Title: Characteristics and Outcomes of Injured Older Adults Following Hospital Admission

Abbreviated Title: Trauma in Older Adults

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ABSTRACT

Objectives: To describe the seriously injured adult population aged ≥65 years; compare the differences in injury characteristics and outcomes in three subgroups aged 65–74, 75–84 and ≥85 years; and to identify predictors of death, complications and hospital discharge destination.

Design: A retrospective secondary analysis of data from the Queensland Trauma Registry (QTR) using all patients ≥65 years admitted from 2003 through 2006.

Setting: Data from 15 regional and tertiary hospitals throughout Queensland, Australia.

Participants: The dataset consisted of 6,069 patients, including 2,291 (38%) patients aged 65–74 years, 2,265 (37%) 75–84 years and 1,513 (25%) aged ≥85 years.

Measurements: Outcome variables included mortality, complications and discharge destination (usual residence, rehabilitation, nursing home, convalescence). Predictive factors incorporated demographic details, injury characteristics and acute care factors.

Results: Hospital survival was 95%, with a median length of hospital stay (LOS) of 8 days (IQR 5–15) and 34% of major injury cases developed a complication. Predictors of death included increasing age, gender, admission to the intensive care unit (ICU), increasing Injury Severity Score (ISS), injury caused by fall, and ≥2 injuries, with those who had surgery less likely to die. Predictors of complications included ICU admission, increasing age and hospital LOS and ≥2 injuries. Predictors of discharge to a nursing home included increasing age, ISS and hospital LOS and injury caused by a fall among others.

Conclusion: Older adults with severe injuries are at risk of poor outcomes. These findings suggest opportunities for improving geriatric trauma care that could lead to better outcomes.

Key Words: older adults, serious injury, outcomes, mortality, complications, discharge placement

Introduction

Trauma is a frequent reason for admission to acute care hospitals, with more than 300,000 admissions annually and almost 8000 deaths due to injury throughout Australia.[1] More than two million Australians sustain long-term post-injury disability.[1] Similar or higher rates of injury and ongoing disability are observed throughout the world, with the World Health Organization estimating 9% of deaths and 12% of burden of disease worldwide being due to injury.[2]

While older adults (≥65 years) experience a higher trauma-related mortality rate than younger adults,[1, 3-5] descriptions of the characteristics of injury and recovery for older people are limited[6] thus targeted prevention and intervention strategies are lacking. Older adults predominantly experience fall-related injuries, with more than 60% of injuries reportedly caused by falls.[4, 6, 7] Road traffic crashes account for approximately 25% of injuries in older adults followed by various mechanisms including assault, machinery and suicide.[4, 6, 7] Although there is some description of injury mechanisms and recovery considerations related to people with hip fractures[8, 9] little information pertains to more serious multi-system injuries. Of note, where researchers have examined general trauma in older adults they have frequently excluded patients with an isolated hip fracture (either specifically or by excluding patients with an Injury Severity Score (ISS) <12).

Significant health care resources are consumed by injured older patients admitted to hospital, with average length of hospital stay (LOS) generally exceeding 10 days[4, 6, 7, 10] and longer admissions to the intensive care unit (ICU) than younger patients. Importantly, the development of hospital-acquired complications is an independent predictor of increased mortality in the older trauma population.[6] Further, only approximately 50% of these patients return to independent living after acute care discharge, with 15–25% admitted to a skilled nursing facility or nursing home, and 20% admitted to a rehabilitation facility.[6, 7, 11] There is growing interest in the characteristics and outcomes of older people following trauma-related hospital admission. However, no publications could be located that reported the characteristics of the older population with general injuries within Australia; most of the literature originates in North America. It is therefore timely to explore whether the outcomes of older injured patients in Australia reflect similar characteristics as those reported in other countries. It may also help to identify non-injury related factors such as health service delivery systems that influence outcomes. Knowledge of these patterns will enable development of therapeutic interventions to improve outcomes. As the older population increases, it is reasonable to expect that the number injured will increase. This has implications for both acute health care resources and longer term community resources.

This study was designed to replicate the study undertaken in 2002 by Richmond and colleagues in Pennsylvania.[6] Highlighting similarities and differences between two cohorts within different health care systems helps to better understand why these patterns occur and potentially facilitate development of interventions that build on the strengths of each system. Specifically, the aims of this study were to describe the seriously injured older adult population; characterize and compare the differences in injury characteristics and outcomes in three subgroups of seriously injured older adults aged 65–74, 75–84, and ≥85 years; and to identify predictors of for death, complications and hospital discharge placement.

