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Investigating the effects of frailty on six-month outcomes in older trauma patients admitted to UK major trauma centres: a multi-centre follow up study

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Abstract

Background Pre-injury frailty is associated with adverse in-hospital outcomes in older trauma patients, but the association with longer term survival and recovery is unclear. We aimed to investigate post discharge survival and health-related quality of life (HRQoL) in older frail patients at six months after Major Trauma Centre (MTC) admission.

Methods This was a multi-centre study of patients aged ≥ 65 years admitted to five MTCs. Data were collected via questionnaire at hospital discharge and six months later. The primary outcome was patient-reported HRQoL at follow up using Euroqol EQ5D-5 L visual analogue scale (VAS). Secondary outcomes included health status according to EQ5D dimensions and care requirements at follow up. Multivariable linear regression analysis was conducted to evaluate the association between predictor variables and EQ-5D-5 L VAS at follow up.

Results Fifty-four patients died in the follow up period, of which two-third (64%) had been categorised as frail pre-injury, compared to 21 (16%) of the 133 survivors. There was no difference in self-reported HRQoL between frail and not-frail patients at discharge (Mean EQ-VAS: Frail 55.8 vs. Not-frail 64.1, $p = 0.137$) however at follow-up HRQoL had improved for the not-frail group but deteriorated for frail patients (Mean EQ-VAS: Frail: 50.0 vs. Not-frail: 65.8, $p = 0.009$). There was a two-fold increase in poor quality of life at six months (VAS ≤ 50) for frail patients (Frail: 65% vs. Not-frail: 30% $p < 0.009$). Frailty (β-13.741 [95% CI -25.377, 2.105], p = 0.02), increased age (β -1.064 [95% CI [-1.705, -0.423] $p = 0.00$) and non-home discharge (β -12.017 [95% CI [118.403, 207.203], $p = 0.04$) were associated with worse HRQoL at follow up. Requirements for professional carers increased five-fold in frail patients at follow-up (Frail: 25% vs. Not-frail: 4%, $p = 0.01$).

Conclusions Frailty is associated with increased mortality post trauma discharge and frail older trauma survivors had worse HRQoL and increased care needs at six months post-discharge. Pre-injury frailty is a predictor of poor longer-term HRQoL after trauma and recognition should enable early specialist pathways and discharge planning.

Keywords Frailty, Older Trauma, Geriatric trauma, Health-related quality of life, Outcomes.

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Background

Traumatic injury is a substantial health burden for older patients with a significant proportion having ongoing functional and psychological difficulties long after hospital discharge [1]. Populations are ageing, and there is a corresponding increase in the proportion of older trauma patients [2]. Trauma systems are also better at identifying previously under-recognised populations of older trauma patients [3]. Accordingly, trauma systems have adapted their practice and guidance for older patients, focussing on differing mechanisms of injury and age-related physiological variations, to ensure timely assessment and management in the early phases of care [4, 5]. However older trauma patients are a heterogeneous group in relation to age, pre-injury functional status and comorbidities, all of which might impact on longer-term recovery [6]. Recent evidence suggests that in older trauma patients, frailty rather than chronological age is strongly associated with in-hospital and 30-day mortality and adverse discharge disposition [2, 7, 8]. Frailty is a state of reduced physiological and cognitive reserve and may affect an individual's ability to respond to a stressor event such as traumatic injury [9]. Between six and twelve months post trauma-discharge, frail patients are also more likely to have a trauma-related readmission [10] and poor functional status [11], yet the effect of frailty on longer term survival and quality of recovery is not widely reported.

