



Advancing Clinical Nutrition
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THE 'MUST' REPORT

Nutritional screening of adults: a multidisciplinary responsibility

Development and use of the
'Malnutrition Universal Screening Tool' ('MUST')
for adults

Professor Marinos Elia
Chairman of MAG and Editor

MAG
Malnutrition Advisory Group
A Standing Committee of BAPEN

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The British Association for Parenteral and Enteral Nutrition

BAPEN is a multi-professional association and registered charity established in 1992. Its membership is drawn from doctors, dietitians, nurses, patients, pharmacists and from the health policy, industry, public health and research sectors. The Malnutrition Advisory Group (MAG) is a Standing Committee of BAPEN.

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BAPEN's principal functions are to:

- Enhance understanding and management of malnutrition
- Establish a clinical governance framework to underpin the nutritional management of all patients
- Enhance knowledge and skills in clinical nutrition through education and training
- Communicate the benefits of clinical and cost-effective optimal nutritional care to all healthcare professionals, policy-makers and the public
- Fund a multi-professional research programme

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10 Key Points

1. Malnutrition, used here to mean under-nutrition, affects at least 2 million people in the UK, detrimentally affecting their health, wellbeing, and ability to work.
2. Malnutrition is under-recognised and under-treated. It leads to disease, delays recovery, increases visits to GP and increases the frequency and length of hospital stay.
3. Nutritional care would improve with adoption of a screening tool which could detect malnutrition and guide action in all care settings.
4. 'MUST' can detect over-nutrition (overweight and obesity) as well as under-nutrition and is linked to a flexible care plan, which varies according to healthcare setting, patient group, and local resources.
5. Such a tool has been developed by the Malnutrition Advisory Group (MAG) of BAPEN. It is called the 'Malnutrition Universal Screening Tool' ('MUST') to indicate that it can be applied to all types of adult patients in all care settings.
6. 'MUST' is valid, reliable, and easy to use, and, with cautious interpretation, can be applied to all adult patients, even those who cannot have their weight or height measured, who have fluid disturbances, amputations, plaster casts, or who are pregnant and lactating.
7. 'MUST' has been made user friendly through extensive field testing by a wide range of professionals in different health care settings.
8. 'MUST' promotes multidisciplinary care and responsibility, with consequent improvements in clinical outcome.
9. 'MUST' could be appropriately used to implement the nutritional screening that is recommended or required by key initiatives in the UK, such as the National Framework for Older people, Essence of Care, Care Homes for Older People (Care Standards Act), and Food, Fluid and Nutritional Care in Hospitals (Scotland).
10. 'MUST' would be most effective if deployed in a healthcare system that prioritised nutrition strategies, training, and implementation.

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Executive summary

This report examines the need to screen for malnutrition in clinical practice, sets out the criteria that need to be fulfilled, and describes the development and use of the 'Malnutrition Universal Screening Tool' ('MUST') for adults, which takes these criteria into account. The tool primarily aims to identify risk of poor protein-energy status, rather than status of individual nutrients. It is linked to a care plan, which can vary according to healthcare setting, local policies, and resources. Guidance on undertaking measurements using 'MUST' is provided.

A: Nutritional screening

1. Malnutrition (undernutrition) and overweight/obesity as major clinical and public health problems in the UK

1.1 Malnutrition (undernutrition): Underweight (BMI <20 kg/m²) is typically present in 10-40% of patients admitted to hospital, but malnutrition risk, established using the 'MUST', is even greater. In the general population, it is estimated that one in seven subjects aged 65 years and over has a medium or high risk of malnutrition, but the prevalence is higher in subjects who are institutionalised than those who are free living (i.e. living in their own homes). Malnutrition predisposes to disease, delays recovery from illness, and adversely affects body function, well-being and clinical outcome. There is no formal economic evaluation of disease-related malnutrition but it is estimated that the cost is greater than that of obesity.

1.2 Obesity: The incidence of obesity (body mass index (BMI) >30 kg/m²) is increasing in both adults and children, and currently affects one in five adults. It predisposes to many health problems, including heart disease, diabetes, high blood pressure and osteoarthritis, with an estimated annual cost to the economy of over £2 billion, of which £0.5 billion represents a direct cost to the National Health Service.

2. Malnutrition (undernutrition): under-recognised and undertreated

Malnutrition is often unrecognised and untreated in hospitals (both in-patients and out-patients), nursing homes and in the community, causing concern among a wide range of health professionals, national organisations and colleges, UK government departments, and the Council of Europe. Despite this, there are no national guidelines for commissioners and planners of healthcare.

3. Inadequate nutritional care

Nutritional care is frequently inadequate because of diffuseness of responsibility, lack of an integrated infrastructure for dealing with nutritional problems within and between different healthcare settings, poor education, and lack of consistent criteria to identify and treat malnutrition. There are well over 50 published nutrition screening tools and many more unpublished tools in clinical use, taking anything from two minutes to over thirty minutes to complete. These differ in the criteria they use, the weighting factors applied to the criteria, the scoring systems, the intended users (who are sometimes not specified), and the tool's practical acceptability in routine clinical practice. Many have not been tested for reliability or validity, and many lack an evidence base. Furthermore, several different tools may be in use in the same hospital and in the community, contributing to confusion about how to recognise and manage malnutrition.

4. Common principles of nutritional screening and care

The problems and principles of nutritional screening are illustrated by examining the common threads that apply to underweight and overweight children and adults, including pregnant and lactating women. The section on children is also included because nutritional problems in children become nutritional problems in adults, especially if there is inadequate continuity of care.

5. Nutritional screening and assessment

Nutritional screening, which is the focus of this report, refers to a rapid, general, often initial evaluation undertaken by nurses, medical or other staff, to detect significant risk of malnutrition and to implement a clear plan of action, such as simple dietary measures or referral for expert advice. Nutritional assessment is a more detailed, more specific, and more in-depth evaluation of nutritional status by an 'expert', so that specific dietary plans can be implemented, often for more complicated nutritional problems. This difference is often misunderstood, contributing to confusion.

6. Recommendations

6.1 Routine use of a nutritional screening tool: A nutritional screening tool should be used routinely for patients admitted to hospitals and care homes. It should also be used with new patients attending general practitioner (GP) surgeries, in those aged 75 years and over undertaking routine annual health assessments, in vulnerable groups, and in those for whom there is clinical concern (e.g. those who are frail and elderly, the poor and socially isolated, and those with severe diseases and disabilities). Screening should be repeated at intervals depending on the healthcare setting and clinical condition. The same tool should be used to screen patients at risk of malnutrition as they move from one healthcare setting to another.

6.2 Characteristics of the nutrition screening tool: (i) The screening tool should be: practical (easy to understand, easy and quick to complete, and acceptable to patients/subjects and healthcare workers), reliable, valid and evidence based. It should also incorporate a scoring system that is applicable and relevant to different clinical conditions and care settings, and be linked to a care plan. (ii) The screening tool should address the following: current weight status (e.g. underweight or obesity using BMI), as well as recent past and likely future change in weight, both of which are related to food intake and disease severity. Objective measures should be used whenever possible, and less objective measures when necessary. (iii) The screening tool should aid rather than replace clinical judgment.

6.3 The nutritional screening programme: After application of the screening test, which aims to identify patients at risk of malnutrition, it is often necessary to undertake more detailed and more specific assessment (e.g. by referral to a dietitian or nutritional support team) as part of a care plan. The policy for the entire screening programme - from the initial test to assessment, treatment, monitoring, documentation, communication and evaluation - should be established by a multidisciplinary group of healthcare workers, according to recommended procedures for screening and guideline development, and according to local resources.

6.4 Weighing scales and stadiometers: Accurate and reliable weighing scales and stadiometers, for measuring weight and height respectively, should be available to all hospital wards, outpatient clinics, care homes, GP surgeries, and other healthcare settings.

6.5 Consistent framework and principles for nutritional screening programmes:

Screening programmes for malnutrition in children and obesity in adults and children should follow the same principles as screening for malnutrition in adults. Unintentional weight loss in obese individuals should be taken seriously since it may suggest the presence of an underlying disease. In contrast, persistent weight gain in children may be inadequate to sustain normal growth. Adult malnutrition screening programmes should note obesity when it exists, link with childhood nutritional programmes, and cater for individuals in different healthcare settings using the same sound principles and procedures operating through an appropriate infrastructure. Screening tests and programmes should be evaluated with respect to their application and effectiveness.

6.6 Infrastructure and clinical governance: Commissioners, planners and providers of healthcare should be part of a coherent and integrated infrastructure, extending through all levels of the health and care service from Government departments, regional and local services, to individual health and care workers. This continuum should foster the development of nutrition strategies and the establishment of responsibilities and policies for the prevention and treatment of malnutrition across conditions and healthcare settings. The effectiveness of such policies, including nutritional screening programmes, education, training and personal development plans, should be monitored and evaluated.

B: Validity, reliability and practicality of using the 'Malnutrition Universal Screening Tool' ('MUST')**7. The acronym 'MUST'**

Although it is recognised that the 'Malnutrition Universal Screening Tool' for adults may not effectively screen for deficiencies or toxicities of certain micronutrients, it can be readily applied to all types of patient groups in different healthcare settings. These include those with eating disorders, mental health problems and critical illness, as well as those with fluid disturbances, pregnancy, or lactation. It uses the same conceptual framework for all adults, employing more subjective criteria (e.g. when there are fluid disturbances) or modified criteria (e.g. weight changes during pregnancy) in some circumstances. The acronym, which is presented in inverted commas to indicate these caveats, is also used as a means of encouraging screening for malnutrition in a range of care settings where this is currently not carried out routinely.

8. Development of the evidence base

'MUST' was developed for use in adults in response to the criteria set out in section A of this report. It provides a theoretical and practical framework for the clinical detection and management of nutritionally responsive conditions, caused by physical and psychosocial problems. The tool is simple, valid, and reliable, and is suitable for practical use by a range of healthcare workers operating in different healthcare settings.

9. The tool and its components

'MUST' was developed by a multi-disciplinary group of health professionals and patients to detect both undernutrition (poor protein-energy status, referred to as malnutrition in this document) and obesity in adults of different ages and diagnoses in different healthcare settings. The tool involves assessment of weight status (BMI), change in weight, and the presence of an acute disease resulting in no

dietary intake for more than 5 days (or likely to result in no dietary intake for more than 5 days). It can also be viewed as tracing the clinical journey of the patient, from the past (history of unintentional weight change) to the present (current weight status or BMI) and into the future (likely effect of underlying condition). All three components can independently influence clinical outcome. In situations where weight and height cannot be measured, self-reported measurements, other surrogate measurements, and clinical judgment can be used to reliably estimate underweight, obesity and overall malnutrition risk. The tool categorises subjects into low, medium, or high risk of malnutrition and identifies the obese. It provides guidance on the interpretation of measurements, and suggests appropriate care plans, which can be modified to take into account local policy and resources.

10. Validity

The tool has face validity, content validity, concurrent validity with a range of other screening tools, and predictive validity. In hospitals (medical, elderly and orthopaedic wards), 'MUST' predicts length of stay (e.g. up to 2-4 times longer in high than low risk patients in elderly medical wards), discharge destination (e.g. to nursing homes and other hospitals from orthopaedic wards), and mortality after controlling for age. In the community, 'MUST' predicts rates of hospital admissions and GP visits, and shows that appropriate nutritional intervention improves outcome.

11. Reliability and internal consistency

The tool is internally consistent and reliable. It has very good to excellent reproducibility when different observers assess the same patients in hospitals (in-patients and out-patients), GP surgeries, and care homes (kappa values between 0.8 and 1.0).

12. Practicality

The tool has been found to be easy and quick to use and acceptable to both patients/subjects and healthcare workers.

13. Further evidence based consideration

Justification is provided for the use of an acute disease effect in 'MUST', equal weightings of the three component categories of 'MUST' (BMI, weight loss and acute disease effect), and the lower boundary BMI of 20 kg/m² for the elderly.

C: Guidance on undertaking measurements and using 'MUST'

14. Measurements

Procedures for measuring weight, height, and establishing BMI and weight loss are described, together with methods for estimating them (from ulna length, knee height, demispan, mid-upper arm circumference (MUAC)) when they cannot be measured directly.

15. Interpretation and use of the tool

Guidance is provided on how to use the tool in a range of situations, particularly those in which confounding factors influence the interpretation of weight change and BMI. Considerations and alternative measures relevant to these situations are summarised below.

15.1 Fluid disturbances: (i) *BMI* A low BMI is more significant if underweight is present with than without oedema. In the presence of barely detectable oedema, a correction can be applied by subtracting 2-3 kg from the measured weight.

MUAC can also be used as an indicator of underweight when there is oedema or excess fluid in the legs or trunk (including ascites) but not in the arms. Alternative strategies are to re-measure weight after correcting disturbances in hydration status, and to classify subjects as thin, acceptable weight, or overweight by inspecting them, noting if they are obviously wasted (very thin) or very overweight (obese).

(ii) *Weight change* When there are large and fluctuating fluid shifts, a history of changes in appetite and presence of conditions likely to lead to weight change can be used as part of an overall subjective evaluation of malnutrition risk, which categorises patients into low or medium/high risk categories.

15.2 Lactation: (i) *BMI* Use measured BMI. (ii) *Weight change* As for oedema.

15.3 Pregnancy: (i) *Pre-pregnancy BMI* Measurements of weight and height before pregnancy (or during early pregnancy, which is associated with little change in body weight) or recalled values can be used to estimate pre-pregnancy BMI; MUAC changes little during pregnancy and can be used to establish approximate pre-pregnancy BMI categories. (ii) *Weight change* Weight gains <1kg (<0.5kg in the obese) or >3kg per month during the 2nd and 3rd trimester generally require further evaluation.

15.4. Critical illness: *Acute disease effect (no or unlikely dietary intake for >5 days)* Most patients in typical intensive care units are at risk of malnutrition.

15.5 Plaster casts: Synthetic and Plaster of Paris casts for upper limbs weigh <1kg; those for the lower leg and back weigh 0.9 - 4.5kg depending on the material and site (see section C.3.2.6).

15.6 Amputations: Weight adjustments can be made from knowledge of the weight of missing limb segments: upper limb 4.9% of body weight (upper arm 2.7%; forearm 1.6%; hand 0.6%); lower limb 15.6% (thigh 9.7%; lower leg 4.5%; foot 1.4%).

16. The overall risk of malnutrition

This is linked to a care plan, but the operational pathways can vary from centre to centre to take into account specific groups of patients and the available resources.

A

Nutritional screening

A.1 Definitions

A.1.1 Malnutrition

Surprisingly, there is no universally accepted definition of malnutrition. The term literally means 'bad nutrition', but it is difficult to define the boundaries between normal and abnormal nutrition. For nutrition to be 'bad', it must have some short-term or long-term detrimental effects on the function of the body, such as susceptibility to disease and outcome of disease. The following definition has been suggested¹:

Malnutrition is 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, and composition) and function, and clinical outcome.

Malnutrition arises when nutrient intake is deficient, excessive, or otherwise imbalanced relative to demands. The adverse consequences of malnutrition often respond to nutritional intervention, although certain long-term effects may be irreversible, such as short adult stature resulting from prolonged childhood malnutrition, or blindness due to long-standing vitamin A deficiency. Malnutrition can be subdivided in different ways. One way is to divide it into undernutrition, which is due to a deficiency of nutrients, and overnutrition (e.g. obesity), which is due to an excess of nutrients. Another way is to subdivide it into nutritional problems due to micro-nutrients (trace elements and vitamins) and macronutrients (protein, fat carbohydrate). Yet another way is to divide it into clinical and sub-clinical (or pre-clinical) malnutrition, which implies that it is possible to use biochemical or other sensitive tests of tissue or body function to identify malnutrition before it becomes clinically detectable. However, the term malnutrition is commonly used to refer to under-nutrition rather than overnutrition, and it is in this sense that malnutrition is used in this report.