Methods

A retrospective secondary analysis of data from the Queensland Trauma Registry (QTR) was undertaken using all patients between January 2003 and December 2006. The QTR contains data regarding all patients admitted to 15 regional and tertiary hospitals throughout Queensland for ≥24 hours for the acute treatment of injury coded as S00–S99, T00–T35, T63, T66–T71 or T75 using the International Statistical Classification of Disease and Related Health Problems (10th Revision) – Australian Modification (ICD 10-AM). Specific injuries were coded according to the Abbreviated Injury Scale (AIS) – 1990.[12] Patients who died following presentation to an Emergency Department (ED) at a participating hospital were included, but patients who died prior to reaching a participating hospital were not included.

Patients were included for analysis if they were aged ≥65 years, and either had an operation, an ICU admission, or hospital LOS greater than 3 days. In order to replicate Richmond et al's[6] study as closely as possible, and to concentrate on the group of older patients who have multiple and/or complicated injuries, individuals were excluded for an isolated femoral neck fracture as a result of a low fall (<1metre), including those that occurred in conjunction with superficial skin injuries to other parts of the body (i.e. injuries coded with an AIS severity of 1 in any body region).

The dataset incorporated standard demographic details, injury characteristics, acute care factors and outcomes. Injury characteristics included injury mechanism, nature of main injury, body region with most severe injury, total number of injuries, number of body regions injured, ISS and body system with maximum AIS. The AIS '90 is the most widely used anatomical rating scale to categorize injury type.[13] The AIS, a consensus-derived, anatomically-based injury categorization system, ranks and compares injuries by severity according to body system involved, with relative severity ranked on a scale of 1 (minor injury) to 6 (incompatible with life). The six body systems are head/neck, face, thorax, abdomen, extremities, and external. The ISS is derived from the AIS with a range of scores of 1 (least severe) to 75 (most severe).[14] The ISS provides one numerical score that compares multiple injuries across body systems and is the most widely used anatomic severity measure.

Acute Care Factors included length of ICU stay (if relevant), acute hospital LOS, level of definitive care hospital (tertiary, large regional, small regional), surgery and transfer from another hospital.

The New ISS (NISS)[15] was calculated and included in statistical models to assess whether it predicted outcomes more effectively than ISS. No improvement in predictive modeling was achieved; therefore these data have not been included.

Outcomes included acute hospital mortality, complications and discharge destination. Mortality included all deaths occurring between ED presentation and discharge from definitive care. Complications were defined as a disease or injury that developed during hospitalization for the treatment of trauma, and were classified into 10 categories incorporating 79 specific conditions based on the UCSD Medical Center Trauma Service Provider-Related and Disease-Related Complications Dictionary.[16] These categories included pulmonary, cardiac, abdominal, hematological, infection, renal/genito-urinary, musculo-skeletal/integumentary, neurological, vascular and system complications. Data relating to the development of complications were collected for patients with major injury only (ISS ≥16). Discharge destination was categorized as transfer to usual residence (including a nursing home if this was their usual pre-injury residence, their home, or to a home of family or friends), rehabilitation, nursing home/hospice/palliative care facility (if not originating from these facilities), convalescence (regional, rural or private hospital, usually located close to the patient's home, where the focus is on gradual recovery and planning for discharge rather than definitive care), and other (psychiatric treatment or another acute care hospital). In-hospital deaths were not included in this outcome.

Data quality

Data quality within the QTR was optimized by using trained coders and direct extraction from the health care record. Coders were either Registered Nurses with ED experience or Health Information Managers. Education and audit processes were conducted routinely to ensure data reliability. Logic and range checks were performed on the data prior to analysis.

Ethical Considerations

Approval to conduct this study was gained from Princess Alexandra Hospital, Griffith University and University of Queensland Human Research Ethics Committees (HREC). The routine operation of the QTR is approved by the HRECs of all participating hospitals and The University of Queensland and is recognized within the provisions of the Health Legislation Amendment Regulation (no. 7) 2006 under the Health Services Act 1991 (Queensland) for the purpose of data collection.

Statistical Analysis

Stata version 10.0 (Stata Corporation, College Station, Texas) was used for data checking and analyses. Descriptive statistics for all continuous predictors are reported using medians and inter-quartile ranges (IQR) given their non-normal distributions and equality of medians between age groups were tested using Pearson's $\chi 2$ tests. Because of the non-normal distribution, LOS, ISS, and number of injured body regions were categorized into clinically and statistically meaningful groups. The standard groups adopted by the QTR were used to describe all categorical predictors. Those predictors with more than five groups have been revised into fewer, but still meaningful categories for modeling purposes.

For the three outcomes of death, complications, and discharge destination, statistically significant predictor variables (p-value <0.10) were identified using univariate analyses. All demographic, injury, and acute care factors were assessed for association with these outcomes, including the three factors used to determine inclusion into the study: LOS, length of ICU stay, and surgery. LOS was not used in the mortality model because LOS does not predict mortality for people who died – the death dictates the LOS (i.e. the prediction is reversed).

