







BMJ Open Configurations and outcomes of acute hospital care for frail and older patients with moderate to major trauma: a systematic review

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ABSTRACT

Objective To systematically review research on acute hospital care for frail or older adults experiencing moderate to major trauma.

Setting Electronic databases (Medline, Embase, ASSIA, CINAHL Plus, SCOPUS, PsycINFO, EconLit, The Cochrane Library) were searched using index and key words, and reference lists and related articles hand-searched.

Included articles Peer-reviewed articles of any study design, published in English, 1999–2020 inclusive, referring to models of care for frail and/or older people in the acute hospital phase of care following traumatic injury defined as either moderate or major (mean or median Injury Severity Score ≥ 9). Excluded articles reported no empirical findings, were abstracts or literature reviews, or referred to frailty screening alone.

Methods Screening abstracts and full text, and completing data extractions and quality assessments using QualSyst was a blinded parallel process. A narrative synthesis, grouped by intervention type, was undertaken.

Outcome measures Any outcomes reported for patients, staff or care system.

Results 17 603 references were identified and 518 read in full; 22 were included—frailty and major trauma (n=0), frailty and moderate trauma (n=1), older people and major trauma (n=8), moderate or major trauma (n=7) Or moderate trauma (n=6). Studies were observational, heterogeneous in intervention and with variable methodological quality.

Specific attention given to the care of older and/or frail people with moderate to major trauma in the North American context resulted in improvements to in-hospital processes and clinical outcomes, but highlights a relative paucity of evidence, particularly in relation to the first 48 hours post-injury.

Conclusions This systematic review supports the need for, and further research into an intervention to address the care of frail and/or older patients with major trauma, and for the careful definition of age and frailty in relation to moderate or major trauma.

International Prospective Register of Systematic Reviews (PROSPERO) CRD42016032895.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This review has taken a comprehensive approach to including both those classified as frail as well as those who are older in recognition that definitions vary and frailty has not always been routinely assessed.
- ⇒ Widening our approach to capture both moderate and major trauma, according to classifications of severity of impact on a younger population, allows us to indicate where a more inclusive approach may have benefits for older people.
- ⇒ The review was strengthened by following international guidelines for the conduct of reviews and established tools for the quality assessment of the included studies.
- ⇒ The review's limitations include its broad definitions and therefore the heterogeneity of the included studies' populations and outcomes, as well as of quality.

The original protocol for the review can be found in online supplemental file 1.

INTRODUCTION

As the population ages, so does the proportion of older people affected by major trauma. In the UK, registry data show the incidence of major trauma in those over 75 years old doubled in a 9-year period, and nearly 150 000 people were affected from 2012 to 2017.^{1,2} Older patients with trauma frequently experience medical comorbidities, cognitive deficits and polypharmacy, and have a higher level of morbidity and mortality than younger patients.^{3–5} These poorer outcomes are associated with the physiological and biological changes of ageing that lead to a reduced ability to tolerate injury.^{6,7}

Deficiencies in care of the older patients with trauma have been reported in the



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literature, including under-recognition of injury severity, delays to imaging and missed identification of injuries.^{8–11} This has led to the development of specific quality standards and education programmes to address the differing needs of older patients with trauma.^{12–14} In the UK, the National Institute for Health and Care Excellence recommend that there are acute specialist services for older patients with trauma but recognise the challenge in identifying aspects of service configuration that impact on patient outcomes.¹⁵

Older people are a heterogeneous group and it is not just chronological age that impacts on outcomes. There is increasing evidence that frailty, a long-term condition characterised by accumulative deficits in physiological, physical and mental function, rather than age impacts on outcomes in major trauma.^{16 17} Frailty status is offered as a way of further categorising older patients who could benefit from targeted interventions following major trauma. In England, the introduction of a quality measure leading to a payment subsidy for patients with major trauma aged 65 years or over who have a frailty assessment within 72 hours of admission has recently been introduced.¹⁸ Early assessment of frailty in patients with major trauma in the emergency department (ED) is possible but not yet reflected in the clinical guidance.¹⁹ Frailty-specific models of care for geriatric fracture and patients with mild trauma have been shown to improve length of hospital stay, readmission rates and independence.^{20 21}

It is not clear which components of major trauma care specifically focused on frail or older patients are associated with improved outcomes, or precisely where the ‘cut point’ for defining trauma as ‘major’ in older and/or frail people should be, although a new definition taking account of differential impact of trauma has recently emerged.²² While recognising that age and frailty are not directly correlated, trauma providers who do not use formal frailty screening in older people with trauma are reported to commonly include age in their determinations of frailty and to show limited consensus around definitions.²³ In this context, we therefore asked the following review question, specifically designed to capture the breadth of definitions related to age/frailty and trauma/major trauma: what is the configuration and impact of current models of care for frail or older patients presenting with moderate to severe trauma in hospital?

