

Penetrating head gunshot wounds in children and adolescents: Factors predicting outcomes

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Researchers from Memphis, Tennessee, have examined intracranial gunshot wounds (GSWs) in children and adolescents, and identified nine clinical, laboratory, and radiological factors that were predictive of these patients' outcomes. The factors are described and discussed in the article "Pediatric intracranial gunshot wounds: the Memphis experience," by Michael DeCuyper, MD, PhD, and colleagues, published today online, ahead of print, in the *Journal of Neurosurgery: Pediatrics*.

"When presented with a child who has sustained an intracranial GSW," the authors state, "the neurosurgeon must quickly decide whether the child has a fatal injury, an injury that is potentially nonfatal but very likely to have a devastating neurological outcome, or a survivable injury with a reasonable chance of maintaining or regaining meaningful neurological function."

Based on the neurosurgeon's appraisal and wishes of the family, a decision must be made on how to proceed with treatment, and this process is more challenging in children than in adults. Little has been written on the treatment of intracranial GSWs in [pediatric patients](#) as well as on the prediction of outcomes in this group, in part because overall these injuries are not common. In the United States, however, particularly in urban settings, penetrating head injuries are on the rise and, unfortunately, children and adolescents are not exempt from becoming victims. Predictive factors in adults with such injuries may not be helpful in managing care in children and adolescents, because of differences in the two patient groups; for example, following cranial GSWs pediatric patients have a lower mortality rate and a greater chance for neurological recovery than their adult counterparts.

The authors of this study practice in Memphis, Tennessee, a city where the death rate for gunshot wounds in children is one of the highest in the country. In their paper, the authors set out to answer two questions: 1) what clinical, laboratory, and radiological findings predict death in pediatric patients who have sustained a penetrating GSW to the head, and 2) how valid is the 2012 St. Louis Scale for Pediatric Gunshot Wounds to the Head in predicting death or survival in these patients.

The authors examined the medical records of all pediatric patients (18 years or younger) who received care for penetrating GSWs to the head between 1996 and 2013 at Le Bonheur Children's Hospital or the Elvis Presley Memorial Trauma Center in Memphis. Only patients suffering from a single trauma were included in the study. There were 71 pediatric patients with a mean age at presentation of 14 years (range 19 months to 18 years). Surgery was performed in 39 patients (55%).

The primary outcome in this study was the Glasgow Outcome Scale score (1, death; 2, persistent vegetative state; 3, severe disability; 4, moderate disability; and 5, good recovery).

The overall mortality rate in these patients was 48% (34/71). Of the surviving 37 patients, 30 (81%) achieved a favorable outcome (Glasgow Outcome Scale Score 4 or 5).

The authors looked at a variety of clinical, laboratory, and computed tomography (CT) findings to see if they were predictive of death in this group of patients. The authors identified nine factors statistically associated with mortality: bilateral fixed and dilated pupils; systolic blood pressure lower than 100 mm Hg; anemia (an initial hematocrit lower than 30%); intravascular volume depletion (a

base deficit of less than -5 mEq/L); Glasgow Coma Scale score of 5 or lower; and brain injuries involving the deep nuclei or third ventricle, three or more brain lobes, or a projectile passing through the ventricles (transventricular injury) or affecting both brain hemispheres (bihemispheric injury).

The authors applied the recently developed St. Louis Scale to predict outcomes in the 71 pediatric patients and then evaluated the scale's predictability. The St. Louis Scale separates predictive factors into three weighted groups. Bilateral fixed and dilated pupils, involvement of the brain's deep nuclei and/or third ventricle, and intracranial pressure measuring more than 30 mm Hg are each given three points. A mix of supratentorial/infratentorial involvement, injury to three or more brain lobes (or only one lobe if it is the cerebellum), and injury passing through ventricles are each given two points. Injury to both cerebral hemispheres, systolic blood pressure lower than 100 mm Hg at presentation, and a midline shift of brain structures are each given one point. The points are summed, with the highest (and worst) potential score totaling 18.

According to the article by Bandt *et al.*¹ that introduced the St. Louis Scale, a score of 5 or higher is associated with death and a score of 4 or lower is associated with survival. In the present study, DeCuyper and colleagues found that nine survivors of cranial GSWs had been assigned a St. Louis Scale score of 5 or higher. The authors state that "some survivors with the potential for a favorable outcome may be missed if judged using the St. Louis Scale alone." On the basis of their analysis, the authors conclude that the St. Louis Scale fared better at predicting favorable outcomes than mortality.

The authors point out the value of rapidly collecting clinical, laboratory, and radiological factors associated with mortality to guide treatment plans and predict outcomes in pediatric patients with intracranial GSWs. The authors caution, however, that only the finding of bilateral fixed and dilated pupils can be relied on alone to predict mortality; the other predictive factors should be used collectively to inform decision-making in the treatment of this challenging patient population.

"There is an immediate sobering feeling the moment you are faced with a child who has sustained a cranial gun shot wound, regardless of the circumstances," states Dr. Paul Klimo, the corresponding author, "It is a distasteful reality of our society. Almost all of the authors of this study have children or grandchildren. However, kids are amazing in their ability to overcome severe neurological injuries. We were greatly encouraged, but ultimately not surprised, to find that the functional outcome, as graded by the Glasgow Outcome Scale (GOS), for those who survived their injuries was remarkably good—30 of 37 patients (81%) had a GOS score of 4 or 5. This underscores the importance of rapid assessment, resuscitation, and treatment—medically or surgically."

More information: DeCuyper M, Muhlbauer MS, Boop FA, Klimo P Jr: Pediatric intracranial gunshot wounds: the Memphis experience. *Journal of Neurosurgery: Pediatrics*, published online, ahead of print, Jan. 5, 2016; DOI: [10.3171/2015.7.PEDS15285](https://doi.org/10.3171/2015.7.PEDS15285)

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