Delay in Arrival to Care in Perpetrator-Identified Nonaccidental Head Trauma: Observations and Outcomes

Sudhakar Vadivelu[1], Debra Esernio-Jenssen[2], Harold L. Rekate[1], Raj K. Narayan[1], Mark A. Mittler[1], Steven J. Schneider[1]

■ BACKGROUND: **Children who sustained nonaccidental head trauma (NAHT) are at severe risk for mortality within the first 24 hours after presentation.**

■ OBJECTIVE: **Extent of delay in seeking medical attention may be related to patient outcome.**

■ METHODS: **A 10-year, single-institution, retrospective review of 48 cases treated at a large tertiary Children's Hospital reported to the New York State Central Registrar by the child protection team was conducted. The perpetrator was identified in 28 cases on the basis of confession or conviction. The medical and legal records allowed for identification of time of injury and the interval between injury and arrival to the hospital; this information was categorized as follows: <6 hours (without delay); 6–12 hours (moderate delay); and >12 hours (severe delay). The King's Outcome Scale for Childhood Head Injury (KOSCHI) score was recorded for each case.**

■ RESULTS: **All children were 3 years of age or younger (2.1–34 months) and predominantly male (68%; 19/28). On arrival, 61% of patients (17/28) presented with moderate or severe delay. A low arrival Glasgow Coma Scale (GCS) score ($P < 0.0001$) and extracranial injuries ($P < 0.0061$) correlated with worse clinical patient outcomes. Patients with an arrival GCS score <7 predominantly arrived without delay or with moderate delay. Patients presenting without delay or with severe delay were more likely to have a higher KOSCHI outcome score on discharge ($P < 0.0426$). Four of the 6 patients who died presented after moderate delay.**

■ CONCLUSION: **Patients presenting to medical care 6–12 hours after NAHT (moderate delay) appeared to have worse outcomes than those presenting earlier or later.**

INTRODUCTION

Compared with adults, the immature brain's response to traumatic brain injury—principally those with inflicted injuries—demonstrates particular vulnerability (7). The injury itself evolves quickly from a combination of threats including angular forces from shaking episodes, hypoxia, and blunt trauma (5, 7, 15). The severity of brain response to nonaccidental head trauma (NAHT) accounts for 86% mortality with more than half of the mortalities occurring within the first 24 hours. The acute period becomes increasingly important as only 17% of those mortality cases arrived within 3 hours and 31% after 6 hours post injury (with delay) (11). This time in presentation delay may represent an identifiable factor affecting outcomes, as seen in both adult and pediatric stroke (2, 16). Previous data reporting higher NAHT mortality after 6 hours and treatment guidelines in stroke suggest delay in arrival, in part, may help in recognizing those with an increased chance of survival >24 hours.

Despite the initial history and confession generally observed to be limited or erroneous (1, 18) and the unreliability of computed tomography (CT) scans in predicting the time of injury, Willman et al. (21) determined the time of injury to be restricted to the immediate time after the last observed "period of wellness" (21).

Key words
- Child abuse
- Decompressive craniectomy
- Hypoxic - ischemic stroke
- Inflicted head injury
- Shaken baby
- Traumatic brain injury

Abbreviations and Acronyms
CNS: Central nervous system
CPCT: Child protection consultation team
GCS: Glasgow Coma Scale
KOSCHI: King's Outcome Scale for Childhood Head Injury
NAHT: Nonaccidental head trauma

From the [1]The Cushing Neuroscience Institutes and the Department of Neurosurgery, Hofstra North Shore—Long Island Jewish School of Medicine at Cohen Children's Medical Center and the North Shore—Long Island Jewish Health System, Manhasset, New York, USA; and [2]Department of Pediatrics, University of Florida School of Medicine at Shands Children's Hospital, Gainesville, Florida, USA

To whom correspondence should be addressed: Sudhakar Vadivelu, D.O. [E-mail: sudhakar.vadivelu@cchmc.org]

Drs. Mitter and Schneider contributed equally to this study.

