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Does age matter? The relationship between age and mortality in penetrating trauma

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ABSTRACT

Purpose: Trauma is a significant cause of mortality among elderly patients, with blunt mechanisms accounting for the majority of deaths in this population. Penetrating trauma promises to evolve as an increasingly important aetiology of mortality in the elderly; particularly as the age composition of the overall population continues to shift. Unfortunately, very little data regarding outcomes following penetrating trauma in the elderly exists. The purpose of this study was to define the relationship between age and mortality following penetrating injuries and determine if differences between outcomes of elderly patients sustaining penetrating and blunt trauma exist.
Methods: After IRB approval, we conducted a retrospective trauma registry review at an urban Level 1 trauma centre between January 1, 1998 and December 31, 2005. Demographic, injury, and mortality data for all patients were recorded. The relationship between age and mortality for both blunt and penetrating injuries was examined by comparison of age-specific mortality and relative risk of mortality for both mechanisms at 10 year age intervals. Additionally, the relative risk and 95% confidence interval for mortality in each age group were compared.
Results: There were 26,333 blunt trauma admissions and 8843 penetrating trauma admissions during the 8-year study period. The mortality following both blunt and penetrating trauma remained stable until the age of 55 and increased steadily thereafter. When differences in mortality following blunt and penetrating mechanisms were examined, the overall mortality of penetrating trauma was found to be 2.63 times that of blunt (11.0% vs. 4.2%, RR 2.63; 95% CI: 2.42, 2.85, $p < 0.0001$). After adjustment for age and other confounding factors, the relative risk of mortality due to penetrating mechanisms was 1.65 (95% CI: 0.88, 2.89, $p = 0.10$) that of blunt mechanism counterparts. Although statistically higher in penetrating trauma, the relative risk of mortality between penetrating and blunt trauma decreased with increasing age.
Conclusion: The mortality rate with respect to penetrating trauma remains relatively constant until the age of 55, increasing thereafter. When compared to blunt trauma, the relationship between age and mortality in penetrating trauma is similar except that the relative mortality in penetrating trauma is significantly higher for each age group.

Introduction

According to U.S. Census Bureau projections, the age of the American population will continue to mature in the coming decades. In the year 2000, Americans over the age of 45 comprised 34.5% of the population. By the year 2020, this figure is predicted to reach 41.2%. According to 2004 projections, this shift in age demographics is anticipated to continue well into the 21st century.[9]

While penetrating mechanisms are less common sources of trauma among more elderly members of the population, the number of older individuals sustaining these injuries is likely to increase as the national age demographic evolves. Unfortunately, comparatively less is known about the outcomes of older patients following penetrating trauma than more common blunt mechanisms. Even as understanding of the effects of age-related

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physiological responses to trauma continues to evolve,[4,5] the relationship between age and outcomes of penetrating trauma remains poorly appreciated.

Patients and methods

After approval from the Institutional Review Board, a retrospective review of the trauma registry at the Los Angeles County+University of Southern California (LAC+USC) Medical Center was performed to identify all trauma patients admitted between January 1, 1998 and December 31, 2005. Demographic and clinical data, including age, gender, injury mechanism, Glasgow Coma Scale (GCS), Injury Severity Score (ISS), Abbreviated Injury Score (AIS) and mortality were obtained and entered into a computerised spreadsheet (Microsoft Excel 2003, Microsoft Corporation, Redmond, WA). All statistical analysis was performed using SPSS for Windows©, version 12.0 (SPSS Inc., Chicago, IL).

For the analysis, age was considered in 10-year intervals beginning at 15 years and other continuous variables were dichotomised using clinically relevant cut-points (GCS ≤ 8 or >8, ISS ≥ 16 or <16 and AIS >3 or ≤ 3). Differences in baseline demographic and clinical characteristics between patients with blunt and penetrating injury mechanisms were assessed using chi-square or Fisher's exact test for comparison of proportions and Student's *t*-test or Mann–Whitney for comparison of means.

In order to identify a possible cut-off age after when a significant increase in mortality occurs, the mortality rate within each age group was calculated with the relative risk of death compared to the prior age group was derived. This analysis was performed separately for patients with a blunt and for those with a penetrating mechanism of injury.

Bivariate analysis was performed to identify differences in mortality between blunt and penetrating injuries within each age group. Relative risk and 95% confidence interval was derived. A graphic comparison of the mortalities by mechanism within each age group was obtained by plotting the age-specific mortality for blunt and penetrating injuries and identifying the overlaps of the error bars representing the 95% confidence intervals for each age-specific mortality rate.

