

The evidence for assessing frailty and sarcopenia in an acute medical unit: a systematic review

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Abstract

Background/objectives: A systematic review was conducted to assess if frailty and sarcopenia were associated with poorer outcomes in older adults admitted to an acute medical unit (AMU).

Methods: Eligible studies included older adults with an unplanned admission to an AMU and included a measure of frailty or sarcopenia, completed within 72 hours of admission. Risk of bias was assessed.

Results: Of 1659 identified articles, 16 were included (4 on sarcopenia and 12 on frailty). There was significant study heterogeneity. Overall, frailty and sarcopenia were associated with worse outcomes. Targeted interventions appeared to improve outcomes.

Conclusion: Current evidence suggests some benefit in screening older adults admitted to an AMU for frailty and sarcopenia. However, further studies are required before clinical adoption.

Keywords

Acute medical unit, Frailty, Sarcopenia, Older adults, Mortality, length of stay, Hospital outcomes.

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Introduction

Older people experience worse health outcomes following an acute medical admission, spend longer in hospital and account for the majority of healthcare use and spend.¹ Thirty percent of unplanned admissions to acute hospitals in older adults require an increase in social care on discharge.² The process of assessment and securement of services causes a delayed transfer of care (DTC) with 66% of all DTC occurring in acute NHS Trusts and the vast majority occurring to older adults.¹ However, ageing is heterogeneous, and age alone is not a strong predictor of hospital outcome. There is a great need to identify older patients on admission who are most likely to experience poor outcomes or who may have the potential to regain function with specific input, at the time of admission.³

Frailty is a syndrome which increases the vulnerability of an individual to stressors.^{4,5}

The pathophysiology of frailty is poorly understood. The immune system appears central to its development⁶ and frailty has been associated with an increase in a number of pro-inflammatory cytokines including IL-6 and TNF α and the acute phase protein CRP.^{7–10} Higher baseline of IL-6 and CRP were predictive of muscle strength loss at three year follow up.¹¹ Frailty

is common in older adults¹² and associated with poor outcomes including falls, incident disability, hospitalization, increased mortality and reduced quality of life^{13–15} as well as significant healthcare costs.¹⁶ It is operationally defined as meeting three out of five phenotypic criteria, indicating compromised energetics: low grip strength, low energy, slowed walking speed, low physical activity, and/or unintentional weight loss.¹⁷ The prevalence of frailty varies from 4.0–59% among community-dwelling older individuals¹² and 19–76% in nursing homes.¹⁸ The high estimate variability stems from differences between the assessment tools and the characteristics of populations in a given study. Previous studies that have specifically focused on the prevalence of frailty in acute care settings have estimated it to affect 34–69% (median) of older patients in this context.¹⁹ In general, the degree of frailty predicts the risk of adverse events independent of age.²⁰ In hospital, frailty is associated with increased length of hospital stay, an escalation of social care, readmissions and mortality. In the community setting, frailty can be reversible through targeted interventions, and the risks of irreversible frailty can be partially mitigated through careful patient management, including avoiding polypharmacy.²¹

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Sarcopenia is a progressive and generalised skeletal muscle disorder which is clinically defined as low muscle strength; with low muscle strength suggestive of sarcopenia, low muscle strength and low muscle quantity or quality confirming sarcopenia and associated low physical performance indicative of severe sarcopenia.²² Like frailty, it is common in older adults and is associated with an increased likelihood of adverse outcomes, including falls, fractures, physical disability, significant morbidity and mortality.²³ Sarcopenia is associated with frailty but can occur independently and is under-diagnosed in clinical practice despite evidence of available treatment with benefit.²⁴ The reasons for under diagnosis are complex, but one barrier is the requirement for low muscle mass to be confirmed.²³ Gold- standard methods such as Dual energy X-ray absorptiometry (DXA) and Computer tomography (CT) or Magnetic resonance imaging (MRI) are expensive and challenging in a frail population.²⁵ Ultrasound is a portable diagnostic tool that could be utilised to assess low muscle mass and therefore form a diagnosis of sarcopenia and recent research has reported that ultrasound is a reliable and valid tool for the assessment of muscle size in older adults.²⁶⁻²⁹ Of note, akin to frailty, there are relationships between sarcopenia and inflammation with a recent systematic review suggesting that inflammatory cytokines are negatively related to muscle strength and mass and sarcopenia is associated with higher serum inflammatory parameters in stable patients.³⁰ These relationships are less well understood during acute presentations of illness³¹ which often are associated with heightened inflammatory signalling.

In a recent study of 129 adults, admission to hospital was associated with a change from non-frail to pre-frail in over 56% of older adults at one year follow up. However, 23% changed from pre-frail to non-frail and 2.5% changed from frail to non-frail and the authors were unable to predict the direction of change using data collected as part of routine care.³² The effect of bed rest is well described and more marked in older adults with five days of bed rest resulting in loss of lean leg mass and strength in older but not younger adults,³³ although the degree of loss varied considerably. Hospitalisation is known to impact on both frailty and sarcopenia, but trajectories vary and currently cannot be predicted.

There is a need to understand the relationship between sarcopenia, frailty and outcomes in patients acutely admitted to hospital, and to determine if and when hospitals should be screening for these conditions. The first opportunity for screening might be when patients are within an acute medical unit (AMU), but these are already services under

pressure and so any additional resource burden must be weighed against the potential benefits for patients.

This systematic review was conducted to curate the current evidence for a relationship between sarcopenia and frailty in older adults, as assessed in an acute medical unit, and hospitalised outcomes.

Methods

Outcome of interest

The primary outcome was all-causes 1-year mortality. Secondary outcomes included length of stay, escalation of care needs, physical function or medical outcomes, service use, and quality of life among this same population.

Protocol and registration

The study protocol was registered in the PROSPERO international prospective register of systematic reviews: ID CRD42019136843. The preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines were followed.

Eligibility criteria

Studies were eligible if they were randomised controlled trials, observational studies, qualitative studies, case series or uncontrolled studies. All studies required at least 10 participants; focusing on older patients (aged 65 years or older) with an unplanned admission (of any cause) to an acute medical unit in a secondary care hospital and included a measure of frailty or sarcopenia completed within 72 hours of the admission, using any validated tool. All studies not meeting these inclusion criteria were excluded.

Search strategy and selection process

Targeted searches of specialist databases were conducted using specific search strings using index/ MeSH (Medical Subject Headings) and strings of keyword terms. Databases included the Cochrane Database of Systematic Reviews, MEDLINE (PubMed), Embase, CINAHL and the Cochrane Central Register of Controlled Trials (CENTRAL). Databases were searched with no date or language restriction. Articles obtained through the databases were exported into EndNote X9 software (Thomson Reuters) and RAYYAN qcri for screening.³⁴ Hand searches were conducted for articles in reports/ systematic reviews using NHS Evidence, NICE, The King's Fund and The Cochrane Database of Systematic Reviews.

Selection was undertaken independently by all team members (VK, AS and ES), screening titles and abstracts for potential eligible studies. Full texts were then reviewed, and disagreements were resolved by discussion.

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Quality assessment and risk of bias of included studies

All of our included records were non-randomised prospective studies. Therefore, the Newcastle-Ottawa Scale (NOS) was used for quality assessment. Two reviewers independently checked each selected article to minimize bias. Disagreement was resolved using a third reviewer. Information from the risk of bias assessments was utilised when synthesising the data to explain differences in study results and to comment upon the reliability of conclusion arisen from the analysis.

Data extraction and collection process

Data extraction was conducted by two reviewers (VK and ES) using a pre-designed data extraction form of the core study areas, together with data on the methods and results necessary to support critical appraisal in accordance with PRISMA guidelines. Extracted data included authors and year of publication, type of study, study aims, population sampled and sample size, validated tool used to measure frailty and/or sarcopenia, primary outcome as mortality, secondary outcomes such as length of stay, escalation of care needs, physical function or

medical outcomes, service use, and re-admission rates. Sample size and description, intervention content, nature of control group where applicable, length of follow-up, analysis methods, results, and intervention effectiveness were also extracted. Where clarifications or full results were needed, authors were contacted. Studies were excluded if there were no responses after two attempts.

Analysis

Data was extracted and analysed using Microsoft Excel (version number 16.16.24, Microsoft, IBM). The effect of the estimates for all the studies included was assessed by the level of risk of bias, quality of the study, study settings and data collection methods. The risk of bias or quality assessment of included studies were classified as low, moderate or high. The heterogeneity of studies allowed only descriptive analysis.

Results

Included studies search process

One thousand six hundred and fifty-nine articles were identified from initial screening of the literature. After titles and abstracts screening (completed by

