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Malnutrition in hospital outpatients and inpatients: prevalence, concurrent validity and ease of use of the 'malnutrition universal screening tool' ('MUST') for adults†

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The 'malnutrition universal screening tool' ('MUST') for adults has been developed for all health care settings and patient groups, but ease of use and agreement with other published tools when screening to identify malnutrition requires investigation. The present study assessed the agreement and the prevalence of malnutrition risk between 'MUST' and a variety of other tools in the same patients and compared the ease of using these tools. Groups of patients were consecutively screened using 'MUST' and: (1) *MEREC Bulletin* (MEREC) and Hickson and Hill (HH) tools (fifty gastroenterology outpatients); (2) nutrition risk score (NRS) and malnutrition screening tool (MST; seventy-five medical inpatients); (3) short-form mini nutritional assessment (MNA-tool; eighty-six elderly and eighty-five surgical inpatients); (4) subjective global assessment (SGA; fifty medical inpatients); (5) Doyle undernutrition risk score (URS; fifty-two surgical inpatients). Using 'MUST', the prevalence of malnutrition risk ranged from 19–60 % in inpatients and 30 % in outpatients. 'MUST' had 'excellent' agreement (κ 0·775–0·893) with MEREC, NRS and SGA tools, 'fair–good' agreement (κ 0·551–0·711) with HH, MST and MNA-tool tools and 'poor' agreement with the URS tool (κ 0·255). When categorisation of malnutrition risk differed between tools, it did not do so systematically, except between 'MUST' and MNA-tool ($P=0{\cdot}0005$) and URS ($P=0{\cdot}039$). 'MUST' and MST were the easiest, quickest tools to complete (3–5 min). The present investigation suggested a high prevalence of malnutrition in hospital inpatients and outpatients (19–60 % with 'MUST') and 'fair–good' to 'excellent' agreement beyond chance between 'MUST' and most other tools studied. 'MUST' was quick and easy to use in these patient groups.

Malnutrition: Screening: Validity: Adults

Malnutrition can be defined as: 'a state of nutrition in which a deficiency, excess or imbalance of energy, protein, and other nutrients causes measurable adverse effects on tissue/body form (body shape, size, composition) and function and clinical outcome' (Elia, 2003; Stratton *et al.* 2003*b*). Routine screening of patients to identify risk of malnutrition has been recommended by many national, international and specialist organisations (British Dietetic Association, 1999; Elia, 2000, 2003 (British Association for Parenteral and Enteral Nutrition); Department of Health, 2001; Council of Europe, 2002; Royal College of Physicians, 2002; Kondrup *et al.* 2003 (European Society of Parenteral and Enteral Nutrition); NHS Quality Improvement Scotland, 2003). These recommendations have been made for several reasons. First, malnutrition adversely affects physical and psychological function (Elia, 2000; Stratton *et al.* 2003*b*) and impairs patients' recovery from disease and injury, thereby increasing morbidity and mortality. Such detrimental effects are costly to society, increasing health care utilisation (Stratton *et al.* 2002). Second, despite being a common problem (Stratton & Elia, 2000; Stratton *et al.* 2003*b*), malnutrition is frequently unrecognised and untreated in many health care settings, including nursing and other care homes, general practice, and hospital outpatients and inpatients (Consumer's Association, 1996, 1999; Elia, 2000). Implementing routine screening to detect malnutrition has been hindered by the lack of universally agreed criteria to identify it. Consequently, there are a variety of nutritional tools in use that incorporate different anthropometric, biochemical and clinical criteria which have often been developed for use in a particular setting or for a specific patient group

Abbreviations: HH, Hickson and Hill tool; MEREC, *MEREC Bulletin* tool; MNA, mini nutritional assessment; MNA-tool, short-form mini nutritional assessment; MST, malnutrition sceening tool; 'MUST', 'malnutrition universal screening tool'; NRS, nutrition risk score; SGA, subjective global assessment; URS, undernutrition risk score.

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†Some of the results have been presented as abstracts at meetings of the British Association for Parenteral and Enteral Nutrition (BAPEN) and the European Society of Parenteral and Enteral Nutrition (ESPEN). For more information and for a free download of the malnutrition universal screening tool and the explanatory booklet, see www.bapen.org.uk

(Stratton *et al.* 2003*b*). The use of such varied criteria means that different tools may identify different types and proportions of individuals as being at risk of malnutrition. This can be confusing and might effect decisions about nutritional management. The use of a variety of different tools also hinders comparisons of the prevalence of malnutrition across different settings and patient groups. The 'malnutrition universal screening tool' ('MUST') for adults has recently been developed for multi-disciplinary use by the multi-disciplinary Malnutrition Advisory Group of the British Association for Parenteral and Enteral Nutrition (www.bapen.org.uk). The tool is supported by the British Dietetic Association, the Royal College of Nursing, the Registered Nursing Homes Association and the British Association for Parenteral and Enteral Nutrition. The NHS Quality Improvement Scotland Clinical Standards for 'Food, fluid and nutritional care in hospitals', which have made nutritional screening mandatory in Scottish hospitals, consider 'MUST' to be appropriate for hospital use (and is the only tool mentioned by name; NHS Quality Improvement Scotland, 2003). 'MUST' (Fig. 1) is a screening tool that has been devised for application to all adult patients across all health care settings (Table 1; Elia, 2003). In the absence of a definitive method to diagnose malnutrition, 'MUST' has been developed to detect protein–energy malnutrition and the risk of developing malnutrition using evidence-based criteria (Elia, 2003). Three independent criteria are used. (1) Current weight status using BMI. The BMI cut-offs used are in line with recommendations made by a range of national and international organisations. (2) Unintentional weight loss, using cut-off points that reflect practical and approximate boundaries between normal and abnormal intra-individual changes in weight and the likely presence of a treatable underlying condition, which if undetected could produce further weight loss and malnutrition. There is also evidence that a weight loss of 5–10 % can produce physiologically relevant changes in body function (Shetty & James, 1994; Elia, 2003). (3) Acute disease effect producing or likely to produce no nutritional intake for

