Original Article

Road Crashes in Older Persons and the Use of Comorbidity Polypharmacy Score in an Asian Population

Mui Teng Chua, [1,2] *MBBS, MCEM, MPH*, Keshav Bhandari, [3] *MBBS,* Victor YK Ong, [1,2] *MBBS, FRCSEd(A&E)*, Win Sen Kuan, [1,2] *MRCSEd(A&E), MCI*

Abstract

Introduction: Age-related physiological changes predispose older road users to higher mortality from traffic crashes. We aimed to describe the injury epidemiology of these patients, and explore the association between the comorbidity polypharmacy score (CPS) and outcomes. Materials and Methods: This retrospective study utilised data from the Trauma Registry in the National University Hospital, Singapore, between January 2011 and December 2014. Patients involved in traffic crashes aged 45 years and above with injury severity scores (ISS) of 9 and higher were included. Results: There were 432 patients; median age was 58 (interquartile range, 51 to 65.5) years with predominance of male patients (82.2%) and Chinese ethnicity (66%). Overall mortality was 9.95%, with lower odds associated with higher Glasgow Coma Scale (odds ratio [OR] 0.73; 95% confidence interval [CI], 0.65 to 0.81, *P* <0.001), higher diastolic blood pressure (OR 0.98; 95% CI, 0.97 to 1.00, *P* = 0.031), and lower ISS of 9 to 15 (OR 0.10; 95% CI, 0.02 to 0.43, *P* = 0.002). The need for blood products was associated with higher mortality (OR 7.62; 95% CI, 2.67 to 21.7, *P* <0.001). CPS did not predict mortality. Independent predictors of discharge venue included length of stay, tier of injury and CPS group. Moderate CPS was statistically significant for nursing home placement (OR 10.7; 95% CI, 2.33 to 49.6, *P* = 0.002) but not for rehabilitation facility. Conclusion: CPS score is useful in predicting discharge to a nursing home facility for older patients with traffic crashes. Further larger studies involving other trauma types in the Asian population are needed to evaluate its utility.

Ann Acad Med Singapore 2017;46:185-94

Key words: Elderly, Motor vehicle crashes, Trauma severity indices

Introduction

In 2014, 11.2% of Singapore residents were aged 65 years and older.[1] This proportion is projected to increase to 18.7% by 2030.[2] The ageing population will herald a larger number of older road users, especially as improved healthcare renders them community-ambulant. Physiological changes and underlying comorbidities may predispose them to traffic crashes and poorer outcomes despite a lower injury severity. In Singapore, road crashes were only second to falls as the most common mechanism of injury in the adult trauma population.[3]

Age-related physiological changes such as cognitive impairment reduces ability to process information; diminution in vision and hearing delays recognition of road hazards; and reduced flexibility can affect older drivers' response to traffic conditions.[4,5] Older drivers are also more likely to have medical illness as a causative factor for traffic crashes.[6-8] Additionally, older crash victims have higher admission and fatality rates compared with the younger age groups.[4,9-11]

Traditional trauma scoring systems such as the Injury Severity Score (ISS) and Revised Trauma Score (RTS) have been shown to be variable in predicting mortality in the older population.[12,13] To better predict outcomes in older trauma patients, the Comorbidity Polypharmacy Score (CPS) was developed by a group of physicians in

[1]Emergency Medicine Department, National University Hospital, National University Health System, Singapore
[2] Department of Surgery, Yong Loo Lin School of Medicine, National University of Singapore, Singapore
[3]Ministry of Health Holdings Pte Ltd, Singapore
Address for Correspondence: Dr Chua Mui Teng, Emergency Medicine Department, National University Hospital, Singapore, 5 Lower Kent Ridge Road, Singapore 119074.
Email: mui_teng_chua@nuhs.edu.sg

the Ohio State University Wexner Medical Center and was first described in 2013.[14] CPS has been validated to predict mortality and likelihood of older trauma survivors being discharged home.[15-17] It has also been proposed to be a better measure of physiological age and frailty.[17,18] To the best of our knowledge, this novel scoring system has not been widely used or studied in the Asian trauma population.

The objectives of this study are: 1) To describe the injury epidemiological characteristics of older patients (aged 45 years and above) involved in motor vehicle crashes with an ISS of 9 and above; and 2) To explore the association between existing comorbidities and polypharmacy with outcomes using the CPS.