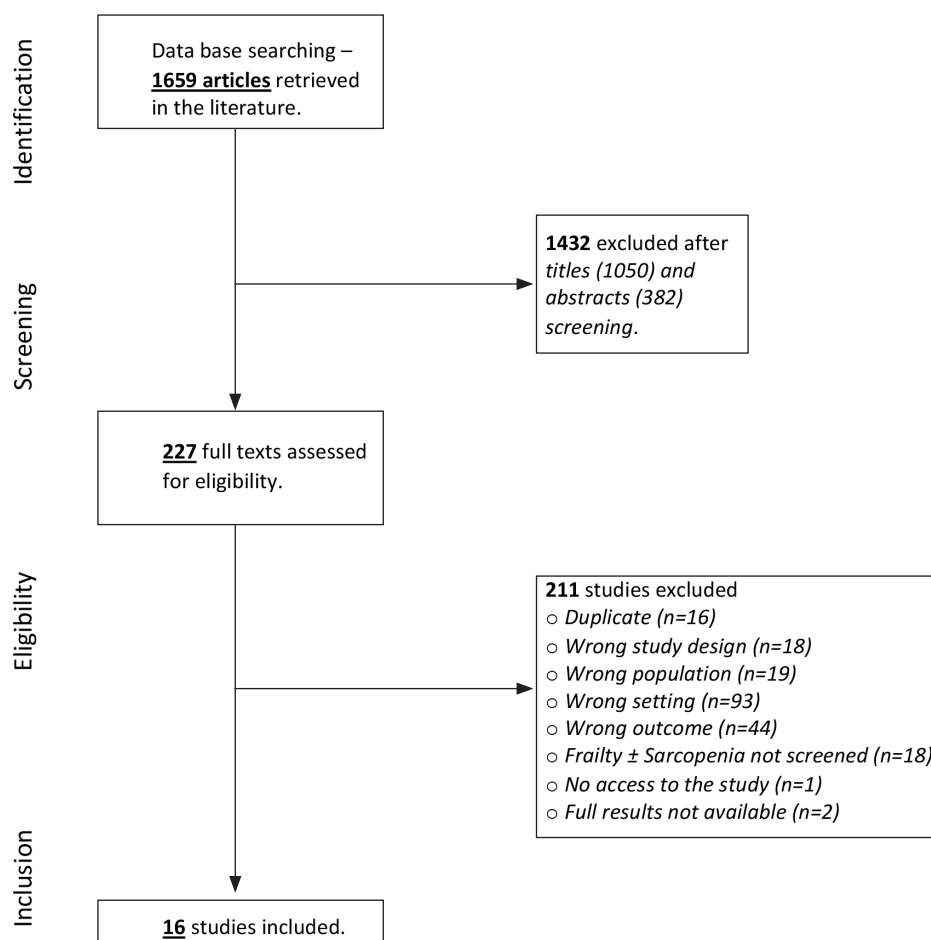


Figure 1. PRISMA flowchart of study selection process with reasons for exclusion.

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VK, AS, ES), only 227 were deemed eligible for full review. A total of 211 articles were subsequently excluded for reasons as outlined in Figure 1 and 16 studies were included for final review. All included studies were observational studies.

Characteristics of included studies

Study participation

The characteristics of the included studies are summarised in Table 1 and outcome measures are described in Table 3. All included studies were non-randomised prospective and hospital-based studies; 14 (87.5%) were observational non-controlled studies and only 2 (12.5%) were prospective controlled studies.^{35, 36} Twelve studies (75%)

screened for and measured frailty³⁵⁻⁴⁶ and 4 (25%) focused on sarcopenia.⁴⁷⁻⁵⁰ None of the included studies looked at both conditions.

While all studies used validated tools to measure frailty, 12 different tools were used across studies (Table 2). Three studies^{38, 43, 46} used more than one tool to measure frailty with the most popular tools including Clinical Frailty Scale and Frailty Index. All studies screening for sarcopenia used the European Working Group on Sarcopenia in Older People criteria (EWGSOP).

Five studies were conducted in Canada^{38, 40-43}, 3 in the United Kingdom,⁴⁴⁻⁴⁶ 2 in Sweden,^{35,36} 3 in Italy,^{47, 48, 50} with the Italian studies assessing sarcopenia and not frailty; and 1 each in Australia,⁽⁴⁹⁾

Table 1. Studies characteristics.

Study (Authors, year)	Country of origin	Type of study	Participants: n (age) - % gender	Mean age, years $\pm$ SD or Median (IQR)	Co-morbidities	Duration of follow up (f/u)	Frailty screening	Sarcopenia screening	Groups / Sub-groups; N and description
Ahlund & al, 2017 * (35)	Sweden	Prospective controlled trial	408 (75+) - 56% female (F), 44% male (M)	85.7 $\pm$ 5.4	CCI score	3 months f/u in hospital or home	FRESH	Not assessed	Intervention group (CGA unit; n= 206); IG Control group (n=202); CG
Basile & al, 2018 (37)	Brazil	Prospective cohort	156 (65+) - 59% F, 41% M	81.5 $\pm$ 6.2	HTN, DM, Dementia, COPD, Ca, IHD or hypertensive HD, CKD.	6 months and 1 year	FI	Not assessed	FI at admission (aFI) FI on discharge (dFI) Difference FI (Δ FI)
Beauchet & al, 2019 (38)	Canada	Observational Retro cohort	166 (75+) - 75.3% F, 24.7% M	Not reported	Mobility and neuro-psychiatric disorders, organ failure, social issues.	No F/U	PRISMA-7 questionnaire 6-item BGA	Not assessed	P7Q normal (n=22) & P7Q abnormal (n=144) 6-iBGA low (n=58), moderate (n=85) & high risk (n=23)
Cerri & al, 2015 (47)	Italy	Prospective observational study	103 (65+) - 59.2% F, 40.8% M	84.2 $\pm$ 7.1	MI, CHF, PVD, CVA, Dementia, COPD, Connective tissues, Peptic ulcer disease, Liver and renal disease, DM, Tumour without mets, Haematological Ca.	3 months	Not assessed (CGA)	EWGSOP	Sarcopenic group (n=22) Non-sarcopenic (n=58) Uncertain diagnosis (n=23)
Chua & al, 2018 (39)	Singapore	Prospective cohort study	314 (70+) - 59.9% F, 40.1% M	84 (7)	Not recorded	6 months	CFS	Not assessed	Single cohort
Ekerstad & al, 2017 * (36)	Sweden	Prospective controlled trial	408 (75+) - 56% F, 44% M	85.7 $\pm$ 5.4	CVD CCI score	3 months	FRESH	Not assessed	Intervention group (CGA unit; n= 206); IG Control group (n=202); CG

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Study (Authors, year)	Country of origin	Type of study	Participants: n (age) - % gender	Mean age, years $\pm$ SD or Median (IQR)	Co-morbidities	Duration of follow up (f/u)	Frailty screening	Sarcopenia screening	Groups / Sub-groups; N and description
Evans & al, 2014 (40)	Canada & USA	Prospective cohort study	751 (75+) - 60.7% F, 39.3% M	84 $\pm$ 5.5	Not recorded	30 days	FI-CGA	Not assessed	Single cohort
Juma & al, 2016 (41)	Canada	Prospective cohort study	75 (65+) - 64% F, 36% M	81.39 $\pm$ 8.76	CCI score	90 days	CFS	Not assessed	Non-frail (n=21) Mild-to-moderate frailty (n=38) Severe frailty (n=16)
MacKenzie & al, 2017 (43)	Canada	Prospective study	433 (65+) - 56.6% F, 43.4% M	81.5 $\pm$ 8.2	DM	No F/U	FI & CFS	Not assessed	Non-frail Mildly frail Moderately frail Severely Frail
Martin-Marero & al, 2018 (44)	UK	Prospective study	1929 (75+) - 55% F, 45% M	82 (NR) 86 (NR) 84 (NR)		30 days	Local WMUH-CFS	Not assessed	Discharged group (n=443) - AMU team Frail group (n=301) - AFT team; A1, A2, A3 & B. Control group (n=1185) - Usual care team
Martone & al, 2017 (48)	Italy	Prospective study	394 (65+) - 53.6% F, 46.4% M	79.6 $\pm$ 6.4	HTN, DM, CHD, CHF, COPD, Stroke, Cancer.	Within 24hours post-discharge (d/c)	Not assessed	EWGSOP	Sarcopenic group (n=336) Non-sarcopenic (n=58)
McAlister & al, 2019 (42)	Canada	Retrospective cohort study	452785 (75+) - 59.6% F, 40.4% M	83.0 $\pm$ 5.6	-	12 months	HFRS	Not assessed	
McKay & al, 2018 (45)	Scotland	Prospective study	285 (65+) - Not recorded		-		HIS frailty screening tool	Not assessed	2015 group (n=101) 2016 group (n=97) 2017 group (n=87)
Perez-Zepeda & al, 2017 (49)	Australia	Prospective study	172 (70+) - 72%F, 28%M	85.2 $\pm$ 6.4	CCI score	12 months	Not assessed	EWGSOP	Sarcopenic group (n=69) Non-sarcopenic (n=103)
Vetrano & al, 2014 (50)	Italy	Observational multicentre study	770 (65+) - 56% F, 44% M	80.8 $\pm$ 7	HTN, COPD, DM, HF, CKD, Dementia, CVA, AF, Infections, Cancer, PVD.	12 months	Not assessed	EWGSOP	Sarcopenic group (n=214) Non-sarcopenic (n=556)
Wou & al, 2013 (46)	UK	Observational cohort study	667 (70+) - 57.9%F, 42.1%M	80 (75,85)	CCI score, geriatric syndromes	90 days	Fried (CHS model) - Ensrud (SOF model) - Rothman's instrument - Ávila-Funes' instrument - FI	Not assessed	Groups by frailty scale

Legend:
 6-item BGA: 6 - item Brief Geriatric Assessment
 AF: Atrial Fibrillation
 Ca: Cancer
 CCI score: Charlson Comorbidity Index
 CFS: Clinical Frailty Score
 CGA: Comprehensive Geriatric Assessment
 CHF: Chronic Heart Failure
 CHS model: Cardio-vascular Health Study model
 CKD: Chronic Kidney Disease
 COPD: Chronic Obstructive Pulmonary Disease
 CVA: Cerebro - Vascular Accident
 CVD: Cardio - Vascular Diseases
 DM: Diabetes Mellitus
 EWGSOP: European Working Group for Sarcopenia in Older People

FI: Frailty Index
 FRESH: Frail Elderly Support Research
 HD: Heart Disease
 HF: Heart Failure
 HFRS: Hospital Frailty Risk score
 HIS: Health Improvement Scotland
 HTN: Hypertension
 IHD: Ischaemic Heart Disease
 Mets: Metastasis
 MI: Myocardial Infarction
 PVD: Peripheral Vascular Disease
 SOF model: Study of Osteoporotic Fracture model
 WMUH - CFS: West Middlesex University Hospital - Clinical Frailty Score

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Table 2. Validated tools for frailty screening and studies reported using it.

