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Implementation Of Provider And Workflow Strategies To Increase Adherence To Tqip Guidelines In Traumatic Brain Injury

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IMPLEMENTATION OF PROVIDER AND WORKFLOW STRATEGIES TO INCREASE ADHERENCE TO TQIP GUIDELINES IN TRAUMATIC BRAIN INJURY

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ABSTRACT

Traumatic brain injury (TBI) is a leading cause of death and permanent disability worldwide. The American College of Surgeon's Trauma Quality Improvement Program (TQIP) has developed a set of recommendations for the management of trauma-related injuries, including TBI. The objective of this evidenced-based practice project was to implement provider- and workflow-based strategies to improve adherence to TQIP recommended guidelines for the placement of intracranial pressure (ICP) monitors. The primary outcome measured was number of ICP monitors placed post-intervention.

The author reviewed available literature and found six articles pertaining to guideline implementations. Analysis of the literature was performed utilizing Melynk and Fineout-Overholt's evidence table formatting and classified using the Johns Hopkins evidence level and quality guide. Utilized articles encompassed meta- and systematic reviews of quasi-experimental studies and qualitative studies. The results supported the implementation of multiple strategies that would affect both provider actions and workflow processes.

Following literature analysis, a provider- and workflow-based strategy for TQIP guideline adherence was evaluated by the trauma team at a Level I trauma center. This was done using a pre-post implementation study on eligible TBI patients, aged 16 years and older utilizing TQIP inclusion and exclusion criteria. Patient record analysis for the retrospective cohort was conducted from October 2010 through September 2015, and the

post-implementation cohort from October 2015 through September 2016. Patient information obtained included age, race, gender, ED GCS score, AIS head score, insurance type, ISS score, and ETOH level. Clinical data collected included initial head computed tomography (CT) findings, hyperosmolar agent used (if any), plan of care upon initial exam by neurosurgery, ICU LOS, and hospital LOS.

A total of 563 cases were reviewed for study participation, but only 305 patients met TQIP TBI inclusion criteria in both pre- and post-implementation cohorts. After adjustment for confounding variables, the odds of receiving ICP monitoring in the post-implementation group was 76% lower than in the pre-implementation cohort (AOR 0.24 [95% CI 0.07-0.82], p 0.023). However, the post-implementation was 92% more likely to receive hypertonic saline infusion than pre-implementation cohort (AOR 0.08 [95% CI 0.04 – 0.20], p <0.0001). Mortality was not found to be significantly associated with provider or workflow-strategy implementation.

End results conclude that the provider and workflow-strategies were not statistically significantly related to increasing TQIP guideline adherence in the placement of ICP monitors. Recommendations for future practice include more robust inter-departmental communication, administrative advocacy for best practice guidelines, and expanding departmental scope of practice.

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LIST OF ABBREVIATIONS

AIS .... Abbreviated Injury Score

ACS .... American College of Surgeons

BTF .... 0The Brain Trauma Foundation

CPP .... Cerebral Perfusion Pressure

CT .... Computed Tomography

EDSBP .... Emergency Department Systolic Blood Pressure

GCS .... Glasgow Coma Scale

ICH .... Intracranial Hypertension

ICP .... Intracranial pressure

ICU .... Intensive Care Unit

ISS .... Injury Severity Score

LOS .... Length of Stay

MAP .... Mean Arterial Pressure

MOI .... Mechanism of Injury

OR .... Odds Ratio

SCIP .... Surgical Care Improvement Plan

TBI .... Traumatic Brain Injury

TQIP .... Trauma Quality Improvement Program

CHAPTER I

INTRODUCTION

In the United States, trauma is a leading cause of death in people under the age of 46 years, and the fourth leading cause of death in all age groups (American Association for the Surgery of Trauma, 2017). Healthcare provider response to traumas of all causes requires a unified team approach. At the pinnacle of provider and patient interaction are nurses that play a vital role in preventing secondary injury and complications in critically injured patients through detailed clinical assessment and nursing interventions (McNett & Gianakis, 2010). Nurses also often act as the liaison among specialties; assisting in care coordination and communicating amongst providers. As the primary executor of health care treatment plans, nurses understand the complexities involved in implementation efforts, and can provide insight into the communication methods, resources, and training required to be successful in new guidelines or protocols (Balas et al., 2012). As part of the interdisciplinary team, nurses help improve trauma patient outcomes (Fewster-Thuente & Velsor-Friedrich, 2008). This is especially crucial when defining treatment parameters for traumatic brain injury.

Traumatic brain injury (TBI) is a leading cause of death and permanent disability world-wide (WHO, 2006). Each year the United States nearly 1.7 million people seek medical treatment for a TBI (Faul, Xu, Wald, Coronado 2010). Of those, approximately 275,000are hospitalized and an estimated 52,000 result in death. A projected 5.3 million people live with a TBI-related disability with varying degrees of cognitive dysfunction, motor dysfunction, sensation impairment, and emotional changes (Faul, Xu, Wald, & Coronado 2010; Alali, et al., 2015). The economic burden of TBI in the United States is estimated at $76 billion when including the costs of rehabilitation, disability, and loss of productivity (American Association for the Surgery of Trauma, 2017; Alali, et al., 2015).

Evidence suggests that preventing secondary brain injury post-TBI improves overall patient outcomes (Karamanos et al., 2014). Monitoring intracranial pressure from the onset of brain injury may help indicate to providers sooner when secondary brain injury is likely to occur (Alali et al., 2013). The purpose of this evidenced-based practice project was to implement provider- and workflow-based strategies to improve adherence to TQIP recommended guidelines for placement of intracranial pressure (ICP) monitors.

Significance of Problem

The historically poor patient outcomes and high financial burden of TBI have led many domestic and international organizations to develop guidelines that address risks and interventions specific to the TBI population (Carney et al., 2016). However, adoption and utilization rates are suboptimal with current evidence-based guidelines (Shafi et al., 2014). A survey of trauma directors found that of Level I trauma centers with TBI guidelines, 31.48% reported non-adherence to those guidelines (Piper, Zogg, & Schneider, 2015). However, research has shown that using guidelines could reduce mortality rates. Shafi et al. (2014) found that a 10% increase in guideline compliance resulted in a 12% reduction in risk of death in a New York State study (OR 0.88). Arabi et al., (2010) also found ICU and hospital mortality reduction with the use of BTF guideline. The benefits of utilizing TBI guidelines are exemplified in these studies, yet despite evidence, adherence is still a primary concern.

A possible contributing factor to poor TBI management may stem from the lack of high quality evidence supporting the use of ICP monitors (Chesnut et al., 2012). ICP monitors measure the pressure created by cerebral spinal fluid within the skull and spinal cord (Czosnyka & Pickard, 2004). In head injury, pressures are often increased, limiting cerebral tissue perfusion and potentially causing irreversible ischemic secondary brain injury (Steiner & Andrews, 2006). The added benefit of an external ventricular drain makes the ICP monitor not only diagnostic, but therapeutic as well, allowing drainage of excess CSF to reduce pressures (Kirkman & Smith, 2014). However, the evidence supporting the use of the invasive monitoring to improve patient outcomes is limited. For example, Chesnut et al. (2012) conducted the only randomized controlled trial comparing the use of ICP monitors against serial CT scans with measured outcomes of survival and functionality in TBI patients. The results were not statistically significantly different between the two groups; though researchers still concluded ICP monitoring had an important role in TBI management (Chesnut, et al., 2015; LeRoux, 2014). A handful of retrospective studies correlated lower mortality rates with patients receiving ICP monitoring (Gerber et al., 2013; Bremmer et al., 2010, Arabi et al., 2010, Shafi et al., 2014, Alali et al., 2013). Contrasting findings suggest that ICP monitoring may decrease survival and functionality (Tang et al., 2015), or have insignificant impact on patient outcome in light of increaased guideline adherene (Dawes et al., 2015). These mixed conclusions may give insight as to why neurosurgeons do not always adhere to guideline recommendations for ICP monitoring.

Guidelines Currently Used

In the United States, the most utilized TBI guidelines are those produced by the Brain Trauma Foundation (BTF, 2007). The BTF guidelines were first introduced in 1995, with subsequent editions released in 2000, 2007, and 2016 (Carney et al., 2016). Many researchers have analyzed the effect of BTF guidelines in relation to morbidity and mortality in traumatic brain injury patients. In 2008, the American College of Surgeons (ACS) created the Trauma Quality Improvement Program (TQIP) which allows trauma centers across the United States to compare trauma-related risk-adjusted benchmark scores with other participating hospitals across the nation, while also providing education to improve the quality of their data (ACS, 2017). Retrospective studies since 2008 have looked at how well TQIP hospitals have adhered to BTF guidelines (Alali et al., 2013; Rayan et al., 2012), but in 2015, TQIP released their own version of TBI management guidelines. To date, no studies have been published looking at the effect of using TQIP TBI guidelines.

Both TQIP and BTF TBI guidelines aim to provide treatment recommendations through the synthesis of the most current research available with the end goal of providing best-practice care TBI (ACS, 2017; BTF,2007). Similar topics that are addressed within each framework include: need for decompressive craniectomy, use of prophylactic hypothermia, hyperosmolar therapy, cerebrospinal fluid drainage (ICP monitoring), ventilation therapy, steroid and sedative use, nutrition initiation, and infection and deep vein thrombosis prophylaxis. However, only TQIP gives a complete guide to elderly interventions and considerations in TBI and trauma who comprise a considerate proportion of TBI patients due to falls (CDC, 2017). They also include a three-tiered approach to the management of intracranial pressure. In contrast, BTF guidelines have an exclusive set of recommendations for pediatric patients, as well as prognostic and withdrawal of medical support guidelines for TBI patients. A side by side comparison is available in Appendix A.

Best Practice Innovation

The ACS' TQIP is the only national program that offers guidelines, outcome feedback, and quality improvement education to hospitals for TBI management. Currently, over 700 trauma Level I and II hospitals participate in TQIP, with opportunities for Level III hospitals to join in 2017 (ACS, 2017). Their unique three-tiered approach to intracranial pressure management could have the most impact on patient survival and functionality by reducing progression to brain herniation, a known complication of increased cranial pressure. ICP monitor placement in qualified patients allows for real-time trending of cerebral pressures that could guide medical and surgical interventions more quickly than clinical assessment alone. However, choice of guideline will remain irrelevant without substantial strategies in place to help implement the new recommendations.

Strategies to assist providers to adhere to guidelines have been researched and implemented with success. Evidence has correlated more robust adherence with implementation methods that affect both providers and their workflow directly (Flanagan, Ramanujam, & Doebbeling, 2009). Examples of provider-based strategies can include clinical meetings, ground rounds presentations, complete guideline distribution to providers, academic detailing, and teleconferences. Workflow-focused strategies aim to alter the delivery or tools utilized to carry out tasks such as computer reminders, new patient intake forms, or flowcharts that direct care decisions. The use of a facilitator to lead, assess, and alter the implementation of new guidelines is also necessary to keep progress on track (Dogherty, Harrison, Baker, and Graham, 2012). The multi-faceted nature of implementation strategies aims to affect both organizational structure and provider behaviors when introducing a new guideline.