Materials and Methods

This retrospective study was carried out using data collected by the Trauma Registry in the National University Hospital, Singapore. Data was gathered from patients aged 45 years and above with T1 (ISS score ≥16) and T2 (ISS scores 9 to 15)[19] injuries, who were seen in the emergency department (ED) from January 2011 to December 2014. The local ethics committee approved waiver of informed consent. This age group was selected as they commonly have chronic medical conditions requiring long-term pharmacotherapy and polypharmacy[15,20] and the shift in the median age of the local population to 45 years by 2025 makes this an important watershed group to study.[21]

Detailed review of electronic medical records that included inpatient notes, ED charts and past medical history was performed by 2 independent data abstractors. Variables collected include the injury epidemiology, injury severity, outcome measures (mortality, ED disposition and discharge venues), and types of comorbidities and medications used. Any discrepancies were discussed and a third member of the study team was consulted to achieve a final consensus. CPS were calculated by adding pre-injury comorbidities (both past and current) and number of medications,[15-17] including over-the-counter medications or supplements for each patient. The CPS severities were then subdivided into minor (CPS of 0 to 7), moderate (8 to 14), severe (15 to 21) and morbid (≥22).[15]

Statistical Analysis

Results were analysed using Stata 14 (StataCorp LP, College Station, TX). Categorical data were analysed using chi-squared test or Fisher's exact test. Kruskal-Wallis and Mann-Whitney U tests were used for non-parametric variables; analysis of variance and Student's t test for parametric variables. Medians were reported with interquartile ranges (IQR) and means with standard deviations (SD). The outcomes of mortality, ED disposition and hospital discharge venue were examined. Variables with a *P* value of <0.10 were included for multivariate analysis. For the binary outcomes of mortality, logistic regression was used to obtain the odds ratio (OR) with its corresponding 95% confidence interval (CI).

For the analysis of discharge venue from the hospital for survivors, patients who were transferred to private or overseas hospitals were excluded because the study team could not obtain information on whether they required any step-down facility upon discharge. After the exclusion, univariate analyses were repeated for all the variables. Multinomial logistic regression was used to calculate ORs and 95% CIs for the likelihood of being discharged to a rehabilitation facility or nursing home compared to being discharged home. A *P* value of <0.05 was set for statistical significance after multivariate analysis.

Results

A total of 432 patients with T1 and T2 injuries from traffic crashes attended the ED between January 2011 and December 2014. The median age was 58 (IQR 51 to 65.5) years, with Chinese (n = 285, 66%) and male predominance (n = 355, 82.2%). Motorcycle riders constituted 45.6% (197/432) of the patients, 21.1% (91/432) were pedestrians and 12.5% (54/432) were cyclists. There were higher proportions of motorcycle riders in the younger groups, whereas pedestrians made up the majority in those 75 years and older (Table 1).

With regard to the severity of injuries, the majority (71.8%, 28/39) of the oldest group had an ISS of 16 and above, and advanced age was associated with a higher median length of stay (LOS) (Table 1). Patients aged 60 years and above were also more likely to require blood product transfusion, and have head and neck injuries compared to patients aged 45 to 59 years (Table 1).

The overall mortality was 9.95% (43/432), with higher proportion of deaths in the older groups (Table 2). After multiple logistic regression, higher Glasgow Coma Scale (GCS) scores (OR 0.73; 95% CI, 0.65 to 0.81, *P* <0.001), higher diastolic blood pressure values (OR 0.98; 95% CI, 0.97 to 1.00, *P* = 0.031) and lower ISS of 9 to 15 (OR 0.10; 95% CI, 0.02 to 0.43, *P* = 0.002) resulted in lower odds of mortality. The need for blood products transfusion in ED was associated with higher mortality (OR 7.62; 95% CI, 2.67 to 21.7, *P* <0.001).

The median CPS was 2 (IQR 0 to 6); 79.6% (344/432) had a CPS indicating minor severity, 18.3% (79/432) with moderate severity and 2.1% (9/432) in the severe group (Table 3). No patient had a morbid CPS score. Although higher CPS scores were not significantly associated with mortality, higher proportions of deaths were observed

Table 1. Injury Epidemiology, Severity and Mortality by Age Group

	45 to 59 Years n = 245 (%)	**60 to 74 Years n = 148 (%)**	**≥75 Years n = 39 (%)**	***P* Value**
Resident status				<0.001
Citizen	165 (67.4)	130 (87.8)	38 (97.4)	
Permanent resident	22 (8.98)	5 (3.38)	0 (0.0)	
Foreign worker	56 (22.9)	9 (6.1)	0 (0.0)	
Tourist/foreigner	2 (0.8)	4 (2.7)	1 (2.6)	
Gender				0.003
Male	214 (87.4)	114 (77.0)	27 (69.2)	
Female	31 (12.7)	34 (23.0)	12 (30.8)	
Ethnic group				0.037
Chinese	146 (59.6)	108 (73.0)	31 (79.5)	
Malay	51 (20.8)	25 (16.9)	6 (15.38)	
Indian	31 (12.7)	11 (7.4)	1 (2.6)	
Others	17 (6.9)	4 (2.7)	1 (2.6)	
Injured person type				<0.001
Motorbike rider	132 (53.9)	58 (39.2)	7 (18.0)	
Pillion	9 (3.7)	2 (1.4)	0 (0.0)	
Pedestrian	30 (12.2)	38 (25.7)	23 (59.0)	
Cyclist	24 (9.8)	27 (18.2)	3 (7.7)	
Vehicle driver	32 (13.1)	15 (10.1)	3 (7.7)	
Back passenger	15 (6.1)	6 (4.1)	1 (5.1)	
Front passenger	3 (1.2)	1 (0.7)	1 (2.6)	
Unknown	0 (0.0)	1 (0.7)	0 (0.0)	
Vehicle type				<0.001
Not applicable (pedestrian)	30 (12.2)	38 (25.7)	23 (59.0)	
Motorcycle	140 (57.1)	61 (41.2)	8 (17.9)	
Pedal cycle	24 (9.8)	27 (18.2)	2 (7.7)	
Taxi	6 (2.4)	5 (3.4)	1 (2.6)	
Private car	16 (6.5)	5 (3.4)	4 (12.8)	
Van/pickup truck	11 (4.5)	5 (3.4)	0 (0.0)	
Heavy transport vehicle	15 (6.1)	5 (3.4)	0 (0.0)	
Bus	3 (1.2)	0 (0.0)	0 (0.0)	
Others	0 (0.0)	2 (1.4)	0 (0.0)	
Type of object collided with				0.001
None	50 (20.4)	11 (7.4)	1 (2.6)	
Car, pickup truck or van	87 (35.5)	70 (47.3)	20 (51.3)	
2- or 3-wheel motor vehicle	10 (4.1)	11 (7.4)	5 (15.4)	
Heavy transport vehicle	60 (24.5)	28 (18.9)	6 (15.4)	
Fixed or stationary object	28 (11.4)	24 (16.2)	4 (12.8)	
Pedal cycle	2 (0.8)	2 (1.4)	1(2.6)	
Unknown	8 (3.3)	2 (1.4)	0 (0.0)	

