Reviews in Clinical Gerontology 2009 19; 77–85 First published online 17 September 2009
© *Cambridge University Press 2009* doi:10.1017/S0959259809990177

Older people and major trauma

Elaine Cole[1,2], Antonia Lynch[1,2], Jackie Bridges[1] and Anita West[2]
[1] *City University London and* [2] *Barts and the London NHS Trust*

Summary

Major traumatic injury is a leading cause of death in younger age groups, but increasingly older people are affected also. Adverse outcomes, both physical and psychological, are associated with injury in the older population. This review aims to locate and describe the evidence relating to older people and major trauma in order to inform policy, practice, research and education. The published research and systematic reviews fall into three main topics: mechanism of traumatic injury in older people, the effects of co-morbidities on older trauma patients and outcomes following serious traumatic injury in older people. The psychological impact of traumatic injury and the resulting functional alteration cannot be underestimated in this group of patients.

Keywords: Trauma, injury, older people, outcome.

Introduction

The population in the United Kingdom and other countries is ageing. In 2006, there were 4.7 million people aged 75 years or more. This number is projected to increase to 5.5 million by 2016 and to 8.2 million by 2031, a rise of 76% over 25 years.[1] While ischaemic heart disease and cerebrovascular disease are the leading causes of death for older patients, major trauma is also known to lead to poor outcomes.[2,3] Traumatic injury occurs when a blunt or penetrating external force is exerted on the body.[4] The incidence of trauma in older people is likely to rise due to the growth within this cohort of the population. It is therefore important to better understand and make explicit the needs and characteristics of older people who have experienced major trauma, so that policy and practice can be developed accordingly.

This paper aims to give a comprehensive overview[5] of research literature pertaining to older people and major trauma, with a view to making recommendations for policy, practice, research and education. While the focus of the recommendations is on the UK context, international literature has been drawn on in the review and the findings will therefore be of relevance to readers in other countries.

Search methods

QUOROM[6] guidelines have been used to guide reporting of the review process. Full details of the methods are available from the lead author (EC). Briefly, the bibliographic databases Medline, Ovid Nursing, British Nursing Index and EBM reviews (including the Cochrane Library) were searched using the MeSH terms: older person or older adult or geriatric or elderly AND major trauma or traumatic injury or poly trauma. Isolated hip fractures or fractured neck of femur were excluded, as they are not considered to be a serious traumatic injury (Injury Severity Score (ISS) >15) by the Trauma Audit and Research Network.[7] Other papers were identified by hand searches of reference lists of papers retrieved and contact with experts in the field. Studies published in English between June 2000 and April 2009 were included, regardless of study design.[8] The initial database search revealed 95 items, and 31 of these were found to meet the inclusion criteria after quality assessment and review by the two lead authors (EC and AL).

The start date was chosen because it corresponds with the publication of the UK Royal College of Surgeons and British Orthopaedic Association document *Better Care for the Severely Injured*.[9] At the time of publication, this report noted the increasing numbers of older trauma patients, often presenting with multiple co-morbidities, requiring significant resources and specialist care. Although written nearly a decade ago, this document was the last national UK recommendation to be published about trauma care prior to the release of *Trauma: Who Cares?*, a report of the National Confidential Enquiry into Patient Outcome and Death (NCEPOD) in 2007.[10]

Address for correspondence: Elaine Cole, City University, Philpot Street, London E1 2EA. Email: e.cole@city.ac.uk

https://doi.org/10.1017/S0959259809990177 Published online by Cambridge University Press

Findings

The published research and systematic reviews fall into three main topics:

1. Mechanism of traumatic injury in older people.
2. The effects of co-morbidities on older trauma patients.
3. Outcomes following serious traumatic injury in older people. This final category is further subdivided into three areas: mortality, increased risk of long-term disability and dependence, and altered psychological coping.

The findings reflect that much of the research is of insufficient quality to guide policy or practice. Just two prospective studies[11,12] were identified in the search. The remainder of the papers reported retrospective evaluations of trauma databases and registries. The quality of data stored in databases and registries will vary between institutions and will often rely on an individual or group of individuals to input the data, rather than the research teams themselves.

The findings have allowed us to identify some inferences for practice. However, we are cautious about making absolute recommendations due to the retrospective nature of most of the work.