Statement of purpose and PICOT

The goal of this evidence-based project is to evaluate whether implementing provider and workflow-strategies are effective in increasing the placement of ICP monitors in qualifying TBI patients. While the trauma team took an active leadership role in implementing the project, the strategies selected were aimed towards the neurosurgeons that managed TBI. A PICO question was constructed to help convey variables important to the research question. PICO stands for population, intervention, control, and outcomes, and can often be seen written as PICOT; the T indicating time (Melnyk & Fineout-Overholt, 2015). The PICOT question in this project was: In traumatic brain injury patients, does the implementation of provider and workflow-based strategies increase intracranial pressure monitor placement over one years' time? Table 1.1 conveys the questions' components with their correlating summarized definitions.

The population of interest (P) are patients aged 16 years and older with traumatic brain injury presenting a level I trauma facility. The intervention (I) is the implementation of provider and workflow-based strategies. Provider strategies selected for implementation include interdisciplinary clinical meetings, ground rounds presentations with representation from trauma and neurosurgery providers, and teleconferences between trauma and neurosurgery departments. New TBI patient intake forms were created to affect the workflow process for providers which addressed patients' clinical status, TQIP intervention tier, and plan of action. These strategies were selected based on low cost and the established familiarity providers had with TQIP guidelines. The intervention group is compared to the control (C), a retrospective analysis of TBI patients five years prior to implementation. The outcome (O) measured is the number of ICP monitors that were placed in qualifying TBI patients during the intervention period, with a secondary outcome of mortality rate. Lastly, the (T) indicates the one-year time span that the intervention will be implemented for sufficient patient data for a retrospective comparison.

Table 1.1 PICOT Definitions

Population	Intervention	Comparison Intervention	Outcome	Timing
Adult patients aged 16 years and older presenting for head injury and meet TBI diagnosis (AIS of the head 3 and GCS 3-8),	Increase number of ICP monitors placed as recommended by TQIP TBI guidelines through: Provider-Focused strategies: -Clinical meetings -Ground rounds -Teleconferences -Facilitator Workflow-Focused strategies: -TBI intake form	5 year retrospective cohort will be compared to 1 year post-implementation.	Increase percentage of qualifying patients receiving ICP monitors in prospective cohort as compared to retrospective cohort. Decreased mortality rates	12 months of post-implementation will be reviewed

Chapter Summary

ICP monitoring has shown to be an effective means of reducing morbidity and mortality in TBI patients. Though recommended by nationally-recognized organizations, adherence to this recommendation is sub-optimal and often left to a neurosurgeons' discretion. To help improve adherence to TQIP guidelines with respect to ICP monitor placement, interdisciplinary clinical meetings, ground rounds presentations, teleconferences, and new TBI patient intake forms were implemented at a level I trauma facility and monitored over one year's time. The number of ICP monitors placed was compared in a pre-post implementation study to determine effectiveness of implemented strategies.

CHAPTER II

LITERATURE REVIEW

Evidence to support the clinical question was researched for Chapter II. The PICOT question asks: In traumatic brain injury patients, does the implementation of provider and workflow-based strategies increase intracranial pressure monitor placement over one years' time? The literature review is comprised of the search process, literature analysis, and synthesis of evidence supporting implementation strategies for new clinical guidelines. All information gathered is conveyed in an evidence table in Appendix B.

Description of Search Strategy

A literature review was conducted to assess for current data regarding adherence to clinical guidelines, the supported use of intracranial pressure monitoring systems, mortality rates associated with traumatic brain injury, and barriers to compliance of recommended guidelines. The initial search was conducted in March 2016 using Medline (Ovid), PubMed, and CINAHL online databases. Limits on retrieved articles were only those in English, studies conducted in adult populations aged 16 and older, and studies published in the past twenty years (1996-2016). Search terms for evidence supporting ICP monitor guideline implementation included combinations of MeSH terms and similar words to describe traumatic brain injury and guideline adherence. A sample of the Medline Ovid search is shown in Table 2.1 and included terms such as traumatic brain/head injury, intracranial pressure, monitoring/physiologic, practice guidelines, guideline adherence, guideline implementation, barriers to implementation, and any combination of the aforementioned. Similar searches were conducted in CINAHL and PubMed. To aid in the analysis of factors that improve adherence to newly implemented guidelines, the search criteria was broadened to allow for studies that looked at implementing any medical guideline in an adult population including guideline implementation for COPD, CHF, handwashing, and nutritional support in the ICU. It was presumed that many of the same barriers and effective strategies in the implementation process could be generalized to another clinical guideline.

TABLE 2.1: Description of Search Strategies

Step	Search condition	No. of publication
1	exp brain injury/ or exp brain injuries, traumatic/ or exp craniocerebral trauma/ or head injury mp.	77,639
2	Exp intracranial pressure/ and exp monitoring, physiologic/ and intracranial pressure monitor.mp	39
3	Exp practice guidelines as topic/ or guideline adherence/ or guideline implementation.mp	112,652
4	And/ 1, 2, 3	4

A Medline search identified 4 articles, all which were relevant to guideline implementation. The CINAHL search resulted in 3 relevant articles, 2 which had been previously found and one new additional article. The PubMed search resulted in 2 relevant articles, though they had previously been found in the prior searches. A simple search for TQIP alone revealed 23 articles, only one which was utilized. Six total articles were analyzed for information pertinent to implementing clinical guidelines.

Analysis of the Evidence

The Johns Hopkins Nursing Evidence-Based Practice: Model and Guidelines (2012) was used in an effort to maintain a systematic approach for evaluating the level and quality of the scientific literature (See Figure 2.1). Within the guidelines, evidence strength is divided into four levels, with strength correlation descending from randomized control trials (I) to quasi-experimental trials and systematic reviews (II), to non-experimental designs (III), to case studies and expert opinion (IV). In addition, selected studies were organized by sample size, control of confounding variables, conclusions, and consistency of data mirrored with recommendations.

Summarization of the Literature

Six articles were analyzed for information pertinent to implementation of TQIP TBI guidelines. Only one article utilized researched the effects of implementing Brain Trauma Foundation guidelines. Expansion to Subsequent articles selected analyzed the components necessary for successful implementation of other medical guidelines including CHF, COPD, handwashing, and nutritional support. Subcategories were created to help focus concepts found in the literature including TBI guideline implementation, implementation strategies, implementation barriers, and adaptation of existing clinical guideline. Complete analysis of the evidence is synthesized below, and summarized in a table format in Appendix B.

TBI Guideline Implementation

Arabi et al. (2010) conducted a pre-post guideline implementation study utilizing recommendations provided BTF. The primary outcome was mortality rate for hospital stay, though measures for morbidities were also conducted through assessment of tracheostomies placed, mechanical ventilation duration, and ICU LOS. The protocol implemented was agreed upon by both the Intensivist and Neurosurgical team, and became a pre-printed order form to be completed on every qualifying TBI admission. Though there were no direct indications for when an ICP monitor should be placed, components of the protocol addressed the goal treatment parameters with and without ICP monitoring. Data was collected for approximately five years and compared to a five year retrospective cohort with a final sample of 434 patients. Researchers found that there was an independently associated reduction in hospital mortality with the use of protocol after adjusting for confounding variables (AOR 0.45 [95% CI 0.24-0.86], p 0.02). Use of ICP monitoring did decline from the control to the protocol group with the retrospective cohort using ICP monitors in 34.7% of patients versus 8.6% in the case group. The evidence found in this research could be considered Level II with good quality based on its quasi-experimental structure, but limited control group size for accurate comparison.

Implementation Strategies

Flanagan, Ramanujam, and Doebbeling (2009) researched whether provider or workflow-focused strategies increased provider acceptance of new clinical guidelines. Surveys were sent to 2,438 providers in the Veterans Affairs Medical Centers regarding their familiarity and acceptance of strategies employed for COPD, CHF and MDD (major depressive disorder) guideline implementation. Among the provider focused strategies were clinical meetings, academic detailing, grand rounds, complete guideline dissemination, brief guideline summary, pocket cards, storyboards, guideline champions, teleconferences and personal digital assistants. Workflow-focused strategies included computer reminders, computer tools to document services, new forms created or revised, and altered responsibilities for providers. Using multi-level analytic models, results of the survey indicated that provider acceptance was significantly correlated with both workflow and provider-focused strategies ($p<0.001$), though revealing that there was greater acceptance with provider-focused strategies across all three guidelines based on parameter estimates. When used as a multi-faceted approach, graphed models indicated even higher acceptance rates.

While this study aims to find correlation between specific strategies employed to increase guideline acceptance, the authors were not able to specify further than provider or workflow strategy. Additionally, utilization of survey cannot accurately depict the true adherence rates of the provider-accepted guideline. This study would be considered a Level III of good quality based on its qualitative design, but powerful population sample.

Grol and Grimshaw (2003) presented a literature review regarding approaches to changing medical practice that influenced the uptake of evidence-based guidelines. Their multi-faceted review utilized a systematic review of 54 articles that addressed guideline dissemination and implementation strategies, with a subsequent summarization of range effect and median effect across studies per intervention. Nine articles were found supporting the use of educational strategies, 16 articles on the use of audit and feedback, 14 reviews of reminders and computers, 6 articles on substitution of tasks, 5 reviews on multi-professional collaboration, 1 systematic review on mass media campaigns, 1 systematic review of total quality management, 6 reviews on financial interventions, 8 reviews on patient-mediated interventions, and 16 reviews on combination interventions. Of the interventions discussed, small group meetings, educational outreach visits, reminders, computerized decision support, computers in practice, multi-professional collaboration, mass media campaigns, and combined interventions were deemed most effective in provider-based situations. The authors concluded that multi-strategy approach to guideline implementation would be the most beneficial in clinical settings.

Grol & Grimshaw (2003) also summarized four studies that identified attributes of a guideline that posed as barriers to implementation. They found that the complexity of a health problem, the quality of the evidence supporting interventions, the compatibility of recommendations with existing values, the complexity of decision making, and the need for new skills or organizational change were all attributes that could negatively impact guideline implementation. However, these attributes only varied provider performance in less than 20% of case indicating they may not be the primary influencing factor in guideline uptake.

Finally, the authors applied theoretical reasoning to explain provider behaviors during a change process. Theories included cognitive theory that suggest providers have poor knowledge regarding a given topic. Behavioral theory suggests that performance is modified through external factors such as feedback or incentive. Furthermore, social influence would suggest that a cultural or social norm must be in place for a guideline to be accepted, and adult-learning theory suggest provider need to have a problem they are unable to fix without a new guideline in place. These theories were researched in a separate study conducted by the same authors, and of 120 providers; knowledge, behavioral routines, social influence, and organizational structure were found to be an obstacle by at least 40% of providers. This would indicate that provider mentality was a greater barrier than the attributes of a given clinical guideline.

Grol and Grimshaw's literature review (2003) was a Level II study of good quality. While there was a systematic review conducted on interventions, the methodology used to find the articles, including which databases were searched, was not presented. In their own limitations, the authors cite a lack of research into the economic and political approaches that affect change processes.

