Early Feeding Initiation: A Checklist for the Daily Management of Pediatric Severe Traumatic Brain Injury

Holly N. Michael, BSN, RN

Edson College of Nursing and Health Innovation, Arizona State University

Author Note

Correspondence concerning this article should be addressed to Holly N. Michael, Edson College of Nursing and Health Innovation, Arizona State University, 502 North 3rd Street, Phoenix, AZ 85004. Phone: (480) 433-3683, Email: hnemmons@asu.edu

The author has no conflicts of interest or funding to declare.

Abstract

Background: Traumatic brain injury (TBI) is a leading cause of death and long-term disability among children. The Brain Trauma Foundation (BTF) guidelines integrate initiation of early enteral nutrition which is essential for achieving best clinical outcomes. Gaps in knowledge, consistency, and collaboration when managing these patients hinder adherence to the guidelines and puts the patient at risk.

Objective: This project purpose was to review the updated BTF guidelines and implement a rounding checklist to increase the early initiation of enteral feeding following a TBI.

Methods: This quality improvement project was conducted in the pediatric intensive care unit (PICU) at a level one pediatric trauma center and included all patients admitted with severe TBI. A pre- and post-test accompanied education regarding the guidelines and instructions for checklist completion. The checklists included all BTF guidelines, with a primary focus on early initiation of feeds. Checklist data was presented by the bedside nurse during rounds.

Results: Using descriptive statistics, the average pre-test score was 69% and average post-test score was 93%. Prior to the education, 82% of registered nurses believed a bedside checklist would help manage patients with severe TBI and increased to 95% after education. The checklist was used on 7 (100%) patients and 43% had feeds initiated within 72 hr post-injury *(n* = 3).

Conclusions: Early initiation of feeding in critically ill patients impacts patient outcomes. A rounding checklist can improve interprofessional communication and healthcare quality by delivering standardized pediatric TBI care. Research regarding enteral nutrition is needed to ensure nutrition is provided in a safe, timely manner.

Keywords: pediatric, severe traumatic brain injury, checklist, early enteral nutrition, guideline adherence

Early Feeding Initiation: A Checklist for the Daily Management of Pediatric Severe Traumatic Brain Injury

Traumatic brain injury (TBI) is a leading cause of death and long-term disability among children. The clinical presentation of children with a head injury varies depending on the severity of the trauma. Although the management differs based on severity, there is variability between the dissemination of and adherence to the Brain Trauma Foundation (BTF) guidelines.

Problem Statement

According to the Centers for Disease Control and Prevention (CDC), there were over 812,000 children with TBI-related Emergency Department (ED) visits, over 23,000 TBI-related hospitalizations, and 2,529 TBI-related deaths in 2014 (Centers for Disease Control and Prevention [CDC], 2019). It is estimated that every 11 s someone sustains a TBI (Love Your Brain, n.d.). A TBI is identified as a nondegenerative, noncongenital insult to the brain from an external mechanical force, with potential transient or permanent impairment of psychosocial, cognitive, and physical functions, associated with an altered or diminished level of consciousness (Ortiz et al., 2020). Pediatric survivors of TBI are at a greater risk for behavioral and social dysfunction compared to their peers (Ryan et al., 2016). The outcomes after a TBI depend on several factors, but timely, high-quality acute care is vital.

The BTF guidelines for the management of pediatric severe TBI were published to offer guidance for the acute medical management of severe TBI in infants, children, and adolescents. The guidelines provide a platform for developing and standardizing best practices (Saherwala et al., 2018). The BTF publishes evidence-based guidelines to improve outcomes for children with severe TBI, and clinicians can use these guidelines to create care policies (Vavilala et al., 2019). The updated guidelines were published in March 2019 with the newest evidence-based

recommendations using high-level literature, with modifications and updates from the previous BTF guidelines.

Purpose and Rationale

Patients are at risk for devastating outcomes if there is a lack of adherence to the guidelines for the management of severe TBI. Gaps in knowledge, consistency, and collaboration when managing patients with a severe TBI hinder adherence to the guidelines. A consistent and standardized approach can improve patient outcomes. The purpose of this paper is to review the current literature and determine if adhering to the updated BTF guidelines improves patient outcomes by decreasing morbidity, mortality, and hospital length of stay for patients with a severe TBI.

Background and Significance

Pediatric Patients with Severe Traumatic Brain Injury

TBI affects the pediatric population worldwide and poses a significant health concern from the time of initial insult until years later when long-term side effects manifest. Out of all traumatic injuries, brain injuries are most likely to result in death or permanent disability (Araki et al., 2017). Primary TBI is the direct damage to the brain at the time of injury, whereas secondary injury is the result of hemodynamic, inflammatory, excitotoxicity, and metabolic processes (Vavilala et al., 2017). Although the primary injury is not preventable by providers, they can deliver best practice interventions to prevent secondary insults (hypoxia and hypotension) and injury (Vavilala et al., 2017).

BTF Guideline Adherence Through Education and a Rounding Checklist

Acute care providers play an essential role in the identification, management, and treatment of pediatric severe TBI. Maintaining the appropriate course of care throughout a

patient's hospitalization impacts a patient's risk of morbidity and mortality. The BTF guidelines provide the most current evidence for best practice in the care of pediatric patients with severe TBI to improve outcomes. Saherwala et al. (2018) evaluated the relationship in hospitals between participation in the Adam Williams Initiative (AWI) and adherence to the BTF guidelines for patients with a TBI. Saherwala et al. described the AWI as a program designed to offer education and resources to urge hospitals across the United States to incorporate the guidelines into practice. They discovered with the work of AWI and promoting adherence to the guidelines for the care of patients with a TBI, there was an association of high adherence to the BTF guidelines (Saherwala et al., 2018). Vavilala et al. (2019) assessed the implementation and effectiveness of the Pediatric Guideline Adherence and Outcomes (PEGASUS) program in children with severe TBI using key performance indicators. They concluded implementation improves adherence to the guidelines and is associated with improved discharge outcomes.

Standardized checklists exchange patient information between providers, patients, and caregivers in a timely and accurate manner. Ganesan et al. (2017) implemented a daily rounding tool in a pediatric intensive care unit (PICU) to prompt discussion regarding prioritized patient care measurements and improve interprofessional participation in daily rounds. Ganesan et al. (2017) found through implementation, there was a significant improvement in the frequency of discussing important clinical elements. The authors found that bedside nurse presence and participation on rounds could result in greater opportunities to participate in patient care conversations and education (Ganesan et al., 2017). Hallam et al. (2018) performed a qualitative study evaluating perceptions of rounding checklists in the intensive care unit (ICU). Although there were conflicting results, participants described the purpose of rounding checklists as a daily

reminder for evidence-based practice and a tool for increasing shared understanding of patient care (Hallam et al., 2018).

Comparison/Current Practice

In 1995 a systematic survey of nearly 270 trauma centers was conducted, and the BTF collected data and compared treatments used for intracranial hypertension. The results showed considerable variation in the management of severe TBI, and the BTF recommended the creation of consistent, evidence-based guidelines (Ghajar et al., 1995). Inconsistencies in implementing the guidelines remain a problem. Vavilala et al. (2014) found an average overall adherence rate across five pediatric trauma centers was 72.8%. Recommendations for TBI guidelines are based on available evidence and written with the intent of using expertise and overall provider agreement to create protocols (Kochanek et al., 2019). Protocols may differ depending on the knowledge of providers, hospital capabilities, and resources available to create policies and protocols that coincide with the guideline recommendations.

Enteral Nutrition Timing

Optimal nutritional support is essential for achieving the best outcomes for critically ill children (Rice-Townsend & Aldrink, 2019). The metabolic demands of the body increase significantly in response to TBI, resulting in additional nutritional requirements (Rice-Townsend & Aldrink, 2019). For years, evidence-based guidelines for the management of severe TBI have been in place, with all editions emphasizing the significance of nutritional support (Meinert et al., 2018). The most recent edition recommends the initiation of early enteral nutritional support, within 72 hr from injury, because evidence suggests it decreases mortality and improves outcomes (Kochanek et al., 2019). Meinert et al. (2018) performed a secondary analysis of a randomized controlled trial of therapeutic hypothermia. They examined the relationship between

the timing of initiating nutritional support in children with severe TBI and outcomes. Earlier initiation of nutrition was associated with improved survival (Meinert et al., 2018). Balakrishnan et al. (2019) performed a retrospective, multicenter study to examine the current practice of the initiation of enteral nutrition in children with TBI and evaluate the risk factors associated with delayed initiation of enteral nutrition. Delayed enteral nutrition was an independent risk factor for a worse outcome at discharge (Balakrishnan et al., 2019). Rice-Townsend and Aldrink (2019) reviewed research and guidelines that could identify the effectiveness and safety of enteral nutrition in patients with TBI. They concluded that with pediatric TBI, nutrition should be initiated within 72 hr post-injury and advanced to goal feeds by the seventh-day post-injury. The enteral route is preferred to parenteral (Rice-Townsend & Aldrink, 2019).

Severe TBI is a problem that requires a thoughtful, interprofessional approach using the most recent evidence-based guidelines to improve patient outcomes and decrease morbidity and mortality. As described, guideline adherence is important, including initiating early nutritional support. A review of the evidence reveals that checklists improve interprofessional communication regarding patient goals. Although not specifically implemented for patients with TBI, it is anticipated that improved communication will lead to improved guideline adherence.

Internal Evidence

A large, freestanding children's hospital in the southwestern United States recognized as a level one pediatric trauma center cares for patients who suffer from severe TBI. There are gaps in knowledge and effective team communication and collaboration when managing patients with a severe TBI in the pediatric intensive care unit (PICU); therefore, limiting the shift and adherence of the guidelines to bedside management. The care of children with severe TBI at this children's hospital differs depending on the provider and nurses involved. Nursing presence during patient

care rounds is not required, and not all nurses understand the physiology and management necessary to care for this patient population. National benchmarks for the outcomes expected for patients with a severe TBI are not being met. Therefore, the active pursuit of strategies to increase adherence to TBI guidelines is underway. This improvement is expected to decrease morbidity, mortality, and hospital length of stay.

PICOT Question

Interest in this problem led to a review of current evidence to determine the best interventions for the management of severe TBI. This literature review has led to the clinically relevant PICOT question, "In pediatric patients with severe TBI, does education regarding the updated brain trauma guidelines and the implementation of a rounding checklist increase the initiation of enteral feeding within 72 hr of injury compared with the current practice over 12 weeks?

Search Strategy and Sources

An exhaustive search was performed in the electronic databases Cumulative Index of Nursing and Allied Health Literature (CINAHL), PsycINFO, and PubMed. These databases were chosen because of the relevance to healthcare and application to the PICOT question.

Inclusion Criteria, Exclusion Criteria, and Limitations

The inclusion criteria focused on studies published in English with dates between 2015 to present. Articles published more than five years ago were excluded. Boolean terms were used to broaden the search. Most studies included analysis of hospitals in the United States, although studies from other countries were included if they were published in English. Opinion articles, clinical practice guidelines (CPGs), and study protocols were excluded. Inclusion and exclusion criteria were the same for all databases.

Keyword Selection

Keywords included: *pediatric, child, children, infant, adolescent, severe traumatic brain injury, severe TBI, tools, checklist, strategies, guidelines, instrument, critical care, intensive care, ICU, nutrition, diet, food, nourishment, food intake, eating,* and *rounding.* Various combinations of keywords yielded correlating articles on all databases. Titles and abstracts were reviewed on search yields of less than 300. Rapid critical appraisals were completed on 25 articles, and the final 10 articles were chosen. Those chosen addressed the PICOT appropriately and explored the relationship between multiple key terms.

