Malnutrition Screening and Assessment in Hospitalised Older People: a Review

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Malnutrition (undernutrition) remains one of the most serious health problems for older people worldwide. Many factors contribute to malnutrition in older people, including: loss of appetite, polypharmacy, dementia, frailty, poor dentition, swallowing difficulties, social isolation, and poverty. Malnutrition is common in the hospital setting, yet often remains undetected by medical staff. The objective of this review is to compare the validity and reliability of Nutritional Screening Tools (NSTs) for older adults in the hospital setting. We also provide an overview of the various nutritional screening and assessment tools used to identify malnutrition in hospitalised older adults. These include: Subjective Global Assessment (SGA), the Mini Nutritional Assessment (MNA), MNA-short form (MNA-SF), Malnutrition Universal Screening Tool (MUST), Simplified Nutritional Appetite Questionnaire (SNAQ), Geriatric Nutrition Risk Index (GNRI) and anthropometric measurements. The prevalence and outcomes of malnutrition in hospitalised older adults are also addressed.

Introduction

Malnutrition (undernutrition), sometimes called "hidden hunger", is caused by many factors including starvation, disease, and the ageing process (1-3). Older adults are particularly susceptible to malnutrition, which in turn, places them at increased risk of adverse clinical outcomes including mortality, functional decline, increased risk of infection, and admission to aged care facilities (4-14). In the hospital setting, malnutrition is very common amongst older adults, with around half of older adults affected (15).

Unfortunately, hospitals are renowned for contributing to further declines in nutritional status. Acute illness and injury can exacerbate weight loss during hospitalisation (5, 16). In addition, there is often an inadequate meal service, with inflexible meal times, limited food choice, insufficient time to eat meals, and a lack of culturally specific food (17-20). Meals may also lack sufficient energy requirements for patients, or patients may need to fast prior to medical tests (21, 22). Compounding this situation is that malnutrition regularly remains unrecognised in the hospital setting (5, 23).

Understandably, early identification of patients with malnutrition in the hospital setting remains crucial for optimal nutritional care (24). Nutritional Screening Tools (NSTs) offer a good opportunity to rapidly identify malnutrition (25, 26). There are a reported 32 nutritional screening tools (NSTs) for use in the hospital setting (25), with 23 of these specific to older adults (27). Despite this large number of screening tools, the literature shows limited comparison of the validity and reliability of these tools for older adults in the hospital setting. A recent review by Power et al. (2018) (27) looked at the validity of NSTs across various setting, however, they only examined criterion validity (validation against a "gold/reference standard"), and did not investigate construct validity. Similarly, a systematic review by van Bokhorst-de van der Schueren and colleagues (25) reported NSTs in the hospital setting, although their results were generic and did not focus specifically on older adults. Another recent systematic review by Marshal et al. (28) only looked at the validity of nutritional assessment instruments in hospitalised older people, and not NSTs (28).

The objective of this review is therefore to provide a comprehensive insight into the validity and reliability of NSTs for older adults in the hospital setting. We also provide an overview of the various nutritional screening and assessment tools used to identify malnutrition in hospitalised older adults. A brief introduction on prevalence and outcomes of malnutrition in the hospital setting is additionally provided to highlight the context and importance of the topic. The terms malnutrition and undernutrition are used interchangeably in the literature, and for this review, malnutrition will allude to undernutrition rather than over-nutrition (29).

Methodology

Literature Search Strategy

A quasi-systematic review was performed. Publications were identified using the PubMed database using broad search terms previously used in systematic reviews (28, 30). Searches were limited to "human" and "English", and age limits were not set in order to identify studies which incorporated older adults as part of subset analyses. Date restrictions were not set. Broad search terms were: Nutrition*, Malnutrition, Protein Energy Malnutrition, Undernutrition, Diagnos*, Evaluat*, Nutrition Status, Subjective Global Assessment, Mini Nutritional Assessment, Nutritional Screening, and Hospital. A lateral search was also conducted whereby the reference lists of relevant articles were searched for additional publications.

What is malnutrition?

There is currently no gold standard definition of malnutrition, although the common international consensus is that malnutrition is an inadequate nutritional status associated with adverse clinical outcomes (29). Recently, the European Society for Clinical Nutrition and Metabolism (ESPEN) (1) have supported the definition of malnutrition as "a state resulting from lack of intake or uptake of nutrition that leads to altered body composition (decreased fat free mass) and body cell mass leading to diminished physical and mental function and impaired clinical outcome from disease" (3). In Australia and New Zealand, the International Classification of Diseases code (version 10, Australian modification) (ICD-10-AM) is used to define malnutrition, as: "< 18.5 kg/m2 or unintentional weight loss of ≥ 5% with evidence of suboptimal intake resulting in subcutaneous fat loss and/or muscle wasting" (31).