Implementation Barriers

Simpson and Doig (2007) conducted a two-part study in New Zealand and Australia to assess which strategies facilitated the implementation of a newly developed guideline for nutritional support in an intensive care unit. In a prior study, 14 hospitals in urban and rural areas had been selected to employ the new guideline and detail the process and results of their implementation efforts (Simpson & Doig, 2005). A subsequent survey was sent to the facilitators of the EBP implementation with questions regarding their familiarity with the interventions they were trained to use, barriers to change, clinical scenarios that commonly encountered barriers to change, and which sequence of interventions were used when another had failed. Strategies that facilitators had been taught to employ included outreach education, academic detailing, peer nominated opinion leaders, active reminders, timely audit and feedback, passive reminders, and in-servicing.

The results of questionnaires were analyzed for the most effective implementation strategies. The study had a 100% hospital response rate, and were asked to rank the effectiveness of a practice intervention from most successful (1) to least successful (10). Only active reminders scored a median score of 5 across all hospitals. Site visits by chief investigator and academic detailing by a clinician site investigator were among the top 3 most effective interventions in more than 75% of the hospitals. However, academic detailing by a peer-nominated opinion leader was ranked least successful.

In at least 8 of the hospitals, primary barrier to change was either physician or nurse related, included reluctance to start nutrition, or nurse failure to restart nutrition or change feed rate (per the guidelines). Physician and nurse non-compliance were addressed by active reminders in at least 40% of hospitals, followed by academic detailing and in-servicing if practice failed to change.

The authors concluded that site assessment when implementing a new guideline would include assessment of available resources, barriers unique to the site, potential for combination of interventions, and potential for the combination of interventions to reduce provider workload. This study qualifies as a Level III study of good quality based on its qualitative design and subjective responses. Hospital data comparison was challenging, and the authors primarily utilized ranking systems making it difficult to identify the most statistically significant implementation strategies.

Swennen, Van der Heijden, Blijham, and Kalkman (2011) researched whether career stage had any effect on the acceptance of evidence-based medicine. The study was conducted at two hospitals departments' of anesthesiology in the Netherlands; one academically affiliated and the other a general hospital. Data was collected individually through a semi-structured interviewed. Data analysis was conducted using grounded theory approach.

Anesthesiologist in varying career stages were interviewed in open-end question technique regarding their perceptions of evidence-based medicine and perceived barriers to implementation. The sample size was comprised of 12 anesthesiologists. Of the 12, 4 anesthesiologists were still in training; 4 were mid-career; and 4 were considered experts with greater than 10 years of experience. Data collected was analyzed for patterns, and a taxonomy of barrier to practice evidence-based medicine (EBM) was developed, citing the ten sequential steps that must be taken by a provider to practice EBM.

Analysis revealed that varying career stages correlated with differences in career goals and interest. New professionals were more interested in learning fundamental and technical skills, with limited emphasis on why they were performing techniques in a particular manner. Anesthesiologist with greater than 10 years' experience not holding leadership roles felt threatened by new evidence and feared litigation if there was as change in practice. In contrast, the professionals with leadership roles and greater than 10 years of experience found EBM to be a welcome change, and embraced the change as an augmentation of clinical expertise. The authors concluded that career stage did have an impact on whether EBM would be implemented.

Several barriers to implementation of EBM were identified from the authors' data analysis. These barriers were subsequently ordered from the most basic to most complex. A new condition model created suggests it is much like a hierarchy of needs to successfully implement EBM rather than a categorical barrier system that is seen in much of the literature. The model descends through availability and access to evidence, to awareness of and positive attitudes towards evidence-based practice, to positive attitudes towards change, evaluation of evidence, to integration of appraised evidence with clinical expertise, to medical decision to apply evidence, to evaluation of prior managerial conditions for implementation of evidence, to multidisciplinary decision to implement evidence, to initiation of evidence, and finally to integration in routine clinical practice. This was a novel approach to identifying barriers and takes internal and external conditions into consideration at each level.

The evidence reviewed may have limited applicability for this research based on study quality and limitations. The evidence presented was Level III of good quality, though threats to the study include relatively small sample size, the qualitative and subjective nature of the responses, and the sampling of only anesthesiologist in the Netherlands. Generalizability to other countries or departments may be difficult due to cultural differences. Additionally, identification of whether physicians were from the university-affiliated hospital or from the general hospital was not evident from their published study.

Adaption of Existing Clinical Guidelines

Dogherty, Harrison, Baker, and Graham (2012) evaluated the role that facilitators played in the implementation process of an existing nursing clinical guideline. Three different hospitals were selected to implement guidelines on various nursing practice levels (i.e. local, regional) as well as various guideline focus and scope of implementation. All guidelines pertained to the improvement of cancer care in Canada and were conducted over 12 to 24 month period. Four local and two external facilitators were utilized by the three hospitals, and each hospital operationalized their case independently without prior prescription by the facilitators. Data on implementation progress and phases was analyzed through a focus group interview to understand how guideline adaption occurred.

Post-facilitator interview, major facilitator roles were identified from the collected data. The role of facilitator required four major actions including: planning for change, leading and managing, monitoring progress, and evaluation of changes. These four actions could be subdivided into 11 smaller activities including: increasing awareness, developing a plan, knowledge and data management, recognizing the importance of context, administrative and project-specific support, project management, group dynamics, problem-solving, providing support, effective communication, and assessment. These were consistent with the revised Stetler model determination of whether an action was a role of the facilitator, as noted in the study. Facilitators noted that of the most important facilitator actions, communication, relationship building, team dynamics, and delegation to project leads was most helpful in having guidelines adapted at their facilities.

This study meets Level II high quality evidence based on its quasi-experimental design and its qualitative data collection method. Study limitations include generalizability to departments other than nursing, as well as the small sample size of three hospitals. The researchers also note that facilitators were hired for the role which may have affected their responses.

Synthesis of Literature

A synthesis of available literature was conducted for levels of evidence, quality, and summary in order to evaluate effective methods for TBI guideline implementation. After databases were searched, six articles were included in the final literature review. The John Hopkins nursing evidence-based practice model and guidelines were utilized to appraise the evidence. Due to the primarily qualitative nature and quasi-experimental designs, none of the articles met a Level I evidence rating. Of the articles utilized, one met Level II with high quality data, two met Level II with good quality data, and three met Level III good quality data.

Synthesis of the literature revealed a lack of evidence pertaining to implementing TQIP TBI guidelines, and limited information on implementing TBI guidelines from other sources (Arabi et al., 2010). Several qualitative studies demonstrated implementation strategies for clinical guidelines worked best when they affected multiple aspects of a provider's interpersonal relationships and their work environment (Flanagan et al., 2009; Grol & Grimshaw, 2003; Simpson & Doig, 2007) Specifically, all articles supported the use of multi-professional collaboration through peer to peer reminders, clinical grand rounds, teleconferences, clinical meetings, and educational outreach. Factors that affect a provider's workflow such as computer reminders, computer decision support, new intake forms, and brief guideline summaries (or pocketcards) were also found beneficial in improving new guideline adherence. The literature also discussed the benefits of a utilizing a champion, or facilitator, for a newly implemented guideline (Flanagan et al., 2009; Simpson & Doig, 2007, Dogherty et al., 2012). The role of a guideline facilitator encompasses planning for change, leading and managing, monitoring progress, and evaluating for adherence (Dogherty et al., 2012). The studies confirmed that use of multiple strategies to implement a new guideline was superior to using any one method alone (Flanagan et al., 2009; Grol & Grimshaw, 2003; Simpson & Doig, 2007).

In addition to implementation strategies, common barriers to guideline implementation were also reviewed. Social, cognitive, and behavior theories may explain personal, environmental, and organizational influences on providers' willingness to accept new guidelines (Grol & Grimshaw, 2003). Similarly, career-stage and leadership roles may also have an impact on guideline acceptance with those more advanced in their career and in leadership positions being more open to new clinical guidelines (Swennen et al., 2011).

In the literature reviewed, there was a dearth of Level I studies supporting specific measures to help implement a new clinical guideline. Likewise, statistics regarding the most significant implementation methods were unavailable. To summarize, use of multiple strategies to implement a new guideline is more effective than any one method alone. These strategies may include multi-professional collaboration, guideline summaries, computer reminders, new intake forms, and the use of a guideline facilitator (Flanagan et al., 2009; Grol & Grimshaw, 2003; Simpson & Doig, 2007, Dogherty et al., 2012). Barriers to guideline adherence may be explained by cognitive, behavioral, or social theory; and guideline acceptance may be negatively impacted by a providers' career stage and leadership roles they may have (Grol & Grimshaw, 2003; Swennen et al., 2011).

Recommendations for Practice Innovation

Evidence from the scientific literature suggests multiple methods of implementation are required in order to implement TQIP TBI guidelines. These methods should include the use of a guideline facilitator, academic detailing, active reminders, clinical meetings, grand rounds, brief guideline summary, and new TBI intake forms. More provider-focused based methods as opposed to will be utilized for implementation of TQIP guidelines based on the support from the literature and the limited costs associated with implementation (Flanagan et al, 2009). Below, selected methods for guideline implementation are defined.

Champion/Facilitator for the Guideline

A facilitator is key to ensure implementation has a strong process including planning, implementing, monitoring, and evaluating. Effective communication and leadership skills must be strong. This position is ideal for the project leader.

Academic Detailing

This is a provider based strategy that encompasses face-to-face interactions between providers. Often accompanied by a PowerPoint or resource book, academic detailing was noted in the literature to be extremely effective (Flanagan et al., 2009 and Simpson and Doig, 2007) when used in conjunction with other strategies. This particular strategy does not include self-paced learning modules. This is a feasible strategy for Palmetto Health Richland with minimal extra costs or time involved. The neurosurgery and trauma team would all receive this type of strategy.

Active Reminders

Active reminders are peer to peer conversations regarding guideline adherence, often conducted by the guideline facilitator. Feasibility issues may arise with facilitator time constraints.

Clinical Meetings

Interdepartmental face-to-face meetings which may include providers, nurses, and case managers regarding patient care. Feasibility issues with this type of strategy include differences in provider schedules.

Grand Rounds

Grand rounds are often used in teaching hospitals to facilitate the learning process. The attending provider rounds on patients in groups with medical students and other healthcare providers to discuss diagnosis and treatment options. Grand rounds are not limited to medical providers; often they are interdisciplinary and may involve consulting providers, nurses, physical therapist, and pharmacists.

Brief Summary

Also noted multiple times in the literature is a brief summary of the new guideline. This helps to ensure clarity and consistency across the care spectrum. This is a one-time distribution of the current evidence to support the change in guidelines.

Computer Tools/Forms Created

New tools created for documentation purposes help to guide providers in assuring tasks are completed. For ease of research, documentation of pertinent neurological scores such as AIS and GCS scores should be present, as well as a brief summary of TQIP guidelines, and reasons for or against placement of ICP monitor.

Chapter Summary

A literature review conducted through CINAHL, Medline (Ovid), and PubMed helped the author to determine which strategies were best for implementing a new clinical guideline at a Level I trauma facility. While Level I evidence was lacking, several Level II and III studies examined the effects of strategies employed to alter provider actions and their workflow processes (Flanagan et al., 2009; Grol & Grimshaw, 2003; Simpson & Doig, 2007). These included multiple methods of interpersonal communications and the development of new computer reminders or intake forms that specifically address guideline attributes (Flanagan et al., 2009; Grol & Grimshaw, 2003; Simpson & Doig, 2007; Dogherty et al., 2012). In moving forward, strategies that will be utilized to implement TQIP TBI guidelines will include the use of a guideline facilitator, academic detailing, active reminders, clinical meetings, clinical grand rounds, dispersion of a brief guideline summary, and new TBI intake forms.

