

A Review of Head Trauma at Columbus Children's Hospital: Perspectives from Pre- and Post-level 1 Trauma Center Certification

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Abstract

Introduction: Historically, head trauma has accounted for a significant portion of trauma admissions to both neurosurgical services and hospitals in general. This study compares pediatric head trauma mortality at a single institution over six decades and through the transition from Level II to Level I pediatric trauma center status.

Methods: Retrospective chart review of the Columbus Children's Hospital Trauma Registry compared pediatric head trauma data at Columbus Children's Hospital from the following three five-year blocks, defined as periods 1, 2 and 3 respectively: 1958-1962, 1978-1982, and 2000-2004. Analysis of the data is made within each period and trends are defined with respect to diagnoses, mortality, and vulnerability of gender.

Results: The following trends were noted: (1) a significant increase in major traumatic head injury admissions in Period 3 after obtaining Level I trauma center designation, (2) a significant decrease in mortality rate of major head trauma between periods 1 and 2, but no change between periods 2 and 3, and (3) early parity in head injury incidence between genders in Periods 1 and 2, with development of a significant male predominance in Period 3.

Conclusion: Transitioning from Level II to Level I pediatric trauma center status correlated with a significant increase in pediatric head trauma admissions in this particular market. Although there have been significant decreases in mortality secondary to head trauma for various reasons between 1958 and 1978, there has been little change between 1978 and 2004 at the facility being studied despite transitioning from a Level II to Level I pediatric trauma center during that time period. There was a significant male predominance to sustain head trauma as compared to females in the most recent time period.

Keywords: Pediatric, Traumatic brain injury, Trauma, Head trauma, Level 1, Subdural hematoma, Epidural hematoma, Skull fracture

Introduction

The most efficacious pre-hospital care, acute in-hospital care, and long term rehabilitation methodologies for pediatric patients suffering from traumatic brain injury is an area of research interest. While the trauma center designation process is developed at either the state or local level, The American College of Surgeons (ACS) has created a set of guidelines, which includes recommendations pertaining to both adult and pediatric in-hospital trauma resources, that assists in assigning the various trauma center level designations. Hospitals interested in pursuing advanced trauma center designations will typically undergo ACS site visits in which the presence of the recommended resources commensurate with the desired trauma level designation will be verified [1,2].

According to the ACS, Level I is the most advanced trauma center, as it designates a tertiary care facility providing total care ranging from prevention to rehabilitation of patients. Level I Trauma Center designation includes "24-hour in-house coverage by general surgeons,

and prompt availability of care in specialties" such as orthopedic surgery, neurosurgery, anesthesiology, emergency medicine, radiology, critical care, internal medicine, plastic surgery, oral and maxillofacial care, and pediatric care as well as "helicopter landing capabilities approved by state and federal authorities" to accept incoming trauma transfers [1,2]. Besides availability of medical expertise and resources, the Level 1 trauma designation also involves continuous trauma care and awareness focused education of staff, residents, and the surrounding communities along with persistent trauma focused research efforts. Level I trauma centers subject themselves to frequent and comprehensive quality assessment programs, directed to ensure the usage of updated technology and resources, as well as the maintenance of surgeon competence. Trauma surgeons at this particular level are required to receive continuous medical education, in addition to initial certifications by the medical board.

Despite the strict protocol of trauma centers to preserve their Level I designations, there is debate as to whether there is a marked difference in outcomes between Level I and Level II trauma designations in regards to general trauma and traumatic brain injury in particular [3-7]. While there are many similarities between Level I and II trauma center designations, including in-house general surgery presence with

prompt availability of sub-specialists, there are also some key differences mainly in trauma volume, teaching institution status, community outreach, and research requirements [8].