In this report, emphasis is given to clinically identifiable protein-energy malnutrition (poor protein-energy status). A useful epidemiological and clinical indicator of chronic protein-energy status is body mass index (BMI), a reproducible weight-for-height index (weight/height²) that is related to both mortality and body function. There are of course difficulties in identifying cut-off points, due to constitutional differences between individuals, but the classification shown in Table A.1 is widely accepted in the UK and elsewhere. Obesity is generally defined as a BMI > 30 kg/m², and underweight by a BMI <20 kg/m² (<18.5 kg/m² according to some classification systems).

Whereas BMI reflects chronic protein-energy status, a recent change in BMI or weight reflects acute changes in protein-energy status. The cut-off points for recent protein-energy malnutrition are difficult to establish, and there are no internationally accepted standards, either for adults or children. However, unintentional weight loss outside the normal intraindividual range suggests the presence of underlying disease processes or psychological problems that predispose to malnutrition.

Table A.1 Categories of BMI for identifying risk of chronic protein-energy malnutrition in adults

BMI category (kg/m ²)	Weight category	Interpretation of status
<18.5	Underweight	chronic undernutrition probable
18.5-20	Underweight	chronic undernutrition possible
20-25	Desirable weight	chronic under- or overnutrition unlikely (low risk)
25-30	Overweight	increased risk of complications associated with chronic overweight
>30	Very overweight (obesity)	moderate (30-35 kg/m ²), high (35-40 kg/m ²) and very high risk (>40 kg/m ²) of obesity-related complications

- (i) The adult BMI categories apply to both men and women of different ages. The categorisation can be overridden by clinical judgment e.g. the presence of oedema can be misleading, producing a higher BMI; and some perfectly healthy adults, especially young adults, with a BMI of 18.5-20 kg/m².
- (ii) The categories provide a simple but approximate indication of malnutrition risk, which is also influenced by other factors, such as the presence of diseases/disabilities, family history of diseases, diet, physical activity, and body composition. It is also influenced by a change in body weight.
- (iii) BMI also gives an indication of body composition (% fat and fat free mass), but at a given BMI body composition varies with gender (more % fat in women than men), age (more % fat in older than younger adults, especially in men), muscularity (less % fat in muscular individuals), fluid status (oedema, dehydration) and race.
- (iv) The cut-off values for overweight and obesity are largely based on risk of premature death in initially healthy individuals, but they are related to morbidity. The cut-off values for malnutrition are largely based on loss of pathophysiological function in individuals with and without disease, but they are also related to mortality in previously healthy individuals. They may be affected by race. There is general international consensus for choosing cut-off values of 18.5-20 kg/m² for underweight. Amongst the considerations are the following: reduced work capacity and muscle strength; the effect of low maternal BMI in producing low birth weight babies, who are more prone to neonatal problems and mortality, and increased risk of cardiovascular disease in adult life; and response to nutritional therapy.

It has been suggested that unintentional weight loss greater than 5% of body weight over a 3-6 month period, represents a cut-off for malnutrition¹. Unintentional weight loss of more than 10% of body weight over 3-6 months is generally considered to be clinically significant, partly because it suggests the presence of an underlying disease or psychological condition, and partly because it causes loss of body function^{1,2}. In the absence of disease, lean subjects begin to develop adverse physiological effects after about 5% weight loss. These become more marked by 10% weight loss and severe by 20% weight loss. Unintentional weight loss of 5% or more over a period of 6 months in adults of various ages, who were followed up

either as hospital outpatients or in-patients, was found to have an identifiable, treatable physical cause in the majority of cases³. Another study of elderly subjects investigated in hospital found that a more than 5% weight loss over 12 months was also associated with an underlying physical problem in the majority of cases⁴.

A.1.2 Risk

Although severe malnutrition and obesity are clinically obvious, there is some uncertainty about recognising lesser degrees of malnutrition. In the absence of universally accepted criteria for identifying malnutrition with high sensitivity and specificity, the concept of risk or probability is invoked.

Risk is a measure of the likelihood that malnutrition or obesity is present or likely to develop. Since malnutrition, by definition, is related to function and clinical outcome, risk is also related to these detrimental outcomes. These may relate to poor wound healing after effective surgery, delayed recovery from illness, or complications related to obesity such as type 2 diabetes, cardiovascular disease, and premature death^{5, 6}.

A.1.3 Screening

The UK National Screening Committee has provided two definitions for screening. These definitions, which appeared in the first⁷ and second⁸ reports of the National Screening Committee respectively, are set out below.

Screening (definition 1) The systematic application of a test or inquiry to identify individuals at sufficient risk of a specific disorder that warrants further investigation or direct preventive action, amongst persons who have not sought medical attention on account of symptoms of that disorder.

Screening (definition 2) A public health service in which members of a defined population, who do not necessarily perceive they are at risk of, or are already affected by a disease or its complications, are asked a question or offered a test to identify those more likely to be helped than harmed by further tests or treatment to reduce the risk of disease and its complications.

Although both definitions have common themes, the second definition incorporates two additional elements. First, since the test is offered, individuals have the opportunity to make a choice about being screened. Second, informed consent implies that the individual should appreciate the risks and benefits of the screening programme. However, the distinction between a 'screening procedure' and a routine clinical procedure, such as taking a pulse, blood pressure, or weighing a patient is not always clear.

Screening can be divided into proactive and opportunistic screening.

Proactive screening refers to the application of a screening programme to the

Table A.2 Screening programmes in England, where guidance exists⁷

Type of screening	Target population
Breast cancer	all women aged 50-64 y invited once every 3 y women over 65 y on request
Cervical cancer	all women aged 20-60 y invited once every 5 y
Phenylketonuria	all neonates
Physical examination	all neonates
Congenital hypothyroidism	all neonates
Child health screening	General Medical Service regulations
Cardiovascular risk factor screening	General Medical Service regulations: newly registered patients and patients not seen within 3 years
Child health screening	General Medical Service regulations
Elderly - general assessment	General Medical Service regulations: Patients aged 75 years and over assessed every 12 months
Bladder cancer	occupational exposure
HIV antibody	all women receiving antenatal care

whole of a target population. An example is the National Breast Screening programme, in which all known women aged 50-65 years are invited to be screened over a three year period. Other examples are shown in Table A.2⁷.

Opportunistic screening refers to the opportunity taken to screen individuals during routine contacts with health professionals. An example is blood pressure screening, which aims to identify and treat hypertension at an early stage to reduce the risk of cardiovascular complications, such as stroke or heart failure.

Nutritional screening for chronic protein-energy status in free-living subjects (e.g. using BMI) is opportunistic, but for those in nursing homes and hospitals, proactive screening is recommended.

It is important to distinguish between a screening test and a screening programme.

Screening test refers to the application of a test to identify a disease or a condition.

Screening programme refers to the full range of activities from identification of risk using a screening test or tool, to definitive diagnosis and treatment of the disease or condition. The 'Malnutrition Universal Screening Tool' involves the use of a screening test, as part of a screening programme.

A.1.4 Nutritional screening versus assessment

Screening is generally regarded as an initial brief evaluation, which often precedes an in-depth and more accurate evaluation of those considered to be at risk of a

particular disease or condition. The term 'nutritional screening' is used loosely by various workers around the world, so that some 'screening tools' involve a lengthy and detailed enquiry into the nutritional status of individuals⁹ rather than a brief initial enquiry. For the purposes of this document, which is primarily concerned with nutritional care of patients in the UK, a distinction is made between nutritional screening and assessment.

Nutritional screening is a rapid, simple and general procedure used by nursing, medical or other staff, often at first contact with the patient, to detect those with significant risk of nutritional problems, so that clear guidelines for action can be implemented, e.g. simple dietary measures or referral for expert help. The screening process may be repeated at intervals.

Nutritional assessment is a more detailed, more specific, and in-depth evaluation of a patient's nutritional state, typically by an individual with nutritional expertise (e.g. a dietitian, clinician with an interest in nutrition, or nutrition nurse specialist) or by a nutritional support team. This will usually be conducted in the case of serious nutritional problems identified by the screening process or when there is uncertainty about the appropriate course of action. The assessment process allows more specific nutritional care plans to be developed for the individual patient. It can also be used to identify micronutrient status, although confirmation may depend on laboratory investigations.

These definitions of screening and assessment are important, since blurring the distinction between them can lead to misunderstandings and lack of compliance with both processes.

A.2 Aims

The overall aim of this section of the 'MUST' report is to make recommendations about the principles of nutritional screening, with a view to establishing more coherent, more consistent screening procedures that are intimately linked to pathways of prevention and treatment, even when they span more than one healthcare setting. The focus is on malnutrition (used synonymously with undernutrition in this report (see section A.3)), which is less well recognised than overweight/obesity. This report complements another recent report 'Tackling Obesity in England'¹⁰. Section A of the 'MUST' report aims to use a consistent integrated approach to consider both under- and overnutrition. Objectives are:

- (i) To identify patients with significant malnutrition, who need immediate nutritional care (e.g. appropriate food, help with eating, oral nutritional supplements, or artificial nutrition by the enteral or parenteral route).
- (ii) To identify patients who may be well-nourished initially, but who are at risk of becoming malnourished unless intervention is taken (e.g. critical care patients and those who have recently developed difficulties in swallowing or other problems with eating).
- (iii) To identify overweight and obese patients, who have an increased risk of

mortality and morbidity from a variety of conditions (e.g. cardiovascular disease, cancer, osteoarthritis).

- (iv) To provide baseline information for reference in any future episodes of illness, to detect trends in individuals that may predict future health problems and to facilitate or improve health promotion programmes.
- (v) To facilitate better nutritional care leading to improved clinical outcome and reduced burden on healthcare resources.
- (vi) To provide a common healthcare framework across the community, hospital, and other healthcare settings, and to encourage continuity of information and care during the patient journey between these settings.

Table A.3 Percentage of underweight adult patients (BMI < 20 kg/m²) admitted to hospital in the UK and Ireland*

	Number of Subjects	% with BMI <20 kg/m²	Hospital Sector*
Dundee	500	37.5	M, S, R, E, O
London	65	29.3	E
Manchester	326	>24	M, S, O
London	186	22	M
Glasgow	219	18	S, M
Cambridge	100	21	E
Cambridge	57	21	M, S
London	692	17	M, S, O
Dublin	569	13.5	M, S, R, E, O
Glasgow	70	21.4	E (day hospital)
Manchester	100	23	M, S, E
Leicester	69	>19	M
Southampton	402	13	M, S, E, O

M = Medicine; S = Surgery; R = Respiratory; E = Elderly; O = Orthopaedic

* update of Stratton & Elia¹¹

A.3 The need for nutritional screening programmes

A.3.1 Major public health and clinical problems

Nutritional problems are major clinical and public health problems in the UK. The incidence of malnutrition is most common in the elderly, who represent the fastest growing segment of the population. Between 10-40% of adult patients admitted to hospital are underweight (BMI <20 kg/m²) (Table A.3)¹¹, but further loss of weight frequently occurs before patients are discharged back into the community¹², where more than 95% of underweight individuals are found. Patients living in institutions, especially nursing homes, are also frequently underweight, as are free-living individuals with disease (Table A.4)^{13-18,20}.

Population group	Underweight adults (%)
General population	
England	5.2 ¹³
Scotland	5.5 ¹⁵
Wales	5.0 ¹⁸
Subjects in the community	
Major surgery in previous 6 weeks	>10.6 ¹⁴
Chronic diseases of the lung, gastrointestinal tract and central nervous system	12.2 ¹⁶
Subjects in institutions	
Institutions in the UK (>65 years)*	16 ²⁰
Institutions in Scotland (>65 years)**	29 ¹⁷
Subjects in Hospital	13-40 (Table A.3)
* 57% registered residential homes, 30% nursing homes, 9% dual registration homes, and 4% other facilities	
** mainly nursing homes and some long term hospital wards; patients not terminally ill and in care for >3 months	

Recent unintentional weight loss beyond the normal range of variability also indicates an increased risk of developing malnutrition. A secondary analysis¹⁹ of the National Diet and Nutrition Survey (NDNS) data²⁰ has been undertaken to assess the prevalence of malnutrition risk in individuals aged 65 years and over. The risk was assessed using criteria similar to those in 'MUST', which incorporates both BMI and weight loss (see case study 1a in Annexe). It suggests that about 14%¹⁹ of all such individuals (those who are free-living and in care homes) are at medium/high risk of malnutrition, with a significantly greater proportion at risk in residential than in free living conditions (20.5% v 12.4 %) and in the North versus the South of England (19.4 %v 11.8%), mirroring and perhaps contributing to the distribution of other health inequalities²¹. The prevalence of malnutrition in hospitals is even greater (18-60%; see section B for results using 'MUST'). Malnutrition is both a cause and consequence of disease; it delays recovery from illness, and adversely affects clinical outcome (section A.5.3.1).

The incidence of obesity in adults (BMI >30 kg/m²) has increased 3 fold in the last 20 years and is set to increase further¹⁰. It now affects one in five adults^{10, 13}, and predisposes to heart disease, type 2 diabetes, hypertension, cancer, and arthritis. It also reduces survival and increases complications after blunt trauma²², increases risk of nosocomial infections²³ and post-operative critical respiratory events (in the case of gross obesity²⁴). Childhood obesity, which tends to result in adult obesity, is also increasing²⁵ and is expected to continue increasing at a rapid rate.

A.3.2 Under-recognition and under-treatment

At present both extremes of the nutritional spectrum are under-treated through lack of any formal screening programme that links effective recognition to effective treatment. There is now considerable evidence in the literature to suggest that nutritional interventions can be effective, although this is not always appreciated. In the case of obesity, a sustained weight loss of as little as 10% of body weight is associated with as much as a 50% reduction in health risks²⁶ (section A.6).

However, there is a need to demonstrate that nutritional programmes are effective in producing sustained weight loss or in preventing weight gain. Conversely, treatment of malnutrition is associated with both improved clinical outcome and decreased costs of care^{27, 28, 29}. There is particular concern about the frequent failure to recognise malnutrition in different healthcare settings (section A.4.2.1), as well as the lack of continuity of nutritional care when this spans across healthcare settings (section A.4.2.3). As many as 8 million patients are admitted and discharged from hospitals each year in England³⁰ and failure to recognise common treatable nutritional conditions represents a missed opportunity for addressing important clinical and public health problems. The lack of a consistent and coherent framework for dealing with these problems throughout the UK reflects a degree of uncertainty and confusion about the principles and processes involved in the development of nutritional screening tests and programmes. There is also uncertainty about the responsibilities of different healthcare workers (A.4.1.1).