Table 2.2 Johns Hopkins Nursing Evidence-Based Practice: Model and Guidelines (Dearholt & Dang (2012)

<table>
<tr><th>Evidence Levels</th><th>Quality Guides</th></tr>
<tr><td>Level I
Experimental study, randomized controlled trial (RCT)
Systematic review of RCTs, with or without meta-analysis</td><td rowspan="3">A <u>High quality</u>: Consistent, generalizable results; sufficient sample size for the study design; adequate control; definitive conclusions; consistent recommendations based on comprehensive literature review that includes thorough reference to scientific evidence

B <u>Good quality</u>: Reasonably consistent results; sufficient sample size for the study design; some control, fairly definitive conclusions; reasonably consistent recommendations based on fairly comprehensive literature review that includes some reference to scientific evidence

C <u>Low quality or major flaws:</u> Little evidence with inconsistent results; insufficient sample size for the study design; conclusions cannot be drawn</td></tr>
<tr><td>Level II
Quasi-experimental study
Systematic review of a combination of RCTs and quasi-experimental, or quasi-experimental studies only, with or without meta-analysis</td></tr>
<tr><td>Level III
Non-experimental study
Systematic review of a combination of RCTs, quasi-experimental and non-experimental studies, or non-experimental studies only, with or without meta-analysis
Qualitative study or systematic review with or without meta-synthesis</td></tr>
<tr><td>Level IV
Opinion of respected authorities and/or nationally recognized expert committees/consensus panels based on scientific evidence

Includes:
• Clinical practice guidelines
• Consensus panels</td><td>A <u>High quality</u>: Material officially sponsored by a professional, public, private organization, or government agency, documentation of a systematic literature search strategy, consistent results with sufficient numbers of well-designed studies; criteria-based evaluation of overall scientific strength and quality of included studies and definitive conclusions,; national expertise is clearly evident; developed or revised within the last five years

B <u>Good quality</u>: Material officially sponsored by a professional, public, private organization, or government agency; reasonably through and appropriate systematic literature search strategy,; reasonably consistent results, sufficient numbers of well-designed studies; evaluation of strengths and limitations of included studies with fairly definitive conclusions; national expertise is clearly evident; developed or revised within the last 5 yeas

C <u>Low quality of major flaws</u>: Material not sponsored by an official organization or agency; undefined, poorly defined, or limited literature search strategy; no evaluation of strengths and limitations of included studies; insufficient evidence with inconsistent results, conclusions cannot be drawn; not revised within the last 5 years</td></tr>
<tr><td></td><td></td></tr>
</table>

Level V Based on experiential and non-research evidence Includes: • Literature reviews • Quality improvement, program or financial evaluation • Case reports • Opinion of a nationally recognized experts(s) based on experiential evidence	**Organizational Experience:** **A <u>High quality:</u>** Clear aims and objectives; consistent results across multiple settings; formal quality improvement, financial or program evaluation methods used; definitive conclusions; consistent recommendations with thorough reference to scientific evidence **B <u>Good quality:</u>** Clear aims and objectives; consistent results in a single settings; formal quality improvement or financial or program evaluation methods used; reasonably consistent recommendations with some reference to scientific evidence **C <u>Low quality or major flaws:</u>** Unclear or missing aims and objectives; inconsistent results; poorly defined quality improvement, financial or program evaluation methods; recommendations cannot be made **Literature Review, Expert Opinion, Case Report, Community Standard, Clinician Experience, Consumer Preference:** **A <u>High quality</u>**: Expertise is clearly evident; draws definitive conclusions; provides scientific rationale; thought leader(s) in the field **B <u>Good quality</u>**: Expertise appears to be credible; draws fairly definitive conclusions; provides logical argument for opinions **<u>C Low quality of major flaws</u>**: Expertise is not discernable or is dubious; conclusions cannot be drawn

CHAPTER III

METHODS

Introduction

The study took place at Palmetto Health Richland Hospital (PHRH), a Level I trauma center affiliated with the University of South Carolina in Columbia, South Carolina. PHRH is a state and American College of Surgeons (ACS) designated Level I trauma center that has participated in TQIP since 2012. The study was a classical pre-post cohort study where exposure was TBI care received after the initiation of the intervention, and outcomes were adherence rate as well as in-hospital mortality. In addition to number of ICP monitors, the author had interest in comparing the groups' mortality rates, hospital LOS, and the neurosurgeons' original treatment plan upon initial consultation. Components of the study's design are outlined in the subsequent paragraphs.

Setting

The study was conducted at a Level I trauma center affiliated with the University of South Carolina in Columbia, South Carolina; a confirmed participant in the Trauma Quality Improvement Program's initiatives. Hospital capabilities included 24 hour CT scanning, operating rooms, and specialty services. The 18 bed surgical trauma intensive care unit (STICU) was the primary unit for the treatment of traumatic brain injury for patients ages 15 and older.

Care Team

Though a trauma-based initiative, participation from the neurosurgery and hospitalist departments is standard practice with additional consults as needed on individual basis. Patients presenting to the emergency room with head trauma were admitted by the trauma team, with consults placed for neurosurgery. Currently, 50% of the neurosurgery team is comprised of credentialed nurse practitioners; often conducting the initial examination of TBI patients and outlining treatment plans for management of increased intracranial pressure. Upon patient admittance to the STICU, a 24 hour interdisciplinary care team including registered nurses, nurse technicians, respiratory therapists, medical residents, medical fellows, a chief resident, nurse practitioners, physicians' assistants, and attending physicians. Consulting providers rounded daily as needed. Team members excluded from the care team were pharmacists and rehabilitation services as they were not readily staffed on the STICU unit.

Institutional Review Board Approval

Following the hospital Institutional Review Board approval in Spring 2016, chart review commenced to collect patient data pertaining to patient age, gender, insurance status, ETOH level, results of initial head CT, and neurosurgery's' treatment plan. All information obtained was documented into a Microsoft Excel spreadsheet and de-identified and coded prior to analysis at the University of South Carolina. No identifying information was retained that could be traced back to patient charts.

Design

A descriptive pre-test and post-test design was employed to compare provider based and workflow strategies influence on the number of ICP monitors placed in TBI patients between 2010-2014 (pre-test) and 2015-2016 for post-test. A trauma-based facilitator was used as the main point of contact, communication, and implementation.

Between the trauma and neurosurgery departments, provider based strategies included personal conversations, emails, grand rounds, monthly committee meetings, secondary review meetings, and an exchange of semi-annual benchmark reports indicating adherence to TQIP guidelines (provided by TQIP). While the number of times each strategy was employed varied, the primary facilitator worked to establish weekly lines of communication with neurosurgery and trauma providers. Workflow-based strategies included brief summary of TQIP guidelines for ICP monitor placement through digital communication, and the creation of a TBI Review form to be completed on every TBI admission (Figure 3.1). The TBI review form was utilized on every head trauma admission to establish if the patient met guideline criteria. The template included date of admission, ED GCS score, initial CT findings, neurosurgery date and time of consult, neurosurgeries initial plan, and a prompt on whether the injury was at high-risk for progression to secondary injury. The form also indicates selection of tier for management of TBI (of the three tiers recommended by TQIP to manage ICP). A second page is in checkbox form and allows the neurosurgeons to select why they did not place an ICP monitor with four subsets of reasons including provider choice, mortality concerns, organ system conflict, or other existing co-morbidity. Corrective action for incomplete or missing action is also in checkbox form and is communicated by either the trauma nurse navigator or trauma quality facilitator.

The above implementation strategies were felt to be feasible because they required minimal resources and skill development. The neurosurgery team expressed familiarity with the TQIP guidelines and did not require further education on ICP monitor placement. The provider-based review template was standardized for all patients coming in with head trauma and required the most education regarding how to fill it out correctly, though still with minimal instruction.

After implementation strategies were employed for a year, a retrospective analysis of case and control patients was conducted. Data mining on the five years prior to guideline implementation was conducted on eligible TBI patients. This resulted in chart reviews from October 2010 to October 2015 for the control group, and November 2015 through October 2016 for the post-implementation group. Data organization was then conducted on the case studies with completed trauma forms which yielded 12 months of data. All information regarding eligible patients was extracted from the electronic medical record. Data was de-identified and coded prior to data transfer out of the hospital setting, in addition to being in a password protected document. All information gathered was used for comparison purposes on patient demographics and treatment modalities in the pre- and post-implementation populations.

Sample

The eligible sample-was determined through TQIP specifications for study participation. TQIP inclusion criteria were patients aged 16 years or older presenting with a head AIS score ≥3, an ED GCS score ≥3 and ≤8, and evidence of structural brain damage on initial head CT. Excluded in the sample population were patients who had died during transit, an AIS score greater than 2 in any other non-head AIS body region, those with ED vitals considered unsurvivable or unknown (see Table 3.1 for various combinations), diagnosis of an unsurvivable head injury based on the AIS scale, those with prior advanced directives withholding life-sustaining interventions, those with a discharge disposition of home, home with services or transfer to another hospital from the ED, and those with 2nd or 3rd degree burns as determined by medical codes. Patient records with missing data in inclusion or exclusion criteria were not analyzed, nor were those that died prior to neurosurgery's initial consultation or prior to initial CT scan.

Table 3.1. Unsurvivable ED Vital Sign Combinations Leading to Study Exclusion

Combination Number	**ED Systolic Blood Pressure**	**ED Pulse** Rate	**ED GCS Motor Score**
1	SBP= 0	0	1
2	NK/NR	0	1
3	SBP= 0	0	NK/NR
4	0	NK/NR	1
5	NK/NR	0	NK/NR

ED=Emergency Department, NK/NR= Not Known/Not Recorded

Patient Outcomes

Information regarding patient treatment plans were extracted from the attending neurosurgeon's, or physician's assistants' notes. Treatment plans were collapsed into five categories: ICP monitor, monitor, no consultation note, non-operable, or surgery. This step was taken to determine whether there were discrepancies found between the physician's original treatment plan and what transpired in patient care. The primary outcome measured was the number of ICP monitors placed in the eligible population. Secondary outcome measured were mortality rates for patients with and without monitor placement.

Data Analysis

Differences between means of continuous variables were examined using Student's *t* test, and differences in proportions of categorical variables were examined using a X^2 test. We examined all categorical variables where expected values were less than 5 using the Fisher exact test. A logistic regression model assessed the intervention effect on patient mortality and ICP monitor placement with results in unadjusted and adjusted format. Odds ratio (OR) and 95% confidence interval (CI) were also calculated. We used propensity scores to model the conditional probability that similar patients were subjected to TBI treatment before and after the implementation. All tests were two-tailed. P values of 0.05 and less were considered statistically significant in the analyses. All statistical analyses were performed with SAS software version 9.4.