DuBose et al. noted that trauma patients admitted to a Level II trauma center had a mortality rate of 13.9%, whereas those admitted to a Level I Trauma Center had a mortality rate of 9.6%, which remained statistically significant after controlling for other variables [5]. Based on a retrospective review of the National Trauma Data Bank encompassing 130,154 patients, those with an Injury Severity Score (ISS) >15 that were treated at Level I trauma centers had significantly lower mortality when compared to those treated at Level 2 trauma centers [4]. A retrospective review of 208, 866 patients from the Pennsylvania Trauma Outcomes Registry admitted to Level I and Level II trauma centers supported the tiered designation system for trauma centers given the 15% lower risk for mortality of those admitted to Level I centers (Glance et al.). It should be noted that the difference in mortality risk between Level I and II centers was insignificant in those with lesser traumatic injuries (ISS < 15) [7]. This trend of improved outcomes at Level I trauma centers is not completely consistent across the literature. A retrospective review of the North Carolina Trauma Registry compared the outcomes of patients at Level I and II trauma centers treated for four specifically morbid traumatic injuries (thoracic aortic disruption, liver lacerations, pulmonary contusions, and pelvic fractures) and found no significant difference in mortality rates between the two facilities. A separate retrospective review of 140, 691 trauma patients in Pennsylvania showed no significant difference in mortality rates between Level I and II trauma centers and noted variability between facilities suggesting that factors other than those required to obtain Level I status, including age of the trauma system, play a part in mortality outcomes [8]. Future contributions to the literature will continue to investigate the effects of trauma center designation status on outcomes and mortality.

The ACS has separate trauma center level designations for adult and pediatric trauma centers given the different expertise and resources required for optimal care of the pediatric population [1]. As with adult trauma center level designation, there are strong requirements for neurosurgical expertise and availability in the ACS guidelines for pediatric trauma level designations given the acuity and significance of pediatric neuro trauma in general, and traumatic brain injury in particular [2]. As with adult trauma, there is also some debate as to the outcome of pediatric brain injury based on the trauma level designation of the admitting institution. Given that the major difference between Level 1 and 2 trauma designations are based on volume, teaching institution status, and research but the sub-specialties required by the ACS are available at both Level 1 and 2 centers, it is prudent to investigate differences in outcomes between centers [1]. Given the fact that 25% of the U.S. population lives in a county without a neurosurgeon and 44% of practicing neurosurgeons are over age 55, this question is especially pertinent from a public health perspective as clinical equipoise between neuro trauma outcomes at Level 1 and 2 trauma centers would provide a great logistical advantage for distributing the burden of trauma care, especially in less populated areas of the country [9]. In an attempt to provide clarification on this issue, this retrospective case review of patients at Columbus Children's Hospital (now Nationwide Children's Hospital) investigates mortality rates in pediatric head injury compared across several decades and the transition from Level I to Level II pediatric trauma center designations.

Methods

A review of the Columbus Children's Hospital was conducted and all traumatic brain injuries including intra parenchymal hemorrhage, subdural hematoma, epidural hematoma, diffuse axonal injury and depressed skull fractures were identified and recorded in an Excel spreadsheet. The data was divided into three periods of five-year blocks (Period 1: 1958-1962; Period 2: 1978-1982; and Period 3: 2000-2004), with Period 3 representing the post-Level I trauma certification era (Figure 1). Analysis of the data collected by the Columbus Children's Hospital Trauma Registry was done with respect to diagnoses, mechanisms of injury, mortality, gender predilection. All patients meeting study criteria within the specified time frame were included in the data set; thereby, extending the study's external validity. The population included all patients less than 18 years old. Frequency distributions and summary statistics were used to describe mortality. Comparisons between groups were performed using simple graphic representations.

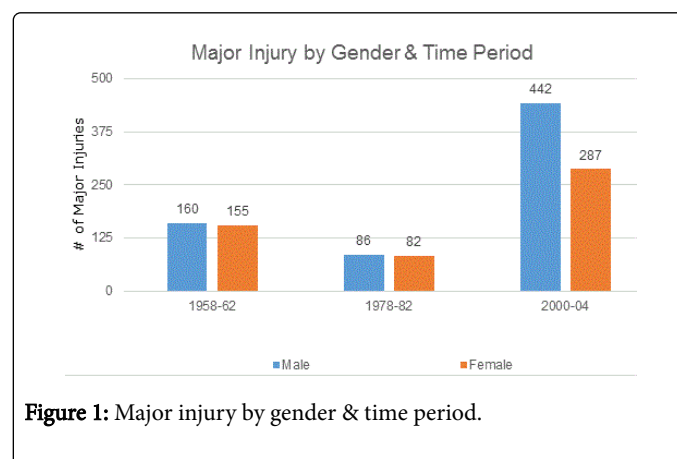


Figure 1: Major injury by gender & time period.

Results

There was a predilection for males to suffer head trauma more frequently than females in period 3, while there was near parity in earlier periods. From period 1 to period 2, there was an almost 50% decrease in the incidence of brain injury followed by an almost 5x increase in period 3. There was a significant increase in mortality per diagnosis from period 2 to period 3 for subdural hematoma, intra cerebral hemorrhage, diffuse axonal injury, and depressed skull fracture, while mortality from epidural hematoma remained relatively stable (Figures 2 and 3). There was a decrease in mortality rate from period 1 (16%) to period 2 (9.3) and virtually no change in period 3 (9.4%).