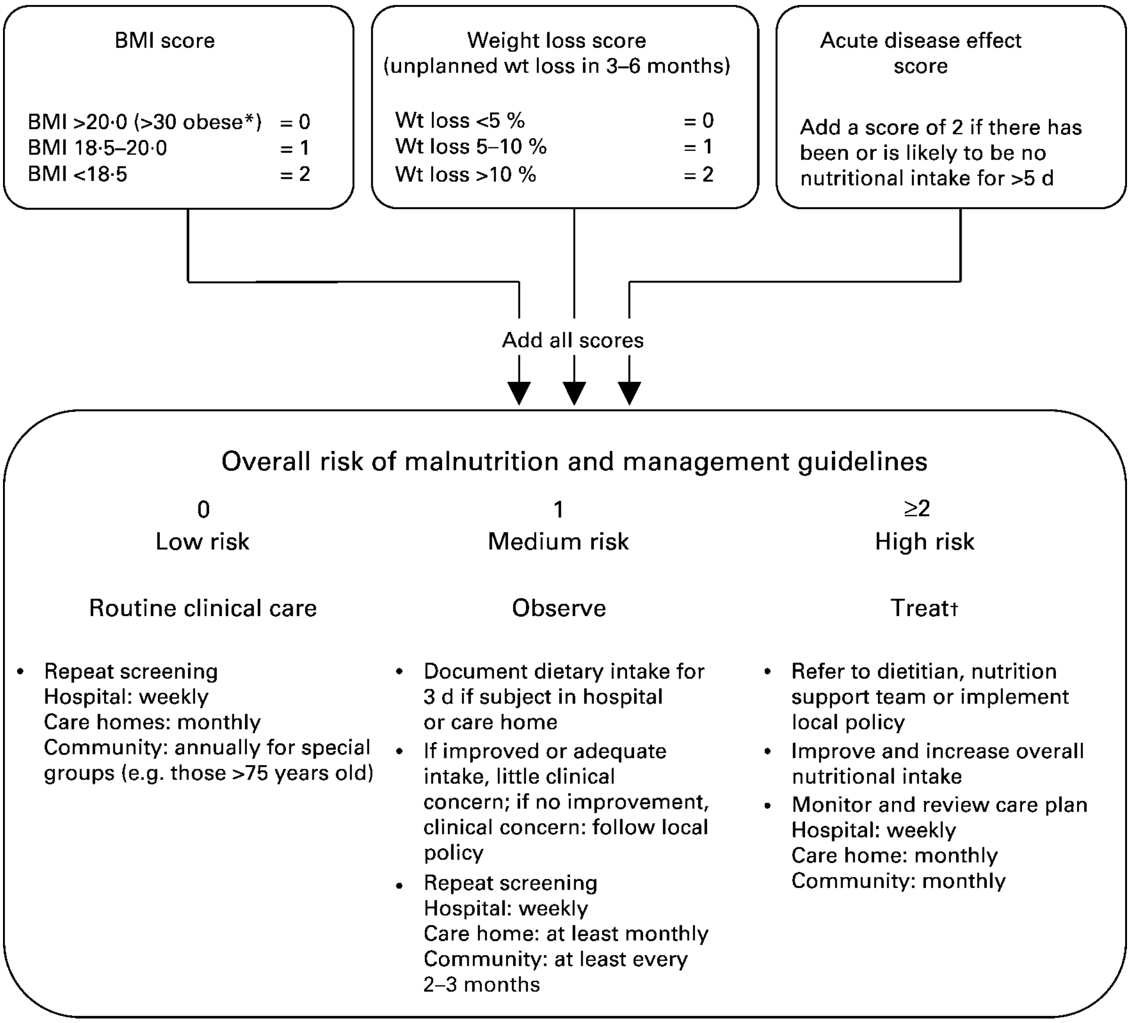

Fig. 1. The 'malnutrition universal screening tool' ('MUST') for adults: record malnutrition risk category, presence of obesity and/or need for special diets and follow local policy; re-assess those identified at risk as they move through care settings. †Unless detrimental or no benefit is expected from nutritional support, e.g. imminent death. *In the obese, underlying acute conditions are generally controlled before treatment of obesity. If unable to obtain height and weight, alternative measurements and subjective criteria are provided (Elia, 2003). ©British Association for Parenteral and Enteral Nutrition.

Table 1. Application of the 'malnutrition universal screening tool'*†

- Different care settings (e.g. hospital inpatients, outpatients, care homes, general practitioners' surgeries)
- Different groups of patients (e.g. elderly, surgical, medical, orthopaedic patients, those requiring intensive care and mental health care and with adaptation, even for pregnant and lactating women)
- For detecting malnutrition due to different causes (e.g. psychosocial and physical causes, including social and learning disabilities, those with eating and mental health problems)
- For use by different professionals (e.g. nurses, doctors, dietitians, health care assistants, social workers, students)
- For identifying disturbances in protein–energy status (both under- and over-nutrition) even when weight or height cannot be measured
- For clinical and public health purposes
- For adaptation according to local policy

* From Elia (2003).
† The tool is not designed to identify specific nutrient deficiencies or excesses, which should be detected through more detailed nutritional assessment, and clinical and laboratory tests.