What causes malnutrition?

Older adults are at an increased risk of developing malnutrition due to multiple causal factors, including: co-morbidities and their complications such as polypharmacy, inflammation and pain (32, 33); lifestyle factors (2, 34, 35); psychological causes (36, 37); and age-related pathophysiology such as impairments in swallowing, taste, smell, sight, appetite and gastric emptying (2, 36, 38). Age-related loss of weight and appetite is termed the ‘anorexia of ageing’ (39-41) and is well known to contribute to malnutrition in older adults. Around a quarter of malnutrition cases in older people have no known cause, and more often than not, an older adult will have several co-existing risk factors (14).

It is interesting that hospitalised older adults with malnutrition have been found to exhibit an increased likelihood of physiological system failure than non-malnourished patients (42). Decline in multiple physiological systems is a common premise of the geriatric condition of frailty (43, 44). Frailty is understandably linked to malnutrition, with the two conditions having similar aetiology (40, 41, 45-47), and often co-existing in both hospitalised (48) and community dwelling (49, 50) older adults. Similarly, malnutrition is closely related to sarcopenia (51), which is the “age-associated loss of skeletal muscle mass and function” (52, 53). Sarcopenia is common in hospitalised older adults with malnutrition (15).

Malnutrition Prevalence in the Hospital Setting

Older people have a much higher prevalence of malnutrition than younger people upon hospital admission, ranging from 1.2 – 2.3 times higher in patients aged over 65 years than those younger than 65 years based on several studies using the Subjective Global Assessment (SGA) for malnutrition classification (54-56). There is also much difference in malnutrition prevalence between hospitals predominantly due to different instruments used to diagnose malnutrition. For example, Baccoro and Sanchez (57) found large differences in malnutrition prevalence in their study of hospitalised women, with malnutrition diagnosed by the Subjective Global Assessment (SGA) (rating B + C) and by low Body Mass Index (BMI) being 49 % and 10 % respectively. Likewise, Bauer and colleagues (58) found variation in prevalence rate between instruments, with malnutrition diagnosed by the Mini Nutritional Assessment (MNA) (scores <17) and SGA (rating B + C) being 33 % and 45 % respectively. We emphasise the importance of identifying malnutrition prevalence using full nutritional assessment, rather than NSTs which tends to over-identify malnutrition - based on low-moderate specificity values (30).

Other factors contributing to the observed inter-study differences in malnutrition prevalence include inter-tester reliability, the hospital location, the age distribution of patients (datasets with more older patients tend to report high malnutrition prevalence), and the characteristics of the patients included in studies (29). For instance, hospital-based studies with a high percent of females may have a higher prevalence of malnutrition, given that female patients have been reported to have a higher risk of becoming malnourished (57). In addition, whether the study included surgical and/or medical patients, or those with dementia can have a large impact on prevalence rates of malnutrition (29). Of note, older adults with dementia are regularly excluded from studies of hospital-based malnutrition prevalence, even though they have a high likelihood of malnutrition compared with the general population (59, 60).

Consequences of Malnutrition in Hospitalised Older People

Malnutrition can have dire consequences for hospitalised older adults. A malnourished patient is at an increased risk of many adverse clinical outcomes, such as: mortality (6, 14, 29, 30, 61-66), infection (67), prolonged length of stay (LOS) (6, 29, 63, 68, 69), functional decline (30, 61, 70), discharge to higher level care (6, 8, 30, 68), falls (71), and rehospitalisation (29, 72). Hospital malnutrition is also costly to the health care system (73, 74).

Malnutrition and Mortality

Based on prospective studies, malnutrition in hospitalised older people generally increases mortality risk (29, 61-66). However, not all studies agree. For example, in a study of 444 Swedish patients with a heavy disease burden by Vischer et al. (75), MNA-SF categories were not associated with mortality at discharge, nor at 1 or 4 years follow-up. This lack of a relationship could potentially be due to the high number of co-morbidities overbearing the impact of malnutrition or from the benefits of nutritional care post-hospitalisation (75).

In studies that do show malnutrition contributes to mortality, much variation exists in the actual contribution of malnutrition to mortality risk. This variation can mostly be explained by the differences in nutritional assessment methods used, the differences in follow-up time and the lack of covariates controlled for in several studies and the potential protective effect of nutritional care post-hospitalisation. Overall, in the limited number of studies in which confounders have been controlled for, malnutrition has been found to consistently associate with mortality (14, 29, 61, 65, 75-81).