METHODS

This systematic review was designed and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA),^{24 25} and registered with the International Prospective Register of Systematic Reviews (PROSPERO), CRD42016032895.²⁶

Patient and public involvement

There was no direct patient and public involvement in this systematic review. The review question was derived

however during conduct of a study of feasibility and accuracy of ED frailty identification in older patients with trauma: a prospective multicentre study, during which the patient and public involvement activities highlighted the importance of the subject.¹⁹

Eligibility criteria

The eligibility criteria underpinning the broader terms utilised in the review question are defined in detail as follows.

Inclusion

1. Population: patients with major (ISS >15) or moderate (ISS ≥9 and ≤15) trauma who are older and/or present with frailty.²⁷ ‘Major trauma’ was defined as serious and often multiple injuries where there is a strong possibility of death or disability.²² Classically major trauma includes those classed as having severe injuries determined by an Injury Severity Score (ISS) above 15 but due to the disproportionate impact of trauma on older patients we elected after conducting initial screening to also include moderate trauma (ISS ≥9).²² Definitional variation was anticipated due to the relatively recent introduction of the term ‘frail’ in emergency care trauma and the conflation of age >70 with frailty.^{23 27} Frailty or being older was therefore defined according to the criteria set in each paper.
 2. Intervention: configuration of acute care for older and/or frail patients presenting to hospital after moderate to major trauma. We defined ‘hospitals’ as a facility capable of receiving patients with traumatic injuries; and ‘configuration’ to include any type of care specific to the frail or older status of the patient. These definitions result in a broad review, with the evidence for the subgroups within our definitions presented separately.
 3. Comparison: Any or none.
 4. Outcomes: prevalence and type of acute care model; and any outcomes reported for patients, staff or care system. ‘Impact’ was any outcomes for the patient, staff or care system.
 5. Study design: Any that allowed measurement in a primary study.
- Studies were grouped for synthesis according to their intervention.

Exclusion criteria

Articles were additionally excluded if they were not published in the English language, reported on injuries with a mean or median ISS (or calculated estimated mean ISS from grouped data) of <9 or presented no information on ISS, reported no empirical findings, were published as an abstract or were literature reviews.

Information sources

The electronic databases Medline, Embase, Applied Social Sciences Index and Abstracts, CINAHL Plus, SCOPUS V.4, PsycINFO, EconLit and The Cochrane Library were searched from the beginning of January 1999 to end December 2020, with the initial 20-year

period (1999–2019) selected following scoping that suggested that most papers on the topic were published in the 2010s but with some earlier work in the 2000s. During the review conduct process we elected to add the year 2020 in order to update.²⁸

The search strategies were developed initially utilising the topic knowledge of the team and scoping papers to produce a set of terms for each of the elements of the eligibility criteria, mapping these to the index terms of the different databases,²⁸ and utilising these index terms as additional key words in the databases without indexing.

No language or publication status restrictions were imposed at this stage; see online supplemental file 2 for the search strategies for all information sources.

In addition, we used ‘lateral searching’ techniques²⁹ - we checked reference lists of systematic reviews identified at the abstract screening stage and papers selected for inclusion after full-text reading, and used the Scopus ‘Cited by’ and the Pubmed ‘Related articles’ functions.

Selection process

Relevant studies were selected using title and abstract screening, followed by full-text screening, by author pairs (MH with PM, STK, DB or LG) screening independently in parallel, with disagreements resolved in discussion, against the eligibility criteria. Articles excluded at full-text screening are listed in online supplemental file 3.

Data collection process and data items

Author pairs independently extracted the general characteristics of studies and results into a spreadsheet and the lead author conducted a consistency check across all for level of detail of data extracted. The data items collected were author and year of publication, aim, study design and methods, study setting (country, section of acute care), intervention/model of care/pathway, comparison (if any), participants (population and sample), mean or median ISS, outcomes and their effect measures and key findings against outcome. Where ISS was presented as a range, the study team calculated an estimate mean ISS based on a mid-point assumption in grouped ISS data and the sample numbers. A summary of the data extracted on characteristics and outcomes is found in the online supplemental data files (characteristics and outcomes).