>5 d. This allows for the effects of acute conditions (such as a stroke) that can cause there to be no dietary intake, resulting in rapid weight loss. Such a level of dietary restriction in the presence and absence of disease has also been shown to detrimentally affect body function. The criteria used are in line with recommendations made by other expert bodies (e.g. ASPEN Board of Clinical Directors, 1987). These three components can reflect the 'journey' of the patient from the past (weight loss), to the present (current BMI) and into the future (effect of disease). Each of the three components can independently predict clinical outcome with the importance of individual components varying with the clinical circumstances. Together the three components are better predictors of outcome than the individual components (Elia, 2003). There is also a large body of evidence detailing the physical and psychological effects of malnutrition (for review, see Stratton *et al.* 2003*b*). 'MUST' is linked to a generic care plan for the treatment of patients at risk of malnutrition, which is modifiable according to local policy and the resources available and is outlined in Fig. 1. To support this, there are many reviews, including systematic reviews and meta-analyses that detail the evidence base for the treatment of malnutrition (e.g. Potter *et al.* 1998; Akner & Cederholm, 2001; Lewis *et al.* 2001; Stratton *et al.* 2003). For more information about the evidence base for 'MUST', refer to Elia (2000, 2003).

In the absence of a 'gold standard' for malnutrition it is difficult to establish the validity of nutrition screening tools. However, 'MUST' has content validity (comprehensiveness of the tool), face validity (issues which are relevant to the purpose of the test) and internal consistency. 'MUST' has some predictive validity, e.g. predicting length of hospital stay, mortality and discharge destination of groups of hospital patients (King *et al.* 2003; Wood *et al.* 2004) and general practitioner visits and hospital admissions in free-living individuals (Stratton *et al.* 2002). 'MUST' also has excellent reproducibility (κ 0·809–1·000) between users (nurses, health care assistants, doctors, nursing and medical students) in different health care settings across the UK (Elia, 2003; Stratton *et al.* 2003*a*). However, the concurrent validity of this tool needs investigation. Concurrent (correlational) validity involves comparison of a tool with another validated criterion measure or reference measure. A tool can have concurrent validity if it shows good to excellent agreement with other tools or with a reference standard, (e.g. assessed by κ, a chance-corrected measure of agreement). 'MUST' has been shown to have excellent agreement with a dietitian's assessment of malnutrition (Elia, 2003), but whether it has agreement with other previously published tools used in the UK in adults is unknown and requires study. Generally there is little information about the concurrent validity of other tools and when this has been established, it has usually been through comparison of only a few tools in one particular patient group and health care setting (e.g. Correia *et al.* 2003). A comparison of the ease of use of 'MUST' with other tools is also warranted. Therefore, the aims of the present series of studies were: (1) to compare the prevalence of malnutrition risk assessed by 'MUST' and a variety of other published tools in both hospital outpatients and inpatients; (2) to investigate the concurrent validity of 'MUST' with these other published tools and to assess whether the same patients are identified as malnourished; (3) to compare the ease of use of 'MUST' with these other published tools.

Subjects and methods

Ethical approval was obtained for all studies from the Local Research Ethics Committee. Only patients able to give informed consent were eligible for recruitment, and so those with conditions such as dementia, confusion and unconsciousness were excluded. Less than 5 % of patients approached refused to give informed consent. A series of five separate investigations were undertaken, one in hospital outpatients and four in hospital inpatients to assess the following.

Prevalence of malnutrition. 'MUST' was used to categorise hospital outpatients and inpatients into three malnutrition risk categories (low-, medium- or high-risk) and two risk categories (low-risk and combined medium-risk + high-risk of malnutrition). The prevalence of malnutrition, using seven other published nutritional tools, was also recorded and compared with the results from 'MUST' in specific patient groups specified later. The tools included were selected because they were commonly used in the UK and were appropriate for the patient populations and settings in which the studies were carried out. The seven tools chosen were: the *MEREC Bulletin* tool (MEREC) (National Prescribing Centre, 1998), the Hickson and Hill tool (HH; Hickson & Hill, 1997), the nutrition risk score (NRS; Reilly *et al.* 1995), the malnutrition screening tool (MST; Ferguson *et al.* 1999), the short-form mini nutritional assessment screening tool (MNA-tool; Nestle S.A., Switzerland; Rubenstein *et al.* 2001), the subjective global assessment (SGA; Detsky *et al.* 1987) and the undernutrition risk score (URS; Doyle *et al.* 2000).

Concurrent validity of 'malnutrition universal screening tool' with other tools. The concurrent validity of 'MUST' with the seven published nutritional tools mentioned earlier was investigated (MEREC, HH, NRS, MST, MNA-tool, SGA and URS). Agreement and chance-corrected agreement (κ) of malnutrition risk categorisation between pairs of tools applied to the same patient group were assessed (for details, see later). Disagreements in categorisations by pairs of tools were examined for systematic under or over-categorisation of risk (for further details, see p. 803).

Ease of use and time taken to complete tools. The time taken to complete each tool was recorded and the ease of use on a four-point Likert scale (very easy, easy, difficult, very difficult) noted.