Malnutrition and Functional Decline

Only a handful of studies have prospectively looked at the influence of malnutrition and functional decline in hospitalised older people in acute care (61, 70, 79) and sub-acute care (72, 82-84). These studies all suggest that malnutrition is associated with a decline in activities of daily living (ADL) both in hospital and post-hospital in older people (61, 70). The extent of functional decline in malnourished patients varied between studies, which could be due to the measure of functional decline used, the country of the population assessed and the degree of intervention patients encountered. One study also looked decline in instrumental activities of daily living (IADL) and found malnutrition was not related (61).

On the other hand, nutritional status improvements have been linked with functional gain in hospitalised older adults. For example, a recent Australian study found that one quarter of malnourished long-stay patients in Geriatric Evaluation and Management Units (GEMUs) improved their nutritional status over hospitalisation, which in turn was associated with gains in mobility scores (85).

Nutritional Screening

Malnutrition in older people is hard to identify (37, 86) and easily missed by clinical staff if nutritional screening is not performed (87, 88). Failing to identify malnutrition will lead to failing to treat (87); an undesirable outcome. Ultimately, to identify malnutrition or risk of malnutrition, a full nutritional assessment should be performed (29). However, such a comprehensive assessment is not feasible to perform on all patients in the hospital setting due both time and financial constraints (29). A more practical option is to use nutritional screening. Nutritional screening offers a relatively rapid and inexpensive method to identify patients who are at risk of malnutrition. In the hospital setting, nutritional screening is recommended to be accompanied by both a full nutritional assessment and an appropriate intervention for any patients identified with a risk of malnourishment (89-91). Nutritional screening is therefore a crucial precursor to the Nutrition Care Process (NCP) (92).

Despite the reported importance of nutritional screening for all hospitalised older patients (87, 93), several studies have reported that nutritional screening remains irregularly performed in the hospital setting due to several common, persisting factors (see Box 1). These include: time and staff shortages; confusion regarding which screening tool to use; limited information for staff to implement the screening tool; screening not seen as an admission priority or embedded in admission systems; and the common misconception by health practitioners that their judgement of a patient being underweight is superior to nutritional screening. In addition, nutritional screening is often not performed with a validated screening tool (36), particularly not one validated in the hospital setting (34).

Also notable as a major barrier to nutritional screening is the lack of effectiveness of current nutritional intervention strategies (7, 93). For example, a systematic review of oral nutritional support in older patients discharged from hospital found that whilst all studies found patients gained weight and/or increased their energy intake, mortality rates were not affected by nutritional supplementation in any studies (94). Notwithstanding this, a randomised controlled trial in Australia found that if nutritional screening was paired with an early intervention malnutrition care plan in malnourished patients (MNA score < 17), then patient length of stay was reduced from an average of 19.5 to 10.6 days (88).

Nutritional Screening Tools (NSTs)

There are several characteristics of a good NST. These include: rapid and easy application (95, 96); cost effectiveness (97); acceptance by patients (29); acceptance into the clinical setting (uses routinely collected information, and requires no complex computations) (29); can identify those who will need a nutritional assessment (1, 23, 25); population-specific (29); has criterion validity, [which is how well the tool compares to either an objective assessment by a dietitian/geriatrician, full nutritional assessment, or MNA/SGA] (98); content (face) validity [includes relevant components] (29, 99), and construct validity (how well the NST compares to other NSTs and laboratory values (29, 98). A bonus feature is that the NST can predict nutritional-related outcomes (30, 98).

Currently no reference standard for nutritional screening in older people has been agreed upon for clinical application and accordingly, various NSTs have been developed. NSTs tend to include BMI and a short string of questions regarding recent weight loss, food intake and risk of accelerated nutritional decline due to chronic disease (89). Several recent reviews of NSTs in older people have been conducted, including an evaluation of their validity and reliability (27, 29, 89, 98, 100, 101). Of note, because there is not one set reference standard for malnutrition assessment/diagnosis, NSTs are often validated against many standards of malnutrition assessment (27, 102). This section describes some of the most commonly used nutritional screening tools applicable to the hospital setting, and compares their validity and reliability head-to-head for hospitalised older patients.

The Mini Nutritional Assessment Short Form (MNA-SF)

The Mini Nutritional Assessment (MNA) short form (MNA-SF) (103, 104) comprises six questions from the full MNA, and is the first part of a two-part process: the MNA-SF for screening for malnutrition or risk of malnutrition, followed by referral for MNA assessment (105). The MNA-SF is generally considered to be user friendly in that it takes less than 5 minutes to apply, at least in community dwelling older people (29). The MNA-SF has a high sensitivity and specificity when compared against the full MNA (103, 106), although this is a form of incorporation bias as the MNA-SF contains questions from the MNA (98). When the MNA-SF was compared against nutritional assessment or professional assessment of nutritional status in hospitalised older people, it showed poor specificity (107, 108).