Characterising pre-injury frailty may help to support prognostication in the acute phases of trauma care [12, 13] but it may also identify those who are vulnerable to longer term mortality, poor recovery and reduced quality of life. Health related quality of life (HRQoL) describes an individual's perception of their physical and mental health, cognitive and emotional status [14]. Patient reported HRQoL measures are used to quantify the effect of injury on health, assessing functional, psychological, social and mobility dimensions to provide an insight into recovery [15]. There are a variety of HRQoL measures and in the UK the Euroquol EQ-5D-5 L measure has been implemented within a national programme of patient-reported outcomes after major trauma for all ages of adult patients [16]. A recent systematic review identified that EQ-5D-5 L had good feasibility and application when administered to older people, including when support to complete was required [17]. Understanding HRQoL following trauma is also important in planning and supporting ongoing care, and to ensure that patients and families or carers are given realistic information on their expected recovery [14]. In older, frail trauma patients HRQoL appears to deteriorate after discharge from hospital. At 30 days after injury, frailty is reported to negatively impact on the recovery of health-related quality of life compared to the discharge baseline [18]. Beyond this time-point, the effects of frailty on longer-term HRQoL after trauma are not widely reported. Frail survivors of a trauma admission may suffer a markedly worse longer-term outcome and HRQoL compared with those who are not frail. Therefore, we aimed to investigate health related quality of life at six months following discharge from hospital, in older trauma survivors with and without pre-injury frailty. We also aimed to compare longer-term care needs between these two patient groups.

Methods

This research comprised the longer-term outcome evaluation of the 'Frailty in Major Trauma' (FRAIL-T) multicentre prospective observational study, carried out at five Major Trauma Centres (MTCs, Level 1 equivalent hospitals) in England [19]. The study was approved by the UK Social Care Research Ethics Committee (REC: 19/IEC08/0006).

Eligibility criteria included participants aged 65 or over, requiring trauma team activation and subsequently admitted to an MTC, irrespective of their injury severity score. All MTCs use a tiered trauma team activation (TTA) system depending on whether a full trauma team is required or not. Patients were approached for enrolment regardless of the level of TTA. Pre-injury frail status was determined during the in-patient phase of FRAIL-T and confirmed by geriatricians using the Clinical Frailty Scale (Frail defined as Clinical Frail Scale ≥ 6) [19]. Participants were consented for follow-up at the time of enrolment into the study. If a participant lacked capacity, then in line with the Health Research Authority for England and Wales guidance, a personal consultee who was able to advise on whether the patient should be included was approached. Quality of life data were collected via a questionnaire at two time points: on the day of discharge from hospital and at follow up, namely six months following discharge from hospital. When providing consent participants were asked to state their preference for receiving a follow-up questionnaire either by post or email, or administered over the telephone by a researcher trained in undertaking telephone interviews. Prior to follow-up at six-months the patient's survival status was checked via the national digital record system (National Health Service Spine) to ensure it was appropriate to make contact. Participants who were known to be alive at follow up but who did not respond to the initial request were contacted by telephone up to three times, at which point if there no response they were assumed 'lost to follow-up'.

The primary outcome was patient reported health related quality of life (HRQoL) at follow up compared to hospital discharge. HRQoL was assessed using two elements: the Euroqol EQ-VAS (visual analogue scale) which rates overall health on 0–100 scale where endpoints are labelled 'The worst health you can imagine' through to 'The best health you can imagine' [20]. A poor HRQoL

was defined as a VAS rating ≤ 50 [21, 22]. Descriptions of the individual's health status was measured using the EQ-5D-5 L system, a preference-based measure of self-reported health, which has been successfully validated in geriatric populations [23] and in frail older patients [24]. EQ-5D-5 L consists of five dimensions: mobility, self-care, usual activities, pain and discomfort, and anxiety and depression, and respondents report each dimension as *no problems, slight problems, moderate problems, severe problems* and *extreme problems* (or unable to complete) [25]. It has been developed for use either in face-to-face or telephone/online interviews when respondents are capable of self-reporting their health-related quality of life but unable to self-complete a paper/digital questionnaire [21]. We also recorded patient reported alteration in dependence status and care needs at follow up.