Study risk of bias assessment

Author pairs independently appraised study quality using the QualSyst checklists for quantitative and qualitative studies,³⁰ with any disagreement moderated by MH. Scoring cut points were not employed to decide on inclusion or exclusion²⁸; rather the differences in scores on the risk of bias assessment were utilised in the synthesis, accounting for heterogeneity in study paradigms, methods and results.³⁰

Synthesis methods

Heterogeneity of the interventions and outcomes investigated in the included studies precluded meta-analysis. Therefore, narrative synthesis was undertaken³¹ and

conducted against guidance: developing a theory of how, why and for whom the intervention works; developing a preliminary synthesis of findings; exploring relationships; and assessing the robustness of the synthesis³² through a process of discussion and tabulation of the outcomes, initially against population subgroups and then against the intervention groups, and taking into account the limitations of lower quality evidence during synthesis.³³

RESULTS

Search results

The search strategy identified 17603 references, from which we selected 518 for full-text review. Of these, 85 described major or moderate trauma, and 22 of these were included for data collection, quality appraisal and data analysis; see [figure 1](#) PRISMA flow diagram.

The included evidence is summarised below in three subsections: characteristics of included studies, methodological quality, and synthesis of findings.

Characteristics of included studies

Four population descriptor groups were constructed (see [figure 2](#)). Only one study was found that specifically explored configurations and/or outcomes of interventions for frail patients with moderate trauma.³⁴ The remainder of the studies included major (ISS >15)^{34–45} or moderate through to major (ISS ≥9) trauma^{46–54 55} in populations defined by their authors as ‘older’, with or without a version of a frailty assessment being part of the intervention. Studies included classifications of ‘older’ at differing starting ages, ranging from 55 to 70 years.

The publication years ranged from 2002³⁵ to 2019³⁴; all but two were from 2011 onwards. All were conducted in North America and were in single localities, either one hospital or facilities within one or two administrative regions. Included studies were all observational in design.

No two studies presented precisely the same intervention, though five distinct intervention groups were identified (see online supplemental data characteristics and outcomes).

Injury severity in the samples varied widely.

Outcome measures varied across studies, although there were groupings around quality-assured processes of geriatric-specific care and around hospital (eg, length of stay and cost) and patient (eg, mortality) outcomes.

Online supplemental data characteristics present the characteristics for each study, chronologically within each intervention group.

Methodological quality

The studies were of variable methodological quality. The mean quality score was 75.2% (SD 14.6), median 76.1%, minimum 45.8%,⁴⁸ maximum 95.5%,³⁷ IQR 25 (64.5 to 89.2). The full quality scores are shown [table 1](#); all but one studies⁴⁸ were judged as being below the ‘relatively liberal’ cut point for suggested inclusion in reviews and 12 studies to be above the ‘relatively conservative’ cut point of 75%

