Epidemiology of Major Trauma in Older Adults within Scotland: A national perspective from the Scottish Trauma Audit Group (STAG)

Injury

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Abstract:	Background Major trauma in older adults (MTOA) poses distinctive health and social care challenges, further underlined by the unique socioeconomic and geographical environment of Scotland. This study provides epidemiological trends of MTOA, to provide insight into areas where further evaluation and research are required. Materials and Methods Pseudonymised aggregated demographic, injury and outcome data from 2011-2020 were obtained from the Scottish Trauma Audit Group (STAG) Database, covering 28 hospitals across Scotland. Only individuals age ≥70 with an Injury Severity Score (ISS) >15 were included. Results There was an average of 216 annual cases of MTOA, with a 259% rise in incidence from 2011-2020. This was predominantly driven by a rise in low velocity trauma (fall <2m height; 287% increase). The proportion of all major trauma attributable to those aged ≥70 rose from 18.5% in 2011 to 34.6% in 2020. Death censored median (IQR) acute hospital length of stay was 18 days (9-30). Overall, 30-day survival was 65.3%, with no improvement seen between 2011-2020 (p = 0.50). Independent predictors of improved 30-day survival included Ages 70-79 & 80-89 [compared to reference ≥90] (OR 3.12; 95%CI 2.24,4.31; p<0.001 and OR 1.66; 95%CI 1.21,2.29; p=0.002 respectively), and Extremity injury (OR 1.89; 95%CI 1.48,2.41; p<0.001). Head injury (OR 0.72; 95%CI 0.54,0.96; p=0.027) and increasing ISS score (OR 0.88, 95%CI 0.86,0.89; p<0.001) were associated with lower likelihood of 30-day survival. A further model also including the admission ward (from eSTAG data November 2017 onwards) demonstrated an association with reduced 30-day survival with admission to General Surgery (OR 0.42; 95%CI 0.19,0.93; p=0.033), Intensive Care (OR 0.25; 95%CI 0.10,0.60; p=0.002) and Medical Specialities (OR 0.33; 95%CI 0.15,0.73; p=0.007) compared to the reference (Major Trauma). Exponential Smoothing predictions revealed a further potential 184% rise in incidence of MTOA from 2021-2030 (3657 per 100,000 population at risk to 10392 per 100,000 population at risk).

	Conclusion MTOA is likely to be a rising health care burden, requiring larger quantities of health and social care resource. Urgent preventative strategies are required to reduce low velocity trauma (standing height falls), as well as the high mortality and morbidity of MTOA.
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Abstract

Background

Major trauma in older adults (MTOA) poses distinctive health and social care challenges, further underlined by the unique socioeconomic and geographical environment of Scotland. This study provides epidemiological trends of MTOA, to provide insight into areas where further evaluation and research are required.

Materials and Methods

Pseudonymised aggregated demographic, injury and outcome data from 2011-2020 were obtained from the Scottish Trauma Audit Group (STAG) Database, covering 28 hospitals across Scotland. Only individuals age ≥70 with an Injury Severity Score (ISS) >15 were included.

Results

There was an average of 216 annual cases of MTOA, with a 259% rise in incidence from 2011-2020. This was predominantly driven by a rise in low velocity trauma (fall <2m height; 287% increase).

The proportion of all major trauma attributable to those aged ≥70 rose from 18.5% in 2011 to 34.6% in 2020. Death censored median (IQR) acute hospital length of stay was 18 days (9-30).

Overall, 30-day survival was 65.3%, with no improvement seen between 2011-2020 ($p = 0.50$). Independent predictors of improved 30-day survival included Ages 70-79 & 80-89 [compared to reference ≥90] (OR 3.12; 95%CI 2.24,4.31; $p<0.001$ and OR 1.66; 95%CI 1.21,2.29; $p=0.002$ respectively), and Extremity injury (OR 1.89; 95%CI 1.48,2.41; $p<0.001$). Head injury (OR 0.72; 95%CI 0.54,0.96; $p=0.027$) and increasing ISS score (OR 0.88, 95%CI 0.86,0.89; $p<0.001$) were associated with lower likelihood of 30-day survival. A further model also including the admission ward (from eSTAG data November 2017 onwards) demonstrated an association with reduced 30-day survival with admission to General Surgery (OR 0.42; 95%CI 0.19,0.93; $p=0.033$), Intensive Care (OR 0.25; 95%CI 0.10,0.60; $p=0.002$) and Medical Specialities (OR 0.33; 95%CI 0.15,0.73; $p=0.007$) compared to the reference (Major Trauma).

