Injury, Int. J. Care Injured 45 (2014) 1350–1354

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

A standardized trauma care protocol decreased in-hospital mortality of patients with severe traumatic brain injury at a teaching hospital in a middle-income country

Matthew R. Kesinger [a,*], Lisa R. Nagy [b], Denisse J. Sequeira [c], Jose D. Charry [d], Juan C. Puyana [b], Andres M. Rubiano [d]

[a] University of Pittsburgh School of Medicine, United States
[b] University of Pittsburgh School of Nursing, United States
[c] University of Pittsburgh, United States
[d] Universidad Surcolombiana, Colombia

ARTICLE INFO

Article history:
Accepted 18 April 2014

Keywords:
Quality improvement in LMIC
Trauma
Severe TBI
Outcomes

ABSTRACT

Introduction: Standardized trauma protocols (STP) have reduced morbidity and in-hospital mortality in mature trauma systems. Most hospitals in low- and middle-income countries (LMICs) have not implemented STPs, often because of financial and logistic limitations. We report the impact of an STP designed for the care of trauma patients in the emergency department (ED) at an LMIC hospital on patients with severe traumatic brain injury (STBI).

Methods: We developed an STP based on generally accepted best practices and damage control resuscitation for a level I trauma centre in Colombia. Without a pre-existing trauma registry, we adapted an administrative electronic database to capture clinical information of adult patients with TBI, a head abbreviated injury score (AIS) $\geq$3, and who presented $\leq$12 h from injury. Demographics, mechanisms of injury, and injury severity were compared. Primary outcome was in-hospital mortality. Secondary outcomes were Glasgow Coma Score (GCS), length of hospital and ICU stay, and prevalence of ED interventions recommended in the STP. Logistic regression was used to control for potential confounders.

Results: The pre-STP group was hospitalized between August 2010 and August 2011, the post-STP group between September 2011 and June 2012. There were 108 patients meeting inclusion criteria, 68 pre-STP implementation and 40 post-STP. The pre- and post-STP groups were similar in age (mean 37.1 vs. 38.6, $p = 0.644$), head AIS (median 4.5 vs. 4.0, $p = 0.857$), Injury Severity Scale (median 25 vs. 25, $p = 0.757$), and initial GCS (median 7 vs. 7, $p = 0.384$). Post-STP in-hospital mortality decreased (38% vs. 18%, $p = 0.024$), and discharge GCS increased (median 10 vs. 14, $p = 0.034$). After controlling for potential confounders, odds of in-hospital mortality post-STP compared to pre-STP were 0.248 (95%CI: 0.074–0.838, $p = 0.025$). Hospital and ICU stay did not significantly change. The use of many ED interventions increased post-STP, including bladder catheterization (49% vs. 73%, $p = 0.015$), hypertonic saline (38% vs. 63%, $p = 0.014$), arterial blood gas draws (25% vs. 43%, $p = 0.059$), and blood transfusions (3% vs. 18%, $p = 0.008$).

Conclusions: An STP in an LMIC decreased in-hospital mortality, increased discharge GCS, and increased use of vital ED interventions for patients with STBI. An STP in an LMIC can be implemented and measured without a pre-existing trauma registry.

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Introduction

Injury is a major health problem on a global scale, leading to approximately 5.8 million deaths worldwide each year and causing disability in millions more [1]. Ninety percent of trauma deaths occur in low- and middle-income countries (LMICs) [2]. Nearly 2,000,000 lives could be saved annually in LMICs through improvements in global trauma care [3].

* Corresponding author at: University of Pittsburgh, Department of Surgery, 200 Lothrop Street, Suite F1263.3, Pittsburgh, PA 15213, United States. Tel.: +1 2143948860.
E-mail addresses: kesingermr2@upmc.edu, matthewryankesinger@gmail.com (M.R. Kesinger), lisarnagy7@gmail.com (L.R. Nagy), Des103@pitt.edu (D.J. Sequeira), danielcharry06@hotmail.com (J.D. Charry), puyajc@upmc.edu (J.C. Puyana), rubianoam@gmail.com (A.M. Rubiano).

http://dx.doi.org/10.1016/j.injury.2014.04.037
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The burden of traumatic brain injury (TBI) is disproportionally high in LMICs, especially in Latin America [4,5]. There are many factors that contribute to this, one of which is a lack of adherence to evidence-based practices. Trauma centres in high-income countries are often required by governmental accreditation agencies to ensure that all emergency medical physicians and trauma surgeons maintain active certification of training and competences from an organization that offers continued medical education in the care of trauma patients [6]. The Advanced Trauma Life Support (ATLS) course, created by the Committee on Trauma of the American College of Surgeons, has become the most used and recognized certification and has been advocated as the "gold standard" in basic trauma care in USA and Europe as well as several other countries. Though there is no Class I evidence (RCT trials), studies performed on the effectiveness of teaching and using such standardized trauma care protocols have shown improved patient outcomes and indirect measures associated with improved outcomes in both mature trauma systems as well as a in LMICs [7–12].