Search Yield

An initial search in CINAHL using the key terms *severe traumatic brain injury* OR *severe TBI* AND *pediatric* OR *child* OR *children* OR *infant* OR *adolescent* yielded 260 results. Combinations of the remaining keywords, *tools, checklist, strategies, guidelines, instrument, critical care, intensive care, ICU, nutrition, diet, food, nourishment, food intake, eating,* and *rounding* were entered to obtain additional relevant articles. Further searches yielded 5–704 results. Fourteen publications were saved for in-depth evaluation.

A subsequent search in PsycINFO using the key terms *severe traumatic brain injury* OR *severe TBI* AND *pediatric* OR *child* OR *children* OR *infant* OR *adolescent* yielded 370 results. Combinations of the remaining keywords, *tools, checklist, strategies, guidelines, instrument, critical care, intensive care, ICU, nutrition, diet, food, nourishment, food intake, eating,* and *rounding* were entered to maximize article yield. Additional searches yielded 1–67 results. Five publications were saved for further evaluation.

The initial search in PubMed using the key terms *severe traumatic brain injury* OR *severe TBI* AND *pediatric* OR *child* OR *children* OR *infant* OR *adolescent* yielded 2,023 results.

Combinations of the remaining keywords, *tools, checklist, strategies, guidelines, instrument, critical care, intensive care, ICU, nutrition, diet, food, nourishment, food intake, eating,* and *rounding* were entered to maximize article yield. Additional searches yielded 21–343 results. Seven publications were saved for evaluation.

Critical Appraisal and Synthesis of Evidence

Ten studies were retained for this review and arranged into an evaluation table (see Appendix A1 and see also Appendix A2). The studies included two systematic reviews, one secondary analysis of a randomized controlled trial, five cohort studies, one observational study, and one cross-sectional study. Six studies were qualitative, while four were quantitative (see Appendix A1 and see also Appendix A2 and Appendix A3). The level of evidence for most of the studies was level III (see Appendix A1 and see also Appendix A2 and Appendix A3). There is limited research on nutrition and TBI guideline adherence in the pediatric severe TBI population. Three of the six studies that were conducted in ICUs with enteral nutrition protocols and early feeding included generalized critical care patients. There are limited studies exclusively related to TBI, but the studies that have been conducted have indicated that early feeding improves mortality. Eight study samples were pediatric, and five of them looked specifically at TBI patients with differing interventions (see Appendix A3). This literature review included six studies where authors assess the early initiation of feeding, two evaluated TBI guidelines and adherence, and two evaluated the use of a checklist during patient care rounds (see Appendix A3). All interventions were implemented in an acute care setting.

Heterogeneity was noted in the measurement tools and intervention designs. The authors of two studies that looked at the initiation of feeding had varying definitions of early or late initiation of enteral nutrition, but commonalities were identified in the results (see Appendix A1

and see also Appendix A2). The authors of the studies that looked at the use of a rounding checklist had different study purposes but identified areas of improvement with the use of them (see Appendix A1 and see also Appendix A2). Lastly, the authors of the studies that looked at the use of TBI guidelines had different study designs and purposes but identified using and adhering to the guidelines improves outcomes (see Appendix A1 and see also Appendix A2 and Appendix A3). Only two groups of authors described potential bias (see Appendix A1 and see also Appendix A2). Reliability and validity can be assumed for the quantitative studies because of the quality of measurement tools and methods used, and the occurrence of statistically significant results (see Appendix A2).

Conclusions and Discussion

The combination of studies retained for this review had differing topics, but the results of each study were promising to their topic of interest. The review of evidence emphasized the importance of the following: early initiation of feeding in critically ill patients to decrease morbidity and mortality and improve patient outcomes; the use of a rounding checklist to improve patient outcomes and communication between the interprofessional team; and the use of and adherence to the BTF guidelines to improve the quality of health care delivery to deliver standardized pediatric TBI care (see Appendix A1 and see also Appendix A2 and Appendix A3). It is reasonable to assume adhering to the BTF guidelines using a rounding checklist, including early initiation of nutrition, will improve patient outcomes.

Theoretical Framework Application

The Normalization Process Theory (NPT) was selected as the theoretical framework for this project (see Appendix B, Figure 1). NPT is an action theory concerned with explaining what people do instead of their beliefs or attitudes. NPT proposes four concepts that signify different

kinds of work people do that are important when implementing, embedding, and integrating new practice: coherence, cognitive participation, collective action, and reflexive monitoring (Wood, 2017). NPT was built from the concepts to offer a framework for understanding how innovations become sustainable new practices (Wood, 2017). NPT identifies aspects that help and hinder the routine incorporation of complex interventions in everyday practice and was designed to provide a systematic and comprehensive mapping that an intervention will require (Murray et al., 2017). It focuses on the work people do to allow an intervention to become normalized (Murray et al., 2017). NPT applies to this project because it can be used to guide the staff education, and the creation and implementation of the rounding checklist to facilitate a sustainable change in practice. The checklist will aide in standardizing the care of severe TBI patients and once implemented, the bedside nurse presented the data on the checklist daily while on rounds. The daily incorporation and use of the checklist for severe TBI patients normalizes the intervention.

Implementation Framework

The model that was chosen to guide this project is the evidence-based practice (EBP) model, the Iowa Model (see Appendix B, Figure 2). This model was chosen because it is useful in acute care and is the best fit for large organizations. It is an algorithm with several defined steps to help identify issues, research solutions, and implement changes. Using the identified steps, the model was applied throughout the stages of this project. The first two steps were completed through several meetings with the Director of the Children's Surgery and Trauma Programs at a children's hospital in the southwestern United States. Soft data of the problem was discussed and recognized as a priority for the organization. The third step, forming a team with stakeholders to assist in developing, evaluating, and implementing the change, was achieved. The stakeholders involved include the following: physicians and nurse practitioners from the

trauma department, pediatric intensive care unit (PICU), neurosurgery, and neurocritical care; PICU dieticians; and nurses in the PICU. Steps four and five, assemble, critique, and synthesize relevant literature were completed (see Appendix A1 and see also Appendix A2). Step six was decided when the stakeholders joined, the intervention was created, and it was found there was sufficient research to implement the rounding checklist. Steps seven and eight were completed during the implementation and analysis stages of the project, with evaluation and revisions performed during these stages before the hospital introduces the change across the department.

Methods

This project was conducted in the PICU at a large, freestanding children's hospital and level one trauma center in the southwestern United States. All patients admitted to the PICU with a severe TBI were included. No individual patient data was accessed from the patient's medical records. The intervention began with a brief education module in the form of a PowerPoint presentation provided by onsite Trauma Team members. The module included a short overview of the BTF guidelines and instructions for completing the checklist on rounds. The Trauma Team members provided all documents (pre-test and post-test) to the ASU student. A pre- and post-test accompanied the education to evaluate effectiveness of the material. The pre- and post-tests were not linked on an individual level. The DNP student used the information gathered from these sessions to inform the outcome of the rounding checklist. All staff involved in the care and management of severe TBI patients were asked to participate in the education portion of the project. The pre-test was emailed to all PICU nurses, nurse practitioners, fellows, and attendings. All PICU nurses were required to attend the PICU annual competency review (ACR) in-person. The pre-test was printed out and completed by the nurses who attended ACR and collected by the educators prior to beginning the education module. The completed pre-test served as their

consent to participate in the education portion of the project and entry into the education. In-person participants completed a post-test immediately following the education and returned it to the educators prior to exiting the ACR. All staff who did not receive in-person education and training received the same information via email. After each person received the education from one of the methods provided (in-person or email), the rounding checklist was implemented. The full education module was emailed to all PICU nurses, nurse practitioners, fellows, and attendings for future reference and review. The nurse caring for the patient presented the data from the checklist at the start of patient care rounds on each shift, for the first seven days post-injury, while the patient was in the PICU. The checklists were kept in a folder by the patient chart, without using patient identifiers. The checklists from the folder were gathered by an on-site staff member. The use of the checklist allowed for the evaluation of the recommended management, including nutrition for the patient. The checklist served as the tool to measure patient outcomes and adherence to the BTF guidelines. Institutional Review Board (IRB) for Arizona State University and the hospital determined this project did not meet the definition of research; therefore, this quality improvement project received exempt status approval. Staff education began July 2020, TBI checklists were implemented between October 2020 and February 2021, and evaluation and dissemination was completed.

The measurable outcomes of this project include knowledge gain of severe TBI physiology and management, rounding checklist use, and frequency of the initiation of feeds within 72 hr. Knowledge gain regarding severe TBI physiology and management along with the rationale and use of the rounding checklist, were measured through pre- and post-education tests. Rounding checklists were used during patient care rounds and collected daily to evaluate utilization and

indicated increased adherence to the BTF guidelines. Evaluation of the frequency of the initiation of feeds within 72 hr was indicated on the rounding checklist.

The pre- and post-education test has the following question pertaining to enteral nutrition (see Appendix A, Figure 1):

- According to the Brain Trauma Foundation Guidelines and hospital TBI Management Guidelines, nutritional support should be started when? (select all that apply)

The rounding checklist has the following nutrition questions (see Appendix A, Figure 3):

- Enteral feeding, yes or no?
- If yes, date and time initiated.
    - If yes, advancing? Trophic? At goal?
- If no, provide brief rationale.
    - TPN? Interruptions? (i.e.: NPO for imaging)

The expected cost of this project is $15,462.08 with an estimated $3,771.50 from in-kind support, totaling $11,690.58 (see Appendix B, Figure 4).

Results

The education module was provided to 143 PICU registered nurses. Using descriptive statistics, the average pre-test score was 69% and the average post-test score was 93%. Prior to the education, 82% of the nurses believed a bedside checklist would help them better manage patients with severe TBI. After the education, this increased to 92%. The TBI checklist was implemented, and data was collected from October 12, 2020 to February 6, 2021. Thirty-five patients were admitted with a TBI. Of those 35 patients, 28 were excluded (mild or moderate TBI, transfer to the floor or discharged within 24 hr of admission to the PICU, or sustained a

nonsurvivable injury) and seven patients were included. Seven patients (100%) used the TBI checklist, and four patients (57%) had feeds initiated within 72 hr of injury.

Discussion

Knowledge and opinions regarding severe TBI management from the interprofessional team can significantly affect buy-in and overall outcomes. The implementation of the TBI rounding checklist did not lead to 100% adherence to the recommended BTF guidelines, but there were important lessons learned from this project. Informal post-implementation discussions were held with providers and nurses in the PICU. Positive feedback was provided including the following: ease of the checklist; ability to be aware of specific recommendations regarding TBI management, and when to recognize there is non-adherence. Nurses reported that not having the TBI checklist as a part of the electronic charting resulted in inconsistencies when filling out the checklist. The nurses also expressed they would prefer the checklist be filled out by the previous nurse and reviewed together during report to ensure effective use of time. Discussion remains regarding the lack of consistency and interprofessional collaboration while acutely managing TBI patients in the PICU.

Noteworthy limitations exist for this project. First, the checklists were in paper format and difficult to keep track of. Although each patient that met inclusion criteria received a separate folder with checklists, folders and checklists were unaccounted for. Variations in the data collection were observed and missing values were present (date when it was filled out and other valuable data and rationale). While the checklist was created from the most recent evidence-based guidelines, the checklist is not a validated tool. Finally, further discussion is needed to understand the details behind the delay in initiating feeds in some patients.

