Validity of the Malnutrition Universal Screening Tool for Evaluation of Frailty Status in Older Hospitalised Patients

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Abstract

The malnutrition-universal-screening-tool (MUST) is commonly used for screening malnutrition in hospitalised patients but its utility in the detection of frailty is unknown. This study determined the utility of MUST in detection of frailty in older hospitalised patients. This prospective-study enrolled 243 patients $\geqslant$65 years in a tertiary-teaching hospital in Australia. Patients with a MUST score of $\geqslant$1 were classified as at-risk of malnutrition. Frailty status was determined by the Edmonton-Frail-Scale (EFS) and patients with an EFS score of >8 were classified as frail. We validated the MUST against the EFS by plotting a receiver-operating-characteristic-curve (ROC) curve and area-under-the-curve (AUC) was determined. The mean (SD) age was 83.9 (6.5) years and 126 (51.8%) were females. The EFS determined 149 (61.3%) patients as frail, while 107 (44.1%) patients were at-risk of malnutrition according to the MUST. There was a positive linear but weak association between the MUST and the EFS scores (Pearson's correlation coefficient= .22, 95% CI .12– .36, $p < .001$). The sensitivity, specificity, positive and negative predictive value of MUST in the detection of frailty was 51%, 67%, 78.5% and 37%, respectively and the AUC was .59 (95% CI .53–.65, $p < .001$). The MUST is moderately sensitive in detection of frailty in older-hospitalised patients.

Introduction

With the advances in modern medicine in the last 50 years, there has been a dramatic increase in life expectancy in the developed nations (United Nations, 2015). This trend is expected to continue in future and in Europe, by 2070 the expected increase in proportion of those $\geqslant$65 years will increase from 20% to 30% and those over the age of 80 years from 6% to 13% (European Commission, 2021). In Australia, in 2018 people aged $\geqslant$65 years constituted 16% of the total population and this group is estimated to increase to 21–23% by 2066 (Australian Institute of Health and Welfare (AIHW), 2020). In 2017–18, 42% of hospital admissions in Australia were for patients aged 65 years or older and they constituted 48% of hospital (patient) days (AIHW, 2018).

Ageing is associated with a reduction in physiological reserves and function, which reduces individual's ability to cope with acute stressors, and, when advanced, this condition

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is typically defined as frailty (Denfeld et al., 2017). Frailty is associated with adverse health outcomes such as a reduction in the health-related quality of life (HRQoL) and increases risk of falls, residential care placement and mortality (Cheung et al., 2017; Ensrud et al., 2018). In Australia and New Zealand, studies indicate that 21% of community dwelling patients ≥65 years are frail while the prevalence of frailty was as high as 48.8% in hospitalised older patients (Richards et al., 2019; Thompson et al., 2018) and this prevalence is increasing over time (Sharma et al., 2021). Hospitalised frail patients have worse clinical outcomes measured in terms of falls, susceptibility to nosocomial infections, and surgical complications leading to a prolonged length of hospital stay (LOS), unplanned readmissions and death (Hubbard et al., 2017; Wallis et al., 2015). Early detection of frailty can lead to inpatient interventions which significantly improve health outcomes (Deer et al., 2016; Roberts et al., 2018). Malnutrition is also widely prevalent in hospitalised older population with a prevalence rate ranging from 30–50% in Australia and New Zealand, depending upon the settings, and, like frailty, malnutrition also leads to poor clinical outcomes when compared to well-nourished patients (Barker et al., 2011; Dent et al., 2019; Wham et al., 2017).