Exponential Smoothing predictions revealed a further potential 184% rise in incidence of MTOA from 2021-2030 (3657 per 100,000 population at risk to 10392 per 100,000 population at risk).

Conclusion

MTOA is likely to be a rising health care burden, requiring larger quantities of health and social care resource. Urgent preventative strategies are required to reduce low velocity trauma (standing height falls), as well as the high mortality and morbidity of MTOA.

Introduction

Major trauma in older adults (MTOA) has been increasingly recognised as a global healthcare concern [1,2]. Coupled with increased frailty and co-morbidity these patients can place a considerable burden on healthcare systems [3]. Previous evidence has suggested that these patients frequently receive a lower standard of care than those in younger age groups, despite having significantly greater associated mortality and morbidity [4].

An ageing population is likely to significantly exacerbate this problem further. However, the exact scale of this potential change is currently unknown. Scotland provides a suitable testbed for analysis given its diverse socioeconomic background, urban/rural spread, with a proportion of older adults that is similar to many other western populations [5,6]. In order to ensure adequate service provision for this patient group, it is essential that we understand the current and potential future burden of MTOA.

The Scottish Trauma Audit Group (STAG) is part of a national programme of audits, hosted by Public Health Scotland, that evaluate care provision across Scotland. It has run in its current form since 2011, with full coverage of all levels of units contained within the Scottish Trauma Network. Data from STAG has previously been used to evaluate several aspects of trauma care across Scotland [7-9], as well as production of annual reports that are used to evaluate care processes and standard attainment [10]. Consequently, STAG data provides the optimum platform to evaluate the epidemiological trends and outcomes for those with MTOA.

Against this background, we therefore set out to examine the current status of MTOA in Scotland, including prognostic factors and outcomes, with the view of gaining better understanding of practice and to inform future service provision for this population.

Materials and Methods

Study design, setting and participants

All patients in the STAG database over 10 years (between 2011 and 2020) who were aged ≥ 70 years with an Injury Severity Score (ISS) > 15 were included. The ISS is a validated and widely used injury scoring system that assess the combined impact of multiple injuries, according to Abbreviated Injury Scale codes, to determine overall severity [11].

Our study included all trauma patients presenting to participating Emergency Departments in Scotland who had sustained an injury within the previous 7 days and fulfilled the criteria of either: a minimum length of stay of 3 days, admission to critical care or those who have died in hospital.

Exclusion criteria consisted of: isolated minor head injury (GCS>13 and no fracture), isolated superficial wounds to face/thorax/abdomen/limbs, isolated pubic rami fractures, hip fracture, isolated closed limb injury, all hand & foot injuries except amputation (excluding fingers/toes) or crush mechanism, pathological fractures.

Data for STAG were collected prospectively by Local Audit Co-ordinators (LACs) employed specifically for the role. Data quality assessment is performed through utilisation of the Scottish Morbidity Record 01 (SMR01) which captures coding for the cause of all inpatient hospital episodes, with subsequent review of potential cases by the LACs to ensure all eligible patients are identified and included in the audit. There were two distinct periods of data collection included: a paper record from 2011 – October 2017, and then an electronic data collection tool (eSTAG) with expanded variable capture from November 2017 onwards.

Data Collection

Demographic and patient variables collected include: Year of attendance, Age-group (70-79/80-89/≥90), Sex, Injury type, Injury Mechanism, Admission Speciality (eSTAG only – Major Trauma, General Surgery, Orthopaedics, Medicine, Intensive Care and Emergency Department), Anatomical injury location (derived from the six regions of the Abbreviated Injury Scale – head, face, chest, abdomen, extremity, external [lacerations, bruises, abrasions, burns] & spine), and ISS Score.

Outcome variables included 30-day survival, length of stay, and discharge destination (eSTAG only).

Statistical Analysis

Initial data characterisation was undertaken, with 15 out of 17 variables having full data completion. No formal data imputation techniques were therefore required. For the two other variables (admission speciality and discharge destination) they were only collected during the later period of eSTAG and were therefore analysed in a subset of the sample (N = 1061) on a complete case basis for these results.

