

## Predictors of Outcome in Gunshot Wounds to the Head

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### INTRODUCTION

Up to 71% percent of patients with civilian GSWH die at the scene and 14 percent within 5 hours. In Siccardi et al experience with 314 patients with GSWH, 84 percent of the patients died either at the scene (72.6%) or within three hours (12%). In Zafonte's series of 442 patients with GSWH, 36% were dead on arrival and 41% of the resuscitated patients died within 48 hours of emergency department admissions. Less than one half of the civilian GSWH who are admitted to trauma centers alive benefit from neurosurgical care. In the Hernesniemi, Siccardi et al and Kaufman et al investigations this proportion was 14, 14 and 19 percent respectively. There is evidence that very few patients with GSWH remain in a persistent vegetative state or severe disability state (GOS scores 2 and 3); however, this could create a good opportunity to select a few victims of CGSWH and offer them the best chance of long-term survival.

### METHODS

We posited two questions: 1) What percentage of subjects with GSWH died across the state of Maryland; and 2) What were the predictors of good outcome (GOS) following GSWH? Demographics, clinical, imaging and acute care data of 786 civilians who sustained GSWH were analyzed. Univariate and regression analyses were used to analyze the data.

### Results

Of this cohort (N= 786 patients), 594 died at the scene and 122 died following admission to 9 Level I-III Trauma Centers. Seventy-four patients made it to TBI rehabilitation of which 30 (3.8%) had surgery.

From the 69 patients who were admitted to this Level I Trauma Center, 78.6% were male, mean age was 34.8, injury severity score 26.7, GCS 7.1, and abnormal pupillary response to light (APR) was present in 41% of patients. CT scan indicated midline shift in 17.5%, obliteration of basal cisterns in 41.5%, intracranial hematomas in 35% and intraventricular hemorrhage in 49% of cases. Two subsets of admissions were studied: (1) 27 patients who died during acute care and (2) 15 patients who had a good outcome when followed a mean of 39 months.

Missile trajectory ( $p < 0.001$ ), admission GCS ( $p < 0.001$ ), APR ( $p = 0.002$ ), patency of basal cisterns ( $p = 0.01$ ), age ( $p = 0.02$ ) and intraventricular bleed ( $p = 0.03$ ) had significant relationship with outcome. Stepwise multivariable logistic regression analysis indicated that GCS and patency of basal cistern were significant determinants of outcome. Exclusion of GCS from the regression models indicated missile trajectory and APR were significant players in determining outcome.

**Conclusions:** GCS at admission, APR to light, patency of basal cisterns and the trajectory of the missile were significant determinants of outcome in civilian GSWH.

**LEARNING OBJECTIVES:** This investigation will empower neurosurgeons to better select victims of GSWH for the best possible outcome

**REFERENCES:** Coronado VG et al: Surveillance for traumatic brain injury-related deaths--United States, 1997-2007. *MMWR Surveill Summ* 60:1-32, 2011  
Grahm TW et al: Civilian gunshot wounds to the head: a prospective study. *Neurosurgery* 27:696-700; discussion 700, 1990...Hernesniemi J: Penetrating craniocerebral gunshot wounds in civilians. *Acta Neurochir (Wien)* 49:199-205, 1979  
Kaufman HH: Civilian gunshot wounds to the head. *Neurosurgery* 32:962-964; discussion 964, 1993  
Kaufman HH et al: Gunshot wounds to the head: a perspective. *Neurosurgery* 18:689-695, 1986. Lin D et al: "Time is brain" the Gifford factor - or: Why do some civilian gunshot wounds to the head do unexpectedly well? A case series with outcomes analysis and a management guide. *Surg Neurol Int* 3:98, 2012  
Siccardi et al: Penetrating craniocerebral missile injuries in civilians: a retrospective analysis of 314 cases. *Surg Neurol* 35:455-460, 1991  
273:1778-1780, 1995  
Zafonte RD et al: Penetrating head injury: a prospective study of outcomes. *Neurol Res* 23:219-226, 2001