Studies	6-item BGA	PRISMA-7 questionnaire	CFS	FI	FRESH	HFRS	CHS model	SOF model	Rothman's instrument	Avilas-Funes's instrument	HIS	WMUH – CFS
Ahlund et al, 2017					X							
Basile & al, 2018				X								
Beauchet et al, 2019	X	X										
Chua et al, 2018			X									
Ekerstad et al, 2017					X							
Evans et al, 2014				X								
Juma et al, 2016			X									
Mackenzie et al, 2017			X	X								
Martin-Marero et al, 2018												X
McAlister et al, 2019						X						
McKay et al, 2018											X	
Wou et al, 2013				X			X	X	X	X		

Legend:
An “x” indicates the tool was used in the study.

6-item BGA: 6 – item Brief Geriatric Assessment;
CFS: Clinical Frailty Score
CHS model: Cardio-vascular Health Study model

FI: Frailty Index
FRESH: Frail Elderly Support Research
HFRS: Hospital Frailty Risk score
HIS: Health Improvement Scotland
SOF model: Study of Osteoporotic Fracture model
WMUH – CFS: West Middlesex University Hospital – Clinical Frailty Score

Singapore⁽³⁹⁾ and Brazil.⁽³⁷⁾ Male and female aged 65 years and above were included, with a majority of females in each of the studies.

Risk of bias and quality assessment

A quality assessment of the included studies showed that 12 were considered to be of high quality and 4 were of low quality. The latter were either found to have unclear follow up duration with no description of those lost to follow up; or no information provided on the comparability of cohorts, on the basis of the design or analysis controlled for confounders. See Figure 2A for frailty studies and Figure 2B for sarcopenia studies.

Outcomes measurement

Mortality: Many studies reported mortality, but at different timepoints (with some studies including multiple timepoints). Nine reported in-patient (IP)

mortality at no pre-determined time, 3 reported mortality at 30 days, 5 at 90 days, 1 at 4 months, 2 at 6 months and 3 at 12 months.

Of the 9 studies reporting IP mortality, 2 focused on sarcopenia and 7 focussed on frailty. Both sarcopenia studies noted higher mortality rates in patients with sarcopenia compared with non-sarcopenic controls. Vetrano *et al*⁵⁰ reported an adjusted HR 3.45 (1.35–8.86) and Cerri *et al*⁴⁷ reported that all IP death events recorded occurred only in the sarcopenic group (n=4/22; N=103).

Amongst the 7 frailty studies, 2 assessed whether frailty was associated with or predictive of IP mortality. Basile *et al* reported that the FI score on admission (aFI) was directly associated with higher risk of in-hospital death (OR = 5.9; 95% CI 2.0–17.5; p = 0.001) and aFI also had a high discriminative accuracy for in-patient mortality (AUC 0.856, 95% CI 0.774–0.937).³⁷ Mackenzie *et al* found that

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	Risk of bias								Overall
	D1	D2	D3	D4	D5	D6	D7	D8	
Ahlund 2017	+	+	+	X	+	+	+	X	+
Basile 2019	+	-	+	+	+	+	+	+	+
Beauchet 2019	+	+	+	+	+	+	+	+	+
Chua 2018	+	+	+	+	+	+	+	+	+
Ekerstad 2017	+	+	+	X	+	+	+	+	+
Evans 2014	+	+	+	+	+	+	+	+	+
Juma 2016	+	+	+	X	+	+	+	+	+
MacKenzie 2017	+	-	-	+	?	+	-	+	X
Martin-Marero 2018	+	+	+	+	?	+	+	+	X
McAlister 2019	+	+	+	X	+	+	+	+	+
McKay 2018	+	-	+	+	?	+	+	+	X
Wou 2013	+	+	+	X	?	+	+	+	X

D1: Representativeness exposed cohort
 D2: Selection non-exposed cohort
 D3: Ascertainment of exposure
 D4: Demonstration outcome not present at start of study
 D5: Comparability/ controlled for confounders
 D6: Appropriate assessment of outcome
 D7: Appropriate follow up period
 D8: Follow up complete/Lost to follow up acknowledged

Judgement
 X High
 - Unclear
 + Low
 ? No information

Legend. The risk of bias was assessed for each study using the robvis tool (51) against eight different domains (D1-D8).

The selection domain was assessed from D1 – D4 (maximum of 4 points); D5 evaluated the comparability domain (maximum of 2 points) and D6 – D8 focused on the outcome/exposure domain (maximum of 3 points).

To be considered of high quality, these conditions had to be met: score 3 or 4 in selection domain AND 1 or 2 in comparability domain AND 2 or 3 in outcome/exposure domain.

To be considered of fair quality, these conditions had to be met: score 2 in selection domain AND 1 or 2 in comparability domain AND 2 or 3 in outcome/exposure domain.

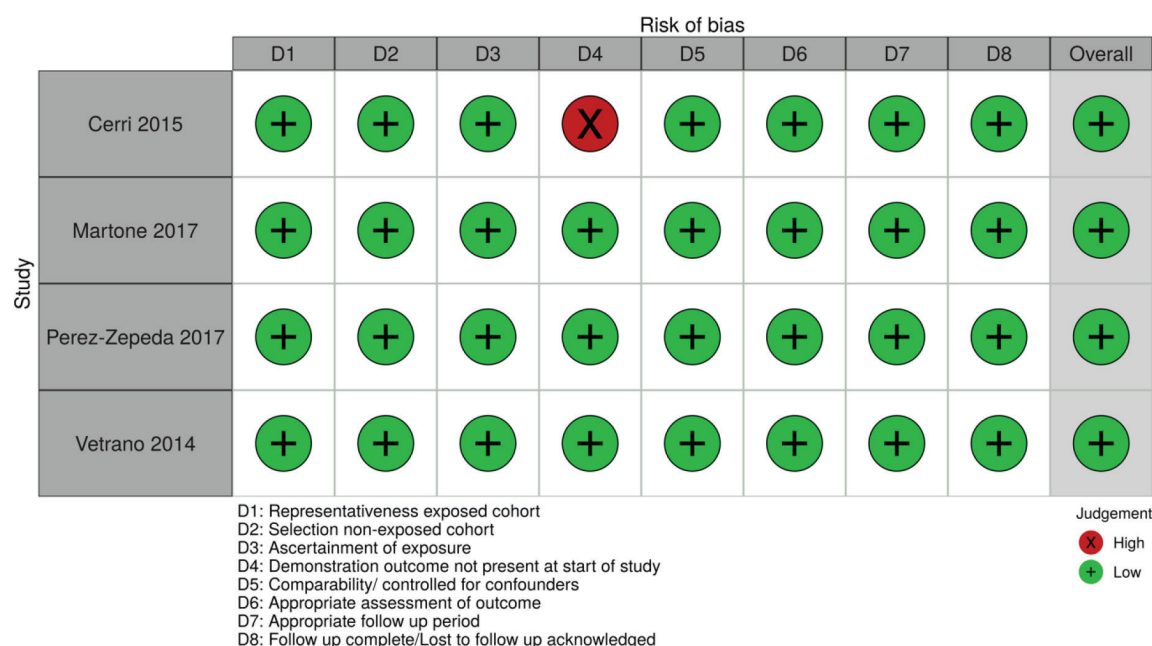
To be considered of low quality, these conditions had to be met: score 0 or 1 in selection domain OR 0 in comparability domain OR 0 or 1 in outcome/exposure domain.

Figure 2A. Risk of bias summary for frailty studies.

screening patients using the clinical frailty score (CFS) predicted IP mortality 4.2 times more than using the frailty index (FI) screening tool (OR 1.06; $p < 0.001$).⁴³ McKay *et al* explored the impact of pro-

active screening and early multidisciplinary team intervention on the IP mortality in older adults. They found that there was no significant difference compared to the group who had received usual care.⁴⁵

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Legend. The risk of bias was assessed for each study using the *robvis* tool (51) against eight different domains (D1-D8).

The selection domain was assessed from D1 – D4 (maximum of 4 points); D5 evaluated the comparability domain (maximum of 2 points) and D6 – D8 focused on the outcome/exposure domain (maximum of 3 points).

To be considered of high quality, these conditions had to be met: score 3 or 4 in selection domain AND 1 or 2 in comparability domain AND 2 or 3 in outcome/exposure domain.

To be considered of fair quality, these conditions had to be met: score 2 in selection domain AND 1 or 2 in comparability domain AND 2 or 3 in outcome/exposure domain.

To be considered of low quality, these conditions had to be met: score 0 or 1 in selection domain OR 0 in comparability domain OR 0 or 1 in outcome/exposure domain.

Figure 2B. Risk of bias summary for sarcopenia studies.

The last 4 frailty studies only reported percentages of IP deaths in their respective populations and these varied between 5.41 – 18.7%.

Only frailty studies comparing frail groups and non-frail groups reported 30-days mortality. Chua *et al* recorded an overall of 7.64% deaths, with 2.7% within the non-frail group compared to 17.3% in the severely frail group.³⁹ Evans *et al* reported an overall rate of 12.4% after 30 days, in a moderately frail population at baseline.⁴⁰ McAlister *et al* showed an overall rate of 13.7% deaths after 30-day of admission, with 16.8% recorded in the moderately frail group, 15.5% in the severely frail group and 12.7% in the non-frail group.⁴² Overall, the death rate increased with any unit of increment in the frailty score.