While frailty and malnutrition are different conditions, they share many predisposing factors and older people who are malnourished are also more likely to be frail (Chye et al., 2018). Malnutrition also plays a key role in the pathogenesis of frailty and vice versa, especially in hospitalised patients (Cruz-Jentoft et al., 2017; Dorner et al., 2014). While a number of screening tools are available for both frailty and malnutrition in hospitalised patients, the use of a single screening tool for these two common maladies would be of benefit to time pressured acute care clinicians (Shah et al., 2019; Van Bokhorst-de van der Schueren, 2014). The Malnutrition Universal Screening tool (MUST) is a quick screening tool commonly used in hospitalised patients but has not yet been validated for use in the detection of frailty (Sharma et al., 2017). Its role in identifying malnutrition is established but it might also identify frailty because the three components of MUST i.e., body mass index (BMI), history of weight loss and impact of acute illness on nutritional intake (Gomes-Neto et al., 2021) can also be measures of frailty. Previous studies (Rietman et al., 2018; Xu et al., 2020) have strongly correlated low BMI with frailty in older patients. Comorbidities which can lead to significant weight loss over a short period of time such as cancer, cardiac cachexia, chronic kidney disease etc. not only contribute to malnutrition but are also strongly associated with frailty (Zazzara et al., 2019). Similarly, it is expected that the impact of acute illness on food intake during hospitalisation, will not only worsen a patient's nutrition status but will also contribute to frailty (Hammami et al., 2020). Evidence (Lang et al., 2009) indicates that frailty can be dynamic condition and patients can shift from being pre-frail to frail during the course of hospitalisation due to a range of factors including malnutrition.

Therefore, it is possible that MUST can also be a useful measure of an acutely unwell hospital in-patient's frailty status, but, such a role needs verification against an established frailty screening tool. Although previous studies have used the Mini-Nutritional Assessment (MNA) (Dent et al., 2012) and the Patient Generated-Subjective Global Assessment (PG-SGA) (Han et al., 2021) to assess frailty, we specifically used the MUST because compared to the other tools, this tool is less lengthy and is thus easy to administer in acute care settings.

Aims

The aims of this study were to determine the prevalence of frailty and malnutrition in hospitalised older patients and to assess whether the MUST can be useful in the identification of frailty. The hypothesis for this research was that the MUST will be a valid screening tool for frailty in older hospitalised patients.

Materials and Methods

This study included all adult patients ≥65 years age who needed medical admission to Flinders Medical Centre (FMC), Adelaide, South Australia. FMC is a 520-bed tertiary-level teaching hospital with 23,000 medical admissions per year and caters to a population of 372,000 in the southern suburbs of Adelaide. Consecutive patients were approached if they were admitted for >48 hours and a written informed consent was obtained. Study exclusion criteria included: age <65 years, lack of a valid consent, terminally ill patients, and not wishing to participate in research. Ethical approval was granted by the Southern Adelaide Human Research Ethics Committee (SA HREC) and this study was registered with the Australia and New Zealand Clinical Trial Registry (ANZCTR).

Data regarding the MUST were obtained from the medical records. In FMC, it is a mandatory requirement that all hospitalised patients undergo 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 (Sharma et al., 2017). A MUST score of 0 indicates low risk, one moderate risk and ≥2 high risk of malnutrition (Frank et al., 2015). The MUST has been designed to identify the need for nutritional treatment as well as to establish nutritional risk on the basis of knowledge about the association between impaired nutritional status and impaired function (Leiva Badosa et al., 2017). This tool has an excellent inter-rater reliability with other nutritional screening tools (k ≥ 0.783), and has predictive validity for hospital outcomes such as LOS, mortality, discharge destination and 30-days readmissions (Guerra et al., 2016; Sharma et al., 2017).

Frailty status of the patients was assessed by use of the Edmonton Frail Scale (EFS) within 48 hours of hospital

admission (Keenan et al., 2017). The EFS is a valid and reliable instrument for identification of frailty in hospitalised patients and predicts clinical outcomes (Keenan et al., 2017; Stillman et al., 2021). 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 (Stillman et al., 2021). 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).

In addition, we collected data on the socio-demographic status of the participants such as residential status, whether living alone or with the family, education level, smoking status and alcohol intake. The number of comorbidities was assessed by use of the Charlson comorbidity index (CCI) (Shebeshi et al., 2021) and principal admission diagnosis and number of medications were recorded.