Challenges were detected during the onset of implementation that if discovered during the beginning of the project design could have been addressed to support a more cohesive implementation. First, obtaining buy-in from all members of the interprofessional team is crucial. Buy-in was formed late in the creation of this project. Obtaining early buy-in may have led to greater interprofessional collaboration and acceptance of the checklist. Second, providing early and ongoing education about severe TBI management including nutrition timing, and how to fill out and use the checklist may have allowed for greater approval and understanding of the project's importance. It is likely that making the checklist electronic would make it easier for nursing to use and result in greater checklist completion and guideline adherence rates. Creating an electronic version with a reminder would remove the need for someone to remind the staff on each shift to fill out the checklist during report, making the checklist more sustainable.

Research is not available to assess the use of checklists in the PICU for severe TBI patients regarding guideline adherence, specifically early initiation of enteral nutrition init. Fortunately, there is available research for portions of the project that allow for comparison. Brolliar et al. (2016) identified factors associated with provider adherence to the TBI guidelines and discovered similar beliefs and provider management of TBI found in this project. Nursing identified the desire for standardization of care because of the inconsistency when working with providers who had a preferred plan of care. Providers and nursing requested additional education on the hospital's TBI policy. Brolliar et al. identified respectful, open interprofessional communication is critical for TBI care. Balakrishnan et al., (2019) had similar findings and barriers as this project. The authors were unable to obtain rationale behind a delay in initiating feeds within the recommended timeframe and 47-52% of patients had delayed feeding initiation. Canarie et al. (2015) identified risk factors for delayed enteral nutrition in critically ill children.

After review, the PICU management revealed their commitment to early enteral nutrition but found significant variation in practice when compared with current guidelines and research. Lastly, Hallam et al. (2018) assessed staff perceptions of rounding checklists in the ICU and acknowledged checklists facilitate effective communication, address problems that arise, and standardize the rounding approach. The authors identified strategies to ensure the checklist is effective including making sure the checklist is relevant to the rounding team and is consistent and integrated with patient care. There was a similar staff report of the checklist being time consuming; a point that was mentioned in the evaluation of this project.

Conclusions and Implications for Practice

Severe TBI is a common admission requiring acute management in the PICU. With effective buy-in, the use of a rounding checklist can improve bedside nurse management of severe TBI patients and encourage interprofessional communication. Promoting education regarding enteral nutrition initiation, converting the checklist to an electronic format, and encouraging frequent evaluation of the process, can facilitate a sustainable change in practice. This may result in improvements to pediatric severe TBI care and a decrease in morbidity, mortality, and hospital length of stay through increased adherence to the TBI guidelines. Further research regarding enteral nutrition is needed to ensure nutrition is provided in a safe, timely manner. Other aspects of checklist need to be critically assessed.

References

Appenteng, R., Nelp, T., Abdelgadir, J., Weledji, N., Haglund, M., Smith, E., Obiga, O., Sakita, F. M., Miguel, E. A., Vissoci, C. M., Rice, H., Vissoci, J. R., & Staton, C. (2018). A systematic review and quality analysis of pediatric traumatic brain injury clinical practice guidelines. *PLOS ONE*, *13*(8), e0201550. https://doi.org/10.1371/journal.pone.0201550

Araki, T., Yokota, H., & Morita, A. (2017). Pediatric traumatic brain injury: Characteristic features, diagnosis, and management. *Neurologia Medico-Chirurgica (Tokyo), 57*, 82–93. https://doi.org/10.2176/nmc.ra.2016-0191

Bagci, S., Keles, E., Girgin, F., Yildizdas, D. R., Horoz, O. O., Yalindag, N., Tanyildiz, M., Bayrakci, B., Kalkan, G., Akyildiz, B. N., Koker, A., Koroglu, T., Anil, A. B., Zengin, N., Dinleyici, E. C., Kiral, E., Dursun, O., Yavuz, S. T., Bartmann, P., & Muller, A. (2018). Early initiated feeding versus early reached target enteral nutrition in critically ill children: An observational study in pediatric intensive care units in Turkey. *Journal of Paediatrics and Child Health, 54*, 480–486. https://doi.org/10.1111/jpc.13810

Balakrishnan, B., Flynn-O'Brien, K. T., Simpson, P. M., Dasgupta, M., & Hanson, S. J. (2019). Enteral nutrition initiation in children admitted to pediatric intensive care units after traumatic brain injury. *Neurocritical Care, 30*, 193–200. https://doi.org/10.1007/s12028-018-0597-6

Brolliar, S. M., Moore, M., Thompson, H. J., Whiteside, L. K., Mink, R. B., Wainwright, M. S., Groner, J. I., Bell, M. J., Giza, C. C., Zatzick, D. F., Ellenbogen, R. G., Boyle, L., Mitchell, P. H., Rivara, F. P., & Vavilala, M. S. (2016). A qualitative study exploring factors associated with provider adherence to severe pediatric traumatic brain injury guidelines. *Journal of Neurotrauma*, *33*(16), 1554–1560.

https://doi.org/10.1089/neu.2015.4183

Brown, C. G. (2014). The Iowa Model of evidence-based practice to promote quality care: An illustrated example in oncology nursing. *Clinical Journal of Oncology Nursing*, *18*(2), 157–159. https://doi.org/10.1188/14.CJON.157-159

Canarie, M. F., Barry, S., Carroll, C. L., Hassinger, A., Kandil, S., Li, S., Pinto, M., Valentine, S. L., & Faustino, E. V. (2015). Risk factors for delayed enteral nutrition in critically ill children. *Pediatric Critical Care Medicine*, *16*(8), 283–289. https://doi.org/10.1097/PCC.0000000000000527

Centers for Disease Control and Prevention (2019). TBI data and statistics. https://www.cdc.gov/traumaticbraininjury/data/index.html

Cifra, C. L., Houston, M., Otto, A., & Kamath, S. S. (2019). Prompting rounding teams to address a daily best practice checklist in a pediatric intensive care unit. *The Joint Commission Journal on Quality and Patient Safety*, *45*(8), 543–551. https://doi.org/10.1016/j.jcjq.2019.05.012

Elke, G., van Zanten, A. R., Lemieux, M., McCall, M., Jeejeebhoy, K. N., Kott, M., Jiang, X., Day, A. G., & Heyland, D. K. (2016). Enteral versus parenteral nutrition in critically ill patients: An updated systematic review and meta-analysis of randomized controlled trials. *Critical Care*, *20*(1), 117. https://doi.org/10.1186/s13054-016-1298-1

Ghajar, J., Hariri, R. J., Narayan, R. K., Iacono, L. A., Firlik, K., & Patterson, R. H. (1995). Survey of critical care management of comatose, head-injured patients in the United States. *Critical Care Medicine, 23*(3), 560–567. https://doi.org/10.1097/00003246-199503000-00023

Ganesan, R., Rajakumar, P., Fogg, L., Silvestri, J., & Kane, J. M. (2017). We care 4 kids: Use of a rounding tool in the pediatric intensive care unit. *Pediatric Quality & Safety, 2*(6), e044. https://doi.org/10.1097/pq9.0000000000000044*3*

Hallam, B. D., Kuza, C. C., Rak, K., Fleck, J. C., Heuston, M. M., Saha, D., & Kahn, J. M. (2018). Perceptions of rounding checklists in the intensive care unit: A qualitative study. *BMJ Quality & Safety, 27*(10), 836–843. https://doi.org/10.1136/bmjqs-2017-007218

Keenan, H. T., Presson, A. P., Clark, A. E., Cox, C. S., & Ewing-Cobbs, L. (2018). Longitudinal developmental outcomes after traumatic brain injury in young children: Are infants more vulnerable than toddlers? *Journal of Neurotrauma, 36*, 282–292. https://doi.org/10.1089/neu.2018.5687

Khormi, Y. H., Gosadi, I., Campbell, S., Senthilselvan, A., O'Kelly, C., & Zygun, D. (2018). Adherence to brain trauma foundation guidelines for management of traumatic brain injury patients and its effect on outcomes: Systematic review. *Journal of Neurotrauma*, *35*(13), 1407–1418. https://doi.org/10.1089/neu.2017.5345

Kochanek, P. M., Tasker, R. C., Carney, N., Totten, A. M., Adelson, P. D., Selden, N. R., Davis-O'Reilly, C., Hart, E. L., Bell, M. J., Bratton, S. L., Grant, G. A., Kissoon, N., Reuter-Rice, K. E., Vavilala, M. S., & Wainwright, M. S. (2019). Guidelines for the management of pediatric severe traumatic brain injury, third edition: Update of the brain trauma foundation guidelines, *Pediatric Critical Care Medicine, 20*, 1–82. https://doi.org/10.1097/PCC.0000000000001736

LoveYourBrain Foundation (n.d.). Love Your Brain Foundation. https://www.loveyourbrain.com/

Mehta, N. M., Bechard, L. J., Zurakowski, D., Duggan, C. P., & Heyland, D. K. (2015). Adequate enteral protein intake is inversely associated with 60-d mortality in critically ill children: A multicenter, prospective, cohort study. *The American Journal of Clinical Nutrition, 102*(1), 199–206. http://doi.org/10.3945/ajcn.114.104893

Meinert, E., Bell, M. J., Buttram, S., Kochanek, P. M., Balasubramani, G. K., Wisniewski, S. R., & Adelson, P. D. (2018). Initiating nutritional support before 72 hours is associated with favorable outcome after severe traumatic brain injury in children: A secondary analysis of a randomized, controlled trial of therapeutic hypothermia. *Pediatric Critical Care Medicine, 19*(4), 345–352. https://doi.org/10.1097/PCC.0000000000001471

Murray, E., Treweek, S., Pope, C., MacFarlane, A., Ballini, L., Dowrick, C., Finch, T., Kennedy, A., Mair, F., O'Donnell, C., Ong, B. N., Rapley, T., Rogers, A., & May, C. (2010). Normalisation process theory: A framework for developing, evaluating, and implementing complex interventions. *BMC Medicine, 8*(1), 63. https://doi.org/10.1186/1741-7015-8-63

Ortiz, J. B., Sukhina, A., Balkan, B., Harootunian, G., Adelson, P. D., Lewis, K. S., Oatman, O., Subbian, V., Rowe, R. K., & Lifshitz, J. (2020). Epidemiology of pediatric traumatic brain injury and hypothalamic-pituitary disorders in Arizona. *Frontiers in Neurology, 10*(1410). https://doi.org/10.3389/fneur.2019.01410

Rice-Townsend, S. E. & Aldrink, J. H. (2019). Controversies of enteral nutrition in select critically ill surgical patients: Traumatic brain injury, extracorporeal life support, and sepsis. *Seminars in Pediatric Surgery, 28*, 47–52. https:/doi.org/10.1053/j.sempedsurg.2019.01.008

Ryan, N. P., Catroppa, C., Godfrey, C., Noble-Haeusslein, L. J., Shultz, S. R., O'Brien, T. J.,

Anderson, V., & Semple, B. D. (2016). Social dysfunction after pediatric traumatic brain injury: A translational perspective. *Neuroscience & Biobehavioral Reviews*, *64*, 196–214. https://doi.org/10.1016/j.neubiorev.2016.02.020

Saherwala, A. A., Bader, M. K., Stutzman, S. E., Figueroa, S. A., Ghajar, J., Gorman, A. R., Minhajuddin, A., & Olson, D. M. (2018). Increasing adherence to brain trauma foundation guidelines for hospital care of patients with traumatic brain injury. *Critical Care Nurse, 38*(1), e11– e20. https://doi.org/10.4037/ccn2018691

Vavilala, M. S., King, M. A., Yang, J., Erickson, S. L., Mills, B., Grant, R. M., Blayney, C., Chesnut, R. M., Jaffe, K. M., Weiner, B. J., & Johnston, B., D. (2019). The pediatric guideline adherence and outcomes (PEGASUS) programme in severe traumatic brain injury: A single-centre hybrid implementation and effectiveness study. *Lancet Child Adolescent Health, 3*, 23–34. https://doi.org/10.1016/s2352-4642(18)30341-9

