World Journal
of Surgery

Ethnic Disparities in Trauma Mortality Outcomes

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Abstract

Background Ethnic disparities in trauma mortality outcomes have been demonstrated in the United States according to the US National Trauma Data Bank. The aim of this study was to determine the effect of race/ethnicity on trauma mortality in Singapore.

Methods This was a retrospective review of patients aged 18–64 years with an injury severity score (ISS) ≥9 in the Trauma Registry of Tan Tock Seng Hospital, a 1,300-bed trauma center in Singapore, from 2006 to 2010. Chinese, Malay, and Indian patients were compared with patients of other ethnic groups. Multiple logistic regression analyses determined differences in survival rates after adjusting for demographics, anatomic and physiologic ISS and revised trauma score, mechanism or type of injury.

Results A total of 4,186 patients (66.4 % of the database) met the inclusion criteria. Most patients were male (76.3 %) and young (mean age 40 years). Using Chinese as the reference group, we found no statistically significant differences in unadjusted or adjusted mortality rates among the ethnic groups. Independent predictors of mortality included age [odds ratio (OR) 1.05, 95 % confidence interval (CI) 1.03–1.06, $p < 0.0001$], presence of severe head injury (OR 1.75, 95 % CI 1.13–2.69, $p = 0.012$), and increasing ISS ($p < 0.0001$).

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Conclusions Ethnicity is not an independent predictor of trauma mortality outcomes in the Singapore population. Our findings contrast with those from the United States, where race/ethnicity (Black and Hispanic) remains a strong independent risk factor for trauma mortality. This study attests to the success of the Singapore health care/trauma system in delivering the same quality of care regardless of ethnicity.

Introduction

Trauma patients are typically sent to an emergency facility where it is expected that they will be treated according to their injury regardless of who they are, their insurance status, or the color of their skin. As such, trauma has long been considered a great equalizer in health care. Trauma providers are trained to treat their patients swiftly and appropriately, solely in accordance to injury severity score (ISS) and clinical condition.

This "assumption" that any trauma patient is being treated equally has been increasingly challenged. Racial disparities in posttraumatic discharge disposition [1], functional outcomes [2–4], and mortality [5, 6] have been described in adult and pediatric trauma populations. For example, in a 2008 analysis of the National Trauma Data Bank (NTDB), the largest repository of trauma data in the United States, demonstrated that African American and Hispanic patients had, respectively, 1.17 and 1.47 times increased odds of dying after trauma compared to Whites even after accounting for differences in ISS, age, type, and mechanism of injury [5]. These findings were congruent with data from the Healthcare Cost and Utilizations Project, which showed that relative to injured White patients,

Black and Asian patients, respectively, had 1.14 and 1.39 times the risk of dying from their injury.

Research on racial disparities in non-American trauma patient populations has been limited. An Israeli study showed that Arab children were more likely to be hospitalized and operated on because of road accidents than Jewish children, but it did not find any inpatient mortality differences [7]. Like the United States, Singapore is a multi-ethnic society in Southeast Asia. Its population predominantly consists of Chinese, Malays, and Indians. Because trauma is the fifth leading cause of death in Singapore [8], it is important to understand factors affecting the delivery of trauma care. Factors affecting trauma outcomes have not been previously investigated in Singapore. Therefore, the aim of this study was to determine if and how race/ethnicity affects trauma-related mortality in the Singaporean population.

Methods

Study design and patient population

Singapore is an island city-state of about 700 km^2, roughly 3.5 times the size of Washington, DC [9]. The total population was 5.18 million people as of 2011, with 3.79 million (73 %) being citizens or permanent residents and 1.39 million (37 %) being nonresidents [10]. Serving this population is a total of six acute general hospitals, of which Tan Tock Seng Hospital (TTSH) is the second largest, with 1,600 beds, more than 30 intensive care unit beds, and 26 operating theaters. TTSH handles the highest number of trauma patients in Singapore and admits more than 1,000 severely injured (ISS $\geq$9) trauma patients yearly. Hence, it may be considered the busiest trauma and acute care hospital in Singapore.

We reviewed TTSH's prospectively maintained trauma database for the years 2006 to 2010 and identified patients aged 18–64 years with an ISS $\geq$9. We excluded patients in the pediatric ($\leq$17 years) and elderly ($\geq$65 years) population because studies have shown that trauma affects patients in these age groups differently [3, 11–13]. Trauma patients with an ISS $\geq$9 were included because they suffered at least moderate injury and would be at risk of dying from their injury [5]. Ethnicity or race was verified via patients' National identification (ID) or Foreign National ID record, which contains self-reported ethnicity. Chinese, Malay, and Indian patients were compared with patients of "Other" ethnicities. Multiple logistic regression analyses determined differences in survival rates after adjusting for demographics, anatomic and physiologic injury severity [ISS and revised trauma score (RTS)], and mechanism or type of injury.