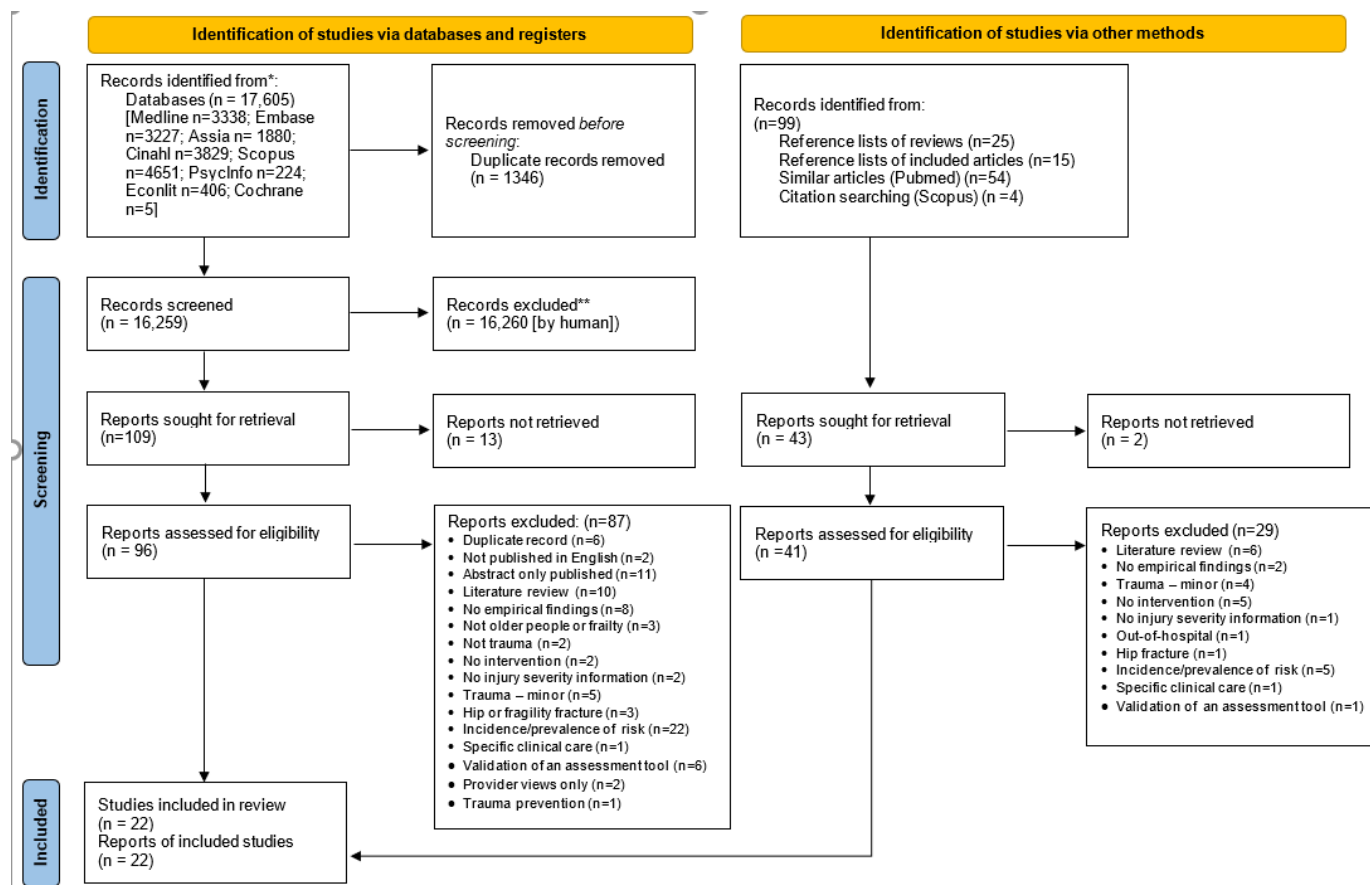


Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram.

raised as examples of potential cut point by the authors of the QualSys tools.³⁰ The most important methodological issues were uncontrolled comparison, lack of statistical adjustment for patient characteristics and underpowered or not discussed statistical power, according to the definitions of the quality assessment tool used.³⁰

Narrative synthesis according to intervention group

The studies are presented in the five ‘intervention’ groupings: frailty pathways, geriatric consultation, geriatric specific care, palliative care and triage to trauma service provision.

Frailty pathways

One paper was identified specifically regarding the patient with frail trauma; this did not include patients with injuries defined as major trauma. Bryant *et al* evaluated preimplementation and postimplementation of interdisciplinary care pathways for frail moderately injured patients with trauma admitted to the trauma service.³⁴ Patients were screened with the FRAIL scale²⁰ and specific frailty interventions/pathways of care indicated by the assessment included hospital specialist consults, family engagement, palliative care, social work and rehabilitation input. Early identification of frailty and focused care pathways were associated with significant reductions in adjusted risks of delirium and readmission, although the study self-reports being underpowered.³⁴

Geriatric trauma consultation

The seven studies categorised as ‘geriatric consultation’ delivered this within different time frames after admission (24 or 72 hours) and points in the patient’s journey (ED, ward, intensive care unit (ICU)), but were otherwise similar in design and intervention, looking before and after the introduction of a system of geriatric-specific assessment and care planning. The studies measuring care processes focused on identified and/or treated ‘geriatric-specific’ issues. Varying outcomes are reported: documentation of delirium as unchanged⁵² or improved³⁸; presence of delirium reduced⁴⁰; no change in falls or use of physical restraint⁴⁰; reduced subspecialty consultant requests to internal medicine^{41 53} and psychiatry⁵³; and unchanged trauma quality indicators or quality outcome scores.^{38 41 53}

Outcomes included length of stay, discharge disposition, readmission and mortality. Length of stay in ICU and in-hospital was reported to be longer after geriatric consultation in the ICU,⁴⁸ but not significantly different for all, based on age criteria.^{41 52 53} ICU re-admission rate was reduced significantly.⁵² Discharge disposition showed fewer patients⁴⁸ or similar numbers⁴¹ returning home, similar numbers^{41 48} or fewer to long-term or higher level care.^{40 51} Deaths were reported to be fewer in patients who had received geriatric consultation in one study,⁴⁸ but not in others for in-hospital mortality^{40 52 53} or at 30 days

