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ORIGINAL RESEARCH

Does frailty scoring help to predict outcomes in older patients with major trauma? A retrospective study at a major trauma centre

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Abstract

Objective: The objective of the present study was to evaluate the impact of frailty on outcomes for older patients presenting with major trauma to a tertiary ED in Aotearoa New Zealand.

Methods: A retrospective observational study of patients 65 years and older who presented to Christchurch ED, New Zealand, with major trauma between 1 January and 31 December 2022. The primary outcome was a composite of in-hospital mortality or increased care requirements on discharge from hospital. Demographic details, in-hospital management, and outcomes were retrieved. Clinical Frailty Scale scoring had prospectively been recorded at the time of admission. Univariable analysis of discrete dependent variables was carried out. Mediation analysis was undertaken, wherein frailty was the mediator between age and the primary outcome variable.

Results: After exclusion criteria were applied, 134 patients were included for analysis. Even after controlling for age, for every additional point on the Clinical Frailty Scale, the odds of in-hospital mortality or increased care requirements on discharge increased by 36.4% (95% confidence interval: 9.4–85). Only 33% of these major trauma patients were appropriately identified at presentation and so received a trauma team activation, with worsened activation rates with increasing frailty.

Conclusions: The presence of significant injuries in older trauma patients is under-recognised. Frailty scoring could be used in the ED for early identification of those patients at high risk of poor outcomes, so that active management strategies can be put in place to optimise their care.

Key words: *emergency department, frailty, trauma.*

Key findings

- Increasing age and frailty both predict poor outcomes in older major trauma patients.
- After controlling for age, for every extra point on the Clinical Frailty Scale, the odds of in-hospital mortality or increased care requirements on discharge for major trauma patients 65 years and older increased by 36.4%.
- Recognition of major trauma in older adults remains poor, with only 33% of patients in the present study having a trauma team activation in the ED, despite retrospectively meeting criteria for major trauma.

Introduction

Older adults make up a significant proportion of trauma patients in New Zealand. The rate of trauma in those over 75 years is approximately 50/100 000, whereas the rate in all adult patients is 34/100 000.[1] Studies have shown that in-hospital mortality can be as high as double in patients over the age of 65, compared to those under 65 years.[2] At a population level, frailty increases with age. Gordon and Hubbard defined ageing as 'the passing of chronological time' and frailty as 'the increased risk of adverse outcomes over time'.[3] In the context of trauma, frailty can be thought of as a vulnerability to stressors.[4]

Frailty, disability and comorbidity are not necessarily synonymous,[5] just as frailty and age do not always go hand in hand. It is now understood that age – which increases with time – is not always matched by 'ageing'. Older patients who are

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also increasingly frail may experience different clinical outcomes from those who are less frail, such as more significant injuries from less significant mechanisms of injury.[6–8]

Recent systematic reviews and meta-analyses have shown evidence around the impact of frailty on outcomes for trauma patients.[6–8] The presence of frailty is significantly associated with mortality, complications and adverse discharge disposition after multisystem trauma; however, the studies included were all observational in nature. These studies highlighted the need for trauma system optimisation to meet the complex needs of older patients.[6–8]

How these findings apply to the Australasian setting has not been examined in depth. The present study aimed to evaluate the impact of frailty on outcomes for older patients presenting with major trauma to a tertiary ED in Aotearoa New Zealand. The results may be used to inform the development of specific pathways for the assessment and management of older adult trauma patients.

Methods

The STROBE (Strengthening the reporting of observational studies in epidemiology) checklist was used in the preparation of this manuscript and is included in Appendix S1.[9]

Study design

This was a retrospective observational study conducted using data from patients 65 years and older who presented to the ED of Christchurch Hospital with major trauma during 2022. Ethical approval for the present study was granted by the University of Otago Ethics Committee (HD24/001) and was endorsed by the Māori Health Advancement committee at the University of Otago, Christchurch. Locality approval for use of data was provided by the Canterbury District Health Board Research Office (CDHB) (RO#24033). Approval was gained from Dalhousie University for the use of the Clinical Frailty scale in this research.[10]