Statistical analysis

Using a multivariable logistic regression model, we analyzed survival differences based on ethnicity. Patient data were adjusted for demographics (age, sex) and other factors known and/or shown to affect trauma mortality. These covariates were chosen a priori in accordance with recommendations from leading trauma researchers [14]. They include anatomic and physiologic severity, as measured by ISS and RTS respectively. The ISS was treated as a categoric variable with three groups (ISS 9–15 indicates moderate injury; 16–24 indicates severe injury; $\geq$25 indicates most severe injury). Patient data were also adjusted for type of injury (penetrating vs. blunt) and mechanism of injury. Six "mechanism of injury" categories are used by the coordinators in our Trauma Service based on local epidemiology: assault, fall, falling object, sports, vehicular accident, others.

A t test was used to compare continuous variables, and a chi square test was used to compare categoric variables during the univariate analysis. After adjusting for patient demographics and ISS, we calculated the odds ratios (ORs) for mortality. SAS 9.3 software (SAS Institute, Cary, NC, USA) was used for all analyses. Statistical significance was defined as $p < 0.05$.

Results

Of 6,308 patients in the TTSH Trauma Registry during the years studied, 4,186 (66.4 %) met the inclusion criteria: having suffered moderate to severe injury (as determined by ISS $\geq$9) and being 18–64 years of age (Fig. 1). Overall, the mean age was 40 years, and more than three-fourths of the patients were men. In terms of severity of injury, on univariate analysis there did not appear to be any observable differences in the mean ISS or RTS (measures of anatomic and physiologic ISS). There was a significant difference in patients who had severe head injury, with 15.8 % in Chinese patients compared to 10.1 % in Malays, 11.3 % in Indians, and 13.9 % in patients of other ethnicities ($p = 0.003$). There was also a disproportionate of Malay (2.6 %), Indian (3.8 %), and Other (3.9 %) patients having penetrating injuries compared to Chinese patients (1.9 %) ($p = 0.008$). The top two mechanisms of injury for all patients were road traffic accidents (45.7 %) and falls (40.1 %) (Table 1).

Crude mortality rates were 6.6, 4.5, 5.5, and 5.5 % for the Chinese, Malay, Indian, and others groups, respectively. There was a trend toward significance in terms of differences among the ethnic groups ($p = 0.07$). On multivariable analyses, patients with complete data for all variables were included in the regression models (100 %,

$n = 4,186$). After adjusting for demographic and ISS variables, we found that there was no significant difference in mortality between the ethnic groups (Table 2).

Other independent predictors of mortality include age ($p < 0.0001$), presence of severe head injury ($p = 0.012$), and increasing ISS. Notably, patients with severe injury (ISS 16–24) had 19.2-fold increased odds of mortality [95 % confidence interval (CI) 4.6–80.0, $p < 0.0001$]. Patients with a very severe injury (ISS $\geq$25) had 254.8-fold increased odds of mortality (95 % CI 67.6–960.2, $p < 0.0001$) (Table 2).
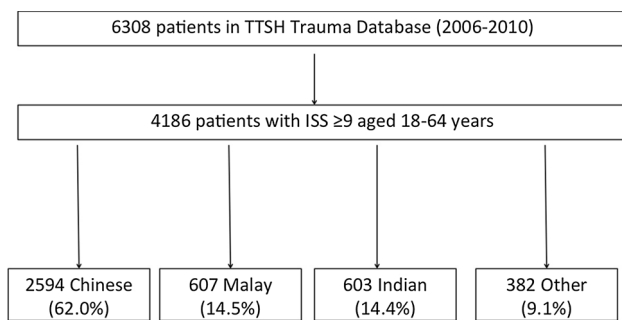
Fig. 1 Flowchart of patient selection. *TTSH* Tan Tock Seng Hospital, *ISS* injury severity score

Discussion

Examining racial disparities in health care outcomes has been an area of intense research during the past decade ever since the US Institute of Medicine published a report entitled "Unequal Treatment." In multi-ethnic Singapore, this is a subject of increasing interest across specialties [15–18].

Our single-center trauma database analysis examines ethnic disparities in trauma outcomes in Singapore. In contrast to the NTDB, our data are not a convenience sample consisting of centers voluntarily reporting data. We utilize a prospectively collected robust trauma registry that captures every single patient admitted every day to the Trauma Service of TTSH. Therefore, missing data was not an issue when performing our analyses, with 100 % complete data available.

In terms of demographic profile, our trauma patients are similar to those from other countries, with the majority in the working class adult group and mostly male [5, 19]. Most injuries were blunt type, consistent with a nation that does not permit civilian ownership of guns. The top two mechanisms of injury were road traffic accidents and falls from a height (Table 1).