Logistic regression was used for the death and complication models, and multinomial logistic regression was used to model discharge destination, using usual residence as the reference outcome category. Modeling included all statistically significant univariate predictors and used the backward elimination method. After removal of each non-significant predictor, the model was assessed using likelihood-ratio (LR) tests and Wald statistics. The fit of the final models for each of death, complications and discharge destination was assessed using the Hosmer-Lemeshow goodness-of-fit chi square statistic, while discrimination of models used the area under the ROC curve. Results for these models are reported using an Odds Ratio (OR) and 95% Confidence Interval (CI) for each factor. Results for the multinomial model are reported using a Relative Risk Ratio (RRR) and 95% CI for each factor. Missing data was negligible (0.25% cases) and was restricted to 15 patients who did not have an ISS. ISS cannot be calculated for patients with conditions such as poisoning, hanging, envenomation and drowning.

Results

The final dataset includes 6,069 patients aged ≥65 years who were admitted to a QTR hospital for trauma during four years from January 2003 to December 2006. There were 11,890 patients aged ≥65 years from a total 49,705 patients included in the QTR during the study time period. Of these 11,890 patients, 3,353 (28%) were aged 65–74 years, 4,654 (39%) were aged 75–84 years and 3,883 (33%) were aged ≥85 years. Once restrictions regarding operations, ICU admission and hospital LOS were implemented, the number of patients in each age group decreased to 2,966 (28%), 4,175 (39%) and 3,531 (33%) patients respectively. Finally, patients who sustained isolated femoral neck fractures following a low fall were excluded, resulting in the final cohort including 2,291 patients (38%) aged 65–74 years, 2,265 (37%) aged 75–84 years, and 1,513 (25%) aged ≥85 years (Table 1).

Although the 65 – 74 year age group had a greater number of injuries than the older groups (p <0.001), the 75 – 84 and ≥85 year groups had injuries in more body regions (p<0.001) and the ≥85 year age group had a lower ISS than the younger groups (p=0.001). LOS increased with age, with the median LOS increasing from 7 days (IQR 4–13) in the 65–74 age group to 9 days (IQR 5–16) in the 75–84 age group and 10 days (IQR 6–17) in the ≥85 age group (p<0.001). In contrast, LOS in ICU was shorter for the ≥85 year age group than the younger age groups (p<0.001) (data not shown). Fifteen percent (899/6069) of patients had an ISS ≥16 and were classified as having a major injury.

Females were over-represented (59%) in this cohort compared to the general Queensland population (54%)[17] with the percentage increasing with increasing age group (Table 2). Falls were the most common injury mechanism overall, with those aged ≥85 years having a higher percentage of falls (86%) than those in the youngest age group (59%). Most of the other descriptive factors and outcomes examined in this study also varied across the three age groups (Table 2).

Forty-two percent of patients were admitted to one of the three tertiary hospitals in Queensland, with 26% of these patients being discharged from acute care to rehabilitation. In comparison, 20% of patients admitted to one of the three large regional hospitals and 17% of patients admitted to one of the seven small regional hospitals in Queensland were discharged to rehabilitation. Twenty-three percent of patients were transferred from another hospital for definitive care, with transfers less likely to occur in the oldest patients (16%) compared to those aged 65 – 74 years (30%) (Table 2). Fifty-six percent of transferred patients were discharged to their usual residence. In comparison, 68% of those directly transported to hospital were discharged to their usual residence. Increasing age was also associated with a lower likelihood of having an operation and being admitted to ICU. In particular, the percentage of patients aged ≥85 years and admitted to ICU (5%) was significantly lower than the percentage in the youngest age group (13%). Discharge destination also varied with age, with just over half of patients aged ≥85 years returning to usual residence, compared to 78% in the youngest age group (Table 2). Overall, 5,768 patients survived to hospital discharge and 304 of the 899 major injury patients (34%) had a complication recorded.

Multivariate regression models identified no statistically significant interaction effects between predictors. Although the factors that have been incorporated into the following models are clinically relevant to all outcomes, caveats must be put on interpretation. For example, patients who had a LOS of 1–3 days must have had an operation and/or been admitted to ICU for study inclusion. Fourteen percent of patients had a LOS of 1–3 days, and it is therefore clinically and statistically relevant (i.e. cell size was sufficient) to include this variable as a potential predictor. The same argument can be made for surgery and ICU stay.

Hospital mortality for the entire group was 5%, and 6% for the ≥85 years group. After adjusting for other predictors, older patients were more likely to die than 65–74 year olds (Table 3). Admission to ICU, increasing ISS, injury caused by falls, ≥3 injuries, and male gender were also significant predictors of death. The likelihood of death was decreased for patients with upper extremity trauma and those who had surgery.

