

Original Article

Nutritional risk assessed by the Malnutrition Universal Screening Tool as a predictor of frailty in acutely hospitalised older patients: an observational study

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Background and Objectives: Frailty and malnutrition are overlapping geriatric syndromes and leads to poor clinical outcomes in older patients. This study determined whether Malnutrition Universal Screening Tool (MUST) can predict frailty in older hospitalised patients. **Methods and Study Design:** This prospective study recruited 243 patients ≥ 65 years in a tertiary-teaching hospital in Australia. Frailty assessment was performed by use of the Edmonton-Frail-Scale (EFS), while malnutrition-risk was determined by use of the MUST. Patients with an EFS score >8 were classified as frail, while patients with a MUST score of 1 as at moderate malnutrition-risk and ≥ 2 as at high malnutrition-risk. Multivariable logistic regression determined whether malnutrition-risk predicts frailty after adjustment for various co-variates. **Results:** The mean (SD) age was 83.9 (6.5) years and 126 (51.9%) were females. One-hundred and forty-nine (61.3%) patients were classified as frail, while 66 (27.2%) were found to be at high malnutrition-risk according to the MUST. Frail patients were more likely to be older with a higher Charlson-index and on polypharmacy than non-frail patients. Patients who were at high malnutrition-risk were more likely to be living alone and on vitamin D supplementation than those at low malnutrition-risk. Patients who were at a high malnutrition-risk but not those who were at moderate malnutrition-risk, were more likely to be deemed frail (aOR 2.6, 95% CI 1.2–5.5, $p=0.015$) when compared to those who were at low malnutrition-risk. **Conclusions:** Only patients who were classified as at high malnutrition-risk according to the MUST are more likely to be deemed frail.

Key Words: frailty, malnutrition, Edmonton Frail Scale, Malnutrition Universal Screening tool, frailty predictors

INTRODUCTION

Frailty is a geriatric syndrome which is more likely to be associated with advanced age and occurs due to progressive accumulation of deficits over time leading to impaired physiologic reserves.^{1,2} Frailty is associated with adverse health outcomes such as falls, poor health related quality of life (HRQoL), hospitalisation, and nursing home placement.^{3,4} The prevalence of frailty in hospitalised patients can range from 30–60% depending upon the settings and choice of screening tools used.^{5,6} Hospitalisation may further lead to worsening of frailty status due to immobility, anorexia and inflammation.⁷ Hospitalised frail patients have worse clinical outcomes measured in terms of length of hospital stay (LOS), mortality and unplanned hospital readmissions.^{8,9}

Previous studies have described several characteristics which may be associated with frailty. The most widely accepted characteristics include namely: age, female sex and physical inactivity.^{10,11} Malnutrition is also common

in hospitalised patients with studies reporting prevalence rates between 15–50% depending upon the settings.^{12,13} The relationship between malnutrition and frailty is complex because malnutrition also can progress during hospitalisation¹⁴ and can be a symptom of frailty or may be a contributing factor in the pathogenesis of frailty.^{15,16} Malnutrition is associated with a loss of both fat and fat free mass and leads to reduced muscle strength, so a biological link between malnutrition and frailty is plausible but

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has not been confirmed.¹⁷ It is important to distinguish malnutrition from frailty because they do not always coincide in the one patient and each has different implications on outcomes and treatment strategies.¹⁸

Hospitalisation is associated with a further worsening of nutritional status due to factors such as anorexia, nosocomial fasting and polypharmacy.¹⁹ It is plausible that worsening of nutritional status in hospitalised patients is associated with further exacerbation of frailty. The ease of identification and co-associations of frailty and malnutrition have not been systematically compared and only limited studies have examined the relative importance of shared predisposing factors in the same population. In addition, it is not known whether commonly used screening tools such as the Malnutrition Universal Screening tool (MUST) can be useful in predicting frailty status of older patients or the frailty screening tools for predicting malnutrition. Thus, the aims of the current study were to determine factors associated with frailty and malnutrition risk in acutely hospitalised older patients, the ease of prediction of these geriatric syndromes and whether malnutrition risk as determined by the MUST tool can be used as a predictor of frailty and vice versa. The hypothesis for this research is that the predictive factors for frailty and malnutrition are highly similar and equally obvious in a hospitalised older inpatient.