Study setting

Christchurch Hospital is a major trauma tertiary hospital in the South Island of New Zealand, which sees over 130 000 ED attendances and more than 400 major trauma admissions per year.[11] At the time of the present study, Christchurch Hospital used a two-tier system for Trauma Team Activation (TTA). The criteria for TTA includes both physiological and mechanism of injury parameters, but with no age-specific guidance. The highest tier of TTA, a 'Trauma Call', is placed *via* the operator, with an automated process that assembles a disciplinary team and blood bank being notified. The second tier, a 'Standby', is based on mechanism alone. This TTA system has previously been fully described by Nonis *et al.*[12]

Participants and data sources

Participants included all patients aged 65 years or greater who attended Christchurch Hospital ED in the 1-year period from 1 January 2022 to 31 December 2022 with major trauma. Major trauma in New Zealand is defined as Injury Severity Score (ISS) >12. Exclusions were made in line with the National Trauma Network, including presentations delayed more than 7 days after injury and isolated neck of femur fracture. Also excluded are poisoning or foreign body ingestion not causing injury, injuries secondary to medical procedures, pathology directly resulting in an isolated injury, hangings, drownings, and elderly patients who die with superficial injuries only and/or have co-existing disease that precipitates injury or is precipitant to death.[13] Patients who had been transferred to Christchurch hospital from a peripheral centre greater than 24 h after their injury were also excluded.

Clinical Frailty Scale (CFS) scoring is prospectively recorded by the trauma nursing team at the time of patient admission. The CFS is shown in Figure 1.[10] Patients were identified from the CDHB Major Trauma registry, with clinical records reviewed manually for missing variables. Ethnicity data was prioritised in line with the Te Whatu Ora ethnicity data.[14]

Outcomes

The primary outcome was the effect of frailty on a composite outcome of in-hospital mortality or increased care requirements on discharge from hospital. Whether patients should be coded as requiring 'increased care requirement on discharge', was determined by the data collector using the electronic patient records. This was defined as an ongoing higher requirement for help with daily living, and not simply short-term additional supports (such as a short period of home cleaning or provision of meals). Patients already in a facility providing a high level of care (such as hospital-level care) who returned to this level of care were coded as 'no increased care requirement on discharge'. Other key performance indicators reviewed were time to CT scan, ED length of stay (LOS) and total hospital LOS.

Statistical methods

Univariable analysis of discrete dependent variables was carried out using summaryM() from the Hmisc package in R studio.[15] Length of stay, which was the only continuous dependent variable, was positively skewed and there was heterogeneity of variance in linear models; therefore, a negative binomial model was used *via* the MASS package.[16] Mediation analysis was undertaken *via* the mediation package, wherein frailty was the mediator between age and the primary outcome variable.[17] The standardised coefficients of age and frailty were compared as predictors of the primary outcome using a t test so they could be directly compared in terms of their explanatory power.

Results

There were 134 patients who met inclusion criteria for the present

Figure 1. *The Clinical Frailty Scale scoring system. (Reproduced with permission). Importantly, when assigning scores, clinicians must assess the patient based on their function 2 weeks before admission.*[10]

study, which represented 28% (134/479) of all major trauma presentations to Christchurch Hospital during this time frame. The median CFS score for this cohort was 4 (IQR 2–5), with 49.3% and 41.8% of the patients having a CFS score of 'fit' (1–3) or 'mild to moderate frailty' (4–6), respectively. The median age of this cohort was 77 years, with 81 (60%) being male. One hundred and sixteen (87%) patients were New Zealand European, five (4%) New Zealand Māori, two (1%) Pacific Peoples and 11 (8%) other ethnicities. In comparison, in Canterbury region 3000 (3%) of the 98 200 people who are aged over the age of 65, are of Māori ethnicity.[18]

A fall from standing, fall from >1 m and motor vehicle collision were the mechanisms in most cases (43%, 24% and 15%, respectively). The median ISS was 17 (14–22). Only 44 patients (33%) received a TTA on arrival in the ED, despite all retrospectively meeting the criteria for major trauma (see Table 1 which describes the demographics).

When the results were analysed based on the primary outcome (in-hospital mortality or increased care requirements on discharge), there was a significant difference in several demographics and the hospital management of the groups of patients (see Table 2). Those with the primary outcome were older (83 *vs* 75, $P < 0.001$) and had a higher median CFS score (5 (3–6) *vs* 3 (2–4), $P < 0.001$). There were similar rates of TTA for each group (34% *vs* 31%, $P = 0.717$) and triage codes ($P = 0.074$).