Vavilala, M. S., Lujan, S. B., Qiu, Q., Bell, M. J., Ballarini, N. G., Depetris, M. A., Faguaga, G. A., Baggio, G. M., Busso, L. O., Garcia, M. E., Gonzalez Carrillo, O. R., Medici, P. L., Saena, S. S., Vanella, E. E., Farr, C. K., & Petroni, G. J. (2017). Intensive care treatments associated with favorable discharge outcomes in Argentine children with severe traumatic brain injury: For the South American guideline adherence group. *PLoS ONE, 12*(12), e0189296. https://doi.org/10.1371/journal.prone.0189296

Wood, P. (2017). Overcoming the problem of embedding change in educational organizations: A perspective from Normalization Process Theory. *Management in Education*, *31*(1), 33–38. https://doi.org/10.1177/0892020616685286

Appendix A

Evaluation and Synthesis Tables

Table A1

Evaluation Table Qualitative Studies

Citation	Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	LOE/ Decision for use/ Application to practice
Appenteng et al. (2018). A systematic review and quality analysis of pediatric traumatic brain injury clinical practice guidelines **Funding:** The Fogarty International Center **Country:** Asia, South America, Europe, North America, Australia, **Bias:** Potential bias with the	Phenomenology (inferred)	**Design:** Systematic Review and quality analysis **Purpose:** To assess the quality of available CPGs for acute diagnostics & management of ped TBI	n = 17 **Databases searched:** MEDLINE, EMBASE, Cochrane Library, LILACS, Africa-Wide Information, & Global Index Medicus **Setting:** Prehospital, low-, middle-, & high- income countries **Inclusion:** Abstracts of articles must mention clinical	**D1:** Scope & purpose – evaluate objective, pertinent health questions & target population covered **D2:** Stakeholder involvement – whether relevant professional groups were involved when creating G **D3:** Rigor of development – whether body of evidence leading to recommendations in the Gs was systematically searched & included for review based on clear criteria **D4:** Clarity of presentation –	Quality assessment using the Appraisal of Guidelines for Research and Evaluation II instrument Each domain graded on seven-point scale: score of 7: "strongly agree"; score of 1: "strongly disagree"	Each domain scored & scaled according to formula: obtained score - minimum possible score/ maximum possible score - minimum possible score Descriptive analysis of CPGs	Level of recommendation varied for each CPG; all were recommended for use Quality of future acute TBI G may improve when the Gs are population specific CPGs for acute management of ped TBI have ability to inform development of trauma teams & improve quality of health care delivery.	**LOE:** I **Strengths:** appraiser number large & have diverse clinical experience to minimize bias; first of this; all CPGs used were recommended for use **Weaknesses:** possibility of missed CPGs from non-English TBI Gs; AGREE II G subjective tool with potential for bias

Key: ↑- increased; ↓- decreased; **A –** adherence; **Avg –** average; **BTF-** Brain Trauma Foundation; **CL-** checklist; **D –** days; **E-** early; **ECI –** enteral caloric intake; **ED –** emergency department; **EER –** estimated energy requirements; **EF-** enteral feed; **EIF-** early initiated feed; **EN-** enteral nutrition; **ERTEN-** early reached targeted enteral nutrition; **G-** guideline; **GA-** guideline adherence; **GCS –** Glasgow coma score **h-** hour; **ICP –** intracranial pressure; **ICU –** intensive care unit; **L-** late; **LIF-** late initiated feed; **LOE-** level of evidence **m-** mild; **M-** moderate; **N-** sample (population); **n-** sample size (studies); **P-** physician; **ped-** pediatric; **PICU-** pediatric intensive care unit; **PN-** parenteral nutrition; **PTAM –** Pediatric Trauma Assessment and Management **RN-** registered nurse; **S-** severe; **TC-** trauma center; **TBI-** traumatic brain injury; **VPS -** Virtual Pediatric Systems

Citation	Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	LOE/ Decision for use/ Application to practice
Appraisal of Guidelines for Research and Evaluation II instrument			recommendations, CPGs, treatment guidelines for acute management of TBI; ped population defined (birth-18 y) or subset of ped population in CPGs; All severities of TBI **Exclusion:** Literature reviews, opinion papers editor's letters, animals, case reports, published prior to 1995 **Attrition:** None	evaluates whether recommendations are specific & clear, present different options for management **D5:** Applicability – evaluates availability of tools & resources to implement guidelines, information on resource utilization cost & audit criteria **D6:** Editorial independence – potential competing interests of G development group & influence of funding				**Application to practice:** Address applicability of a G to translate CPG from paper into clinically relevant practice tools & as a resource in limited practice settings
Bagci et al. (2018). Early initiated feeding versus early reached target enteral nutrition in critically ill children: An observational	Quality assurance model (inferred)	**Design:** Prospective, observational **Purpose:** To evaluate current practice in E EN & its effect on mortality rate in	N = 95 **Mean age:** 4 y **Mean weight:** 15.6 kg Female: 46.3% (44)	**Variables:** ERTEN Patients who reached target EN on day 4 **Definitions:**	**Data Review:** Measurement of major variables every 6 h Calculated daily ECI Identified EF initiation time	Kolmogorov-Smirnov test Two-tailed *t*-test	**EIF:** 45 (47.4%) **ERTEN:** 43 (45.3%) ERTEN & EIF is associated with ↓ mortality rate in critically ill children	**LOE:** III **Strengths:** Multicenter study **Weaknesses:** Study included only critically

Key: ↑- increased; ↓- decreased; **A –** adherence; **Avg –** average; **BTF-** Brain Trauma Foundation; **CL-** checklist; **D –** days; **E-** early; **ECI –** enteral caloric intake; **ED –** emergency department; **EER –** estimated energy requirements; **EF-** enteral feed; **EIF-** early initiated feed; **EN-** enteral nutrition; **ERTEN-** early reached targeted enteral nutrition; **G-** guideline; **GA-** guideline adherence; **GCS –** Glasgow coma score **h-** hour; **ICP –** intracranial pressure; **ICU –** intensive care unit; **L-** late; **LIF-** late initiated feed; **LOE-** level of evidence **m-** mild; **M-** moderate; **N-** sample (population); **n-** sample size (studies); **P-** physician; **ped-** pediatric; **PICU-** pediatric intensive care unit; **PN-** parenteral nutrition; **PTAM –** Pediatric Trauma Assessment and Management **RN-** registered nurse; **S-** severe; **TC-** trauma center; **TBI-** traumatic brain injury; **VPS -** Virtual Pediatric Systems

Citation	Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	LOE/ Decision for use/ Application to practice
study in pediatric intensive care units in Turkey **Funding:** Research Fund of Department of Neonatology, Children's Hospital, University of Bonn **Country:** Turkey **Bias:** None		critically ill children; identify factors that affect initiation of feeding within 24 h after PICU admission & adequate enteral caloric intake in first 48 h after PICU admission in critically ill children	**Critical illness:** Sepsis N = 32 Respiratory Failure N = 40 Cardiovascular operation N = 9 Status epilepticus N = 9 Severe head injury N =5 **Setting:** 9 PICUs in Turkey **Inclusions:** Age 1 month - 16 y; expected PICU stay $\geq$ 96 h; use of nasogastric tube; no history of acute or chronic gastrointestinal disease **Exclusions:** Patients with primary	EIF: tube feeding initiated within 24 h of PICU admit LIF: tube feeding initiated 25-96 h of PICU admit ERTEN: patient receives > 25% of enterally within 48 h of PICU admit Delayed gastric emptying: gastric residual > 5 mL/kg every 4 h Enteral feeding intolerance: Gastric residual > 5 mL/kg, or > 50% volume of previous feeding, or > volume of 2 h of continuous feeds ECI: target = 25% of EER		Mann-Whitney *U* test Multi-variable logistic regression analysis Subgroup analysis	L EF resulted in ↓ rate of reached target enteral caloric intake on days 2 & 4 EIF more likely to have ERTEN, receive more calories, & reach target EN on day 4 **Barriers to feeding initiation:** Invasive interventions (intubation & monitoring devices)	ill children who spent at least 4 d in PICU Staff may have retrospectively completed study documents; unable to obtain reasons not initiating feeds **Application:** Focused nutrition visit to critically ill children within 6 h & 18 h of PICU admit eliminating barriers that may delay initiation of EF & ERTEN & to determine target goals on EN support is recommended

Key: ↑- increased; ↓- decreased; **A –** adherence; **Avg –** average; **BTF-** Brain Trauma Foundation; **CL-** checklist; **D –** days; **E-** early; **ECI –** enteral caloric intake; **ED –** emergency department; **EER –** estimated energy requirements; **EF-** enteral feed; **EIF-** early initiated feed; **EN-** enteral nutrition; **ERTEN-** early reached targeted enteral nutrition; **G-** guideline; **GA-** guideline adherence; **GCS –** Glasgow coma score **h-** hour; **ICP –** intracranial pressure; **ICU –** intensive care unit; **L-** late; **LIF-** late initiated feed; **LOE-** level of evidence **m-** mild; **M-** moderate; **N-** sample (population); **n-** sample size (studies); **P-** physician; **ped-** pediatric; **PICU-** pediatric intensive care unit; **PN-** parenteral nutrition; **PTAM –** Pediatric Trauma Assessment and Management **RN-** registered nurse; **S-** severe; **TC-** trauma center; **TBI-** traumatic brain injury; **VPS -** Virtual Pediatric Systems

Citation	Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	LOE/ Decision for use/ Application to practice
			gastrointestinal problems **Attrition:** None					
Balakrishnan et al. (2019). Enteral nutrition initiation in children admitted to pediatric intensive care units after traumatic brain injury **Funding:** 2014 Childress Foundation grant **Country:** US **Bias:** None	Quality health outcomes model (inferred)	**Design:** Retrospective cohort **Purpose:** To examine current practice of initiation of EN in children with TBI & evaluate risk factors associated with delayed initiation of EN	N = 416 **Setting:** 5 PICUs in ped trauma centers **Inclusions:** Trauma patient, age 0-18 y, head injury **Exclusions:** Patients who died < 48 h from admission, patients with incomplete information on EN, Abbreviated Injury Score (AIS) < 2 or no AIS score **Attrition:** None	**Variables:** Mortality, hospital complications, ICU & hospital length of stay, ventilator days, functional status at ICU discharge **Hospital complications:** infections, constipations, abdominal compartment syndrome GCS scores & severity: 13-15: M 9-12: m < 9: S Early initiation: EF started < 48 h from PICU admission Delayed initiation: EF started > 48 h from PICU admission	Patient information merged from institutional trauma registries & VPS database & inserted into PTAM database	Chi-square Fisher's exact tests Mann-Whitney test	Overall mortality: 2.6% (11) Received EN ≤ 48 h of PICU admission: 83% (347) Received EN > 48 h of PICU admission: 17% (69) 52% of patients with S TBI had delayed feeding 4% of patients with m or M TBI had delayed feeding **Average time to feeding initiation (h):** S TBI: 47.4 m or M TBI: 10.7	**LOE:** III **Strengths:** Multiple institutions; first study **Weaknesses:** Limited sample size; association rather than causation; no information on modalities of EF, advancement of feeds, or time to achieve goal calories & protein intake; unable to assess long-term outcomes **Application:** E EF appears safe in ped with TBI even with coexisting abdominal