In total, 4 frailty studies and 1 sarcopenia study reported 90-days mortality rate. Cerri *et al* showed that sarcopenic patients died more frequently than non-sarcopenic ones ($p < 0.001$). However, the overall numbers were low (3/58; 5.2% in those with no sarcopenia and 7/22; 31.8% in those with sarcopenia).⁴⁷ Chua *et al* showed a significant difference in 90 days mortality rates ($p < 0.001$) for those with severe frailty (26.3%) compared to mild-to-moderate frailty (11.3%) and non-frail patients (8.2%).³⁹ The patients included in Ekerstad *et al*'s study did not differ significantly at baseline, including frailty score characteristic, and they

reported no difference in unadjusted mortality at 90 days with 13% deaths in the intervention group who received specialised care versus 18% in the control group who received standard care ($p > 0.05$).³⁶ Evans *et al* reported an overall 90-days mortality rate of 18.2% in a moderately frail cohort population at baseline. Deaths were related to age – highest amongst patients aged 90 and above – but when the FI-CGA was added in the multivariate model, age was no longer significant: each 1% increase in the FI-CGA translated to a 5% increase in the risk of death.⁴⁰ Wou *et al* used 5 different tools to screen for frailty in his cohort study. A higher prevalence of frailty was recorded using the SOF model (66.4% frail) subsequently followed by FI (30.9% frail), Avilas-Funes instrument (24.9% frail), Rothman instrument (24.1% frail) and CHS model (17.9% frail). At 90 days, they documented an overall risk of death of 5.1% (n/N; 34/667) and all the tools used were poorly predictive of mortality.⁴⁶

At 6 months, Basile *et al* reported an overall mortality rate of 22.4% in his cohort study and there was no association between mortality and aFI, FI on discharge (dFI) or difference between aFI and dFI (Δ FI).³⁷ Chua *et al* reported an overall mortality rate of 22.9%, with 35.7% of deaths in the severely frail group compared to 18.9% in the mild-to-moderate frail group and 15.5% in the non-frail

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group; $p=0.001$.³⁹ At 4 months, Evans *et al* recorded a total mortality rate of 19.8% and patients with higher baseline FI-CGA (> 0.65) had a 60% 120-day mortality (95% CI = 42–78).⁴⁰

Basile *et al*³⁷ was the only frailty study to report mortality rate at 12 months. Overall, 28.8% of their population died and there was a direct association between aFI and 1-year mortality (OR = 5.5, 95% CI 2.4–12.7, $p < 0.001$). The aFI, dFI, and Δ FI were all predictive of 12-month mortality, even after adjustment for age and sex (OR = 5.5, 95% CI 2.4–12.7, $p < 0.001$; OR = 3.7, 95% CI 1.3–10.5, $p = 0.002$; OR = 1.035, 95% CI 1.006–1065, $p = 0.015$; respectively). However, dFI had a high discriminative accuracy for the 12-month mortality (AUC 0.827, 95% CI 0.750–0.905).

Two sarcopenia studies also reported 1-year mortality rate. Vetrano *et al* showed that sarcopenia was significantly associated with 1-year mortality (HR 1.59; 95% CI: 1.10–2.41) with 26% of the sarcopenic patients dying compared to 14% in the non-sarcopenic group ($p < 0.001$).⁵⁰ Perez-Zepeda *et al* reported an overall mortality rate of 21%, but patients with sarcopenia were twice as likely to die in the 12-month post-hospitalisation (HR 2.23, 95% CI 1.15–4.34) compared to non-sarcopenic patients.⁴⁹

Overall, deaths were more common in frail and/or sarcopenic older people.

Re-admission rates: In total, 7 frailty studies and 1 sarcopenia study assessed readmission rates, but at different timepoints: 30-day and 90-day readmission were the most reported outcomes with 3 frailty studies recording each of them; 2 frailty studies reported readmission rates at 7 days; 2 at 6 months and one at 28 days. The only sarcopenia study recording readmission rate did so at 12 months.

7 to 30-day readmission: Martin-Marero *et al* described that a group of older frail adults, despite having been holistically managed by a team of specialists, had slightly increased readmission rates at 7 and 30 days compared to frail older adults who had received standard care or were in a monitored bed in AMU. Following a root cause analysis, they suggested a lack of community support services for the frail cohorts may have led to the readmissions.⁴⁴ McKay *et al* recorded 12.8% of their initial population of frail older adults who had received standard care in AMU were readmitted after 7 days and 25.6% after 28 days. Following the introduction of specialist team who provided targeted interventions, there was no statistically significant difference observed in the subsequent exposed cohorts compared to the initial one.⁴⁵

30-day readmission: Martin-Marero *et al* and 2 other frailty studies also reported 30-day readmission rates. Chua *et al* described that 15.5% of their total population was readmitted after 30 days and frail adults were less likely to be re-hospitalised compared to non-frail patients (14.8% vs 22.4%; $p=0.025$). This was probably due to a significantly higher mortality rate ($p < 0.001$) in the severely frail group (17.4%) compared to the non-frail group (2.7%) during that same timeframe;³⁹ McAlister *et al* recorded an overall readmission rate of 12.6% but adults with high or mild to moderate degree of frailty had decreased risks of 30-day readmission (10.0% (OR 0.74, 95% CI 0.69 – 0.79) and 11.2% (OR 0.84, 95% CI 0.82 – 0.86) respectively) compared to their non-frail counterparts (13.1%).⁴²

90-day readmission: Chua *et al* reported a readmission rate of 38.9% with no association with frailty status ($p=0.12$).³⁹ Juma *et al* reported a readmission rate of 29.3%. Severely frail participants had higher readmission rates when compared with those with no frailty (31.2% for severely frail, vs. 34.2% for mild-to-moderately frail vs. 19% for non-frail). However, there was no significant difference in the adjusted analysis ($p=0.46$).⁴¹ Wou *et al* showed that 26.7% of their population were readmitted and frail patients, according to all screening scales, were associated with an increase rate of readmission (RR range 1.1–1.6) but the screening tools could not predict readmissions.⁴⁶ The first two studies used the CFS tool while the latter compared 5 different screening tools, including the FI.

6-month readmission: Basile *et al* reported a 6-month readmission rate of 32.7% and both aFI and FI on discharge (dFI) were predictive of readmission events (OR = 6.3, 95% CI 2.2–17.9, $p = 0.03$; OR = 6.4, 95% CI 1.9–43.3, $p = 0.015$; respectively). In comparison, Chua *et al* didn't find any association of frailty status with higher rate of rehospitalisation ($p=0.77$) and recorded an overall rate of 56.6% readmission.

12-month readmission: Perez-Zepeda *et al* reported that 74% of sarcopenic patients were readmitted at 12 months.

Overall, although the single study reported an increased readmission rate in sarcopenic adults; the majority of frailty studies did not describe a relationship between frailty and readmission, no matter how frailty was measured.

Length of stay (LoS): In total, 11/16 studies measured LoS as an outcome: 9 frailty studies and 2 sarcopenia studies. Most (8/11 studies – 7/9 frailty and 1/2 sarcopenia) presented their results as mean

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with standard deviation. Two studies (1 frailty and 1 sarcopenia) reported median and inter-quartile ranges instead.^{39,47}

Amongst the frailty studies, Chua *et al*, who included a cohort of frail subjects, reported a median (interquartile range / IQR) LoS of 8 (2 – 15). Three studies assessed the relationship between the degree of frailty and LoS, but each used different validated screening tool(s). Beauchet *et al*³⁸ compared the PRISMA-7 questionnaire and the 6-item brief geriatric assessment (6i-BGA) tool and reported a longer stay associated with the 6i-BGA high risk level: odds of longer stay OR 1.1 (1.1 – 8.5; $p = 0.028$) and HR 2.1, $p = 0.004$. MacKenzie *et al*⁴³ used both FI and CFS to assess frailty. They recorded a prolonged LoS (more than 14 days) with an OR 1.02 ($p = 0.003$) if the patients were diagnosed with frailty using the FI tool and OR 2.28 ($p = 0.002$) if the diagnosis was made using the CFS tool. McAlister *et al*⁴² used the Hospital Frailty Risk Score (HFRS) tool and calculated an OR 8.64 (8.3 – 9) in high risk frail patients and OR 3.6 (3.6 – 3.7) in intermediate risk frail patients⁴² compared to their non-frail counterparts.

For sarcopenia studies, Cerri *et al* measured a median (IQR) LoS of 9 (6 – 14.3) in the sarcopenic group ($n=22$) compared to 10 (8 – 14) in the non-sarcopenic one ($n=58$). Martone *et al*⁴⁴ reported odds of a longer stay in hospital for sarcopenic older adults at OR 0.99 (0.95 – 1.03) compared to non-sarcopenic patients.

In summary, both frail or sarcopenic older adults stayed longer in hospital compared to those not affected by these conditions, but studies to date did not describe why the increased LoS occurred (increased medical need or delayed discharge).

Place of discharge: Five studies, all frailty related, reported participants' place of discharge. Chua *et al* described that 71.7% of the study population were discharged home, 16.2% transferred to community hospitals (CH) and 12.1% to nursing homes (NH).³⁹ No association between frailty status and discharge destination was explored but it was recorded that at the time of discharge, frail patients had higher LACE scores and were more likely to be discharged into a facility other than their primary residence. Evans *et al* reported 53.7% of their cohort was discharged home, 26.8% to NH, 10.2% in rehabilitation facilities (RF) and 3% to assisting living facilities (ALF).⁴⁰ Patients discharged home had the lowest admitting mean FI-CGA = 0.38 ($\pm$ SD 0.11) compared to those who were discharged to a nursing home, FI-CGA = 0.49 ($\pm$ 0.11). Juma *et al* described that 4% of their population were admitted to NH.⁽⁴¹⁾ All of these people were severely frail with two patients

found to have a CFS score of 6 and one patient, a CFS = 7. Wou *et al* described 0.9% of their cohort being discharged to a NH⁴⁶ and these adults were vulnerable according to all screening scales used. They were also more at risk of the composite adverse outcome defined as any of the outcomes of mortality, institutionalisation, unplanned hospital readmission and decline in function, at 90 days (RR range 1.2–1.6). Martin-Marero *et al* discharged 97.6% of the patients with frailty from the specialist intervention unit to their original residence compared to 88.9% of the frail ones who only received usual care.⁴⁴ Moreover, higher grade of CFS correlated with reduced percentage of discharge to usual residence.

Overall, the majority of the study population was discharged back to their usual residence, followed by nursing homes, community hospital, rehabilitation facilities and finally, assisting living facilities. Participants transferred to places other than their original residence had the highest levels of frailty.

Level of activities of daily living (ADLs): Two sarcopenia and 2 frailty studies reported on the level of or decline in function / ADLs.