A.3.3 Financial issues

Both malnutrition and obesity place heavy demands on the health service. The National Audit Office report¹⁰ estimated that the direct annual cost of obesity to the National Health Service (NHS) in England in 1998 was £0.5 billion, and the indirect costs, due to sickness, absence or death of workers was another £2 billion. Much of this cost could be saved through effective treatments involving lifestyle changes to reduce the prevalence of obesity. The cost of malnutrition is difficult to estimate but the following considerations provide an insight into the magnitude of this cost and the potential savings associated with appropriate prevention and treatment:

- Up to £266 million (1992 figures) could be saved by the NHS every year if malnourished patients in hospital were identified and treated adequately³¹.
- A reduction in the length of hospital stay by one day, through appropriate nutritional support of malnourished patients, corresponds to a cost saving of £233³², and to an even greater saving if the treatment of expensive complications could be avoided.
- Malnutrition in patients aged 65 years and over probably costs £2-4 billion annually more than caring for an equal number of well nourished individuals. This is mainly due to the increased rates of hospital admission and longer hospital stays (calculations based on a secondary analysis of data obtained by the National Diet and Nutrition Survey²⁰). Every 1% cost reduction produced by interventions corresponds to a saving of £20-40 million annually. Several reports have summarised the benefits of controlled clinical trials involving nutritional support in both hospital and community settings²⁹ (section A.5.3).

In the NHS, disease-related malnutrition places significant pressure on healthcare resources.

Home healthcare: Patients who are malnourished when discharged from hospital are two and a half times more likely to require healthcare at home³³.

GP services: Underweight patients (BMI <20 kg/m²) visit their GPs more frequently (6%) and require more prescriptions (9%) than those with more desirable weight (BMI 20-25 kg/m²)³⁴.

Hospital admissions and discharges: Malnourished elderly patients are more likely to be admitted to hospital than normally nourished elderly patients¹⁹. In addition malnourished patients discharged from hospital are more likely to be admitted to nursing homes³⁵, and readmitted to hospital³⁶ than normally nourished patients.

Length of hospital stay: Malnutrition increases the length of hospital stay, which can be reduced by nutritional intervention^{27, 29}.

A formal economic evaluation that takes into account the benefits produced by nutritional intervention is lacking. One estimate of the annual cost of disease-related malnutrition to the NHS is as high as £15-20 billion³⁷. In addition, the medico-legal costs associated with withholding and withdrawing nutritional support^{38, 39} in patients with disease-related malnutrition may be considerable.

A.3.4 Widespread demand for malnutrition screening

Nutritional screening is not just advocated by a few enthusiasts, but by a wide range of health professionals, professional organisations, the Department of Health, the Royal College of Physicians and the Council of Europe. Table A.5^{1, 17, 31, 40-49, 51} indicates a number of recent reports from multiple sources that reflect this need, in relation to health care settings^{17, 41, 48, 49, 50, 51}, types of individuals⁴³, and types of health professionals^{44, 49}. For example, *The National Service Framework for Older People*⁴³ and *Essence of Care* are two key documents which set out the fundamental aspects of care from which nurses work in relation to nutrition. They aim to improve basic but essential nursing care across wide areas of the NHS.

The widespread need for action is clear, but such action must be structured and effectively integrated into the overall care of the patient, which frequently spans more than one healthcare setting. With so many different screening tools available both in hospitals and the community, there is potential for obtaining different results, generating different workloads, and instituting different treatments in patients with similar characteristics. The situation would be improved dramatically if screening was undertaken using the same sound nutritional principles. This would establish a consistent overarching approach for detecting and managing underweight and overweight/obesity in individuals with acute and chronic conditions, in both primary and secondary care. Such an approach would offer the following advantages:

- The use of the same screening programme for patients moving from one healthcare setting to another avoids confusion and establishes continuity of nutritional care
- Differences in prevalence of malnutrition across geographic regions and health-

Table A.5 Reports that indicate the need for nutritional screening

'Food & Healing' Conference (2003) A Department of Health/NHS Estates report of a conference held in Queen Elizabeth II Conference Centre (Westminster, London) on 21st January 2003, emphasises the need for routine use of nutritional screening in clinical practice.

Improving Health in Wales Nutrition and Catering Framework (2002) This document, produced by the All-Wales Catering/ Nutrition Group for the Welsh Assembly Government (May 2002), recommends that nutritional screening should be undertaken on all patients admitted to hospital.

Food, Fluid and Nutritional Care (2003)⁵¹, produced by NHS Quality Improvement Scotland, recommends nutritional screening as a routine procedure for all patients admitted to hospital and plans to make this a standard (mandatory procedure).

Nutrition in Medicine: a doctor's responsibility (2002)⁴⁰, produced by the Royal College of Physicians, emphasizes the doctor's responsibility in preventing and managing nutritional problems, as part of an integrated, multidisciplinary programme that begins with nutritional screening.

Food and Nutritional Care in Hospitals: how to prevent undernutrition (2002)⁴¹. Evaluation of a report by the Council of Europe which sets out a strategy for treating malnutrition which affects up to 30% of patients admitted to hospital throughout Europe. It emphasizes that the first step in management is nutritional risk assessment.

Care Homes for Older People (2001)⁴², published by the Department of Health, provides minimum national standards for care homes, as part of the Care Standards Act 2000. The report recommends that nutritional risk screening in care homes should be undertaken on admission, and subsequently on a periodic basis. It also recommends that the findings should be recorded, and appropriate action implemented.

The National Service Framework (NSF) for Older People (2001)⁴³, published by the Department of Health, recommends that routine nutritional screening should be undertaken and appropriate action plans implemented. It refers to *Essence of Care*⁴⁴ for more specific standards on nutritional screening. The NSF for Older people also advocated a single integrated assessment framework rather than multiple independent assessment procedures. *The Single Assessment Process for Older People* (<http://www.doh.gov.uk/scg/sap>), provides recommendations for implementing a single assessment process with a scale and depth according to needs, so that assessments converge in an effective way without duplication.

Essence of Care (2001)⁴⁴, published by the Department of Health, provides a benchmarking toolkit to support professionals in working with patients to get the basics right. One of the aspects of care considered is nutrition, which includes two benchmarks on screening and ongoing assessment of nutritional status.

Acute Hospital Portfolio: Hospital Catering Report (2001)⁴⁵, by the Audit Commission, raised concern that many Trusts did not systematically screen patients for malnutrition.

National Nutritional Audit of Elderly Individuals in Long-term Care (2001)¹⁷, published by the Clinical Resource and Audit Group (CRAG) by the Scottish Executive, recommends that high priority should be given to decrease the high prevalence of malnutrition in long-term care facilities. It also recommends that all residents should be

Table A.5 continued

screened for risk of malnutrition within one week of admission and at monthly intervals thereafter.

Managing nutrition in hospital: a recipe for quality (2000)⁴⁶, produced by the Nuffield Trust, stresses the importance of recognizing nutrition as part of routine clinical management.

Detection and Management of Malnutrition (2000)¹, produced by the Malnutrition Advisory Group of the British Association for Parenteral and Enteral Nutrition (BAPEN), reported on the high prevalence of unrecognised and untreated malnutrition and produced a screening tool linked to a care plan to combat the problem in the community.

Eating matters (1997)⁴⁷, produced by the Centre for Health Services Research and the Institute for Health of the Elderly, University of Newcastle, was funded by the DH in response to nurses to improve standards of dietary care in hospital. It was developed for use by a variety of ward staff, but particularly nurses and doctors, and stresses the importance of nutritional screening and assessment, and provides practical guidelines.

Hungry in Hospital (1997)⁴⁸, produced by the Community Health Councils, as part of their role in monitoring the Health Service on behalf of the public, has raised serious concerns about 'hunger' in hospital and has compiled a series of reasons why this occurs. It recommends that the nutritional state of patients should be established on admission to hospital.

Malnutrition in Hospital (1996)⁴⁹, produced by the British Dietetic Association, states that healthcare workers, such as registered nurses or clinicians should detect most nutritional problems on admission to hospital and refer appropriate patients to the dietitian. It also emphasises the need for increased awareness of malnutrition in the community setting, so that continuity of care can be established.

The Kings Fund report, 'A positive approach to nutrition as treatment' (1992)³¹, which has helped raise the profile of clinical nutrition in the UK during the last decade, concluded that the full benefits of nutritional treatment will only be realised when the assessment of every patient's status has become routine.

care settings can be established and attention directed to areas with particularly high needs

- Policy makers and health planners are able to use internally consistent and comparable benchmarks for judging performance. In this way meaningful audits can be carried out, as part of clinical governance, both within and outside institutions.

Before such an integrated and overarching approach can be implemented effectively in the UK, it is necessary to establish the minimum essential criteria for nutritional screening in light of the recommendations made by the National Screening Committee^{7, 8}, and to be clear about terminology (section A.1).

A.4 Malnutrition: barriers to implementing effective nutritional screening programmes and their consequences

A.4.1 Barriers

A.4.1.1 Diffuseness of responsibility: Since nutrition crosses clinical discipline lines, it is understandable that responsibility sometimes falls between disciplines, making effective policies and integrated care plans difficult to implement. It is important to guard against such diffuseness of responsibility at all levels. This particularly applies to the interface between primary and secondary care, and between clinical and public health nutrition. Unfortunately, there are no national guidelines about how commissioners and planners of healthcare should address the problems of malnutrition and obesity, so Hospital and Primary Care Organisations do not usually operate effectively to combat these problems. There is also diffuseness of responsibility between different health workers, including those working in the same hospital (or ward) or Primary Care Trust (or general practice). It is of course necessary to have indicators of the quality of care, such as those recently produced by the Welsh Assembly Government. These indicators, which include a section on 'Eating,' refer to the quality of care which may be expected by those being cared for in any health or social setting⁵².

A.4.1.2 Inadequate infrastructure: Inadequate nutritional care frequently results from uncertainty about professional responsibility, which may be thought to rest with the catering service alone, rather than being an integral part of patient care. For example, a survey⁵³ of all nurses in a general hospital reported that less than half considered that they were responsible for the nutrition of patients, despite explicit statements by the United Kingdom Central Council for Nursing, Midwifery and Health Visiting (UKCC) to the contrary⁵⁴. Similar confusion exists among other health professionals, including doctors, dietitians and those involved in catering. There is also inadequate coordination and cooperation between different types of health professionals, and absence of policies to cover nutritional care across healthcare settings. Most Health Trusts in the UK do not have a nutrition team⁵⁵ or a nutrition steering committee. A nutritional steering committee, comprising a multi-disciplinary group of health professionals and administrators, sets nutritional policy within a Trust, but this may not extend to an integrated policy between hospital and community. Therefore, a coherent infrastructure for dealing with nutritional problems within health authorities is often lacking or inadequate.

A.4.1.3 Lack of consistent criteria or weightings to identify malnutrition/risk of malnutrition using screening tests: A large number of screening tests have been developed for identifying individuals with malnutrition or increased risk of developing malnutrition^{1, 56-58}. For example, the Malnutrition Advisory Group of the British Association for Parenteral and Enteral Nutrition (BAPEN) reviewed 23 community tools¹, and while 44 hospital and community tools⁵⁸ were assessed in a recent review paper. There are well over 50 published tools and many more unpublished tools that are used in clinical practice, but they may give widely different results for a variety of reasons.

- (i) The number and type of criteria used to detect malnutrition may vary considerably. 'Screening' tools frequently rely on anthropometric measurements, such as weight and BMI, but others rely on laboratory tests, or on dietary intake, or combinations of these. Certain screening tools rely entirely on current anthropometric criteria, such as BMI⁵⁹, others rely entirely on changes in anthropometric criteria, such as arm circumference⁶⁰, and many others on a combination of the two^{1, 61}. Some rely entirely on questions and no measurements⁶². The number of criteria in different screening tools varies from 3 to more than 15, frequently with several components to each criterion. The weightings and cut-off points applied to components of the screening tools are also variable and are often entirely based on subjective elements. This means that interpretation and assignment of malnutrition risk category may differ considerably between various types of health professionals^{63, 64}, and potentially between different individuals within the same discipline. Furthermore, various nutrition screening tools were developed for different purposes. The Nutrition Risk Index was initially developed to predict high use of health services by patients in the community⁶⁵, although it has subsequently been applied to hospitalised patients. Its focus is on the future risk of developing nutrition related conditions that utilise healthcare resources, rather than on nutritional status per se. The Subjective Global Assessment tool was originally developed to predict complications after gastro-intestinal surgery (infections, use of antibiotics and length of hospital stay)⁶⁶, although it has subsequently been applied to a variety of other patient groups. Many other tools were developed to recognise and treat established malnutrition, without considering or placing emphasis on utilisation of healthcare resources as the primary end point.
- (ii) Cut-off points for malnutrition vary even when the same criteria are used. For example, the lower cut-off points for BMI, which suggest increased risk of malnutrition, have varied from less than 18.5 to 24 kg/m². Similarly, the extent of weight loss signifying increased risk of malnutrition has varied considerably from less than 5% to more than 10% over 3-6 months.
- (iii) Many tools have not been developed according to recommended procedures for guideline development⁶⁷⁻⁶⁹, and so may not have been adequately tested for validity and reliability, or formulated according to evidence-based criteria. The tests may also be heavily biased towards a profession which may have developed the tool without adequate consultation with other types of health workers and potential users.
- (iv) Some tools have been primarily developed for use by nurses⁵⁷ or dietitians^{70, 71} and others for clinicians⁶⁶ and a variety of health professionals¹. The original Malnutrition Advisory Group (MAG) tool and the subsequent 'MUST' (see sections B and C) were developed for those health professionals who routinely come into contact with patients, including nurses, healthcare assistants, and doctors¹.
- (v) Some tools are more user-friendly and more acceptable to health workers than others. For example, the time taken to apply different screening tools can vary from a couple of minutes to more than half an hour⁷². It is impractical to implement some of the lengthier screening tests in routine clinical practice,

especially when there are already heavy demands on health professionals and/or their assistants. Some of the screening tests have been modified so that they can be undertaken over a shorter period of time, but even these may be too time-consuming for routine clinical practice.

- (vi) Several screening tools incorporate objective and reproducible components, such as measurements of BMI. However, such tools have been criticised because they cannot be used with individuals whose weight and height are not readily measurable. One study in an acute hospital did not establish BMI in as many as 35% of patients because of a failure to measure height and/or weight⁵⁹. Other studies involving patients admitted to medical, surgical and orthopaedic wards have reported even higher figures^{73, 74} although a study⁷⁵ of patients admitted to general medical wards reported that only 10% of patients' measurements could not be readily obtained when the staff were motivated to obtain the measurements.

Taken together, the above issues can cause confusion about the most appropriate tool to use. For example, a Nursing Nutrition Screening Tool applied to a geriatric ward in Sheffield identified 20% of patients as being at moderate/high risk of malnutrition compared to 79% using the Nutrition Risk Index in the same group of patients. Furthermore, only 1% of individuals were classified as being at high risk using the Nursing Nutrition Screening Tool compared to 24% using the Nutrition Risk Index. Differences in the incidence of malnutrition assessed using different criteria or nutritional indices have also been emphasised elsewhere⁷⁵. Added to this there may be poor agreement when the same tool is applied to the same patients by different types of health professionals (e.g. nurse and dietitian)^{63, 64}, particularly in the case of tools based largely on subjective components. Obviously, identification of individuals at risk requires an action plan and adequate resources to implement it. The difficulties of choosing an appropriate nutrition tool is emphasised by an analysis of community tools, which was reported previously by the Malnutrition Advisory Group¹, and a separate analysis of hospital tools, which is reported here. A preliminary evaluation of 28 tools used in hospitals is summarised below. The tools, most of which originated from North America and the United Kingdom, were identified through literature searches, cross referencing and by contact with experts in the field. They were published between 1979 and 2001, and reviewed independently by two individuals.