Patients with the primary outcome had a shorter median time to CT (117 *vs* 159 min, $P = 0.019$), but a longer median hospital LOS (9 *vs* 6.5 days, $P = 0.02$). Median ED LOS was similar for both groups (333 *vs* 367 min). The final disposition from hospital varied, with the majority (62 patients, 89%) of those who did not meet the primary outcome going back to their own home (see Table 2).

Mediation analysis

The relationship between the primary outcome and age, and the primary outcome and frailty score was examined using mediation analysis. When increased care or death was regressed on age only, there was an odds ratio of 1.10 (95% CI 1.05–1.15, $P < 0.001$). When frailty was added to the model, the odds ratio between age and the primary outcome dropped to 1.06 (95% CI 1.01–1.12, $P = 0.02$). The mediation effect of frailty was shown to be significant with 36.4% (95% CI 9.40–85) mediated through frailty ($P = 0.004$) (see Fig. 2).

TABLE 1. *Demographics of study participants by Clinical Frailty Scale scoring*

	All patients, $n = 134$	Fit (CFS 1–3), $n = 66$	Mild–moderate (CFS 4–6), $n = 56$	Severe (CFS 7–9), $n = 12$
Clinical Frailty Scale, median (IQR)	4 (2–5)	2 (2–3)	5 (4–6)	7 (7–7)
Age, median (IQR)	77 (71–85)	73 (68–77)	84.5 (77–90)	82.5 (79.3–88.5)
Sex				
Male	81 (60%)	42 (63.6%)	32 (57.1%)	7 (58.3%)
Female	53 (40%)	24 (36.3%)	24 (42.9%)	5 (41.7%)
Ethnicity				
New Zealand European	116 (87%)	57 (86.4%)	48 (85.7%)	11 (91.7%)
New Zealand Māori	5 (4%)	2 (3.0%)	2 (3.6%)	1 (8.3%)
Pacific Peoples	2 (1%)	1 (1.5%)	1 (1.8%)	0
Other	11 (8%)	6 (9.1%)	5 (8.9%)	0
Injury mechanism				
Fall from standing	58 (43%)	14 (21.2%)	36 (64.3%)	8 (66.6%)
Fall from >1 m	32 (24%)	17 (25.8%)	13 (23.2%)	2 (16.7%)
Motor vehicle collision	20 (15%)	13 (19.7%)	5 (8.9%)	2 (16.7%)
Bike	9 (7%)	8 (12.1%)	1 (1.8%)	0
Other	9 (7%)	8 (12.1%)	1 (1.8%)	0
Extreme sport	6 (4%)	6 (9.1%)	0	0
Major trauma ISS, median (IQR)	17 (14–22)	17 (14–21)	17 (14–26)	14 (13–17.25)
Triage on arrival, median (IQR)	3 (2–3)	2 (2–3)	3 (2–3)	3 (2–3)
Trauma team activation				
Yes	44 (33%)	30 (45.5%)	12 (21.4%)	2 (16.7%)
No	90 (67%)	36 (54.5%)	44 (78.6%)	10 (83.3%)

Comparison after standardisation

The coefficients of both age and frailty were standardised by converting them to a Z score. A t test comparing the two coefficients produced a P-value of 0.89. There is no significant difference between frailty and age in terms of their explanatory value.

Discussion

The number of older trauma patients worldwide is increasing; one third of all major trauma patients admitted to hospital in Australia are over the age of 65, and in the United Kingdom, patients 75 years and older are the second most represented age demographic of trauma patients.[19] Older patients with pre-existing conditions, on anticoagulation, or with a greater injury burden have higher mortality.[6–8] Although older trauma patients have increasing morbidity and mortality, there is more complexity than just age itself.[6–8]

Lehman *et al.* evaluated the relationship between age and trauma triage decisions and found that older trauma patients were 29% less likely to have a TTA. This cohort of under-triaged patients over 65 years had a mortality rate four times greater than those under the age of 65.[20] All patients in the present study were 65 years or older, and only 33% received a TTA, despite all retrospectively meeting the criteria for major trauma. This aligns with previous findings at our site.[12] The rate of TTA also decreased with increasing CFS score.

Regardless of age individuals with higher levels of frailty are more likely to experience adverse outcomes.[6–8] The primary outcome in the present study was a composite of in-hospital mortality or increased care requirements on discharge from hospital. Both the CSF score and age were shown to have a significant impact on this outcome ($P < 0.001$). However, the mediation analysis showed, even when age was controlled for, for every extra 'unit' of frailty, the odds of in-hospital mortality or increased care requirements on discharged increased by 36.4%.