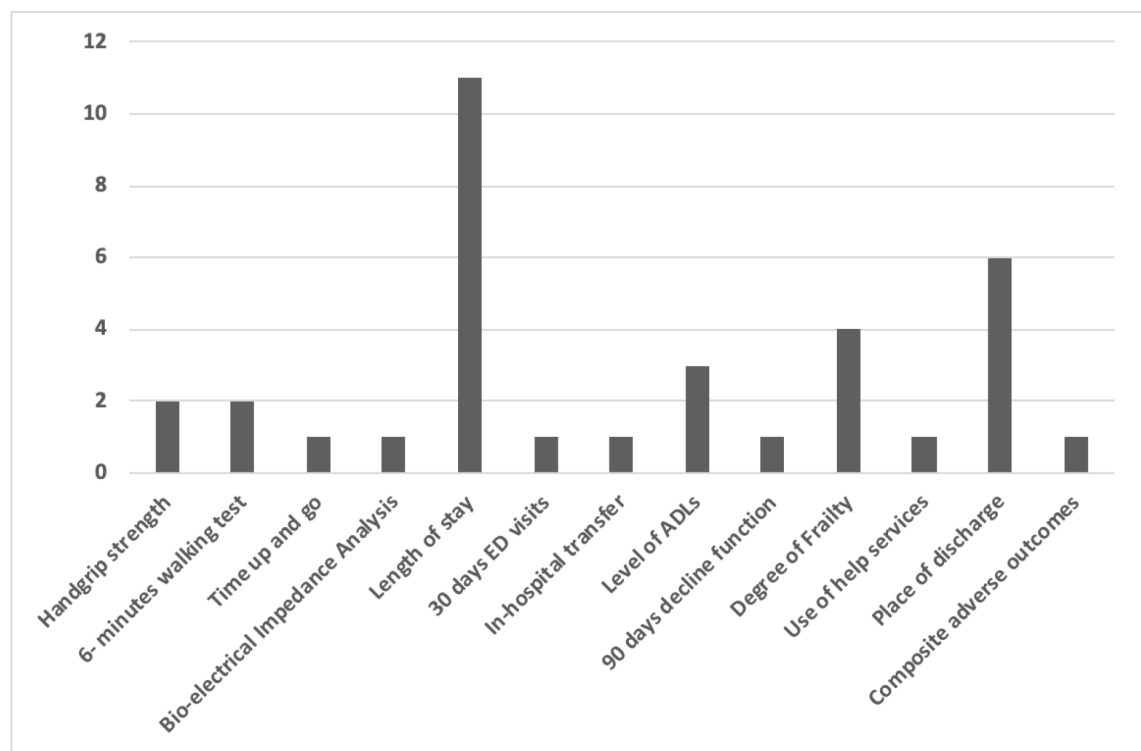
Amongst sarcopenia studies, Martone *et al* reported that sarcopenic patients showed a significantly lower body mass index (BMI) compared with non-sarcopenic peers (25.0 ± 3.8 kg/m² vs. 27.6 ± 4.9 kg/m², respectively; $p < 0.001$). Perez-Zepeda *et al*'s findings confirmed that sarcopenic patients, compared to non-sarcopenic counterparts, were more likely to have lower levels of function for both ADL [Median; IQR (1; 0 – 7 vs 4; 0 – 7 respectively; $p < 0.001$)] and instrumental ADL (2; 0 – 8 vs 3; 0 – 8; $p < 0.001$).

Frailty studies showed similar findings. Ekerstad *et al*⁴⁶ reported that treatment in a Comprehensive Geriatric Assessment (CGA) unit was independently associated with lower risk of decline in ADLs (OR 0.093; 95% CI 0.052–0.164; $p < 0.0001$) and a less prevalent increase in the degree of frailty (OR 0.229; 95% CI 0.131–0.400; $p < 0.0001$). Moreover, when ADLs were classified into three strata (independence, instrumental ADL-dependence, and personal ADL-dependence), changes to a more dependence-associated stratum were less prevalent in the group receiving CGA (OR 0.194; 95% CI 0.085–0.444; $p = 0.0001$). Wou *et al* also established that the more participants were frail, the more they presented with a significant increase in functional decline (RR range 1.2–2.1).

In conclusion, all four studies showed that the most vulnerable older adults had the lowest level of function compared to their less vulnerable or robust peers.

Other secondary outcomes: Other secondary outcomes were reported by studies as shown in

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Legend: ED= Emergency department; ADLs= Activities of Daily Living.

Figure 3. Secondary outcomes reported, number of studies n=16.

Figure 3. Handgrip strength (HS), Time up and go (TUG) and 6-minute walking test (6-MWT) were significantly improved in participants who had received a CGA – OR 4.4 (95% CI 2.2–9.1) $p < 0.001$; 2.5 (95% CI 1.1–5.4) $p < 0.003$; 13.9 (95% CI 4.2–46.2) $p < 0.001$ respectively – compared to patients receiving usual care. These were measured at hospital index care period and at the 3-months follow-up. Data were analysed as the mean change from index to the 3-months follow-up and dichotomised as decline versus stability/improvement in physical fitness.

Participants with high or intermediate degree of frailty had decreased risk of 30 days emergency department (ED) visits (7.3% and 11.1% respectively) compared to non-frail (16%) participants. In-hospital transfer and composite adverse outcomes were both predicted by increased frailty scores but there was no significant difference in increased use of municipal help services (OR 0.682; 95% CI 0.395–1.178; $p = 0.170$) – whether the participants had received conventional care or tailored geriatric assessment (Table 3).³⁶

Discussion

To our knowledge, this is the first systematic review to determine whether the presence of sarcopenia or frailty, assessed on admission to an acute medical unit, are associated with adverse outcomes. There is increasing interest in identifying patients at risk of a prolonged admission, readmission, care escalation

or death as soon as possible when hospitalised for an acute event. This potentially provides a means to focus limited healthcare resource, with an aim of mitigating the frequency or impact of negative outcomes. Frailty and sarcopenia have been suggested as potential markers for poorer outcomes and could be measured in the acute admissions unit upon arrival. However, as these services are already under critical pressure, the resource cost must be justified by clinical benefit.

Overall, there was consensus across studies, with most suggesting that frailty and sarcopenia were associated with worse health outcomes, notably in-patient mortality and LoS when comparing to participants not diagnosed with these conditions. Re-admission rates were only increased in sarcopenic patients, and there was no change in frail cohorts.

However, the number of studies were small, and there was substantial heterogeneity amongst the studies. Although all used validated tools, most studies used different measures to assess frailty. It is recognised that different tools identify different subgroups of patients and the variety of tools used to assess frailty as well as differences in outcomes hindered objective comparisons between studies. Two of the included studies focussed on sarcopenia using the same screening criteria tool; both accounted for potentially confounding factors and suggested the presence of sarcopenia was associated with a higher risk of death as an in-patient. One was unicentral⁴⁷ and the other was a multicentre trial.⁵⁰ LoS were not

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Table 3. Validated tools for frailty screening and studies reported using it.

Study number	Author	Year / Country	Type of study Aim of study	Screening tool used	Total participants (age)	Outcomes
	Ahlund & al (35)	2017 / Sweden	Clinical prospective controlled trial. (intervention: CGA vs. control: conventional care)	FRESH (Frail Elderly Support Research) screening instrument.	408 (>75 y/o)	- Patients in CGA units improved better in every component of physical function and the outcomes were influenced by the intervention - HS OR 4.4 (confidence interval [CI] 95% 2.2–9.1), 6-MWT OR 13.9 (CI 95% 4.2–46.2), and TUG OR 2.5 (CI 95% 1.1–5.4).
	Basile & al (37)	2019 / Italy	Prospective study. (1) Measure the frailty status and its changes occurring during the hospital stay, (2) Determine the relationships among frailty and adverse outcomes.	46-item FI (Frailty Index)	156 (65+)	The admission FI was directly associated with the risk of in-hospital death (OR = 5.9; 95% CI 2.0–17.5; p = 0.001), 1-year mortality (OR = 5.5, 95% CI 2.4–12.7, p < 0.001) and re-hospitalization (OR = 6.3, 95% CI 2.2–17.9, p = 0.03).
	Beauchet & al (38)	2019 / Canada	Observational retro cohort. Which tool best predicts risk of long LOS?	6-item BGA (Brief Geriatric Assessment) PRISMA-7 questionnaire	166 (75+)	- The 6-item BGA risk levels were significantly associated with LOS: low risk associated with short LOS (beta= -4.9, p=0.03) high risk associated with long LOS (beta= 9.9, p=0.001) - Both tools had poor performance for the prediction of long LOS.
	Cerri & al (47)	2015 / Italy	Prospective observational study. (1) Assess the prevalence of sarcopenia among hospitalised patients; (2) Assess whether the European Working Group on Sarcopenia in Older People (EWGSOP) criteria are applicable in an acute care setting; (3) Assess the mortality rate at 3 months.	European Working Group for Sarcopenia in Older People (EWGSOP).	103 (>65 y/o)	21.4% patients were sarcopenic. 56.3% were not and 22.3% were unable to be diagnosed with sarcopenia because unable to perform HS +/- gait speed (bedridden or on intensive care). 3-months deaths F/U: 10.7% of whole population died - 5.2% deaths in not sarcopenic group, 31.8% in sarcopenic group, 4.3% in uncertain diagnosis group. - In-hospital deaths all occurred only in the sarcopenic group. - Kaplan Meier survival curves: sarcopenic patients died more frequently than others (log-rank p<0.001) - Multiple comparison adjustments by Sidak approach: sarcopenic patients differed from those without sarcopenia (p=0.003) and those with uncertain diagnosis (p=0.006)