Descriptive analyses were first performed to identify and understand the nature of demographic variables in the MTOA cohort. This included assessment of changes in demographic profile over time. Chi-square tests (+/- Bonferonni adjustment) were used to evaluate the association between dichotomous variables and outcome, with Mann-Whitney U tests utilised for continuous variables (given non-parametric data). A multivariable logistic regression including anatomical site of injury, age, sex, ISS score, and admission speciality was performed to identify independent predictors of 30-day survival.

In addition, population adjusted projections of future incidence of MTOA (individuals age ≥70 with an ISS of >15) out to 2030 were performed utilising Holt's exponential smoothing projection method of historical time series data. Adjustment for National Record Scotland (NRS) population predictions were included [12]. All results are presented per 100,000 population at-risk per year.

In all analyses $p<0.05$ denoted statistical significance. Analysis was performed utilising R (R Foundation for Statistical Computing, Austria) and SPSS 27 (IBM Corp, USA).

Ethics

Approval for the study was obtained from the STAG Steering Committee (Data protection register number DP21220134, date 08/06/2021). Specific ethical approval was not required due to the use of anonymised aggregated data within a national audit setting. All analyses were undertaken in concordance with the Declaration of Helsinki and the Caldicott principles. This study is reported according to the Reporting of studies Conducted using Observational Routinely collected health Data (RECORD) statement [13]. There is no funding to declare. Code for the analysis performed is available on request to the corresponding author, with data utilised available on reasonable request to the STAG steering group.

Results

A total of 2155 patients were included for analysis. This represented over a quarter (26.2%) of the overall major trauma population admitted over the 10-year study period (2155/8235). The overall yearly number of presentations of MTOA grew over time, rising from 111 patients in 2011 to 399 patients in 2020, an increase of 259% (Figure 1). MTOA as a proportion of all major trauma presentations also nearly doubled, with an increase from 18.5% to 34.6% over the study period (Supplementary Figure 1). Sex distribution was relatively even, with 54.9% (1184/2155) patients male and 45.1% (971/2155) female.

Injury characteristics

99.5% (2144/2155) patients had a blunt mechanism of injury, with the vast majority (60.1%; 2196/2155) occurring due to low velocity falls (<2m height). In addition, the overall yearly number of presentations with low velocity falls rose sharply over time, from 68 in 2011 to 263 in 2020, a 287% increase. Motor vehicle accidents and high velocity falls accounted for 17.2% (370/2155) and 18.4% (396/2155) respectively. The remaining proportion were made up of other causes, for example assault.

The median ISS for included individuals was 21, with a bimodal distribution peaking at 17 (546/2155) and 26 (338/2155). The full distribution of scores in shown in Supplementary Figure 2. Regarding anatomical injury site, the head was the most common region injured (66.7%, 1438/2155), followed by external injuries (66.2%, 1426/2155). Abdominal injury was proportionally rare in this population (7.7%, 166/2155).

30-day Survival

Overall, 30-day survival was 65.3% (1408/2155). There was no change in survival over time from 2011 to 2020 ($p = 0.50$). Those in a lower age group (70-79) had a significantly higher 30-day survival (73.3%, 751/1039), compared to those age 80-89 (60.3%, 537/891) and those age ≥90 (53.3% 120/225), $p<0.001$. No survival differences were observed between the sexes (64.9% vs 65.9% for males vs female respectively, $p = 0.61$).

A multivariable logistic regression model including anatomical site of injury, age, sex, and ISS score was performed (n=2155) to identify independent predictors of 30-day survival (Supplementary Table 1). There were 5 variables identified as statistically significant in the model: Ages 70-79 & 80-89 [compared to reference ≥90] (OR 3.12; 95% CI 2.24, 4.31; $p<0.001$ and OR 1.66; 95% CI 1.21, 2.29; $p=0.002$ respectively), and Extremity injury (OR 1.89; 95%CI 1.48, 2.41; $p<0.001$) were associated with improved survival. Head injury (OR 0.72; 95%CI 0.54, 0.96; $p=0.027$) and increasing ISS score (OR 0.88, 95% CI 0.86, 0.89; $p<0.001$) were associated with lower likelihood of 30-day survival.

A second model including the admission speciality was also performed (n=876) [Supplementary Table 2. In this model head injury was no longer significant ($p=0.88$), but all other significant associations remained. Compared to the reference of admission to the Major Trauma ward, admission to General Surgery (OR 0.42; 95% CI 0.19, 0.93; $p=0.033$), Intensive Care (OR 0.25; 95% CI 0.10, 0.60; $p=0.002$) and Medical Specialities (OR 0.33; 95% CI 0.15, 0.73; $p=0.007$) were associated with a significantly lower likelihood of 30-day survival.