Statistical Analyses

Continuous data are presented as mean (SD) or median (IQR) and categorical data as proportions. Continuous variables were analysed using t-tests or rank sum tests as appropriate and categorical variables by χ^2 statistics. To test the agreement between the MUST and EFS, we categorised the MUST and EFS into a binary variable. Patients with an EFS score ≤7 were classified as non-frail and those with EFS score >8 as frail. Similarly, patients with a MUST score of 0 were classified as 'not at risk of malnutrition' and those with score ≥1 as at 'risk of malnutrition'. The continuous versions of the two tools were compared by the use of Pearson's correlation coefficient. In addition, we determined sensitivity, specificity, positive and negative predictive values to validate the MUST against the EFS. A receiver-operating characteristic curve (ROC) curve was used to determine whether the MUST score predicts frailty based on the EFS and the area under the curve (AUC) was calculated.

Sample size was estimated on the basis of construct validity by using Pearson correlation. We determined a weak correlation (r = .22) between the EFS and MUST scores on the basis of a previous pilot study on 15 patients, with an alpha level of .05 and power of 90% the calculated sample size was 213 patients. Allowing for a 10% withdrawal rate or missing data, a total of 235 patients were deemed to be sufficient for this study. All statistical analyses were conducted by using STATA software version 16. A *p* value of < .05 was considered to be statistically significant.

Results

Three hundred and 20 patients were approached for participation in this research and 243 patients were included in this study (Figure 1). The mean (SD) age was 83.9 (6.5) years

(range 65–103 years) and 126 (51.8%) were females. The majority of patients 220 (90.5%) came from home and were living alone 131 (52.6%) and many were using a walking frame 106 (43.8%) for mobility. The mean (SD) CCI was 5.6 (3.8) and the majority of patients were receiving polypharmacy, mean (SD) number of medications 8.2 (4.2), and many were admitted with an acute respiratory illness (69; 26.4%).

The mean (SD) EFS score was 8.2 (3.2) while the mean (SD) MUST score was .7 (.9). One hundred and forty nine (61.3%) patients were classified as frail according to the EFS, while 107 (44.1%) patients were detected to be at risk of malnutrition according to the MUST score. Frail patients were older, were less likely to be living at home, with a higher comorbidity burden as reflected by the higher CCI and were more likely to be receiving polypharmacy and vitamin D supplements than non-frail patients (Table 1). Patients at malnutrition risk were less likely to be living at home and were more likely to be on vitamin D replacement than those who were not at risk of malnutrition.

The mean (SD) MUST score was significantly higher among frail patients as compared to the non-frail patients (.9 (.9) versus 0.5 (.9), *p* = .002). The mean (SD) EFS score
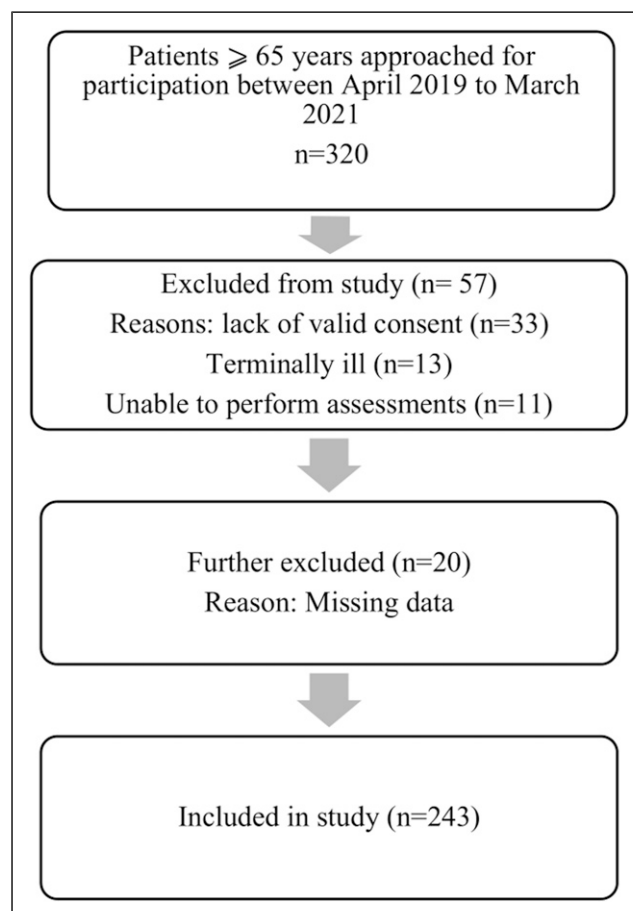

Figure 1. Study flow diagram.