DBP: Diastolic blood pressure; GCS: Glasgow Coma Scale; HR: Heart rate; IQR: Interquartile range; ISS: Injury Severity Score; LOS: Length of stay; SBP: Systolic blood pressure; SD: Standard deviation; T1: Tier 1; T2: Tier 2

Table 1. Injury Epidemiology, Severity and Mortality by Age Group (Cont'd)

	45 to 59 Years n = 245 (%)	60 to 74 Years n = 148 (%)	≥75 Years n = 39 (%)	*P* Value
Median GCS (IQR)	15 (15 to 15)	15 (15 to 15)	15 (10 to 15)	0.004
Mean SBP/DBP (SD)	132 (33)/76 (20)	138 (36)/78 (21)	128 (50)/67 (26)	0.306/0.021
Mean HR (SD)	83 (21)	80 (23)	78 (28)	0.360
Trauma team activated	92 (37.6)	45 (30.4)	15 (38.5)	0.322
Blood products given in ED	23 (9.4)	27 (18.2)	9 (23.1)	0.009
Median LOS (in days)	5.8 (2.5 to 12.6)	6.8 (3.0 to 16.9)	11.6 (4.0 to 30.5)	0.037
Tier of injury				<0.001
T1 (ISS ≥16)	90 (36.7)	58 (39.2)	28 (71.8)	
T2 (ISS 9 to 15)	155 (63.3)	90 (60.8)	11 (28.2)	
Injury type				
Head	93 (38.0)	70 (47.3)	28 (71.8)	<0.001
Face	53 (21.6)	44 (29.7)	14 (35.9)	0.064
Neck	3 (1.22)	21 (14.2)	6 (15.4)	<0.001
Chest	121 (49.4)	75 (50.7)	20 (51.3)	0.956
Abdomen	31 (12.7)	17 (11.5)	7 (18.0)	0.559
Pelvis	34 (13.9)	23 (15.5)	7 (18.0)	0.765
Upper limb	56 (22.9)	48 (32.4)	15 (38.5)	0.033
Lower limb	82 (33.5)	70 (47.3)	15 (38.5)	0.024
Spine	69 (28.2)	31 (21.0)	12 (30.8)	0.220
Overall mortality	18 (7.3)	17 (11.5)	8 (20.5)	0.029

DBP: Diastolic blood pressure; GCS: Glasgow Coma Scale; HR: Heart rate; IQR: Interquartile range; ISS: Injury Severity Score; LOS: Length of stay; SBP: Systolic blood pressure; SD: Standard deviation; T1: Tier 1; T2: Tier 2

(*P* = 0.133) by chi-squared test for trend (Table 3). Of those who survived to admission (n = 415), 51.6% (214/415) were admitted to the general ward and 47.5% (197/415) required admission to the intensive care unit/high dependency (ICU/HD); this was not affected by age or CPS.

Age was also not found to be a significant predictor of discharge venue (Table 4). Higher CPS, resident status, median GCS, injured person type, vehicle type, trauma team activation, median LOS and tier of injury were significantly associated with discharge venue (Table 4). After multinomial logistic regression, only LOS, tier of injury and CPS group remained statistically significant (Table 5). An increase in each day of stay in hospital was associated with higher odds of placement in a nursing home (OR 1.04; 95% CI, 1.02 to 1.05) or a rehabilitation facility (OR 1.02; 95% CI, 1.01 to 1.04). A lower ISS of 9 to 15 has lower likelihood for transfer to a rehabilitation facility (OR 0.41; 95% CI, 0.21 to 0.82); lower ISS also showed a trend towards a lower likelihood for nursing home placement albeit not statistically significant (OR 0.31; 95% CI, 0.07 to 1.49). Moderate CPS score, however, was only statistically significant for nursing home placement but not for placement into a rehabilitation facility (Table 5). When we examined the raw CPS scores, every 1-point increase in CPS increased the odds of nursing home placement compared to being discharged home by 18% (OR 1.18; 95% CI, 1.03 to 1.34, *P* = 0.017).