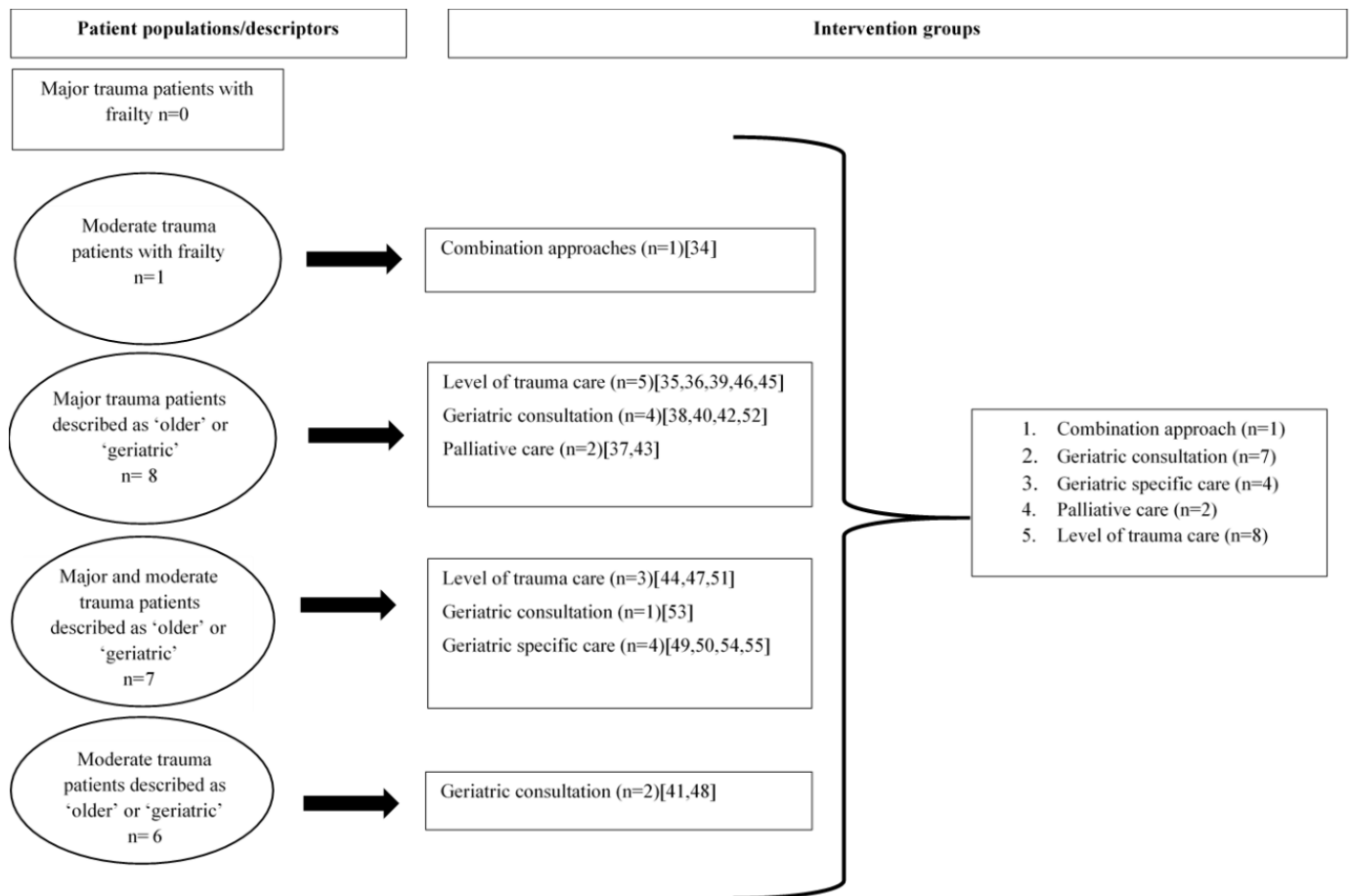


Figure 2 Patient populations/descriptors and intervention groups in included articles.

postdischarge.⁴² Hospital readmission at any measured time point was also unchanged.^{41 52 53}

Min *et al*³⁸ presented a high-quality observational study, using powered intention-to-treat analysis, and parallel data abstraction with inter-rater reliability tested. However, the remainder of the studies in this group utilised univariate analyses between cohorts, with no explanation of statistical power and no adjustment for potential confounding.^{40-42 53} This, coupled with the variation in the geriatric trauma consultation services provided and within the patient groups included, in predominantly uncontrolled observational studies, makes comparison difficult across the varied results.