Mechanism of injury

The most common mechanism of injury associated with older people and major trauma is blunt trauma, which is the focus of eight papers. One study focused on penetrating trauma in relation to older people. Blunt trauma causes injury as a result of energy transfer leading to tissue compression and disruption, while penetrating trauma causes injury when an object or missile penetrates the skin and underlying tissues of the body.[13]

Blunt trauma

Six studies identified that the most common mechanism of injury in older people are falls and road traffic accidents (RTA). A retrospective, descriptive chart review of 125 consecutive patients >65 years admitted to a Canadian hospital over a 3 year period with an ISS of >12 examined mechanism of injury.[14] The injuries sustained were classified into six categories. Falls were the most frequent, with 64% of all trauma admissions in this age group. RTAs were the next most frequent, accounting for 27% of admissions. Machine injuries, natural accidents and suicides accounted for 3%, 2% and 3%, respectively. Burns were the least frequent (1%). Falls were the most frequent cause of death and also made up the highest proportion of injuries overall. A common cause of death within this study was intracranial haemorrhage associated with falls. Results from one Hong Kong study and two US studies, also based on retrospective documentary review, support these findings.[15–17]

A retrospective review in America ($n = 177$) found that falls accounted for 62% of isolated cervical spine fractures (ICSF) and spinal cord injuries (SCI).[18] The study identified that SCI are more common with increasing age and older people require a much lower severity of injury to sustain significant ICSF, possibly due to reduced bone density. An Australian retrospective case review ($n = 282$) reported that falls at home are increasing and in many cases ladders were implicated in the accidents.[19] This was attributed to an increase in popularity of do-it-yourself programmes.

Some studies categorize mechanism of injury as intentional and non-intentional. In a population-based Canadian survey of traumatic injuries in older adults ($n = 1475$), males were at higher risk than females of intentional injury, whilst the majority of trauma was identified as non-intentional (78%).[20] RTA, falls or jumps and impact by an object or animal accounted for 81% of mechanism of injury. Intentional episodes were attributed to suicide (12%), assault (7%) and homicide (2%). Intentional injury continues to account for a small proportion of older adult trauma; however, this may rise as the ageing population continues to grow.

Penetrating trauma

Nagy *et al.*[21] conducted a retrospective study comparing penetrating trauma rates between older and younger people. The study included patients >65 years and patients aged 15–40 years. A chart review was conducted to determine mechanism of injury and ISS, and the two age groups were compared. This study identified 85 older patients and 85 younger people over a 15-year period. Each group contained 66 males and 19 females. Stabbings (52.9% of injuries), gunshot wounds

https://doi.org/10.1017/S0959259809990177 Published online by Cambridge University Press

(45.9%) and shotgun wounds (1.2%) were equally common causes of penetrating trauma in both age groups. This finding contradicts assumptions that older people live less reckless lives and therefore are less at risk of penetrating trauma. It may be that the prevalence of penetrating trauma in this group is, however, increasing and this is worthy of further research.

The effects of co-morbidities on older trauma patients

Findings presented below illustrate the effects of co-morbidities on the older trauma patient. Much of the work is carried out retrospectively. However, little is known about the physiological state of patients prior to their major trauma.

Seven studies were identified that analysed co-morbidities in older trauma patients. From the literature the predominant pre-existing conditions linked to trauma are depression (which correlates with suicide) and hepatic and renal disease, in addition to cancer, neurological, pulmonary, endocrine and cardiovascular disease. Two further studies analysed the effects of lipid-lowering medication and statins on the outcomes of trauma patients.

Psychological factors

Three papers identify suicide or suicidal intention as the cause of major trauma. However, only one study by Crandall *et al.* analysed the scope and burden of hospitalization for suicide attempts among older patients in the United States.[22] This reports that older people have a higher per capita suicide rate than younger people, but that older people who attempt suicide are rarely diagnosed with depression until after the attempt. A total of 1812 people >65 years attempted suicide over a 7-year period, accounting for 9.5% of all admissions to hospital for suicide attempts. A regression analysis demonstrated that older patients who attempted suicide were more likely to be male, white, to have used a firearm and to have insurance than younger people.