Discussion

Motor vehicle crashes are of global health concern. In the World Health Organization's (WHO) 'Global Status Report on Road Safety: Time for Action', it was reported that 50 million road users are injured globally per year due to traffic crashes, with more than 1.2 million deaths.[22] Pedestrians, cyclists and motorcyclists are collectively known as "vulnerable road users" as they constitute half of the road fatalities.[22] These casualties take a toll on a country's health resources and economy. Deaths from automobile crashes are postulated to increase from the 9th leading cause of deaths in 2004 to the 5th cause worldwide by 2030.[23] Yet, road traffic injuries and deaths are eminently preventable.

The top 3 groups of injured persons in our cohort, namely pedestrians, motorcyclists and cyclists, correspond to WHO's "vulnerable road users" who have higher risks of death.[24] This indeed warrants further action to ensure they are protected. The majority of patients (75 years

Table 2. Mortality At Discharge

	Survived, n = 389 (%)	Died, n = 43 (%)	*P* Value
Age (in years)			0.029
45 to 59	227 (58.4)	18 (41.9)	
60 to 74	131 (33.7)	17 (39.5)	
≥75	31 (7.97)	8 (18.6)	
Injured person type			0.522
Motorbike rider	181 (46.5)	16 (37.2)	
Pillion	11 (2.8)	0 (0.0)	
Pedestrian	77 (19.8)	14 (32.6)	
Cyclist	48 (12.3)	3 (14.0)	
Vehicle driver	46 (11.8)	0 (9.3)	
Back passenger	20 (5.1)	0 (7.0)	
Front passenger	5 (1.3)	0 (0.0)	
Unknown	1 (0.3)	0 (0.0)	
Vehicle type			0.101
Not applicable (pedestrian)	76 (19.5)	14 (32.6)	
Motorcycle	192 (49.4)	15 (37.2)	
Pedal cycle	48 (12.3)	4 (14.0)	
Taxi	11 (2.8)	1 (2.3)	
Private car	25 (6.4)	0 (2.3)	
Van/pickup truck	15 (3.9)	2 (2.3)	
Heavy transport vehicle	17 (4.4)	3 (7.0)	
Bus	3 (0.8)	0 (0.0)	
Others/unknown	2 (0.5)	1 (2.33)	
Type of object collided with			0.089
None	61 (15.7)	1 (2.3)	
Car, pickup truck or van	161 (41.4)	16 (37.2)	
2- or 3-wheel motor vehicle	25 (6.4)	2 (4.7)	
Heavy transport vehicle	79 (20.3)	15 (34.9)	
Fixed or stationary object	50 (12.9)	5 (16.3)	
Pedal cycle	5 (1.3)	0 (0.0)	
Unknown	8 (2.1)	2 (4.7)	
Trauma team activated	128 (32.9)	24 (55.8)	0.003
Blood products given in ED	42 (10.8)	17 (39.5)	<0.001
Tier of injury			<0.001
T1 (ISS ≥16)	135 (34.7)	41 (95.4)	
T2 (ISS 9 to 15)	254 (65.3)	2 (4.6)	
CPS group			0.133
Minor	313 (80.5)	31 (72.1)	
Moderate	69 (17.7)	10 (23.3)	
Severe	7 (1.8)	2 (4.7)	

CPS: Comorbidity Polypharmacy Score; ED: Emergency department; ISS: Injury Severity Score; T1: Tier 1; T2: Tier 2

and above) who were involved in traffic crashes were pedestrians (59%, n = 23). The age-related physiological changes, comorbidities and polypharmacy in these patients that prevented them from operating vehicles, continue to impair them even as pedestrians. Older pedestrians often require more time for crossing at traffic junctions,[25,26] hence modifications to pedestrian crossings should be considered. One example locally is the extension of crossing time for older pedestrians at selected traffic junctions using special concession cards.[27] Reducing speed limits at traffic junctions and establishing vehicle-free network of pedestrian routes may also protect these road users.[24]

In the age groups of 45 to 74 years, the greatest proportion of injured person type was the motorcyclists. Older riders are at higher risk for severe injuries and hospitalisation compared to younger ones.[28] Regular health checks, licensing and regulations, and encouraging the use of safer alternative transport are important in reducing traffic crashes in this group of road users.[24] Cyclists were the third largest group to be involved in road accidents (12.5%, n = 54) in our cohort. In order to minimise their risk of crashes and mortality from head injuries, dedicated cycling paths and mandatory helmet use should be established.[24,29]

Of note, the proportion of head and neck injuries was significantly higher in the older patients. This could possibly translate to more catastrophic injuries such as intracranial haemorrhages and cervical spine injuries, leading to drastic functional decline. Furthermore, close to half (47.5%) of the study cohort required ICU/HD admission, indicating a need for higher intensity monitoring and management. The older patients also tended to have longer hospital stay leading to higher consumption of healthcare resources. Mortality rates also increased as the age increases, in congruence with previous studies.[4,9-11,30]