Geriatric-specific care

Four studies evaluated multidisciplinary approaches where institutes or protocols had been implemented to care for the older patient with moderate trauma (see table 1 for ISS descriptors). These sets of interventions were mixed but broadly similar, containing, variously, elements such as protocols for multidisciplinary geriatric-specific input^{49 50 55} (in one case including geriatric consultation alongside investigation and ICU admission guidance),⁴⁹ a number of protocols for ICU care⁵⁰ or for anticoagulation and trauma alert.⁵⁵

These studies reported no mortality difference associated with a geriatric protocol^{49 50 53} and were not

associated with changes to documented guideline-specific care across hospitals.⁴⁷ However, after adjusting for injury severity, reduced mortality rates for the geriatric protocol in combination with a trauma alert for patients on anti-coagulant therapy were reported.⁴⁷ Descriptively, length of stay in the ED and hospital overall were reduced.⁵⁰ The methodologically stronger studies used larger samples and statistically adjusted analyses.^{50 55} Authors interpreted their positive results from retrospective observational studies cautiously in light of their limitations, despite larger samples and statistically adjusted analyses,^{50 55} even where intervention phase data were collected prospectively.⁵⁵

In qualitative inquiry, Saillant *et al*⁵⁵ reported open-ended survey responses indicating the characteristics perceived to be important to improving geriatric trauma outcomes as multidisciplinary care to include geriatrician input and recognising the distinctness of the cohort.

Palliative care

Of the two studies included, one presented the 'before and after' of the implementation of a palliative care consultation for patients with geriatric trauma,⁴³ and one compared the end of life processes (including a palliative care consultation and pathway) for patients with traumatic brain injury.³⁷ Both studies report statistically significant improvements against their own measures, particularly in



Table 1 Quality appraisal³⁰ of individual studies (in alphabetical order)

First author, year	Question / objective described	Study design evident and appropriate	Method of group selection described and appropriate	Subject characteristics sufficiently described?	Random allocation described (if applicable)	Blinding of investigators reported (if applicable)	Blinding of subjects reported (if reported)	Outcome and measure(s) well defined and robust to	Sample size appropriate	Analytic methods justified and appropriate	Some estimate of variance is reported for the main results	Controlled for confounding	Results reported in sufficient detail	Conclusions supported by the results	Total possible sum	Total possible sum %	
Bradburn <i>et al</i> 2018 ⁵⁴	2	2	2	2	n/a	0	n/a	2	1	2	2	2	2	1	19	24	79.167
Bradburn <i>et al</i> 2012 ⁴⁹	2	2	1	2	n/a	2	n/a	2	1	2	2	2	2	1	20	22	90.909
Bryant <i>et al</i> 2019 ⁵⁴	2	2	2	2	n/a	0	n/a	2	1	2	2	2	2	1	20	22	90.909
Cortez 2018 ⁴¹	2	2	2	2	n/a	0	n/a	1	1	1	2	1	1	1	16	24	66.667
Demetriadou <i>et al</i> 2002 ³⁵	2	2	2	2	n/a	0	n/a	2	0	1	2	1	2	1	17	24	70.833
Fallon <i>et al</i> 2006 ⁴⁸	2	1	1	2	n/a	0	n/a	2	0	1	0	0	1	1	11	24	45.833
Fredrickson <i>et al</i> 2011 ⁵⁴	2	2	2	2	n/a	0	n/a	2	2	2	2	2	2	2	22	24	91.667
Kupensky <i>et al</i> 2015 ⁴³	2	2	1	2	n/a	0	n/a	2	0	2	0	0	2	1	14	24	58.333
Lenertowicz <i>et al</i> 2012 ⁴	2	2	2	2	n/a	0	n/a	2	1	2	0	0	2	2	17	24	70.833
Lilley <i>et al</i> 2016 ³⁷	2	2	2	2	n/a	0	n/a	2	1	2	0	0	1	1	15	24	62.5
Melton <i>et al</i> 2002 ⁴⁷	2	2	2	2	n/a	0	n/a	2	0	2	2	2	2	2	20	22	90.909
Min <i>et al</i> 2015 ³⁸	2	2	2	2	n/a	0	n/a	2	2	2	2	2	2	2	22	24	91.667
Olufajo <i>et al</i> 2016 ⁵²	2	2	2	2	n/a	0	n/a	2	1	2	0	0	2	1	16	24	66.667
Rogers <i>et al</i> 2012 ³⁶	2	2	2	0	n/a	0	n/a	2	0	2	2	2	2	1	17	22	77.273
Sahr <i>et al</i> 2013 ⁴⁴	2	1	2	2	n/a	0	n/a	2	0	1	2	0	1	0	13	22	59.091
Saillart <i>et al</i> 2017 ⁵⁵	2	2	2	1	n/a	0	n/a	2	1	2	1	2	1	2	18	24	75
Scheetz <i>et al</i> 2018 ⁴⁶	2	2	2	0	n/a	0	n/a	2	0	2	0	0	0	2	12	22	54.545
Southerland <i>et al</i> 2017 ⁵³	2	2	2	2	n/a	0	n/a	2	0	2	2	1	2	2	21	24	87.5
St John <i>et al</i> 2016 ⁴⁵	2	2	2	2	n/a	0	n/a	2	1	2	2	2	2	2	21	22	95.455
Staudenmayer <i>et al</i> 2013 ³⁹	2	2	2	2	n/a	0	n/a	2	1	2	2	2	2	2	21	24	87.5
Wong <i>et al</i> 2017 ⁴²	2	1	1	2	n/a	0	n/a	1	0	2	0	0	2	2	13	22	59.091
Zafar <i>et al</i> 2015 ⁵¹	2	2	2	2	n/a	0	n/a	2	0	2	2	1	2	1	18	22	81.818