Table 1 Patient characteristics and outcomes

	Died post discharge (n = 54)	Not included in follow up (n = 150)	Included in follow up (n = 133)	*p*-value
Pre-injury frailty	32 (64%)	55 (37%)	21 (16%)	< 0.01
Age^	83.0 (7.8)	80.3 (8.3)	77.7 (7.5)	< 0.01**
Female	32 (59%)	80 (53%)	69 (52%)	0.85
Predominant mechanisms of injury:				0.01
Fall < 2 m	38 (70%)	77 (51%)	72 (54%)	
Fall ≥ 2 m	12 (22%)	42 (28%)	19 (14%)	
Vehicular incident	2 (4%)	24 (16%)	34 (26%)	
Admission GCS^	15 (14–15)	15 (14–15)	15 (15–15)	0.07
Injury Severity Score~	13 (9–20)	13 (9–20)	13 (9–17)	0.63
Critical care admission	6 (13%)	29 (22%)	18 (16%)	0.27
Hospital LOS (days)~	17 (7–27)	14 (5–20)	10 (4–18)	0.02*
Pre-injury residential status:				0.29
Own accommodation	47 (87%)	136 (91%)	126 (96%)	
Residential care	5 (5%)	13 (9%)	5 (4%)	
Warden controlled accommodation	2 (4%)	1 (1%)	1 (1%)	
Discharge to home	30 (56%)	105 (70%)	102 (77%)	< 0.01
Discharge Eq. 5D VAS^	53.9 (24.1)	59.1 (23.0)	61.8 (20.0)	0.16

^mean (standard deviation) or ~ median (Interquartile range) unless otherwise stated. Frail = Clinical Frailty Scale > 5 in hospital by ED or Geriatrician teams. GCS: Glasgow Coma Scale; LOS: Length of Stay, Eq. 5D VAS: Visual Analogue Scale. p value indicates comparison across groups (ANOVA / Kruskall Wallis or Chi Squared tests). ** signifies $p < 0.01$ when comparing age of patients who died and those who were alive and included (Tukeys post-hoc test).). *signifies $p = 0.04$ when comparing LOS of patients who died with those who were alive and included (Dunn post-hoc test)

On day of hospital discharge participants were approached by a research team member and asked to complete the questionnaire. If a patient lacked capacity at follow-up, a relative or proxy (if available) was asked to complete the questionnaire on their behalf [26]. At six-month follow-up participants or their proxy were either sent an HRQoL for self-completion or contacted by telephone to complete the interviewer administered version of the tool.

Data were analysed using Stata (version 16.1). Continuous data were tested for normality using Shapiro Wilk tests. Parametric comparisons were conducted using t-tests or ANOVA with Tukeys post hoc testing, and reported as mean (standard deviation). Non-parametric comparisons were tested using Mann Whitney U or Kruskall Wallis tests with Dunn post hoc testing, and reported as median (interquartile range). All tests were two-sided. Analysis of categorical data was conducted using Fisher's exact test and reported as number and percentage. The five EQ-5D-5 L dimensions were dichotomised into 'no problems' and 'any problems' [20] for comparison between cohorts at discharge and follow up. Multivariable linear regression analysis was conducted to evaluate the association between EQ-5D-5L VAS at follow up and predictor variables including frailty, age, sex, comorbidities, mechanism of injury, critical care admission, injury severity, length of stay and discharge destination. Robust standard errors were used and a p-value of < 0.05 was considered statistically significant. Potential non-linear effects of predictors were explored using fractional polynomial terms. Model specification was also checked by the link test and Ramsey's regression specification-error test. Missing data was addressed using maximum likelihood method [27].

Results

Of the 337 FRAIL-T study patients who survived hospital admission, 150 patients (45%) were not included in the follow up due to: no response 'loss to follow up' (119), not on NHS central record system to check survival status (10), did not consent to follow up (10) or unable to complete the HRQoL due to communication difficulties (10). Fifty-four patients (16%) died post discharge, leaving 133 included in the longer-term analysis (Table 1).

There was a four-fold increase in pre-injury frailty in those who died after discharge compared to those alive and included in the follow-up (Frail died: 64% vs. Frail not followed-up: 37% vs. Frail followed-up: 16%, $p < 0.01$). Patients who died prior to follow up were older (Died: 83 years vs. Not followed-up: 80 years vs. Followed-up: 77 years, $p < 0.01$), had experienced longer hospital stays (Died: 17 days vs. Not followed-up: 12 days vs. Followed-up: 10 days, $p = 0.02$) and were less likely to go directly

to home from the MTC (Died: 56% vs. Not followed-up: 70% vs. Followed-up: 77%, $p < 0.01$).