Table 1 (Column 2) provides an outline of studies validating the MNA-SF against various reference standards. Like the MNA, very few studies have looked at construct validity of the MNA-SF; that is, how well it compares against components of a full nutritional assessment. The MNA-SF also provides the option of assessing calf circumference (CC) in lieu of the difficult to measure BMI (103). CC-incorporated MNA-SF was found to have similar accuracy of identifying malnutrition as the BMI incorporated MNA-SF in a recent Australian study of GEMU patients (109). However, a Spanish study of hospitalised older adults with diabetes disagreed, reporting that BMI-incorporated MNA-SF showed higher accuracy (110). Both these two studies used MNA as a reference standard.

The Malnutrition Universal Screening Tool (MUST)

The Malnutrition Universal Screening Tool (MUST) was developed by the British Association for Parenteral and Enteral nutrition (BAPEN) (111). It classifies patients as either at low, medium or high malnutrition risk based on an older person’s BMI, history of unintentional weight loss and the probability of future weight loss based on acute disease (111, 112). MUST is a popular screening tool in UK national surveys of malnutrition (113) and has been found to have a similar reliability to the MNA in screening for nutritional risk in geriatric populations (99). When compared to the MNA, MUST has been reported to take less time, and to require less subjectivity by interviewers (99). However, MUST does have its disadvantages. It was recently found to have a low completion rate (47 % missing data) in a study of hospitalised older people, with the authors of this study rendering it less clinically applicable than other nutritional screening tools (108). MUST also includes BMI which is complicated to measure in older people (see Section 0) as well as having a BMI cut-off point that has been suggested to be too low for older people (114). Table 1 (Column 3) shows validity and reliability studies incorporating MUST. From this table it can be seen that MUST has been found to have a low agreement with both weight loss and BMI (99, 108) and has been found to have low sensitivity (61 %) and specificity (76 %) in a large study of hospitalised older people of all ages (115).

Simplified Nutritional Appetite Questionnaire (SNAQ)

The Simplified Nutritional Appetite Questionnaire (SNAQ) (116) consists of 4 questions: one each on appetite, taste, satiety and meal frequency (116). Responses to each question are reported on a Likert scale ranging from ‘very poor’ to ‘very good’. A score of 14 or less out of a possible 20 predicts future weight loss in older people (116, 117). SNAQ is advantageous as it is quick and easy to implement and requires no specialist equipment or training of assessors. SNAQ has been validated against weight loss in older people (116). It has also been validated against the MNA in hospitalised older people, where it showed modest sensitivity and specificity values of 71 % and 74 % respectively (118). Considerable more work is needed to validate the SNAQ, particularly against components of nutritional assessment (see Table 1, Column 4). Recently, SNAQ has been found to predict weight loss in patients with liver cirrhosis (119), as well as adverse clinical outcomes in hospitalised older females (120) (see Table 1, Column 4).

Geriatric Nutritional Risk Index (GNRI)

The Geriatric Nutritional Risk Index (GNRI) was developed as a nutritional-risk index for older people, based on the ‘Nutritional Risk Index’ for younger people (121). Since its development, it has also be validated against the MNA, although its agreement is low (kappa = 0.29) (122). The equation for predicting GNRI is as follows:

GNRI = (1.489 x albumin (g/L)) + (41.7 x (weight/WLo))

With WLo = Ideal Weight, using Lorentz equations as described by Boulianne et al. (121):

Men: WLo = H -100 – ((H - 150)/4)

Women: WLo = H - 100 – ((H - 150)/2.5)

With H = height in cm; g = grams; L = Litre

GNRI categories are: major risk (scores < 82), moderate risk (scores < 92), low risk (scores 92 to ≤ 98) and no risk (> 9) (121). The GNRI can be considered as a nutritional screening tool, although more validation studies are needed, as evident from reviewing Table 1 (Column 5).

Other Nutritional Screening Tools

Multiple other nutritional screening tools exist for older people, including the Malnutrition Universal Screening Tool (111), Malnutrition Screening Tool (123), the Determine Your Health Nutritional Screening Initiative (NSI) checklist (124), the Nutritional Status Score (NSS) (125) and the Rapid Screen (RS) (126).

Nutritional Assessment

Without a gold standard definition or assessment method for malnutrition, a reference standard is often used to diagnose malnutrition. This reference standard is usually a Full Nutritional Assessment (FNA) or an assessment by a trained professional such as a dietician, researcher, nurse or doctor (98, 127). A nutritional assessment includes four main components, summarised as 'ABCD': Anthropometric Measures, Biochemical and laboratory measures, Clinical Methods and Dietary Evaluation Methods (128). Functional capacities (grip strength and walking speed) are also important components of a nutritional assessment (29, 129).