Multiple studies have shown the CFS has a good predictive ability for outcomes in geriatric trauma patients.[21–23] The FiTR 1, a UK study which analysed data from 23 major trauma centres, found that

TABLE 2. *Comparison of patients with and without primary outcome: In-hospital mortality or increased care requirements after discharge*

	Primary outcome: In-hospital mortality or increased care requirements		
	Yes (n = 64)	No (n = 70)	P
Injury severity score, median (IQR)	17 (14–26)	16 (14–17)	0.003
Clinical frailty scale score			
Fit (1–3)	20 (31%)	46 (66%)	0.001
Mild–moderate (4–6)	36 (56%)	20 (29%)	
Severe (7–9)	8 (12%)	4 (6%)	
ALL: median (IQR)	5 (3–6)	3 (2–4)	<0.001
Age, median (IQR)	83.00 (74.75–89.25)	75.00 (69.25–80.00)	<0.001
Sex			
Male	36 (56%)	45 (64%)	0.342
Female	28 (44%)	25 (36%)	
Ethnicity			
New Zealand European	55 (86%)	61 (87%)	0.954
New Zealand Māori	2 (3%)	3 (4%)	
Pacific Peoples	1 (2%)	1 (1%)	
Other	6 (9%)	5 (7%)	
Trauma team activation, n (%)			
Yes	22 (34%)	22 (31%)	0.717
No	42 (66%)	48 (69%)	
Triage code, median (IQR)	2 (2–3)	2 (3–3)	0.074
Time to CT (min), median (IQR)	117 (55–239)	159 (114–263)	0.019
ED length of stay (min), median (IQR)	333 (248–485)	367 (289–538)	0.096
Hospital length of stay (days), median (IQR)	9.00 (6.00–13.25)	6.50 (4.00–9.75)	0.02
Admitting team (one patient was discharged straight home from the 'No' group)			
General surgery	19 (30%)	15 (22%)	0.031
Neurosurgery	9 (14%)	17 (25%)	
Orthopaedics	15 (23%)	19 (28%)	
Surgical subspecialty	5 (8%)	12 (17%)	
General medicine	16 (25%)	6 (9%)	
Final disposition from hospital			
Died in hospital	17 (27%)	0 (0%)	<0.001
Own home	19 (30%)	62 (89%)	
Hospital level care	12 (19%)	6 (9%)	
Rest home	14 (22%)	2 (3%)	
Family	2 (3%)	0 (0%)	

age did have a significant negative impact on mortality but not as great an effect as frailty. They concluded that age alone can't be relied on to 'create pathways of care'.[21] A systematic review and meta-analysis published in 2023 of 12 studies also concluded that frailty is more accurate than age in predicting poor outcomes in this subset of patients.[8]