Several assessments of trauma systems in LMICs have found that a significant number of the physicians caring for the injured have not had adequate training and have never completed a certification such as ATLS or similar courses. These assessments have generated recommendations calling for increased training in either ATLS or similar education that teaches the fundamentals of trauma care in a methodical and systematic way [13–18]. Unfortunately, the financial and logistic burdens associated with offering ATLS certification in LMICs have constituted a significant barrier to extend physician training in much of the world where it is most needed [2,13,16–18]. For instance, in the hospital where our study took place, a physician would have to travel to the capital city and pay approximately one month's salary to become certified in ATLS.

On September 1, 2011, Neiva University Hospital (NUH), in Neiva, Colombia instituted system-wide changes in the emergency department (ED) as part of a trauma quality improvement initiative. Drawing on military trauma care protocols designed for austere environments, as well as generally accepted best practices in trauma care [19,20], a set of evidence based algorithms for the initial care and resuscitation of injured patients was developed, adapted and customized to the resources available at NUH. Collectively, we refer to the algorithms as a standardized trauma protocol (STP). The STP described and standardized treatments for patients with severe trauma from the time of arrival at the ED until the time of ED departure to either the operating room or the intensive care unit (ICU). Examples of specific standardizations include the use of arterial blood gas tests to guide transfusion decisions, medication choices in rapid intubation, small volume resuscitation, requiring physician presence in intra-hospital transportation of severely injured patients, and the use of a short checklist in the trauma bay, among others. The implementation was preceded by two courses designed to teach the STP to all physicians in the ED with half of the providers participating in each course. There were no changes in physical or human resources in the ED or anywhere else in the hospital during the study period. The STP was only applicable to the ED.

We hypothesized that after implementation, there would be increased utilization of ED interventions recommended in the STP, decreased in-hospital mortality, and decreased length of hospital stay (LOS). Here we examined those outcomes in patients with severe traumatic brain injury (STBI) before and after STP implementation.

Materials and methods

Approval from the NUH quality improvement office was obtained prior to STP implementation. Approval from the institutional review boards of NUH and the University of Pittsburgh was obtained prior to conducting this retrospective study.

Patient population

NUH is a 504 bed, level I trauma centre and tertiary referral hospital in southern Colombia. NUH admits approximately 2000 adult trauma patients per year and has 30 adult ICU beds. The hospital is the primary trauma centre for 3.2 million inhabitants living in an area extending over 60,000 square miles. Its radius of care extends far into the Amazonian region, where the most intense fighting between rebel groups, cocaine traffickers and government forces has taken place for over 40 years.

At this institution, patients are treated in the adult ED if they are over 13 years of age. Patients were included in the study if they were 14 years or older, had an ICD-10 diagnosis indicating TBI, had an Abbreviated Injury Score (AIS) $\geq$3, presented within 12 h of injury, and had been treated in the ICU between August 2010 and June 2012. Criteria for ICU admission at NUH include GCS $\leq$ 8, cervical spinal cord injury, respiratory failure requiring mechanical ventilation, patients requiring dialysis, shock, sepsis, hepatic failure or pancreatic failure.

A GCS $\leq$ 8 is the most common way of defining STBI. GCS is a measure of unconsciousness, however, and part of the reason it is so widely accepted is because it is easy to use and there is low inter-rater variability [21]. Furthermore, GCS cannot control for confounding associated with non-traumatic causes of decreased brain function, including alcohol, drugs, sedatives used in initial hospitals before transport to trauma centre, shock, extreme hypoxia, hypoglycemia, and metabolic acidosis. Multiple injured patients may present with a low GCS in the setting of only minor head trauma, for instance in the setting of an assault with blunt trauma to the head and penetrating trauma to other body regions causing hypovolemic shock. This is a common presentation in locations with endemic violence like Neiva. Finally, large retrospective trials have shown potential difficulties when using GCS to define STBI in multiple injured patients [22,23], which was a very common presentation in this study cohort. Only detailed medical records or robust trauma registries with dedicated full-time employees, which do not exist in LMICs, can control for this confounding. AIS, however, was obtained based on injury description and diagnostic imaging which is present and recorded at NUH.

Data source

This was a retrospective cohort study. Injury severity, patient demographics, mechanism of injury, LOS and in-hospital mortality were determined by chart review. Like most LMIC trauma centres, there was no trauma registry at NUH. Therefore we identified an electronic database within NUH designed for tracking financial information. In fact, a growing number of hospitals in middle-income countries have begun to use electronic databases to manage financial records before implementation of any other form of electronic medical records. At NUH, these records include fee-for-service scheduling for all supplies and procedures. The same service may cost a different amount depending on the location of use—e.g., bladder catheterization in the ICU vs. bladder catheterization in the ED—and therefore the location of all billable materials is included. In this study, we were able to use these distinctions to obtain information about interventions used in the ED pre- and post-implementation of the STP.

Records were analyzed for all patients who met inclusion criteria to determine trends in mortality, LOS, and the prevalence of interventions between the pre- and post-STP groups. The frequency of blood transfusions, arterial blood gas draws, catheterization of the bladder, use of hypertonic fluids, use of prophylactic antibiotics, administration of the tetanus vaccine in the case of penetrating trauma, use of early analgesics, and spinal immobilization were examined in the pre-STP and post-STP

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