METHODS

This prospective study enrolled all adult patients ≥ 65 years admitted to Flinders Medical Centre (FMC), South Australia between 2019-21. FMC is a 590 bed tertiary teaching hospital and caters to a population of approximately 355,000 residents in the southern suburbs of Adelaide. The exclusion criteria were: age < 65 years, lack of a valid consent, palliative care patients with a limited life expectancy and unwilling to participate in research. Ethical approval for this research was granted by the Southern Adelaide Clinical Human Research Ethics Committee (SAHREC) and this study was registered with the Australia and New Zealand Clinical Trial Registry (ANZCTR).

A member of the research team performed assessments after written informed consent. The frailty status of the patients was assessed by the use of the Edmonton Frail Scale (EFS)²⁰ within 48 hours of hospital admission. EFS is a valid and reliable instrument for identification of frailty in hospitalised patients and predicts clinical outcomes.^{21,22} The EFS contains nine components and is scored out of 17. Individual components include: cognition, general health status, self-reported health, functional independence, social support, polypharmacy, mood, continence and functional performance. The component scores are summed and the following cut-off scores are used to classify the severity of frailty: not frail (0-5), apparently vulnerable (6-7), mild frailty (8-9), moderate frailty (10-11) and severe frailty (12-17).

Data regarding the risk of malnutrition were obtained by the use of the MUST.²³ In FMC, it is a mandatory requirement that all hospitalised patients undergo the MUST screening within 48 hours of their admission. The MUST has been previously validated for malnutrition screening in hospitalised patients and includes a scoring

system based upon the body mass index (BMI), history of recent weight loss, and the effect of acute disease.^{24,25} A MUST score of 0 indicates low risk, 1 moderate risk and ≥ 2 high risk of malnutrition. The MUST has been designed to identify the need for nutritional treatment as well as establishing nutritional risk on the basis of knowledge about the association between impaired nutritional status and impaired function.²⁵ This tool has an excellent inter-rater reliability with other nutritional screening tools ($k \geq 0.783$), and has predictive validity for hospital outcomes such as LOS, mortality, discharge destination and 30-days readmissions.^{24,26}

We determined the following socio-demographic variables: baseline mobility, residential status (whether from home or residential care facility), living status (whether alone or with family), education level (level 1 - attended primary school, level 2 - attended secondary school level 3 - attended university), cognitive impairment (Mini Mental State Examination (MMSE) score < 24), smoking status (never smoked, ex-smokers and current smokers) and history of significant alcohol intake (> 2 standard drinks/day). The number of comorbidities was assessed by use of the Charlson comorbidity index (CCI)²⁷ and the principal admission diagnosis was noted. We recorded the total number of medications and polypharmacy was defined if patients were on ≥ 6 medications before hospital admission. We also recorded whether patients were on vitamin D supplementation at the time of hospital admission. We assessed the health-related quality of life (HRQoL) using the EuroQoL-5D-5Level (EQ-5D-5L) questionnaire and determined the length of hospital stay (LOS).

Statistics

The normality of data was assessed through visual inspection of the histograms and use of the Kolmogorov-Smirnov test. Continuous data are presented as mean (SD) or median (IQR) and categorical data as proportions. Patients with the EFS score ≤ 7 were classified as non-frail and those with the EFS score > 8 as frail. For assessment of malnutrition risk, patients with the MUST score of 0 were classified as 'at low risk of malnutrition', those with a score of 1 as at 'moderate risk of malnutrition' and ≥ 2 as 'high risk of malnutrition'.