While age has long been recognised as a risk factor for poor

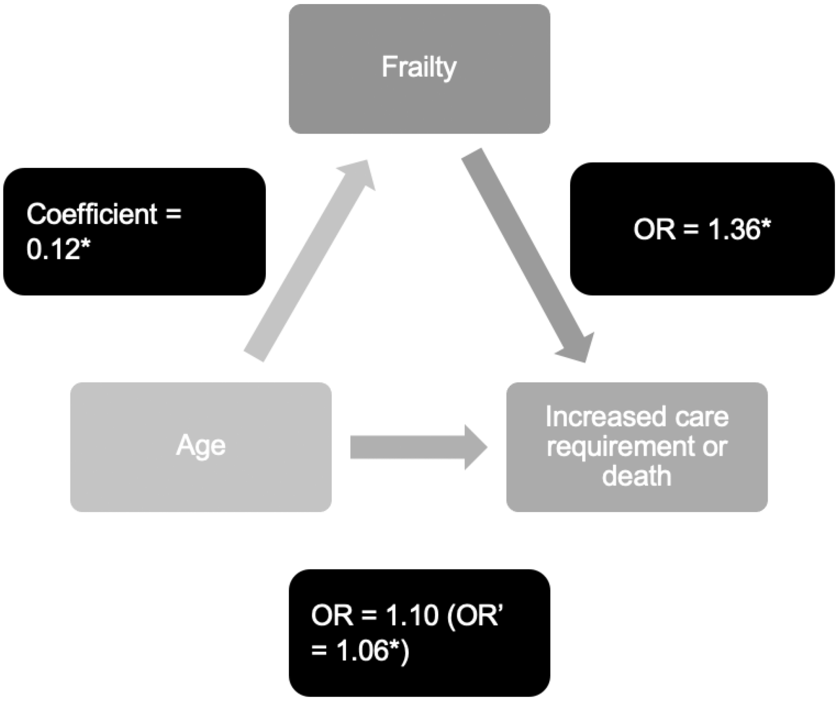

Figure 2. *A visual representation of the mediation effect of frailty on the relationship between age and the primary outcome. Coefficient = 0.12 is the coefficient between age and frailty, which are both continuous. OR = 1.10* is the odds ratio between age and increased care or death before controlling for frailty. OR = 1.06 is what the odds ratio between age and outcome drops to once you control for frailty. OR = 1.36* is the odds ratio between frailty and increased care or death after controlling for age (for each extra unit of frailty, the odds of increased care or death increases 36.4%).*

outcomes in trauma, our results suggest that frailty scoring may provide a more nuanced assessment of a patient's physiological reserve and ability to withstand the stress of traumatic injury. Thompson *et al.* outlined that the use of the CFS score could help clinicians identify vulnerable patients and tailor their treatment/planning appropriately.[24] Frailty scoring can be used to prognosticate recovery after elective surgical interventions, with pre-habilitation of frail patients before surgery aiming to reduce morbidity and improve post-operative function.[25] However, there is currently little evidence that adding frailty scoring to ED trauma pathways reduces morbidity and mortality.

Engelhardt *et al.* used frailty scoring to target 'high-risk' elderly emergency general surgical patients.[26] The present study was relatively small but did indicate that implementation of a multi-disciplinary pathway didn't disadvantage non-frail elderly emergency general surgical patients, but improved hospital length of stay and 30-day readmission rates for frail patients.[26] In addition, the ChIP (chest injury pager) protocol exemplifies how early activation of a multidisciplinary team can improve outcomes such as pneumonia rates in older adults with isolated chest wall injuries.[27]

Frailty screening shows promise in settings outside of major trauma and could be beneficial to predicting outcomes – and therefore instigating early care pathways – for major trauma patients. How this influences morbidity and mortality for this vulnerable group of patients is yet to be fully understood. The above points to the need for early frailty scoring, potentially to even lower the threshold for TTA.

Limitations

There are limitations in data collection and interpretation due to the retrospective and observational nature of the present study. Due to a small sample size, these results may have limited external validity. The number of cases in some of the subgroup analyses is small, which may limit statistical power. The present study is pragmatically restricted to those patients who meet major trauma criteria, as these are the patients included in the local trauma database; however, the inclusion of patients with an ISS score of 12 or less may alter the findings. As ISS scoring is based on body regions, there will be patients with significant single-system injuries who are not included in our major trauma registry, and therefore the present study excludes them, as their ISS will be 12 or less.

We also restricted inclusion to those patients 65 years or greater, as these are the only patients who have CFS recorded in our local database but acknowledge that there will be patients under 65 who are also increasingly frail. Six patients resided in hospital-level care both before and after their trauma admission. These patients have been coded as not requiring an increased level of care on discharge from hospital due to the limitations of retrospective data collection; however, it is possible that their actual level of care had increased. As these patients are likely to have higher levels of frailty, this could cause an under-estimate of the effect of frailty on the primary outcome.

Conclusions

Age and frailty are not synonymous, with both older age and increasing frailty having an impact on outcomes for older patients with major trauma. The present study demonstrates that even after controlling for age, for every extra point on the CFS, the odds of in-hospital mortality or increased care requirements on discharge increased by 36.4%. The presence of significant injuries in older trauma patients is under-recognised, and so a high proportion may be denied TTA, which can expedite appropriate care. Frailty scoring could be used in the ED for early identification of those patients at high risk of poor outcomes, so that active management strategies can be put in place to optimise the care of this complex patient group.

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Competing interests

None declared.

Data availability statement

The data that support the findings of the present study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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Supporting information

Additional supporting information may be found in the online version of this article at the publisher's web site:

Appendix S1. STROBE statement – checklist of items that should be included in reports of observational studies.