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Study number	Author	Year / Country	Type of study Aim of study	Screening tool used	Total participants (age)	Outcomes
	Chua & al (39)	2018 / Singapore	Prospective study. Evaluation of clinical frailty screening in geriatric acute care; Mortality and rehospitalization during the 6-month follow-up. Survival analysis used to compare the time to death and rehospitalization	Clinical Frailty Score (CFS)	314 (70+)	- Severe frailty determined by CFS (HR = 2.09, 95% CI = 1.01-4.33, p = 0.047) and CFS scores (HR = 1.27, 95% CI = 1.05-1.53, p = 0.012) were significantly associated with higher mortality until 6-month post discharge, but not rehospitalization. - Frail inpatients had higher mortality rate at 1, 3, and 6-month follow-ups after discharge (p ≤ 0.001). However, despite higher LACE scores, frail patients were less likely to be re-hospitalised within 1 month after discharge (p = 0.025) - At the time of discharge, frail patients had higher LACE scores, longer length of stay, higher prevalence of in-hospital mortality, and were more likely to be discharged into a community hospital or nursing home.
	Ekerstad & al (36)	2017 / Sweden	Prospective controlled trial. Level of Activities of Daily Living (ADLs) – CGA unit care (int) vs. Conventional acute care (ctrl).	FRESH	408 (>75 y/o) Int : 206 Ctrl : 202	- Up till 3-months post-discharge functional decline: treatment in a CGA unit was independently associated with lower risk of decline in ADLs [odds ratio (OR) 0.093; 95% confidence interval (CI) 0.052–0.164; P<0.0001], and with a less prevalent increase in the degree of frailty (OR 0.229; 95% CI 0.131–0.400; P<0.0001). - When ADLs were classified into three strata (independence, instrumental ADL-dependence, and personal ADL-dependence), changes to a more dependence-associated stratum were less prevalent in the intervention group (OR 0.194; 95% CI 0.085–0.444; P=0.0001). - There was no significant difference between the groups in increased use of municipal help services (OR 0.682; 95% CI 0.395–1.178; P=0.170).

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Study number	Author	Year / Country	Type of study Aim of study	Screening tool used	Total participants (age)	Outcomes
	Evans & al (40)	2014 / Canada & USA	Prospective cohort study. FI-CGA and outcomes in hospitalised older adults.	FI	752 (>75 y/o)	• 30-day mortality was 93 (12.4%; 95%CI = 10–15%) of whom 52 died in hospital. • Risk of dying increased with each 0.01 increment in the FI-CGA: hazard ratio (HR) = 1.05, (95% CI = 1.04–1.07). • Patients discharged home had the lowest admitting mean FI-CGA = 0.38 ($\pm$SD 0.11) compared with those who died, FI-CGA = 0.52 ($\pm$0.12) or were discharged to nursing home, FI-CGA = 0.49 ($\pm$0.11). • Increasing FI-CGA values on admission were significantly associated with a longer LOS (increased from 4.2 in the least frail group to 7.8 in the frailest group).
	Juma & al (41)	2016 / Canada	Prospective cohort study. CFS and LOS prediction	CFS	75 (>65 y/o)	• LOS: severe frailty was associated with longer LOS (Mean = 12.6 ± 12.7 days) compared to mild-to-moderate frailty (mean = 11.2 ± 10.8 days), and non-frailty (mean = 4.1 ± 2.1 days, $p = 0.014$) – significant association after adjustments for age, sex, polypharmacy ($p=0.02$). • 90-days readmission: higher frailty scores showed higher readmission rates when compared with those with no frailty (31.2% for severely frail, vs. 34.2% for mild-to-moderately frail vs. 19% for non-frail) – not significant after adjusted analysis ($p=0.464$). • Transfer to sub-acute medicine: no report • Long-term care placement: 2/75 (CFS=6) and 1/75 (CFS=7). • IP mortality: 1/75 (CFS=5)

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Study number	Author	Year / Country	Type of study Aim of study	Screening tool used	Total participants (age)	Outcomes
	Mackenzie & al (43)	2017 / Canada	Prospective study. Diabetes and frailty: what drive the outcomes?	FI & CFS	433 (65+)	- Mean LOS was 24.5±38.1 days, and mortality rate was 18.7%; 79.5% were frail. Diabetes was present in 32.1%. Patients with diabetes had higher scores on FI than those without diabetes (0.50±0.12 vs. 0.47±0.14, p<0.05) - In logistic regression modelling, frailty by FI and moderate to severe frailty by CFS, but not diabetes, were associated with increased odds ratios (OR) for mortality (FI OR 1.057, p<0.001; CFS OR 4.2, p<0.001), and LOS >14 days (FI OR 1.018, p=0.003; CFS OR 2.281, p=0.001) - In patients with diabetes, admission glucose decreased as frailty increased (p=0.002). - Hypoglycemia was not significantly different across levels of frailty.
	Martin-Marero & al (44)	2018 / UK	Prospective study. Acute frailty MDT vs. usual care (control group)	Local WMUH*-CFS (based on geriatric needs) (*West Middlesex University Hospital – CFS)	443 discharged 301 frail 1185 controls (75+)	- Outcomes per W-CFS: Higher W-CFS correlates with reduced %discharge to usual residence, increased LOS and higher mortality. - LOS in days -Mean (SD): we had a comparable LOS as the younger cohort managed by our AMU colleagues of 1.6 (1.7) while A1 = 2.3 (1.4). The other cohorts showed longer LOS, including B = 16.8 (21.2). % discharged to usual residence: we discharged more patients with frailty to their original residence A1 (97.6%) compared to AMU (88.9%). - Readmissions: 7 and 30 readmissions slightly increased in the Frail groups compared to AMU and C, with Root Cause Analysis showing the need to increase community support services for the Frail cohorts.
	Martone & al (48)	2017 / Italy From the GLISTEN study.	Prospective study. Incidence of sarcopenia in IP (in-patient) older people.	EWGSOP criteria	394 (>65 y/o) 336 – no sarcopenia (ns) 58 – sarcopenia (s)	- LoS (days; mean ± SD): n = 10.2 ± 8.1; ns = 9.9 ± 7.6; s = 12.1 ± 10.3; p=0.05 - Sarcopenic patients spent an average of 5.1 days in bed compared with 3.2 days for those with no sarcopenia at discharge (p = 0.02). - Sarcopenic patients showed a significantly lower BMI compared with non-sarcopenic peers (25.0 ± 3.8 kg/m² vs. 27.6 ± 4.9 kg/m², respectively; p < 0.001).

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Study number	Author	Year / Country	Type of study Aim of study	Screening tool used	Total participants (age)	Outcomes
	McAlister & al (42)	2019 / Canada	Retrospective cohort study. Outcomes prediction in elderly people.	Hospital Frailty Risk score (HFRS) – frailty Hospital one-year Mortality Rate (HOMR) score – one-year mortality	452785 (75+)	- Patients with high or intermediate HFRS had significantly increased risks of prolonged hospitalisation (70.0% (OR 8.64, 95% CI 8.30 to 8.99) or 49.7% (OR 3.66, 95% CI 3.60 to 3.71) vs 21.3% in low-risk HFRS group) and 30-day mortality (15.5% (OR 1.27, 95% CI 1.20 to 1.33) or 16.8% (OR 1.39, 95% CI 1.36 to 1.41) vs 12.7% in low-risk) - But decreased risks of 30-day readmission (10.0% (OR 0.74, 95% CI 0.69 to 0.79) and 11.2% (OR 0.84, 95% CI 0.82 to 0.86) vs 13.1%) or ED visit (7.3% (OR 0.41, 95% CI 0.38 to 0.45) and 11.1% (OR 0.66, 95% CI 0.38 to 0.45) vs 16.0%) - Although only loosely associated (Pearson correlation coefficient 0.265, $p < 0.0001$), both the HFRS and HOMR Score were independently associated with each outcome –HFRS was more strongly associated with prolonged length of stay (C-statistic 0.71) and HOMR Score was more strongly associated with 30-day mortality (C-statistic 0.71). Both poorly predicted 30-day readmissions (C-statistics 0.52 for HFRS and 0.54 for HOMR Score).
	McKay & al (45)	2018 / UK	Prospective study. Proactive identification of frailty within an acute medical unit; 3 distinct periods: 23 – 29 Jan 2015/2016/2017	Health improvement Scotland (HIS) frailty screening tool – HIS >1 = prompt review by REACH nurse.	(65+) 2015: 101 2016: 97 2017: 87	Introduction of REACH screening and intervention appears to be associated with a reduction in length of stay of frail patients (16 vs 13.2 vs 12.6 respectively for 2015/16/17).

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Study number	Author	Year / Country	Type of study Aim of study	Screening tool used	Total participants (age)	Outcomes
	Perez-Zepeda & al (49)	2017 / Australia	Prospective study. (1) Prevalence of sarcopenia; (2) Factors associated with sarcopenia; (3) Association of sarcopenia with adverse clinical outcomes post-hospitalisation.	EWGSOP	172 (70+)	- Sarcopenia was present in 69 (40.1%) of patients - Patients with sarcopenia were twice as likely to die in the 12-months post-hospitalisation (HR, 95% CI=2.23, 1.15–4.34), but did not have an increased likelihood of ED admission. - Patients with sarcopenia compare to non-sarcopenic counterparts, were more likely to have lower levels of function for both ADL [Median; IQR(1, 0 – 7 vs 4, 0 – 7 respectively; $p < 0.001$)] and IADL (2, 0 – 8 vs 3, 0 – 8; $p < 0.001$).
	Vetrano & al (50)	2014 / Italy	Observational multicentre study The CRIME study.	EWGSOP	770 (65+)	- Within the 770 participants (mean age: 81 ± 7 years, 56% women), sarcopenia was present in 214 (28%) of them, 22 participants died during hospital stay, and 113 in the year after discharge. - Participants with sarcopenia had a significantly higher in-hospital (6% vs 2%; $p = .007$) and 1-year mortality (26% vs 14%; $p < .001$) as compared with participants without sarcopenia. - After adjusting for potential confounders, sarcopenia resulted significantly associated with in-hospital (hazard ratio: 3.45; 95% CI: 1.35–8.86) and 1-year mortality (hazard ratio: 1.59; 95% CI: 1.10–2.41).
	Wou & al (46)	2013 / UK	Prospective cohort study Comparing predictive properties at 90 days of 5 frailty-rating scales.	5 Models: Fried (Cardio-vascular Health Study / CHS model) Ensrud (Study of Osteoporotic Fracture / SOF model) Rothman's instrument Ávila-Funes's instrument FI	667 (>70 y/o)	- Frail participants according to all scales were associated with a significant increased risk of mortality [relative risk (RR) range 1.6–3.1], readmission (RR range 1.1–1.6), functional decline (RR range 1.2–2.1) and the composite adverse outcome (RR range 1.2–1.6) - Predictive properties of the frailty rating scales were poor, at best, for all outcomes assessed (AUC ranging from 0.44 to 0.69) – frailty rating scales alone are of limited use in risk stratifying older people being discharged from acute medical units.