A Canadian population-based surveillance of major traumatic injuries in adult residents reported death caused by suicide had an incidence rate of 8.5 per 100,000 in the >85 year age group.[20] A similar study identified that intentional injuries accounted for 6% of all major trauma sustained by older patients from a population of 2557 during a 5-year period.[23] No research has identified effective interventions to reduce traumatic suicide in the depressed older person.

Medication effects on the older trauma patient

Two studies report the effects of pre-injury lipid-lowering medication on older trauma patients. Analysis of a population-based administrative database in Canada reported that, of 1,438,259 adults aged >65 years, patients who received lipid-lowering drugs were less likely to sustain major trauma.[23] This is attributed to this cohort of patients being more health conscious and safety minded than those who did not receive them. However, there is little evidence to support this assumption.

A second study conducted a retrospective observational cohort study of the effects of pre-injury statin use on in-hospital mortality,[24] using the National Study on the Costs and Outcomes of Trauma (NSCOT) database in the United States. Pre-injury statin use and mortality after moderate to severe traumatic injury was analysed in an older population. The study concluded that statins decrease cardiovascular mortality in at-risk patients, which is attributed to the lipid and cholesterol modulating effects of these medications. The presence of cardiovascular co-morbidities was not an indicator of mortality in isolation. However, the combination of cardiovascular disease and statin use negatively influenced survival risk.

Neideen[25] hypothesized that pre-injury beta-blockade would increase mortality in geriatric trauma patients, given that beta-blockers inhibit the patient's physiological responses to hypovolaemic shock. A retrospective review of medical records, injury information and drug history records ($n = 1479$ patients aged >65 years) showed that 273 patients were taking beta-blockers before their traumatic episode, of whom 14.7% died before discharge. The mortality rate in those not taking beta-blockers was 13.4%. Moreover, mortality with head injury was 25.9%, which was significantly associated with warfarin use. In patients without head injuries, beta-blockade had a significant association with mortality. This paper identifies the need to study the effects of

https://doi.org/10.1017/S0959259809990177 Published online by Cambridge University Press

polypharmacy on the older trauma patient in relation to poor trauma outcomes.

Co-morbid diseases

The following two papers identify common co-morbidities seen in older trauma patients in studies conducted in the United States. One study used multiple logistic regression to determine the effects of 21 different pre-existing conditions on 30-day in-hospital mortality ($n = 33{,}781$).[26] The mortality rate was reported as 7.6%. When physiologically controlled following trauma (i.e. stable vital signs, Glasgow Coma Scale and ISS), the pre-existing conditions with the strongest effect on mortality rates were hepatic disease, renal disease and cancer. The study concludes that these data in isolation cannot guide decisions to withdraw treatment. However, it may be a useful component to guide families faced with difficult decisions in relation to geriatric trauma.

Nagy *et al.*[21] reported that a total of 58 older patients with 91 pre-existing conditions were admitted following penetrating injury. These included pulmonary, neurological, endocrine disorders and chronic cardiac problems. The study concludes that older trauma patients have more pre-existing conditions, which may result in longer stays in the intensive care unit and the hospital.

Neither of the studies has linked pre-existing physiological data (e.g. the patient's normal blood pressure) to traumatic injury, to explore how this could positively affect patient outcomes. Linking pre-injury physiological status to injury management may enable trauma clinicians to optimize care delivery and enhance patient outcomes. This is worthy of further research.

Outcomes following serious traumatic injury in older people

It is generally accepted in the literature that, when older people develop complications following traumatic injury (bleeding, infection, raised intracranial pressure, for example), their outcome is adversely affected.[27] For some older patients this means a degree of disability in comparison to their pre-injury state. For many others, the most common outcome is expected or unexpected mortality.

Mortality

A systematic review of 27 research papers, predominantly retrospective registry reviews, examined factors affecting physical outcomes in older adults after severe traumatic injury.[28] Older age was defined as 'anywhere between 45 and 100 years', which is questionable when comparing underlying physiological status. Findings suggested that older people do survive serious injury. However, many have higher short- and long-term mortality in comparison with younger adults. Eight out of the 12 studies included in the review suggested that the risk of older people dying is greater, even after adjustment is made for the heterogeneity of age, pre-existing conditions and mechanism of injury. Causes of mortality included age (with a direct correlation between older age and poorer outcomes), ISS, number of injuries, co-morbidities and complications. Five studies evaluating longer-term mortality (>2 years after discharge from hospital) suggested that the most reliable predictors for survival following injury were age and pre-injury state, with the 'older old' and those with co-morbidities faring worse. The researchers note that none of the studies had recorded pre-injury data. Therefore no causal relationships between age, injury characteristics and outcome were identified.