- About a quarter of tools were used, and in some cases specifically developed for doctors, dietitians and dietetic assistants. The majority were used by nurses. Some tools were used (and probably developed) for particular patient groups, such as surgical, trauma and elderly medical groups, whilst others were used for multiple patient groups.
- The tools varied considerably with respect to type and number of criteria, which included anthropometric, clinical, and laboratory criteria. Some tools incorporated past events (e.g. previous changes in weight or anthropometry), with little consideration of current status (e.g. current weight or BMI) and vice versa. Furthermore, little attention was given to likely future events. The tools contained 2-18 (mean 6) categories and 2-83 items, with about a quarter of tools

having 15 or more items. Some tools had long lists of diagnostic or therapeutic items. The time taken to complete the nutritional screen ranged from a few minutes to more than 30 minutes, although the latter would probably represent nutritional assessment rather than screening, a distinction that was not usually made.

- Evidence of a care plan, which in some cases was simply a referral to a dietitian, was lacking from the majority of tools.
- Evidence that two or more types of health professional were involved in the development of tools was found for only about 10% of tools. Most tools were developed by dietitians.
- Most of the publications did not provide the source or the reason/evidence for the choice of the criteria incorporated in the tools, and none provided information on the strength of recommendations. There was also little or no evidence of field testing and independent peer review prior to publication of the tools.
- Intra- or inter-observer reproducibility was provided for only about half the tools, and validity - admittedly difficult to assess - was lacking from a number of them.
- No evidence was found of plans to review the tools in the light of new information. There was also a lack of information as to whether the tools were amenable to modification according to local resources, particular clinical needs, or economic considerations.

A.4.1.4 Lack of education: Inadequate nutrition education amongst health professionals contributes to many of the above problems. For example, a MORI survey undertaken in 1998 found that 74% of GPs had no undergraduate training in nutrition, and 61% stated that they would welcome advice and training about how to manage their malnourished patients. Most general practices (67%) did not have a dietitian and most GPs (85%) did not follow protocols or guidelines for the treatment of disease-related malnutrition. A recent report suggested that education and training of GPs and community nurses, using a Nutritional Screening Tool, was effective in reducing total prescriptions, resulting in what the authors considered to be more appropriate prescription of supplements⁷⁶. A different survey in a UK teaching hospital concluded that knowledge about the assessment and management of malnutrition among doctors, medical students, nurses and pharmacists was poor⁷⁷. There is also concern about the lack of a minimum essential level of nutrition education among health care assistants and other health workers⁷⁸, who may undertake nutritional screening tests or be involved in the nutritional care of patients in hospitals and the community. The Federation of European Societies has also been concerned about the patchy or absent nutrition education in medical faculties in Europe⁷⁹. In the UK this is at least partly due to inadequate nutrition education at the undergraduate level⁸⁰.

A.4.2 Consequences

A.4.2.1 Under-recognition and under-treatment: The frequent failure to recognise treatable or preventable malnutrition is unacceptable in a modern health service. However, this will not be remedied until nutritional screening and appropriate action becomes part of routine clinical practice. In turn, this is unlikely to happen until there is implementation of educational programmes for health professionals on

the role of nutrition in determining quality of life. Three independent studies in British hospitals were consistent in reporting that most malnourished patients (82%, 71% and 76%)^{12, 59, 81} were not recognised/referred for further assessment and treatment. A further survey involving 70 hospitals in the UK and 771 hospital staff found that 66% of doctors did not know if weight had been measured, and 60% of doctors and 63% of nurses thought that questions about nutrition were unimportant⁸². There are also reports in the UK and elsewhere suggesting a frequent failure to recognise malnutrition in hospital outpatients (45-100%)⁸³, nursing homes (up to 100%)⁸⁴ and in the community (15-50% of children with failure to thrive)^{85, 86}. The Clinical Resource and Audit Group (CRAG), on behalf of the Scottish Executive, reported that 50% of elderly residents in long-term care settings were not recognised as being underweight¹⁷. Less than half were nutritionally screened on admission, and less than a quarter were subsequently screened at monthly intervals. In some of these residential homes weighing scales were not working (15% at the end of the audit). Many hospital wards also lack adequate instruments for measuring weight and/or height. It is obvious that no effective treatment can be implemented when there is either lack of recognition or inadequate recognition of the problem.

A.4.2.2 Failure to link a screening tool to a care plan: Some screening tests identify patients at risk of malnutrition, but they are not linked to a care plan. For example, the Malnutrition Advisory Group, a Standing Committee of the British Association for Parenteral and Enteral Nutrition (BAPEN), reported that only 7 out of 13 published community malnutrition screening tools incorporated a care plan¹. Without this, no effective nutritional programme can be implemented.

A.4.2.3 Failure to establish continuity of care: Patients identified as being malnourished or at risk of becoming malnourished in one healthcare setting are often not followed up when they are transferred into another healthcare setting. This may be due to lack of continuity of information, or communication of confusing information. For example, the results of a nutrition screening tool in one care setting may be difficult to interpret in another care setting, where different criteria and scoring systems for malnutrition are used. An effective screening programme should be internally consistent and valid in different care settings. Since the average length of hospital stay in England is only 7 days (secondary analysis by M Elia using Department of Health data for 2000), some workers feel that there may be too little time to implement nutritional support in hospital for a sufficient period of time to improve nutritional status adequately. However, in the absence of screening, many malnourished patients, among the 8-10 million who are discharged from hospital each year³⁰, will not be detected or given the benefit of nutritional support in the community.

A.5 Malnutrition: criteria for screening

A.5.1 Natural history

Since malnutrition can arise at all ages from a wide range of acute and chronic diseases, as well as psychosocial factors (e.g. social isolation, bereavements), its

natural history also varies. A mild, acute illness may produce trivial nutritional effects that are of little or no concern. With severe acute diseases, there is rapid loss of appetite, weight and body function. It may take weeks or months for full recovery, partly because of inadequate nutrition. With chronic conditions, nutritional problems often arise insidiously and either persist in a relatively stable state, as in some individuals with chronic obstructive pulmonary disease (COPD) or chronic depression, or progress, as in certain types of aggressive cancer. Nutritional problems may also arise episodically, for example when infections complicate chronic diseases such as AIDS. Disease-related malnutrition may be identified and managed in the community, hospital or both. A typical pathway is illustrated in Figure A.1. Deterioration in health may progress for months before admission to hospital, partly because of delays in seeking medical advice and partly due to delays associated with administrative pathways. Weight loss begins before admission, frequently continues in hospital, possibly because of surgical or other procedures, and even persists for a period after discharge. The proportion of an illness spent in hospital is often well below 5%. With acute illness, admission to hospital is rapid, but it may take a considerable time to recover, so that again only about 5% of the total illness may be spent in hospital. Therefore, there is a need to establish a coherent and structured approach to detect and manage malnutrition, which takes into account acute and chronic diseases, as well as healthcare setting. Figure A.1 (Page 26) also helps to illustrate the need for an integrated approach to malnutrition, during a typical journey between community and hospital settings.

A.5.2 The test (nutritional screening tool)

A.5.2.1 General considerations based on existing tools: A large number of screening tests are available, which use a variety of criteria to detect malnutrition. These criteria, which are shown in Table A.6, can be grouped into the following categories: anthropometric indices, diagnoses, history (general and dietary), clinical examination, treatment, and laboratory tests. The number of items and combination of items vary considerably, so that some tests are simple and brief, while others are lengthy and more complicated. Some tools aim to identify diseases, disabilities, symptoms (e.g. loss of appetite, nausea, vomiting), or treatments (e.g. chemotherapy, radiotherapy or drugs) likely to have caused or to cause weight loss. Assessment of dietary intake also aims to identify individuals not consuming enough to meet their needs. Most acute and chronic diseases do not cause an increase in energy expenditure²⁹. Drugs, especially multiple drug use, reflect the number or severity of the underlying conditions, and may cause anorexia, nausea and/or other gastro-intestinal problems that predispose to malnutrition. The laboratory markers may be misleading, because they are non-specific and many of them are more directly influenced by the disease rather than the nutritional status. For example, more than a 10% change in albumin level may occur acutely as a result of surgery or changes in hydration, even in those in good health with good nutritional status. Starvation or semi-starvation, uncomplicated by disease, produces little if any change in albumin^{87, 88}, and in anorexia nervosa, albumin, prealbumin, transferrin, and other proteins that have been labeled as 'nutritional proteins', remain within the normal range⁸⁹. However, investigations which include some of

Table A.6 Items that have been used in nutritional 'screening' tools in varying numbers and combinations

Anthropometric indices	Weight % ideal weight BMI Weight loss Mid-upper arm circumference Skinfold thickness
Diagnoses	Large lists of diagnoses
History	
General	Appetite and change of appetite Height, weight and weight change Diarrhoea and vomiting, nausea Number of drugs
Dietary	Current diet Diet prior to recent event or hospital admission
Clinical examination	Muscle and adipose tissue wasting Fluid retention (ascites, ankle and sacra oedema) Other (e.g. jaundice)
Treatment	Radiotherapy Chemotherapy Surgery Parenteral nutrition Enteral nutrition
Laboratory or other tests	Albumin Prealbumin Retinol binding protein Transferrin Haemoglobin, haematocrit, white cell count N balance, blood urea Delayed cutaneous hypersensitivity

the tests indicated in Table A.6 may be of use in the overall management of the patient, although these are not generally considered necessary for the initial nutritional screening procedure in busy NHS settings. They are more appropriate as part of nutritional assessment.

For a variety of other reasons, laboratory tests and skin tests are also not generally recommended as part of the routine initial screening procedure. There may be considerable delay between taking the sample (or initiating the test) and obtaining the result. For example, the delayed cutaneous hypersensitivity test takes 2 or 3 days to produce a result. The individual undertaking screening in different care settings may not be able to take blood or have ready access to laboratory facilities.

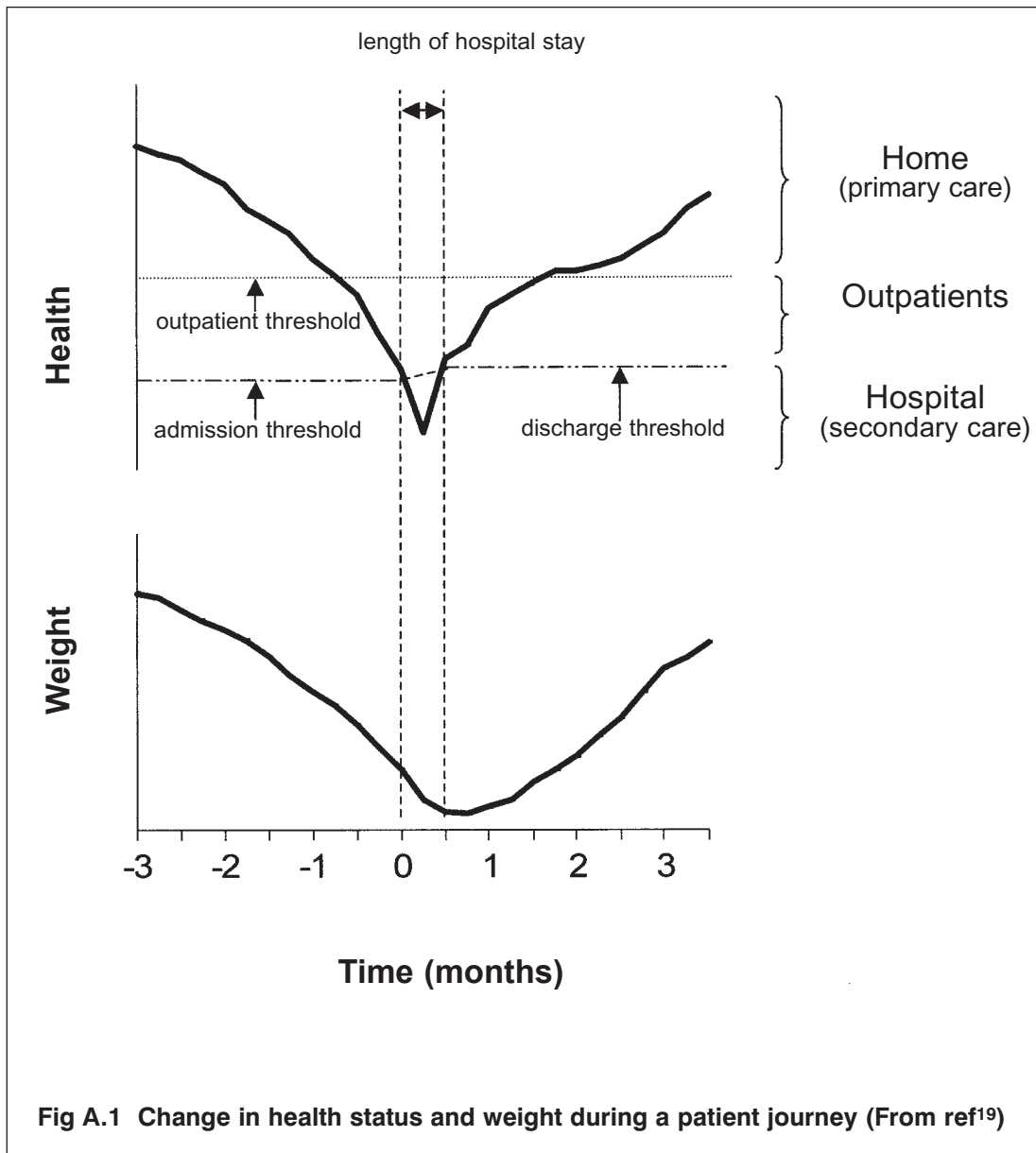


Table A.7 Important characteristics of a nutritional screening tool
<p>Practical</p> <ul style="list-style-type: none"> - Easy and quick to complete - Easy to understand - Acceptable to patients and health workers - Can be used on all adults
<p>Reliable, valid and evidence based</p>
<p>Linked to care plan</p>
<p>Scoring systems applicable to different care settings</p>

the laboratory tests may take longer to perform than the screening test and may be difficult to interpret due to confounding variables. Table A.7 itemises the desirable characteristics of a nutritional screening tool.

A.5.2.2 Fundamental considerations: The screening test should attempt to establish:

- current weight status (e.g. BMI) as well as recent and likely future changes in status (e.g. weight change)
- disease or condition likely to have produced the changes in nutritional status, so that the underlying problem can be treated

The screening tool should attempt to encapsulate these key elements using the most objective procedures and generally accepted cut-off values. BMI and weight loss are objective measurements which are discussed in more detail below. When it is not possible to obtain objective measurements, or there is concern about their interpretation (e.g. oedema, dehydration), alternative less objective measures can be used. The three nutritional elements of the tool, which also apply to overnutrition in adults (section A.6) and children (section A.8), are presented below separately, although they should be regarded as part of the same overall screening infrastructure.

a) Define current status

- Where possible, height and weight should be measured and BMI (weight (kg)/height² (m²)) calculated as an index of chronic protein-energy status. In the UK, a BMI <20 kg/m² is commonly used to indicate underweight (more severe if <18.5 kg/m²), and a BMI >30 kg/m² to indicate obesity (Table A.5). The presence of oedema or ascites, or pregnancy should be noted, since they inflate weight and may give a false impression of normality.
- When measurements of height and/or weight are not possible, alternative measures can be used and interpreted with the aid of age and sex specific tables. For example, knee height⁹⁰ and demispan⁹¹ (distance between supraclavicular (sternal) notch and root of middle finger with an outstretched arm) are useful surrogate measures of height, which have been used in nutritional screening. 'MUST', which is described in sections B and C of this report, also suggests the possible use of ulna length, because it is usually easier than the other measurements. It has also been suggested that waist circumference and mid-upper arm circumference, measured mid-way between the olecranon and acromial process, can be used as surrogate measures for weight and BMI⁵⁹, but experience and validity in routine clinical practice is more limited. Some patients may be able to recall very recent measurements of height and/or weight, which may be more accurate than those established using the surrogate measures. When the more objective measurements cannot be undertaken initially, they should be undertaken when it becomes possible to do so.
- An alternative and additional measure is a clinical impression about whether the patient is thin, of acceptable weight or overweight (including obese), and this impression should also be recorded.

b) Define recent change

Recent changes in protein - energy status are again established by the more objective procedures when possible and less objective measures when necessary.