Citation: World Neurosurg. (2015) 84, 5:1340-1346.
http://dx.doi.org/10.1016/j.wneu.2015.06.023

Journal homepage: www.WORLDNEUROSURGERY.org

Available online: www.sciencedirect.com

In 1995 report, Starling et al. (18) found 97% of identified perpetrators were present at symptom onset. When analyzing the confessions of identified perpetrators further, Starling et al. (19) in 2004 found symptoms appeared immediately after injury and this was irrespective of the mechanism of shaking and/or impact as contributory. Though less reliable than time of injury reported in accidental head trauma cases, Vinchon et al. incorporated this method for demonstrating a trend of longer delay in arrival to medical care with NAHT versus accidental cases, but with sooner observation toward elevated intracranial pressure in the NAHT group (20), suggesting importance to examining time delay in relation to neurologic compromise. In this study, cases with identified perpetrators were included to identify documented time of injury and to hypothesize that the time delay in arrival to care played an important role in overall patient neurologic outcome upon discharge. An a priori temporal profile based on data from NAHT mortality reports and stroke treatment guidelines was evaluated against perpetrator-identified cases included here. This profile of delay in arrival to medical attention is labeled as follows: without delay (0–6 hours), moderate delay (6–12 hours), and severe delay (>12 hours).

METHODS

A retrospective review of charts of all patients evaluated by the medical child protection consultation team (CPCT) and reported to the New York State Central Register over a 10-year span, with approval from the Institutional Review Board, was conducted. The total number of NAHT patients registered included 48 cases. Inclusion criteria enlisted cases where the perpetrator was specifically identified by the Child Protection Services of Nassau and Suffolk Counties and the boroughs ofBrooklyn and Queens and considered a primary suspect in trial for criminal investigation or was convicted by the local/state law enforcement agencies (8). Fourteen cases were excluded because of failure to identify the perpetrator or lack of availability of the chart for review at the time of the study. Twenty-eight cases met the criteria and were included in this study.

Symptom onset and reported time of injury was identified as the time of injury ictus similar to previous studies evaluating identified perpetrator confessions (18, 19, 21). The recorded pediatric emergency department (ED) triage time was identified as the arrival time to medical care. The elapsed time was then categorized into the following temporal classification: 1) No delay 0–6 hours, 2) Moderate delay 6–12 hours, and 3) Severe delay >12 hours. Categorization of time is based on delay in pediatric acute ischemic stroke studies evaluating demonstrating diagnosis and treatment importance within 6 hours (our no-delay group listed in our current study) (2, 16). Only admission Glasgow Coma Score (GCS) scores were recorded from initial ED trauma assessments or emergency medical services' evaluations as modified childhood GCS scores were not identified in all cases included in this study.

Outcomes were assessed on the basis of the following variables: serial imaging, in-hospital morbidity, and neurosurgical interventions. Outcomes were graded on discharge using the King's Outcome Scale for Closed Head Injury (KOSCHI) where a score of 1 = death, 2 = vegetative state, 3 = severe disability, 4 = moderate disability, and 5 = good recovery (4). These outcome scores were collected from archived discharge summaries and recorded and single-blinded from delay in arrival classification of respective cases.

Statistical assessments were performed by the Feinstein Institute Biostatistics Unit. Univariate analyses were performed and included the following variables: patient age, gender, admission delay, neuroimaging findings, operative intervention, GCS, KOSCHI score, and extracranial injuries. A multivariate analysis was not performed due to the limited number of cases included in the study. For statistical purposes, scores were graded in nonparametric ranks to preserve the order of the scoring. A Kruskal–Wallis test or Mann–Whitney test was used to test all univariate analyses, and a side-by-side box plot was generated to illustrate statistical findings. The GCS and KOSCHI score analysis was compared for spearman correlation. A P value of less than 0.05 was considered significant. SAS 9.2 statistical software (SAS Institute, Inc., Cary, North Carolina, USA) was used for all data evaluation.

RESULTS

Patient and Perpetrator Characteristics

We reviewed 28 children with a diagnosis of nonaccidental head trauma in which the perpetrator was specifically identified. This population presented predominantly infantile with an age ranging from 2–34 months, 93% (26/28) younger than 2 years of age (Table 1). Patients most often arrived via ambulance and

Table 1. Demographic Characteristics of Perpetrator—Identified NAHT

Characteristic	Value
Number of patients	28
Gender	
Female	10 (36%)
Male	18 (64%)
Age (months)	33.6 (range 14–54)
<2 years	26 (93%)
GCS (admission)	
<7	17 (61%)
>8	11 (39%)
Radiology	
Subdural hematoma	25 (89%)
Uncal herniation	5 (18%)
Bihemispheric brain edema	1 (4%)
Retinal hemorrhages	25 (89%)
KOSCHI (discharge)	
Home/foster	12 (43%)
Rehabilitation	10 (36%)
Mortality	6 (21%)

GCS, Glasgow Coma Scale; KOSCHI, King's Outcome Scale for Childhood Head Injury.