Older age and increased mortality

Five retrospective studies identified for this review reported that mortality in trauma increases with advancing age.[14,15,27,29,30] The higher mortality rate appears independent of injury[15] or pre-injury state,[29] although one study reports that pre-existing cardiac disease may contribute to increased mortality rates in octogenarians.[30]

Outcomes following neurotrauma in older people

Three papers examined outcomes for older people following severe traumatic brain injury,[31–33] in Australia, the Netherlands and Singapore. Between 15 and 50% of patients in all reviews survived their injuries despite an initial low Glasgow Coma Score (GCS < 8). However, no data were given about post-injury disability. Overall survival rates were described as 'extremely poor', with a clear association between severe traumatic brain

https://doi.org/10.1017/S0959259809990177 Published online by Cambridge University Press

injury and increased mortality (50–85%). Injuries associated with mortality included traumatic subarachnoid haemorrhage, extra- and sub-dural haematomas and brainstem injury. All three papers discussed the need to consider supportive conservative treatment, rather than an aggressive approach where outcomes were considered to be dismal.

Trauma services affecting survival in older people

Five studies were identified[2,34–37] where trauma services directly impacted on the mortality rates of older people following serious injury. A retrospective analysis of 1642 deaths of US patients >55 years showed that they were more likely to die in rural hospitals without an established trauma system than in urban settings.[34] Recommendations stated that rural non-trauma systems need to be more responsive in recognizing older adults' altered physiology, especially in seemingly 'moderate' injuries.

A similar American retrospective analysis of patient records ($n = 455$ aged >80 years) reported that significant predictors of in-hospital mortality included ISS > 30 and being treated in a non-trauma centre.[35] Findings suggest that this group of patients need assessment and resuscitation in a trauma centre.

A Canadian retrospective cohort study examined treatment of people in a level 1 trauma centre ($n = 4717$ aged >65 years).[36] Mortality rates for fall victims ($n = 4111$) were 25.3%, compared with 7.8% for RTA victims ($n = 606$). Older age, ISS and a higher number of injuries all increased mortality. Interestingly, the authors suggest that Canadian level 1 trauma centres were designed to treat younger patients involved in RTAs and 'violent acts'. Their conclusions suggest that the increased demand for care of older people following falls was previously unpredicted and needs to be addressed.

Two American papers draw on the need for an aggressive approach to resuscitating older trauma patients. The first examined criteria for alerting a trauma team in relation to age, injury severity and haemodynamic status.[37] Retrospective analysis of a 7-year period showed that 883 patients ≥70 years were admitted. Only 223 older patients met the criteria for trauma team activation and 107 died following their injuries. Six hundred and sixty older patients did not meet trauma team activation criteria, with seemingly minor or moderate injuries, and 105 died of their injuries. The authors acknowledged that altered haemodynamic signs in older people can suggest stability in a patient who is in fact severely injured. Therefore trauma patients aged ≥70 years, regardless of injury severity should have a trauma team activation.

A follow-up study[2] reports data on patients who presented before the change in trauma team activation criteria with those who presented after the change. There were 260 patients in the pre-protocol group (group 1) and 76 in the post-protocol group (group 2). Groups had similar mechanism of injury, age and ISS. Mortality in group 1 was 53.8% (139 patients) and in group 2 was 34.2% (25 patients) ($P = 0.003$, 95% confidence intervals 1.13 to 2.19). The authors concluded that activation of a trauma team for patients ≥70 years results in increased survival rates.