- Previous weight may be recorded in the patient's notes, allowing objective changes in weight to be calculated. Frequently these measurements are not available, and therefore it is necessary to use less objective measurements.
- The subject is asked about weight and recent unintentional weight change. A reasonable period to make useful clinical judgments is 3-6 months, which is the most commonly used period in several screening tools, although others have employed time intervals ranging from 1 week to one year.
- In the absence of information about weight change (e.g. with elderly or confused patients), the patients and/or their relatives may be asked about whether their clothes or jewellery (rings on fingers) have recently seemed looser or tighter. This may also be confirmed by simple inspection.

c) Define probable direction of change

The patient is asked about appetite and food intake and whether this is improving or deteriorating. Diminished food intake predicts risk of worsening malnutrition, whereas enhanced intake suggests greater likelihood for recovery. Appetite and food intake can also be predicted by the disease and its severity. Examples include patients with prolonged unconsciousness, persistent or progressive swallowing difficulties, or severe illness, with extreme examples being major burns and multiple injuries, which are often treated in intensive care units. Patients who eat virtually nothing for more than 5 days, even in the absence of disease, lose 5-10% body weight. It is obvious that the direction of change (recovery or deterioration) is important in making predictions. Formal food charts and subjective impressions of intake can give an indication of likely change.

- It is suggested that locally developed screening tools should incorporate the above minimum principles. It is also suggested that these parameters are scored numerically using a rational evidence-based procedure. In difficult cases, where no objective measurements can be made about items a, b and c above, an overall single subjective score can be made by noting thinness (item a), recent weight loss (item b), and likely future trends (item c).
- Locally developed screening tools or tests should embody the above principles, but they may need to be adapted and linked to treatment according to the patient population and healthcare setting. The 'Malnutrition Universal Screening Tool' ('MUST') incorporates the common principles indicated above, but the general management guidelines vary according to healthcare setting.
- The screening test for malnutrition should also note the presence of obesity (BMI >30 kg/m²), and any special diets required or being followed by the patient, which can be considered according to local policy.
- The screening test incorporating the above minimum elements should be acceptable to the population being screened, and linked to an agreed policy on further action.
- The result should be recorded in the patient's notes at the earliest opportunity, together with the action taken. The findings should be communicated to relevant

Table A.8 Recommended maximum error allowance of weighing scales (range 0-100 and 50-200 kg)* for specific medical purposes (based on UK Weighing Federation and Directive 90/384/EEC on non-automated weighing instruments)**

	Hospitals Hospital associated medical centres Ante/post natal clinics Medical practice treatment rooms	General practice consulting rooms Mobile/visiting healthcare Nursing homes
Monitoring	0.2 kg	2.0 kg
Diagnosis	0.2 kg	0.2 kg
Treatment	0.2 kg	0.2 kg

* The maximum error allowance of a weighing scale is related to its resolution (division scale; e.g. a division size of 0.2 kg is associated with an error allowance of 0.2 kg).

** Directive 90/384/EEC about non-automatic weighing scales came into effect on 1st January 2003. A non-automatic weighing instrument is one where an operator is involved in the weighing process. Metric units became legal for controlled purposes from 1st January 2003, although instruments that have both metric and imperial (lb & oz) units can continue to be used. Medical weighing instruments purchased and in use before 1st January 2003 can continue to be used even though they do not meet the criteria of the Directive. It is recommended that establishments ensure that their instruments are calibrated at yearly intervals so that they hold their accuracy to the required standards. Further details can be obtained from the UK Weighing Federation (www.ukwf.org.uk) and National Weights and Measures Laboratory (www.nwml.gov.uk). Regulations may be found on HMSO website (www.legislation.hmsso.gov.uk).

health professionals involved in the care of the patient (see also section A.5.3.2).

- To undertake the nutritional screening test it is essential that hospital wards, outpatient facilities, nursing homes, GP surgeries, and other healthcare settings have accurate and reliable clinical weighing scales (see Table A.8) and stadiometers for measuring height (see section A.5.4.5).
- This report has focused on poor protein-energy status, although it is recognised that micronutrient deficiencies can occur independently. For example, iron deficiency anaemia from heavy menstrual losses, thiamine deficiency in alcoholics, and pernicious anaemia in elderly patients may occur in subjects with an acceptable BMI and no history of significant weight loss. Specific nutrient deficiencies may be recognised during nutritional assessment following referral from a screening procedure, but this will miss deficiencies in those who are not referred. Since nutritional problems have multiple causes and manifestations, doctors and other healthcare professionals need to consider the manifestations of nutrient deficiencies when making a differential diagnosis.

A.5.3 The treatment

A.5.3.1 Evidence of effective treatment: A screening programme has limited value if it identifies patients with (or at risk of developing) a particular condition, without

Table A.9 Physical and psychosocial effects of malnutrition (based on reference¹)

Adverse effect	Consequence	Reference
Physical		
Impaired immune responses	Predisposes to infection	130
Reduced muscle strength and fatigue	Inactivity, inability to work effectively, and poor self care. Abnormal muscle (or neuromuscular) function may also predispose to falls or other accidents	87, 131-133
Reduced respiratory muscle strength	Poor cough pressure, predisposing to and delaying recovery from chest infection	87, 134-136
Inactivity, especially in bed bound individuals	Predisposes to pressure ulcers and thrombo-embolism	133
Impaired thermoregulation	Hypothermia, especially in the elderly	132, 137
Impaired wound healing	Failure of fistulae to close, un-united fractures, increased risk of wound infection resulting in prolonged recovery from illness, increased length of hospital stay and delayed return to work	138, 139
Fetal and infant programming	Predisposes to common chronic diseases, such as cardiovascular disease, stroke and diabetes in adult life	5, 6, 140
Psychosocial		
Impaired psycho-social function	Even when uncomplicated by disease, malnutrition causes apathy, depression, self neglect, hypochondriasis, loss of libido and deterioration in social interactions. It also affects personality and impairs mother-child bonding	87, 131, 141

Table A.10 A summary of results obtained from clinical trials involving oral nutritional supplementation in hospital and the community^{28, 29}**Community*****108 trials (3747 patients)**

44 (41%) randomised controlled trials

64 (59%) non randomised controlled trials

Measurements of functional outcomes

63% of randomised controlled trials reported benefit, of which 73% were significant

74% of non-randomised trials reported benefit, of which 65% were significant

0% reported significant detriments

Functional benefits (randomised controlled trials)†

Chronic obstructive pulmonary disease: improved ventilatory capacity

Elderly: improved functional status, increased activity and activities of daily living

Liver disease: improved markers of liver function

Orthopaedics: retention of bone mineral density in femoral shaft

Surgery: preservation of skeletal (hand-grip) muscle strength, and improved physical and mental health/quality of life

Food intakeThe supplemental energy largely added to oral food intake in patients with a BMI <20 kg/m² and largely replaced energy intake in those with a BMI >20 kg/m²**Hospital******58 trials (3873 patients)**

34 (59%) randomised controlled trials

24 (41%) non-randomised controlled trials

Measurements of functional outcomes

65% of randomised controlled trials reported benefit, of which 71% were significant

All non-randomised trials reported benefit, of which 71% were significant

0% reported significant detriments

Clinical benefits (randomised controlled trials)†

Reduced mortality (19% v 25%; p < 0.001; odds ratio 0.61; 95% confidence interval 0.40-0.78; 11 trials, 1965 patients)

Reduced complications (18% v 41%; p<0.001; odds ratio 0.31; 95% confidence interval 0.17-0.56; 7 trials, 384 patients)

Reduced length of hospital stay (9 out of 9 trials)+

* update of review by Stratton & Elia²⁸** based on Stratton, Green & Elia²⁹

+ Formal meta-analysis was not possible because some results were reported as means or medians without standard deviations or range. However, in all 9 trials the mean or median values for length of hospital stay were lower in the supplemented than unsupplemented groups (p < 0.002; binomial test).

† In community patients with chronic conditions, benefits are more likely in patients with a BMI < 20 kg/m² than a BMI > 20 kg/m². In hospitalised patients with acute conditions, benefits are often less dependent on BMI.

offering effective treatment or prevention. For malnutrition, the evidence of benefit comes from two main sources: experimental human studies of nutritional depletion followed by repletion⁸⁷; and controlled clinical trials involving dietary advice, nutritional supplements, and artificial nutritional support. Reviews and meta-analyses of such studies are available^{29, 92-97}. Some of the generally accepted physical and psychological effects of malnutrition, derived from a large body of evidence, are shown in Table A.9^{5, 6, 87, 130, 141}. The table illustrates how malnutrition can detrimentally affect many body systems. Various randomised controlled studies or meta-analyses suggest that nutritional support of malnourished individuals or those at risk of malnutrition can reduce mortality, complications after illness, and length of hospital stay, and improve well-being. The functional benefits vary with the illness. As an illustration, Table A.10^{28, 29} summarises the largest analysis so far undertaken of clinical trials assessing the effect of mixed micronutrient and macronutrient nutritional supplements in hospital and the community. An increase in the energy density of food and/or feeding frequency has been found to increase energy/nutrient intake in healthy and underweight adults and children both in and outside hospital⁹⁸⁻¹⁰⁴. The eating environment has also been shown to have an important effect on food intake, for example in long-term care wards¹⁰⁵. Although formal trials linking these interventions to significant improvements in clinical outcome measures are lacking, increased food intake and increased body weight are considered to be part of the causal pathway between treatment and clinical benefit. A change in catering services in hospital has recently been implemented with a view to improving the quality and increasing the availability and intake of food¹⁰⁶. However, in some cases the change in dietary intake may increase the intake of protein and energy and not micronutrients.

The scores of screening tools, like all symptoms, signs and tests, should be interpreted with sound judgment, and treatment should be appropriate to the patient's circumstances. For example, a patient whose death is imminent may have high nutritional risk, but aggressive nutritional support may be inappropriate and counter-productive. Therefore, the screening test should aid rather than replace overall judgment.

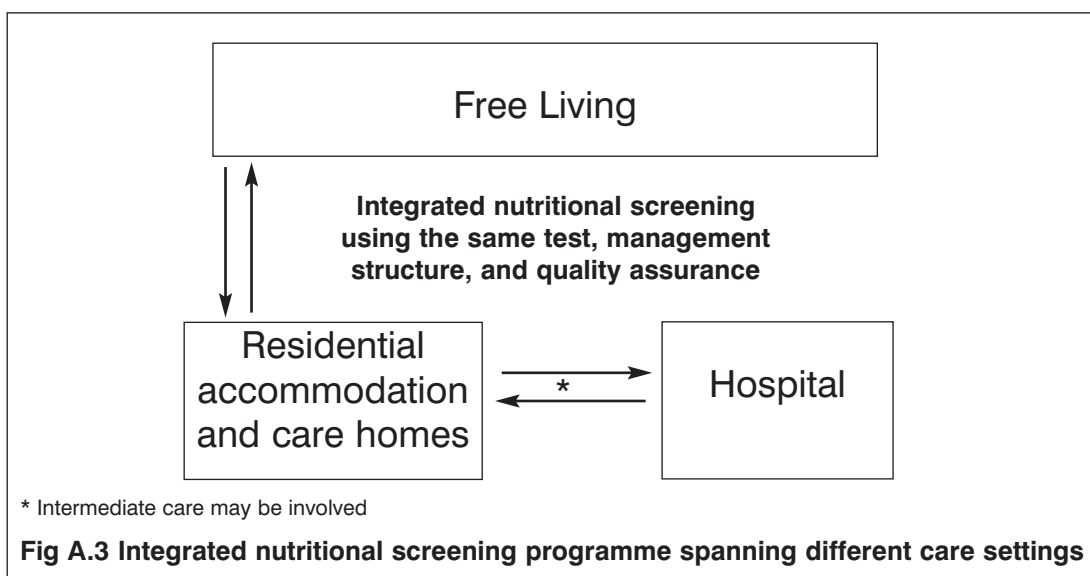
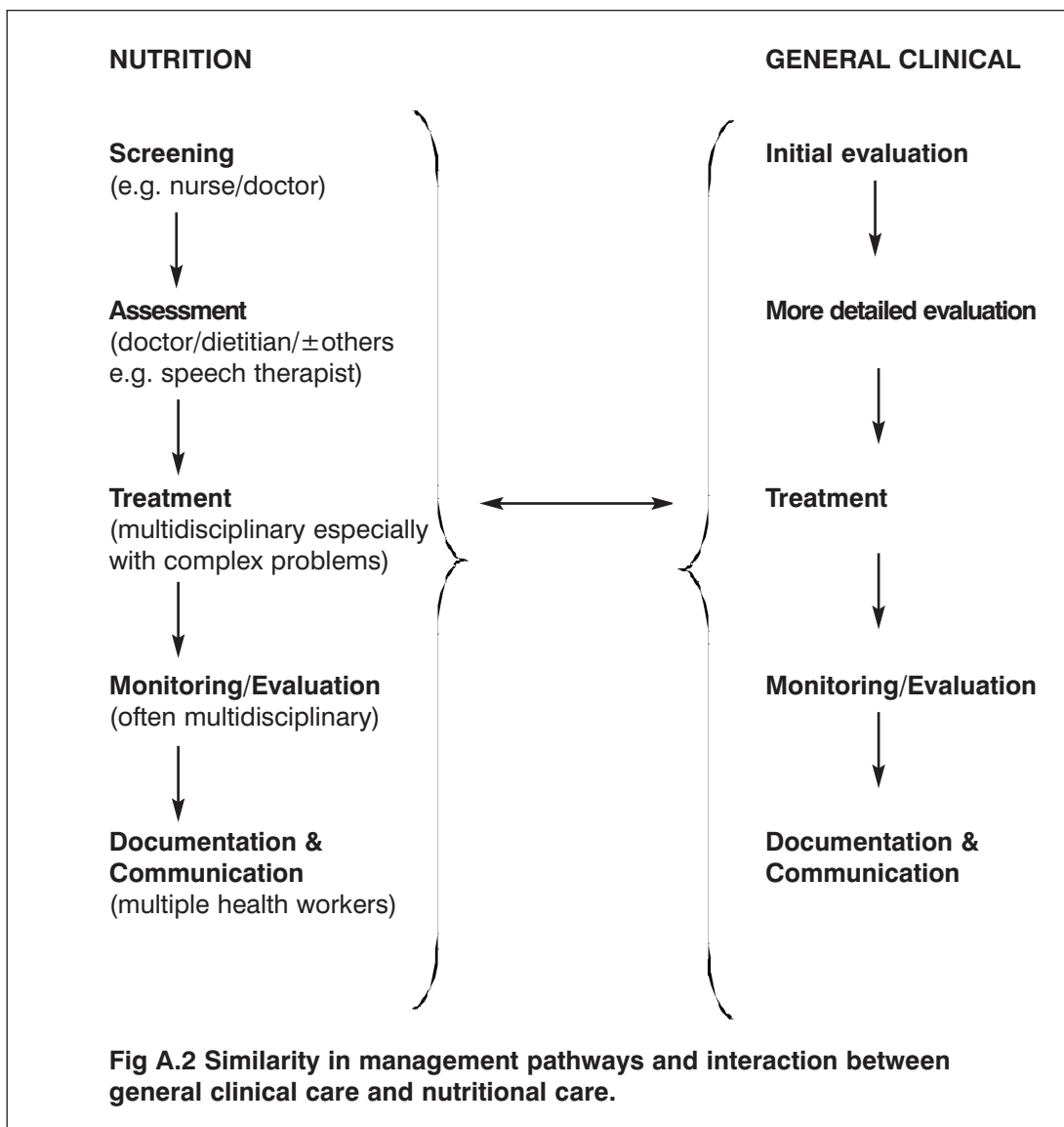
A.5.3.2 Policies: There should be agreed policies about the course of action, including which individuals should be offered treatment and the type of treatment offered. There should also be policies about professional responsibilities, education and training.