Discharge destination and length of stay

710 patients had data available for discharge destination in the eSTAG cohort. Only 46.6% (331/710) patients were discharged directly home following admission, with notable difference in discharge destination by age group (Figure 3).

Overall median length of stay was 11 days (Interquartile Range [IQR] 4-24). Length of stay was significantly longer in the 70-79 age group compared to 80-89 and ≥90 (median 13 days vs 10 days and 9 days respectively, p <0.001). There was however no difference in length of stay for males vs females (median 11 days for both groups, p = 0.11).

Death censored length of stay was also assessed. The median value was 18 days (IQR 9-30). Again, length of stay was significantly longer in the 70-79 group compared to those age 80-90 and ≥90 (p=0.002)

Future Trends

With adjustment for NRS population records the overall incidence of MTOA in the at-risk population increased 330% from 2011 to 2020 (701 per 100,000 population at risk to 3022 per 100,000 population at risk). Exponential Smoothing Predictions with adjustment for changes in future population dynamics suggest the potential for a further 184% (80% CI 55.9% to 216%) rise out to 2030 (3657 per 100,000 population at risk to 10392 per 100,000 population at risk) [Figure 4].

Discussion

Major trauma in older adults has escalated significantly over the last decade and is expected to become an even greater burden to health and social care services in the future. We provide strong evidence that MTOA can occur despite a preponderance of low velocity trauma (standing height falls), and it is therefore imperative that clinicians are alert to the potential for major trauma in older adults despite mechanisms that would traditionally not raise suspicion for significant injury. Notably 30-day survival has not improved over the last decade in this population, despite significant advances in other comparable populations, such as those who sustain hip fracture [14]. Significant differences in 30-day survival independently associated with various admission specialities requires further investigation to determine the potential causal nature of this relationship.

Our findings are broadly in line with those of the previous Trauma Audit Research Network (TARN) publication evaluating Major Trauma in Older adults (age >60) published in 2017 [4]. This study also found a significantly higher mortality amongst older adults sustaining major trauma, as well as major differences in the presentation characteristics and injury patterns of these patients compared to

other age groups. They also evaluated service provision and found that compared to other ages those with MTOA were less likely to be triaged as major trauma, less likely to be seen by a consultant in the emergency department and have a prolonged time to surgery. Other work from the TARN database has also demonstrated significant variation in the application of trauma care in older adults with major trauma nationally [15].

This study also highlighted a similar significant prevalence of head injuries in this population. Further public health measures should consider how best to reduce the risk and sequelae of serious head injury in older adults who sustain low velocity injuries (standing height falls). Anticoagulation is common amongst older adults and is a significant concern in head injury patients. Previous evidence has suggested that up to 16% anticoagulated patients suffer haemorrhagic complications following head injury [16]. Furthermore Grandhi et al. 2008 [17] identified that in a matched cohort of non vs anticoagulated patients with head injury the latter had significantly greater morbidity and mortality. Current evidence however suggests that overall the benefits of anticoagulation in those with Atrial Fibrillation outweigh the associated hazards, even considering those with a high falls risk [18]. Focus therefore needs to be on falls prevention, with several potential interventions highlighted in the recently published world guidelines for falls prevention and management for older adults [19]. Significant progress in falls prevention would also likely help to arrest the growth of MTOA predicted with changes in future population demographics.

Findings from this study also highlight the significant potential 30-day mortality associated with MTOA. This is comparable to some of the most widely recognised high-risk conditions, such as a ruptured aortic aneurysm [20], sepsis [21], and stroke [22]. Similar populations, such as hip fracture patients, have seen significant improvements in mortality made over the last decade which were not identifiable in our study population [23]. These differences can likely be attributed to the role of national audit in standardising high-quality care for this specific cohort of patients, who present unique medical, nursing, and social challenges that are separate to most other major trauma.

Hip fracture care specifically has been supported by significant evidence for the positive role of joint surgical and medical (Orthogeriatric) care. Recent changes have been introduced to the Scottish Trauma Network to include record Clinical Frailty Scale (CFS) [24] and if Comprehensive Geriatric Assessment (GCA) has been commenced within 72 hours (in >65 years). This will help to understand the current geriatrician provision across trauma units/centres with the hope that this will promote a move towards shared care in this population that is likely to positively influence healthcare outcomes, as suggested in the FiTR 2 study [25].