relation to the documentation of advanced care planning and family discussion,^{37 43} with more people discharged to home or hospice.³⁷ Neither of these studies, however, justified their sample size or controlled for confounding in their analyses, despite describing differences in the age or ISS of their ‘intervention’ and ‘control’ groups.

Triage to trauma service provision

Eight retrospective studies considered the impact of delivering care for older patients with trauma managed in differing levels of service provision, in three subsets: level of trauma centre, proportion of older patients with trauma managed by the trauma centre and trauma team activation.

Comparing trauma centres with non-trauma centres

Three studies evaluated care delivered at trauma centres in comparison to non-trauma centres, with mortality as the primary outcome. One study used unadjusted analysis to report no difference in mortality in those aged over 55 cared for at a trauma or non-trauma centre⁴⁶; however, the two studies which used adjusted predictive models reported reduced mortality rates in trauma centres in patients aged over 80,⁴⁷ and those aged over 55.³⁹

Comparing trauma centres seeing different proportions of older patients with trauma

In a different comparison, Zafar *et al*⁵¹ reported benefits for older patients managed in high-volume centres, with lower risk-adjusted mortality rates in centres seeing a higher proportion of those aged 65 and over compared with those with a lower proportion of older patients with trauma.

Notwithstanding that none of the papers comparing trauma centres (sections ‘Comparing trauma centres with non-trauma centres’ and ‘Comparing trauma centres seeing different proportions of older patients with trauma’) achieved blinding among investigators in retrospective analyses of routinely collected data and the absence of information about sample size power in all (though accepting the large sample sizes), we see evidence of different impacts of trauma facility on outcomes.

Trauma team activation within the receiving hospital

Within the four papers on trauma team activation, all looked at an extension to current activation criteria, focused on broadening to include older people with a lesser injury (eg, rib fracture⁴⁴) than would ordinarily trigger an activation, or all persons with trauma above certain age limits (eg, 65⁴⁵ or 70³⁵ years) or using a risk tool.³⁶ Two studies measured length of stay, adverse events and mortality outcomes before and after the institutional change in trauma team activation criteria,^{35 44} one compared the outcomes for younger and older patients⁴⁵ and the other compared mortality associated with correct and undertriage.³⁶ Extended activation criteria³⁵ and ‘correct’ triage³⁶ were associated with improved outcomes including reduced mortality^{35 36}; reduced length of stay in

ICU and overall⁴⁴; and, descriptively, reduced permanent disability.³⁵

These positive reports of the impact of essentially lowered thresholds for trauma are considered in the context of study quality. None of these studies explained their sample size and only St John *et al* adjusted their analyses for confounders, reporting that trauma team activation was not associated with a reduced relative risk of death in older people when compared with younger patients.⁴⁵ Even in this more robust analysis, the authors suggest that their sample size was not large enough. All of the studies are appraised to at least partially over-reach on their conclusions.

DISCUSSION

The systematic search for evidence relating to configuration and impact of care for older patients with or without classified frailty suffering moderate to major trauma yielded a large potential pool of studies, of which we included 22 for synthesis. None of the included studies specifically addressed the needs of the older person with frailty experiencing major trauma as defined by ISS >15. In summary, the included studies were all observational, mostly retrospective in design, comparing processes and/or outcomes of acute hospital care following an intervention against a ‘control’ of a preceding period of time. Studies ranged in quality, with concerns particular to little consideration of confounding by age and injury severity, and to statistical power. All studies were from North America.