Table 1. Characteristics of Non-Frail/Frail and Nourished/Malnourished Patients.

Variable	Non-frail	Frail	p Value	Not at Malnutrition Risk	At Risk of Malnutrition	p Value
N (%)	**94 (38.7)**	**149 (61.3)**		**136 (55.9)**	**107 (44.1)**	
Age, years mean (SD)	82.7 (6.8)	84.7 (6.2)	.023	83.5 (6.5)	84.6 (6.4)	.157
Age group, years n (%)						
65–74	4 (4.3)	1 (.7)	.161	4 (2.9)	1 (.9)	.562
75–84	53 (56.4)	77 (51.7)		75 (55.2)	55 (51.4)	
85–94	35 (37.2)	64 (42.9)		53 (38.9)	46 (42.9)	
≥95	2 (2.1)	7 (4.7)		4 (2.9)	5 (4.7)	
Sex female n (%)	50 (53.1)	76 (51.0)	.740	73 (53.7)	53 (49.5)	.521
Charlson index mean (SD)	4.6 (2.8)	6.8 (3.4)	<.001	5.7 (3.4)	6.2 (3.4)	.265
Principal diagnosis n (%)						
Respiratory illness	23 (24.5)	40 (26.9)	.156	37 (27.2)	26 (24.3)	.870
CVS Disease	22 (23.4)	23 (22.2)		31 (22.8)	24 (22.4)	
Falls	8 (8.5)	24 (16.1)		15 (11.0)	17 (15.9)	
CNS Disease	6 (6.4)	17 (11.4)		13 (9.6)	10 (9.4)	
Genitourinary disease	6 (6.4)	6 (4.0)		8 (5.9)	4 (3.6)	
Miscellaneous	29 (30.8)	29 (19.4)		32 (23.5)	26 (24.4)	
Medications mean (SD)	7.2 (4.2)	8.9 (4.0)	.002	8.1 (4.3)	8.4 (4.0)	.562
Living status, alone n (%)	48 (51.6)	69 (50.7)	.172	60 (51.3)	57 (48.7)	.106
Education level secondary school n (%)	34 (39.1)	66 (45.5)	.187	58 (43.9)	42 (42.0)	.908
Residential status home n (%)	93 (98.9)	127 (85.2)	<.001	128 (94.1)	92 (85.9)	.031
Vitamin D supplements n (%)	29 (31.8)	67 (44.9)	.044	45 (33.3)	51 (48.6)	.017
Alcohol >2 std. drinks/day n (%)	32 (35.1)	51 (34.7)	.941	52 (38.2)	31 (30.4)	.209
Smokers n (%)	43 (48.3)	73 (50.0)	.801	69 (51.1)	47 (47.0)	.533
MUST score mean (SD)	.5 (.9)	0.9 (0.9)	.002	0	1.7 (.6)	<.001
EFS score mean (SD)	5.1 (1.6)	10.3 (1.9)	<.001	7.6 (3.1)	9.1 (3.0)	.0002
EQ-5D index mean (SD)	0.91 (0.09)	0.81 (0.14)	<.001	0.86 (0.13)	.83 (.14)	.224
VAS mean (SD)	61.4 (19.9)	49.3 (17.7)	<.01	55.2 (19.2)	52.3 (19.8)	.249
LOS median (IQR)	3.9 (7.3)	6.8 (8.9)	.005	5.6 (9.3)	5.6 (8.5)	.382
In hospital mortality n (%)	0	6 (4.1)	.04	3 (2.2)	3 (2.8)	.771
30-day readmissions n (%)	5 (5.4)	25 (16.9)	.008	17 (12.6)	13 (12.3)	.939

Note. SD = standard deviation; CVS = cardiovascular system; CNS = central nervous system; MUST = malnutrition universal screening tool; EFS = Edmonton frail scale; EQ-5D = European quality of life five dimension questionnaire; VAS = visual analogue scale; LOS = length of hospital stay; IQR = interquartile range.

was significantly higher among patients at risk of malnutrition compared to those who were at low risk of malnutrition (9.1 (3.0) versus 7.6 (3.1), $p < .0002$) (Table 1). There was a positive linear but weak association between the MUST and EFS scores (Pearson's correlation coefficient = .22, 95% CI .12–.36, $p < .001$). The sensitivity of the MUST score in the detection of frailty was 51% while specificity was 67%. The positive and negative predictive values for the diagnosis of frailty were 78.5% and 37%, respectively (Table 2).