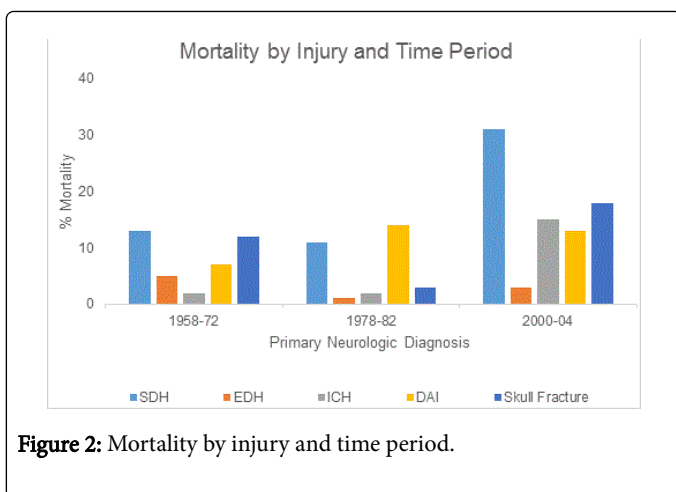


Figure 2: Mortality by injury and time period.

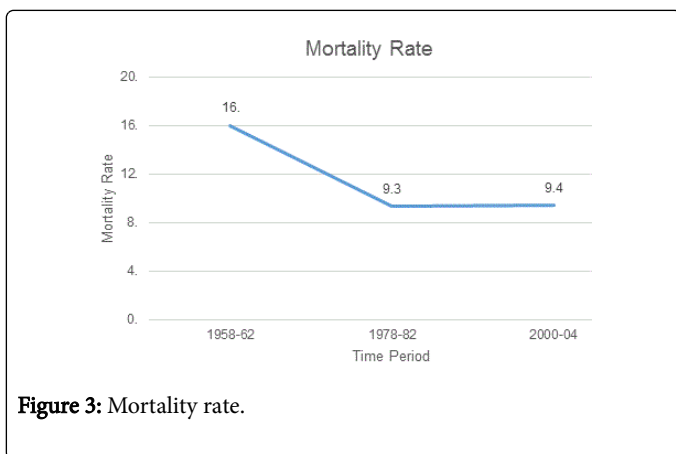


Figure 3: Mortality rate.

Discussion

This retrospective review was conducted with the goal of examining changes in pediatric head trauma mortality over time. A secondary aim was determining the effect of transitioning from Level II to Level I pediatric trauma center status on mortality secondary to pediatric head trauma. This review encompassed patients over a wide time period ranging from 1958 through 2004, which undoubtedly includes many improvements in the management of traumatic brain injury. There was a significant decrease in mortality from pediatric head injury between 1958 and 1982. That being said, the mortality between 1982 and 2004 due to head injury changed very little. This is an interesting finding, as the Columbus Children's Hospital transitioned from a Level II to Level I pediatric trauma center during this period. It can be hypothesized that the decreased mortality rates between Period 1 and Period 2 are partly due to a series of technological advances and widespread introduction of advanced imaging techniques allowing

more accurate and prompt diagnosis/monitoring, rather than administrative changes. While some of the literature cites increased exposure to specific trauma pathologies as a likely reason for the improved outcomes at Level I trauma centers, the results of this study show that despite increases in major head trauma admissions under the Level I designation in Period 3, head injury mortality rates did not improve at the institution.

At this point, it is unclear if a Level I trauma center designation correlates with improved pediatric head trauma outcomes as compared to Level II facilities. Given the paucity of both Level I trauma centers and neurosurgeons that treat pediatric neuro trauma across large portions of the country, further investigation into this subject may be warranted. Given that some studies have found parity in general trauma outcomes between certain Level I and II trauma centers, further investigation into the factors that improve outcomes, other than those required to obtain Level I status, is warranted. Many factors, including volume of trauma, type of trauma, experience of staff physicians and nursing staff, quality of local EMS services, hospital infrastructure, local socioeconomic factors and access to government and community services may all play a part in the final outcomes of trauma patients, regardless of the specific facilities trauma center designation. Despite the evolution of large scale administrative changes to trauma centers around the world, further study is warranted as to the impact of these changes on mortality in patients, both pediatric and adult, presenting with traumatic brain injury.

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