The continuous variables were analysed using the t test or one way analysis of variance (ANOVA) or rank sum or the Kruskal Wallis H test, as appropriate while categorical variable were assessed by the χ^2 statistics or the Fishers exact test. In case of significant differences, post-hoc pairwise comparisons were made using the Bonferroni correction. We used multivariable logistic regression model to determine whether malnutrition risk as determined by the MUST predicts frailty after adjustment for the following co-variables: age, sex, CCI, cognitive impairment, living status, medications, alcohol intake and smoking status. Model fit was tested by the goodness-of-fit test using the 'estat gof' command in STATA. The probability of being assessed as frail according to the EFS at different MUST scores was assessed and a graph of predictive margins with 95% confidence intervals was constructed. In addition, we used multinomial logistic regression model to determine whether frailty was associ-

ated with different levels of malnutrition risk after adjustment for the above mentioned covariates. All statistical analyses were conducted by using STATA software version 17.0. A p value of <0.05 was considered as statistically significant.

RESULTS

Three hundred and twenty patients were approached for participation in this research and 243 patients were included in this study. Seventy seven patients were excluded due to various reasons: lack of a valid consent ($n=33$), terminally ill patients ($n=13$), unable to perform assessments ($n=11$) and incomplete data ($n=20$) (Figure 1). The mean (SD) age was 83.9 (6.5) years (range 65–103 years) and 126 (51.9%) were females. The majority of patients 220 (90.5%) came from home and were living alone 117 (52.2%) and were independent 103 (42.5%) in mobility. The mean (SD) CCI was 5.9 (3.4) and the majority of patients were on polypharmacy, mean (SD) number of medications 8.2 (4.2). The most common diagnosis at the time of admission was an acute respiratory illness 63 (26.2%) followed by miscellaneous causes (such as sepsis, gastrointestinal diseases etc.) in (58; 23.8%) of patients. The mean (SD) MUST score and EFS scores were 0.74 (0.94) and 8.3 (3.1), respectively. One hundred and forty nine (61.3%) patients were classified as frail according to the EFS, while, 41 (16.8%) were found to be at moderate risk of malnutrition and 66 (27.2%) at high risk of malnutrition according to the MUST (Figure 1).

Characteristics associated with frailty

Patients who were classified as frail according to the EFS were more likely to be older, with a history of cognitive impairment and less likely to be living at home and inde-

pendent in mobility when compared to non-frail patients ($p<0.05$) (Table 1). Frail patients had a significantly higher number of comorbidities as reflected by the higher CCI and were more likely to be on polypharmacy and on vitamin D supplementation than non-frail patients. However, there were no significant differences in gender, education level, smoking status or significant alcohol consumption between the frail and non-frail groups ($p>0.05$). LOS was significantly longer and HRQoL was significantly worse in frail than in non-frail patients.

Characteristics associated with malnutrition risk

Patients who were classified as at moderate or high risk of malnutrition according to the MUST were more likely to be living alone at home and were more likely to be on vitamin D supplementation than those at low risk of malnutrition. Other clinical characteristics were not significantly different between the three malnutrition risk groups ($p>0.05$) (Table 1).

Prediction of frailty according to malnutrition risk

The mean (SD) EFS scores were significantly higher among patients who were at a high risk of malnutrition according to the MUST when compared to those at low risk of malnutrition (9.5 (2.7) vs. 7.6 (3.1), ($p<0.05$)), respectively. However, no significant differences in frailty scores were found between patients who were at moderate risk of malnutrition when compared to those at low risk patients after Bonferroni correction (8.6 (3.4) vs. 7.6 (3.1), $p=0.254$), respectively. Unadjusted analysis suggested that patients who were at high risk of malnutrition according to the MUST were 2.9 fold more likely to be assessed as frail according to the EFS (OR 2.9, 95% CI