Investigators and training

Before undertaking the studies, all investigators underwent a series of training sessions (up to 7 h) provided by the same three individuals (two dietetic research fellows, one physician–professor) experienced in undertaking nutritional measurements and using screening tools. The ability of investigators to undertake measurements and screening appropriately was verified before data collection and at intervals during the studies. The investigators were from a variety of disciplines (nursing, medicine, nutrition). Although it is recognised that nurses are most likely to undertake screening in some health care settings, 'MUST' has been developed for multi-disciplinary use and in some settings may be used by doctors, dietitians etc. In addition, previous studies have shown excellent agreement between raters of different disciplines when using 'MUST' (Elia, 2003), although this information does not exist for all of the screening tools tested in this series of studies.

'Malnutrition universal screening tool' methodology

In all investigations, 'MUST' (Fig. 1) was completed as follows. Height was measured to the nearest 1 mm using a portable, free-standing stadiometer (Seca, Leicester, UK), according to standard methodology (Elia, 2003). If height could not be measured accurately (e.g. patient unable to stand), recalled height (if reliable and realistic; Elia, 2003; Stratton *et al.* 2003*a*) or knee height (Elia, 2000, 2003) were used to calculate height. Weight was measured to the nearest 0·01 kg using ward or clinic-based clinical scales, all of which were calibrated at the start of the study. If weight could not be measured accurately, recalled weight (if reliable and realistic) was used (Elia, 2003; Stratton *et al.* 2003*a*). BMI (kg/m^2) was calculated and scored accordingly (Fig. 1). If neither weight nor height could be obtained, subjective criteria assessing physical appearance (very thin, thin etc.) were used, combined with a measurement of mid-upper arm circumference <235 mm to identify individuals with BMI <20 kg/m^2 (Elia, 2003). The percentage unplanned weight loss in the previous 3–6 months was calculated from documented weights in patients' notes or from patients' reports and scored accordingly (Fig. 1). Subjective criteria could be used if reliable records or reports could not be obtained. These included the presence of loose fitting clothes or jewellery indicative of weight loss and psychological and/or physical illnesses leading to weight loss. An acute disease effect (if there has been or is likely to be no nutritional intake for >5 d) was noted and scored (Fig. 1). For a detailed explanation of the methods and evidence-base for 'MUST', see Elia (2003).

Investigation of malnutrition in hospital outpatients

Comparison of the 'malnutrition universal screening tool' with the MEREC Bulletin *tool and the Hickson and Hill tool in gastroenterology outpatients.* Fifty consecutive patients (thirty-one female, nineteen male; mean age 56 (SD 16) years; BMI 28·4 (SD 10·1) kg/m^2) attending a gastroenterology outpatient clinic were included in the study. The diagnoses included oesophageal stricture, colitis, diverticular disease and gluten-sensitive enteropathy. All patients were screened by a nurse with 'MUST' and two other screening tools: (1) MEREC tool; (2) HH tool (see Table 2 for details). Each of the tools ('MUST', MEREC, HH) categorised patients into three risk categories: low- (routine clinical care), medium- (observe) and high- (treat) risk.

Investigations of malnutrition in hospital inpatients

Comparison of the 'malnutrition universal screening tool' with nutrition risk score and malnutrition screening tool in medical inpatients. This study included seventy-five consecutively admitted elective and emergency medical patients (thirty female, forty-five male: age 44 (SD 14) years; BMI 27·0 (SD 5·48) kg/m^2). The reasons for admission to hospital were varied and included respiratory infections, Crohn's disease, cancer and accidental falls. Many patients were admitted for investigation of gastrointestinal or respiratory complaints. All patients were screened within 72 h of admission to hospital by a fourth-year medical undergraduate using 'MUST' and two other tools: (1) NRS; (2) MST (see Table 2 for details). 'MUST' and NRS categorised patients into three malnutrition risk categories (low, medium and high) and MST categorised patients into two risk categories. For comparison, the three risk categories for both 'MUST' and NRS were also consolidated into two risk categories (low and medium + high).

Comparison of the 'malnutrition universal screening tool' with short-form mini nutritional assessment screening tool in elderly medical and surgical inpatients. This study included consecutively admitted elderly medical patients (n 86; age 78 (SD 7·37) years, BMI 25·5 (SD 5·22) kg/m^2)) and surgical (mostly gastrointestinal) patients (n 85; age 61 (SD 20·2) years, BMI 26·7 (SD 4·70) kg/m^2)). The reasons for admission to elderly medical wards included chronic obstructive pulmonary disease, cerebrovascular accident, pneumonia, angina, heart and renal failure, and gastrointestinal complaints. The main reasons for admission to the surgical wards were gastrointestinal complaints, including bowel obstruction, pancreatitis, appendicitis and cholecystitis. All patients were screened by two final-year nutrition undergraduates using 'MUST' and the MNA-tool (for details, see Table 2) within 72 h of admission to hospital. As the MNA-tool categorised patients into two malnutrition risk categories (not at risk and possible risk), the two-category combined version of 'MUST' (low and medium + high) was used for comparison.