The findings of associated higher mortality for those admitted to specific specialities within this study warrants further investigation to determine if this relationship is due to differences in patient characteristics or a more direct effect. It does however appear to support the importance of prompt recognition of MTOA and the need for appropriate support in a specialised environment with experience of trauma care and an ability to promptly recognise the deteriorating trauma patient.

Strengths of our study include the large volume of high-level audit data that provides unique insights into historic MTOA across Scotland, including prediction of potential future trauma burden. Limitations comprise scope of the data by nature of the source, the potential that identified rises in burden are due to improved detection of MTOA rather than true increases (though these identified increases are consistent with other geographical locations [26,27]), and the challenge with drawing any causal links to the included outcomes. The truncation of data collection at 30 days may underestimate the true mortality rate and length of stay burden associated with these injuries.

Conclusions

Major trauma in older adults is a major public health problem that requires urgent attention to avoid a further significant increase in burden associated with an ageing population. National measures that target falls prevention are likely to be critical reducing the risk of major trauma in this population. Mortality outcomes across Scotland have remained stagnant over the last decade, with a critical need for further high-quality research to guide the best approach to develop preventative strategies and management of this patient group across the course of their treatment journey.

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Conflict of Interest: MC, AK, and MP are part of the Scottish Trauma Audit Group (SHFA) Steering Committee which provided the data for the submitted work. LF is currently in receipt of a Chief Scientist Office Scotland Clinical Academic Fellowship which is unrelated to the submitted work.

Funding: None

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LF	Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Resources; Software; Supervision; Validation; Visualization; Writing – original draft; Writing – review & editing. He is the Guarantor.
TD	Data curation; Formal analysis; Investigation; Validation; Writing – original draft; Writing – review & editing
MP	Data curation; Formal analysis; Investigation; Validation; Writing – review & editing
AK	Data curation; Investigation; Validation; Writing – review & editing
EC	Conceptualization; Writing – review & editing
MG	Conceptualization; Writing – review & editing
AA	Conceptualization; Methodology; Writing – review & editing
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15/02/2023

Subject: Submission of an Original Contribution

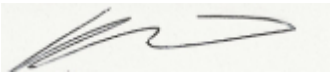
Dear Professor Giannoudis,

We are pleased to submit an original article entitled **"Epidemiology of Major Trauma in Older Adults within Scotland: A national perspective from the Scottish Trauma Audit Group (STAG)"** to be considered for publication in Injury.

We have identified current trends and epidemiology of major trauma in older adults. We provide insight into survival trends, incidence rates and predictors of important healthcare outcomes that will help to guide the future management of these injuries. We feel that Injury provides an excellent platform to disseminate our findings to a wide range of potential interested professionals including orthopaedic healthcare professionals, policymakers and providers.

I can confirm the paper has not been submitted to, and will not be published in, in whole, or in part, in any other journal. All authors have read & agreed to the contents of the manuscript in its submitted form.

Yours sincerely,



Mr Luke Farrow
Clinical Research Fellow – University of Aberdeen
For and on-behalf of all co-authors