Less than a fifth of the followed-up patients (16%) had been categorised as frail whilst in hospital according to the clinical frailty scale [28] (Table 2). Only half of frail patients were able to complete the follow up independently compared to 92% of the not-frail group. Frail patients alive at follow up were older (Frail: 79 years vs. Not-frail 77 years, $p = 0.04$), had a greater number of co-morbidities (Frail: 3.3 vs. Not-frail: 2.1, $p < 0.01$) and the majority sustained injury during a low-level fall (Frail: 76% vs. Not-frail: 50%, $p = 0.03$). There were no differences in re-admission rates between frail and not-frail patients during the post-discharge period (Table 2).

At discharge, self-reported health related quality of life (HRQoL) was similar between groups (VAS: Frail: 55.8 vs. Not-frail: 64.1, $p = 0.137$, Fig. 1A). Whereas at follow-up, those who were not frail had improved, compared to a deterioration from discharge baseline in frail patients (VAS: Frail: 50 vs. Not-frail: 65.8, $p < 0.01$, Fig. 1B). The percentage of those reporting poor quality of life (VAS ≤ 50) at discharge was comparable between groups (Fig. 1C), but at follow up there was a two-fold increase in poor HRQoL for frail patients (Frail: 65% vs. Not-frail: 30% $p < 0.01$, Fig. 1D). In multivariable regression the presence of frailty (β-13.741 [95% CI -25.377, -2.105], $p = 0.02$), increased age (β -1.064 [95% CI [-1.705, -0.423] $p = < 0.01$) and non-home discharge (β -12.017 [95% CI [118.403, 207.203], $p = 0.04$) were associated with a poor quality of life at follow up (Table 3).

Table 2 Frail vs. Not-frail patients characteristics and outcomes

	Frail (n = 21)	Not-frail (n = 112)	*p*-value
Follow up completed by patient	10 (50%)	103 (92%)	-
Age^	79.2 (6.9)	77.0 (7.2)	0.04
Female	14 (67%)	55 (49%)	0.15
n. co-morbidities^	3.3 (1.5)	2.1 (1.3)	< 0.01
Fall < 2 m	16 (76%)	56 (50%)	0.03
Fall ≥ 2 m	3 (14%)	16 (14%)	0.99
Vehicular incident	1 (5%)	33 (29%)	0.01
Injury Severity Score~	13 (9–20)	13 (9–17)	0.53
Critical care admission	1 (5%)	17 (15%)	0.30
Hospital LOS (days)~	14 (2–20)	9 (4–17)	0.95
Pre-injury residential status:			0.11
Own accommodation	18 (86%)	109 (97%)	
Residential care	2 (10%)	3 (3%)	
Warden controlled accommodation	1 (5%)	0 (0%)	
Discharge to home	15 (71%)	87 (78%)	0.57
Hospital re-admission	7 (33%)	22 (20%)	0.13
n. re-admissions^	1.17 (0.41)	1.50 (0.83)	0.35

^mean (SD) or ~ median (interquartile range) unless otherwise stated. Frail = Clinical Frailty Scale > 5 in hospital by ED or Geriatrician teams. LOS: Length of Stay. p value indicates comparison between frail and not-frail patients

At both discharge and follow up, frail patients reported more problems of any severity in all EQ5D dimensions except pain, compared to the not-frail cohort (Fig. 2A, B). Both groups of older patients reported increased self-care problems at follow up compared to discharge, but this was significantly higher in those with frailty (Frail: 88% vs. Not-frail: 55%, $p = 0.01$, Fig. 2B). Twice the proportion of frail patients were anxious or depressed at follow up compared to the not-frail group (Frail: 76% vs. Not-frail: 39%, $p < 0.01$, Fig. 2B). Although not significant, frail patients were more dependent on care at follow-up (Frail: 45% vs. Not-frail: 29%, $p = 0.191$) and there was a five-fold increase in requirements for state-funded or private carers in those with frailty (Frail: 25% vs. Not-frail: 3.5%, $p < 0.01$, Fig. 3).