The included studies reported on a range of interventions aiming to improve care and outcomes for the frail or older patient presenting with trauma: trauma centre use^{39 46 47 51}; lower thresholds for trauma team activation^{35 36 44 45}; geriatric consultation^{38 40–42 52 53} or palliative care consultation^{37 43} early in the patient’s care pathway; other geriatric specific care processes^{49 50 54 55}; and combinations of the above in frailty-specific interventions.³⁴

The synthesised literature suggests that what is currently known in terms of configurations that improve the outcomes for older patients with moderate and major trauma are as follows: some improvements to geriatric-specific care processes and to patient and service outcomes were associated with the above interventions, but these improvements were not universal in the included studies. The highest-quality papers suggest reduced mortality associated with trauma centre use,³⁹ particularly if that trauma centre sees a high proportion of older patients,⁴⁷ with trauma team activation for all aged over 65⁴⁵ and with geriatric care protocols.^{46 49 53} They also point to reduced length of stay with ICU protocol⁵⁰ and reduced readmission with frailty-specific pathways,³⁴ as well as improved delirium and mobility care with daily geriatrician visits to trauma surgical patients.³⁸ Overall, however, the evidence is not strong—there are no groups of studies reporting the same interventions or results, and there are limitations in study design.

This review raises three key discussion points in relation to what is already known: the absence of studies specific to frailty pathways in patients with major trauma and one in moderate trauma, the definition of major trauma in frail and/or older patients and measuring the impact of interventions containing multiple elements of care. These require further research.

The number of studies closely related to our particular review question is indicative that adverse outcomes for older people presenting with trauma are being addressed. The interventions of many of these studies—providing a higher than usual level of trauma care and/or the involvement of the multidisciplinary team, particularly what many of the papers refer to as ‘geriatric’ consultation—also highlights a recognition that this is unlikely to be an issue that can be solved by either the ED or the medical or surgical inpatient teams alone. Given the relatively low age limits of inclusion to the reviewed studies, frailty in the whole of each study sample cannot be assumed. However, the frailty-specific study³⁴ appears in the most recent years of our review period, coinciding with professional guidance on this population, colloquially referred to as ‘silver trauma’.²⁷ The quantitative ‘frailty’ study we located included patients with relatively low ISSs³⁴ and, notwithstanding the impact of lower severity trauma on older adults, there remains a gap in the literature.

These points—and our own difficulties drawing a clear line through the cut-off point in both injury severity and age or frailty for this review—highlight the problematic area of the definition of major trauma in those who are frail and/or older.

The studies included also highlight issues with measuring impact in interventions with multiple components. In such interventions, causality and effect size are difficult to determine and it is possible that a number of interacting interventions might each contribute to an overall beneficial outcome, or that a single intervention might be impactful. We argue that the limitations of many of our included studies make it difficult to be definitive about beneficial effect, and randomised controlled trial evidence of such complex interventions is desirable.

This review itself has a number of limitations. We excluded all papers where the primary focus was on hip fracture or other single fragility fracture alone; however, the poor definition of presenting conditions may mean we did not include some appropriate studies. Likewise, including studies of both frail and older people risks conflating two different groups; we have presented the literature on these groups separately but note that frailty assessment is a relatively recent addition to acute care, and the populations of the studies including a more general older sample are also likely to include those with frailty. We also present a narrative synthesis³¹; while meta-analysis is not indicated with diverse non-randomised study types,⁵⁶ and we have extracted data items consistently, the analysis remains limited, specifically in not conducting sensitivity analyses, and not having formally

assessed the risk of bias due to reporting bias, or certainty in the body of evidence.

We conclude that the body of evidence, while heterogeneous and of moderate quality, gives an indication that some interventions focused on the specific care needs of frail and/or older patients with trauma (trauma centres seeing a high proportion of older patients, geriatric or frailty-specific care protocols and daily geriatrician visits) have positive impact on care processes and some outcomes based on the examples of different approaches from the North American context. Despite the complexities of major trauma and of frailty interventions alike, overall this systematic review supports the need for the development and prospective, well-powered evaluation of a novel intervention, building from the elements showing promise in this review, to intervene as early as possible in the pathway of those attending the ED with significant injury sustained in those rendered vulnerable by frailty and/or extremes of age.

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Contributors HJ, PM, EC, RC and MB conceived of the study. MH led the design of the review with HJ, PM, EC, RC, MB and DB. Searches, screening, data extraction and critical appraisal were undertaken by MH, PM, DB, LG and STK. MH acts as the guarantor. Synthesis was written by this team, under guidance from HJ, EC, RC and MB. MH was the lead on preparation of the manuscript. All authors contributed and reviewed the content for submission. Patients and the public were not directly involved.

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