The complication model consisted of the 899 individuals with major injury (ISS ≥16). Admission to ICU, hospital LOS ≥8 days, level of definitive care hospital, ≥2 injuries, and aged ≥85 years were statistically significant predictors of complications (Table 4). After adjusting for other factors, patients sustaining injuries to the head were less likely to develop complications than those with injuries to the lower extremities or spine.

We investigated transfer to a rehabilitation facility, nursing home, convalescence or other destination in reference to discharge to usual residence using multinomial regression. In interpreting the multinomial model in Table 5, the relative risk ratios can be interpreted by saying ‘The risk of going to rehabilitation vs going to usual residence was 3.09 times greater in patients aged 85+ as compared to those aged 65 – 74.

Overall, the risk of transfer to destinations other than usual residence increased with age but was lower for females (Table 5). Males were significantly less likely to be transferred for rehabilitation. Patients injured in a road traffic crash were less likely to be discharged to a nursing home than those injured in a fall; however, for most other external causes discharge destinations did not vary. Patients sustaining injuries to the thorax, pelvis, abdomen or an upper extremity were less likely to be transferred to rehabilitation than those with lower extremity or spine and/or spinal cord injuries.

Transfer to rehabilitation or a nursing home increased with increasing ISS (Table 5), with patients with ISS $\geq$26 most likely to be transferred to rehabilitation or to a nursing home. Patients admitted to ICU were more likely to be transferred to either rehabilitation or convalescence, while long LOS resulted in a lower likelihood of discharge home.

Patients transferred from an outlying hospital to the trauma hospital were more likely to be transferred for convalescence following definitive care (Table 5). Patients treated at either small or large regional hospitals were more likely to be discharged to either a nursing home or convalescence than those treated in a tertiary hospital.

Discussion

This study explored the characteristics and outcomes of older adults admitted to hospital for acute injury. Although mortality was only 5%, approximately one-third of patients required residential care after discharge from definitive care and approximately one third of patients with an ISS>15 developed a complication during hospitalization.

Although the cohort reported in this study was significantly smaller than that in Richmond *et al*.'s paper[6] many characteristics were similar, although both complication and surgery rates were higher. Both groups were of similar age, while the current cohort was less severely injured (lower ISS), had experienced injury to fewer body systems, had lower mortality, and shorter hospital LOS than Richmond *et al*.'s cohort.[6] Given that all tertiary hospitals and more than 90% of the regional hospitals contributed data to the QTR, and a range of mechanisms were in place to ensure identification of all relevant patients, we are confident this study provides an accurate summary of older injured patients in Queensland. Thus it is possible that the differences between our sample and Richmond's reflect a difference in either the treatment patterns between the two countries, or alternatively differences that have evolved in trauma care over the 10 years. It is also likely that Richmond's cohort was more severely injured because it was comprised of only those triaged to trauma centers as compared to this current cohort cared for in a broader range of hospitals.

Patients in this cohort differed across the age groups, with falls increasing with age and other mechanisms of injury decreasing with age; this suggests that injury prevention strategies should also vary across age groups to optimize the chance of success. Patients in the younger group were also more likely to be transferred for definitive care, to undergo surgery and be admitted to the ICU. While mortality increased with age in a similar manner to that identified by both Richmond *et al.*[6] and Grossman *et al.*[7], the rate of complications did not vary across the age groups in our cohort. Discharge to locations other than usual residence also changed, with the rate increasing in all destinations as age increased; again this pattern is similar to that reported by Grossman *et al.*[7].

The complication rate we report is high (36%), particularly when compared to Richmond *et al*.'s study[6] (15%), but is consistent with other reports of severely injured older cohorts of patients.[4] This may indicate the higher incidence of complications in the more severely injured trauma patients as is also reported by Gowing *et al*.[4] This link of severity and complication rate is supported by the Richmond *et al*.[6] study where older adults with an ISS >15 were also more likely to develop complications. Complications have previously been proposed as being related to mortality and while evidence of this relationship is limited it was identified as an independent predictor of mortality by Richmond *et al*.[6] Complications were unable to be included in the modeling of death in the current study since complication data were only available for major injury patients.

More than half the cohort underwent surgery. This is in contrast with the 28% who underwent surgery in Pennsylvania,[6] with few other studies reporting the incidence of surgery. The higher surgical rate in the current study could reflect a change in practice over the past 10 years or perhaps differing practices between the two countries or groups of clinicians. Surgery might be particularly important in the improvement of outcome, given that both studies identified surgery as reducing mortality. While some of these surgical interventions involved damage control surgery, a range of other surgical interventions were also included, and this raises the need for further exploration to determine the timing and situations where surgical intervention is most beneficial.

