per Month	Daily	Daily	Daily	Daily	5 Days per week
In the moment/ real-time feedback	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Reporting of process improvement to staff	--	--	Each Quarter	Each Month	--	--	--	--	--	Each Month	Each Quarter	Dash board updated daily	--	--	Each Month
Rounding led trained professional	Expert/ Champion	Infection control committee	RN	Educator Infect-ionist	RNs, MDs and residents	RN Chart Review	RN team	Special team	MD and residents	Unit leader + Infection specialist	Round-Team	RNs and MD assigned days	Unit based RNs	RN	RN and QI leader

Legend:

1. Anderson et al., 2015
2. De Cristofano et al., 2016
3. Hermon et al., 2015
4. Hill et al., 2012
5. Hulyalkar et al., 2017
6. Khan et al., 2016
7. McBeth et al., 2018
8. Mendez et al., 2013
9. Nassikas et al., 2020
10. Ormsby et al., 2020
11. Rawat et al., 2017
12. Snyder et al., 2020
13. Su et al., 2017
14. Wallace & Macy, 2016
15. Wilder et al., 2016

Appendix E

Stakeholder Analysis

Stakeholder Analysis						
Stakeholder Name	Impact	Influence	What is important to them?	How can they contribute?	How can they block the project?	Strategy for engaging them
Chief of Neurosurgery (Dr. M)	High	High	Infection prevention/ Patient outcomes	Approval of project intervention Engaged in evidence-based care of patients, accountability among neurosurgery physicians/residents and efforts to reduce practice variability	Competing priorities	Reinforce project goal to reduce hospital-acquired infections, reduce healthcare costs, and improve patient outcomes-align with organization mission. Member of project team-share monthly project updates
Senior neurosurgery resident (Dr. B)	High	High	Infection prevention/ Patient outcomes	Accountability of residents. Positive influence and role model for resident group	Not holding residents accountable. Lacking oversight	Reinforce project goal to reduce hospital-acquired infections, reduce healthcare costs, and improve patient outcomes-align with organization mission. Member of project team-share monthly project updates. Celebrate successes
Nursing leaders: NTICU (OR), SICU (B. D), VICU (T. E), PICU (L. O)	High	High	Infection prevention/ Patient outcomes. Cost. Staff engagement and competence	Accountability and engagement of nursing staff	Not holding staff accountable, not disseminating information	Reinforce project goal to reduce hospital-acquired infections, reduce healthcare costs, and improve patient outcomes-align with organization mission. Member of project team-share monthly project updates. Celebrate successes. Friendly competition between units
Bedside nurse (S. P)	High	High	Ease of implementation/Time commitment.	Staff engagement. Insight into barriers and facilitators of change at bedside	Lack of engagement, competing priorities	Adequate education/preparation and reward for participation (career advancement opportunity). Project will standardize care of patients with EVD, limit uncertainty. Active involvement in training/dissemination of information.
Director of Quality department (H. C)	Moderate	Moderate	Infection prevention/ Patient outcomes. Cost	Support of project goals. Enthusiastic. Influence to move patient safety priorities through approvals	Competing priorities	Reinforce project goal to reduce hospital-acquired infections, reduce healthcare costs, and improve patient outcomes-align with organization mission. Share monthly updates/outcome data
Infection Preventionist (M. J)	Moderate	Moderate	Infection prevention/ Patient outcomes. Cost. Personal satisfaction for impacting effective change	Support of project goals. She has experience with system infection surveillance for other device-associated infections	Competing priorities	Reinforce project goal to reduce hospital-acquired infections, reduce healthcare costs, and improve patient outcomes-align with organization mission. Group recognition for contributions.
Neurotrauma CNS (E.H)	Moderate	High	Infection prevention/ Patient outcomes. Cost containment	Accountability and engagement of nursing staff. Individual is a role model and experienced in EBP project implementation	Competing priorities	Reinforce project goal to reduce hospital-acquired infections, reduce healthcare costs, and improve patient outcomes-align with organization mission
Pharmacist	Low	Moderate	Cost effectiveness. Consistent ordering practices for medications	Individual has been active participant in several EBP projects for trauma patients and has influence in pharmacy department to enforce changes	Competing priorities	Positive reinforcement of value to the project-cost savings improving ordering consistency. Group recognition for contributions.

