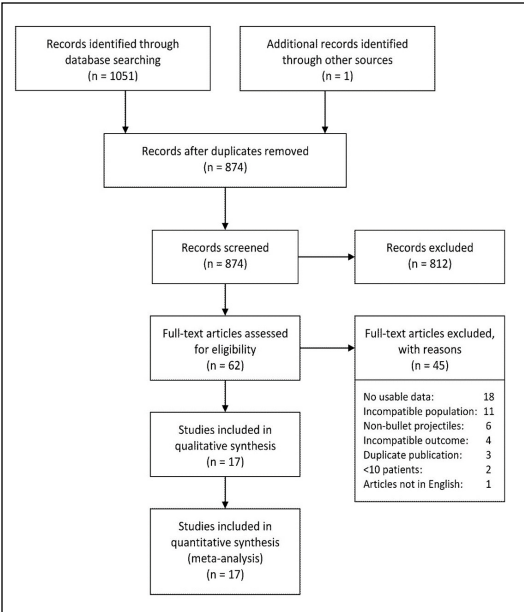


Introduction

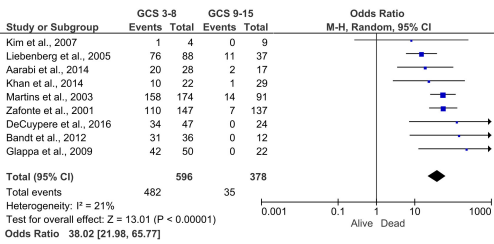
There is currently no consensus regarding prognosis and management for civilian craniocerebral gunshot injuries (cCGI). To the authors’ knowledge, this is the first meta-analysis to study mortality prognostic factors in cCGI.

Methods

Five online databases and the reference lists of relevant articles were queried for cohort studies of cCGI reporting factors associated with mortality. PRISMA guidelines were followed. Study quality was assessed using the Newcastle-Ottawa scale. Pooled estimates of odds ratios and 95% confidence intervals were derived using random-effects models. Heterogeneity was assessed with I-square and meta-regression. Funnel-plots were utilized to assess publication bias.



Effect of Post-Resuscitation GCS on mortality

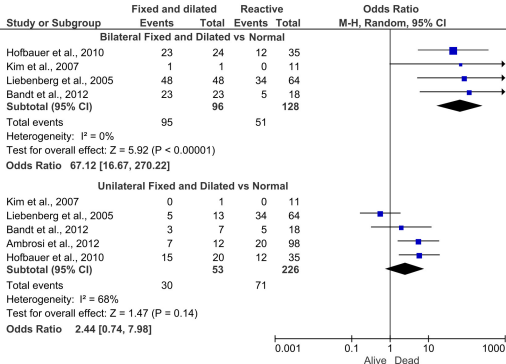


Lower Glasgow Coma Scale (GCS), measured after initial resuscitation, was associated with higher mortality. Patients with GCS 3-8 had higher mortality than patients with GCS 9-15 (OR 38 .02 ; $P < 0.0001$). About 38-81% of cGSWH patients have admission GCS between 3 and 5, while 48-94% have GCS 8 or less. However, aggressive fluid resuscitation for all patients, irrespective of pre-resuscitation GCS, can lead to survival in up to 28% of patients with initial GCS 3-5.

Results

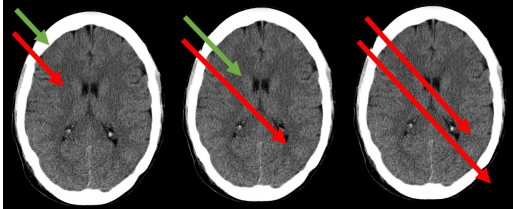
We identified 17 retrospective cohort studies encompassing 1774 cCGI patients. Out of the factors assessed, the ones significantly associated with mortality were: older age (Odds Ratio 3.44, 95% Confidence Interval [1.71-6.91]), suicide attempt (5.78 [3.07-10.87]), post-resuscitation Glasgow Coma Scale (GCS) 3-8 (38.02 [21.98-65.77]), bilateral fixed and dilated pupils (67.12 [16.67-270.22]), penetration of the dura (29.07 [4.30-196.53]), bullet trajectory through both hemispheres (4.23 [2.32-7.68]), and through multiple lobes (6.53 [1.99-21.42]).

Effect of Pupillary Abnormalities on Mortality



(A) Bilateral fixed and dilated pupils were associated with higher mortality than bilateral reactive pupils (OR 67.12; $P < 0.0001$). However, having a single fixed and dilated pupil (B) had no significant effect on mortality ($P = 0.14$). A unilateral fixed and dilated pupil may be caused by pressure of the oculomotor nerve by localized mass effect (eg. bullet impingement or facial injury).

Effect of bullet trajectory on mortality.



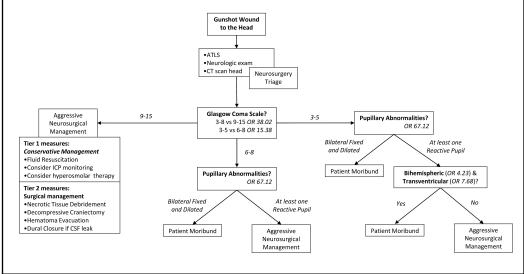
Injuries penetrating the dura (B, penetrating) were more lethal than those stopping outside the dura (A, tangential) (OR 29.07; $P = 0.0005$). Conversely, injuries with an exit wound (C, perforating) had no difference in mortality than penetrating (B) injuries ($P = 0.85$).

Conclusions

This is the first attempt to systematically assess prognostic factors for civilians with gunshot injuries to the brain. The following are the strongest predictors of in-hospital mortality:

- Age = 40 years
- Glasgow Coma Scale = 8 after initial resuscitation
- Bilateral fixed and dilated pupils
- Suicide attempt
- Intracranial pressure >20 mmHg
- Bullet penetrating the dura
- Bihemispheric bullet trajectory
- Multilobar bullet trajectory
- Transventricular bullet trajectory

Proposed cGSWH Management Algorithm



References

1. The International Brain Injury Association. Part 2: Prognosis in penetrating brain injury. Journal of Trauma. 2001;51:S12 –S15.

2. Aarabi B, Tofighi B, Kufera JA, et al. Predictors of outcome in civilian gunshot wounds to the head. Journal of neurosurgery. 2014;120(5):1138 -1146.