Road traffic injuries in the elderly

W Y Yee, P A Cameron, M J Bailey

Objective: Elderly victims of motor vehicle collisions are increasing with the aging population. This study aimed to investigate the injury pattern of elderly victims involved in motor vehicle collisions.

Methods: This was a retrospective study using data from the Victorian State Trauma Outcome Registry and Monitoring Group (VSTORM) from June 2001 to July 2003, Australian Bureau of Statistics year 2001 population estimates, and Victoria Transport Accident Commission year 2001 total road death toll. Elderly victims were defined as age 65 and above. Comparison of fatality rates and general injury patterns for the elderly and young victims was undertaken.

Results: The total fatality rate of the elderly group was almost double that of the younger group. The elderly victims had a higher rate of chest injuries (23.42% vs 18.17%; p = 0.003). The three most common chest injuries of the elderly victims were rib fractures (23.58%), flail chest (9.55%), and sternum fractures (5.97%). Elderly chest injured patients also had longer intensive care unit stay compared with the younger group (7.96 days vs 5.31 days; p = 0.048).

Conclusions: Elderly victims of motor vehicle collisions have a higher risk of chest injuries, especially of chest wall injuries. Age specific injury patterns are important in determining primary and secondary prevention strategies.

The rising proportion of the population aged 65 and older is increasing demands on the healthcare system and causing concern in many countries. From 1992 to 2002, the proportion of people aged 65 years and over in the United States for example, grew 27% faster than that of the total population. The elderly are more likely to use health care facilities for both medical and traumatic illnesses. Different rates and patterns of injury in the elderly result in poorer outcomes in this group. There are potential opportunities for primary and secondary injury prevention strategies to improve morbidity and mortality in the elderly, particularly those serious injuries resulting from road traffic collisions.

With the aging population, there has been a corresponding increase in the total number of older road users, either as vehicle occupants or as pedestrians. Preusser et al showed that drivers aged 65–69 years were 1.29 times more at risk of being involved in fatal crashes and drivers aged 85 and older were 3.74 times more at risk when compared to drivers aged 40–49. Older drivers have a major impact on other road users, increasing the risk of morbidity and mortality of their passengers and other passenger vehicles’ occupants. Elderly collision victims have an increased risk of fatality because of increased fragility. In the US, Lyman has projected a 178% increase in road crashes involving the elderly and a 155% increase in fatalities involving the elderly. This will account for about 40% of the expected increase in all road crashes and more than 50% of the expected increase in fatalities.

Similar aging trends have been seen in the state of Victoria, Australia from 1996 to 2001. The median age of the population had increased from 33 to 35 years. While the proportion of people aged 65 years and over increased marginally from 12% to 12.7%, the proportion of people aged 14 and less decreased from 21.2% to 20.4%. In the year 2003, there was a total of 330 fatalities on the roads, 6.71 deaths per 100 000 people in the population. Older drivers (aged 65+) represented 13% of license holders but accounted for 16% of fatalities and 10% of serious injuries. In terms of fatalities per kilometre traveled, older drivers were seven times more likely to be killed than the lowest risk age group, 45–54 year olds. Older pedestrians represent 13% of the population, but account for 36% of fatalities and 15% of serious injuries.

Many countries have seen growing numbers of older road users and greater numbers of elderly present to the emergency department as the result of motor vehicle collisions. Few studies have examined the injury pattern in elderly victims despite the fact that the elderly have a higher risk of fatality. The aim of this study was to investigate the differences in injury pattern for elderly patients involved in motor vehicle collisions. This could be helpful in guiding prevention and management strategies in this age group.

METHODOLOGY

This is a retrospective study carried out using data collected by the Victorian State Trauma Outcome Registry and Monitoring Group (VSTORM).

Setting

The state of Victoria, Australia has a population of 4.9 million people with two thirds of its population in the metropolitan Melbourne. It has two adult and one paediatric major trauma centres.

Data

The Victorian State Trauma Registry (VSTR) database collects standardised trauma data from the hospitals for all major traumas in Victoria. All Victorian hospitals other than one health service provide these data. It is estimated that during the period of study, more than 90% of the major trauma patients were included. In the VSTR, patients meeting the following criteria were included:

Abbreviations: AIS, Abbreviated Injury Score; GCS, Glasgow Coma Score; ICU, intensive care unit; ISS, Injury Severity Score; TAC, Transport Accident Commission; TRISS, Trauma and Injury Severity Score; VSTORM, Victorian State Trauma Outcome Registry and Monitoring Group; VSTR, Victorian State Trauma Registry.
1. All deaths after injury.
2. All patients admitted to an intensive care unit (ICU) or high dependency area for more than 24 hours and are mechanically ventilated after admission.
3. Significant injury to two or more Injury Severity Score (ISS) body regions (corresponding to Abbreviated Injury Score (AIS) AIS>2 in two or more body regions) or ISS>15.
4. Urgent surgery (within 24 hours of injury) for intracranial, intrathoracic, or intraabdominal injury, or fixation of pelvic or spinal fractures.
5. Electrical injuries, drowning, asphyxia included if admitted to an ICU and have mechanical ventilation greater than 24 hours.
6. All patients with injury as principal diagnosis whose length of stay is three days or more—unless meet exclusion criteria.
7. All patients, with injury as principal diagnosis, transferred or received from another hospital for further emergency care or admitted to a high dependency area—unless meets exclusion criteria.