Key: ↑- increased; ↓- decreased; **A –** adherence; **Avg –** average; **BTF-** Brain Trauma Foundation; **CL-** checklist; **D –** days; **E-** early; **ECI –** enteral caloric intake; **ED –** emergency department; **EER –** estimated energy requirements; **EF-** enteral feed; **EIF-** early initiated feed; **EN-** enteral nutrition; **ERTEN-** early reached targeted enteral nutrition; **G-** guideline; **GA-** guideline adherence; **GCS –** Glasgow coma score **h-** hour; **ICP –** intracranial pressure; **ICU –** intensive care unit; **L-** late; **LIF-** late initiated feed; **LOE-** level of evidence **m-** mild; **M-** moderate; **N-** sample (population); **n-** sample size (studies); **P-** physician; **ped-** pediatric; **PICU-** pediatric intensive care unit; **PN-** parenteral nutrition; **PTAM –** Pediatric Trauma Assessment and Management **RN-** registered nurse; **S-** severe; **TC-** trauma center; **TBI-** traumatic brain injury; **VPS -** Virtual Pediatric Systems

Citation	Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	LOE/ Decision for use/ Application to practice
				Initiation of feeds: any oral diet or tube feeds at any rate Head injury: concussion, intracranial injury, skull fracture			Reasons for delayed initiation of EN: abdominal/pelvic injury diagnoses or procedures, mechanical ventilation, ICP monitoring, higher injury & illness severity scores, lower GCS score, non-reactive pupils E feeding not associated with ↑ in complications ↓ functional status at discharge with delayed EF S TBI: Fed ≤ 48 h: 48% Fed ≤ 72 h: 65%	injury & associated with improved outcome
Brolliar et al. (2016). A qualitative study exploring factors associated with provider adherence to severe pediatric traumatic brain injury guidelines	Knowledge-attitude-behavior model (inferred)	**Design:** Observational cohort **Purpose:** To identify & explore provider perspective on factors	N = 129 P: 42% (54) N: 58% (74) **Setting:** 5 Level 1 trauma centers **Inclusions:** ICU & ED providers	**Domain 1:** G credibility & applicability **Domain 2:** Implementation & dissemination at institutional level **Domain 3:** Provider culture, communication, &	Focus groups with in person interviews using a discussion guide with open-ended questions	Nivo 9.0 qualitative data analysis of interviews Content analysis	Model of factors related to A was created: Barriers & facilitators of A to Gs were placed in 3 domains with associated factors	**LOE:** III **Strengths:** Large sample size **Weaknesses:** Small number of ped trauma centers

Key: ↑- increased; ↓- decreased; **A –** adherence; **Avg –** average; **BTF-** Brain Trauma Foundation; **CL-** checklist; **D –** days; **E-** early; **ECI –** enteral caloric intake; **ED –** emergency department; **EER –** estimated energy requirements; **EF-** enteral feed; **EIF-** early initiated feed; **EN-** enteral nutrition; **ERTEN-** early reached targeted enteral nutrition; **G-** guideline; **GA-** guideline adherence; **GCS –** Glasgow coma score **h-** hour; **ICP –** intracranial pressure; **ICU –** intensive care unit; **L-** late; **LIF-** late initiated feed; **LOE-** level of evidence **m-** mild; **M-** moderate; **N-** sample (population); **n-** sample size (studies); **P-** physician; **ped-** pediatric; **PICU-** pediatric intensive care unit; **PN-** parenteral nutrition; **PTAM –** Pediatric Trauma Assessment and Management **RN-** registered nurse; **S-** severe; **TC-** trauma center; **TBI-** traumatic brain injury; **VPS -** Virtual Pediatric Systems

Citation	Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	LOE/ Decision for use/ Application to practice
Funding: National Institute of Neurological Disorders and Stroke grant R01 NS072308-03 (Vavilala) and National Center for Advancing Translational Sciences grant KL2TR000421 (Moore) **Country:** US **Bias:** None		associated with A to TBI Gs	who provide acute treatment for ped S TBI **Exclusions:** None stated **Attrition:** None	attitude towards protocols			Domain 1: A is based on P belief that Gs were relevant to patient; Ps modified management depending on injury type; RNs aware of Gs & advocated for E EN and other TBI care protocols Domain 2: support G A by using formal process for incorporating Gs into practice by adding provider preferences; RNs identified need for consensus because of inconsistency when working with Ps who had preferred plan of care; requested standard treatment bundles; Ps & RNs need education on	included. Study data based on provider recall & disclosure of events in front of their peers **Application:** Creating a culture of collaboration, delivering standardized ped TBI care, & open communication while taking barriers & associated factors into consideration, may help G A

Key: ↑- increased; ↓- decreased; **A –** adherence; **Avg –** average; **BTF-** Brain Trauma Foundation; **CL-** checklist; **D –** days; **E-** early; **ECI –** enteral caloric intake; **ED –** emergency department; **EER –** estimated energy requirements; **EF-** enteral feed; **EIF-** early initiated feed; **EN-** enteral nutrition; **ERTEN-** early reached targeted enteral nutrition; **G-** guideline; **GA-** guideline adherence; **GCS –** Glasgow coma score **h-** hour; **ICP –** intracranial pressure; **ICU –** intensive care unit; **L-** late; **LIF-** late initiated feed; **LOE-** level of evidence **m-** mild; **M-** moderate; **N-** sample (population); **n-** sample size (studies); **P-** physician; **ped-** pediatric; **PICU-** pediatric intensive care unit; **PN-** parenteral nutrition; **PTAM –** Pediatric Trauma Assessment and Management **RN-** registered nurse; **S-** severe; **TC-** trauma center; **TBI-** traumatic brain injury; **VPS -** Virtual Pediatric Systems

Citation	Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	LOE/ Decision for use/ Application to practice
							hospital's TBI policy Domain 3: communication styles & behaviors identified as barriers to A; respectful communication critical for continuity of care	
Canarie et al. (2015). Risk factors for delayed enteral nutrition in critically ill children **Funding:** Grants from the National Institutes of Health & American Heart Association **Country:** US **Bias:** None	Relational theory (inferred)	**Design:** Retrospective cross-sectional **Purpose:** To review nutritional practices to determine risk factors associated with delayed EN in critically ill children	**N=** 444 Early EN = 356 Delayed EN = 88 **Setting:** 6 PICUs **Inclusions:** children (age 0–21 years) admitted to the PICU for ≥ 72 h **Exclusions:** low severity of illness on admission, postoperative abdominal surgery, **Attrition:** None	From admission, the following times were calculated: Start of EN, achievement of full EN, nutrition consult, discharge from PICU Early EN – EN initiated by 48 h of admission with intent to advance regardless of mode of delivery Full EN – 100% of volume prescribed by nutrition or care team	Chart review	Mann-Whitney test Chi-square Log-rank test Logistic regression Statistical analysis with 2-tailed level of significance of 0.05 using Strata 13	Higher levels of respiratory support, ↑ severity of illness, procedures, & gastrointestinal disturbances associated with delayed EN. Review of PICU management disclosed commitment to early EN, but significant variance in practice when compared with current guidelines & research	**LOE:** III **Strengths:** conducted in setting where most critically ill children in US receive their care, diagnoses of children in this study are like that described in other studies, patient population in study is representative of children who would benefit the most from EN

Key: **↑- increased; ↓- decreased; A –** adherence; **Avg –** average; **BTF-** Brain Trauma Foundation; **CL-** checklist; **D –** days; **E-** early; **ECI –** enteral caloric intake; **ED –** emergency department; **EER –** estimated energy requirements; **EF-** enteral feed; **EIF-** early initiated feed; **EN-** enteral nutrition; **ERTEN-** early reached targeted enteral nutrition; **G-** guideline; **GA-** guideline adherence; **GCS –** Glasgow coma score **h-** hour; **ICP –** intracranial pressure; **ICU –** intensive care unit; **L-** late; **LIF-** late initiated feed; **LOE-** level of evidence **m-** mild; **M-** moderate; **N-** sample (population); **n-** sample size (studies); **P-** physician; **ped-** pediatric; **PICU-** pediatric intensive care unit; **PN-** parenteral nutrition; **PTAM –** Pediatric Trauma Assessment and Management **RN-** registered nurse; **S-** severe; **TC-** trauma center; **TBI-** traumatic brain injury; **VPS -** Virtual Pediatric Systems

Citation	Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	LOE/ Decision for use/ Application to practice
							Patients who received EN: 356 (80.2%) Patients who had Nutrition consulted: 217 (444) Avg EN start time: 20 h after PICU admission Avg time to full EN in early EN group: 30 h Avg. time to full EN in delayed EN group: 96 h	**Weaknesses:** study relied on interpretation of medical records as data source, documentation may differ across hospital sites, unable to discern providers' rationale & intent regarding initiation or delay of EN, study not designed to look at mortality or PICU length of stay **Application:** the study described deficiencies & areas that PICUs could use to have greater accuracy determining & satisfying

Key: ↑- increased; ↓- decreased; **A –** adherence; **Avg –** average; **BTF-** Brain Trauma Foundation; **CL-** checklist; **D –** days; **E-** early; **ECI –** enteral caloric intake; **ED –** emergency department; **EER –** estimated energy requirements; **EF-** enteral feed; **EIF-** early initiated feed; **EN-** enteral nutrition; **ERTEN-** early reached targeted enteral nutrition; **G-** guideline; **GA-** guideline adherence; **GCS –** Glasgow coma score **h-** hour; **ICP –** intracranial pressure; **ICU –** intensive care unit; **L-** late; **LIF-** late initiated feed; **LOE-** level of evidence **m-** mild; **M-** moderate; **N-** sample (population); **n**- sample size (studies); **P-** physician; **ped-** pediatric; **PICU-** pediatric intensive care unit; **PN-** parenteral nutrition; **PTAM –** Pediatric Trauma Assessment and Management **RN-** registered nurse; **S-** severe; **TC-** trauma center; **TBI-** traumatic brain injury; **VPS -** Virtual Pediatric Systems

Citation	Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	LOE/ Decision for use/ Application to practice
								nutritional needs
Hallam et al. (2018). Perceptions of rounding checklists in the intensive care unit: A qualitative study. **Funding:** The Foundation for the National Institutes of Health **Country:** US **Bias:** None	Grounded theory (inferred)	**Design:** Observational cohort **Purpose:** To understand how ICU providers perceive rounding CLs & develop a framework for more effective rounding CL implementation	N = 89 interviews **Setting:** 32 ICUs in 14 hospitals 114 hours of direct observation **Inclusions:** Hospitals with at least 1 adult ICU **Exclusions:** None stated **Attrition:** 7 (8%) people declined to interview	ICU characteristics – CL use, date when CL implemented, frequency & structure of rounds Rounding CL – tool used to remind clinicians to address specific topics related to health care quality or efficiency on daily rounds	CL review, direct observation, & semi structured interviews	NVivo; deductive & inductive constructs Thematic analysis of observations & interviews	17/32 (53%) ICUs had a rounding CL 12/17 (70%) used the CL Themes: **1: purposes of check lists:** 3 main purposes listed: to serve as reminder to discuss important topics that may be omitted from discussion, to crease shared understanding among team about patients' medical problems & goals for the day, to ↑ round efficiency **2: negative aspects of check list use:** may depersonalize care by overly standardizing it; time consuming	**LOE:** III **Strengths:** positive & negative aspects of CLs were presented **Weaknesses:** None stated **Application:** CLs facilitate effective communication & address problems that arise; CLs standardize rounding approach; CLs should be a tool for quality improvement; strategies to ensure effective implementation include: CL is relevant to rounding team & it is consistent &