Importantly, The American Society for Parenteral and Enteral Nutrition (ASPEN) and the Academy of Nutrition and Dietetics have jointly proposed that malnutrition should be diagnosed when two or more out of six criteria co-exist: weight loss, low energy intake, loss of subcutaneous fat, fluid accumulation, muscle mass loss, and weakened grip strength (130). Recently, the Global Leadership Initiative on Malnutrition (GLIM) (ESPEN and ASPEN endorsed) has recommended that malnutrition be diagnosed when there exists: at least one of three phenotypic criterion (unintentional weight loss, low BMI and/or decreased muscle mass) and at least one of two aetiological criterion (decreased food intake or assimilation, and inflammation or disease burden) (91, 96). Other validated reference standards for nutritional assessment in older people include the Subjective Global Assessment (SGA) and the MNA (42,79).

Subjective Global Assessment (SGA)

The Subjective Global Assessment (SGA) (131, 132) is a multidimensional nutritional assessment instrument evaluating: weight loss history, change in dietary intake, persistent gastro-intestinal symptoms (> 2 weeks), functional capacity (optimal, sub-optimal, ambulatory or bedridden), disease diagnosis and its influence on nutritional requirements (none, low, moderate or high stress), physical features of the patient (low subcutaneous fat levels, muscle wasting, ankle and/or sacral oedema and ascites) (132). The SGA has no numerical scoring system, rather it is used by professionals to subjectively classify patients as being well nourished (SGA A), with mild-moderate malnutrition (SGA B) or with severe malnutrition (SGA C) (129, 132). SGA was initially developed for use in people of all ages (132), but has since been validated for use in older hospitalised patients (133-135).

The SGA has been endorsed by several organisations, including The American Society for Parenteral and Enteral Nutrition (ASPEN) (136), by The European Society for Clinical Nutrition and Metabolism (ESPEN) (137) and the Dieticians Association of Australia (DAA) (138). However, the SGA is not objective like the MNA, thereby rendering it impractical for intervention and follow-up studies. Another limitation of the SGA is that both its construct (25) and concurrent validity (demonstration of a correlation between SGA and a ‘reference standard’ of malnutrition diagnosis) (28) are low.

The Mini Nutritional Assessment

The Mini Nutritional Assessment (MNA) is an eighteen question nutritional assessment instrument specifically developed for use in older people (139-141). It is comprised of four components: anthropometry (BMI, calf circumference (CC) and mid-arm circumference (MAC) measure ment); self-reported health; dietary questions (including weight loss) and clinical health (105, 139, 141). The MNA is scored out of 30, with scores < 17/30 classified as ‘malnourished’, scores 17-23.5 as ‘at risk of malnourishment’, and scores > 23.5 as ‘well nourished’ (105, 139, 141). In the literature, the MNA is frequently used as both a NST and an assessment instrument.

The MNA has undergone extensive validity and reliability testing, particularly in community based studies, and is popular for use in older people globally (28, 139, 142-144). Table 1 (Column 1) lists validity studies of the MNA, including studies specifically looking at hospitalised older people. From this table it can be seen that there are only a limited number of studies looking at the validity of the MNA in hospitalised older people, with sensitivity and specificity values appearing low overall. Recently, the MNA has also been improved for specificity by using population specific cut-offs for its anthropometric measures of BMI, calf circumference (CC) and mid arm circumference (MAC) (145, 146) but these studies have yet to be applied to acute care geriatric wards. Also evident from this Table are the mixed results of studies of hospitalised older people looking at the construct validity of MNA, that is, how well it compares against components of a full nutritional assessment.

MNA has many advantages, including identification of malnutrition before severe weight loss occurs (139) and its ability to monitor changes in nutritional status (139). However, the MNA has disadvantages. It includes subjective questions, which are more suited to community dwelling rather than hospitalised older people (89) and which can result in a lack of inter-tester reliability (147, 148) It can over-diagnose risk of malnutrition in frail, older people (149), perhaps because the MNA itself can also identify frailty (2, 49). Other disadvantages of the MNA include its lack of ability to predict future malnutrition (149) and its inability to be used in patients with cognitive impairment (29) or in those with enteral feeding (150).

Weight

Weight assessment is often overlooked in geriatric wards. A study of a geriatric ward in Germany found weight was only documented in 54 % of geriatric patients (151). Even nutritional studies of older hospitalised patients have reported not measuring patient weight due to difficulties in assessing. For instance, Stratton and colleagues (63) were only able to weigh 56 % of patients in their study validating the MUST. Additionally, Tsai and colleagues (152) did not measure body weight in any of their long term care subjects, citing a lack of equipment available as the reason they did not measure weight. Multiple other reasons exist why weight measurement is difficult to perform in older people, including issues such as hearing or vision loss, dementia, incontinence, language barriers, delirium and frailty (29). It could also be that a patient is simply too ill to be weighed (153).