The exclusion criteria were:

1. Isolated fractured neck of femur.
2. Isolated upper limb joint dislocation, shoulder girdle dislocation (unless associated with vascular compromise) and toe/foot/knee joint dislocation—unless meets inclusion criteria 1, 2, or 4.
3. Isolated closed, limb fractures only (for example, fractured femur, Colles fracture)—unless meets inclusion criteria 1, 2, or 4.
4. Isolated injuries distal to the wrist and ankle only (for example, finger amputations)—unless meets inclusion criteria 1, 2, or 4.
5. Soft tissue injuries only (for example, tendon and nerve injury and uncomplicated skin injuries)—unless meets inclusion criteria 1, 2, or 4.
6. Burns to less than 10% of the body—unless meets inclusion criteria 1, 2, or 4.

Data were gathered from patients injured in motor vehicle collisions from June 2001 to July 2003. The following data were used for the study: biodata of the patient, prehospital information, presenting physiological data, ICD10 diagnosis codes (the International Classification of Diseases, 10th Revision, Australian Modification, which is based on the official version of the World Health Organization’s 10th Revision), operative procedures, length of stay in the ICU and hospital, and outcome of the patient. Injury scoring according to the AIS 1990 revision was performed by VSTORM. Other calculated data generated include the Revised Trauma Score (RTS) calculated from emergency department arrival physical data generated include the Revised Trauma Score (AIS) AIS to the AIS 1990 revision was performed by VSTORM. Other official version of the World Health Organization’s 10th edition, the Australian Modification, which is based on the official version of the World Health Organization’s 10th Revision). The use of de-identified data in this study was approved and provided by VSTORM. VSTORM obtained full ethics committee approval from each hospital/health service contributing to the Registry before data collection in that setting.

### RESULTS

The VSTR database recorded a total of 1539 major trauma patients involved in road traffic collisions between 1 June 2001 and 31 July 2003. The young group included all patients less than 65 years with a mean age 30.5 years and the elderly group included all patients more than or equal to 65 years (65 years). There were 1361 patients in the young group and 178 patients in the elderly group. The mean age of the elderly group was almost double that of the younger group. A comparison of the physiological factors and injury scores between the two groups showed that there was no difference between the GCS, RTS, and ISS. TRISS score was lower in the younger group (old, 0.88 v young, 0.97; p<0.0001) This was a road or road related area in Victoria. Death had to be within 30 days of the date of crash and excluded suicides, off-road crashes, and natural causes (for example, heart attacks).
The types of collisions and the inhospital mortality rates according to the collision type are shown in table 2. For elderly pedestrians who presented to the hospital after a collision, the inhospital mortality rate was similar to the younger group. However elderly motor vehicle occupants, who survived to hospital, showed a statistically significant higher mortality rate compared to the younger group.

A patient may have multiple body regions involved in the collision. Moreover each body region may demonstrate several different types of injuries. For example, the patient may have chest, abdominal, and extremities body regions involvement by AIS classification. For chest injuries, the patient may have rib fractures, pneumothorax, and cardiac contusion. Thus analysis of the AIS body regions and type of injuries were calculated according to the injuries noted and not to the number of patients. This resulted in a larger number of cases than the total number of patients as shown in the analysis.

The elderly group had a higher rate of chest injuries while the young group had higher abdominal and facial injury rates (table 3). There were no significant differences between the severity of the injury for each AIS region between the two groups. The increased rate of chest injuries in the elderly group was mainly due to motor vehicle occupants (table 4).

In the elderly group the most common chest injuries were those involving the chest wall, (table 5) namely rib fractures (23.58%), flail chest (9.55%), and sternal fractures (5.97%). All these figures were significantly higher than that for the young group. Spinal injuries were noted to be significantly higher for the young group in both analysis of chest (21.74%, p<0.001) and abdominal injuries (31.46%, p = 0.02).