Chapter Summary

The evidenced based quality improvement project will be implemented through a qualitative study design at level I trauma facility. Providers that are an integral part of a 24-hour interdisciplinary team will implement measures to improve placement of ICP monitors. The sample population will include patients that have a traumatic brain injury that meets criteria for TQIP inclusion. Patient outcomes will be analyzed through descriptive statistics, Fisher exact test, X^2 test, odds ratio, and a linear regression model utilizing SAS software. Chapter IV will discuss the results of the project.

Traumatic Brain Injury Review | **2015**

Admission Date and Time:______________________ Patient Name:______________________________

Medical Record #___________________________ Financial #_________________________________

ED GCS: ___ _ ☐Intubated ☐Sedated ☐Paralyzed ☐BAC______ ☐Other confounder ____

Initial CT Findings: **☐SAH ☐SDH ☐EDH ☐IVH ☐IPH** ☐Right ☐Left ☐Bilateral ☐shift present ☐herniation present

____

NS Consult Date and Time: _________ Date and Time of Arrival: _______Responding APP: _______________ Neurosurgeon: ____________________

Initial Plan: ____

____

Is injury a high risk for progression? ____

Tier 1	Tier 2	Tier 3
☐HOB elevated 30 degrees	☐Manitol 0.25 – 1GM/KG	☐Barbiturate or Propofol Coma
☐Repeat Head CT	☐3% 250cc over 30 minutes	☐Chemical Paralysis
☐Bolt Date and Time Placed:	☐23.4% 30cc over 10minutes	☐Decompressive Craniotomy
☐EVD Date and Time Placed:	☐Q6 Serum Osmolarity and Serum Sodium	
☐Sedation	☐Chemical Paralysis	
☐Analgesia		
☐Intermittent EVD Drainage		

Reviewer Comments:

____

____

____

____

____

Initiated: 12/7/2015

Figure 3.1 Traumatic Brain Injury Intake Form

Contributing Factors: (Choose up to 5)	❑ No factors identified ❑ Other: Provider: ❑ Error in Management ❑ Error in Technique ❑ Delayed Diagnosis ❑ Missed Diagnosis ❑ Deviation from Protocol ❑ Deviation from SOC Mortality: ❑ Anatomical Diagnosis ❑ DNR Order ❑ DOA or DOS ❑ Survival Probability ❑ Withdrawal of Life Supp. System: ❑ Communication Deficiency ❑ Communication Failure ❑ Departmental Deficiency ❑ Departmental Failure ❑ Equipment or Supply Deficiency ❑ Equipment Failure ❑ Protocol Deficiency ❑ Protocol Failure Morbidity: ❑ Co-morbidity ❑ Disease Related ❑ Other Pre-Existing Condition ❑ Patient Behavior or Refusal
Opportunity for Improvement Status: (Select one)	❑ Unanticipated Event with Opportunity for Improvement (P) ❑ Anticipated Event with Opportunity for Improvement (PP) ❑ Event without Opportunity for Improvement (NP)
Case Determination:	System Related: Yes No Disease Related: Yes No Provider Related: Yes No
Grade: (Select one)	❑ Grade Not Assigned ❑ Grade I – Non-life Threatening (No lasting disability) ❑ Grade II – Potentially life Threatening (No residual disability) ❑ Grade III – Life Threatening (Residual disability) ❑ Grade IV – Death ❑ Not applicable
Care Given Status: (Select one)	❑ Acceptable ❑ Acceptable w/ reservations ❑ Unacceptable
Corrective Action: (Choose up to 5)	❑ No action Items Taken ❑ Referral: ❑ Peer Review ❑ M&M ❑ Education Offering ❑ Disciplinary Action ❑ Develop Policy or Protocol ❑ Administrative Action ❑ Revise Policy or Protocol ❑ Improve Resources ❑ Provider or Team Counseling ❑ Unknown ❑ Improve Communication ❑ Other
Primary Review	Signature:____________ Date Sent: ❑ Trauma Nurse Navigator ❑ Trauma PI Coordinator Date Reviewed: ________
Attending Review	Signature:____________ Date Sent: Date Reviewed: ________

Initiated: 12/7/2015

Figure 3.1 (continued) Traumatic Brain Injury Intake Form

CHAPTER IV

RESULTS

Introduction

The primary outcome in this evidence-based quality improvement project was to increase the number of ICP monitors placed in qualifying TBI patients. The patient outcomes measured comprised various processes of care such as number of ICP monitor placed, the use of mannitol or hypertonic saline, and number of patients undergoing craniotomy or craniectomy. Mortality rate was also an outcome of interest in pre- and post-intervention cohorts. A retrospective chart audit was compared to a one-year post-implementation of provider and workflow processes that were defined in Chapter III. Chapter IV reveals sample analysis with included inferential statistics.

Sample

Out of 563 charts retrieved for eligibility, only 305 met inclusion criteria (control =250, case=55) (See Figure 4.1 for flowchart). Pairwise comparisons of cases and controls was conducted on 9 different variables including patient demographics, clinical outcomes, and processes of care measures as shown in Table 4.1. Both cases and controls were predominantly male (72.4% control and 83.6% case, p=0.084). Mean age of adults in the pre-implementation group was 47.4 years compared to 53.1 years in the post-implementation group. Both cohorts exhibited primarily white patients (control= 56%, cases=52.7%) with second majority being African American (control=30.4%, case=32.7%). There were no statistically significant differences between cases and controls with respect to age or race. Patient insurance type was coded as private, Medicare, Medicaid, self-pay, and other; and varied significantly between case and control group (p=0.001). The control group high a greater proportion of self-pay patients (32.4% vs. 7.3%), and lower percent of Medicaid or other type of insurance (Medicaid control=12.4% vs. 23%; other control=8% vs. 16.4%). Analysis of patient clinical findings found ISS to be higher in the post-implementation group versus the control group (ISS=25 vs ISS=18, P=0.002).

Other categories analyzed included ICU LOS hospital LOS, GCS, and ETOH level >0.08. ICU LOS mean was 5 days in control versus 6 days in post-implementation. Mean hospital LOS was 8.5 days in control and 9 days in post-implementation. group. ED GCS score mean was 4.2 in control and 4.5 in post-implementation cohort. These categories did not have statistical differences between control and case group.

ICP monitor placement decreased from 10.4% in the control cohort to 7.3% in the case cohort. Process of care outcomes only varied significantly in regards to increased use of hypertonic saline in the case group (22.4% vs. 52.7%, P <0.0001). Crude hospital mortality rate was 40.8% in control and 49.1% in case group.

The independent predictors for ICP monitoring that were used to build the inverse propensity weighted logistic regression model are shown in Table 4.2. After adjustment, odds of receiving ICP monitoring was 76% lower among the post-intervention cohort (AOR 0.24 [95% CI 0.07 – 0.82], p 0.023). Adjusted odds of receiving hypertonic saline among the post-intervention cohort was 92% higher than the pre-intervention cohort (AOR 0.08 [95% CI 0.04 – 0.20], p <0.0001, respectively). No other demographic or clinical characteristic was statistically significantly associated with receipt of ICP monitoring prior to the provider and workflow-strategy.

Table 4.3 conveys the propensity scores calculated using the six covariates included in the adjusted logistic regression model. Inverse probability weights were assigned to each patient and used to balance the groups. Because of sample size, weights were grouped into quintiles. After adjustment, odds of receipt of ICP monitoring among the post-intervention cohort was 0.65 lower than the pre-intervention cohort (95% CI 0.40 – 1.08, p 0.099).

Discrepancies were found between the plan of care notes, and the number of ICP monitors placed in the pre-implementation phase; more patients received ICP monitoring than had been planned. In pairwise contrasts, there were no statistically significant differences in patient documentation during the study period. After adjusting for sex, insurance status, injury severity, and hypertonic saline use, there were no significant differences found between groups on mortality or ICP monitor placement post-guideline implementation.

TABLE 4.1: Characteristics of patients pre- and post-implementation strategies

	Severe TBI		
Characteristic	Pre-implementation (%, SEM)	Post-implementation (%, SEM)	p value
Demographics			
Male	181 (72.4)	46 (83.6)	0.084
Age (SEM)	47.4 (21.6)	53.1 (22.8)	0.094
Race			
White	140 (56.0)	29 (52.7)	0.907
African American	76 (30.4)	18 (32.7)	
Other	34 (13.6)	8 (19.1)	
Insurance type			0.001
Private	56 (22.4)	12 (21.8)	
Medicare	62 (24.8)	17 (30.9)	
Medicaid	31 (12.4)	13 (23.6)	
Self-Pay	81 (32.4)	4 (7.3)	
Other	20 (8.0)	9 (16.4)	
Clinical			
ISS*	18 (14 - 25)	25 (17 - 26)	0.002
ICU stay*	5 (2 - 10)	6 (2 - 10)	0.566
LOS stay*	8.5 (2 - 22)	9 (1 - 21)	0.919
GCS (SEM)	4.2 (1.8)	4.5 (1.8)	0.386
ETOH > 0.08	84 (33.6)	18 (32.7)	0.901
Processes and outcomes of care			
Craniotomy or craniectomy	59 (23.6)	14 (25.5)	0.770
Mannitol	41 (16.4)	10 (18.2)	0.749
Hypertonic Saline	56 (22.4)	29 (52.7)	<0.0001
Expired	102 (40.8)	27 (49.1)	0.260
ICP monitor	31 (12.4)	4 (7.3)	0.280

* median and inter-quartile range (Q1 - Q3) ; Standard errors of the mean (SEM)

Table 4.2: OR of patient characteristics pre- and post-implementation strategies

	Severe TBI		
Characteristic	Odds Ratio (OR)	95% CI	p value
Post intervention	0.24	0.07 - 0.82	0.023
Male	2.39	0.81 - 7.03	0.115
Age	0.98	0.95 - 1.01	0.177
Insurance type			
Private	ref	ref	--
Medicare	0.95	0.18 - 4.92	0.917
Medicaid	0.59	0.16 - 2.09	0.378
Self-Pay	0.82	0.28 - 2.41	0.836
Other	1.23	0.29 - 5.18	0.544
ISS	1.00	0.95 - 1.06	0.948
Hypertonic Saline	0.08	0.04 - 0.20	<0.0001

Table 4.3: Propensity score weighted outcome model

Characteristic	Odds Ratio (OR)	95% CI	p value
Post intervention	0.65	0.40 - 1.08	0.099

Table 4.4: Attending physician's treatment plan pre- and post-implementation strategies

	Pre implementation	Post implementation	p value
Physician's note			0.203
ICP monitor	26 (10.4)	4 (7.3)	
Monitor, no intervention	103 (41.2)	23 (41.8)	
No consultation record	0 (0.0)	1 (1.8)	
Injury deemed non-operable	75 (30.0)	14 (25.5)	
Surgery	46 (18.4)	13 (23.6)	