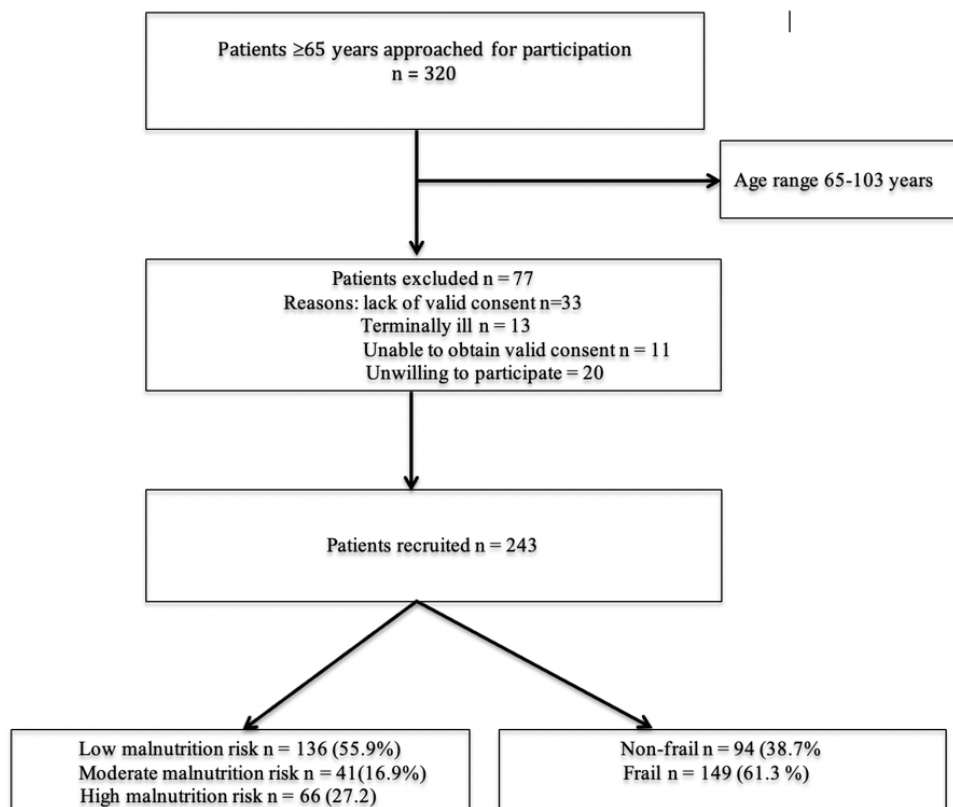


Figure 1. Study flow diagram.

Table 1. Patient characteristics associated with malnutrition risk and frailty status