Figure 1

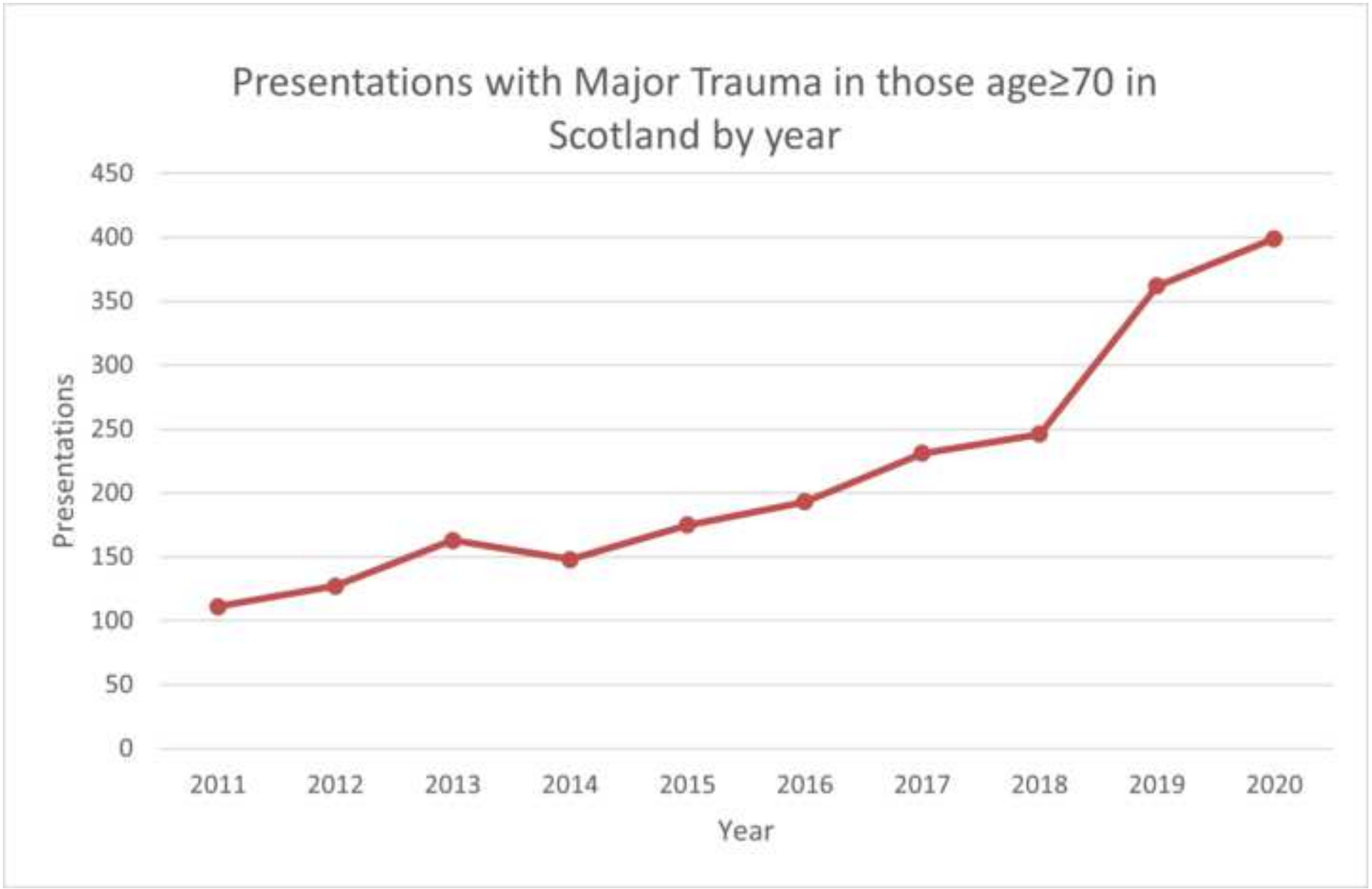


Figure 2

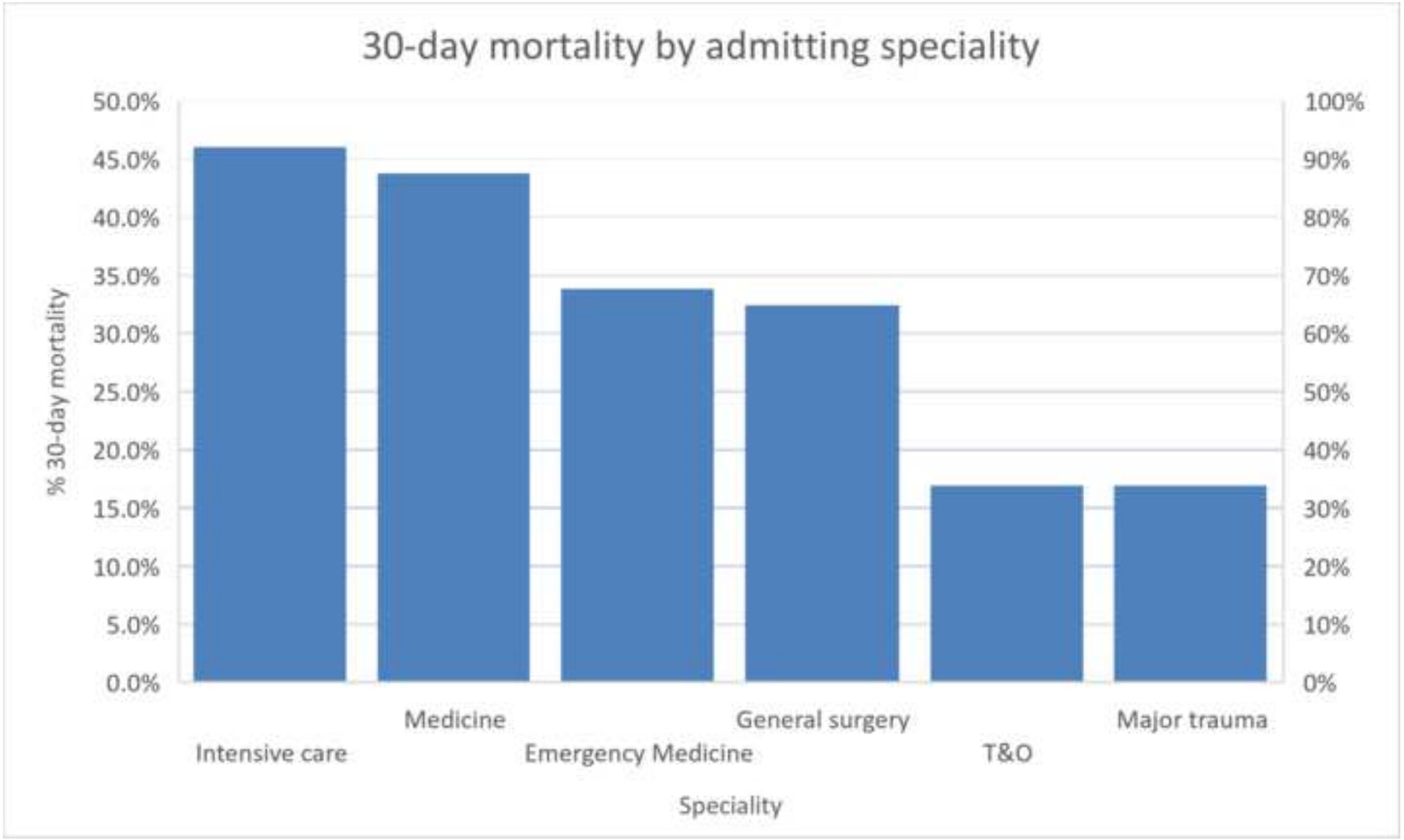