Increased risk of long-term disability and dependence

For older patients who survive serious injury, outcomes on leaving hospital vary. Whilst it is acknowledged that discharge from hospital to home is a crude outcome measure, a number of papers focused on older patients' destination following hospital. The destination is often dictated by functional outcomes, especially disability. Two prospective and four retrospective studies were identified that specifically evaluated discharge outcomes.[11,12,28,30,38]

The first prospective study evaluated outcomes of admitted patients ≥65 years following 'any potentially serious form of trauma'.[11] Conducted over a 1-year period, 239 consecutive patients were enrolled in one American hospital. ISS was calculated for each patient and data were collected on pre-existing conditions, mechanism of injury and functional outcomes. While patients were followed for the length of their hospital stay, the stage at which outcomes were measured is not reported. At the start of the study, outcomes had been defined as *functional* (return to pre-injury state), *fair* (the need for moderate assistance with activities of daily living), *alive but poor* (ventilator dependence or a vegetative state) and *dead*. No formal measurement tool was used to determine these definitions such as an outcome score or cognitive assessment tool.

https://doi.org/10.1017/S0959259809990177 Published online by Cambridge University Press

A logistic regression model was used to examine the significance of age (defined as <80 or ≥80 years) to outcome following trauma. Any variable found to be significant (such as ISS, co-morbidity) was stratified by mechanism of injury, with significance defined as $P < 0.5$. However, there was no way of formally measuring pre-injury status. Overall, outcomes reported 193 older patients to be functional at baseline, 15 fair, 4 poor and 27 people died. The only variable found to significantly affect outcome was ISS ($P < 00.1$), with a score of >25 associated with higher mortality. The most common mechanism of injury for the functional outcome group was falls. The mean age was 78.2 years in the functional outcome group, 77.7 years in fair, 80.3 years in poor and 78.0 years for those who died. Of the surviving patients, 107 went home, 62 went to a rehabilitation unit, 38 went to a nursing home and five patients were transferred to another hospital. The report suggests that the 'oldest old', defined as ≥75 years, were more frequently admitted to care facilities rather than going home, in comparison with the younger patients (65–74 years).

The second prospective descriptive follow-up study was designed to examine outcomes in older adults at discharge and then 3 months later.[12] Injured patients aged >65 years, who stayed in hospital for at least 72 hours, were admitted to ICU or surgery (ISS > 9) and scored >23 on a Mini Mental State Examination (MMSE) were recruited. The research took place in an American level 1 trauma centre where more than 200 seriously injured older people are admitted per annum. Patients were interviewed before leaving hospital and 3 months after discharge. During the two interviews a number of validated scales were used to measure social support, impact of events and depressive symptoms. Concurrent medical problems were scored using the Charlson Index of Comorbidity.

Over an 18-month period, just 20 participants were recruited of 87 patients screened. Sixteen died in hospital and 23 were excluded due to a low MMSE score, dementia or unexpected confusion. Thirty-one patients were excluded due to pre-existing co-morbidities. Of the remaining patients, the mean age was 73.5 years, 95% of whom had sustained blunt injury and 5% gunshot wounds. Thirty-five per cent were discharged to rehabilitation, 15% to a nursing care facility and 10% to home alone. At the 3-month follow-up interview, only nine patients participated. This group had low levels of co-morbidity and high levels of social support pre-injury. The attrition rate was due to refusal to participate, death, adverse change in mental status and loss to follow-up. Of the four patients who refused a follow-up interview, two had forgotten consenting in the first place.

Of note is the large number of patients who developed cognitive impairment due to delirium in hospital. The researchers noted that they were often the first person to have identified this. They suggest that earlier detection of delirium is needed as there is a clear link with adverse outcomes, such as longer hospital stays and increased mortality rates.

The small sample means that further analysis is not possible. However, the findings suggest suboptimal outcomes for this group of patients. Physical disability was significant in that, pre-injury, 40% of the patients had lived alone and 20% were carers themselves. Both studies demonstrate that a large proportion of seriously injured patients will need nursing or rehabilitation following discharge. Similarly, the findings from the systematic review[28] suggest that it is unlikely that older people will be discharged directly back to their own homes to live independently, often needing a care home or rehabilitation facility.

Retrospective analysis of trauma data to determine outcomes in older people was conducted over a 10-year period in Pennsylvania, USA.[39] The data yielded 38,707 patients with a mean age of 77.5 years. Half of the patients who survived their injuries (52.2% of the total) went home, but 25.4% were admitted to a nursing care home. Increasing age, abdominal or extremity injury and lower functional level predicted the need for continuing care. Furthermore, the odds of being discharged from hospital to a nursing care home increased by 11% for each additional year of age. Another review found advancing age and increased dependence to be significant.[30] Outcomes in injured patients aged 65–79 years, when compared with patients ≥80 years, were more likely to be discharged home (53.3 *vs.* 28.8%, $P = 0.001$), regardless of injury.