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normally distributed and were either expressed in mean and standard deviation or in median and inter-quartiles but in general, all studies recorded a longer in-patient stay in frail and/or sarcopenic older adults compared to their robust counterparts.

Other specific risk factors associated with those negative effects were not robustly highlighted in this AMU population; but it is known that older adults admitted in any other settings, such as emergency departments (ED) or medical wards, do worse if they are found to live alone or have: an older age, recent hospitalisation or ED use, delirium, cognitive decline, lack of social support and functional impairment.⁵²⁻⁵⁶ As part of a response to the latter, a recent randomised controlled trial (RCT) showed that a tailored exercise training program improved physical function, maximal muscle strength, and muscle power in acutely hospitalised older patients.⁵⁷ It is also likely that a good nutritional status might lead to better outcomes.^{47, 58}

Of note, the poor outcomes described appear to be preventable or modifiable in some instances. Included studies suggest that implementing multidisciplinary team (MDT) approaches at an earlier stage (such as comprehensive geriatric assessments conducted by a team of specialists) can improve outcomes, for at least some patient groups. This is in agreement with other studies reporting that routine assessment of frailty and/or sarcopenia by trained professionals in older patients admitted in other specialties such as: emergency medicine,⁵⁹⁻⁶⁴ critical care⁶⁵ or surgery,⁶⁶⁻⁶⁹ can help identify patients at higher risk of mortality – during admission or post-discharge – and those requiring special needs, in order to coordinate a plan to improve outcomes.

There is evidence suggesting benefit from screening older adults admitted in an acute medical unit for frailty and sarcopenia. However, a standardisation of the screening tools used, and the tailored assessments administered to those patients are essential to determine if this should be incorporated into routine practice. Further interventional studies are required to understand the relationship between frailty and sarcopenia, how they evolve during an acute admission and what could impact on patients screening scale scores. This will help identify the most vulnerable older adults and intervene at an earlier stage of their illness to improve their hospital outcomes.

Strength and limitations

Strengths

Our review followed the PRISMA guidelines, therefore adopting robust methodology. The studies included were carefully assessed for their quality and almost all of them were of good quality. Foreign

languages studies were translated and screened in accordance with the guidelines before being excluded if not meeting the inclusion criteria. Furthermore, our findings can reflect the clinical practice in a vast majority of populations because of the diversity of countries from which the studies were conducted.

Limitations

Not all authors provided a full dataset when requested, leading to study exclusion. Studies were small and heterogenous. There was a lack of standardisation in frailty screening and assessment; a wide range of different outcomes reported in the studies, preventing a meta-analysis. Most of the studies assessed frailty and/or sarcopenia on admission only and there was limited data reporting their impact on the use of health services which we believe is an important indicator of the efficiency of targeted interventions implemented by the healthcare personnel. This review focused on an acute medical unit setting and should not be extrapolated to other settings. Potentially both baseline and dynamic changes in frailty and sarcopenia over time may be more informative than a single measure to predict longer term outcomes (where a low baseline or a deterioration in either measure identifies an especially vulnerable group).

Conclusion and implications

This systematic review of the literature suggests that frailty and sarcopenia are associated with a number of adverse outcomes following acute hospitalisation in older adults (death, increased length of stay, a reduction in functional status and potentially readmission). Further, there is some evidence to suggest that identifying sarcopenia and frailty in acute medical units and instigating measures to treat these conditions may improve outcomes for patients. However, these findings are tentative, and more studies are required to determine a standardised approach to assess frailty, the most relevant outcome measures, what the best form of therapy may be to improve these outcomes and the health economics of implementing routine testing.

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Conflicts of interest.

VK and AS have no conflicts of interest to declare. ES declares funding from HDR-UK, The Wellcome Trust, MRC, NIHR, British Lung Foundation and Alpha 1 Foundation.

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References

- Gonçalves-Bradley DC, Lannin NA, Clemson LM, *et al.* Discharge planning from hospital. *Cochrane Database of Systematic Reviews*. 2016.
- Pendlebury S, Lovett N, Smith S, *et al.* Observational, longitudinal study of delirium in consecutive unselected acute medical admissions: age-specific rates and associated factors, mortality and re-admission. *BMJ Open*. 2015; **5(11)**: e007808-e.
- Ellis G, Gardner M, Tsiachristas A, *et al.* Comprehensive geriatric assessment for older adults admitted to hospital. *Cochrane Database Syst Rev*. 2017; **9**: CD006211.
- Morley JE, Vellas B, Abellan van Kan G, *et al.* Frailty Consensus: A Call to Action. *Journal of the American Medical Directors Association*. 2013; **14(6)**: 392–7.
- Clegg A, Young J, Liffé S, *et al.* Frailty in elderly people. *The Lancet*. 2013; **381(9868)**: 752–62.
- Wilson D, Jackson T, Sapey E, *et al.* Frailty and sarcopenia: The potential role of an aged immune system. *Ageing Res Rev*. 2017; **36**: 1–10.
- Leng S, Chaves P, Koenig K, *et al.* Serum interleukin-6 and hemoglobin as physiological correlates in the geriatric syndrome of frailty: a pilot study. *Journal of the American Geriatrics Society*. 2002; **50(7)**: 1268–71.
- Leng SX, Cappola AR, Andersen RE, *et al.* Serum levels of insulin-like growth factor-I (IGF-I) and dehydroepiandrosterone sulfate (DHEA-S), and their relationships with serum interleukin-6, in the geriatric syndrome of frailty. *Ageing clinical and experimental research*. 2004; **16(2)**: 153–7.
- Walston J, McBurnie MA, Newman A, *et al.* Frailty and activation of the inflammation and coagulation systems with and without clinical comorbidities: results from the Cardiovascular Health Study. *Archives of internal medicine*. 2002; **162(20)**: 2333–41.
- Schoufour JD, Echteid MA, Boonstra A, *et al.* Biochemical measures and frailty in people with intellectual disabilities. *Age and ageing*. 2016; **45(1)**: 142–8.
- Schaap LA, Pluijm SMF, Deeg DJH, *et al.* Inflammatory markers and loss of muscle mass (sarcopenia) and strength. *The American journal of medicine*. 2006; **119(6)**: 526.e9–17.
- Collard RM, Boter H, Schoevers RA, *et al.* Prevalence of frailty in community-dwelling older persons: a systematic review. *Journal of the American Geriatrics Society*. 2012; **60(8)**: 1487–92.
- Renne I, Gobbens RJJ. Effects of frailty and chronic diseases on quality of life in Dutch community-dwelling older adults: a cross-sectional study. *Clinical Interventions in Aging*. 2018; **13**: 325–34.
- Muscudere J, Waters B, Varambally A, *et al.* The impact of frailty on intensive care unit outcomes: a systematic review and meta-analysis. *Intensive Care Medicine*. 2017; **43(8)**: 1105–22.
- Hewitt J, Long S, Carter B, *et al.* The prevalence of frailty and its association with clinical outcomes in general surgery: a systematic review and meta-analysis. *Age and ageing*. 2018; **47(6)**: 793–800.
- Hajek A, Bock J-O, Saum K-U, *et al.* Frailty and healthcare costs-longitudinal results of a prospective cohort study. *Age and ageing*. 2018; **47(2)**: 233–41.
- Fried *et al.* - 2001 - Frailty in Older Adults Evidence for a Phenotype.pdf.
- Kojima G. Prevalence of Frailty in Nursing Homes: A Systematic Review and Meta-Analysis. *J Am Med Dir Assoc*. 2015; **16(11)**: 940–5.
- Hao Q, Zhou L, Dong B, *et al.* The role of frailty in predicting mortality and readmission in older adults in acute care wards: a prospective study. *Sci Rep*. 2019; **9(1)**: 1207.
- Mitnitski AB, Mogilner AJ, Rockwood K. Accumulation of deficits as a proxy measure of aging. *The Scientific World Journal*. 2001; **1**: 323–36.
- Turgeon J, Michaud V, Steffen L. The Dangers of Polypharmacy in Elderly Patients. *JAMA Intern Med*. 2017; **177(10)**: 1544.
- Sanchez-Rodriguez D, Hope S, Piotrowicz K, *et al.* Sarcopenia in Acute Care Patients: Protocol for the European Collaboration of Geriatric Surveys: Sarcopenia 9+ EAMA Project. *Journal of the American Medical Directors Association*. 2019;20.
- Cruz-Jentoft AJ, Bahat G, Bauer J, *et al.* Sarcopenia: revised European consensus on definition and diagnosis. *Age and Ageing*. 2019; **48(1)**: 16–31.
- Cruz-Jentoft AJ, Baeyens JP, Bauer JM, *et al.* Sarcopenia: European consensus on definition and diagnosis: Report of the European Working Group on Sarcopenia in Older People. *Age and ageing*. 2010; **39(4)**: 412–23.
- Stringer HJ, Wilson D. The Role of Ultrasound as a Diagnostic Tool for Sarcopenia. *The Journal of frailty & aging*. 2018; **7(4)**: 258–61.
- Nijholt W, Scafogliari A, Jager-Wittenaar H, *et al.* The reliability and validity of ultrasound to quantify muscles in older adults: a systematic review. *Journal of cachexia, sarcopenia and muscle*. 2017; **8(5)**: 702–12.
- Ismail C, Zabal J, Hernandez HJ, *et al.* Diagnostic ultrasound estimates of muscle mass and muscle quality discriminate between women with and without sarcopenia. *Frontiers in physiology*. 2015; **6**: 302.
- Wilson DV, Moorey H, Stringer H, *et al.* Bilateral Anterior Thigh Thickness: A New Diagnostic Tool for the Identification of Low Muscle Mass? *Journal of the American Medical Directors Association*. 2019; **20(10)**: 1247–53.e2.
- Wilson DV, Moorey H, Stringer H, *et al.* Bilateral Anterior Thigh Thickness: A New Diagnostic Tool for the Identification of Low Muscle Mass? *J Am Med Dir Assoc*. 2019; **20(10)**: 1247–53.e2.
- Bano G, Trevisan C, Carraro S, *et al.* Inflammation and sarcopenia: A systematic review and meta-analysis. *Maturitas*. 2017; **96**: 10–5.
- Welch C, K Hassan-Smith Z, A Greig C, *et al.* Acute Sarcopenia Secondary to Hospitalisation - An Emerging Condition Affecting Older Adults. *Ageing and disease*. 2018; **9(1)**: 151–64.
- Marchiori GF, Tavares DMDS. Changes in frailty conditions and phenotype components in elderly after hospitalization. *Revista latino-americana de enfermagem*. 2017; **25(0)**: e2905-e.
- Tanner RE, Brunner LB, Agergaard J, *et al.* Age-related differences in lean mass, protein synthesis and skeletal muscle markers of proteolysis after bed rest and exercise rehabilitation. *The Journal of physiology*. 2015; **593(18)**: 4259–73.
- Ouzzani M, Hammady H, Fedorowicz Z, *et al.* Rayyan-a web and mobile app for systematic reviews. *Syst Rev*. 2016; **5(1)**: 210.
- Ahlund K, Back M, Oberg B, *et al.* Effects of comprehensive geriatric assessment on physical fitness in an acute medical setting for frail elderly patients. *Clinical Interventions in Aging*. 2017; **12**: 1929–39.
- Ekerstad N, Dahlin Ivanoff S, Landahl S, *et al.* Acute care of severely frail elderly patients in a CGA-unit is associated with less functional decline than conventional acute care. *Clin Interv Aging*. 2017; **12**: 1239–49.
- Basile G, Catalano A, Mandraffino G, *et al.* Frailty modifications and prognostic impact in older patients admitted in acute care. *Ageing Clin Exp Res*. 2019; **31(1)**: 151–5.
- Beauchet O, Fung S, Launay CP, *et al.* Screening for older patients at risk for long length of stay: which clinical tool to use? *BMC Geriatr*. 2019; **19(1)**: 156.
- Chua XY, Toh S, Wei K, *et al.* Evaluation of clinical frailty screening in geriatric acute care. *J Eval Clin Pract*. 2019.
- Evans SJ, Sayers M, Mitnitski A, *et al.* The risk of adverse outcomes in hospitalized older patients in relation to a frailty index based on a comprehensive geriatric assessment. *Age and Ageing*. 2014; **43(1)**: 127–32.
- Juma S, Taabazuing M-M, Montero-Odasso M. Clinical Frailty Scale in an Acute Medicine Unit: a Simple Tool That Predicts Length of Stay. *Canadian Geriatrics Journal*. 2016; **19(2)**: 34–9.
- McAlister F, van Walraven C. External validation of the Hospital Frailty Risk Score and comparison with the Hospital-patient One-year Mortality Risk Score to predict outcomes in elderly hospitalised patients: a retrospective cohort study. *BMJ Qual Saf*. 2019; **28(4)**: 284–8.
- MacKenzie HT, Tugwell B, Theou O, *et al.* Frailty and diabetes in older hospitalized adults: What drives outcomes? *Endocrine*