Figure 3

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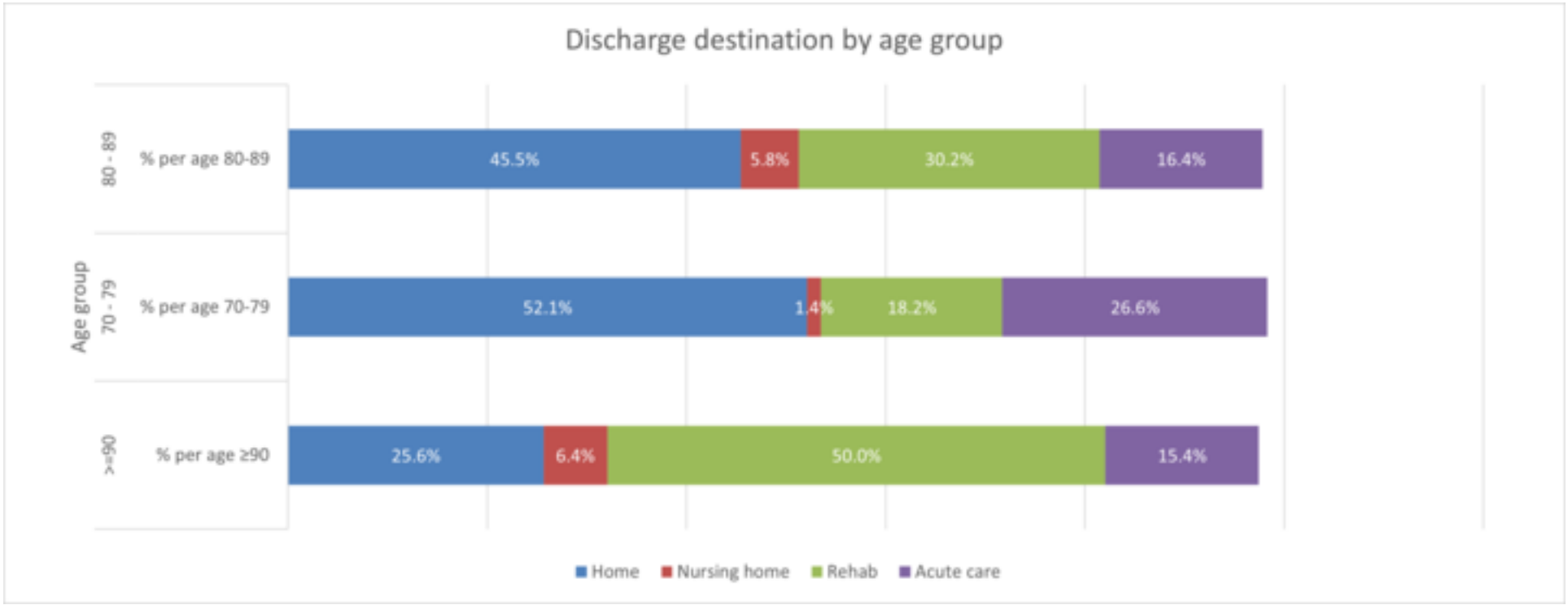