Weight Loss

Many NSTs (including MNA and MUST) incorporate weight loss information. Weight loss in older people is associated with many detrimental outcomes, including prolonged hospital admissions (99), increased infection risk (67), functional decline (154) and reduced life expectancy (139, 155, 156). A five year follow-up study of the Cardiovascular Health Study (CHS) also reported that weight loss was the best predictor of mortality in older people (157).

Body Mass Index (BMI)

Body Mass Index (weight(kg)/height(m)^2) is an established part of clinical nutrition screening and is often used as a screening tool for malnourishment on hospital admission (29). It is included as part of many NSTs of older people, including the MNA and MUST. BMI is quantitative and has the further advantages of being correlated with both fat mass (158) and MNA (159) in older people. Nevertheless, the use of BMI as a NST in older people is contentious for several reasons: it may not be a sensitive, reliable or valid measure of nutritional status in older people due to inaccuracies in assessing both height and weight (158); it does not correlate with weight loss in geriatric inpatients (99); it is overestimated in those who are well nourished and underestimated in those with risk of malnutrition (159); it is not an indicator of protein-energy malnutrition (29); and its correlation with fat mass is significantly lower in older people compared with younger people (160).

The optimal BMI for older people is also disputed and until this is defined, a broad range of BMI cut-offs for malnutrition detection in older people will exist. Even screening tools do not have standard BMI cut-offs, with the MUST and the MNA having BMI cut-offs of 18.5 kg/m^2 and 20 kg/m^2 respectively. Moreover, the ideal BMI for older people may be significantly higher than the commonly accepted 20-25 kg/m^2 for younger adults (158). This higher optimal BMI may mean BMI cut-offs for malnourishment detection in both the MNA and MUST are currently too low. These low BMI cut-offs may impede diagnoses of malnutrition based on weight loss. For instance, a Dutch study found that several older adults with a BMI above 25 kg/m^2 who had unintentional weight loss were not identified as being malnourished (161). The ESPEN have designated a BMI less than 22 kg/m^2 to define malnutrition in individuals aged 70 years or over (90)

Limb Circumference Measures

Circumference measurements reflect body levels of both lean and fat mass (162). Therefore these measures can be used to assess nutritional status in older people without needing to rely on height or weight measures. Commonly used circumference measures in the hospital setting include mid-arm circumference (MAC) and calf circumference (CC). Both of these measures are included in the MNA, and CC is nowadays included in the MNA-SF as an option in lieu of BMI (103). CC and MAC measures are popular with hospital staff as they are simple and easy to measure (29).

CC is measured as the widest girth of the calf; MAC as the mid-point circumference of the upper arm, mid-way between the acromion process and the elbow's lateral epicondyle (163). CC has been found to be more accurate at identifying malnutrition than MAC, except in people with end-stage functional decline (164). Despite their advantages, CC and MAC do have limitations. For example, MAC, although correlated with BMI (154) has been found to be a poor marker of malnutrition (165) and CC is highly influenced by common presence of ankle oedema.

Conclusion

Malnutrition is common in hospitalised older adults, yet often remains undetected by medical staff. Nutritional assessment is the ideal process to identify older adults requiring nutritional support, however it is time consuming to complete. Nutritional screening tools are useful for rapid, early identification of malnutrition, but need to be paired with nutritional assessment for accurate malnutrition identification. This review identified that most nutritional screening tools are not well validated against nutritional assessment. Further research is therefore needed to validate nutritional screening tools for older adults in the hospital setting, particularly regarding domains of nutritional assessment.

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Conflicts of interest

There are no conflicts of interest.

Box 1: Barriers and Problems with Implementation of Nutritional Screening Tools in the Hospital Setting

Barriers and Problems to Implementation
1. Lack of time and staff to implement the NSTs (166)
2. Cost (167)
3. Nutritional screening is not seen as important for patients on admission (168)
4. Nutritional screening is not a standard, routine procedure in a patient's hospital admission (169, 170)
5. Indecision over which NST to use (102)
6. Results of nutritional screening are not always documented in patient charts (93)
7. Patients who do not outwardly look malnourished are often not screened with a NST (166)
8. Most NSTs use BMI computations, which require the often difficult measurement of patient height and weight (166). Moreover, weight and height are commonly not measured in the hospital setting (167)
9. The use of BMI may be masking malnutrition (158)
10. Lack of information on validity and reliability (102)
11. NSTs are validated against many reference standards of malnutrition assessment as there is not one set reference standard for malnutrition assessment/diagnosis (171)
12. Nutritional screening is often not performed with a validated screening tool (172) or is performed with a screening tool not validated in that specific population (166)
13. The common belief by nurses that individual judgement of a patient being underweight is superior to a nutritional screening tool in detecting malnutrition or risk of malnutrition (166)
14. Multiple referral pathways for a full nutritional assessment often can result in a 'verbal' referral rather than a NST being utilised for referral (166)
15. The common misconception that patients not in the hospital for very long do not need to be screened (166)
16. Limited information for health practitioners on how to implement the NST appropriately (29)
17. Health Care professionals report that there are too many screening tools to choose from, so they choose none (99).
18. Interventions as the result of nutritional screening may not always be beneficial to patients, particularly in the short term (170)