Table 2. Summary of published tools used in studies

Screening tool*	Criteria (n)	Criteria	Specific groups or settings
'MUST'	3	BMI, % unintentional weight loss in 3–6 months, no intake for >5 d (past or future). Alternative measures (for height and BMI) and subjective criteria provided when objective measures not possible	All settings, all adults. A development of the Manutrition Advisory Group community tool (Elia, 2000)
MEREC	3	BMI, unintentional weight loss, intake of food/fluid	Community (National Prescribing Centre, 1998)
HH	5	Unintentional weight loss in 3 months,BMI, appetite, ability to eat/retain food, clinical/medical stress factor	Community version of hospital tool (Reilly *et al.* 1995)
NRS	5	Unintentional weight loss in 3 months, BMI, appetite, ability to eat and/or retain food, clinical and/or medical stress factor	Hospital
MST	3	Weight loss, quantity of weight loss, poor intake/appetite (all subjective: no measurements required)	Initially developed for acute hospital patients
MNA-tool	6	Declining food intake over 3 months, mobility, psychological stress and/or acute disease, neuropsychological problems, BMI (sub-section of the full MNA, which has eighteen criteria)	MNA initially developed for elderly patients but now widely used across specialties
SGA	9	Clinical history: weight change, change in dietary intake, gastrointestinal symptoms, functional capacity, disease and its relation to nutritional requirements Physical examination: loss of subcutaneous fat, muscle wasting, ankle or sacral oedema, ascites (all subjective)	SGA initially developed for surgical hospital patients but now widely used across specialties
URS	7	Acceptable weight (appearance), unintentional weight loss in 3 months, appetite, age, ability to eat, gut function, medical condition	Surgical hospital patients

'MUST', 'malnutrition universal screening tool'; MEREC, *MEREC Bulletin* tool; HH, Hickson and Hill tool; NRS, nutrition risk score; MST, malnutrition screening tool; MNA, mini nutritional assessment; MNA-tool, short-form mini nutritional assessment tool; SGA, subjective global assessment; URS, undernutrition risk score.

* 'MUST': Elia (2003); MEREC: National prescribing centre (1998); HH: Hickson & Hill (1997); NRS: Reilly *et al.* (1995); MST, Ferguson *et al.* (1999); MNA-tool: Nestlé S.A., Switzerland, Murphy *et al.* (2000), Rubenstein *et al.* (2001); SGA: Detsky *et al.* (1987); URS: Doyle *et al.* (2000).

Comparison of the 'malnutrition universal screening tool' with the subjective global assessment tool in <65-year-old medical inpatients. This study included fifty consecutively admitted medical patients (age 45 (SD 13·9) years, BMI 27·3 (SD 6·30) kg/m^2). Reasons for hospital admission were varied and included chest pain, shortness of breath, gastrointestinal problems (e.g. severe vomiting, gastroenteritis), chronic renal failure and pneumonia. All patients were screened by a fourth-year medical undergraduate using 'MUST' and SGA (for details, see Table 2). SGA categorised patients into three risk categories (well nourished, moderately malnourished, severely malnourished), but a two-category combined version of the SGA (well nourished and moderately malnourished + severely malnourished) was also used for comparison.

Comparison of the 'malnutrition universal screening tool' with the undernutrition risk score in general surgical inpatients. This study included fifty-two consecutively admitted elective and emergency general surgical patients (twenty-nine female, twenty-three male: age 62 (SD 16) years; BMI 27·7 (SD 6·08) kg/m^2). Reasons for admission included hernia repair, varicose vein removal, cholecystectomy and urological surgery. A fourth-year medical undergraduate screened all patients using 'MUST' and URS. The URS categorised patients into three risk categories (low, moderate, high), but a two-category combined version of the URS (low risk and moderate + high risk) was also used for comparison.

Statistical analysis

To test the concurrent validity between tools, agreement and chance-corrected agreement (κ) between pairs of tools applied to the same patients were assessed. A κ value of 1·000 signifies perfect agreement, κ of 0·000 no agreement and κ of $-1{\cdot}000$ perfect disagreement. κ values 0·400–0·750 are considered to indicate 'fair–good' agreement and κ values $>0{\cdot}750$ 'excellent' agreement beyond chance (Landis & Koch, 1977). Power calculations suggested that with sample sizes of 50, 80 and 100 subjects, the estimated 95 % CI for κ (irrespective of the value of κ) would be $\kappa \pm 0{\cdot}28$, $\kappa \pm 0{\cdot}22$ and $\kappa \pm 0{\cdot}20$ respectively (using two risk categories and a malnutrition prevalence (medium + high risk) of 30 %; Cantor, 1996). The binomial test was undertaken to examine systematic under- or over-categorisation of malnutrition risk between two tools. For tools with two categories this corresponds to the McNemar test. Differences in the prevalence of malnutrition (medium + high risk) between two tools used in the same patients were assessed by the test of paired proportions. Statistical analysis was undertaken using SPSS statistical software package (version 11.0; SPSS, Woking, Surrey, UK).

Results

Prevalence of malnutrition

The prevalence of malnutrition risk (medium + high) using 'MUST' ranged from 19–60 % across patient groups and 19–65 % with the other tools (see Fig. 2). Using 'MUST', the prevalence of malnutrition in gastroenterology outpatients was 30 % (18 % medium-risk and 12 % high-risk). In hospital, the lowest prevalence of malnutrition risk was in a group of general surgical patients (elective and non-elective surgery for a range of conditions including hernia repair, varicose vein removal; 19 %) and the highest prevalence was in a group of patients admitted mostly for gastrointestinal surgery (60 %). Using other tools, the lowest (19 %) and highest (65 %) prevalences of malnutrition risk were in general surgical patients (using SGA) and elderly medical patients (using MNA-tool) respectively (see Fig. 2). Compared with 'MUST', a significantly higher proportion of patients were identified as being at risk by the URS in general surgical patients (35 *v*. 19 %; *P*=0·001) and the MNA-tool in elderly medical patients (65 *v*. 44 %; *P*=0·0005) and a significantly lower proportion by the MNA-tool in gastrointestinal surgical patients (47 *v*. 60 %; *P*=0·0005) (Fig. 2).