In a review of older patients following penetrating injury,[21] of 78 patients who survived to discharge, 71 went home and only 7 needed admission to a care facility. The single-system nature of penetrating injuries may account for the low rates of long-term dependence. Yeung *et al.*,[15] examining trauma care in Hong Kong, reported

https://doi.org/10.1017/S0959259809990177 Published online by Cambridge University Press

that at discharge, most older patients were able to go home (40.5%, 328 patients), although the degree of independence is not stated. No information is given about the social care system or increased family support that may be available in China.

The findings in this section suggest that when older people survive serious injury, many have poor functional outcomes and disability, which results in a reduction in independence.

Altered psychological coping

In their prospective study, Richmond *et al.*[12] found that older trauma patients had altered psychological coping. Symptoms of post-traumatic stress disorder (PTSD) remained at elevated levels 3 months after discharge. In a 3-year retrospective review[38] of trauma patients aged ≥ 65 years ($n = 171$), psychological problems following injury were found to impact on quality of life (QOL). SF-36, a Medical Outcomes Study 36 item Short Form that measures patients' views on their QOL, was administered via telephone interview 2–6 weeks after discharge and scores were compared with age-adjusted Canadian norms. Twenty-one patients could not be contacted, two had died, eight could not speak English and two had developed cognitive impairment. Findings suggested that when measuring QOL in older people, physical health has a definite impact, with loss of independence and reduced mobility adversely affecting psychological coping. Findings suggest that physical disability post-injury resulted in decreased emotional, social and mental health in comparison with the uninjured norms.

Discussion

Much of the published literature about older people and traumatic injury comes from retrospective data analysis. Falls remain the most common cause of serious, often fatal injury in older people and primary health strategies should focus on screening older people to identify those at risk of falls, to provide targeted injury prevention. Depression has been reported as a cause of intentional injury in older people, which needs further investigation. The literature on co-morbidities suggests that cardiovascular, hepatic and renal diseases all confer poorer outcome following injury.

Older people are living longer. However, their survival after serious injury is poor compared with younger patients. Older age (>75 years) combined with existing co-morbidities and a frail pre-existing state increases the risk of mortality. Trauma services need to be responsive to the needs of older people, specifically in relation to recognizing altered physiology following injury. The expected cardiovascular norms indicating shock may not be present. Pre-existing disease may predispose the older patient to increased complications. Therefore an early aggressive approach to management must be adopted, even with seemingly mild or moderate injury.[37]

Gaps in the literature have been noted in relation to clinical guidelines and processes of care. In other populations, such as paediatric or pregnant trauma patients, clear guidance on clinical interventions, for example fluid resuscitation, exists. This is not the case for older adults, where their heterogeneity makes it difficult to provide a 'one size fits all' model. One study reported older adults admitted to ICU following trauma were at high risk of developing delirium. This mirrors a report on the development of delirium in older people admitted to surgical ICU.[40] Research is needed to explicate the risk factors for, and outcomes of, delirium in this group of patients.

When older people survive injury, outcome scores need to be more specific to their needs. The words *functional outcome* and *disability* are used interchangeably but have differing definitions.[41] Existing outcome measures (such as the Functional Independence Measure[42] and the Glasgow Outcome Scale[43]) help to assess and score post-traumatic physical outcome. However, such measures do not qualitatively measure QOL in older trauma patients. A combined trauma outcome measure relating to both specific physical *and* psychological needs should be investigated to augment the rehabilitation process. The large psychological impact of injury may be underestimated in this group of patients and the physical impact on psychological and social outcomes cannot be ignored for older people.

The difficulties of conducting research with this group may account for the lack of prospective research in this field, particularly the lack of evidence about effective treatments. The dearth of UK-based research is noteworthy, but it is hoped that this review will serve as a stimulus

https://doi.org/10.1017/S0959259809990177 Published online by Cambridge University Press

to improvements in policy, practice, research and education in this field.

Conflicts of interest

The authors have no conflicts of interest to report.

References

1 National Statistics. UK population set to increase to 65 million over the next ten years. National Statistics 2007; available from: http://www.statistics.gov.uk/pdfdir/pproj1007.pdf

2 Demetriades D, Karaiskakis M, Velmahos G, Alo K, Newton E, Murray J *et al.* Effect on outcome of early intensive management of geriatric trauma patients. *Br J Surg* 2002; **89**: 1319–22.

