

Factors affecting outcomes among older trauma patients in Singapore: A retrospective observational study

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Dear Editor,

Singapore faces a rapidly ageing population with its median age projected to be above 45 years by 2030. Our greying demographics is accompanied by a rise in chronic diseases and medication use, including polypharmacy.¹ Longer life expectancy and increased activity levels have contributed to higher incidence of geriatric trauma locally, with a three-fold rise between 2004 and 2015.² Older patients are at greater risk of poorer outcomes following trauma.³ However, the impact of comorbidities and medication use on post-trauma outcomes in Singapore's ageing population remains unclear.

From the trauma registries at 2 tertiary trauma centres—Singapore General Hospital and National University Hospital—in Singapore, we identified patients aged 45 years and above who presented to the emergency departments (EDs) for injuries between 2011 and 2015. Data on demographics, injury types and severity, comorbid conditions and medication use were collected through chart reviews of electronic medical records. We evaluated these factors in relation to clinical outcomes including mortality, ED disposition, hospital length-of-stay and discharge venue. Patients were divided into the following age groups for analysis: 45–64 (middle-aged), 65–74 (young-old), 75–84 years (middle-old) and 85 years and above (old-old) (Table 1).⁴

Among 4522 patients in the study, the median age was 70 (interquartile range [IQR] 59–80) years with slight male predominance (53.8%). More males were in the “middle-aged” (70.2%) and “young-old” (55.3%) groups, whereas more females were in the “middle-old” (59.8%) and “old-old” (69.4%) groups. The prevalence of various medical conditions (e.g. cardiovascular diseases, chronic obstructive lung disease and renal disease) in the study cohort increased with rising age, except

for asthma. The use of medications such as antiplatelets, antihypertensives and hypoglycaemic agents also increased across the age groups, but not for opioids, antiepileptics and benzodiazepines/hypnotics.

One in 5 patients required trauma team activation in the “middle-aged” group compared to 1.9–7.6% in the 3 other age groups. The “middle-aged” group also had the highest proportion of injuries due to road crashes. Most injuries sustained by the “young-old”, “middle-old” and “old-old” groups were due to falls (71.4%, 83.2% and 89.8%, respectively) and occurred at home (44.7%, 63.9% and 74.1%, respectively). Overall, all-cause mortality at discharge was 8.4%, with significantly lower mortality in the “middle-aged” group (6.8%) compared to elderly patients aged 65 and above (10.9%) ($P=0.004$). Among elderly patients, overall mortality increased from the “young-old” (8.0%) to “old-old” (11.6%) subgroups, despite no significant differences in tier of injuries between age-differentiated subgroups. A higher proportion of patients in the younger age groups were admitted to the intensive care and high dependency units. These younger patients had a shorter median length of inpatient stay (“middle-aged” 7.5 [IQR 3.6–15.3] days, “young-old” 9.2 [4.2–18.2] days, “middle-old” 10.3 [4.8–18.3] days and “old-old” 9.7 [4.3–16.8] days, $P<0.001$). More patients in the older age groups required stepdown care to a community hospital or long-term care facility upon discharge (“middle-aged” 13.8%, “young-old” 24.6%, “middle-old” 32.1% and “old-old” 29.0%, $P<0.001$).

The presence of cardiac arrhythmia, congestive heart failure, coronary artery disease, moderate-to-severe renal disease, valvular heart disease, and use of antiplatelets, anticoagulation and diuretics were significantly associated with mortality in univariate analyses. After adjustment for age and Injury

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Table 1. Comorbidities, medications, injury epidemiology and outcomes.

Variables	"Middle-aged" 45–64 years (n=1772)	"Young-old" 65–74 years (n=962)	"Middle-old" 75–84 years (n=1151)	"Old-old" 85 years and above (n=637)	P value
Comorbidities, no. (%)					
Asthma	47 (2.7)	34 (3.5)	45 (3.9)	24 (3.8)	0.236
Congestive heart failure	43 (2.4)	32 (3.3)	72 (6.3)	54 (8.5)	<0.001
Coronary artery disease	143 (8.1)	163 (16.9)	265 (23.0)	157 (24.7)	<0.001
Cerebrovascular accident	102 (5.8)	135 (14.0)	219 (19.0)	98 (15.4)	<0.001
Chronic obstructive lung disease	8 (0.5)	13 (1.4)	34 (3.0)	18 (2.8)	<0.001
Diabetes mellitus	384 (21.7)	347 (36.1)	396 (34.4)	170 (26.7)	<0.001
Hypertension	612 (34.5)	622 (64.7)	825 (71.7)	474 (74.4)	<0.001
Moderate-to-severe renal disease ^a	77 (4.3)	59 (6.1)	80 (7.0)	46 (7.2)	0.007
Medications, no. (%)					
Antiplatelets	204 (11.5)	259 (26.9)	388 (33.7)	210 (33.0)	<0.001
Anticoagulation	29 (1.6)	43 (4.5)	66 (5.7)	27 (4.2)	<0.001
ACE-Is/ARBs	276 (15.6)	300 (31.2)	380 (33.0)	199 (31.2)	<0.001
Beta blockers	245 (13.8)	264 (27.4)	359 (31.2)	187 (29.4)	<0.001
Calcium channel blockers	258 (14.6)	298 (31.0)	406 (35.3)	242 (38.0)	<0.001
Diuretics	92 (5.2)	121 (12.6)	164 (14.2)	91 (14.3)	<0.001
Opioids	10 (0.6)	6 (0.6)	11 (1.0)	2 (0.3)	0.558 [^]
Antiepileptics	46 (2.6)	26 (2.7)	32 (2.8)	14 (2.2)	0.751
Benzodiazepines/Hypnotics	27 (1.5)	6 (0.6)	15 (1.3)	8 (1.3)	0.241
OHGAs ^b	282 (15.9)	260 (27.0)	273 (23.7)	99 (15.5)	<0.001
Insulin	89 (5.0)	65 (6.8)	50 (4.3)	9 (1.4)	<0.001 [^]
Injury epidemiology, no. (%)					
Mechanism of injury (Top 3 listed)					<0.001
Fall	824 (46.5)	687 (71.4)	957 (83.2)	572 (89.8)	
Road traffic crash	555 (31.3)	135 (14.0)	72 (6.3)	10 (1.6)	
Blunt	187 (10.6)	102 (10.6)	98 (8.5)	47 (7.4)	
Place of occurrence (Top 3 listed)					<0.001
Home	393 (22.2)	430 (44.7)	735 (63.9)	472 (74.1)	
Road	628 (35.4)	175 (18.2)	99 (8.6)	15 (2.4)	
Public places	329 (18.6)	243 (25.3)	211 (18.3)	103 (16.2)	