Abbreviations: NST = Nutritional Screening Tool; BMI = Body Mass Index

Table 1: Comparisons of Selected Nutritional Screening Tools and Nutritional Risk Indices†

Feature	Nutritional Screening Tool				
	MNA (141)	**MNA-SF(104)**	**MUST(111)**	**SNAQ(116)**	**GNRI (121)**
Items Included	Weight Loss BMI and CC Appetite Loss Mobility Stress/Acute Disease Dementia/ Depression Living Situation Drugs Skin Lesions Full Meals Protein Intake Fruits, Vegetables Fluid Intake Mode of Feeding Nutritional Status Health Status MAC	Weight Loss BMI or CC Appetite Loss Mobility Stress/Acute Disease Dementia/Depression	Weight Loss BMI Acute Disease	Appetite Taste Satiety Meal Frequency	Serum Albumin Weight Height
Criterion Validity and Reliability	1. Validated in multiple studies of community dwelling older people where it has shown good sensitivity and specificity against a full nutritional assessment (139, 173). **<u>Hospitalised Older People</u>:** 2.Validated against nutritional assessment by physicians: **Se = 79 %; Sp = 90 %** in 65 patients aged ≥ 65 years. Visvanathan et al. 2004 (126). 3. Validated against nutritional assessment by dieticians: **Se = 57 %; Sp = 69%** in 160 patients aged ≥ 65 years. Azad et al. 1999 (174). 4. Validated against full nutritional assessment: **Se = 77 %; Sp = 36%** in 60 patients aged > 65 years. Thorsdottir et al. 2005.(175).	1. Validated against nutritional assessment by physicians: MNA-SF-BMI: **Se = 89 %; Sp = 82 %,** MNA-SF-CC: **Se = 85 %, Sp = 84 %** in 2032 people aged ≥ 65years; 1346 in residential care, 490 community dwelling, 127 hospitalised, 65 in rehabilitation. Kaiser et al. 2009 (103). 2. Validated against MNA: **Se = 98 %, Sp = 100 %** in 881people (mean aged 76.4 years); with 650 community dwelling, 105 hospitalised, others not defined. Rubenstein et al. 2001 (104). **<u>Hospitalised Older People:</u>** 3. Validated against MNA: **Se = 100 %, Sp = 70 %** in 408 patients aged ≥ 60 years. Cohendy & Rubenstein, 2001 (106). 4. Validated against nutritional assessment by clinical nutritionist: **Se = 100 %, Sp = 38 %** in 69 patients aged ≥ 70 years. Rahnoff et al. 2005 (108). 5. Validated against nutritional assessment (low BMI & weight loss): **Se = 100 %, Sp = 39 %** in 171 patients aged > 60 years. Neelemaat et al. 2011 (108) 6. **85 % agreement** with MNA in 444 patients aged ≥ 75 years. Vischer et al. 2012 (75).	1. Validated against SGA: **Se = 61 %. Sp = 76 %** in 995 patients of all ages. Kyle et al. 2006 (115). **<u>Hospitalised Older People:</u>** 2. Validated against SGA: **Se and Sp not reported. Agreement = 92 % (k = 0.783)** in 50 patients (mean age 45 years). Stratton et al. 2004 (111). 3. Agreement with MNA (**k = 0.790**) in 531 patients aged ≥ 65 years by Cansado et al. 2009 (99) 4.Agreement with combined index of malnutrition: **Se = 81%, Sp = 99 % (k = 0.810)** in 141 patients ≥ 65 years. Baek et al. (178)	1. Validated against MNA: **Se = 71 %, Sp = 74 %** in 175 community/hospitalized and residential care people aged ≥ 65 years. Rolland et al. 2012 (118). **<u>Hospitalised Older People:</u>** 2. Validated against SGA (B+C) **Se = 100 %, Sp = 53 %** in 134 patients > 65 years. Young et al. 2013 (127)	(1) Agreement with MNA **Agreement: k = 0.29** in 241 residential care residents. Cereda et al. 2009 (122). **<u>Hospitalised Older People:</u>** 2.Agreement with combined index of malnutrition : **Se = 95%, Sp = 67 % (k = 0.600)** in 141 patients ≥ 65 years. Baek et al. (178)