Figure 2 shows the ROC curve for the detection of frailty. The AUC of the ROC demonstrated that the MUST had modest accuracy in the identification of frailty (AUC .59, 95% CI .53 to .65, $p < .001$). Table 3 shows measures of the ability of the MUST to detect frailty at different cut-off scores. For the MUST, at the standard malnutrition cut-off score of ≥1, its sensitivity for detection of frailty was 51% with a specificity of 67%. At a MUST cut off score of ≥2 the specificity increased to 84% but sensitivity decreased to 34.2%.

Discussion

The findings of this study suggest that there is a high prevalence of frailty (61.3%) according to the EFS when it is applied to hospitalised older patients. Similarly, a substantial proportion (44.1%) of older hospitalised patients were found to be at risk of malnutrition according to the MUST. There was a positive but weak association between MUST and EFS scores. The sensitivity of MUST for detection of frailty was 51% and specificity of 67% with AUC of .59. The MUST had a positive predictive value of 78.5% and negative predictive value of 37% for detection of frailty.

The prevalence of both frailty and malnutrition in our study was high and these results correspond to other recent studies indicating a high burden of these maladies in older hospitalised patients (Dent et al., 2019; Richards et al., 2019; Thompson et al., 2018).

Due to the low sensitivity, the MUST in its present form, cannot be recommended for screening patients for frailty.

Table 2. Comparison of MUST against EFS for detection of frailty.

EFS	MUST		Total
	Positive (at risk)	Negative (not at risk)	
Frail	76	73	149
Not-frail	31	63	94
Total	**107**	**136**	**243**
Prevalence		**95% CI**	
Sensitivity	51%	42.7%–59.5%	
Specificity	67%	56.6%–76.4%	
ROC area	0.59	.53–.65	
Positive likelihood ratio	1.55	1.11–2.15	
Negative likelihood ratio	0.73	.58–.91	
Positive predictive value	78.5%	72.2%–83.4%	
Negative predictive value	37%	32.1%–42.1%	

Note. EFS = Edmonton frail scale; MUST = malnutrition universal screening tool; CI = confidence interval; ROC = receiver operating curve.
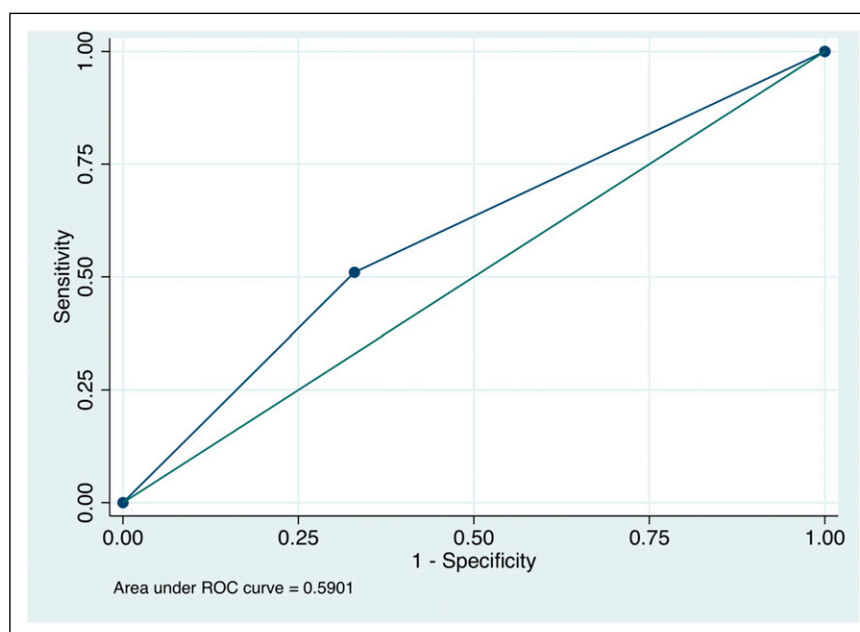
Figure 2. Receiver operator curve for identification of frailty by the malnutrition universal screening tool.