As the ageing population grows with increasing incidence of chronic diseases, there will be a greater proportion of ambulant elderly road users on chronic medications. Apart from the injuries, the underlying comorbidities and interaction of polypharmacy may add to their frailty and compound their injury severity. Therefore, a better prognosticating tool for these patients is needed. The CPS was developed with such an intention to better quantify their true frailty, rather than rely on their “chronological age”.[15,17,31]

Part of our results differs from previous studies, which had demonstrated that CPS is an independent predictor of mortality[15,16,32] and discharge to a facility.[18,31] Our results did not show a significant association between CPS and mortality. This could be due to the low mortality (n = 43, 9.95%) in our cohort and the lack of power due to small numbers. The need for blood products in the ED as a predictor for mortality was also plausibly due to survival

Table 3. Demographics, Severity and Mortality by CPS Group

	CPS Minor (0 to 7) n = 344	CPS Moderate (8 to 14) n = 79	CPS Severe (15 to 21) n = 9	*P* Value
Age (in years)				<0.001
45 to 59	218 (63.4)	26 (32.9)	0 (11.1)	
60 to 74	99 (28.8)	42 (53.2)	7 (77.8)	
≥75	27 (7.9)	11 (13.9)	1 (11.1)	
Gender				0.037
Male	289 (84.0)	60 (76.0)	3 (66.7)	
Female	55 (16.0)	19 (24.0)	3 (33.3)	
Ethnic group				0.269
Chinese	225 (65.4)	52 (65.8)	4 (88.9)	
Malay	64 (18.6)	17 (21.5)	1 (11.1)	
Indian	35 (10.2)	8 (10.1)	0 (0.0)	
Others	20 (5.8)	2 (2.5)	0 (0.0)	
Resident status				<0.001
Citizen	245 (71.2)	79 (100.0)	5 (100.0)	
Permanent resident	27 (7.9)	0 (0.0)	0 (0.0)	
Foreign worker	65 (18.9)	0 (0.0)	0 (0.0)	
Tourist	7 (2.0)	0 (0.0)	0 (0.0)	
Trauma team activated	118 (34.3)	30 (38.0)	4 (44.4)	0.402
Blood products given in ED	36 (10.5)	21 (26.6)	2 (22.2)	<0.001
Median LOS (in days)	6.3 (2.8 to 13.8)	6.8 (2.5 to 24.0)	8.0 (1.7 to 30.0)	0.708
Tier of injury				0.919
T1 (ISS ≥16)	138 (40.1)	36 (45.6)	1 (22.2)	
T2 (ISS 9 to 15)	206 (59.9)	43 (54.4)	7 (77.8)	
Disposition from ED				0.538
General ward	173 (50.3)	35 (44.3)	6 (66.7)	
HD/ICU	157 (45.6)	37 (46.8)	2 (33.3)	
OT	3 (0.9)	1 (1.3)	0 (0.0)	
Died in ED	11 (3.2)	6 (7.6)	0 (0.0)	
Overall mortality	31 (9.0)	10 (12.7)	2 (22.2)	0.133
Discharge venue for survivors (n = 389)				0.006
Home	267 (85.3)	51 (73.9)	6 (85.7)	
Rehab facility	34 (10.9)	10 (14.5)	1 (14.3)	
Nursing home	4 (1.3)	7 (10.1)	0 (0.0)	
Other hospitals	8 (2.6)	1 (1.4)	0 (0.0)	

CPS: Comorbidity Polypharmacy Score; ED: Emergency department; HD: High dependency; ICU: Intensive care unit; ISS: Injury Severity Score; LOS: Length of Stay; OT: Operating theatre; T1: Tier 1; T2: Tier 2

bias, since patients who were more severely injured were more likely to require transfusion and thus have higher mortality. Nevertheless, our study showed that patients with moderate CPS have higher risk of being admitted to a nursing home compared to patients with minor CPS. Unfortunately, we did not have any patients in the severe CPS group who were admitted to the nursing home for analysis.

The lack of significant association between CPS and discharge to a rehabilitation unit could be due to their admission criteria. Generally, only patients who are able to participate in rehabilitation would be accepted and patients with higher CPS may be too incapacitated for any rehabilitation. We postulated this as a proportion of patients who were discharged home had moderate (15.7%) or severe (1.9%) CPS. Notwithstanding, knowledge that patients with more comorbidities and medications have higher