Predictors of mortality identified in the current study and by Richmond *et al.*[6] included age, ISS, number of injuries, absence of surgical intervention and trauma to the thorax, pelvis and abdomen. Of note, in our cohort mortality increased significantly with admission to ICU and patients who had experienced a fall were more than twice as likely to die as patients injured in a road traffic crash. We found no other studies that examined these predictors in this population. It is likely that co-morbidities would significantly contribute to the mortality model and perhaps weaken the contribution of chronological age.[18, 19] Unfortunately, our dataset did not have information on co-morbid medical problems.

Predictors of complications in the current study included ICU admission, hospital LOS greater than one week, increasing number of injuries, and increasing age. These predictors are consistent with current thought, particularly in relation to the relationship with increasing LOS. When hospitalized, older people are at risk of iatrogenic complications.[20, 21] These complications are frequently preventable and are often associated with the rapid decline in muscle strength, aerobic capacity and pulmonary ventilation that older patients experience.[20] Recognition of the relationship between serious injury and associated care, such as immobility, in older patients is essential in order that health care teams modify the acute hospital environment wherever possible to minimize the risk of complications.

The majority (65%) of patients in the current study were discharged to their usual residence. This included more than half of the 751 patients who were injured in a residential institution and who returned to the same residence. In contrast, a maximum of 53% of patients in Pennsylvania[6, 7] and 32–46% in various regions of

Canada[4, 11] were discharged to their usual residence, although some of these figures did not include patients from a residential institution who returned to that same institution after acute care. Variation in the proportion of patients who return to their usual residence may reflect differences in the need for ongoing support after definitive care or may be a reflection of the available resources; for example, if a health system does not have many rehabilitation places available then only small numbers of patients will be discharged to such a location. In addition, skilled nursing facilities within the US health care system appear to provide a unique role, with increased focus on a low level of rehabilitation that is not common within Australian aged care facilities, and therefore may provide a beneficial discharge destination that is not offered within the Australian health care system.

When considering predictors across the majority of discharge destinations compared to usual residence, increasing age, LOS, injury severity, and ICU admission were consistently identified. Of note, being initially transferred from another hospital was a predictor of both rehabilitation and convalescence. The return for convalescence at another hospital may be a reflection of pragmatic considerations as the injured patient was admitted to a small hospital near their usual residence, then transferred to a large regional or tertiary hospital for definitive care, and subsequently returned to a small hospital close to family and friends for the final stages of recovery.

Although patients with an isolated hip fracture were excluded, falls remained by far the most frequent cause of injury. Falls were an independent predictor of mortality and were also associated with a higher likelihood of discharge to a nursing home, compared to other causes of injury. In contrast, Richmond *et al*.[6] reported that the mechanism of injury was not a predictor of mortality, but was a predictor of increased discharge to a skilled nursing facility.

Carter and Gupta[22] examined all injury-related ED visits in patients aged ≥65 years and found that fall-related injuries increased the risk of hospitalization by 76% compared to other injuries, but they did not explore the effect on mortality. Gowing[4] studied only those elderly patients with ISS ≥12, thereby effectively excluding those patients with isolated hip fractures, and found falls to be the most common cause of injury. While falls are widely recognized as a cause of hospitalization as a result of hip fracture they are often not acknowledged as resulting in more serious injury and subsequent poor outcomes.

The retrospective nature of our study limited the analytic opportunities. Some fields of data were not available for all patients, particularly complications, which were only available for patients with major injury. Co-morbidities were not collected for any patients. In a number of situations the temporal relationship of various factors was not able to be determined from the dataset; for example, whether the existence of complications led to a longer ICU or hospital stay or vice versa.

Despite these limitations, this study in conjunction with Richmond *et al*'s study provides compelling evidence that older adults experience severe injuries, are at risk of poor outcomes and these findings are consistent across trauma systems and nations. Although LOS increased with age, the majority of the other markers of resource utilization such as surgery, transfer to another hospital for definitive care and ICU admission, reduced with age. A range of different factors are related to each of the outcomes that were examined, however in general these factors indicate increasing severity of injury and increasing duration or severity of intervention within hospital. These findings indicate the intense need to bring increased scrutiny and science to the care of serious injury in older adults. As the proportion of the population aged over 65 continues to increase there is a growing imperative to identify the most efficient means of effectively intervening at the most appropriate points in the care continuum to improve patient outcome.