To further analyse the relationship between age and mortality in penetrating and blunt trauma, logistic regression was performed to adjust for all factors that were significantly different between the two populations at $p < 0.2$. Adjusted relative risk of mortality between penetrating and blunt injuries, controlling for both age and the confounding factors identified, was converted from the adjusted odds ratio and 95% confidence interval.[10]

Results

During the 8-year period, a total of 35,184 patients were admitted. Of these, 25% sustained penetrating injuries. Individuals older than 55 years represented 3% of the total in the penetrating group and 17% in the blunt group ($p < 0.0001$). As outlined in Table 1, the penetrating and blunt injury groups also differed significantly for gender, GCS, ISS and AIS. Patients in the penetrating group more often were male (92% vs. 73%, $p < 0.0001$), had a GCS ≤ 8 (11% vs. 9%, $p < 0.0001$) and an ISS ≥ 16 16 (22% vs. 13%, $p < 0.0001$).

The age-specific death rates and 95% confidence intervals for the blunt and penetrating injury groups are summarised in Tables 2 and 3, respectively. For blunt injuries, no significant difference in mortality was identified between the age groups up to age 54. Beginning at the 55–64 age group, however, the mortality rate became significantly higher compared to the younger age group. A further increase in mortality was observed for those aged 65 and older, who were at significantly higher risk of death compared to the patients in the 55–64 age group (Table 2).

For penetrating injuries, a similar pattern of age-specific mortality rates was observed. The mortality rates remained constant among the younger age groups, but showed an increase at the 55–64 age group. However, this increase did not reach statistical significance. The relative risk of mortality for the 55–64 age group was 1.5 (95% CI: 0.98, 2.32; $p = 0.09$) compared to the younger age groups. In the age group 65 and older, the mortality rate was significantly higher than the 55–64 age group ($p = 0.015$). Similar to what was observed in the blunt group, the 55–64 age group also appears to be the age group in which mortality begins to increase following penetrating injury.

The relative risk of death for penetrating injury compared to blunt injury was significantly higher in all age groups (Table 4). Table 4 also shows that the relative risk for mortality, although significantly higher for penetrating trauma in all age groups, decreased with increasing age. Fig. 1 provides additional information on the comparison of age-specific mortality rates according to the mechanism of injury. As demonstrated in this chart, the error bars representing the mortality 95% confidence intervals does not overlap in any of the age groups.

Table 1
Comparison of patient characteristics and injury severity between blunt and penetrating injuries.

Characteristic	Blunt injury (*N* = 26,339)	Penetrating injury (*N* = 8845)	*p*-Value
Male	73% (19,249/26,339)	92% (8111/8845)	<0.0001
Age ≥ 55 years	17% (4558/26,339)	3% (290/8845)	<0.0001
ISS ≥ 16	13% (3436/26,947)	22% (1973/8830)	<0.0001
Abdominal AIS > 3	1.4% (373/26,339)	6.8% (598/8845)	<0.0001
Chest AIS > 3	1.6% (430/26,339)	7.6% (670/8845)	<0.0001
Head AIS > 3	7.4% (1952/26,339)	5.5% (486/8845)	<0.0001
GCS ≤ 8	8.5% (2177/25,676)	11.4%(1000/8744)	<0.0001

Table 2
Relative risk of mortality according to age group for blunt injuries.

Age group in years	Blunt injury		
	%Died (# died/# in group)	Relative risk[a] (95% CI)	*p*-Value
<15	2.5% (60/2303)	–	–
15–24	2.7% (138/4976)	1.06 (0.79, 1.43)	0.75
25–34	2.7% (147/5249)	1.01 (0.89, 1.27)	0.98
35–44	3.5% (176/4907)	1.27 (1.02, 1.58)	0.03
45–54	3.9% (150/3670)	1.13 (0.92, 1.40)	0.27
55–64	6.0% (125/1974)	1.52 (1.20, 1.91)	0.0005
65+	12.3% (303/2155)	2.07 (1.69, 2.53)	<0.0001
Total	4.2% (1099/26,333)	–	–

[a] Compared to prior age group.

Table 3
Relative risk of mortality according to age group for penetrating injuries.

Age group in years	Penetrating injury		
	%Died (# died/# in group)	Relative risk[a] (95% CI)	*p*-Value
<15	12.3% (26/185)	–	–
15–24	11.3% (434/3391)	0.92 (0.64, 1.33)	0.75
25–34	10.3% (257/2244)	0.91 (0.78, 1.05)	0.20
35–44	10.0% (140/1259)	0.97 (0.80, 1.18)	0.83
45–54	9.4% (58/559)	0.94 (0.70, 1.26)	0.73
55–64	14.1% (26/158)	1.50 (0.98, 2.32)	0.09
65+	26.4% (28/78)	1.87 (1.16, 3.01)	0.015
Total	11.0% (969/8843)	–	–

[a] Compared to prior age group.