Discussion

This multi-site study examined survival and health related quality of life at six months after injury in older trauma patients with or without pre-injury frailty. Death was strongly associated with frailty during the six-month post discharge period. At six months, quality of life had deteriorated from discharge baseline for frail survivors but improved in those without frailty. Frail patients experienced more problems across all EQ-5D-5 L dimensions except pain and there was a significant increase in state-funded and private care provision associated with frailty.

Health related quality of life is an important outcome for older patients after critical illness or injury [29]. At six months post trauma frailty has been strongly associated with adverse functional status [11] and reduced neurological recovery [30]. Our frail trauma patients experienced poor quality of life at this time-point. HRQoL is reported to 'recover' by six months after hip fracture in the majority of older people [31] and in our not-frail cohort we observed an improvement in quality of life at this stage post injury. However, this was not the case for those with frailty, where HRQoL had significantly deteriorated from the discharge baseline. The six-month HRQoL scores for our frail cohort were worse than those of older trauma patients in a recent study of longer-term recovery [32], although our group were older on average (79 years compared to 73 years). We found that frailty, increased age and not being discharged to the usual place of residence were associated with poor HRQoL at six-months. Identifying frail trauma patients during the in-hospital phase of care and implementing frailty-specific pathways [33, 34] similar to those seen with hip-fracture populations [31], may enable targeted discharge planning, community rehabilitation and information to shape realistic expectations and prognostication [12, 35], none of which is standardardised UK trauma practice currently.

Self-care and anxiety and depression were the greatest problems experienced at six-months post injury for