Conflict of interest – see attached table

Author Contributions:

LA – concept and design, interpretation of data, preparation of manuscript

EB – data analysis and interpretation, preparation of manuscript

JL – data analysis and interpretation, preparation of manuscript

WC – concept and design, interpretation of data, preparation of manuscript

TR – concept and design, interpretation of data, preparation of manuscript

Sponsor's Role:

There was no sponsor for this study

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Table 1. Description of Injured Elderly Patients (n = 6,069)

Variable	Median (IQR)
Age, years	78 (71–84)
Total number of injuries	2 (1–3)
Number of body regions injured	1 (1–2)
Injury Severity Score	9 (4–10)
New Injury Severity Score	9 (4–13)
Maximum AIS injury severity across all body systems injured	3 (2–3)
Length of acute care stay, days	8 (5–15)
Length of stay in the intensive care, days (n = 638)	3 (1–7)

Table 2. Demographic, Injury and Acute Care Characteristics by Age Group (n= 6069)

Variable	65–74 Years	75–84 Years	85+ Years	Total
	n (%)			
Sex				(p<0.001)
Female	1,054 (46.0)	1,394 (61.6)	1,127 (74.5)	3,575 (58.9)
Male	1,237 (54.0)	871 (38.4)	386 (25.5)	2,494 (41.1)
Mechanism of injury				(p<0.001)
Fall	1,355 (59.1)	1,678 (74.1)	1,302 (86.1)	4,335 (71.4)
Road traffic crash	220 (9.6)	170 (7.5)	66 (4.4)	456 (7.5)
Collision with person/object	118 (5.2)	63 (2.8)	34 (2.3)	215 (3.5)
Machinery	147 (6.4)	49 (2.2)	8 (0.5)	204 (3.4)
Other road traffic crash	114 (5.0)	56 (2.5)	12 (0.8)	182 (3.0)
Pedestrian	68 (3.0)	84 (3.7)	25 (1.7)	177 (2.9)
Animal	79 (3.5)	35 (1.6)	9 (0.6)	123 (2.0)
Cutting	49 (2.1)	16 (0.7)	5 (0.3)	70 (1.2)
Burns/scalds	32 (1.4)	25 (1.1)	4 (0.3)	61 (1.0)
Other	109 (4.8)	89 (3.9)	48 (3.2)	246 (4.1)
Nature of main injury				(p<0.001)
Fracture	1,397 (61.0)	1,520 (67.1)	1,086 (71.8)	4,003 (66.0)
Intracranial injury	251 (11.0)	289 (12.8)	168 (11.1)	708 (11.7)
Superficial/open wound	167 (7.3)	167 (7.4)	123 (8.1)	457 (7.5)
Injury to internal organ	115 (5.0)	78 (3.4)	38 (2.5)	231 (3.8)
Injury to nerve/vessel/muscle/tendon	146 (6.4)	53 (2.3)	12 (0.8)	211 (3.5)
Dislocation/sprain/strain	66 (2.9)	83 (3.7)	58 (3.8)	207 (3.4)

Crushing injury/amputation	61 (2.7)	19 (0.8)	6 (0.4)	86 (1.4)
Burns	34 (1.5)	27 (1.2)	4 (0.3)	65 (1.1)
Other	54 (2.4)	29 (1.3)	18 (1.2)	101 (1.7)
Body region with most severe injury				(p<0.001)
Lower extremity	931 (40.6)	933 (41.2)	730 (48.3)	2,594 (42.7)
Upper extremity	532 (23.2)	415 (18.3)	228 (15.1)	1,175 (19.4)
Head	279 (12.2)	318 (14.0)	196 (13.0)	793 (13.1)
Thorax	203 (8.9)	190 (8.4)	96 (6.4)	489 (8.1)
Pelvis/abdomen	92 (1.0)	159 (7.0)	123 (8.1)	374 (6.2)
Spine	102 (4.5)	105 (4.6)	73 (4.8)	280 (4.6)
Face	59 (5.6)	61 (2.7)	29 (1.9)	149 (2.5)
Neck	48 (2.1)	44 (1.9)	26 (1.7)	118 (1.9)
External	45 (2.0)	40 (1.8)	12 (0.8)	97 (1.6)
Transferred from another hospital	685 (29.9)	501 (22.1)	236 (15.6)	1,422 (23.4) (p<0.001)
Level of definitive care hospital				(p=0.003)
Tertiary Hospital	902 (39.4)	978 (43.2)	689 (45.5)	2,569 (42.3)
Large Regional Hospital	743 (32.4)	703 (31.0)	430 (28.4)	1,876 (30.9)
Small Regional Hospital	646 (28.2)	584 (25.8)	394 (26.1)	1,624 (26.8)
Underwent surgery	1,512 (66.0)	1,190 (52.5)	672 (44.4)	3,374 (55.6) (p<0.001)
Admission to Intensive Care Unit	301 (13.1)	266 (11.7)	71 (4.7)	638 (10.5) (p<0.001)