Table 3. MUST score cut-off values for detection of frailty by the EFS.

MUST Score Cut-Off Value	Sensitivity (%)	Specificity (%)	Correctly Classified as Frail (%)	Positive Likelihood Ratio	Negative Likelihood Ratio
≥0	100	.00	61.32	1.00	
≥1	51.01	67.02	57.20	1.5467	.7310
≥2	34.23	84.04	53.50	2.1450	.7826
≥3	3.36	97.87	39.92	1.5772	.9875
≥4	.00	98.94	38.27	0.0000	1.0108
>4	.00	100.00	38.68		1.0000

According to this study, at a higher MUST cut-off score of ⩾2, which is indicative of a higher risk of malnutrition, its specificity to detect frailty increased to 84% but sensitivity further declined. This suggests that at the higher level of MUST score, there will be few false positive results for frailty, and thus the associated burdens can be reduced: including costs of additional screening and unwanted patient stress. However, for a good screening tool, sensitivity should also be high (so that there are fewer false negatives) and this limits the use of the MUST as a screening tool for frailty. To our knowledge, there has been no previous study comparing the MUST with the existing frailty tools. Dent et al. (Dent et al., 2012) in their study involving older patients, mean (SD) age of 85.2 (6.1) years, who were admitted to a geriatric unit, validated the MNA tool against the modified Fried's frailty criteria and also found a lower sensitivity (56%) but a higher specificity (91.2%) of MNA to detect frailty.

The low sensitivity and specificity of MUST for the detection of frailty in older hospitalised patients may be due to several reasons. Frailty is a multidimensional condition and, in addition to nutritional parameters, such as weight, frailty is also determined by other factors such as mobility, social status, cognition and polypharmacy (Carneiro et al., 2017; Freer & Wallington, 2019; Hammami et al., 2020). The MUST does not include measures of function, activities of daily living, cognition or social support, which are other determinants of frailty. The hallmark of frailty is a history of fatigue and exhaustion which is indicative of muscle dysfunction (Choe et al., 2020). The MUST, specifically, does not include components which can measure muscle dysfunction. This is in contrast to some other nutritional tools such as the PG-SGA (Jager-Wittenaar & Ottery, 2017) which includes measures of functional capacity and has been found to have a comparatively higher sensitivity (71.1%) and specificity (74.6%) for the detection of frailty in older hospitalised patients (Han et al., 2021).

Too many frail (52.4%) in-patients went undetected by the MUST. Thus, the MUST in its current form is not a particularly useful tool for identification of a multidimensional syndrome such as frailty. It is possible that the value of MUST can further be enhanced by breaking it down into its component parts or by the addition of measures which contribute to frailty such as patient's living status, presence of cognitive impairment and polypharmacy (Hammami et al., 2020). Future studies can then determine whether this new measure, heavily based on nutritional state, can be used to detect frailty.

Limitations

This study included only a limited number of patients with cognitive impairment, a major risk factors for both frailty and malnutrition (Ng et al., 2015; Wanaratna et al., 2019). It is also possible that we could have overestimated the rates of both frailty and malnutrition because this study included only hospitalised patients and the effect of acute illness could have led to higher scores for the components such as reduced mobility and exhaustion. The results of this study may not be applicable to the community-dwelling older population, especially with regards to the positive predictive value of the MUST, which is dependent upon the underlying prevalence of disease in the population. It is expected that the positive predictive value of the MUST for frailty would be lower in community-dwelling older people because of the lower prevalence rates of both frailty and malnutrition in that environment as compared to hospitalised patients.

Conclusion

Our study confirms a high prevalence of frailty and malnutrition in older hospitalised patients. Despite malnutrition and frailty sharing many predisposing factors, the MUST in its current form was found to have a low sensitivity in the detection of frailty in this vulnerable population and cannot be recommended to replace pre-existing more frailty-specific screening tools.

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