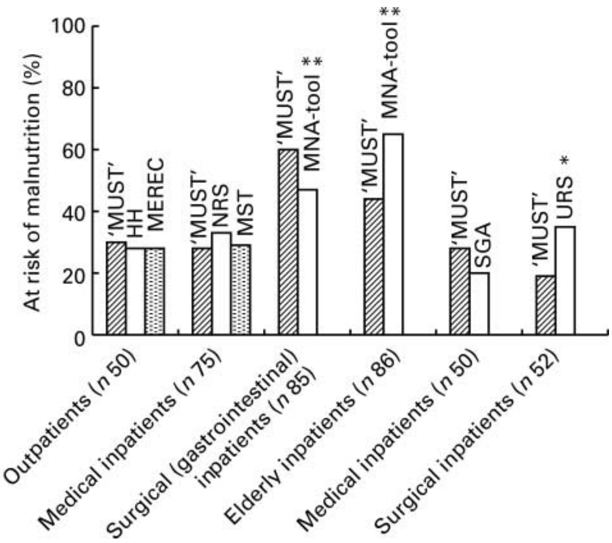

Fig. 2. The proportions of patients identified as at malnutrition risk using the 'malnutrition univeral screening tool' ('MUST') and other screening tools. HH, Hickson and Hill tool; MEREC, *MEREC Bulletin* tool; NRS, nutrition risk score; MST, malnutrition screening tool; MNA-tool, short-form mini nutritional assessment; SGA, subjective global assessment; URS, undernutrition risk score. For details of tools and procedures, see Figure 1, Table 2 and pp. 801–803. Mean values were significantly different from those assessed by 'MUST' (in the same patient group): **P*<0·001, ***P*<0·0005.

Concurrent validity of the 'malnutrition universal screening tool' with other tools

Hospital outpatients: comparison of the 'malnutrition universal screening tool' with the MEREC Bulletin *tool and the Hickson and Hill tool in gastroenterology outpatients.* 'MUST' had 'excellent' agreement beyond chance with the MEREC tool (κ 0·825) and 'fair–good' agreement beyond chance with the HH tool (κ 0·647) (Landis & Koch, 1977; see Table 3). The disagreements between tools were not systematically under- or over-categorised.

Hospital inpatients: comparison of the 'malnutrition universal screening tool' with the nutrition risk score and the malnutrition screening tool in medical inpatients. 'MUST' had 'good to excellent' agreement beyond chance (Landis & Koch, 1977) with the NRS (κ 0·775) and the MST (κ 0·707) tools when applied to the same patients (Table 3). The disagreements between tools were not systematically under- or over-categorised. Although a similar overall proportion of patients were

Table 3. Concurrent validity between the 'malnutrition universal screening tool' ('MUST') and other nutritional screening procedures in hospital and community settings*

Tool comparison	Categories (*n*)	Patients	*n*	Agreement %†	Agreement κ‡	SE
Community setting						
'MUST' *v*. MEREC	3	Outpatients	50	92	0·893	0·077
'MUST' *v*. HH	3	Outpatients	50	84	0·711	0·105
Hospital setting						
'MUST' *v*. NRS	3	Medical <65 years old	75	89	0·775	0·072
'MUST' *v*. NRS	2	Medical <65 years old	75	92	0·813	0·073
'MUST' *v*. MST	2	Medical <65 years old	75	88	0·707	0·091
'MUST' *v*. MNA-tool	2	Medical >65 years old	86	77	0·551	0·081
'MUST' *v*. MNA-tool	2	Surgical	85	80	0·605	0·083
'MUST' *v*. SGA	3	Medical	50	72	§	§
'MUST' *v*. SGA	2	Medical	50	92	0·783	0·102
'MUST' *v*. URS	3	Surgical	52	67	0·255	0·101
'MUST' *v*. URS	2	Surgical	52	77	0·431	0·130

MEREC, *MEREC Bulletin* tool; HH, Hickson and Hill tool; NRS, nutrition risk score; MST, malnutrition screening tool; MNA-tool, short-form mini nutritional assessment screening tool; SGA, subjective global assessment; URS, undernutrition risk score.
* For details of tools and procedures, see Figure 1, Table 2 and pp. 801–803.
† Percentage of patients placed in the same malnutrition risk category by the two tools. Disagreements in categorisation between tools were not systematically biased, except between MUST and MNA-tool in medical and surgical patients (two categories, *P*=0·0005) and MUST and URS (two categories, *P*=0·039).
‡ κ 0·400–0·750 fair–good; κ > 0·750 excellent agreement beyond chance (Landis & Koch, 1977).
§ As the observer did not categorise any patients as high risk with SGA, κ was not calculated for the three category comparison.

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identified as being at risk of malnutrition by two different tools (e.g. 'MUST' 28 %, MST 29 %), Table 4 indicates that individual patients were categorised differently.

Hospital inpatients: comparison of the 'malnutrition universal screening tool' with the short-form mini nutritional assessment tool in elderly medical and surgical inpatients. There was 'fair–good' agreement beyond chance between 'MUST' (two categories) and the MNA-tool in elderly medical and surgical (mostly gastrointestinal) patients, with κ values 0·551 and 0·605, respectively (Landis & Koch, 1977; see Table 3). However, there was a significant bias when the disagreements in malnutrition risk categorisation between 'MUST' and MNA-tool were considered in these two patient groups (see Table 5). The MNA-tool systematically over-categorised risk of malnutrition in elderly medical patients (nineteen out of twenty patients; $P = 0·0005$ binomial test), but significantly under-categorised risk in this group of surgical patients (fourteen out of seventeen patients; $P = 0·0005$) compared with 'MUST' (Table 5), reflected in the prevalence figures for malnutrition (Fig. 2).