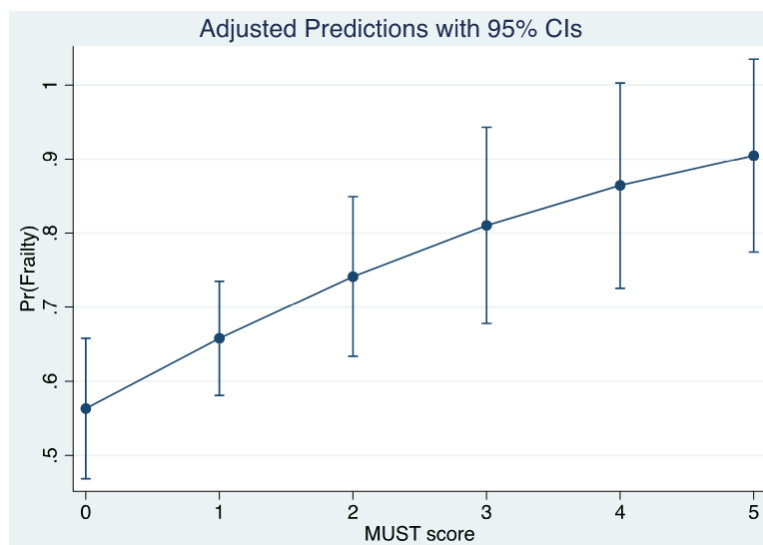
Variable	Low malnutrition risk	Medium malnutrition risk	High malnutrition risk	<i>p</i> value	Non-frail	Frail	<i>p</i> value
N (%)	136 (55.9)	41 (16.8)	66 (27.2)		94 (38.7)	149 (61.3)	
Age in years, mean SD	83.4	84.8	84.5	0.88	82.7 (6.8)	84.7 (6.2)	0.02
Age groups n (%)				0.61			
65-75	4 (2.9)	1 (2.4)	0		4 (4.3)	1 (0.7)	0.16
75-84	75 (55.2)	19 (46.3)	36 (54.5)		53 (56.4)	77 (51.7)	
85-94	53 (38.9)	20 (48.8)	26 (39.4)		35 (37.2)	64 (42.9)	
>95	4 (2.9)	1 (2.4)	4 (6.1)		2 (2.1)	7 (4.7)	
Sex female n (%)	73 (53.7)	21 (51.2)	32 (48.5)	0.78	50 (53.2)	76 (51.0)	0.42
From home n (%)	128 (94.1)	36 (87.8)	56 (84.9)	0.08	93 (98.9)	127 (82.2)	<0.001
Mobility independent n (%)	57 (41.9)	18 (45.0)	28 (42.4)	0.30	60 (64.5)	43 (28.8)	<0.001
Living alone n (%)	60 (46.8)	27 (72.9)	30 (50.8)	0.02	48 (51.6)	69 (52.7)	0.49
Education secondary school n (%)	58 (43.9)	15 (40.5)	27 (42.8)	0.70	34 (39.1)	66 (45.5)	0.19
Cognitive impairment n (%)	20 (14.7)	11 (27.5)	15 (22.7)	0.13	6 (6.4)	40 (26.9)	<0.001
CCI mean (SD)	5.7 (3.4)	5.7 (3.5)	6.5 (3.3)	0.27	4.6 (2.8)	6.8 (3.4)	<0.001
Presenting illness respiratory n (%)	37 (27.2)	5 (12.2)	21 (31.8)	0.40	23 (24.5)	40 (26.8)	0.16
Medications mean (%)	8.1 (4.3)	7.8 (3.6)	8.8 (4.2)	0.40	7.2 (4.2)	8.9 (4.0)	0.002
Vitamin D supplements n (%)	45 (33.3)	17 (42.5)	34 (52.3)	0.03	29 (31.8)	67 (44.9)	0.04
Smoking status n (%)				0.18			0.42
Never smoked	57 (47.5)	25 (69.4)	28 (47.5)		42 (51.2)	68 (51.1)	
Ex-smokers	52 (43.3)	9 (25.0)	24 (40.6)		35 (42.7)	50 (37.6)	
Current smokers	11 (9.2)	2 (5.6)	7 (11.9)		5 (6.1)	15 (11.3)	
Alcohol >2 std. drinks/day n (%)	52 (38.2)	14 (35.9)	17 (26.9)	0.29	32 (35.2)	51 (34.7)	0.52
LOS median (IQR)	5.6 (9.3)	4.6 (8.5)	5.8 (8.5)	0.56	3.9 (7.3)	11.1 (6.8)	<0.001
EQ5D index	0.86 (0.13)	0.85 (0.14)	0.82 (0.15)	0.66	0.91 (0.10)	0.81 (0.14)	<0.001
MUST score mean (SD)	0	1 (0)	2.1 (0.4)	<0.001	0.5 (0.9)	0.9 (0.9)	0.003
EFS score mean (SD)	7.6 (3.1)	8.6 (3.4)	9.5 (2.7)	<0.001	5.1 (1.6)	10.3 (1.9)	<0.001

SD: standard deviation; CCI: Charlson comorbidity index; LOS: length of hospital stay; EQ5D: European quality of life 5 dimension questionnaire; MUST: Malnutrition Universal Screening Tool; EFS: Edmonton Frail Scale.