The percentages of head and neck injuries and the severity of the injuries for both groups were similar, but there was a lower operative rate (old, 9.27% vs young, 16.71%, p = 0.007) for the old group. Operative rates for chest, abdomen, muscular skeletal, spine, and others were the same for both age groups. The total length of stay in the acute hospital and ICU was not found to be different between the young and old group. However, when total ICU stay was analysed according to the AIS injury region, the old group with chest injury had a longer ICU stay compared to the younger group (old, 7.96 days vs young, 5.31 days, p = 0.048).

Inhospital mortality was higher in the old group (old, 26.40% vs young, 9.49%, p>0.001). This did not appear to be due to injuries from a particular body region.

**DISCUSSION**

Motor vehicle collisions involving elderly people have become an important problem that requires further investigation. Age in itself is an important injury risk factor, increasing the rate of injury and severity. Our study has shown that road traffic injuries in the elderly resulted in an inhospital mortality rate double that of younger patients and that there was a significantly higher rate of chest injuries. On a population basis, overall road traffic fatality rates for the elderly were almost double that of the younger group.

Most of the research in this area has been performed in the US. Compared to the US, Victoria has a lower fatality rate. Although the rates were lower, most of the trends seen in the US were also reflected in our data. Male involvement was significantly greater than that of female involvement across all age groups. Interestingly, similar to the US trend, elderly females had a sharp increase in fatality rate. The fatality rate of the elderly female was almost three times that of the younger female.

The US motor vehicle collision fatality data for the elderly showed death was mainly due to motor vehicle occupants rather than pedestrians. A similar trend was shown in our study. In major trauma patients who survived to hospital, the total mortality rate of the elderly group involved was 26.4%, with driver mortality and passenger mortality both at 27.16% and pedestrian mortality at 25%. Given that two thirds were motor vehicle occupants and they generally have a higher mortality rate, the question of limiting the elderly from

### Table 2 Collision and mortality according to type of collision involved versus age

<table>
<thead>
<tr>
<th>Collision</th>
<th>Mortality*</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>Motor vehicle driver</td>
<td>531</td>
</tr>
<tr>
<td>Motor vehicle passenger</td>
<td>269</td>
</tr>
<tr>
<td>Motorcycle driver</td>
<td>254</td>
</tr>
<tr>
<td>Motorcycle passenger</td>
<td>15</td>
</tr>
<tr>
<td>Other transport</td>
<td>25</td>
</tr>
<tr>
<td>Bicyclist</td>
<td>80</td>
</tr>
<tr>
<td>Pedestrian</td>
<td>187</td>
</tr>
<tr>
<td>Total</td>
<td>1361</td>
</tr>
</tbody>
</table>

*Mortality is expressed as a percentage to the collision of the type of collision involved.
†p values were not calculated for these values as the number involved were too small. NS, not significant.

### Table 3 AIS body region versus age

<table>
<thead>
<tr>
<th>Body region</th>
<th>&lt;65 years %</th>
<th>&gt;65 years %</th>
<th>Total %</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdomen or pelvic content</td>
<td>491</td>
<td>11.54</td>
<td>44</td>
<td>8.18</td>
</tr>
<tr>
<td>Chest</td>
<td>773</td>
<td>18.17</td>
<td>126</td>
<td>23.42</td>
</tr>
<tr>
<td>External</td>
<td>829</td>
<td>19.49</td>
<td>100</td>
<td>18.59</td>
</tr>
<tr>
<td>Extremities or pelvic gird</td>
<td>824</td>
<td>19.37</td>
<td>116</td>
<td>21.56</td>
</tr>
<tr>
<td>Face</td>
<td>394</td>
<td>9.26</td>
<td>29</td>
<td>5.39</td>
</tr>
<tr>
<td>Head or neck</td>
<td>943</td>
<td>22.17</td>
<td>123</td>
<td>22.86</td>
</tr>
<tr>
<td>Total</td>
<td>4254</td>
<td>100</td>
<td>538</td>
<td>100</td>
</tr>
</tbody>
</table>
Road traffic injuries in the elderly

Table 4 Involvement of the body region versus age group in different collision type

<table>
<thead>
<tr>
<th>Body region</th>
<th>Motor vehicle drivers</th>
<th>Motor vehicle passenger</th>
<th>Motor vehicle passenger</th>
<th>Pedestrians</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;65 years</td>
<td>%</td>
<td>&gt;65 years</td>
<td>%</td>
</tr>
<tr>
<td>Abdomen and pelvic content</td>
<td>197</td>
<td>11.10</td>
<td>19</td>
<td>7.76</td>
</tr>
<tr>
<td>Chest</td>
<td>331</td>
<td>18.66</td>
<td>65</td>
<td>26.53</td>
</tr>
<tr>
<td>External</td>
<td>350</td>
<td>19.73</td>
<td>47</td>
<td>19.18</td>
</tr>
<tr>
<td>Pelvic and extremities</td>
<td>332</td>
<td>18.71</td>
<td>51</td>
<td>20.82</td>
</tr>
<tr>
<td>Face</td>
<td>186</td>
<td>10.48</td>
<td>15</td>
<td>6.12</td>
</tr>
<tr>
<td>Head and neck</td>
<td>378</td>
<td>21.31</td>
<td>48</td>
<td>19.59</td>
</tr>
<tr>
<td>Total</td>
<td>1774</td>
<td>100.00</td>
<td>245</td>
<td>100.00</td>
</tr>
</tbody>
</table>

NS, not significant.