Key: ↑- increased; ↓- decreased; **A –** adherence; **Avg –** average; **BTF-** Brain Trauma Foundation; **CL-** checklist; **D –** days; **E-** early; **ECI –** enteral caloric intake; **ED –** emergency department; **EER –** estimated energy requirements; **EF-** enteral feed; **EIF-** early initiated feed; **EN-** enteral nutrition; **ERTEN-** early reached targeted enteral nutrition; **G-** guideline; **GA-** guideline adherence; **GCS –** Glasgow coma score **h-** hour; **ICP –** intracranial pressure; **ICU –** intensive care unit; **L-** late; **LIF-** late initiated feed; **LOE-** level of evidence **m-** mild; **M-** moderate; **N-** sample (population); **n-** sample size (studies); **P-** physician; **ped-** pediatric; **PICU-** pediatric intensive care unit; **PN-** parenteral nutrition; **PTAM –** Pediatric Trauma Assessment and Management **RN-** registered nurse; **S-** severe; **TC-** trauma center; **TBI-** traumatic brain injury; **VPS -** Virtual Pediatric Systems

Citation	Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	LOE/ Decision for use/ Application to practice
							3: barriers & facilitators to implementation: CLs too long; not relevant to ICU patient diagnosis case mix; check list did not have quality gaps; brief CLs easier to implement; implementation supported when CL could evolve with changing needs; needs to be a combination of people understanding the CL & a short, simple, efficient CL to work Framework created for effective ICU rounding check lists	integrated with patient care

Key: ↑**-** increased; ↓**-** decreased; **A –** adherence; **Avg –** average; **BTF-** Brain Trauma Foundation; **CL-** checklist; **D –** days; **E-** early; **ECI –** enteral caloric intake; **ED –** emergency department; **EER –** estimated energy requirements; **EF-** enteral feed; **EIF-** early initiated feed; **EN-** enteral nutrition; **ERTEN-** early reached targeted enteral nutrition; **G-** guideline; **GA-** guideline adherence; **GCS –** Glasgow coma score **h-** hour; **ICP –** intracranial pressure; **ICU –** intensive care unit; **L-** late; **LIF-** late initiated feed; **LOE-** level of evidence **m-** mild; **M-** moderate; **N-** sample (population); **n**- sample size (studies); **P-** physician; **ped-** pediatric; **PICU-** pediatric intensive care unit; **PN-** parenteral nutrition; **PTAM –** Pediatric Trauma Assessment and Management **RN-** registered nurse; **S-** severe; **TC-** trauma center; **TBI-** traumatic brain injury; **VPS -** Virtual Pediatric Systems

Table A2

Evaluation Table Quantitative Studies

Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	LOE; Decision for use/ application to practice
Cifra et al. (2019). Prompting rounding teams to address a daily best practice checklist in a pediatric intensive care unit **Funding:** Grant received from the University of Iowa Stead Family Children's Hospital Stead Leadership Award. **Country:** US **Bias:** None	Relational Theory (inferred)	**Design:** Prospective cohort **Purpose:** To improve A to the rounding CL by implementing real-time audit & feedback by dedicated quality champion	N= 444 Time period: 1. N= 69 2. N= 133 3. N= 242 **Inclusions:** Intervention implemented for all patients age 0-21 years in a 20-bed PICU **Exclusions:** Patients with a hospital length of stay greater than the study period, patients readmitted to PICU during same hospital admission, patients transferred from another ICU **Attrition:** None	PICU rounding CL **3 time periods:** **1.** No CL: before implementation of CL (3 months – 12/1/12 to 2/28/13) **2.** No prompting: after implementation of CL but before real-time audit & feedback by dedicated PICU quality champion (4.5 months – 12/1/15 to 4/14/16) **3.** Prompting: after real-time audit & feedback by PICU quality champion to ↑ use of CL (4.5 months –	Chart review; staff survey with Likert scale; PICU quality champion participant in daily rounds	Descriptive data analysis Post hoc analysis Kruskal-Wallis Chi-square Fisher's exact tests Student's *t*- test Statistical analysis using Stata 12.1	No difference in mean rounding time per patient before & after prompting (8.4 vs 8.2 minutes p = 0.403), indicating prompting did not prolong rounds CL A improved from 75.7% to 86.6% after prompting started PICU & hospital length of stay ↓ across all time periods Time period & PICU length of stay (days): 1. 3 2. 2 3. 2 p = 0.08 Time period & hospital length of stay (days): 1. 8	**LOE:** III **Strengths:** Findings like other previous studies **Weaknesses:** Single-site study with no control group; short study periods; patients who were admitted & discharged within each time period; patients' severity of illness less after prompting started which could explain improvements in length of stay; catheter associated urinary tract infection reduction efforts were implemented during study period; fewer PICU staff responded to

Key: ↑- increased; ↓- decreased; **A –** adherence; **Avg –** average; **BTF-** Brain Trauma Foundation; **CL-** checklist; **D –** days; **E-** early; **ECI –** enteral caloric intake; **ED –** emergency department; **EER –** estimated energy requirements; **EF-** enteral feed; **EIF-** early initiated feed; **EN-** enteral nutrition; **ERTEN-** early reached targeted enteral nutrition; **G-** guideline; **GA-** guideline adherence; **GCS –** Glasgow coma score **h-** hour; **ICP –** intracranial pressure; **ICU –** intensive care unit; **L-** late; **LIF-** late initiated feed; **LOE-** level of evidence **m-** mild; **M-** moderate; **N-** sample (population); **n-** sample size (studies); **P-** physician; **ped-** pediatric; **PICU-** pediatric intensive care unit; **PN-** parenteral nutrition; **PTAM –** Pediatric Trauma Assessment and Management **RN-** registered nurse; **S-** severe; **TC-** trauma center; **TBI-** traumatic brain injury; **VPS -** Virtual Pediatric Systems

Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	LOE; Decision for use/ application to practice
				4/15/16-8/31/16)			2. 7 3. 5 $p = 0.02$ Prompting PICU rounding teams to address a daily best practice rounding CL improved some care outcomes Survey response: CL helped improve care for patients	2nd survey given, which may create bias **Application:** A dedicated quality champion may add value by auditing performance
Elke et al. (2016). Enteral versus parenteral nutrition in critically ill patients: An updated systematic review and meta-analysis of randomized controlled trials **Funding:** None **Country:** US **Bias:** Positive treatment effect of EN compared to	Relational theory (inferred)	**Design:** Systematic Review & meta-analysis **Purpose:** To perform an updated systematic literature review & meta-analysis to evaluate the effect of the route of nutrition (EN versus PN) on clinical outcomes in adult critically ill patients	n= 18 N= 3347 N EN= 1681 N PN= 1666 **Databases:** MEDLINE, Embase, CINAHL, Cochrane Library **Inclusions:** Type of study: RCT with parallel group	**IV-** EN, PN **DV-** clinical outcome Route of nutrition (EN versus PN) on clinical outcomes in adult critically ill patients	Article Review	Statistical analyses using RevMan 5.3 model Pooled risk ratio calculated with Mantel-Haenszel estimator Weighted mean difference estimated	No difference in overall mortality between EN or PN groups (RR 1.04, 95% CI 0.82, 1.33, $P = 0.75$, heterogeneity $I^2 = 11\%$) PN group received more calories than EN EN group ↓ in infectious complications compared to PN (RR 0.64, 95% CI	**LOE:** I **Strengths:** Comprehensive, up-to-date search of worldwide literature, without only English-written articles; inclusion of data from largest, most recent RCT **Weaknesses:** Missing outcome data points in some included trials; small number of aggregated trials

Key: ↑- increased; ↓- decreased; **A –** adherence; **Avg –** average; **BTF-** Brain Trauma Foundation; **CL-** checklist; **D –** days; **E-** early; **ECI –** enteral caloric intake; **ED –** emergency department; **EER –** estimated energy requirements; **EF-** enteral feed; **EIF-** early initiated feed; **EN-** enteral nutrition; **ERTEN-** early reached targeted enteral nutrition; **G-** guideline; **GA-** guideline adherence; **GCS –** Glasgow coma score **h-** hour; **ICP –** intracranial pressure; **ICU –** intensive care unit; **L-** late; **LIF-** late initiated feed; **LOE-** level of evidence **m-** mild; **M-** moderate; **N-** sample (population); **n-** sample size (studies); **P-** physician; **ped-** pediatric; **PICU-** pediatric intensive care unit; **PN-** parenteral nutrition; **PTAM –** Pediatric Trauma Assessment and Management **RN-** registered nurse; **S-** severe; **TC-** trauma center; **TBI-** traumatic brain injury; **VPS -** Virtual Pediatric Systems

Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	LOE; Decision for use/ application to practice
PN may be attributed to differences in caloric intake & significant publication bias among trials			Population: critically ill adult patients (≥ 18 years); ICU admit Intervention: enteral versus parenteral nutrition Trial outcomes: Primary outcome: overall mortality Secondary outcomes: ICU & hospital length of stay, duration of mechanical ventilations; ICU length of stay7 **Exclusions:** Patients not critically ill, no clinical outcomes meeting inclusion criteria reported, duplicate studies, reviews of published trials			by inverse variance Random effects model of DerSimonian & Laird Mantel-Haenszel X^2 test & I^2 statistic	0.48, 0.87, P = 0.004, heterogeneity I^2 = 47%) EN significant reduction in ICU length of stay (P = 0.003) Positive treatment effect on EN on infectious morbidity & ICU length of stay	with data on clinical endpoints ICU length of stay & mechanical ventilation duration; variation in reporting caloric intake; time of nutrition intervention; definitions used for infections; unable to separate effect of protein intake via both routes **Application:** EN should be considered first-line nutritional therapy in adult critically ill patients with functioning gastrointestinal tract

Key: ↑- increased; ↓- decreased; **A –** adherence; **Avg –** average; **BTF-** Brain Trauma Foundation; **CL-** checklist; **D –** days; **E-** early; **ECI –** enteral caloric intake; **ED –** emergency department; **EER –** estimated energy requirements; **EF-** enteral feed; **EIF-** early initiated feed; **EN-** enteral nutrition; **ERTEN-** early reached targeted enteral nutrition; **G-** guideline; **GA-** guideline adherence; **GCS –** Glasgow coma score **h-** hour; **ICP –** intracranial pressure; **ICU –** intensive care unit; **L-** late; **LIF-** late initiated feed; **LOE-** level of evidence **m-** mild; **M-** moderate; **N-** sample (population); **n-** sample size (studies); **P-** physician; **ped-** pediatric; **PICU-** pediatric intensive care unit; **PN-** parenteral nutrition; **PTAM –** Pediatric Trauma Assessment and Management **RN-** registered nurse; **S-** severe; **TC-** trauma center; **TBI-** traumatic brain injury; **VPS -** Virtual Pediatric Systems

Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	LOE; Decision for use/ application to practice
			or subgroups of included studies, non-randomized or pseudo-randomized study design, control group received a non-standard enteral formula **Attrition:** None					
Mehta et al. (2015). Adequate enteral protein intake is inversely associated with 60-d mortality in critically ill children: A multicenter, prospective, cohort study **Funding:** Internal grant from the Division of Critical Care Medicine at Boston Children's Hospital & a K24HD058795 National Institute of Health grant from the National	Relational theory (inferred)	**Design:** Prospective, cohort **Purpose:** To identify factors associated with optimal protein delivery in the PICU, (particularly the identification of modifiable bedside practices)	**N**= 1245 **Setting:** 59 PICUs worldwide **Inclusions:** PICU with ≥ 8 beds & dietician or individual with knowledge of clinical nutrition committed to data collection, children (1 month to 18 years) admitted to the PICU with anticipated stay > 48 h who required mechanical	**IV:** EN energy adequacy, EN protein adequacy **DV:** 60-day patient mortality **Nutritional variables:** Energy & protein goals prescribed by local nutrition team, actual daily macronutrient delivery achieved, route of delivery, frequency & duration of feeding interruptions, use of adjunctive drugs	Outcome data collected until 60 days after PICU admission Variables, data completeness, & logic checks put into remote data-collection tool & database	Descriptive Statistics Linear mixed-effects regression model Mann-Whitney *U* test Multivariable logistic regression model Wald's test Statistical analysis conducted	Protein under prescribed in 466 patients (37%) EN in 985 patients (79%) Patients receiving EN: Initiated by day 2 in 60% Initiated by day 3 in 80% EN interrupted at least once in 724 subjects (58%) Median duration of interruption was 8 h	**LOE:** III **Strengths:** The study emphasizes opportunities for improving protein prescription & delivery & the potential for improving clinical outcomes in this population; the largest multicenter study with this study purpose **Weaknesses:** study limited to PICUs with ≥ 8 beds, so observations may not be applicable to patients in smaller PICUs or those not