- *Population to be screened* There should be an agreed policy on the types of individuals who should be screened. It is suggested that a simple nutritional screening procedure is carried out as an integral part of clinical care in patients admitted to hospital and care homes. It is also suggested that this procedure be carried out on new patients attending GP surgeries, during the routine annual health assessment of patients aged 75 years and over, in vulnerable groups, and in those for whom there is clinical concern (e.g. in those with swallowing problems). The screening test should be repeated at intervals, depending on the clinical condition, resources available, and healthcare setting. For example, in nursing homes, weighing patients once a month may be adequate, whereas in acute hospitals it is

- more appropriate to weigh patients once a week or even more frequently.
- *Link of screening test to care plan* The plan may in the first instance involve observations to assess whether the patient's appetite, food intake and weight are improving or deteriorating. Food charts may be used in hospitals or nursing homes to obtain more objective measures of the changes in food intake. The course of action may also involve referral of patients to dietitians, who are able to assess patients in more detail and provide more specific therapy. Similar policies should exist with regard to specialised forms of treatment, such as enteral and parenteral nutrition, which are given to a relatively small group of individuals. In all these situations the goal of the intervention should be established and the underlying disease treated appropriately.
 - *Documentation* There should be a policy that nutritional screening results are recorded in the patient's notes, or electronic patient records, and should include height and routine measurements of weight and weight change. There should be a concluding statement describing nutritional risk, treatment, and goals of treatment.
 - *Communication* All health workers involved in the nutritional screening programme should communicate appropriately, just as they should in routine clinical practice. The recent introduction into some hospital wards of collaborative care notes, which may be electronic or paper versions, provides an important opportunity of simultaneously documenting and communicating patient nutritional information, so that multidisciplinary care can proceed in an effective manner. It is particularly important to communicate results of nutritional screening, as well as the treatment plans and their goals when an individual's care changes from one health setting to another (e.g. from hospital to the community).
 - *Health worker responsibilities* It is also necessary to establish policies about the role of different health professionals. Screening is often undertaken by those most likely to interact with patients in routine clinical practice, typically nurses or health care assistants. The doctor normally establishes the aims of treatment, and takes overall responsibility for coordinating the care of the patient. The role of different health workers involved in the management of the patient may vary, depending on local resources, skills, policies, and the type and severity of the underlying conditions. Suggested roles of different health workers are shown in Table A.11.
 - *Education* Policies of best practice are dependent on continuing education and training (section A.9), which encompasses the clinical governance framework.
 - *Integration* The nutritional screening programme should be regarded as an integral part of routine clinical care. Similarities in pathways and interaction between the nutritional screening programme and routine clinical care are illustrated in Figure A.2. In addition, the screening programme is more likely to be effective if it operates in a coherent operational infrastructure that covers different healthcare settings, using the same screening test, management structure, and quality assurance (Figure A.3).
 - *Development of screening test and programme* There should be guidelines and a

Health worker	Screening test	Treatment		Monitoring documentation communication
		Underlying conditions	Malnutrition	
Registered nurse	√	Help with a variety of physical and psychological problems. Encourage eating. Receive general guidance from dietitians.	Reinforce dietary advice and assess compliance, and in some cases establish care plan in conjunction with doctor and other health professionals. Help with feeding and monitor food intake.	√
Healthcare assistant (e.g. assistant to nurse or dietitian)	√	Assist health professionals in treatment of underlying conditions.	Dedicate a great deal of time and inordinate patience to maintain sound nutrition in severely disabled individuals, especially those with feeding problems.	√
Doctor	√	Overall responsibility. Initiate treatments and refer to other health professionals.	Advise on overall care plan and prescribe supplements (on advice of dietitian).	√
Dietitian	√	Special nutritional problems and provide advice about special diets. Assess suitability of adult food supplements. Train professional and support staff, identify dietary idiosyncrasies potentially leading to deficiencies.	Expert on many nutritional issues, deal with more formal and detailed assessment of specific management issues (referral from doctor/nurse). Advise on food and supplements, enteral and parenteral nutrition, and special diets.	√
Health visitor	√	Detect problems, assess family dynamics, monitor growth, initiate weighing when there is concern, and refer to other health workers.	Refer for expert advice if concerned about nutritional care.	√
Occupational therapist	*	Help feeding practice by advising on specialised cutlery and crockery and seating, and functional ability to prepare food.	Refer for expert advice if concerned about nutritional care.	√
Pharmacist	*	Aware of malnutrition induced by side effects of drugs, such as loss of appetite, nausea, gastrointestinal disturbances and confusion.	Refer for expert advice if concerned about nutritional care.	√
Physiotherapist	*	Help with mobility, muscular coordination, breathing.	Refer for expert advice if concerned about nutritional care.	√
Psychologist/ Psycho-therapist	*	Deal with specific psychological/psychiatric problems and eating disorders.	Refer for expert advice if concerned about nutritional care.	√
Social worker	√	Help with living conditions and social problems.	Benefit entitlement, support from carers, 'meals on wheels' and lunch clubs.	√
Speech & language therapist	√	Help with swallowing, texture modification of food, and communication.	Refer for expert advice if concerned about nutritional care.	√
Dentist	*	Deal with oral and dental hygiene.	Refer for expert advice if concerned about nutritional care.	√
Midwife	√	Detect malnutrition in expectant mothers and families, refer to doctors.	Refer for expert advice if concerned about nutritional care.	√
Voluntary services		Carers and patients associations to deal with a variety of practical issues and provide psychological support and companionship.		√(Communication)

* These health workers may be involved in screening, especially when they are the first to come in contact with patients in primary, intermediate, or secondary care. For establishment of training and competency of health care workers, see section A.9.2 (and C.5)



policy about how to develop and apply a screening test and programme (see section A.5.4.7).

A.5.3.3 *Optimisation prior to full implementation of screening programme:* The clinical management of malnutrition and overall patient care should be optimised by a multidisciplinary group of health workers prior to implementation of the full screening programme. This includes establishment of an efficient recording and referral system, checking that adequate resources are available, and ensuring that care is continued from one health setting to another.

It is essential that staff involved in nutritional screening should be properly trained and motivated, and that regular audits of the use of screening tests are carried out.

A.5.3.4 *Monitoring: GPs, and community health professionals involved with management:* Hospital health professionals also have a role in managing patients outside the hospital environment, by liaising with community health professionals, providing up-to-date information about patients after discharge from hospital or after outpatient attendance, and advice about specific management issues. To ensure continuity of care, it is essential that there is prompt and effective communication between primary and secondary care, particularly for malnourished patients who have a short hospital stay. Hospital and community health professionals can also improve care by establishing an agreed care plan based on common principles.

A.5.4 The screening programme

In implementing screening programmes, consideration of the following issues is generally recommended:

A.5.4.1 *Evidence:* Health professionals should aim to establish evidence, which includes high quality randomised controlled trials, that a screening programme is effective in reducing mortality or morbidity. This may be easier to undertake for a specific disease than 'disease-related malnutrition'. This is partly because disease-related malnutrition includes a wide range of diseases, both physical and psychiatric, partly because malnutrition is both a cause and consequence of disease, and partly because nutritional care is currently a variable component of routine clinical care. Nevertheless, health professionals should aim to examine the overall effectiveness of an opportunistic nutritional screening programme that spans the community, hospital, and other care settings.

A.5.4.2 *Acceptability:* There should be evidence that the complete screening programme, including screening test and treatment, are clinically and ethically acceptable to health professionals and the public. It is almost certain that very time-consuming screening tools will not be generally accepted by busy health professionals working in the NHS.

A.5.4.3 *Benefits versus possible harm:* The benefits of the screening programme should outweigh the possible physical and psychological harm caused by the screening tool, and the procedures and treatment that follow.

A.5.4.4 Health economics: Attempts should be made to evaluate the screening programme economically in relation to the overall costs of medical care.

A.5.4.5 Equipment, resources and quality assurance: There should be adequate resources for managing the screening programme using agreed quality assurance standards. For example, audits can be undertaken to ensure that nutritional screening is carried out, that staff are adequately trained to use the screening test appropriately, and that the overall programme is effective. In addition, since nutritional screening is recommended as an integral part of routine clinical practice, it is necessary to have close access to reliable and accurate weighing scales and stadiometers (see A.10 Annexe, case study 1). Different types of weighing scales may be necessary for the grossly obese (extended weight range) and those who cannot stand (chair or harness weighing scales). It may also be possible to use electronic bed scales to measure body weight as the difference between the weight of the bed and bed plus patient. Portable but reliable lightweight stadiometers (or simple reliable electronic instruments for measuring height¹) and weighing scales are available for home visits. The instruments should be calibrated regularly (e.g. annually for clinical weighing scales in institutions; see A.10 Annexe, case study 1). If possible, equipment intended for domestic use should not be used for clinical monitoring of patients, because it is less accurate, less reliable and less amenable to appropriate calibration procedures. The recommended criteria for weighing scales are shown in Table A.8.

A.5.4.6 Other options: Other options for managing malnutrition should be considered, (as well as the timing and type of nutritional care) in the context of other medical treatments. For example, in critically ill patients it is important to resuscitate to ensure haemodynamic and metabolic stability before aggressive nutritional therapy is started. The similarity of nutritional care to overall clinical care is illustrated in Figure A.2.

A.5.4.7 Development of a nutritional screening test and programme: In developing nutritional screening tools and programmes that are integrated into routine clinical practice, it is advisable to follow recommendations for guideline development. The following are some of the recommendations:

- The nutritional screening test and programme should be evidence based, practical, and established by a multidisciplinary group. It is advisable to develop the programme using experts in nutrition, individuals involved in guideline/screening development, and potential users. Development by a single profession without appropriate consultation could result in the programme being unbalanced and biased towards that profession, and impractical for patients. It is also valuable to obtain constructive criticism from independent referees (especially those who can provide an expert opinion about the clinical content), from those involved in large or multidisciplinary screening programmes or guideline development, and from potential users⁶⁸. Any national screening programmes should be assessed by the National Screening Committee.

- Establish validity, reproducibility and practicalities of using the tool.
- Provide a source of scientific evidence to back up each recommendation and a grading for the strength of recommendations in both the screening test and programme.

The following is a widely used grading system for the strength of supporting research¹⁰⁷:

- A:** requires at least one randomised controlled trial as part of the body of literature of overall good quality and consistency addressing the specific recommendation,
- B:** requires availability of well-conducted clinical studies but no randomised clinical trials on the topic of recommendation,
- C:** requires evidence from expert committee reports or opinions and/or clinical experience of respected authorities. Indicates absence of directly applicable studies of good quality.

A grade of the overall evidence for the screening programme, provided by the National Screening Committee, is as follows:

- A:** robust evidence that benefit outweighs harm
- B:** evidence that benefit outweighs harm
- C:** evidence of both benefit and harm
- D:** evidence that harm outweighs benefit
- E:** robust evidence that harm outweighs benefit
- F:** insufficient or inadequate evidence about benefit and harm.

A.5.5 Overall organisational infrastructure and clinical governance

Since nutrition is linked to general health and wellbeing and affects every system of the body, and since it is used to prevent and treat a range of diseases and disabilities, it involves a wide spectrum of health professionals. Therefore it is important to define responsibilities, especially during multidisciplinary care, so that quality of care can be improved. The following are recommended to achieve this aim:

A.5.5.1 Organisational infrastructure:

- *Individual health workers* An infrastructure should exist to establish personal development plans for those working for the NHS. This involves identifying individual needs, through reflections on personal portfolio and through appraisal, in the context of the strategic direction of the Trust. The Audit Commission has strongly recommended the establishment of such an infrastructure because it has identified significant numbers of staff whose training and development needs are unidentified, either because these needs have not been explored, or the identification process is poor⁵⁰. Since nutrition affects every branch of medicine, Trusts should encourage incorporation of a nutritional education and training component in personal development plans.
- *NHS Hospital Trusts* Each NHS Trust should have a multidisciplinary Nutrition Steering Committee to establish, integrate and implement coordinated nutritional

policies within the Trust. The Nutrition Steering Committee should have wide representation from the different divisions of the Trust, and have power to make changes and initiate audit. Each Trust should have a Nutrition Support Team or access to such a team to deal with special or difficult problems, such as those involving parenteral nutrition.

- *Commissioners and planners of healthcare* Each health region should establish overarching policies for prevention and treatment of malnutrition, with a consistent practice that operates across different healthcare settings. All NHS Trusts should be familiar with one common policy so that integrated care, which includes social services, can be implemented. A case study illustrating the nutrition policy of a former Health Authority is shown in the Annexe (A.10, case study 2).
- *Health service departments* Health service governmental departments should encourage and facilitate the above developments, ensure that appropriate resources are available to establish the infrastructure and undertake audit at local, regional and national levels.

A.5.5.2 Performance assessment, audit, and resource implications: Like other initiatives, those involving nutrition need to be audited and assessed, and adequate resources made available for this process. Since there are a large number of potential audits it is necessary to prioritise them.

A.6 Screening for obesity in adults

A.6.1 Benefits of weight loss in obesity

The same general principles about screening programmes indicated above apply to overweight and obesity, where the aim is to establish weight control and weight reduction. Sustained weight loss will reduce the risk of obesity-related morbidity and mortality. A report by the Royal College of Physicians in 1998²⁶ suggested that the following benefits can result from a 10% weight loss in a 100kg individual with obesity related co-morbidities:

- 30-40% reduction in diabetes related deaths
- 40-50% reduction in cancer deaths
- 20-25% reduction in total mortality
- 10% fall in total cholesterol
- clinically significant fall in diastolic and systolic blood pressure.

A.6.2 Lack of effective screening programmes for obesity

- The National Audit report on obesity in England¹⁰ concluded that there is little NHS activity related to the management of obesity apart from that in general practice. Even here, obesity management is not widely practised, rarely represents a comprehensive framework for the management of patients, and has not been independently evaluated for effectiveness. There are also no national guidelines about how health planners should address the obesity problem, and

none have been set centrally for the development of local policies. However, since the recent 'epidemic' of obesity is probably largely due to behavioural changes involving reduced physical activity and altered eating habits, there is a need to address these lifestyle changes at national and local levels through integrated public health and clinical approaches. From a clinical perspective, the following are relevant to the development of a screening programme:

- (i) Although obesity is usually easily recognised both by the patient and health professionals, there are opportunities in routine clinical practice for identifying those at high risk of complications (e.g. high BMI, high waist circumference, rising weight, and family history of co-morbidities, such as diabetes).
- (ii) Patients may be unaware of the risks and complications associated with obesity, and there are opportunities for education, especially in primary care, where 95% of the interactions with health workers occur.
- (iii) Patients seek medical help about a wide range of medical and/or psychosocial problems, which may or may not be related to their obesity. If their problems are identified as being obesity-related, then attempts to educate and motivate patients to participate in a weight control or reducing programme are likely to be more successful.
- (iv) Experience suggests that appropriate follow up by health professionals can encourage patients to remain motivated, provides an opportunity to reinforce advice about the role of diet and exercise to promote weight control, and ensures that co-morbidities are kept under control.
- (v) The National Audit Report on Obesity¹⁰ suggested that hospital admissions provide an important opportunity to undertake screening for obesity, and that there is a need to ensure that patients are referred and followed up with appropriate treatment after discharge. Patients are likely to become more motivated and more responsive to medical advice about weight control following a severe obesity-related illness, especially if this is life threatening.