Table 4. Discharge Venues for Survivors

	Home n = 324 (%)	Rehab Facility n = 45 (%)	Nursing Home n = 11 (%)	Other Hospitals n = 9 (%)	*P* Value
Age (in years)					0.188
45 to 59	192 (59.3)	23 (51.1)	4 (36.4)	6 (88.9)	
60 to 74	109 (33.6)	16 (35.6)	5 (45.5)	0 (11.1)	
≥75	23 (7.1)	6 (13.3)	2 (18.2)	0 (0.0)	
Resident status					0.006
Citizen	250 (77.2)	40 (88.9)	9 (81.8)	1 (33.3)	
Permanent resident	22 (6.8)	2 (4.4)	0 (0.0)	0 (0.0)	
Foreign worker	47 (14.5)	3 (6.7)	2 (18.2)	2 (55.6)	
Tourist	5 (1.5)	0 (0.0)	0 (0.0)	1 (11.1)	
Median GCS (IQR)	15 (15 to 15)	15 (14 to 15)	15 (9 to 15)	15 (10 to 15)	<0.001
Injured person type					<0.001
Motorbike rider	158 (48.8)	15 (33.3)	1 (9.1)	7 (77.8)	
Pillion	9 (2.8)	2 (4.4)	0 (0.0)	0 (0.0)	
Pedestrian	59 (18.2)	10 (22.2)	6 (54.5)	1 (22.2)	
Cyclist	39 (12.0)	8 (17.8)	1 (9.1)	0 (0.0)	
Vehicle driver	38 (11.7)	6 (13.3)	2 (18.2)	0 (0.0)	
Back passenger	17 (5.2)	3 (6.7)	0 (0.0)	0 (0.0)	
Front passenger	4 (1.2)	1 (2.2)	0 (0.0)	0 (0.0)	
Unknown	0 (0.0)	0 (0.0)	1 (9.1)	0 (0.0)	
Vehicle type					<0.001
Not applicable (pedestrian)	58 (17.9)	10 (22.2)	6 (54.5)	1 (22.2)	
Motorcycle	167 (51.5)	17 (37.8)	1 (9.1)	6 (77.8)	
Pedal cycle	39 (12.0)	8 (17.8)	1 (9.1)	0 (0.0)	
Taxi	9 (2.8)	0 (0.0)	2 (18.2)	0 (0.0)	
Private car	23 (7.1)	2 (4.4)	0 (0.0)	0 (0.0)	
Van/pickup truck	11 (3.4)	4 (8.9)	0 (0.0)	0 (0.0)	
Heavy transport vehicle	15 (4.6)	2 (4.4)	0 (0.0)	0 (0.0)	
Bus	1 (0.3)	2 (4.4)	0 (0.0)	0 (0.0)	
Others/unknown	1 (0.3)	0 (0.0)	1 (9.1)	0 (0.0)	
Type of object collided with					0.092
None	58 (17.9)	2 (4.4)	1 (9.1)	0 (0.0)	
Car, pickup truck or van	131 (40.4)	19 (42.2)	5 (45.5)	3 (55.6)	
2- or 3-wheel motor vehicle	20 (6.2)	3 (6.7)	1 (9.1)	1 (11.1)	
Heavy transport vehicle	65 (20.1)	11 (24.4)	1 (9.1)	2 (22.2)	
Fixed or stationary object	43 (13.7)	5 (11.1)	1 (9.1)	1 (11.1)	
Pedal cycle	3 (0.9)	1 (2.2)	1 (9.1)	0 (0.0)	
Unknown	3 (0.9)	4 (8.9)	1 (9.1)	0 (0.0)	
Trauma team activated	98 (30.3)	22 (48.9)	6 (54.6)	2 (22.2)	0.029
Median LOS (in days)	5.9 (3.0 to 12.5)	19 (13.0 to 31.3)	62.8 (43.0 to 99.2)	5.5 (2.0 to 25.3)	0.001

CPS: Comorbidity Polypharmacy Score; GCS: Glasgow Coma Scale; IQR: Interquartile range; ISS: Injury Severity Score; LOS: Length of stay; SBP: Systolic blood pressure; SD: Standard deviation; T1: Tier 1; T2: Tier 2

Table 4. Discharge Venues for Survivors (Cont'd)

	Home n = 324 (%)	Rehab Facility n = 45 (%)	Nursing Home n = 11 (%)	Other Hospitals n = 9 (%)	*P* Value
Tier of injury					<0.001
T1 (ISS ≥16)	97 (29.9)	26 (57.8)	8 (72.7)	3 (44.4)	
T2 (ISS 9 to 15)	227 (70.1)	19 (42.2)	3 (27.3)	5 (55.6)	
CPS group					0.006
Minor	267 (82.4)	34 (75.6)	4 (36.4)	7 (88.9)	
Moderate	51 (15.7)	10 (22.2)	7 (63.6)	1 (11.1)	
Severe	6 (1.9)	1 (2.2)	0 (0.0)	0 (0.0)	

CPS: Comorbidity Polypharmacy Score; GCS: Glasgow Coma Scale; IQR: Interquartile range; ISS: Injury Severity Score; LOS: Length of stay; SBP: Systolic blood pressure; SD: Standard deviation; T1: Tier 1; T2: Tier 2

Table 5. Results from Multinomial Logistic Regression on Discharge Venue

	Rehab vs Home		NH vs Home	
	Adjusted OR (95% CI)	*P* Value	Adjusted OR (95% CI)	*P* Value
LOS (days)	1.02 (1.01 to 1.04)	0.001	1.04 (1.02 to 1.05)	<0.001
Tier of injury				
ISS (≥16)	1.00		1.00	
ISS (9 to 15)	0.41 (0.21 to 0.82)	0.011	0.31 (0.07 to 1.49)	0.145
CPS group				
Minor	1.00		1.00	
Moderate	1.33 (0.60 to 2.99)	0.484	10.7 (2.33 to 49.6)	0.002
Severe	1.59 (0.17 to 14.8)	0.683	No patients	

CPS: Comorbidity Polypharmacy Score; ISS: Injury Severity Score; LOS: Length of stay; NH: Nursing home; OR: Odds ratio

risk of nursing home placement may prompt clinicians to undertake early discharge care planning to prevent prolonged hospital stay.