Key: ↑- increased; ↓- decreased; **A –** adherence; **Avg –** average; **BTF-** Brain Trauma Foundation; **CL-** checklist; **D –** days; **E-** early; **ECI –** enteral caloric intake; **ED –** emergency department; **EER –** estimated energy requirements; **EF-** enteral feed; **EIF-** early initiated feed; **EN-** enteral nutrition; **ERTEN-** early reached targeted enteral nutrition; **G-** guideline; **GA-** guideline adherence; **GCS –** Glasgow coma score **h-** hour; **ICP –** intracranial pressure; **ICU –** intensive care unit; **L-** late; **LIF-** late initiated feed; **LOE-** level of evidence **m-** mild; **M-** moderate; **N-** sample (population); **n-** sample size (studies); **P-** physician; **ped-** pediatric; **PICU-** pediatric intensive care unit; **PN-** parenteral nutrition; **PTAM –** Pediatric Trauma Assessment and Management **RN-** registered nurse; **S-** severe; **TC-** trauma center; **TBI-** traumatic brain injury; **VPS -** Virtual Pediatric Systems

Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	LOE; Decision for use/ application to practice
Institute of Child Health 7 Human Development **Country:** 15 countries (countries not listed) **Bias:** None			ventilatory support **Exclusions:** patients who were not ventilated within the first 48 h of admission to the PICU, on compassionate care toward the end of life, or enrolled in any other nutritional intervention trial **Attrition:** N = 82 (6.6%)			with IBM/SPSS	Significant association between adequacy of enteral protein intake & 60-d mortality ($P < 0.001$) Early initiation of EN is a predictor of optimal enteral protein intake Adequacy of enteral protein intake significantly associated with mortality in mechanically ventilated children	mechanically ventilated; accurate energy requirements for cohort could not be determined **Application:** Protein intake in the PICU can be optimized with early EN initiation, a ↓ duration of EN interruption
Meinert et al. (2018). Initiating nutritional support before 72 hours is associated with favorable outcome after severe traumatic brain injury in children: A secondary analysis of a randomized, controlled trial of	Relational theory (inferred)	**Design:** Secondary analysis of a Randomized Controlled Trial **Purpose:** To understand the relationship between the timing of initiation of nutritional support in	**N=** 90 **Setting:** 17 hospitals **Inclusions:** age < 18 years, post-resuscitation GCS ≤ 8, GCS motor score < 6, available to be randomized within 6 h after injury	Time of institution of nutritional support: the hour after the injury when EN or PN was started **Group 1:** No nutritional support over first 7 days **Group 2:** Nutritional support initiated < 48 h after injury	Information recorded into study database	Data analyzed with SAS v9.2 Chi-square tests Logistic regression models	Mortality rate in groups: Group 1: 60% Group 2: 6.3% Group 3: 11.1% Group 4: 17.6% E nutrition initiation associated with improved Glasgow outcome scale	**LOE:** II **Strengths:** Study adds to previous literature suggesting earlier initiation of nutritional support can be beneficial to children with S TBI **Weaknesses:** Database was not designed to gather

Key: ↑- increased; ↓- decreased; **A –** adherence; **Avg –** average; **BTF-** Brain Trauma Foundation; **CL-** checklist; **D –** days; **E-** early; **ECI –** enteral caloric intake; **ED –** emergency department; **EER –** estimated energy requirements; **EF-** enteral feed; **EIF-** early initiated feed; **EN-** enteral nutrition; **ERTEN-** early reached targeted enteral nutrition; **G-** guideline; **GA-** guideline adherence; **GCS –** Glasgow coma score **h-** hour; **ICP –** intracranial pressure; **ICU –** intensive care unit; **L-** late; **LIF-** late initiated feed; **LOE-** level of evidence **m-** mild; **M-** moderate; **N-** sample (population); **n-** sample size (studies); **P-** physician; **ped-** pediatric; **PICU-** pediatric intensive care unit; **PN-** parenteral nutrition; **PTAM –** Pediatric Trauma Assessment and Management **RN-** registered nurse; **S-** severe; **TC-** trauma center; **TBI-** traumatic brain injury; **VPS -** Virtual Pediatric Systems

Citation	Theory/ Conceptual Framework	Design/ Method	Sample/ Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis	Findings/ Results	LOE; Decision for use/ application to practice
therapeutic hypothermia **Funding:** National Institute of Neurological Disorders and Stroke; Society of Critical Care Medicine; National Institute of Child Health and Human Development; National Institutes of Health; Codman Neuro, National Center for Advancing Translational Sciences; Phoenix Children's Hospital; Adelson Medical Consulting; Thieme Publishing **Country:** US, Australia, New Zealand **Bias:** None		children with S TBI & outcomes	**Exclusions:** Normal head computerized tomography, GCS = 3, hypotension for > 10 minutes (5th % for age), uncorrectable coagulopathy, hypoxia (oxygen saturation < 90% for > 30 minutes), pregnancy, penetrating injury, unavailability of a parent or guardian to consent at centers without emergency waiver of consent **Attrition:** None	**Group 3:** Nutritional support initiated 48 - < 72 h after injury **Group 4:** Nutritional support initiated 72 h – 168 h after injury				information necessary to explore more detailed analyses of nutritional parameters of interest; could not determine the quantity or quality of macronutrients that was provided; unknown effects of hypothermia on nutritional requirements or the nutrition initiation timing; small sample size **Application:** Earlier initiation of nutritional support can be beneficial to children with S TBI

Key: ↑- increased; ↓- decreased; **A –** adherence; **Avg –** average; **BTF-** Brain Trauma Foundation; **CL-** checklist; **D –** days; **E-** early; **ECI –** enteral caloric intake; **ED –** emergency department; **EER –** estimated energy requirements; **EF-** enteral feed; **EIF-** early initiated feed; **EN-** enteral nutrition; **ERTEN-** early reached targeted enteral nutrition; **G-** guideline; **GA-** guideline adherence; **GCS –** Glasgow coma score **h-** hour; **ICP –** intracranial pressure; **ICU –** intensive care unit; **L-** late; **LIF-** late initiated feed; **LOE-** level of evidence **m-** mild; **M-** moderate; **N-** sample (population); **n-** sample size (studies); **P-** physician; **ped-** pediatric; **PICU-** pediatric intensive care unit; **PN-** parenteral nutrition; **PTAM –** Pediatric Trauma Assessment and Management **RN-** registered nurse; **S-** severe; **TC-** trauma center; **TBI-** traumatic brain injury; **VPS -** Virtual Pediatric Systems

Table A3

Synthesis Table

Author	Appen-teng et al.	Bagci et al.	Balak-rishnan et al.	Brolliar et al.	Canarie et al.	Cifra et al.	Elke et al.	Hallam et al.	Mehta et al.	Meinert et al.
Basics										
Year	2018	2018	2019	2016	2015	2019	2016	2018	2015	2018
Quantitative						X	X		X	X
Qualitative	X	X	X	X	X			X		
Design	SR	P, O	R, cohort	O, cohort	R, CS	P, cohort	SR & MA	O, cohort	P, cohort	SA of RCT
LOE	I	III	III	III	III	III	I	III	III	I
Study Characteristics										
N		95	416	129	444	444	3347	89	1245	90
n	17						18			
Age (years)	≤ 18	≤ 16	≤ 18	≤ 18	≤ 21	≤ 21	≥18	>18	≤ 18	<18
Setting	NA	PICU	PICU	ED & PICU in TC	PICU	PICU	ICU	ICU	PICU	PICU
TBI patients	X	X	X	X						X
Topic	TBI G	EN	EN	TBI GA	EN	R CL	EN	R CL	EN	EN
Interventions										
EIF		X	X		X		X		X	X
ERTEN		X								
R CL						X		X		
TBI Gs	X			X						

Key: ↑- increased; ↓- decreased; **CL-** checklist; **CS –** cross-sectional; **D/C –** discharge; **ED –** emergency department; **EIF-** early initiated feed; **EN-** enteral nutrition; **ERTEN-** early reached targeted enteral nutrition; **G-** guideline; **GA-** guideline adherence; **H –** hospital; **ICU –** intensive care unit; **LOE-** level of evidence; **LOS –** length of stay; **MA –** meta analysis; **N-** sample (population); **n-** sample size (studies); **NC –** no change; **O –** observational; **P –** prospective; **PICU-** pediatric intensive care unit; **QI –** quality improvement; **R –** retrospective; **RCT –** randomized controlled trial; **Retro-** retrospective; **R –** rounding; **SA –** secondary analysis; **SR –** systematic review; **TC-** trauma center; **TBI-** traumatic brain injury

Outcomes										
Morbidity							↓			
Mortality		↓	NC						↓	↓
H LOS			NC			↓				
ICU LOS			NC			↓	↓			
Complications					↓		↓			
QI	↑			↑				X		
Functional Status at D/C			↑							