Table 2. Multivariable logistic regression model comparing patients with moderate and high risk of malnutrition to those with low risk as baseline in prediction of frailty

Variable	OR	95% CI	<i>p</i> value
High risk of malnutrition	2.60	1.20–5.52	0.015
Moderate risk of malnutrition	1.50	0.60–3.54	0.402
Age	1.06	1.00–1.11	0.034
Sex male	0.86	0.45–1.67	0.667
Living status alone	1.09	0.57–2.09	0.776
Cognitive impairment	5.56	1.78–17.39	0.003
CCI	1.16	1.04–1.29	0.007
Polypharmacy	1.09	1.01–1.19	0.030
Smokers	1.06	0.54–2.06	0.16
Alcohol consumption	1.21	0.61–2.39	0.579

OR: odds ratio; CI: confidence interval; CCI: Charlson comorbidity index.

**Figure 2.** Margins plot showing prediction of being assessed as frail at different MUST scores.

1.5–5.7, $p=0.002$) but the odds of being diagnosed as frail were not significantly different for those who were at moderate risk of malnutrition (OR 1.3, 95% CI 0.7–2.7, $p=0.411$) when compared to low malnutrition risk patients.

After adjustment for age, sex, CCI, presence of cognitive impairment, living status, number of medications, smoking status and significant alcohol intake, patients who were at high risk of malnutrition were 2.6 fold more likely to be diagnosed with frailty when compared to those judged as low risk of malnutrition (OR 2.6, 95% CI 1.2–5.5, $p=0.015$) but the odds ratio was not significantly different for those who were at moderate risk of malnutrition when compared to low risk patients (Table 2). The probability of being classified as frail increases significantly with increasing MUST scores (Figure 2).

A multinomial logistic regression model suggested a higher risk of frailty among patients who were in the high risk malnutrition group when compared to those who were in low risk group (RR 2.7, 95% CI 1.3–5.9, $p=0.010$), after adjustment for the above mentioned covariates. However, frailty risk was not significantly higher among patients who were in the moderate malnutrition risk group when compared to those who were at low risk of malnutrition (RR 1.66, 95% CI 0.6–4.1, $p=0.259$).

DISCUSSION

The results of this study suggest a high prevalence of both frailty and malnutrition risk in older hospitalised patients. There were many predictors of frailty (Figure 3) including older age, not living at home, poor mobility, higher comorbidity burden, polypharmacy and being on vitamin D supplementation. Only a few factors, namely living alone and whether on vitamin D supplementation, predicted whether patients were at significant risk of malnutrition. Patients who were at high risk but not at moderate risk of malnutrition were more likely to be deemed frail according to the EFS and frail patients are more likely to be at high risk of malnutrition.

The results of this study are concordant with other studies in terms of the prevalence and the predictors of frailty status in older medical inpatients.^{10,28} In addition to those studies' findings, we found that patients who were on vitamin D supplementation were more likely to be deemed frail. Previous studies,^{29,30} suggest that vitamin D deficiency is associated with frailty and it is possible that owing to clinical vigilance and prior detection of this micronutrient deficiency, patients in our study were already on vitamin D replacement therapy.

Our study found that there were very few patient characteristics which predicted significant risk of malnutrition