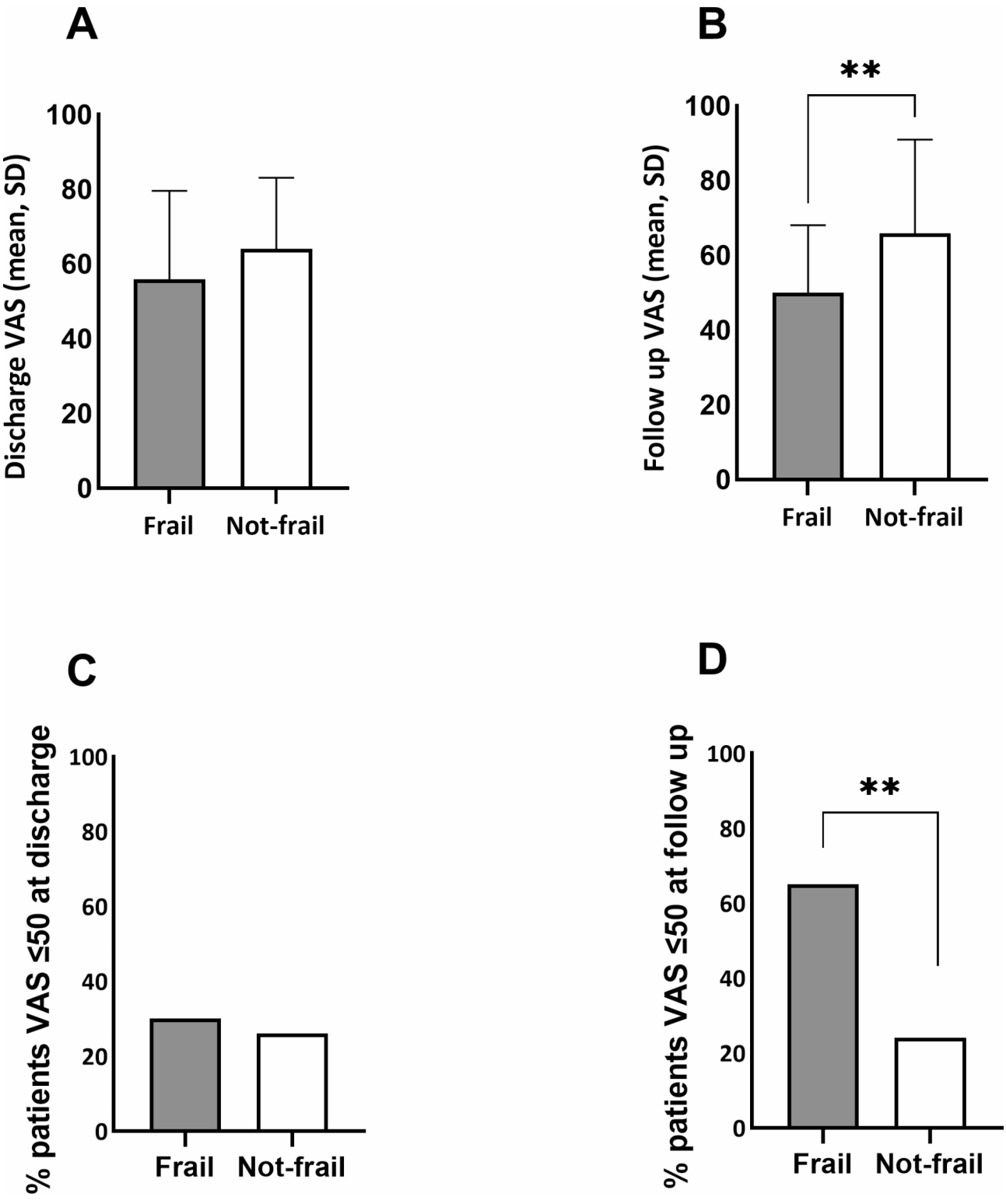

Fig. 1 Self-rated health related quality of life (HRQoL). **(A)** Visual analogue scores (VAS) (Mean, Standard Deviation) **at hospital discharge**: **Frail** 55.8 (42.7–69.0) vs. **Not-frail** 64.1 (60.0–68.1), $p = 0.137$. **(B)** VAS (Mean, Standard Deviation) **at follow up**: **Frail** 50.0 (41.3–58.6) vs. **Not-frail** 65.8 (61.0–70.7), $p < 0.01$ (T-tests) **(C)** Percentage patients with a VAS ≤ 50 at discharge: **Frail** 30% vs. **Not-frail** 26%, $p = 0.784$. (D) Percentage patients with a VAS ≤ 50 at follow up: **Frail** 65% vs. **Not-frail** 25%, $p < 0.009$ (Fishers exact test)

Table 3 Factors associated with Health Related QoL (Eq. 5D VAS) at follow up

	Beta coefficient	95% Confidence Intervals	*p*-value
Frail CFS > 5 based on in-hospital score	-13.741	[-25.377, -2.105]	0.02
Age	-1.064	[-1.705, -0.423]	< 0.01
Sex (Female = ref)	-5.083	[-14.518, 4.351]	0.29
Number of comorbidities	-0.608	[-4.487, 3.272]	0.76
Mechanism of injury (Others = ref)			
Fall < 2 m	3.237	[-12.402, 18.876]	0.68
Fall from ≥ 2 m	3.010	[-13.845, 19.865]	0.72
Critical care admission	1.304	[-13.260, 15.867]	0.86
Length of stay in Major Trauma Centre	0.182	[-0.242, 0.606]	0.40
Transfer to other care (Discharge to home = ref)	-12.017	[-23.232, -0.802]	0.04
Intercept	162.803	[118.403, 207.203]	< 0.01

R-squared = 0.194. Injury severity was removed from the final model due to missing data and a further analysis using maximum likelihood method: $p = 0.392$

frail patients. Injury in older people can lead to a process of activity restrictions and isolation which negatively influences psychological quality of life [36]. The effects of frailty can also adversely affect engagement in usual activities [37, 38] which may also impact on mood and mental health. In hip fracture populations frailty on admission has been reported as a strong prognostic factor for depressive symptoms up to a year after injury [39]. Whilst frailty is a chronic state of low physiologic reserve, the effects of an acute event such as trauma may enhance progression in frail status [40] increasingly impairing psychological and physical quality of life. Post-discharge recovery programmes for older frail patients following acute hospital episodes have reported improvements in longer-term HRQoL [41], with major benefits for the self-care and usual activities dimensions within Eq. 5D [42]. Frailty-led targeted discharge planning and specialist community support may help to avoid or improve the problems reported by our frail trauma patients [43].