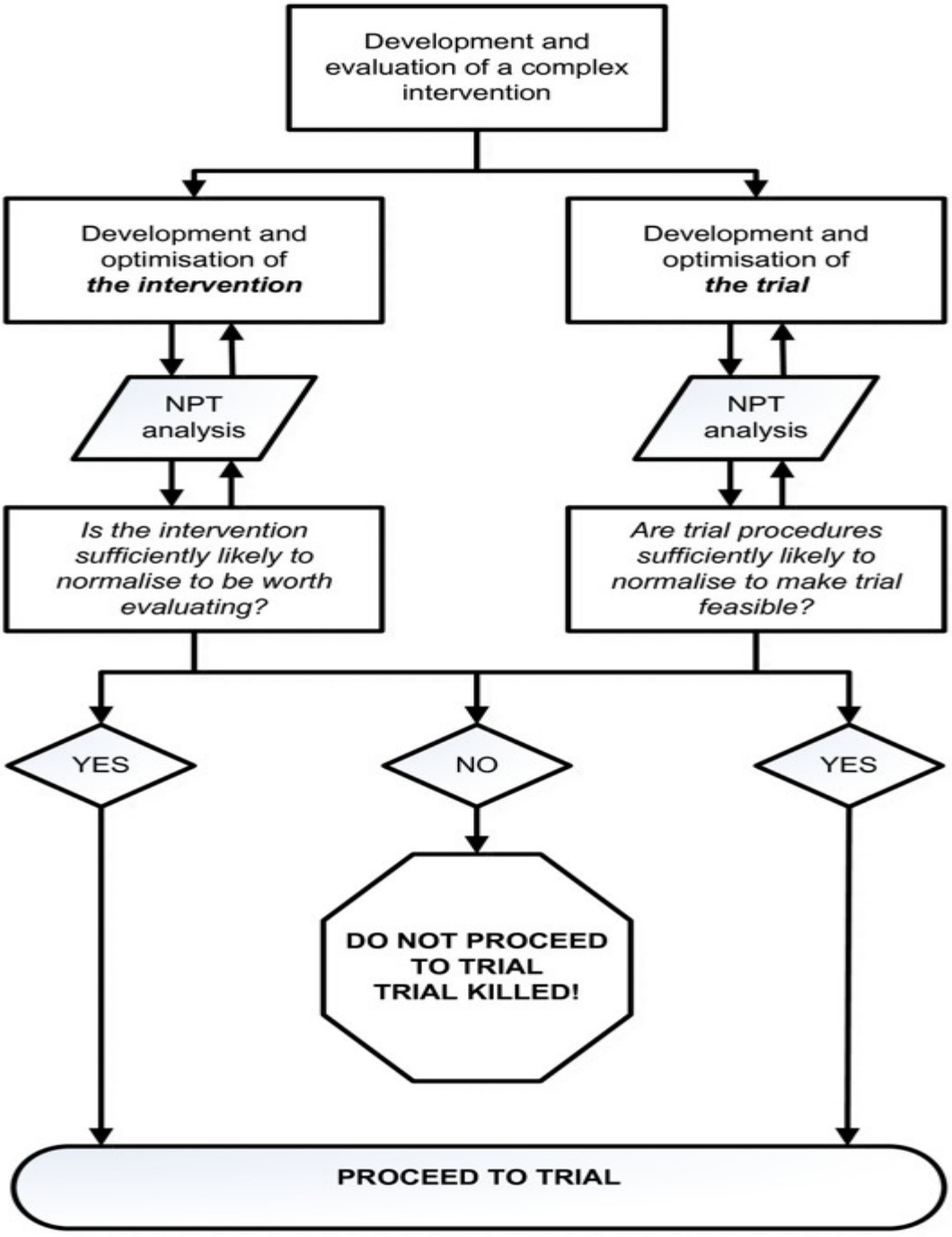
Key: ↑- increased; ↓- decreased; **CL-** checklist; **CS –** cross-sectional; **D/C –** discharge; **ED –** emergency department; **EIF-** early initiated feed; **EN-** enteral nutrition; **ERTEN-** early reached targeted enteral nutrition; **G-** guideline; **GA-** guideline adherence; **H –** hospital; **ICU –** intensive care unit; **LOE-** level of evidence; **LOS –** length of stay; **MA –** meta analysis; **N-** sample (population); **n**- sample size (studies); **NC –** no change; **O –** observational; **P –** prospective; **PICU-** pediatric intensive care unit; **QI –** quality improvement; **R –** retrospective; **RCT –** randomized controlled trial; **Retro-** retrospective; **R –** rounding; **SA –** secondary analysis; **SR –** systematic review; **TC-** trauma center; **TBI-** traumatic brain injury

Appendix B

Models, Frameworks, and Budget Plan

Figure 1

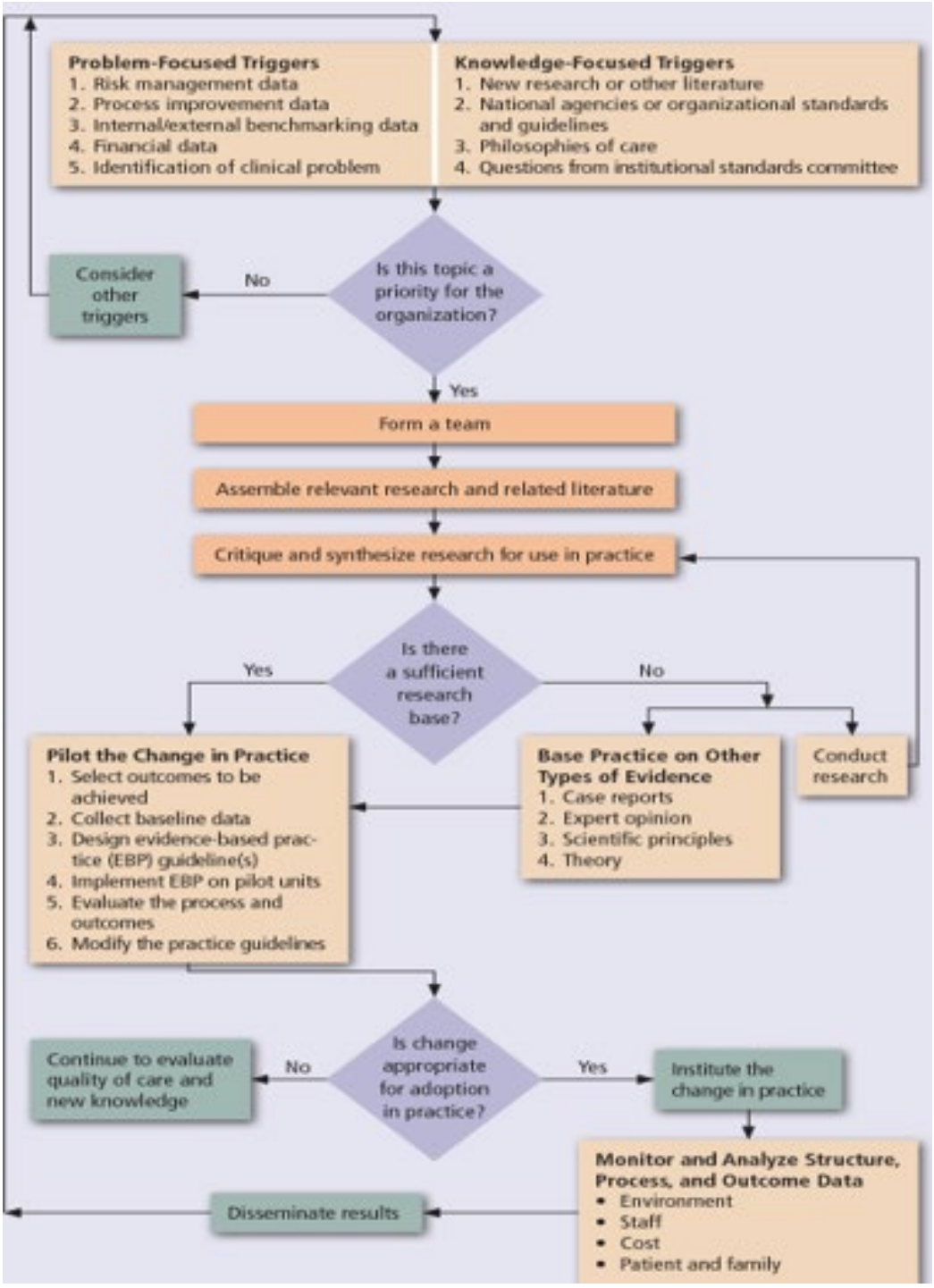
Normalization Process Theory Model



Murray (2010).

Figure 2

Iowa Model



Brown (2014).

Figure 3

Data Collection

FORM # __ __-__ __

	Completed date and time/shift	Date:			◻ Days (7am) ◻ Nights (7pm) ◻ Presented on rounds?
Events	Events from previous shift: ◻ Neuroimaging ◻ Neurosurgical intervention ◻ Any other trip off PICU ◻ Blood transfusion	Prophylaxis used: ◻ DVT prophylaxis – SCDs ◻ DVT prophylaxis – pharm			Description:
Tier 1	Enteral feeding? *Date and time initiated:	◻ No	◻ Yes	If no, provide brief rationale: ◻ TPN ◻ Interruptions? (i.e.: NPO for imaging) If yes: ◻ Advancing ◻ Trophic ◻ At goal	
Tier 1	Any instance of hypoxia? *(SpO2 < 94%)*	◻ No	◻ Yes, < 30 min	◻ Yes, > 30 min	Description:
Tier 1	Any instance of hypotension? *(See patient's order set for parameters)*	◻ No	◻ Yes, < 30 min	◻ Yes, > 30 min	Description:
Tier 1	Any instance of PaCO2 out of range? *(PaCO2 < 30 or > 40)*	◻ No	◻ Yes, < 30 min	◻ Yes, > 30 min	Description:
Tier 1	Maintaining temperature 36.5 – 37.5 °C	◻ No	◻ Yes	Description: ◻ Cooling device	
Tier 1	Any instance of fever? *(Temperature > 38.5 °C)*	◻ No	◻ Yes	◻ Medications used ◻ Persistent ◻ Brief	
Tier 2	Any instance of elevated ICP? *(ICP > 20 mmHg for > 5 min)* ◻ N/A – no ICP monitor	◻ No	◻ Yes	Select any interventions used to manage elevated ICP from previous shift: ◻ HOB 30-40° ◻ CSF drainage ◻ Hypertonic saline ◻ Mannitol ◻ Adequate sedation ◻ Neuromuscular blocking agent ◻ Barbiturates	
Tier 2	Any instance of decreased CPP? *(CPP < 40 mmHg for > 5 min)* ◻ N/A – no ICP monitor	◻ No	◻ Yes	◻ Fluid bolus ◻ Vasopressor ◻ Hypertonic saline	
Prevention	C-collar care bundle completed (see policy)	◻ No	◻ Yes	If no, provide brief rationale:	
Prevention	Repositioning every 2 hours ◻ Micro shifts only? ◻ Range of motion	◻ No	◻ Yes	If no, provide brief rationale:	
Prevention	Pulmonary hygiene VAP bundle compliant	◻ No	◻ Yes	If no, provide brief rationale:	

Print name of nurse completing form: _____ Thank you!!! -Holly, Megan, and Todd

Figure 4

Budget Plan

Funding				
Source				**Total**
In-kind support (*)				$3,771.50
Expenses				
Phase	**Activities**	**Cost**	**Subtotal**	**Total**
Preparation	**Direct Cost Activities**			
	Design and develop video of nurse-led checklist presentation (equipment supplied by film students; $20/hr per student x2 students, x3 hours)	$120		
	Design and develop online education PowerPoint modules (computer, time of trauma APRN and site champion) estimated 20 hours @ avg. $44.71/hr	$894.20		
	Design and develop online pre- and post-intervention surveys (computer, time of trauma APRN and site champion) estimated 4 hours @ avg. $44.71/hr	$178.84		
	Design and develop TBI checklist (computer, time of trauma APRN and site champion) estimated 12 hours @ avg. $44.71/hr	$536.52		
	Copies – 100 copies of checklist, 125 copies each of pre- and post-intervention surveys = 350 copies $0.09 ea.	*$31.50		
	Indirect Cost Activities			
	PICU educator recruiting participants estimated 2 hours @ $36.84/hr	$73.68		
	Trauma APRN recruiting participants estimated 2 hours @ $48.07/hr	$96.14		
	Project site champion time spent at meetings estimated 10 hours @ $41.34/hr	$413.41		
	Trauma APRN time spent at meetings estimated 10 hours @ $48.07/hr	$480.70	**$2,824.99**	
Delivery	**Direct Cost Activities**			
	Rent conference rooms at PCH for education days (avg. $115 per hour x6 hours)	*$690		
	Computer and projector	*$2,450		
	Refreshments, snacks ($100 per education day x6 days)	*$600		

	Indirect Cost Activities			
	Education to PICU nurses while on shift (avg. RN hourly wage $36.11 x 95 nurses x 2h)	$6,860.90		
	Education to providers while on service (avg. PICU attending hourly wage $111.91 x 12 attendings x1 h; avg. APRN hourly wage $48.07 x 5 APRNs x 1h)	$1,583.27		
	Education to PICU dieticians while on shift (avg. hourly wage $26.46 x 2 dieticians x 1h)	$52.92	**12,237.09**	
Evaluation	**Direct Cost Activities**			
	Review and analysis of results (statistician fixed rate)	$400	**$400**	15,462.08
				$15,462.08 - 3,771.50 (In-kind support) **$11,690.58**