Hospital inpatients: comparison of the 'malnutrition universal screening tool' with the subjective global assessment tool in <65-year-old medical inpatients. There was 'excellent' agreement beyond chance between 'MUST' (two categories) and the SGA (two categories), with a κ value 0·783 (Landis & Koch, 1977; see Table 3). The two category versions of 'MUST' and SGA (in which medium- and high-risk categories were combined) were compared as the investigator did not categorise any of these patients into the high-risk group (severely malnourished) using the SGA. There were no systematic differences between categorisations using 'MUST' and SGA.

Hospital inpatients: comparison of the 'malnutrition universal screening tool' with the undernutrition risk score in general surgical inpatients. There was 'poor' agreement beyond chance between 'MUST' and the URS when the three malnutrition categories were used (three-category versions of tools, κ 0·255). When two categories were used (Table 3), there was 'fair–good' agreement beyond chance (κ 0·431), but there was a significant over-categorisation of risk by URS relative to 'MUST'

Table 4. Cross-tabulation of malnutrition risk according to the 'malnutrition universal screening tool' ('MUST') and the malnutrition screening tool (MST)*

		'MUST' (two categories)		
		Low risk	Medium + high risk	Total
Medical <65-year-old patients (*n* 75)†		*n*	*n*	*n*
MST (two categories)	No risk	49‡	4	53
	Risk	5	17	22
Total		54	21	75

* For details of tools and procedures, see Figure 1, Table 2 and p. 802

† κ 0·707. Similar total proportion identified as at risk by two tools (28 % 'MUST', 29 % MST), but individual patients categorised differently by the two tools.

‡ Agreements.

Table 5. Cross-tabulation of malnutrition risk in surgical and elderly medical patients according to the 'malnutrition universal screening tool' ('MUST') and the short-form mini nutritional assessment screening tool (MNA-tool)*

		'MUST' (two categories)		
		Low risk	Medium + high risk	Total
		n	*n*	*n*
Surgical patients (*n* 85)†‡				
MNA-tool (two categories)	No risk	31¶	14	45
	Risk	3	37¶	40
Total		34	51	85
Elderly medical patients (*n* 86)§‖				
MNA-tool (two categories)	No risk	29¶	1	30
	Risk	19	37¶	56
Total		48	38	86

* For details of the tools and procedures, see Figure 1, Table 2 and p. 802.

† κ 0·605.

‡ Seventeen disagreements between tools with fourteen out of seventeen subjects under-categorised by MNA-tool *v*. 'MUST' ($P = 0·0005$). Proportion identified as at risk (MNA tool 47 %, 'MUST' 60 %).

§ κ 0·551.

‖ Twenty disagreements between tools with nineteen out of twenty subjects over-categorised by MNA-tool *v*. 'MUST' ($P = 0·0005$). Proportion identified as at risk (MNA tool 65 %, 'MUST' 44 %).

¶ Agreements.

(ten out of twelve disagreements; $P=0{\cdot}039$, McNemar test), reflected in the prevalence values (Fig. 2).

Ease of use and time to complete tools

All of the investigators reported the ease of use of 'MUST' as 'very easy' (by three medical undergraduates, one nutrition undergraduate, one nurse) or 'easy' (by one nutrition undergraduate). MST was rated as 'very easy' (by one medical undergraduate), MNA-tool as 'easy' (by two nutrition undergraduates) and the other tools (NRS, HH, SGA, URS) were rated as 'difficult' (by three medical undergraduates, one nurse). 'MUST' took 3–5 min, MST 3 min (all subjective criteria), MNA-tool 5 min, NRS and HH 5–7 min, and URS and SGA 5–10 min to complete.

Discussion

The present study has demonstrated a high prevalence of malnutrition in hospital inpatients (19–65 %) and in a group of gastroenterology outpatients (28–30 %) using a variety of different tools, including 'MUST', which was used in all patients (Fig. 2). Although previous comparisons between malnutrition tools have been made, they have almost always involved a comparison of only a couple of tools in a single patient group or setting. Importantly, this series of studies has indicated that the overall proportion of patients identified with malnutrition can vary significantly when different procedures are used in the same patient group. Furthermore, even when different tools identify a similar prevalence of malnutrition, the individuals identified at risk may differ (Table 4), which could lead to practical difficulties in managing patients. The absence of a standard measure with which to identify malnutrition makes it difficult to easily ascertain which tool has the more 'correct' classification. Therefore, in such individuals where classification of risk differs, identification of which tool most effectively predicts outcome may be one useful indicator. One way that can help resolve the issues of mis-classification is to undertake large-scale randomised trials using different tools, addressing both clinically and physiologically important outcomes. Another problem is that some tools have been specifically developed for certain types of patients in specific settings (e.g. URS for surgical hospital patients (Doyle *et al.* 2000)), which means that they should not be used to screen other types of patients in other settings without previous validation. In contrast, 'MUST' has been developed for use across all adult patient groups and health care settings. The use of such a tool across adult specialities and health care settings, as in this series of investigations, also highlights how the prevalence of malnutrition varies depending on the type of patient group, as indicated in Fig. 2. Even within one speciality (e.g. surgery), when using 'MUST' the prevalence of malnutrition varies with the type of surgery performed (60 % in a group of predominantly non-elective gastrointestinal surgical patients *v*. 19 % in a group of elective and non-elective surgical patients undergoing a range of procedures).