Table 1. Comorbidities, medications, injury epidemiology and outcomes. (Cont'd)

Variables	"Middle-aged" 45–64 years (n=1772)	"Young-old" 65–74 years (n=962)	"Middle-old" 75–84 years (n=1151)	"Old-old" 85 years and above (n=637)	P value
Tier of injury, no. (%)					0.314
T1	548 (30.9)	319 (33.2)	338 (29.4)	199 (31.2)	
T2	1224 (69.1)	643 (66.8)	813 (70.6)	437 (68.8)	
Outcomes, no. (%)					
ED disposition (excluding deaths in ED)	n=1740	n=952	n=1138	n=634	<0.001
Intensive care unit	213 (12.2)	92 (9.7)	81 (7.1)	20 (3.2)	
Intermediate care unit ^c	57 (3.3)	36 (3.8)	41 (3.6)	14 (2.2)	
High dependency	391 (22.5)	175 (18.4)	148 (13.0)	69 (10.9)	
General ward	1,079 (62.0)	647 (68.0)	867 (76.2)	531 (83.8)	
Discharged from ED ^d	0	2 (0.2)	1 (0.1)	0	
Stepdown care to community hospital or ILTC on discharge	210 (13.8)	205 (24.6)	320 (32.1)	164 (29.0)	<0.001
Overall mortality, no. (%)	121 (6.8)	77 (8.0)	108 (9.4)	74 (11.6)	0.001

ACE-Is: angiotensin converting enzyme inhibitors; ARBs: angiotensin receptor blockers; COPD: chronic obstructive pulmonary disease; ED: emergency department; ILTC: intermediate and long-term care; OHGAs: oral hypoglycaemic agents.

^a Defined as estimated glomerular filtration rate of less than 45 ml/min/1.73 m².

^b Number of OHGAs used ranged from 1 to 4.

^c Intermediate care unit: only in 1 of the 2 centres (Singapore General Hospital).

^d Includes discharges against medical advice.

[^] Fisher's Exact test.

Severity Score in multivariate analyses, congestive heart failure (adjusted OR [AOR] 1.73, 95% confidence interval [CI] 1.04–2.88), moderate-to-severe renal disease (AOR 1.75, 95% CI 1.10–2.80) and diuretic use (AOR 1.90, 95% CI 1.30–2.78) remained statistically significant for overall mortality.

Our study highlighted that trauma among older adults in Singapore is a public health concern with significant mortality and burden on healthcare resources. We sought to better elucidate epidemiological trends by categorising our study population into age-differentiated subgroups, based on the understanding that the elderly are a heterogeneous population group with varying functional status as ageing progresses.⁴ We found that "middle-old" patients (75–84 years old) accounted for the highest proportion of ED trauma presentations. This subgroup required the longest inpatient length-of-stay and was least likely to be discharged home after hospitalisation. The "middle-old" age range may represent a watershed period where patients are more prone to falls due to

poorer physiological reserves compared to the "young-old", but are relatively more mobile compared to the "old-old". More attention should be given to this subgroup, and future studies can focus on how to prevent injuries and improve outcomes among patients in this age range.

Additionally, we found that congestive heart failure and moderate-to-severe renal disease were independently and significantly associated with higher mortality in our study population following multivariate analysis. This was consistent with earlier studies which reported poorer outcomes in adult trauma patients with these conditions.^{5,6} A unifying feature shared between both conditions is fluid overload. Current Advanced Trauma Life Support guidelines recommend initial resuscitation with a litre of crystalloids followed by early resuscitation with blood products, regardless of patient's age or premorbid status. However, elderly trauma patients with congestive heart failure or moderate-to-severe renal disease may be susceptible to develop fluid overload following

intensive volume resuscitation. This can result in higher mortality due to complications of fluid overload such as pulmonary oedema and poor wound healing.⁷ A judicious fluid resuscitation strategy may be considered for elderly trauma patients with underlying diseases which can predispose them to fluid overload.

Among the medication classes we investigated, the pre-injury use of diuretics was found to be significantly associated with higher mortality in our study population. To our knowledge, there is no current literature to suggest an association between diuretic use and mortality in elderly trauma patients. However, previous systematic reviews have highlighted that diuretic use was associated with increased risk of falls among older adults.^{8,9} Use of alternative antihypertensive agents among older adults has been found to be associated with lower risk of injurious falls.^{9,10} These findings may be helpful in guiding prescription practices for elderly patients with hypertension.

Our study highlighted the intricate disease-drug-injury interactions, which may affect outcomes following trauma in older patients. Tailoring the management of older trauma patients while being aware of their underlying comorbid conditions and pre-injury medication use may help improve clinical outcomes.

Keywords: *emergency medicine, geriatric trauma, mortality, outcomes, Singapore*

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