Table 5 Type of chest injuries in young and elderly groups

<table>
<thead>
<tr>
<th>Injury description</th>
<th>&lt;65 years</th>
<th>%</th>
<th>&gt;65 years</th>
<th>%</th>
<th>total</th>
<th>%</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single rib fracture</td>
<td>66</td>
<td>3.32</td>
<td>9</td>
<td>2.69</td>
<td>75</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Multiple ribs fracture</td>
<td>303</td>
<td>15.25</td>
<td>70</td>
<td>20.90</td>
<td>373</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Flail chest</td>
<td>72</td>
<td>3.62</td>
<td>32</td>
<td>9.57</td>
<td>104</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Sternum</td>
<td>47</td>
<td>2.37</td>
<td>20</td>
<td>5.97</td>
<td>67</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Cardiac</td>
<td>42</td>
<td>2.11</td>
<td>9</td>
<td>2.69</td>
<td>51</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Diaphragm</td>
<td>35</td>
<td>1.76</td>
<td>6</td>
<td>1.79</td>
<td>41</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Lung</td>
<td>401</td>
<td>20.18</td>
<td>64</td>
<td>19.10</td>
<td>465</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Pleural</td>
<td>496</td>
<td>24.96</td>
<td>85</td>
<td>25.37</td>
<td>581</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Spine</td>
<td>432</td>
<td>21.74</td>
<td>22</td>
<td>6.57</td>
<td>454</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Vessel</td>
<td>22</td>
<td>1.11</td>
<td>4</td>
<td>1.19</td>
<td>26</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>63</td>
<td>3.17</td>
<td>12</td>
<td>3.58</td>
<td>75</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Wrong</td>
<td>8</td>
<td>0.40</td>
<td>2</td>
<td>0.60</td>
<td>10</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1987</td>
<td>100.00</td>
<td>335</td>
<td>100.00</td>
<td>2322</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NS, not significant.
people have a more compliant chest wall and better musculature. Hence, forces are transmitted by the seatbelt to the spine and result in spinal injuries. Another possibility may be difficulty in differentiating acute spinal fracture from old osteoporotic fractures in the elderly patients. Thus spinal injuries may be underdiagnosed in the elderly group.

For head and neck injuries, both the elderly and young group had similar AIS severity and no significant difference in presenting GCS. However, the operative rate for the elderly group was much lower. In Scotland, it was noted that age appears to be an independent factor in trauma care, with significantly more of the elderly patients dying than would be predicted. With this in mind we did an analysis of mortality by AIS region between the two groups. There was no difference in the mortality rate of head and neck injured patients between the elderly and the young.

Our study has several limitations. The data used for injury pattern do not take into account the people who did not present to hospital, such as those who died at the scene or suffered minor injuries that did not require hospital care. Other limitations include possible missed motor vehicle collisions in database reporting (estimated to be less than 10%)16 and lack of sufficient information about the comorbidities status of the patient beside that documented on discharge data. The functional status of patient on discharge and beyond was not available for this study.

CONCLUSION
Elderly road users have a higher fatality rate when involved in motor vehicle accidents, especially elderly females. Most of the inhospital mortality in the elderly victims was motor vehicle occupants. They are more likely to suffer from chest injuries compared with the younger population, especially chest wall fractures.

This study highlights the high fatality rate, different pattern of injury, and implications for injury prevention and management in the elderly.

ACKNOWLEDGEMENTS
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Competing interests: none.

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Competing interests: both authors are active members of BASICS and The Great North Air Ambulance.

CORRECTIONS

do: 10.1136/emj.2005.003031

In the paper titled, Road traffic injuries in the elderly (Emerg Med J 2006;1:42–6) the first authors name has been listed incorrectly. It should read W Y Lee. The journal apologises for this error.

do: 10.1136/emj.2005.023754corr1

In the paper titled, Cervical osteomyelitis associated with intravenous drug use (Emerg Med J 2006;2:e16) there is an error in the spelling of the third authors name. The correct author listing should read G Singh, R R Shetty, M J Ramdass, P G Anilkumar. The journal apologises for this error.