3 Soreide K, Kruger AJ, Vardal AL, Ellingsen CL, Soreide E, Lossius HM. Epidemiology and contemporary patterns of trauma deaths: changing place, similar pace, older face. *World J Surg* 2007; **31**: 2092–103.

4 Saunderson Cohen S. *Trauma Nursing Secrets*. Philadelphia: Hanley & Belfus Inc, 2002.

5 Mays N, Roberts E, Popay J. Synthesising research evidence. In: Fulop N, Allen P, Clarke A, Black N (eds), *Studying the organisation and delivery of health services*: *research methods*. London: Routledge, 2001; pp. 188–220.

6 Moher D, Cook DJ, Eastwood S, Olkin I, Rennie D, Stroup DF. Improving the quality of reports of meta-analyses of randomised controlled trials: the QUOROM statement. *Rev Esp Salud Publica* 2000; **74**: 107–18.

7 TARN. Standards for practice. Exclusion criteria. The Trauma, Audit and Research Network Procedures Manual 6. Salford, TARN 2009.

8 Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Methodol* 2005; **8**: 19–32.

9 RCS & BOA. Better care for the severely injured. London, Royal College of Surgeons and the British Orthopaedic Association, 2007.

10 Findlay G, Martin IC, Smith M, Wayman D, Carter S, Mason M. Trauma: Who Cares? A report of the National Confidential Enquiry into Patient Outcome and Death. London, NCEPOD, 2007.

11 Ferrera PC, Bartfield JM, D'Andrea CC. Outcomes of admitted geriatric trauma. *Am J Emerg Med* 2000; **18**: 575–80.

12 Richmond TS, Thompson HJ, Kauder D, Robinson KM, Strumpf NE. A feasibility study of methodological issues and short-term outcomes in seriously injured older adults. *Am J Critical Care* 2006; **15**: 158–65.

13 Eaton J. Kinetics and mechanisms of injury. In: O'Shea R (ed), *Principles and Practice of Trauma Nursing*. Edinburgh: Churchill Livingstone; 2005. p. 15.

14 Gowing R, Jain MK. Injury patterns and outcomes associated with elderly trauma victims in Kingston, Ontario. *Can J Surgery* 2007; **50**: 437–44.

15 Yeung JHH, Chang ALM, Ho W, So FL, Graham CA, Cheng B *et al.* High risk trauma in older adults in Hong Kong: A multicentre study. *Injury* 2008; **39**: 1034–41.

16 Scheetz LJ. Effectiveness of prehospital trauma triage guidelines for the identification of major trauma in elderly motor vehicle crash victims. *J Emerg Nurs* 2003; **29**: 109–15.

17 Shinoda-Tagawa T, Clark DE. Trends in hospitalization after injury: older women are displacing young men. *BMJ* 2003; **9**: 214–9.

18 Golob Jr JF, Claridge JA, Yowler CJ, Como JJ, Peerless JR. Isolated cervical spine fractures in the elderly: a deadly injury. *J Trauma* 2008; **64**: 311–5.

19 Kent A, Pearce A. Review of morbidity and mortality associated with falls from heights among patients presenting to a major trauma centre. *Emerg Med Aust* 2006; **18**: 23–30.

20 Laupland KB, Kortbeek JB, Findlay C, Hameed SM. A population-based assessment of major trauma in a large Canadian region. *Am J Surg* 2005; **189**: 571–6.

21 Nagy KK, Smith RF, Roberts RR, Joseph KT, Gary C, An MD *et al.* Prognosis of penetrating trauma in elderly patients: a comparison with younger patients. *J Trauma* 2000; **49**: 190–4.

22 Crandall M, Luchette F, Esposito TJ, West M, Shapiro M, Bulger E. Attempted suicide and the elderly trauma patient: risk factors and outcomes. *J Trauma* 2007; **62**: 1021–8.

23 Redelmeier DA, Naylor CD, Brenneman FD, Sharkey PW, Juurlink DN. Major trauma in elderly adults receiving lipid-lowering medications. *J Trauma* 2001; **50**: 678–83.