A.6.3 General considerations for screening for obesity

- The screening test for overnutrition should consider the same general issues that apply to malnutrition, namely defining current status (BMI), as well as recent changes in weight or BMI and the likely direction of future changes. As with malnutrition, conditions likely to have contributed to obesity and its complications need to be identified, so that appropriate advice and treatment can be offered. Although obesity is generally defined as BMI >30 kg/m², cut-off points to signal concern about weight increase over defined periods of time need to be established. The screening test should be linked to a weight control programme, which may have as its first aim prevention of weight increase, followed by weight reduction. There should be evidence of efficacy.
- A screening test that involves measurement of BMI will identify individuals who are underweight as well as overweight or obese. Conversely, if a screening tool for malnutrition identifies an obese patient, there should be a policy advocating referral to other screening programmes or health professionals.
- Apart from the general similarities in the principles of screening for malnutrition and overnutrition, and the need to establish an integrated programme across

healthcare settings for each of these, it is recommended that the screening programmes interact in a coherent and mutually beneficial manner. This is not only because lean individuals can become obese and obese individuals can become malnourished, but also for practical reasons that minimise duplication of work.

- Since obese patients may develop weight loss due to disease, it is necessary to distinguish between intentional and unintentional weight loss, so that any underlying pathology can be detected and treated early.

A.7 Nutritional screening during pregnancy and lactation

A.7.1 Pregnancy

Screening during the reproductive cycle (from before conception to the post-natal period) can be used for detecting and treating underweight and overweight/obesity before pregnancy has occurred (e.g. in GP surgeries or gynaecology clinics), as well as preventing morbidity and mortality in mother and offspring during gestation and after childbirth. Weight measurements during pregnancy should be taken early to allow sufficient time for appropriate intervention. Therefore, it is recommended that screening to identify those who may need nutritional supplements containing micro- and macro-nutrients should be done during early pregnancy¹⁰⁸.

Screening/assessment later on in pregnancy can help identify mothers eligible for referral to special healthcare facilities, where pre-term and small for gestational age babies can be delivered. Attained body weight at any time during pregnancy appears to be the most valuable indicator of small for gestational age. Evidence also clearly indicates that pregnant women who are clinically undernourished and whose intake is particularly low respond to mixed dietary supplements containing energy, protein, and other nutrients, by increasing their body weight. The effects of these supplements on the body weight of other women who are not clinically undernourished are less pronounced and depend on type of supplement, the timing of supplement administration and pre-pregnancy weight¹⁰⁹.

Nutritional screening during pregnancy is unique in that it aims to reflect not only the nutritional status of the mother, but also the growth/nutritional status of the baby. A prognostic marker of lactation performance will also provide valuable information about the potential growth of the baby after birth. Therefore, the rationale for undertaking nutritional screening during the reproductive cycle is to identify both short-term and long-term reproductive-related problems in the mother (e.g. mortality, pregnancy related complications, lactation performance, and development of chronic disease) and fetus/baby (e.g. mortality, morbidity, intra- and extra-uterine growth retardation, and development of chronic diseases later in life), particularly those likely to respond to interventions. Anthropometric indices are related more strongly to fetal growth than complications of pregnancy and labour¹⁰⁸. However, retardation in fetal growth can occur as a consequence of low availability of nutrients from a malnourished mother as well as from poor transfer of nutrients across the placenta of a well nourished mother. In the latter situation anthropometry is likely to be normal. Therefore, measurements of placental function and ultrasound measurements of intrauterine growth can provide important

complementary information to maternal anthropometry.

Nutritional screening during pregnancy and lactation is also unusual in that it is applied at a time when there are substantial physiological changes in body weight. For example, during pregnancy the increase in body weight may amount to more than 20% of the pre-pregnant weight, especially in underweight women, who often gain more weight than 'normal' or overweight women. In contrast to non-pregnant women, failure to gain weight can indicate a serious underlying problem. Unfortunately, the variability in normal weight gain during pregnancy and lactation is also substantial, which makes effective nutrition screening during the reproductive cycle more challenging than usual. At present only tentative cut-off points can be provided to identify deviations in weight and weight gain that are likely to indicate increased risk of adverse outcomes^{108, 110, 111}. Nevertheless, the principles of nutritional screening during the reproductive cycle are similar to those in other situations, and these are considered sequentially below.

A.7.1.1 Pre-pregnancy BMI and weight change: These may signal the presence of an underlying problem that needs attention. A low pre-pregnancy BMI is associated with increased risk of low birth weight babies¹¹⁰. This effect appears to be independent and additive to the effects produced by low weight gain during pregnancy¹¹². Obesity is associated with menstrual disorders, infertility and miscarriage¹¹³. It also increases the risk of hypertensive and diabetic pregnancy, induced and assisted labour, caesarean section and postpartum haemorrhage. Babies born to obese mothers are more likely to have neural tube defects (two-fold increase), independently of folic acid intake¹¹⁴, have low Apgar scores associated with greater neonatal morbidity and mortality, and increased risk of childhood obesity^{115, 116}. Overweight and obesity are also associated with an increased probability of unsuccessfully initiating breast feeding¹¹⁷ and appear to have a deleterious effect on *in vitro* fertilization outcome¹¹⁸. For these reasons, opportunities should be taken (e.g. in ante-natal clinics) for identifying and treating underweight and overweight/obesity before pregnancy.

A.7.1.2 Weight change during pregnancy: Slow weight gain during pregnancy, especially during the second and third trimesters, is associated with intrauterine growth retardation, which can have detrimental effects on subsequent growth and perhaps neuro-cognitive development and behaviour. There is also a link between low gestational weight gain and risk of infant mortality^{108, 110}. Excessive weight gain can also be detrimental. It can signal pre-eclampsia (retention of water), or excessive gain of fat, which can contribute to the development of obesity later. The relationship between changes in maternal weight during the first trimester of pregnancy and fetal growth is less clear, partly because the magnitude of the weight change is small, and partly because most studies have not measured weight changes during this period. However, even for the second and third trimesters, definitive studies to determine the optimal rates and patterns of weight gain are surprisingly lacking. The effect of protein-energy supplementation in increasing maternal body weight has only been unequivocally demonstrated in starving women and to a lesser extent in those who are clinically undernourished¹⁰⁸. For other women, the effects have been more much

more limited, and related to pre-pregnancy weight, type of diet in early pregnancy, and type of supplement¹⁰⁹. It has been estimated that food supplementation in malnourished pregnant women may reduce the incidence of low birthweight infants by as much as 35%¹¹⁹, even in the absence of an impact on maternal anthropometry^{120, 121}. In a systematic review of balanced protein supplementation in pregnant women from different parts of the world¹²², 6 out of 13 trials were found to report on the incidence of small for gestational age, and all showed a protective effect of supplementation, although in only one trial was the effect significant. The overall effect was to reduce the incidence of small for gestational age by 32%¹²³. In 11 trials that reported birth weight, the overall effect was small and not significant¹²³. It is beyond the scope of this report to review the effects of other types of supplements.

A.7.1.3 Disease effect: Diseases during pregnancy, especially severe acute diseases, can have adverse effects on the fetus. Hyperemesis gravidarum can also lead to failure of the mother to nourish and hydrate herself. Weight loss can be rapid and result in abortion. In a study in which intravenous fluid therapy was initiated at home as well as in hospital, the mean percent weight loss at initiation of therapy was about 5% (sd 6%)¹²⁴.

A.7.2 Lactation

Post-partum nutritional screening/assessment provides an opportunity to identify undernourished or overnourished women so that counselling can be given and specific treatment initiated where appropriate. It may also identify undernourished individuals with poor lactation function and overweight/obese individuals, who have a greater risk of failure to breast feed¹¹⁷. Here, special consideration is given to the role of nutritional screening in relation to lactation performance and the weight/BMI changes that occur during lactation, since these confound the use of standard nutritional screening tools in this situation. However, it should be remembered that malnutrition typically produces adverse effects on various body functions (e.g. muscle function) before significantly affecting lactational performance.

A.7.2.1 BMI and lactation: Lactation is the most energy demanding phase of the reproductive cycle, with an estimated energy cost of producing milk of about 3MJ/day, during the first 6 months (and ~2MJ/day, if lactation is continued for the next 18 months)¹²⁵. Therefore, a link between lactation performance and nutritional status might be expected. Although lactation seems to be well preserved in underweight women, even in those with a BMI as low as 18.5 kg/m²¹²⁶, lactation performance has been reported to be poor in depleted individuals ingesting an inadequate diet. Furthermore, despite substantial variation in milk composition, low nutrient content in breast milk has usually been found in undernourished women¹⁰⁸. There appears to be no relationship between lactation performance and anthropometric indices in well nourished populations. Furthermore, a report published by the World Health Organization¹⁰⁸ concluded that anthropometric measurements could not be used effectively to assess lactation performance because cut-off points had not been adequately defined, either for predicting an undesirable

outcome or for response to interventions. In addition, weight gain during pregnancy also appears to have little effect on the quality and quantity of milk produced during lactation¹¹⁰. In the face of limited information, only provisional anthropometric recommendations can be made. It has been suggested that the upper limit for BMI in lactating women should be the same or very similar to that for non-pregnant non-lactating women e.g. BMI 25 and 30 kg/m² for overweight and obese women¹⁰⁸. This is not only because very few studies have attempted to establish upper levels of BMI during lactation, but also because the recommended weight increments in overweight and obese individuals are relatively small (see section C.3.2.4). Establishing a lower BMI cut-off point has also proved problematic, even after the first 4-6 weeks of lactation. One approach is to use the same value as for non-pregnant non-lactating women or adjust it to take into account the weight increase above that normally gained with age. It has been estimated in a World Health Organization report¹⁰⁸ that a typical 4 kg increment in weight, one month after delivery compared to pre-pregnancy weight, would elevate the recommended cut-off point from 18.5 kg/m² to between about 18.5 and 20 kg/m², depending on the height of the individual. Since some of this excess weight at one month may not be lost subsequently (particular groups of women may actually increase their body weight)¹²⁷, even in malnourished women not given mixed nutritional supplements¹²⁰, and since BMI is typically used to estimate current weight status rather than a variable and uncertain future status, an argument can be made for retaining the same BMI cut-off as in non-pregnant, non-lactating women to indicate current weight status.

A.7.2.2 Weight changes during lactation After delivery, weight loss is generally most rapid during the first month, (when fluid and tissues accrued during pregnancy are lost), continues more slowly until 3-4 months, and stabilises at about 4-6 months. The overall final mean weight gain may only be about 1 kg above that normally gained with age¹¹⁰. However, the pattern of weight change is variable¹²⁷ and depends on the amount of weight gained during pregnancy¹¹⁰, dietary intake, physical activity¹²⁸, and the extent, if any, of breast feeding^{108, 129}. Weight loss during the first 3 months post-partum, is generally higher in mothers who breast feed, especially those who exclusively breast feed¹⁰⁸, although exceptions occur¹²⁷. Weight changes (typically weight loss) during the first 6 months post-partum are generally greater in affluent populations (0.8kg/month) than underprivileged populations (0.1 kg/month). However, these mean values hide considerable variation which may even result in weight gain in some populations, and large weight gains in some individuals¹²⁸. This normal but variable physiological change in weight means that the usual criteria of body weight changes that are used to detect malnutrition risk in non-pregnant non-lactating women should not be applied to lactating women. Alternative ways for dealing with this problem, within the framework of 'MUST', are indicated in section C.3.2.5.

A.8 Nutritional screening in children

A.8.1. Nutritional screening in adults and children

Although 'MUST' is intended for adults only, this section is included for three

reasons. First as children become adults, they carry with them any pre-existing nutritional problems. These problems can be reduced if they are identified and understood at an early stage, and continuity of care is established between childhood and adulthood. Second, the section illustrates that the overarching principles of nutritional screening in children are similar to those in adults. Third, the section indicates the type of information that still needs to be established before a more complete link can be made between nutritional screening in children and adults.

A.8.2 Benefits of recognising and treating malnutrition in children

Malnutrition in children affects every system of the body, as in adults (Table A.9). It may also impair cognitive development, although this appears to be strongly affected by intellectual stimulation and socio-economic status¹⁴². It may reduce exploratory behaviour¹⁴³ and delay puberty or reproductive competence. In addition, chronically malnourished children tend to become short adults, with reduced muscle strength and capacity to work¹⁴⁴, and small pelvic diameters, which in the case of women may increase the risk of obstetric complications. Small birth weight children are more likely to suffer infective complications in childhood¹⁴⁵, and cardiovascular disease, diabetes and hypertension in adult life⁶. For obvious reasons, there are no lifelong intervention trials in humans to directly examine the effects of nutrition, although animal studies indicate that these morbidities can be modulated by nutrition. Since obese children, especially those aged over 10 years, tend to become obese adults, largely as a result of lifestyle factors, preventive strategies are probably better initiated at an early age, and should involve the whole family. As in adults, a wide range of outcome measures have been used to evaluate the effects of nutritional interventions, and these are discussed elsewhere^{29, 107, 108}.

A.8.3 Lack of effective screening programmes for children

The establishment of effective screening programmes to detect malnutrition in children has been hindered by:

- the existence of different screening tools employing different criteria, or different cut-off values for the same criteria.
- inadequate information about intraindividual variation in growth of children of different ages and different initial anthropometric indices.
- inadequate information about the short-term (weeks), medium-term (months), and long-term (years or decades) benefits of nutritional intervention.
- No agreement about what constitutes 'catch-up' growth¹¹⁹.

A.8.4 General considerations for screening children

The nutritional screening test should aim to establish current status, and both recent and likely future changes in growth. Although the same nutritional screening principles apply to children as to adults, childhood growth adds another dimension. A persistent weight gain in healthy adults will lead to obesity, but in children a persistent weight gain may be associated with malnutrition, when it is not sufficiently large to sustain adequate growth and function. Therefore, the anthropometric indices may be more difficult to interpret in children than adults. For example, BMI increases during the first 6 months, then decreases, and begins to increase again, usually by 4-7

years¹⁴⁶. Although BMI can be used to identify obesity and nutritional risk in adults, there is no agreement about cut-off values in childhood. Furthermore, three other anthropometric indices are widely used for detecting malnutrition or obesity (weight-for-age, height-for-age, and weight-for-height).

- weight-for-age: underweight if low, overweight if high
 - height-for-age: shortness if low (stunting when pathological), tallness if high
 - weight-for-height: thinness if low (wasted when pathological), fatness if high
- Weight-for-age depends on both the height (height-for-age) and weight (weight-for-height) of the child. It can be argued that wasting (low weight-for-height) is a feature of relatively recent malnutrition (recent or continuing current weight loss), but even this can take a considerable time to develop. Low weight-for-height generally reflects a severe manifestation of malnutrition, since wasting often occurs after stunting.