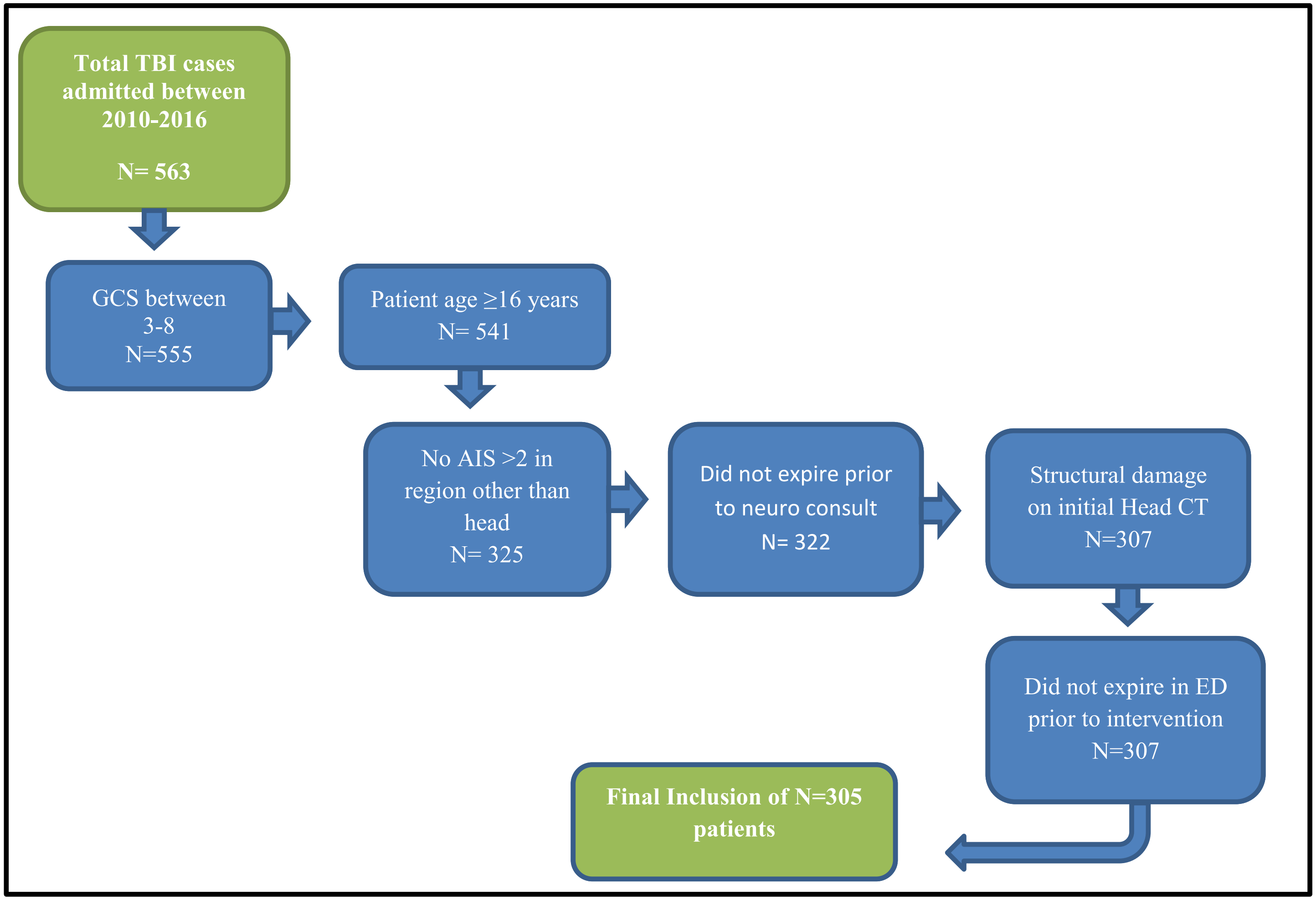

Figure 4.1 Exclusion criteria for all TBI cases between years 2010 and 2016

Chapter Summary

The use of ICP monitoring in TBI patients has been studied for several decades with limited research indicating the best ways to implement TBI clinical guidelines into practice. Chart audits indicated there was a decrease in number of monitors placed between the control and intervention cohorts, though not found to be statistically significant. The increased use of hypertonic saline was evident in the post-implementation group, with a significant 30% increase in use between cohorts. Other significant findings included the decrease in number of self-pay patients from the control to case group, and the increased number of Medicaid patients in the case versus control. Chapter V discusses the results and their application to clinical practice, policy development, future research, and education.

CHAPTER V

DISCUSSION

Introduction

The objective of the study was to increase the placement of intracranial pressure monitors per TQIP recommendations for care of traumatic brain injury. Initiatives both before and after healthcare reform under the Affordable Care Act have accelerated efforts to standardize care for TBI patients. Guidelines such as those produced by the TQIP are shown to reduce patient morbidity and mortality (Arabi et al., 2010). However, despite guideline availability, adherence is sub-optimal at the highest level of trauma centers (Piper et al., 2015), and patients with extensive injuries separate from head trauma have been correlated with even lower rates of trauma guideline compliance (Rayan et al., 2012). While trauma associations and surgeons agree each patient's care should be tailored to their specific injury, it does not negate evidence that use of guidelines correlates with decreased mortality and morbidity (Gerber et al., 2013, Arabi et al., 2010). More specifically, the use of ICP monitoring can help maintain cerebral perfusion and prevent secondary brain injury that could lead to death or loss of function (Alali et al., 2013; Shafi et al., 2014; Gerber et al. 2013). Implementing a TBI guideline in a designated Level I trauma center was not-existent prior to this project, thus, underscoring the need to explore interventions and make recommendations for practice, health policy, and research.

Interpretation of the results indicate that the attempt to increase adherence to ICP monitoring through a provider- and workflow-based strategy did not result in a change of practice. Despite adjustment for demographic and clinical covariates, ICP monitor placement rates fell from 12.4% to 7.3% in the post-intervention cohort. While not found to be statistically significant (p=0.280), it may indicate a problem with either study design in either execution or structure. Mortality rates rose in the post-implementation period from 40.8% to 49.1% and though again, not significant (p 0.260), may be explained by the subsequent increase in ISS scores. Unexpectedly, there was found to be an increased use of hypertonic saline in the post-intervention cohort (22.4% vs. 52.7%, p <0.0001) which does reflect adherence to TQIP's tier 2 TBI management guidelines. TQIP does not discriminate which hyperosmolar agent is used to help decrease ICP, though several studies indicate that hypertonic saline leads to greater ICP stability and improved cerebral perfusion as compared to its mannitol counterpart (Alali et al., 2013; Cottenceau et al., 2011; Mangat et al., 2015). Though an effective means of reducing ICP pressure, the use of hypertonic saline warrants critical patient monitoring; the duration of which could be reduced if used in conjunction with an ICP monitor (Chesnut et al., 2012). Comparison of hyperosmolar agent utilized is an area that could benefit from further research in subsequent TBI guideline efforts at Palmetto Health.

Study Limitations and Barriers

In identifying limitations of the study, several items could be identified as significant contributing factors. Foremost, the size of the post-intervention cohort does not hold great power as compared to the 5-year pre-intervention cohort. Of the 307 patients, only 55 were subjected to post-implementation strategies. The power of the study is greatly affected by the limited sample size, and may have presented skewed findings when comparing a four year retrospective cohort to a one year post-implementation case group.

Another limitation was the under-utilization of proposed methods to improve guideline adherence. Supported by the evidence is the use of academic detailing. This could entail a face-to-face presentation on the benefits of ICP monitoring, or a small reference guide that outlines patient eligibility to receive ICP monitoring. These methods are cost-effective and direct in conveying the proposed goal of increased monitor placement.

Recommendations for Future Research

Moving forward, the project facilitator, in conjunction with process improvement coordinators, should continue to evaluate for ongoing trends in the care of TBI patients. This would include monitoring the number of ICP monitors placed in qualifying TBI patients, as well as evaluating for compliance in other process of care as outlined by the TQIP TBI guidelines. Improvements to the standard of care in TBI patients may be accomplished through data analysis in the coming years.

Furthermore, implementing different workflow processes may improve TQIP TBI guideline adherence. As previously mentioned, the use of academic detailing is cost-effective, and may help remind providers to consider alternative therapies when managing TBI. While not utilized in this project, the use of computer reminders or computer-enhance decision making may be especially helpful in creating a more standard approach to TBI care. Cost-analysis of creating computer reminders in the existing electronic medical record would need to be conducted first, with an inter-departmental task force creating the reminders and decision pathway. These methods could help improve research studies in the future to raise the standard of care that TBI patients are receiving.

Acknowledgement of Provider Mindset

It is important to note the perfunctory effort from the neurosurgery department to adopt a best practice agreement that guides their management of TBI cases. Prior research has implicated neurosurgeons for taking a less active approach in head trauma management based on perceived medicolegal risks, time commitments, and inadequate compensation (Cohn et al., 2007). Significant provider turnover may also have resulted in new neurosurgeons being unaware of existing inter-departmental efforts to increase ICP monitor use. And in this particular project, the lead facilitator was not neurosurgery-based but rather trauma-based. Efforts to help overcome this barrier have already commenced through improved avenues of communication at neurosurgical-trauma weekly liaisons at process improvement meetings. Though this may encourage a team approach, it may also be beneficial to look at fundamental implications involved in altering providers' behaviors.

The use of theory may help explain what barriers impacted the overall change process. The Theory of Reasoned Action and Planned Behavior suggests that two major factors play a role in changing behaviors; individuals' attitude and the social and environmental influence on the subjective norm (Kritsonis, 2005). This theory suggests that neurosurgeons have to possess positive opinions on the change, as well as be supported by their peers. Though trauma surgeons are peers in the medical field, their influence may be limited when trying to change interdepartmental practice. In an editorial regarding changing neurosurgical culture of care, Dr. Benzil (2014) inquires what would motivate a surgeon to abandon the status quo? In medicine, the resounding answer is evidence-based research. But as the Brain Trauma Foundation released their fourth and final edition of TBI management guidelines in 2016, they cited a lack of high quality evidence-based research as a cause for the persistent gap noted in their recommendations (Carney et al., 2016.) Additionally, some providers feel that evidence-based medicine and standardized protocols encourage physicians to see patients as interchangeable, and as a means to discourage creative clinical solutions to complex medical problems (Timmermans and Mauck, 2005). The trauma teams' attempts to alter neurosurgery practice may not have failed based on methods of implementation, but rather on reasons based in lacking peer support, lack of supporting evidence for ICP monitoring, or even in the depersonalization of patient treatment plans.

Future Leadership Implications

If the neurosurgery and trauma team conclude that they are working towards the same goal of increasing ICP monitor placement, the addition of a secondary project facilitator may help improve ownership of the new guideline processes. The secondary facilitator could be a provider from the neurosurgery department, preferably a proponent for change, and a trained professional in leadership and evidence-based practice. As the neurosurgery team at the hospital is already comprised of several APRNs, this would be an obvious choice for leading the proposed guideline changes, acting as a liaison among departments, and keeping providers accountable. The secondary facilitator could improve inter-departmental relationships and hopefully bring successful change in this project, as well as others on the horizon.

Health Policy Implication

The continued support from administration for process improvement is essential in moving forward. Foremost, the hospital does not yet have in their policy program that TQIP TBI guidelines are the standard of care for head trauma patients. Having the policy in place will enforce the administrations' advocacy for evidence-based practice. Additionally, outcomes in quarterly reports must continue to be communicated to heads of departments to help monitor whether improvements in guideline adherence are occurring. The open dialogue between administration and medical departments is congruent with Palmetto Health's mission statement and values for patient care and teamwork. By being an active part of the interdisciplinary team, administration can help keep patient goals in the forefront of providers' intentions.