Frail patients had increased formal care needs at home similar to that of a larger trauma study where frailty led to discharge 'home with health care' [44]. Frailty is associated with increasing health and social care costs [45] and many older people have a strong preference for living as independently as possible with support within their own homes [46]. The challenge is identifying which community-based interventions are clinically and cost effective for frail older people [47], to support those living at home in improving or maintaining quality of life after significant injury.

Limitations

This study has a number of limitations. Firstly, the proportion of frail patients alive and available for follow up in the longer term was small. There were no site-specific differences to account for the loss to follow-up, but it may be that some patients chose not to respond as they did not wish to be reminded of their traumatic event and hospitalisation. However, in those we could follow-up we believe that these findings provide a baseline for a larger scale investigation of quality of life and recovery

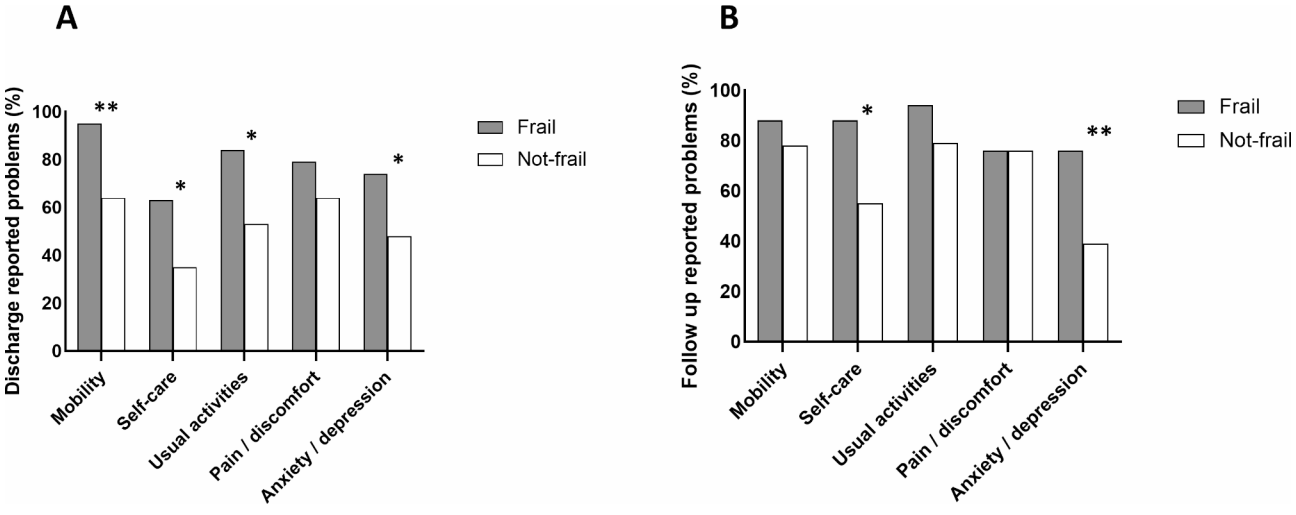

Fig. 2 Percentage of reported problems in EQ-5D-5 L dimensions for frail and not-frail patients at **(A) Discharge.** Mobility: Frail 95% vs. Not-frail 64%, $p < 0.01$, Self-care: Frail 63% vs. Not-frail 35%, $p = 0.03$, Usual activities: Frail 84% vs. Not-frail 53%, $p = 0.01$, Pain: Frail 79% vs. Not-frail 64%, $p = 0.299$, Anxiety/depression: Frail 74% vs. Not-frail 48%, $p = 0.04$. **(B) Follow-up.** Mobility: Frail 88% vs. Not-frail 78%, $p = 0.511$, Self-care: Frail 88% vs. Not-frail 55%, $p = 0.01$, Usual activities: Frail 94% vs. Not-frail 79%, $p = 0.189$, Pain: Frail 76% vs. Not-frail 76%, $p = 0.999$, Anxiety/depression: Frail 76% vs. Not-frail 39%, $p < 0.01$. (Chi squared tests)