The cohort studied here had a median CPS score of only 2, which could be real or artefactual. They may have been genuinely healthy or were simply non-compliant with medications or underdiagnosed due to a lack of health-seeking behaviour. In the National Health Survey 2010, younger residents were found to be less likely to undergo health screening compared to those aged 60 to 69 years.[33] Given the generally low CPS, we found it more meaningful to consider the raw CPS scores without categorising them. Each 1-point increase in CPS was associated with higher odds of need for nursing home placement.

Strengths of this study include the novel use of the CPS score in an Asian trauma population. As alluded to earlier, to the best of our knowledge, this scoring system has not been studied in the Asian context. The epidemiology of road traffic crashes in older persons is also not widely explored. Previous studies on automobile crashes done locally were mainly on fatalities and the general population.[34-38] This study provides an understanding of the injury epidemiology specifically in the older cohort who are more susceptible to severe injuries and death, thus providing insight to the healthcare resources utilised in the management and more importantly, prevention of injuries from traffic crashes for this population.

Limitations

There are some limitations to this study. First, its retrospective design harbours inherent weaknesses. Second, we were not able to contact the patients' primary physicians for added comprehensiveness in data collection of medications and comorbidities, as this information was not available electronically. Third, the numbers of patients discharged to rehabilitation facility and nursing home were relatively small, resulting in imprecise OR estimates. The raw CPS scores however, gave a more precise risk estimate for nursing home placement. We were also unable to examine the effect of severe CPS on nursing home admission. A type II error could not be excluded since the number of survivors admitted to a rehabilitation facility was relatively small

(11.6%, n = 45). However, these results can be used for hypothesis generation and more studies should be conducted to look at a larger cohort, including other trauma types in our local population.

Lastly, most previous studies on CPS were performed on trauma cohorts with various mechanisms of injuries, except for one conducted in burns patients.[18] Hence, its application on a cohort that comprises patients from road crashes may be an oversimplification. This raises the question of whether patients in traffic crashes behave differently from the rest of the trauma subgroups. One postulation is that these patients could be a self-selected group; they are likely to be less frail compared to patients of other trauma types on the basis that they are community-ambulant.

Conclusion

Older victims of road traffic crashes have higher morbidity and mortality compared to their younger peers. The CPS score could potentially be used as an adjunct to current trauma scoring tools to predict the need for discharge to a step-down facility; but larger studies need to be done for further evaluation of its usefulness in Asian populations.