Future Practice Implication

Proficiency in the skill of ICP monitor placement by other providers may help alleviate neurosurgeon workload and improve guideline adherence. The American Association of Neurological Surgeons is an advocate for non-physician providers placing ICP monitors and lumbar drains (American Association of Neurological Surgeons, 2013). Studies at Level 1 trauma hospitals have demonstrated safe patient outcomes when ICP monitors are placed by non-neurosurgeons such as general surgeons, physician's assistants, or nurse practitioners (Oddo et al., 2009; Barber et al., 2012). Additionally, per the Nurse Practice Act in South Carolina, nurse practitioners may practice to the extent of their training and may be an underutilized resource in the neurosurgical team. Education on ICP monitor placement could be led by neurosurgeons, and the creation of a protocol for monitor management would ease concerns for departments involved in neurological injury regarding who is responsible for neurological care moving forward.

Chapter Summary

In the next five years, it would be feasible that Palmetto Health is able to bring research to the table that has been non-existent in the implementation of TBI guidelines. Despite the in-depth understandings of traumatic brain injury and the introduction of guidelines to help manage TBI treatment, there is still considerable variation in guideline use and adherence rates. As the TQIP guidelines for TBI become a mainstay at Palmetto Health, dissemination of effective methods of implementation can help other trauma centers improve their own patient outcomes through guideline use. In the meantime, Palmetto Health will continue to assess, evaluate, and change provider and workflow strategies to improve TQIP guideline adherence.

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Appendix A

Differences Between TQIP and BTF TBI Guidelines

Recommendation Category	Brain Trauma Foundation	TQIP
Decompressive craniectomy	**Level IIA** • Bifrontal DC is not recommended to improve outcomes as measured by the GOS-E score at 6 mo post-injury in severe TBI patients with diffuse injury (without mass lesions), and with ICP elevation to values .20 mm Hg for more than 15 min within a 1-h period that are refractory to first-tier therapies. However, this procedure has been demonstrated to reduce ICP and to minimize days in the ICU. • A large frontotemporoparietal DC (not less than 12 x 15 cm or 15 cm diameter) is recommended over a small frontotemporoparietal DC for reduced mortality and improved neurologic outcomes in patients with severe TBI.	Large traumatic hematoma should be evacuated before neurological deterioration develops, irrespective of the GCS (midline shift >5mm or/or compression of basal cisterns) Formal craniotomy is necessary to perform adequate resection TBI patients in ED in a coma should be taken immediately to surgery if a large hematoma is identified as the cause of the coma Decompressive craniectomy is effective in controlling ICP, but it is uncertain in its potential to improve outcomes of neurologic function at 6 months
Prophylactic hypothermia	**Level IIB** • Early (within 2.5 h), short-term (48 h post-injury), prophylactic hypothermia is not recommended to improve outcomes in patients with diffuse injury.	Hypothermia not currently recommended as initial TBI treatment. It should be reserved for "rescue" or salvage therapy after reasonable attempts at ICP control via 3 tier treatment have failed

Hyperosmolar therapy	*Recommendations from the prior (Third) Edition not supported by evidence meeting current standards.* • Mannitol is effective for control of raised ICP at doses of 0.25 to 1 g/kg body weight. Arterial hypotension (systolic blood pressure ,90 mm Hg) should be avoided. • Restrict mannitol use prior to ICP monitoring to patients with signs of transtentorial herniation or progressive neurologic deterioration not attributable to extracranial causes.	• 3-Tiered approach for management of ICH with higher tiers reflecting more intensive management and increased complications • Failure to control ICH in one tier indicates progression to next tier • Repeat CT imaging and neuro exam should be considered to rule out development of surgical lesion and guide management • CPP goal is >60mmHg but may lower down to 50mmHg to help reduce ICP • PaCO2 goal of 30-35 as long as no brain hypoxia is encountered •
Cerebrospinal fluid drainage	Level III An EVD system zeroed at the midbrain with continuous drainage of CSF may be considered to lower ICP burden more effectively than intermittent use. • Use of CSF drainage to lower ICP in patients with an initial GCS ,6 during the first 12 h after injury may be considered.	EVD is preferred method for ICP monitoring due to its diagnostic and therapeutic abilities Indicated in comatose patients with GCS <8with evidence of structural damage on initial CT image ICP monitoring not indicated in comatose patients without evidence of structural brain damage or elevated ICP on initial CT scan Possible ICP monitoring in patients with GCS >8 with structural damage and high risk for progression Possible ICP monitoring for patients requiring urgent surgery for extracranial injuries who need mechanical ventilation, or those showing evidence of progression on CT imaging

		ICP threshold of 20mmHg with a reasonable range of 20-25mmHg as a trigger for treatment
Ventilation therapies	Level IIB *Prolonged prophylactic hyperventilation with PaCO2 of #25 mm Hg is not recommended.* **Recommendations from the prior (Third) Edition not supported by evidence meeting current standards.* Hyperventilation is recommended as a temporizing measure for the reduction of elevated ICP. Hyperventilation should be avoided during the first 24 h after injury when CBF often is reduced critically. If hyperventilation is used, SjO2 or BtpO2 measurements are recommended to monitor oxygen delivery.	If level of consciousness remains persistently depressed, TBI patients should undergo tracheostomy to facilitate liberation from mechanical ventilation. Relative contraindications to tracheostomy include high ICP, hemodynamic instability, and severe respiratory failure. All TBI patients deemed not likely to improve rapidly should be considered for early tracheostomy within 8 days of injury
Anesthetics, analgesics, and sedatives	Level IIB • Administration of barbiturates to induce burst suppression measured by EEG as prophylaxis against the development of intracranial hypertension is not recommended. • High-dose barbiturate administration is recommended to control elevated ICP refractory to maximum standard medical and surgical treatment. Hemodynamic stability is essential before and during barbiturate therapy. • Although propofol is recommended for the control of ICP, it is not recommended for improvement in mortality or 6-month outcomes. Caution is required as high-dose propofol can produce significant morbidity.	Neuromuscular paralysis via continuous infusion of neuromuscular blocking agent can be employed if there is a positive response to a bolus dose. Peripheral nerve stimulation should indicate that two twitches out of four are maintained via the infusion. Adequate sedation must be utilized. Barbiturate or propofol coma may be induced for those patients that have failed to respond to aggressive measure to control malignant ICH, but only instituted if a test dose results in a decrease in ICP, thus identifying the patient as a “responder”. Hypotension is a frequent side effect and therefore meticulous volume resuscitation should be ensured with possible infusion of vasopressor/inotropes. Continuous EEG may be used to

		ensure targeting of the infusion to burst suppression.
Steroids	Level I • The use of steroids is not recommended for improving outcome or reducing ICP. In patients with severe TBI, high-dose methylprednisolone was associated with increased mortality and is contraindicated.	No current recommendations for steroid use.
Nutrition Level	Level IIA • Feeding patients to attain basal caloric replacement at least by the fifth day and at most by the seventh day post-injury is recommended to decrease mortality. Level IIB • Transgastric-jejunal feeding is recommended to reduce the incidence of ventilator-associated pneumonia.	Nutrition should begin early, as soon as patient is hemodynamically stable and ideally within 24-48 hours of injury. Enteral nutrition is recommended over the use of parenteral nutrition Post-pyloric feeding methods preferred as they are associated with lower rate of pneumonia Full nutritional supplementation should be achieved within 7 days of injury
Infection prophylaxis	Level IIA • Early tracheostomy is recommended to reduce mechanical ventilation days when the overall benefit is thought to outweigh the complications associated with such a procedure. However, there is no evidence that early tracheostomy reduces mortality or the rate of nosocomial pneumonia. • The use of PI oral care is not recommended to reduce ventilator-associated pneumonia and may cause an increased risk of acute respiratory distress syndrome. Level III • Antimicrobial-impregnated catheters may be considered to prevent catheter-related infections during external ventricular drainage.	No current recommendations for antibiotics or antimicrobial devices.
Deep vein thrombosis Prophylaxis	Level III	VTE prophylaxis should be considered within the first

	• LMWH or low-dose unfractioned heparin may be used in combination with mechanical prophylaxis. However, there is an increased risk for expansion of intracranial hemorrhage. • In addition to compression stockings, pharmacologic prophylaxis may be considered if the brain injury is stable and the benefit is considered to outweigh the risk of increased intracranial hemorrhage. • There is insufficient evidence to support recommendations regarding the preferred agent, dose, or timing of pharmacologic prophylaxis for deep vein thrombosis.	72hours following TBI. Earlier initiation of pharmacologic prophylaxis appears to be safe in patients at low risk for progression of intracranial bleed and have stable repeat head CT Prophylactic IVC filter should be considered for patients at righ risk for progression of intracranial hemorrhage who cannot receive pharmacologic prophylaxis, including those with lower extremity fracture. LMWH appears to be the safest option after repeat head CT shows no new changes. Prophylaxis should be withheld for 72 hours in patients who meet any of the moderate risk criteria (subdural or epidural hematoma >8mm, multiple contusions per lobe, subarachnoid hemorrhage with abnormal CTA, contusion or hemorrhage >2cm) and who demonstration progression at 24 hours.
Seizure prophylaxis	Level IIA • Prophylactic use of phenytoin or valproate is not recommended for preventing late PTS. • Phenytoin is recommended to decrease the incidence of early PTS (post-traumatic seizure)(within 7 d of injury), when the overall benefit is thought to outweigh the complications associated with such treatment. However, early PTS have not been associated with worse outcomes. • At the present time there is insufficient evidence to recommend levetiracetam compared with phenytoin regarding efficacy in preventing early post-traumatic seizures and toxicity.	No specifics given on seizure prophylaxis

Elderly Considerations	No complete set of guidelines or recommendations available for treatment of TBI	Reversal of anticoagulant and anti-platelet medications recommended if feasible Older age is associated with higher mortality, but full treatment recommended for at least 72 hours post injury. Arbitrary age guidelines are not recommended in the treatment of TBI due to lack of aggressive medical treatment which may lead to poorer prognosis Complete set of guidelines available for treatment of trauma in elderly. This is separate from guidelines for TBI
Pediatric Considerations	Complete set of guidelines specific to infants, children, and adolescents available from BTF.	Complete set of guidelines specific to pediatrics unavailable Recommend transfer to children's hospital, or pediatric-knowledgeable treatment center Treatment recommendation for pediatric TBI the same as adults, but adjust for age specific parameters including blood pressure, lab values, etc.
Withdrawal of Medical Support	Prognostic guidelines available from BTF utilizing GCS score, age, pupillary diameter and light reflexivity, hypotension, and CT scan features	Recommendations to treat all TBI patients with full medical treatment for minimum of 72 hours Age alone should not limit treatment decisions Caution is advised when using prognostic models It is strongly encouraged that each hospital develop a brain death determination policy It has been found that early care limitations such as DNR orders should not be in place due to poor outcomes in patients not receiving aggressive care.