24 Efron DT, Sorock G, Haut ER, Chang D, Schneider E, MacKenzie E *et al.* Preinjury statin use is associated with improved in-hospital survival in elderly trauma patients. *J Trauma* 2008; **64**: 66–74.

25 Neideen T, Lam M, Brasel KJ. Preinjury beta blockers are associated with increased mortality in geriatric trauma patients. *J Trauma* 2008; **65**: 1016–20.

26 Grossman MD, Miller D, Scaff DW, Arcona S. When is an elder old? Effect of preexisting conditions on mortality in geriatric trauma. *J Trauma* 2002; **52**: 242–6.

https://doi.org/10.1017/S0959259809990177 Published online by Cambridge University Press

27 Taylor MD, Tracy JK, Meyer W, Pasquale M, Napolitano LM. Trauma in the elderly: intensive care unit resource use and outcome. *J Trauma* 2002; **53**: 407–14.
28 Jacoby SF, Ackerson TH, Richmond TS. Outcome from serious injury in older adults. *J Nurs Schol* 2006; **38**: 133–40.
29 Nirula R, Gentilello LM. Futility of fesuscitation criteria for the 'young' old and the 'old' old trauma patient: a national trauma data bank analysis. *J Trauma* 2004; **57**: 37–41.
30 Grossman M, Scaff DW, Miller D, Reed III J, Hoey B, Anderson III HL. Functional outcomes in octogenarian trauma. *J Trauma* 2003; **55**: 26–32.
31 Mitra B, Cameron PA, Gabbe BJ, Rosenfeld JV *et al.* Management and hospital outcome of the severely head injured elderly patient. *ANZ J Surg* 2008; **78**: 588–92.
32 Hukkelhoven C, Steyerberg EW, Rampen AJJ, Farace E, Habbema JDF, Marshall LF *et al.* Patient age and outcome following severe traumatic brain injury: an analysis of 5600 patients. *J Neurosurg* 2003; **99**: 666–73.
33 Gan BK, Lim JHG, Ng IHB. Outcome of moderate and severe traumatic brain injury amongst the elderly in Singapore. *Ann Acad Med Singapore* 2004; **33**: 63–7.
34 Rogers FB, Osler TM, Shackford SR, Morrow PL, Sartorelli KH, Camp L *et al.* A population-based study of geriatric trauma in a rural state. *J Trauma* 2001; **50**: 604–11.
35 Meldon SW, Reilly M, Drew BL, Mancuso C, Fallon Jr W. Trauma in the very elderly: a community-based study of outcomes at trauma and nontrauma centers. *J Trauma* 2002; **52**: 79–84.
36 Sampalis JS, Nathanson R, Vaillancourt J, Nikolis A, Liberman M, Angelopoulos J *et al.* Assessment of mortality in older trauma patients sustaining injuries from falls or motor vehicle collisions treated in regional level I trauma centers. *Ann Surg* 2009; **249**: 488–95.
37 Demetriades D, Sava J, Alo K, Newton E, Velmahos GC, Murray JA *et al.* Old age as a criterion for trauma team activation. *J Trauma* 2001; **51**: 754–7.
38 Inaba K, Goecke M, Philip Sharkey MHK, Brenneman F. Long-term outcomes after injury in the elderly. *J Trauma* 2003; **54**: 486–91.
39 Richmond TS, Kauder D, Strumpf N, Meredith T. Characteristics and outcomes of serious traumatic injury in older adults. *J Am Geriatr Soc* 2002; **50**: 215.
40 Balas MC, Deutschman CS, Sullivan-Marx EM, Strumpf NE, Alston RP, Richmond TS. Delirium in older patients in surgical intensive care units. *J Nurs Scholarship* 2007; **39**: 147–54.
41 WHO. International Classification of Functioning, Disability and Health (ICF). Geneva, World Health Organization 2009. Available from: http://www.who.int/classifications/icf/en/
42 Holbrook TL, Hoyt DB, Anderson JP. The impact of major in-hospital complications on functional outcome and quality of life after trauma. *J Trauma* 2001; **50**: 91–5.
43 Wilson JTL, Pettigrew LEL, Teasdale GM. Emotional and cognitive consequences of head injury in relation to the Glasgow outcome scale. *BMJ* 2000; **69**: 204–9.

https://doi.org/10.1017/S0959259809990177 Published online by Cambridge University Press