Figure 4

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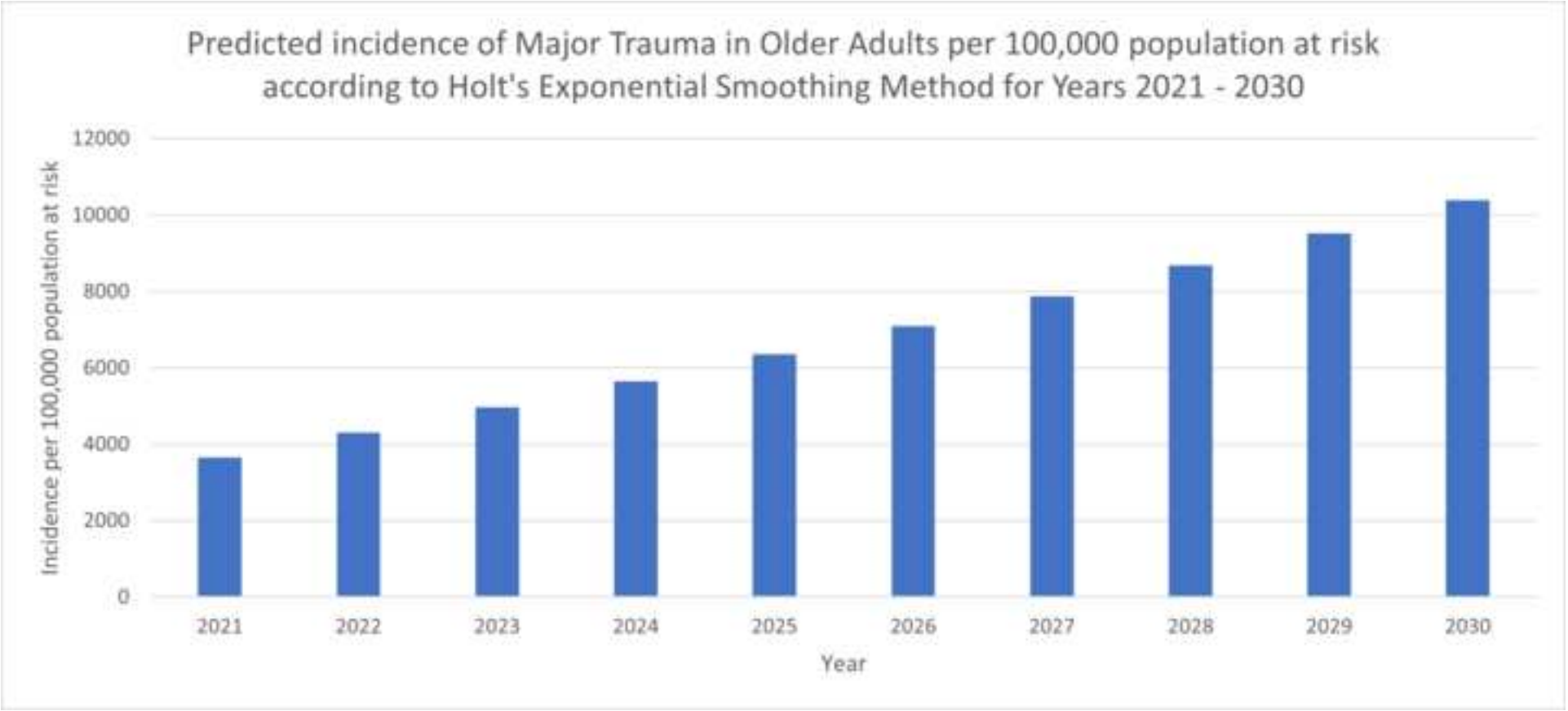

Supplementary Figure 1

Supplementary Figure 2

Supplementary table 1

Supplementary table 2

Record Checklist