Survived to hospital discharge	2,201 (96.1)	2,149 (94.9)	1,418 (93.7)	5,768 (95.0) (p=0.004)
Discharge Destination				(p<0.001)
Usual residence	1,725 (78.4)	1,305 (60.7)	740 (52.2)	3,770 (65.4)
Rehabilitation	281 (12.8)	562 (26.2)	385 (27.2)	1,228 (21.3)
Convalescence	89 (4.0)	116 (5.4)	91 (6.4)	296 (5.1)
Nursing Home	25 (1.1)	96 (4.5)	145 (10.2)	266 (4.6)
Definitive Care	37 (1.7)	25 (1.2)	21 (1.5)	83 (1.4)
Other	44 (2.0)	45 (2.1)	36 (2.5)	125 (2.2)
Developed a complication (major injury only: n = 899)	137 (37.0)	108 (31.1)	59 (32.6)	304 (33.8) (p= 0.09)

p values for variables across age groups calculated using Pearson's chi^2

Table 3: Predictors of Death Following Serious Injury in Older Adults (n = 6054)

Variable (reference category)	**Adjusted Odds Ratio**	**95% Confidence Interval**	**p value**
Age-group (>65 –74) ,years			
75–84	1.47	1.07–2.02	0.017
85 +	2.81	1.97–3.99	<0.001
ICU (No)	6.78	4.82–9.51	<0.001
ISS (0–9)			
10–15	1.39	0.88–2.21	0.159
16–25	2.20	1.37–3.54	0.001
26+	5.16	2.94–9.06	<0.001
External Cause (Fall)			
Road Traffic Crash	0.47	0.32 – 0.70	<0.001
Collision	0.66	0.29 – 1.52	0.334
Other	0.72	0.40 – 1.27	0.254
Location (Lower extremity/spine)			
Head	1.00	0.63–1.57	0.999
Face/Neck	0.81	0.42–1.57	0.527
Thorax/Pelvis/Abdomen	0.64	0.41–0.99	0.047
Upper extremity	0.28	0.14–0.56	<0.001
External	1.76	0.78–3.98	0.174
Number of Injuries (1)			
2	1.49	1.02–2.17	0.041
3+	1.73	1.18–2.53	0.005
Surgery (No)	0.56	0.43–0.75	<0.001
Gender (Female)	1.40	1.07–1.84	0.015

Area under ROC curve = 0.84; Hosmer-Lemeshow chi^2 statistic (8) = 7.76 (p= 0.46)

Table 4: Predictors of Complications Following Serious Injury in Older Adults with an ISS > 15 (n=899)

Variable (reference category)	**Adjusted Odds Ratio**	**95% Confidence Interval**	**p value**
ICU (no)	4.77	3.34 – 6.81	<0.001
Length of Stay (1–3), days			
4–7	1.59	0.76 – 3.35	0.221
8–14	3.38	1.67 – 6.83	0.001
15+	5.76	2.95 – 11.23	<0.001
Number of Injuries (1)			
2	1.93	1.05 –3.56	0.035
3+	2.62	1.64– 4.19	<0.001
Level of definitive care hospital (Tertiary hospital)			
Large regional	1.90	1.31 – 2.77	0.001
Small regional	1.90	1.08 – 3.34	0.026
Age-group (>65–74), years			
75–84	0.82	0.57 – 1.19	0.299
85 +	1.63	1.04 – 2.58	0.032
Location (Lower extremity/spine)			
Head	0.47	0.23 – 0.92	0.027
Face/Neck	0.90	0.32 – 2.48	0.834
Thorax/Pelvis/Abdomen	0.73	0.35 – 1.52	0.401
Upper extremity	0.46	0. 09 – 2.45	0.365
External	1.70	0.48 – 6.06	0.411

Area under ROC curve = 0.80; Hosmer-Lemeshow chi^2 statistic (8) = 5.07 (p=0.75)

Table 5: Adjusted Predictors of Discharge from Definitive Care to Various Destinations Following Serious Injury in Older Adults (n = 5756)