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- Reviews Conference: 99th Annual Meeting of the Endocrine Society, *ENDO*. 2017; **38**(3).
44. Martin-Marero C, Rolph G, Dineros C, *et al*. Successful specialist intervention of older people with frailty at the front door at west middlesex university hospital: Improving patients outcomes. *Age and Ageing*. 2018; **47**: ii25.
 45. McKay L, Russell R, Rimer J, *et al*. Rapid elderly assessment and care in hospital (reach): Proactive identification of frailty within an acute medical unit. *Age and Ageing*. 2018; **47**: ii25.
 46. Wou F, Gladman JRF, Bradshaw L, *et al*. The predictive properties of frailty-rating scales in the acute medical unit. *Age and Ageing*. 2013; **42**(6): 776–81.
 47. Cerri AP, Bellelli G, Mazzone A, *et al*. Sarcopenia and malnutrition in acutely ill hospitalized elderly: Prevalence and outcomes. *Clinical Nutrition*. 2015; **34**(4): 745–51.
 48. Martone AM, Bianchi L, Abete P, *et al*. The incidence of sarcopenia among hospitalized older patients: results from the Glisten study. *J Cachexia Sarcopenia Muscle*. 2017; **8**(6): 907–14.
 49. Perez-Zepeda MU, Sgaravatti A, Dent E. Sarcopenia and post-hospital outcomes in older adults: A longitudinal study. *Arch Gerontol Geriatr*. 2017; **69**: 105–9.
 50. Vetrano DL, Landi F, Volpato S, *et al*. Association between sarcopenia, in-hospital and 1-year mortality in older adults admitted to acute care wards: Results from the crime study. *European Geriatric Medicine*. 2013; **4**: S43.
 51. McGuinness LA, Higgins JPT. Risk-of-bias VISualization (robvis): An R package and Shiny web app for visualizing risk-of-bias assessments. *Research Synthesis Methods*. 2020;n/a(n/a).
 52. Fallon A, Kilbane L, Briggs R, *et al*. Screening for frailty in older emergency department patients: the utility of the Survey of Health, Ageing and Retirement in Europe Frailty Instrument. *QJM*. 2018; **111**(3): 151–4.
 53. Aminzadeh F, Dalziel WB. Older adults in the emergency department: A systematic review of patterns of use, adverse outcomes, and effectiveness of interventions. *Annals of Emergency Medicine*. 2002; **39**(3): 238–47.
 54. Avelino-Silva TJ, Gil LA, Curiati PK, *et al*. Using the frail scale and the identification of seniors at risk tool to predict delirium in hospitalized older adults: Results from a novel geriatric emergency department. *Journal of the American Geriatrics Society*. 2018; **66**: S60–S1.
 55. Curiati PK, Gil Junior L, Cabral KD, *et al*. Predictors of prolonged length of hospital stay in older adults: 12-month results from a geriatric emergency department. *Journal of the American Geriatrics Society*. 2019; **67**: S83.
 56. Alexander K, Adamson J, Cunningham C, *et al*. The effect of delirium and dementia on length of stay (LOS) and functional recovery of patients in elderly medical wards. *Physiotherapy*. 2016; **102**: e180–e1.
 57. Saez de Asteasu ML, Martinez-Velilla N, Zambom-Ferraresi F, *et al*. Physical Exercise Improves Function in Acutely Hospitalized Older Patients: Secondary Analysis of a Randomized Clinical Trial. *J Am Med Dir Assoc*. 2019; **20**(7): 866–73.
 58. Morais JA, Jacob KW, Chevalier S. Effects of aging and insulin resistant states on protein anabolic responses in older adults. *Exp Gerontol*. 2018; **108**: 262–8.
 59. Aijaz F, Conroy S, Banerjee J. Embedding the clinical frailty scale in the emergency department and its impact on patient care. *Age and Ageing*. 2018; **47**: iii20.
 60. Aprahamian I, Arico de Almeida GV, de Vasconcellos Romanin CF, *et al*. Frailty Could Predict Death in Older Adults After Admission at Emergency Department? A 6-Month Prospective Study from a Middle-Income Country. *Journal of Nutrition, Health and Aging*. 2019.
 61. Arora A, Holmes E, Morris AM, *et al*. Admission avoidance in emergency department – What works for frail older people: The exemplar front door (EFD) initiative. *Age and Ageing*. 2018; **47**: iii31.
 62. Greening NJ, Harvey-Dunstan TC, Chaplin EJ, *et al*. Bedside assessment of quadriceps muscle by ultrasound after admission for acute exacerbations of chronic respiratory disease. *American Journal of Respiratory and Critical Care Medicine*. 2015; **192**(7): 810–6.
 63. Barratt R, Keelan R. The older person's assessment and liaison (OPAL) team in emergency department: Impact of embedding specialty staff in ED. *European Geriatric Medicine*. 2017; **8**: S84.
 64. Chan D, Ashrafi T, Agogbua C, *et al*. Frail and older person advice and liaison service (FOPALS), improving care for the frail and elderly people at acute hospitals. *European Geriatric Medicine*. 2017; **8**: S151.
 65. Park H, Ko B. Predictive value of sarcopenia on outcome of sepsis in the emergency department. *Critical Care Conference: 37th International Symposium on Intensive Care and Emergency Medicine Belgium*. 2017; **21**(1).
 66. Farhat JS, Velanovich V, Fau – Falvo AJ, Falvo AJ, Fau – Horst HM, *et al*. Are the frail destined to fail? Frailty index as predictor of surgical morbidity and mortality in the elderly. 2019(2163-0763 (Electronic)).
 67. Jung C, Wernly B, Muessig JM, *et al*. A comparison of very old patients admitted to intensive care unit after acute versus elective surgery or intervention. *J Crit Care*. 2019; **52**: 141–8.
 68. Lee KC, Sturgeon D, Lipsitz S, *et al*. Mortality and Health Care Utilization Among Medicare Patients Undergoing Emergency General Surgery vs Those With Acute Medical Conditions. *JAMA Surg*. 2019; **155**(3): 216–23.
 69. Maxwell CA, Patel MB, Suarez-Rodriguez LC, *et al*. Frailty and Prognostication in Geriatric Surgery and Trauma. *Clin Geriatr Med*. 2019; **35**(1): 13–26.