		7. Validated against MNA: **Se = 90 %, Sp = 78 %** (when using BMI); **Se = 95 %, Sp = 65%** (when using CC) in 100 GEMU patients aged ≥ 75 years. Dent et al. 2017 (109) 8. Agreement with MNA: (**k = 0.575**) in 190 geriatric day hospital patients aged ≥ 65 years. Schrader et al. 2016 (176) 9. Agreement with MNA: (**k = 0.700**) in 201 patients ≥ 65 years. Christner et al. 2016 (177) 10.Low validity against combined index of malnutrition**: Se = 100 %, Sp = 49 % (k = 0.46)** in 141 patients ≥ 65 years. Baek et al. (178) 11. Low validity against SGA (B+C): **Se = 100 %, Sp = 53 %** in 134 patients > 65 years. Young et al. 2013 (127)			2. Validated against MNA: **(k = 0.610)** in 131 patients aged ≥ 60 years. Abd-El-Gawad et al. 2014 (179)
Construct Validity	**Hospitalised Older People:** 1. Agreement with % Weight Loss (**k = 0.293**), BMI (**k = 0.063**) and MUST (**K = 0.790**) in 531 patients aged ≥ 65 years (99) 2. No association with BMI or CRP, iron, cholesterol, vitamin D, Albumin, Prealbumin and Haemaglobin showed a weak relationship. 444 patients aged ≥ 75 years. Adjusted for confounders. Vischer et al. 2012 (75). 3. Associated with low BMI and low levels of albumin, serum cholesterol, Vitamin A, Vitamin D. Se and Sp not reported. Univariate analysis in 106 patients aged ≥ 65 years (180). 4. Associated with triceps skinfold thickness, CC and BMI and Mid-Arm muscle circumference. Multivariate analysis in 109 patients aged > 70 years (181). 5. Associated with BMI, arm muscle area, albumin, transferrin, haemoglobin, lymphocyte	**Hospitalised Older People:** 1. Associated with weight, BMI, Mid-Arm muscle circumference & grip strength in patients aged 65 – 99 years. Univariate analysis. Rasheed et al. 2013 (183). 2. Associated with BMI, albumin haemoglobin, handgrip strength, CC and MAC in 142 patients aged ≥ 65 years. Zhou et al. 2015 (184)	**Hospitalised Older People:** 1. Agreement with % Weight Loss (**k = 0.275**), BMI (**k = 0.111**) and MNA (**K = 0.790**) in 531 patients aged ≥ 65 years by Cansado et al. 2009 (99). 2. Associated with weight, BMI, Mid-Arm muscle circumference, grip strength, albumin and pre-albumin in patients aged 65 – 99 years (183). 3. Validated against low BMI and weight loss): **Se = 67 %, Sp = 82 %** in 171 patients aged > 60	1. Validated against Weight Loss (5 %): **Se = 81 %, Sp = 76%** and Weight Loss (10 %): **Se = 88 and Sp = 84 %** by Wilson et al. 2005 (116); long-term care residents (n=247) and community-dwelling adults (n=352).	**Hospitalised Older People:** 1. Associated with BMI, arm muscle area, albumin, transferring & haemoglobin in 358 older people (77 % in hospital). Univariate analysis. Mean age = 84.6 years (182)

	count, total cholesterol & creatinine in 358 older people (77 % in hospital). Univariate analysis. Mean age = 84.6 years (182)		years. Neelemaat et al. 2011 (108).		2. Associated with BMI, MAC, CC and albumin in 131 patients aged ≥ 60 years. Abd-El-Gawad et al. 2014 (179)
BMI cut-off point (kg/m^2)	< 23	< 23	< 20	n/a	Continuous Variable

† A quasi-systematic review was performed, therefore results do not represent an exhaustive search of the literature.

Abbreviations: BMI = Body Mass Index; CC = Calf Circumference; MAC = Mid-Arm Circumference; MNA = Mini Nutritional Assessment; MNA-SF = MNA short form; MNA-SF-BMI = MNA-SF with BMI; MNA-SF-CC = MNA-SF with CC substituted for BMI; MUST = Malnutrition Universal Screening Tool; SNAQ = Simplified Nutritional Appetite Questionnaire; GNRI = Geriatric Nutritional Risk Index; Se = sensitivity; Sp = Specificity; k = kappa; MAC = Mid Arm Circumference; GEMU = Geriatric Evaluation and Management Unit; n/a = not applicable. 'Patients' refers to hospitalised patients.

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