Variable (Reference Category)	**Rehabilitation v. Usual Residence** RRR (95% CI)	**Nursing Home v. Usual Residence** RRR (95% CI)	**Convalescence v. Usual Residence** RRR (95% CI)	**Other v. Usual Residence** RRR (95% CI)
Age group (65–74)				
75-84	2.51 (2.10-3.00)***	4.10 (2.60-6.47)***	1.86 (1.38-2.52)***	1.27 (0.90-1.80)
85+	3.09 (2.53-3.77)***	10.41 (6.61-16.37)***	2.88 (2.06-4.02)***	2.39 (1.63-3.51)***
Sex (Females)				
Males	0.74 (0.63-0.86)***	0.85 (0.63-1.15)	0.96 (0.74-1.26)	1.34 (0.98-1.83)
External Cause (Fall)				
Road Traffic Crash	1.04 (0.83-1.31)	0.33 (0.17-0.62)***	1.08 (0.74-1.57)	1.33 (0.88-2.03)
Collision with object/person	0.87 (0.53-1.34)	1.01 (0.47-2.17)	0.78 (0.37-1.67)	1.09 (0.51-2.34)
Other	0.66 (0.48-0.92)*	0.69 (0.35-1.35)	0.20 (0.45-1.28)	1.78 (1.10-2.87)
Nature of main injury (Fracture)				
Superficial/open wound	0.36 (0.25-0.53)***	0.79 (0.45-1.38)	0.89 (0.54-1.49)	0.76 (0.40-1.44)
Dislocation/sprain/ strain	0.54 (0.34-0.84)**	0.77 (0.36-1.63)	0.92 (0.47-1.81)	0.98 (0.42-2.30)
Inj to nerve/vessel/muscle/tendon	1.09 (0.63-1.86)	0.48 (0.11-2.08)	0.12 (0.02-0.88)*	1.19 (0.54-2.61)
Injury to internal organ	0.28 (0.17-0.47)***	0.16 (0.04-0.71)*	0.39 (0.18-0.83)*	1.17 (0.53-2.56)
Intracranial injury	0.71 (0.32-1.58)	1.10 (0.29-4.22)	0.31 (0.11-0.88)*	2.31 (0.50-10.54)
Other	0.33 (0.15-0.72)**	0.27 (0.06-1.25)	0.27 (0.07-0.99)*	0.47 (0.17-1.29)
Body region with most severe injury (Lower extremity/spine)				
Head	0.66 (0.31-1.43)	0.75 (0.21-2.67)	1.24 (0.49-3.17)	0.85 (0.19-3.74)
Face/Neck	0.73 (0.49-1.07)	2.08 (1.12-3.89)*	0.69 (0.33-1.43)	2.24 (1.22-4.10)**
Thorax/pelvis/abdomen	0.62 (0.49-0.79)***	0.99 (0.65-1.51)	0.81 (0.53-1.23)	0.74 (0.42-1.30)
Upper extremity	0.48 (0.38-0.60)***	0.92 (0.62-1.36)	0.74 (0.51-1.08)	0.80 (0.49-1.29)
External	0.93 (0.38-2.26)	2.38 (0.51-11.11)	0.35 (0.04-3.06)	2.43 (0.74-8.02)
Injury Severity Score (0-9)				

Variable (Reference Category)	Rehabilitation v. Usual Residence RRR (95% CI)	Nursing Home v. Usual Residence RRR (95% CI)	Convalescence v. Usual Residence RRR (95% CI)	Other v. Usual Residence RRR (95% CI)
10-15	1.30 (1.03-1.62)*	1.52 (1.02-2.28)*	1.07 (0.72-1.60)	1.09 (0.68-1.75)
16-25	2.13 (1.51-3.00)***	3.31 (1.71-6.42)**	2.56 (1.44-4.55)***	1.46 (0.81-2.64)
> 25	2.60 (1.59-4.26)***	4.79 (1.94-11.82)**	2.01 (0.81-5.01)	1.68 (0.75-3.75)
Length of hospital stay (1-3 days)				
4-7 days	5.14 (3.03-8.74)***	1.78 (0.88-3.64)	1.94 (1.13-3.35)*	1.86 (1.02-3.38)*
8-14 days	9.10 (5.37-15.43)***	2.41 (1.18-4.93)*	3.71 (2.17-6.36)***	1.63 (0.87-3.07)
15+ days	12.79 (7.53-21.76)***	5.30 (2.62-10.72)***	3.00 (1.70-5.30)***	3.22 (1.73-5.96)***
ICU admission (No)				
Yes	2.73 (2.06-3.62)***	1.52 (0.84-2.72)	3.33 (2.15-5.16)***	2.46 (1.54-3.95)***
Transferred from another hospital (No)				
Yes	2.09 (1.76-2.50)***	0.93 (0.63-1.38)	4.25 (3.25-5.55)***	1.76 (1.26-2.45)***
Level of definitive care hospital (Tertiary hospital)				
Large regional	0.99 (0.84-1.18)	2.33 (1.71-3.18)***	1.98 (1.43-2.75)***	2.31 (1.64-3.27)***
Small regional	0.84 (0.70-1.01)	1.81 (1.27-2.56)***	2.63 (1.91-3.62)***	1.60 (1.07-2.41)*

Significant difference indicated as follows: * ($p < 0.05$); ** ($p < 0.01$); *** ($p < 0.001$)

Hosmer-Lemeshow chi^2 statistics:
(1) Rehabilitaion v. Usual Residence (2170) = 2088.5, p= 0.89
(2) Nursing Home v. Usual Residence (1889) = 1838.7, p = 0.79
(3) Convalescence v. Usual Residence (1853) = 1959.1, p = 0.04
(4) Other v. Usual Residence (1878) = 2044.8, p = 0.01