REFERENCES

1. Population Trends 2014. Department of Statistics Singapore. Available at: http://www.singstat.gov.sg. Accessed on 11 November 2015.
2. Statistical indicators on the elderly. Singapore: Ministry of Social and Family Development. Available at: http://app.msf.gov.sg/Research-Room/Research-Statistics/Statistical-Indicators-on-the-Elderly. Accessed on 11 November 2015.
3. Wui LW, Shaun GE, Ramalingam G, Wai KM. Epidemiology of trauma in an acute care hospital in Singapore. J Emerg Trauma Shock 2014;7:174-9.
4. Lilley JM, Arie T, Chilvers CE. Accidents involving older people: a review of the literature. Age Ageing 1995;24:346-65.
5. Schwab CW, Kauder DR. Trauma in the geriatric patient. Arch Surg 1992;127:701-6.
6. McGwin G Jr, Brown DB. Characteristics of traffic crashes among young, middle-aged, and older drivers. Accid Anal Prev 1999;31:181-98.
7. Hong K, Lee KM, Jang SN. Incidence and related factors of traffic accidents among the older population in a rapidly aging society. Arch Gerontol and Geriatr 2015;60:471-7.
8. Hansotia P, Broste SK. The effect of epilepsy or diabetes mellitus on the risk of automobile accidents. N Eng J Med 1991;324:22-6.
9. Lee WY, Cameron PA, Bailey MJ. Road traffic injuries in the elderly. Emerg Med J 2006;23:42-6.
10. Ryan GA, Legge M, Rosman D. Age-related changes in drivers' crash risk and crash type. Accid Anal Prev 1998;30:379-87.
11. Etehad H, Yousefzadeh-Chabok S, Davoudi-Kiakalaye A, Moghadam D, Hemati H, Mohtasham-Amiri Z. Impact of road traffic accidents on the elderly. Arch Gerontol Geriatr 2015;61:489-93.
12. Tornetta P, Mostafavi H, Riina J, Turen C, Reimer B, Levine R, et al. Morbidity and mortality in elderly trauma patients. J Trauma 1999;46:702-6.
13. Oreskovich MR, Howard JD, Copass MK, Carrio CJ. Geriatric trauma: injury patterns and outcome. J Trauma 1984;24:565-72.
14. Comorbidity-Polypharmacy Score Validated. Division of Trauma, Critical Care and Burn. Department of Surgery. The Ohio State University Wexner Medical Centre. Available at: http://tinyurl.com/j6bqaev. Accessed on 15 November 2015.
15. Evans DC, Cook CH, Christy JM, Murphy CV, Gerlach AT, Eiferman D, et al. Comorbidity-polypharmacy scoring facilitates outcome prediction in older trauma patients. J Am Geriatric Soc 2012;60:1465-70.
16. Mubang RN, Stoltzfus JC, Cohen MS, Hoey BA, Stehly CD, Evans DC, et al. Comorbidity-polypharmacy score as predictor of outcomes in older trauma patients: a retrospective validation study. World J Surg 2015;39:2068-75.
17. Justiniano CF, Evans DC, Cook CH, Eiferman DS, Gerlach AT, Beery PR, et al. Comorbidity-polypharmacy score: a novel adjunct in post-emergency department trauma triage. J Surg Res 2013;181:16-9.
18. Justiniano CF, Coffey RA, Evans DC, Jones LM, Jones CD, Bailey JK, et al. Comorbidity-polypharmacy score predicts in-hospital complications and the need for discharge to extended care facility in older burn patients. J Burn Care Res 2015;36:193-6.
19. Singapore Trauma. Available at: http://singaporetrauma.com. Accessed on 6 December 2015.
20. Stawicki SP, Gerlach AT. Polypharmacy and medication errors: stop, listen, look, and analyze. OPUS 12 Scientist 2009;3:6-10.
21. A Sustainable Population for a Dynamic Singapore: Population White Paper 2013. Available at: population.sg/whitepaper/resource-files/population-white-paper.pdf. Accessed on 11 November 2015.
22. Global Status Report on Road Safety: Time for Action. Geneva:World Health Organisation, 2009.
23. World Health Statistics. Part 1: Ten Highlights in Health Statistics. World Health Organisation; 2008. Available at: http://tinyurl.com/jhzrck4. Accessed on 11 November 2015.
24. World Report on Road Traffic Injury Prevention. World Health Organisation; 2004. Available at: http://tinyurl.com/hzarhhb. Accessed on 11 November 2015.
25. Langlois JA, Keyl PM, Guralniik JM, Foley DJ, Marottoli RA, Wallace RB. Characteristics of older pedestrians who have difficulty crossing the street. Am J Public Health 1997;87:393-7.
26. Kong PW, Chua YHK, Ooi CY, Sim YJ. Challenges of adequate road crossing time for older persons: a pilot study in Singapore. J Am Geriatr Soc 2013;61:1226-7.
27. Green Man +: one.motoring. Accessed on 6 December 2015.
28. Jackson T, Mello M. Injury patterns and severity among motorcyclists treated in US emergency departments, 2001-2008: a comparison of younger and older riders. Inj Prev 2013;19:297-302.
29. Cameron MH, Vulcan AP, Finch CF, Newstead SV. Mandatory bicycle helmet use following a decade of helmet promotion in Victoria, Australia—An evaluation. Accid Anal Prev 1994;26:325-37.
30. Grossman MD, Miller D, Scaff DW, Arcona S. When is an elder old? Effect of pre-existing conditions on mortality in geriatric trauma. J Trauma 2002;52:242-6.
31. Evans DC, Gerlach AT, Christy JM, Jarvis AM, Lindsey DE, Whitmill ML, et al. Pre-injury polypharmacy as a predictor of outcomes in trauma patients. Int J Crit Illn Inj Sci 2011;1:104-9.

32. Holmes M, Garver M, Albrecht L, Arbabi S, Pham T. Comparison of two comorbidity scoring systems for older adults with traumatic injuries. J Am Coll Surg 2014;219:631-7.

33. National Health Survey, Singapore: Ministry of Health, 2010. [cited 11 Nov 2015]. Available at: http://tinyurl.com/hyuudsu. Accessed on 11 November 2015.

34. Wong E, Leong MKF, Anantharaman V, Raman L, Wee KP, Chao TC. Road traffic accident mortality in Singapore. J Emerg Med 2002;22:139-46.

35. Cheng C, Loy FJ. Traffic accident injuries. A survey of the injured driver, front-seating passenger and motorcyclists. Traffic Med 1979;7:8-13.

36. Chao TC, Khoo JH, Poon WN. Road traffic accident casualties in Singapore (with special reference to drivers and front seat passengers). Ann Acad Med Singapore 1984;13:96-101.

37. Wong ZH, Chong CK, Tai BC, Lau G. A review of fatal road traffic accidents in Singapore from 2000 to 2004. Ann Acad Med Singapore 2009;38:594-6.

38. Lau G, Seow E, Lim ES. A review of pedestrian fatalities in Singapore from 1990 to 1994. Ann Acad Med Singapore 1998;27:830-7.