Crude mortality rates ranged from 4.5 to 6.6 %, a statistic that appears consistent with trauma patients who have an ISS $\geq$9 [5]. Univariate analyses did not show any statistically significant difference in mortality rates between

Table 1 Patient and injury characteristics of trauma patients at TTSH, Singapore (2006–2010)

Ethnicity	Overall ($n = 4,186$)	Chinese ($n = 2,594$)	Malay ($n = 607$)	Indian ($n = 603$)	Others ($n = 382$)	p
Mean age (years)	40.2	43.3	33.8	33.8	34.9	<0.0001
Male (%)	76.3	72.9	79.1	85.7	79.6	<0.0001
Mean ISS	15.3	15.5	15.4	14.8	15.2	0.5803
ISS category (%)						0.0918
ISS 9–15	64.9	64.0	65.9	69.5	62.6	
ISS 16–24	18.8	18.9	19.9	15.8	20.9	
ISS $\geq$25	16.3	17.2	14.2	14.8	16.5	
Mean RTS	7.39	7.40	7.43	7.34	7.42	0.6412
Head AIS $\geq$3 (%)	14.1	15.8	10.1	11.3	13.9	0.0026
Type of injury (%)						0.0082
Penetrating	2.5	1.9	2.6	3.8	3.9	
Blunt	97.5	98.1	97.4	96.2	96.1	
Mechanism (%)						<0.0001
Assault	5.9	4.6	7.7	8.8	7.3	
Fall	40.1	44.0	21.6	37.2	47.6	
Falling object	3.3	2.4	1.2	7.3	6.8	
RTA	45.7	44.2	64.9	42.0	31.4	
Others	5.0	4.8	4.6	4.8	6.8	
Mortality (%)	6.0	6.6	4.5	5.5	5.5	0.0712

ISS injury severity score, *RTS* revised trauma score, *AIS* abbreviated injury score, *RTA* road traffic accident

Table 2 Independent predictors of mortality in trauma patients at TTSH, Singapore (2006–2010)

Predictor	Adjusted odds of mortality (95 % CI)[a]	p
Age	1.05 (1.03–1.06)	<0.0001
Sex		
Male	Reference	Reference
Female	0.89 (0.53–1.49)	0.656
Race		
Chinese	Reference	Reference
Malay	1.20 (0.60–2.5)	0.602
Indian	0.99 (0.52–1.91)	0.995
Others	1.19 (0.55–2.55)	0.665
Type of injury		
Blunt	Reference	Reference
Penetrating	1.24 (0.14–10.94)	0.845
Mechanism of injury		
RTA	Reference	
Assault	0.46 (0.13–1.61)	
Fall	1.25 (0.79–1.97)	
Falling	1.27 (0.31–5.14)	
Others	0.74 (0.18–2.96)	
Presence of severe head injury	1.75 (1.13–2.69)	0.012
ISS category		
ISS 9–15	Reference	
ISS 16–24	19.16 (4.59–80.02)	<0.0001
ISS ≥25	254.8 (67.62–960.21)	<0.0001

CI confidence interval

[a] Adjusted for age, sex, ISS, RTS, mechanism and type of injury, and ethnicity

the four main ethnic groups (Chinese, Malay, Indian, Others). Even after accounting for known confounders, we did not find any differences in adjusted mortality rates. This suggests that implicit bias—purported to be a possible reason for racial disparities in trauma outcomes in the United States [20, 21]—is unlikely to be a contributing factor in our setting.

Other independent predictors of mortality were expected and, not surprisingly, consistent with existing trauma literature. They include age, presence of severe head injury, and increasing ISS (Table 2).

The impetus behind and implications for this study may be interpreted in light of Singapore's historical background. As a young nation, Singaporeans are still plagued by painful memories of the 1964 and 1969 racial riots [22]. It was the 1964 episode that contributed to the UMNO-led federal government's decision to expel Singapore from the Federation of Malaysia in 1965 when the two sides were unable to resolve their disputes. Since independence in 1965, deliberate and extensive efforts on a national policy level were

made to foster racial harmony among Singaporeans by the Government of Singapore. For example, there have been numerous national educational efforts in public schools, public housing quotas for the various races to ensure a healthy residential mix, and an annual Racial Harmony Day [23, 24]. Although the successes of these national policies could be measured by opinion surveys about racial tolerance and harmony, such surveys are subject to survey bias where participants enter the answer they perceive to be correct instead of what they truly think. We opine that this may be more accurately reflected by our study's results, which do not show any trauma mortality differences among the four main races of our Singaporean population. It attests to the high standards of our trauma, emergency, and medical teams in caring for injured patients regardless of their ethnicity.

Our study should be interpreted in light of several limitations. Because we used a retrospective registry, it was not feasible to account for patients' co-morbidities or complications that may occur while they were inpatients. We were also unable to account for prehospital transfer times from the field to the hospital's emergency department, which may affect mortality. Additionally, we were unable to use any surrogate (e.g. residential code, insurance status, payer type) in our Trauma Registry to control for socioeconomic status. Finally, it was a single-center study, which may not be nationally representative. Nevertheless, it provides unique homogeneity to our study, with the same trauma team treating patients over the study period, thereby removing any variability associated with quality of care across multiple centers.

Conclusions

Our study found that ethnicity was not an independent predictor of mortality after trauma in the Singaporean population. While this negative finding may serve as a validation and assurance to our governmental policies and efforts to promote racial harmony, it does not imply that mistrust, subconscious bias, and stereotyping does not exist *entirely* in our health care system. Further studies to elucidate disparities in outcomes among patients utilizing our health care system may be considered, especially regarding chronic noncommunicable diseases such as cancer, diabetes, and cardiovascular disease.

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