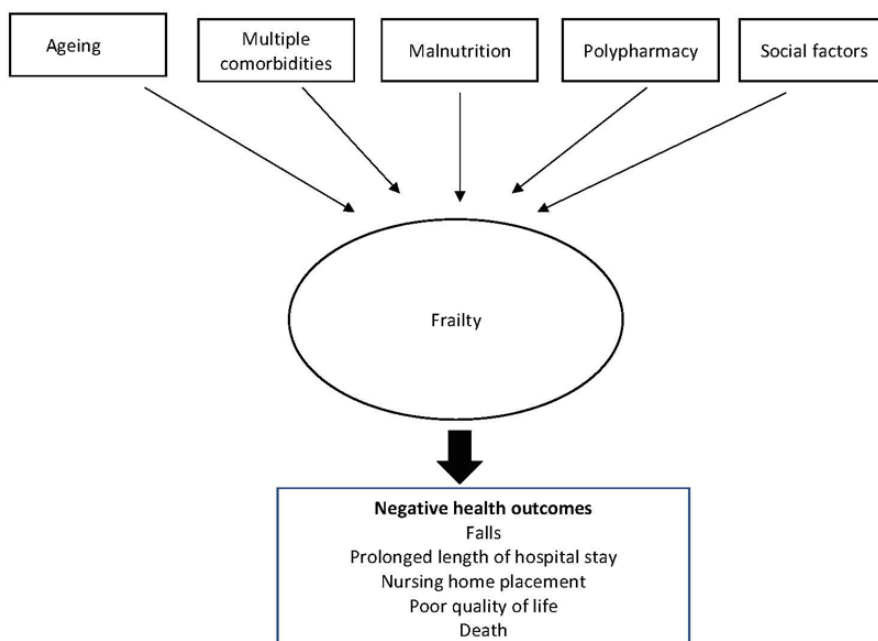


Figure 3. Predictors of frailty and its outcomes in hospitalised patients.

in older inpatients. Our results highlight the importance of the fact that malnutrition is frequently hidden and needs objective measures such as the use of anthropometric measures such as the BMI or nutritional screening tools for identification.³¹ Similar to a study by Feldblum et al³² which included 259 hospitalised patients >65 years and used a short version of the Mini-Nutritional Assessment (MNA-SF) to determine nutritional status of the participants, our study also found that the number of comorbidities and medications cannot be used to predict malnutrition risk in hospitalised patients. Thus, given the characteristics of the frail patients, according to this study, it appears that frailty can be judged at the bedside with some degree of confidence if one takes into account age, residential status, comorbidity burden and polypharmacy, however, there are very few patient characteristics which can point towards the extent of the risk of malnutrition.

This study found that only those patients who were at a high risk of malnutrition according to the MUST were more likely to be deemed frail. Those who were deemed frail were more likely to be deemed at significant risk of malnutrition. Till date, no study has examined the utility of the MUST in determination of frailty. Dent et al, in their study involving 100 hospitalised patients with a mean (SD) age of 85.2 (6.1) also found that MNA-SF can be used to predict both frailty, which was defined by use of the Fried's frailty criteria, and the malnutrition risk. The results of our study assumes importance given the fact that frailty assessment is not systematically or routinely performed in hospitalised patients,⁸ while MUST is routinely performed in hospitalised patients²³ and, considering our finding of difficulty in otherwise detecting malnutrition risk, this tool is imperative. From our work we suggest that patients who are identified at a high risk of malnutrition can be targeted for further assessment for frailty and thus can be candidates for frailty interventions.

Limitations

A major limitation of this study is that the MUST has a

sensitivity of around 70% for identification of malnutrition,²⁵ so it is possible that a significant number of patients who were at risk of malnutrition were missed. In addition, we were unable to recruit a significant number of patients with dementia which is regarded as one of the major risk factors for both frailty and malnutrition.^{33, 34}

Conclusions

Unlike our frailty screening tool, our malnutrition screening tool shared few clinical correlates and should be applied to all admissions of older inpatients. If frailty assessments are to be rationed in clinical practice, focussing them upon those of older age, not living at home, poor mobility, higher comorbidity burden, polypharmacy and being on vitamin D supplementation makes sense. Focussing them upon those at high risk of malnutrition according to the MUST are also more likely to identify those deemed frail than screening all those at low or at moderate risk of malnutrition.

AUTHOR DISCLOSURES

Authors declare that they have no competing interests.

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