Appendix F

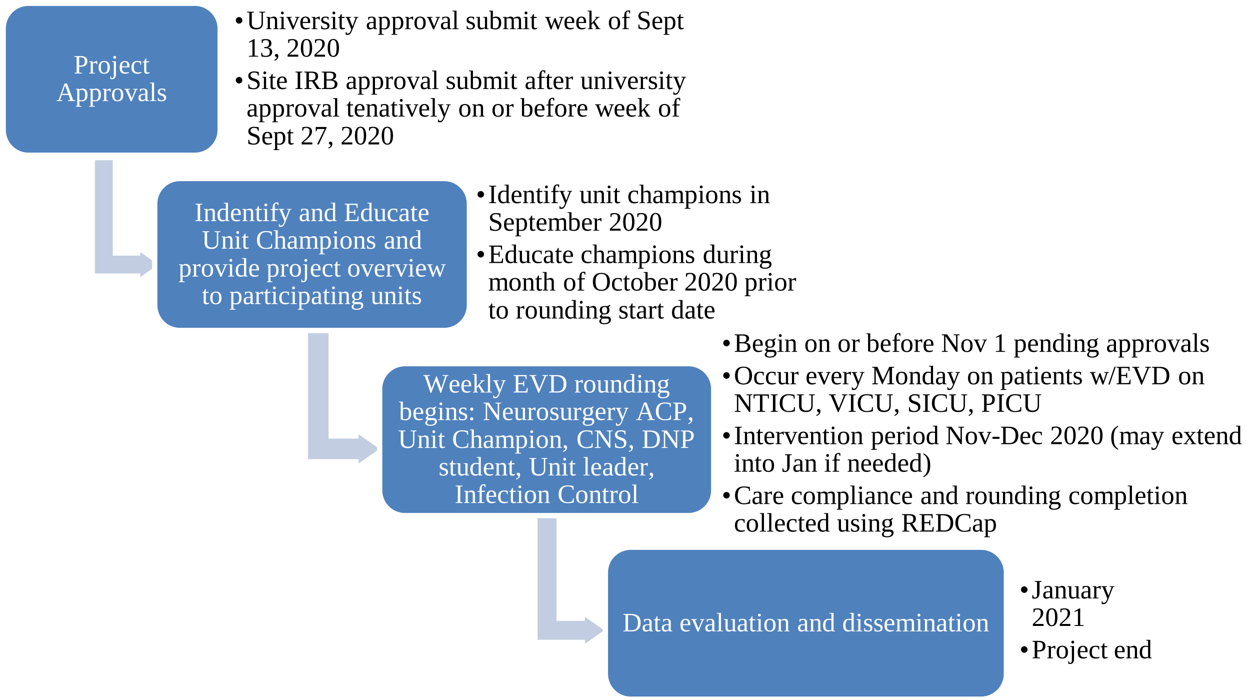
Rounding Checklist and Rounding Compliance Tool:

Interdisciplinary rounding checklist
Date
Room #
Catheter in ? Pattern?
Dressing intact and per protocol?
CSF leak from insertion site or patient ear, nose, or mouth?
Tubing labeled with "Do Not Inject" sticker?
Chlorhexidine (red cap) on EVD tubing luer connections?
For any "No" response please provide comments

Weekly Rounding Compliance
Date
Unit
Total number of patients in the unit with an EVD?
Total number patients with an EVD included in rounding?
If rounding was NOT completed on a patient with an EVD, please describe reason below
Who participated in the rounding process (choices Neurosurgery ACP/provider, neurotrauma CNS, DNP student, unit champion, primary RN, unit nurse leader, infection control, quality)?

Appendix G

Project Overview/Plan



Project Protocol

Monday morning at start of shift Unit Champion identifies patients on their unit with an EVD and remind primary RNs of rounding

- NTICU unit champion contacts VICU, SICU and PICU to determine if EVDs are present on the unit (plan rounding)

Rounding begins between 9:30-10:00am: Neurosurgery ACP, Unit Champion, Neurotrauma CNS, Unit Leader, Infection Control, Quality, DNP student, primary RN

- Begin on NTICU (largest volume of EVDs). Unit champion alerts primary RN to facilitate participation
- Round on each patient with an EVD using rounding checklist and record results in REDCap prior to moving to next patient
- In the moment education, correction, and praise provided for each rounding opportunity and plan for necessary corrections determined prior to performing next patient round
- Upon completion of rounding, prior to moving to next unit, rounding compliance is documented in REDCap

After each month of rounding EVD-associated infection rates will be reviewed with staff

- Infections rates for November and December will be compared to baseline rates and distributed to participating units and successes celebrated
- Post intervention outcome data (infection rates, compliance with evidence-based care and rounding compliance) will be distributed to participating units

Appendix H

UNIVERSITY OF ST. AUGUSTINE
FOR HEALTH SCIENCES

Doctor of Nursing Practice Program
Evidence-Based Practice Review Council
1 University Blvd.
St. Augustine, FL 32086

September 22, 2020

Dear Laura Reiter,

Your proposal titled **Implementing Interdisciplinary Team Rounding to Reduce External Ventricular Drain-Associated Infections** has been reviewed by the University of St. Augustine for Health Sciences Doctor of Nursing Practice Evidence-Based Practice Review Council (EPRC) and determined to:

___ meet the requirements for research as defined in the Federal Register. You must make adjustments to the proposal to reflect the DNP program requirements for an evidence-based practice change project and resubmit for additional review. Work closely with your practicum course faculty member during this process. Research is not appropriate for a DNP scholarly project.

_X__ not meet the requirements for research as defined in the Federal Register. Your proposal reflects an evidence-based practice change project. The proposal must be implemented as submitted (changes are not permitted). You may proceed to obtain approvals from the facility where the project will be implemented as soon as the primary course faculty member has reviewed and approved all facility application materials. Implementation may not begin until you are notified in writing by practicum course faculty that you may implement the project.

Questions regarding the USAHS approval process should be addressed to Dr. Douglas Turner at DTurner@usa.edu. Questions regarding the facility approval process should be addressed to course faculty.

Sincerely,

Douglas Turner

Douglas M Turner, PhD, DNP, RN, CNE, NE-BC, NEA-BC