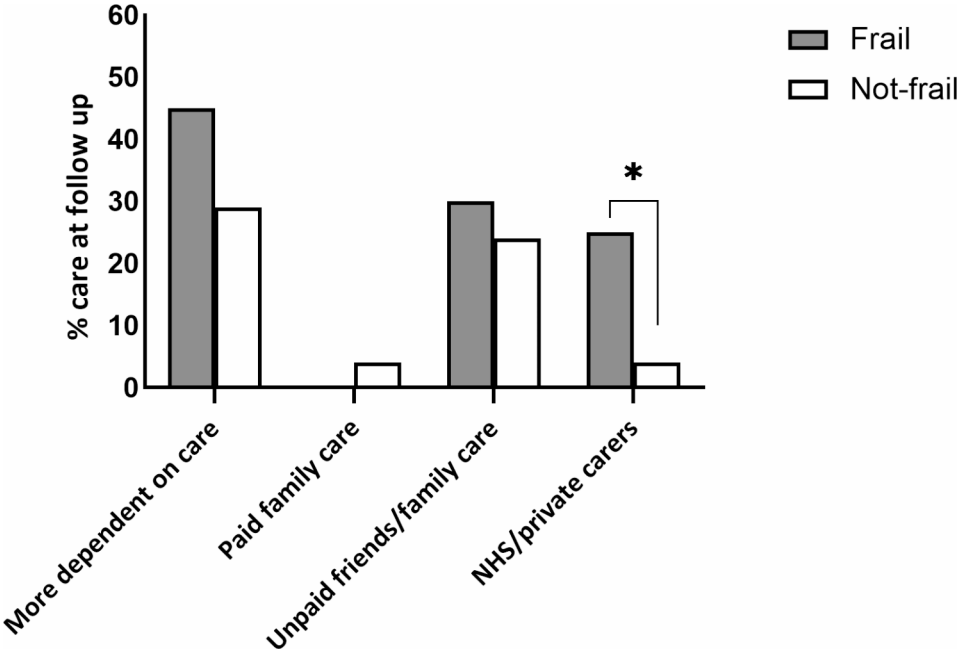

Fig. 3 Care needs at follow up for frail and not-frail patients. ** NHS/private carers frail: 25% vs. not-frail: 4%, $p < 0.01$. (Fishers exact test)

in frail older trauma survivors. Secondly, we only used EQ-5D-5 L to measure and assess HRQoL. EQ-5D-5 L is a patient-reported outcome measure which assesses health status or HRQoL at specific points in time, which we were able to do, compared to population norms, which we were not. It may however be challenging to make comparisons between general population norms and older frail populations [48]. Despite this limitation, EQ-5D-5 L is a patient reported outcome measure recommended for used in older people [49] and recently identified as suitable for further validation with acute older frail populations [50]. Finally, we measured longer term HRQoL and outcome at six months post injury, whereas other trauma studies have followed up patients at time-points between three months and two-three years. We acknowledge that HRQoL may have improved for patients after the six-month period but given the deterioration seen in the frail group, it may also have worsened. Optimal time to measure HRQoL lacks consensus however a recent study of trauma patients aged ≥ 65 years showed no improvement in EQ5D-5 L HRQoL after six months post injury [32].

Conclusion

Despite considerable loss to follow up, frailty in older trauma patients was statistically associated with post-discharge mortality, and in survivors, worse HRQoL and more physical and psychological problems at six months after injury. If frailty is a predictor of poor longer-term HRQoL, specialist pathways should be integral to trauma discharge planning for older patients, in order to set realistic goals and optimize the quality of post-discharge recovery.

Abbreviations

ANOVA	Analysis of Variance
CFS	Clinical Frailty Scale
HRQoL	Health Related Quality of Life
MTC	Major Trauma Centre
VAS	Visual Analogue Scale

Author contributions

HJ, RC, MB and EC contributed to the conception and design of the study. EC and HJ drafted the manuscript. CW and EC completed the data analysis. All authors read, provided comment and approved the final manuscript.

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Data Availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study obtained an ethical opinion for conduct by the UK Social Care Research Ethics Committee (REC no 19/IEC08/0006). Consent guidance for undertaking research in emergency settings and with patients lacking capacity was followed.

Consent for publication

Not applicable.

Competing interests

None.

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