In the absence of a universally accepted definition of malnutrition, it is also difficult to establish the validity of any malnutrition-screening tool. Therefore, it is important to establish the extent of agreement of a newly developed method with a previously used and established method for identifying malnutrition (e.g. MNA, SGA), together with considerations about the reliability, ease of use and predictive outcome of the method (British Dietetic Association, 1999; Elia, 2000). The results of the present study suggest that 'MUST' has 'fair–good' to 'excellent' concurrent validity (κ 0·431 to 0·893) with a range of previously published tools used in clinical practice, with the exception of the URS tool for surgical patients (κ 0·255). The extent of agreement between tools depends on the criteria they include. In an outpatient clinic, there was 'excellent' agreement beyond chance (κ 0·893) between 'MUST' and the MEREC tool, possibly due to their simplicity and the use of a number of common screening criteria (BMI, % weight loss). Agreement between 'MUST' and HH (community version of the NRS) was poorer (κ 0·711, 'fair–good' chance-corrected agreement), which may have been due to HH employing a greater total number of criteria (*n* 5) and including more subjective criteria than 'MUST'. The hospital version of this tool (NRS; Reilly *et al.* 1995) had 'excellent' agreement beyond chance with 'MUST' (three-category (κ 0·775) and two-category (κ 0·813)). This difference in agreement between the hospital and community versions of this tool may have been due to different investigators undertaking the screening in these two studies (medical undergraduate in the hospital, nurse in the outpatient setting). Although 'MUST' has been shown to have 'excellent' inter-rater reliability (κ 0·809–1·000) in a large series of investigations between different health care workers (Elia, 2000, 2003; Stratton *et al.* 2003*a*), the reproducibility of the NRS and HH tools between a variety of different health care professionals has not been undertaken as far as we are aware (Reilly *et al.* (1995) suggests that fourteen out of nineteen assessments agree between nurse and state registered dietitian). Therefore, the possibility of bias in results of concurrent validity tests undertaken by the same individual (e.g. in the present study, 'MUST' and MEREC, 'MUST' and HH) or different individuals within the same profession should also be considered. Alternatively, the differences in agreement could be due to slight differences that exist between the NRS and its community version (HH; Hickson & Hill, 1997). In the hospital, there was also 'excellent' agreement (κ 0·783) between 'MUST' and the assessment tool SGA (two-category) in newly admitted general medical patients, although the investigator (a fourth-year medical undergraduate) did not categorise any patients into the malnourished group when using the SGA. 'MUST' had 'fair–good' agreement beyond chance with other screening tools investigated in the present study, including MST (two-category, κ 0·707) in general medical patients, the MNA-tool (two-category) in elderly medical (κ 0·551) and gastrointestinal surgical (κ 0·605) patients, and URS (two-category, κ 0·431) in general surgical inpatients. However, the agreement of 'MUST' with the URS (three-category versions) was 'poor' (κ 0·255). This poorer agreement is likely to have been due to the use of very different criteria by the two tools, with the inclusion of many more criteria (seven *v*. three), mostly subjective, in the URS (Doyle *et al.* 2000), which unusually included constipation and increasing appetite as risk factors. In addition to the poor agreement between these two tools, there was also a systematic over-categorisation of risk by the URS relative to 'MUST'. There was only one other tool with which there was a systematic bias relative to 'MUST'. The MNA-tool systematically over-categorised in elderly medical patients and under-categorised in surgical patients the risk of malnutrition relative to 'MUST'. A possible reason for this is that the MNA-tool was initially developed for use in the elderly, whilst 'MUST' was developed for use in all adults. Furthermore, the MNA-tool investigated in the present study was the short-form screening component (criteria A to F) of a larger assessment tool, the MNA (eighteen criteria, A to R). Although the MNA was developed and widely validated in elderly people, the use of the short-form as a screening tool (criteria A to F; Murphy *et al.* 2000; Rubenstein *et al.* 2001), termed MNA-tool in the present paper, appears to have been less extensively validated in prospective trials. Another possible reason for the differences in categorisation may be that the action plans following use of the MNA-tool and 'MUST' are different, in that those patients identified as at risk of malnutrition with the MNA-tool are then assessed further with the full MNA. Therefore, the results of 'MUST' were also compared with those of the full MNA assessment tool (three risk categories: not at risk, at risk of malnutrition, malnourished) carried out in the present study by the same investigators. The bias between tools remained (significant over-categorisation of risk in elderly medical ($P=0{\cdot}004$), significant under-categorisation in gastrointestinal surgical ($P=0{\cdot}0005$) patients with MNA relative to 'MUST') reflected in the low κ values (elderly 0·450, surgical 0·356).

It is desirable that a screening procedure is rapid and easy to use. The results of the present study suggested that screening with 'MUST' was quick (3–5 min) and 'very easy' or 'easy' to use in the patient groups studied. Some of the procedures evaluated in this investigation (e.g. SGA, NRS, URS) were found to be lengthier and harder to use than 'MUST'.

In summary, the present study demonstrates that there is a high prevalence of malnutrition in a group of hospital outpatients (30 %) and groups of inpatients (up to 60 %) using 'MUST'. 'MUST' is easy and quick to use and has 'fair–good' to 'excellent' concurrent validity (κ 0·431–0·893) with most of the other tools tested.

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