APPENDIX B

SUMMARY OF LITERATURE REVIEW

Title, Type of Study, Quality rating	Methods	Threats to Validity/Reliability	Findings	Conclusions
Mortality reduction after implementing a clinical practice guidelines-based management protocol for severe traumatic brain injury. (2010) *Arabi et al.* Quasi-experimental using pre-post implementation methods Level II- Good quality	BTF guidelines were used to develop a TBI protocol in a teaching hospital in Saudi Arabia. The protocol was developed and agreed upon by intensivists and neurosurgeons. This included the development of a TBI intake form to be completed with every TBI admission. Patients >12yo, GCS <9 were included. DOA and brain death were excluded from the study. The control group was a 10 month retrospective cohort, and the protocol group spanned 5 years. Primary outcome measured was hospital mortality, with secondary outcome of ICU mortality. Other morbidities associated with TBI were measured.	*Internal Threats* -Retrospective cohort size small compared to protocol (72 vs 362 patients) - Differences in providers in pre vs. post-implementation period *External Threats* -Single center study -Conducted in Saudi Arabia hospital limiting generalizability to USA	434 patients were included in the study. The use of the new TBI protocol was independently associated with significant reduction of hospital and ICU mortality (AOR 0.45 [95% CI 0.24-0.86], p 0.02). Use of protocol did not lead to increased placement of tracheostomies, mechanical ventilation duration, ICU LOS, or hospital LOS. Use of ICP monitoring decline between retrospective cohort and protocol group (34.7% vs 8.6%).	Implementation of BTF guidelines through a mutually agreed upon TBI protocol resulted in decreased mortality rates. The process became less varied and therefore more standardized across providers. The use of ICP monitoring did not aid in the reduced mortality rate in this study.
The effect of provider- and workflow-focused strategies for guideline implementation on provider acceptance. (2009)	This study aimed to look at the effects of two types of strategies to implement process change in the workplace. This includes provider-focused strategies and workflow strategies. These strategies were examined in the	*External Threats* -These results are studied in a short-term environment and may	129 VA Medical Centers participated in the study. 242 were quality managers and 2438 were providers (MD, PA, NP or RN). 38% were MD, 38% RN, 13% APRN with internal medicine most frequently reported specialty (35%).	The study breaks down implementation strategies to those that affect workflow and those that are aimed directly at the providers. Used together, they have the most success, but should be accompanied by a

Flanagan et al. Non-Experimental qualitative study Level III- Good Quality	context of 3 evidence-based clinical practice guidelines for COPD, CHF, and major depressive disorder (MDD). A survey was sent to VA Medical Centers' quality managers and providers involved in CPG acceptance. Survey questions varied slightly between quality managers and providers, but did touch on knowledge and adherence to CPGs, level of agreement to CPGs, culture of facility, dissemination approach, performance feedback, and more. 10 provider focused strategies and 4 workflow focused strategies were assessed in this study. Descriptive statistics and multi-level models were used to analyze the data.	not apply in long-term cultural change <u>*Internal Threats*</u> -Assessed user attitudes towards CPG as opposed to actual adherence rate	The most commonly used provider strategies were distribution of complete guideline and a brief summary of the CPG. Workflow strategies focused on computer reminders and other computer tools to document recommended services. This was true across all CHF, COPD, and MDD. Final analysis showed that provider acceptance of a CPG was correlated with more provider focused strategies and fewer workflow basedd strategies. However, when used jointly, there was an even higher acceptance rate.	high level of provider based strategies for maximum CPG acceptance. In descending order, this particular study used complete guideline and brief summary the most when implementing a new CPG, followed by pocket card of guideline, clinical meetings, champion for the guideline, grand rounds, and teleconference. Workflow processes used computer reminders, computer tools, responsibilities of non-physicians changed, and then forms created to implement strategy.
From best evidence to best practice: effective implementation of change in patients' care (2003) *Grol and Grimshaw*	A systematic review of the literature was conducted to assess for issues that influence the uptake of evidence based practice including: attributes of evidence, barriers and facilitators to changing practice, and effectiveness of dissemination and	<u>*Internal threats:*</u> None <u>*External threats:*</u> -Review focused only on handwashing	Results from Netherlands and U.S. suggest that 30-40% of patients do not receive care according to present scientific evidence, and 20-25% unnecessary or harmful care. 235 articles were reviewed and categorized first into barriers to EBP implementation. The categories of barriers fell under	This article emphasizes that various strategies targeting obstacles at different levels, personal to hospital level, must be implemented to see success in EBP implementation. Additionally, educational material that is not interactive or continuous may not result in

Systematic Review including quasi-experimental studies Level II- Good Quality	implementation strategies. The review was conducted as a case study, looking at the designs for hand hygiene implementation.	scenarios which could limit generalizability *Reliability:* -Review only done up to year 2003	individual (cognitions, attitude/motivation) and routine; under team or unit (social influence and leadership); under hospital or health center (organizational), or under resources. Attitude and motivation was the greatest obstacle at 81%, followed by routine behaviors and inability to see complications as a result of not implementing the change. However, all of the aforementioned categories had greater than 40% of people reporting it as a barrier. Researchers found a large number of studies on feedback of performance and reminders and found they were mostly effective when used for test ordering or prevention purposes, respectively. Interactive small groups were effective but only had 4 studies. 16 studies looked at combined interventions and showed more effective than a single intervention. Multiprofessional collaboration was effective for a range of chronic conditions, and conferences, courses had mixed effects. Specific to the handwashing case study, the multifaceted intervention had the most	long term changes. Economical and political approaches were not studied, and have not been studied so their effect may be greater than we currently know.

			pronounced effects on practice and outcomes.	
Career stage and work setting create different barriers for evidence-based medicine (2011) *Swennen et al.* Qualitative study using survey and interview techniques Level III-Good quality	A personal, confidential interview was conducted face-to-face with anesthesiologists of varying career levels in the Netherlands. They were asked questions regarding their familiarity with EBP, how they felt stakeholders perceived EBP implementation how they felt about EBP, and barriers to implementation. A task list was utilized to ensure all questions were answered, which were then coded for response after interview. The physicians were split into 3 groups: registrars which were in their 5 years of specialization training, consultants which had at least 10 clinical experience after becoming qualified, and seniors which were consultants with additional leadership tasks. The lead investigator conducted all the interviews.	*Internal Threats:* -Relatively small sample size -Only sampled anesthesiologists so may not be generalizable to other professions *External Threats:* -Conducted in Netherlands, may differ in mindset that U.S.	12 participants were used with over 800 minutes of recorded material. The participants came from 2 different hospitals. Original findings were going to be placed in a well-known, 5 category taxonomy of barriers at personal through organizational levels, however, a new 10 condition model prevailed. Much like a pyramid, the first barrier had to be overcome before approaching the next. In ascending order (most basic barrier to most complex): availability and access to evidence, awareness of and positive attitudes towards EBP, positive attitudes towards change, evaluation of evidence, integration of appraised evidence with clinical expertise, medical decision to apply evidence, evaluation of prior managerial conditions for implementation of evidence, multidisciplinary decision to implement evidence, initiation of evidence, and integration in routine clinical practice. Overall findings indicated that registrars were less likely to adopt EBP and had ambivalence towards the need,	There is a great deal of difference in the mindset of the three career groups studied. The youngest of the profession wanted to know how to do something before needing to know why. The consultants feared litigation could oppose their practice and that EBP would be used against better medical judgment. The leadership positions of the seniors, if their personal character was open to change, embraced EBP and felt it to augment that clinical expertise an anesthesiologist may have. Age or stage in profession is not the barrier to overcome, but the position within the organization may have a positive influence on the acceptance and implementation of EBP.

			despite their positive attitudes. Consultants felt experience trumped evidence, and feared loss of autonomy through EBP. Seniors were most likely to equate evidence with expertise and, character willing, would be likely to implement EBP.	
The relative effectiveness of practice change interventions in overcoming common barriers to change: a survey of 14 hospitals with experience implementing evidence-based guidelines (2007) *Simpson and Doig* Quasi-experimental study Level III-Good quality	14 hospitals in New Zealand and Australia participated in a study that developed and implemented EBP for nutritional support in ICU patients. 2 site investigators from each hospital attended a workshop to learn how to implement changes in the hospital setting. The strategies included site initiation (interactive lecture presentation), academic detailing (one-on-one staff conversations), active reminders (short friendly chats with those not complying), timely audit and feedback, passive reminders, and in-servicing. Surveys were sent to the hospitals to analyze which interventions worked best and which were used with most	*External Threats* -Barriers to overcome may only be specific to starting nutritional support and may not be generalizable *Internal Threats* -Survey response may not necessarily match the effectiveness reported within the ICU	14 hospitals (100%) responded to the survey. Site initiation visit and academic detailing via resource book was ranked as most successful at implementing EBP. This was closely followed by in-servicing by a clinical site investigator and academic detailing using critical appraisal summary sheets. All interventions were deemed effective in some capacity but the median rank of most successful interventions were the aforementioned. The top 5 barriers to change most frequently reported included lack of staff on weekends/after hours to fulfill new orders, site specific barrier (write in response), physician reluctance to start new treatment on post-op patient, nurse failure to start treatment, and nurse alteration of	Methods that were most effective were conducted on a one-on-one basis between staff members. Simple resource books or one page appraisal summaries were especially helpful. Passive reminders fell towards the least helpful of tools (including posters, mouse mats, or laminated sheets). Ultimately a multi-faceted approach to implementing change is recommended. One implemented strategy is not enough to overcome various barriers.

	success with particular barriers (physician, nurse, or mixed barriers). Simple descriptive statistics were utilized.		order in response to patient condition.	
Following a natural experiment of guideline adaptation and early implementation: a mixed-methods study of facilitation *Dogherty 2012* Quasi-experimental study Level II-Good quality	A literature review on the facilitation process and role in the implementation of evidence-based practice nursing led to a mixed-methods study with the Canadian "Partnership". 51 facilitation activities were used to audit how the facilitation process was noted in five case studies. A subsequent interview with 6 facilitators revealed their practical experience. Primary outcome was understanding of what occurs when undertaking guideline adaptation.	<u>*Internal Threats:*</u> -Only 3 case studies researched across Canada <u>*External Threats:*</u> -Limited information regarding national acceptance rates of utilized guidelines	3 out of the 5 case studies that were originally chosen made it to the final study. 1 was excluded for using national scope of implementation and was very similar to another case study, and the other group wanted to implement a new guideline as opposed to adapting an existing one. Extensive range of duties were found for a facilitator including planning, leading, managing, monitoring, and evaluating the change. Use of both internal and external facilitators as used, and administrative support was found particularly helpful for support and continuing the drive. Facilitators often extended beyond their role and recognized they had used 46 methods described at least once during their implementation process. Not used was the interpretation of baseline data and providing feedback/insight into performance gaps, linking EBP to patient outcome, and	Facilitators have roles beyond anyone else in the team to ensure adaptation of a new guideline. However, the roles of the team were invaluable to the success of implementation. Facilitators could be viewed as a "home-base" for knowledge and continuing support. Effective communication was the number one attribute for a facilitator and for the change process. This is followed by organizational skills and leadership skills. Choosing a facilitator with these qualities can be a crucial point during the change process.

			acknowledging success. Facilitator activities performed in all three cases included providing resources/tools for change, tailoring services to local setting, consensus-building, scheduling meetings, leading meetings, problem-solving, providing ongoing support, ensuring process/methodology is followed, providing regular communication, and keep group members informed.	