A.8.5 General considerations for screening in children

A.8.5.1 Malnutrition: The WHO classification of chronic malnutrition in children, which uses the National Centre for Health statistics (USA)/World Health Organization standards (NCHS/WHO), is based on standard deviation scores (z scores). Thus, children with a z score of less than -2 (2 standard deviations below the median - corresponding to the 2.3 centile) can be regarded as being at high risk of malnutrition^{108, 147}. However, in the UK, NCHC/WHO standards have not been adopted for routine use, partly because more specific UK reference standards exist¹⁴⁸, and partly because some workers feel that different cut-off values should be used. In addition, although some information exists about intraindividual changes in growth over specific age ranges, such as infancy^{149, 150}, such information is not available throughout childhood, at least in relation to different initial positions on the centile charts. (The UK reference charts were based on cross-sectional measurements.) In the absence of a national screening programme for detection and management of malnutrition in the UK, the following extreme anthropometric indices on the UK 1990 Child Growth Foundation charts¹⁴⁸ suggest a cause for concern¹:

a) First measurement

- Weight is <0.4th centile for age
- Height is <0.4th centile for age
- BMI <0.4th centile for age

A weight-for-age centile that is three or more spaces below the height-for-age centile has also been used as a criterion to indicate concern, although the use of this index to express risk of malnutrition is not a good one, at least statistically¹⁵¹. Similar extreme anthropometric indices at the upper end of the scale are obviously also a cause for concern.

b) Sequential measurements that also suggest risk of malnutrition

- unintentional weight loss in previously growing children, especially young children
- sustained unintentional weight loss through three or more centile spaces, or more than two centiles over 6 months, in children less than 2 years
- sustained unintentional fall through two or more weight centile spaces over a year

in children more than 2 years.

Rapid reductions in weight can occur in acute situations due to poor dietary intake as well as the catabolic effects of disease and inactivity. These reductions should be taken into account in conjunction with the preceding and likely future changes in weight. The screening test should be linked to a care plan, which may involve more detailed assessment of eating disorders and quality of care. The underlying condition should also be identified and treated, and every effort made to ensure continuity of care and information across healthcare settings.

A.8.5.2. Obesity: Similar issues apply to screening for obesity as underweight. For example corresponding cut-off points used for underweight at the lower end of the centile charts can apply to obesity at the other end of the charts. The need to document past, current and future trends in anthropometric indices applies to both adults and children. It is also obvious that the screening test should be linked to a care plan.

A.8.5.3. Integration: Apart from the need to integrate under- and overnutrition screening programmes, as in adults, there is a need to establish continuity of healthcare as children become adults. Finally, some nutritional problems are probably better managed by dealing simultaneously with adults and children of the same family, as for example in the management of obesity (section A.6), especially when these are due to behavioural problems, which represent one of the commonest causes of malnutrition in childhood⁸⁶.

A.9 Education and training

A.9.1 Inadequate training and education

Education and guidelines for nutritional management of patients, including nutritional screening, are required (section A.4.1.4.) for both under- and overnutrition, especially since there is confusion about the efficacy of different treatments and about professional responsibility¹⁰. For example, in a survey of GPs and practice nurses about management of obesity and overweight in primary care, guidance was requested on a variety of topics. These included: the type of patients to target for advice and treatment; a protocol for deciding the most appropriate treatment pathway for each patient; a protocol for deciding the most appropriate referral option for each patient; guidance on the appropriate intervals between consultations for monitoring treatment and follow-up; protocols for follow-up weight maintenance; and case examples of good practice.

The working group considers that nutrition education is inadequately addressed within professions, including medical and nursing professions. Since there is a nutritional component to most diseases, teaching and training should benefit from multi-professional input.

A.9.2 Recommendations

- The Nutrition Task Force Project Team on Nutrition Education and Training has provided specific guidelines for areas of nutritional competence that should be acquired by a range of health professionals, including doctors, nurses, dentists, pharmacists, physiotherapists, speech and language therapists, and other health promotion specialists⁷⁸, and adequate funding and resources allocated. Health workers should appreciate the importance of nutrition in both the prevention and treatment of disease. Nutritional screening has a role to play in both of these.
- Education should begin with undergraduate training and be continued or updated into post-graduate training. The commitment to nutrition education should be demonstrated by including nutrition related questions in examinations. Weight and height measurements are often carried out in clinical practice, and - like pulse, blood pressure and temperature measurements, - they require an initial training programme to ensure that they are undertaken in a competent, safe, and effective manner using appropriate equipment (see table A.8 for weighing scales).
- Adequate resources need to be allocated to training and education of health care professionals to develop these skills and remain competent to practise.
- Nutritional screening should be considered as a basic skill in the routine assessment of patients by doctors and nurses.
- Professional organisations and Royal Colleges that run educational courses should incorporate nutritional education, including nutritional screening. A course dedicated to nutrition education and training of doctors, The *Intercollegiate Course in Nutrition*, is recommended (A.10 Annexe, case study 3).
- There is a need to monitor progress in education and training among the professions. It is suggested that this role is undertaken by the Educational Committee of the General Medical Council, in the case of doctors, and the Nursing and Midwifery Council, in the case of nurses, midwives and health visitors. The Health Professions Council also has a role in setting and managing standards of education and training.
- The Department of Health should also promote nutrition education, particularly with respect to nutritional screening. For example, following a recent Clinical Resource and Audit Group (CRAG) report¹⁷, the Scottish Office invested in an educational programme using interactive learning units developed by 'Partnership in Active Continuous Education (PACE)', a joint initiative between Queen Margaret University College, Edinburgh, and Nutricia Ltd^{152, 153}. This programme, which ultimately results in a certificate for learners, involves distribution of educational material by Health Boards, and workshops that are facilitated by dietitians. This training has been targeted at health care assistants and trained staff involved in the care of the elderly.
- A variety of cross-governmental initiatives should also be integrated for nutrition education, especially with respect to the prevention and treatment of obesity. To initiate lifestyle changes, there is a need to educate and train the public and health professionals. Amongst the bodies that should play a role in this process are the Educational Council, Department of Health, and the Food Standards Agency, which has as one of its core activities, the production of up-to-date

A.10 Annexe

Case study 1. Procurement and maintenance of equipment for nutritional screening (Luton & Dunstable Hospital)

The Luton and Dunstable Hospital conducted an audit of weighing scales and stadiometers in 1998. This was in response to reports of large fluctuations in weight when patients were transferred from one ward to another and the inability to measure height on many wards.

- The audit showed that the type of weighing scales varied from domestic scales donated by relatives to obsolete clinical scales that could not be serviced. Other scales were not serviced or adequately maintained because they did not appear on an asset register. Furthermore, the maintenance contract covered only cleaning and balancing, and so, with a single exception, the Trust's scales were never calibrated. The provision of stadiometers was sporadic. A business case was submitted to the Trust's Charitable Fund Committee, and, in December 1998, funding was secured to replace all inappropriate scales, provide portable stadiometers, and upgrade the maintenance contract to include calibration and a certificate of calibration.
- Staff education is provided to ensure the most effective use of the equipment.

Case study 2. Nutrition specifications by the previous Lambeth, Southwark & Lewisham Health Authority (LSLHA)

The LSLHA was concerned that malnutrition affects one in four patients admitted to hospital, that it is often unrecognized and that there may be poor continuity of care across healthcare settings. In response to this, and government reports emphasising the importance of nutrition, LSLHA developed specifications for nutrition in 1997/1998, which have subsequently been updated. The specifications, which are included as part of Service Agreements with Trusts, are outlined in all contracts it commissions with providers.

The specifications fall into five key areas:

- **Awareness:** All staff should be aware of the role of nutrition in their client group and how it can be improved. To this end, LSLHA wish to see a nutrition education programme for staff, targeting key issues for their client group.
- **Screening for malnutrition:** Nutritional screening should be part of routine clinical care, in the community and in hospital. Nutrition risk assessment should be developed appropriate to the client group, to be used routinely. In the community, the LSLHA Nutrition and Dietetics Reference and Advisory Group recommends the use of the British Association for Parenteral and Enteral Nutrition (BAPEN) and Malnutrition Advisory Group's (MAG's) Guidelines for Detection and Management of Malnutrition¹.
- **Care Planning:** Optimal nutrition is important for the health of every individual and as such must be considered when any healthcare intervention is planned. Appropriate nutrition goals/interventions should be included in the treatment/care

plan for each client/patient.

- **Monitoring:** Ongoing monitoring of changes in nutritional status and progress allows appropriate and timely support to be given. Progress against the care plan and outcome should be monitored and recorded.
- **Audit:** Guidelines to be audited in the year 2002 in all Hospital and Community Trusts.

Case Study 3. The Intercollegiate Course in Nutrition

There has been increasing concern within the medical profession that doctors do not receive adequate nutrition education during their undergraduate and postgraduate careers. The result is failure to recognise malnutrition, especially treatable malnutrition, uncertainties about how to manage common nutritional problems, and uncertainties about responsibilities.

These problems were recognised by 11 Colleges (Royal Colleges of Anaesthetics, General Practitioners, Obstetricians and Gynaecologists, Paediatrics and Child Health, Pathologists, Physicians (London, Edinburgh) and Physicians and Surgeons (Glasgow), Psychiatrists, and Surgeons (England, Edinburgh). They responded by establishing the *Intercollegiate Course in Nutrition*, in collaboration with the British Dietetic Association.

- The overall aim of the 5 day residential course is to provide an understanding of the relevance of human nutrition to the practice of medicine, across all the specialities and disciplines. It has three specific aims:
 - (i) Enable doctors to extend their knowledge of nutritional principles
 - (ii) Bring together sub-specialties to study nutrition across the boundaries of care and in relation to disease processes
 - (iii) Encourage the application of effective nutrition in relation to the promotion of health and the treatment of disease.
- The course is recommended for:
 - (i) Trainees with an interest in nutrition, usually at Specialist Registrar level, from any medical or surgical specialty (for whom this will be their first formal post-graduate nutrition training). Senior House Officers may also be interested in attending.
 - (ii) Consultants or GPs who are developing a special interest in nutrition.
 - (iii) Other professional groups with a special interest in nutrition with background knowledge, equivalent to the standard expected from the average medical school in the UK.
- The course, which began in 1999, has been evaluated and generally found to be very successful by those who have attended it. Details of this course, which currently runs three times a year, can be found at: www.icgnutrition.org.uk.

B

Validity, reliability and practicality of the 'Malnutrition Universal Screening Tool' ('MUST')

B.1 Background and aims

B.1.1 The need for a new tool

Section A of this report highlighted the lack of a consistent framework for identifying malnutrition and its treatment. This was one of the major barriers to the implementation of effective nutritional screening programmes, which could be monitored using consistent benchmarks. Multiple reasons have contributed to this situation. Some malnutrition screening tools have been developed for hospitals whilst others are for the community, and some are concerned primarily with malnutrition (undernutrition) whilst others with overweight and obesity. Furthermore, the screening procedures sometimes involve widely different criteria to detect malnutrition, several of which cannot be applied to all patients in different healthcare settings, or even different patients with the same diagnosis in the same healthcare setting. In addition, some screening procedures have been developed for particular groups of patients and not others. Many tools (see section A.4.1.3) do not appear to have adequate reliability or validity. Others were not developed according to recommended procedures for tool development, or are not practical in routine clinical practice. There is therefore a need to develop a simple, internally consistent and comparable screening procedure that can be used as a first step to aid detection and management of malnutrition in a wide range of patient groups in different healthcare settings. This section of the report deals with the validity, reliability and practicalities of using the tool, whilst section C provides guidance on undertaking measurements using 'MUST'. The work reported in these sections was initiated solely by the Malnutrition Advisory Group (MAG). General aspects of the report, which are presented in section A, also arose from MAG, and were discussed within the Department of Health (organised by NHS Estates).

B.1.2 The term 'Malnutrition Universal Screening Tool' ('MUST')

The quest to establish a malnutrition tool for adults that could fulfill the criteria indicated below led to the acronym 'MUST':

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

- Appropriate for clinical and public health purposes
- Adaptation according to local policy

There was encouragement to adopt this acronym after the successful practical application of the tool to all patients in different types of hospital wards (medical, surgical, elderly, and orthopaedic wards, and intensive care units), in care homes, a GP practice and in the community. It was also found that it could readily be applied to patients with a wide range of diagnoses, including those suffering from fluid disturbances, with the more subjective components of the tool coming into play in some of the more difficult situations. However, there are situations where the use of the acronym may be criticised. One of these concerns identification of specific nutrient deficiencies or excesses. Multiple nutrient deficiencies often occur in association with poor protein-energy status, which is identified clinically by weight status (BMI categories - see Table A.1) and unintentional change in weight. Although 'MUST' primarily aims to determine the presence or the likely future presence of poor protein-energy status, it may miss specific nutrient deficiencies, such as an isolated iron deficiency due to menorrhagia (the tool was not primarily developed for this purpose). In this respect, the 'U' in 'MUST' - indicating 'Universal' - does not apply to all the nutrients. These nutrient deficiencies may be detected through more detailed nutritional assessment/clinical test but mainly through the laboratory. In other situations, there may be large or unusual changes in body weight, such as those due to fluid disturbances, pregnancy, and lactation. Clearly, the standard cut-off points for weight change do not apply to these situations. They were therefore replaced by alternative special criteria (pregnancy) or more subjective criteria (fluid disturbances, lactation), using a consistent framework. In this respect, 'MUST' for adults does not differ from some other tools, which also use subjective criteria for application to a wide range of different circumstances. In all cases the aim is to detect abnormal changes that warrant further attention. The tool was primarily developed and validated in the UK, but similar general principles should apply to other countries. However, it is recommended that further validation is undertaken before use in other countries and that further consideration be given to anthropometric measurements, the magnitude of the malnutrition problem in the population, and local resources/policies, especially in developing countries. Despite the above caveats, the committee decided to adopt the acronym 'MUST', not only because of the tool's versatility, but also to remind healthcare workers of the need to undertake nutritional screening. It is hoped that the acronym is received in this spirit. The acronym is retained in inverted commas to remind the reader of the caveats.

B.1.3. General layout

This section (section B) of the report describes the development of 'MUST' from the original community tool¹, the establishment of an evidence base, and fulfillment of many of the requirements for identification and treatment of malnutrition indicated in section A. The new tool includes all the key criteria of the original community tool, as well as some additional features. Even before the original tool was applied to the hospital setting it was clear that additional features had to be

taken into account, such as the effects of acute diseases, management plans in different care settings, and the need to consider the reproductive cycle. Section C of this report describes how to use the tool in these difficult circumstances. The general philosophy is to use objective measures where possible, but to include subjective criteria, especially when the objective measures cannot be undertaken.

B.2 Development of 'MUST' from the original community tool

The key features of the original MAG community tool are weight loss and BMI categories, and subjective criteria when these could not be obtained by objective measurements. The following new items are incorporated into 'MUST' (Fig B1).

B.2.1 Acute disease effect

Although free-living patients with a desirable BMI and no history of weight loss would normally be classified as having a low risk of malnutrition, they could suddenly develop a high risk if admitted to hospital with severe acute illnesses that lead to prolonged lack of dietary intake (e.g. multiple injuries, conditions requiring major surgery, extensive burns, prolonged unconsciousness, post-operative ileus, or persistent inability to swallow as a result of a stroke). Therefore, it is necessary to consider the likely course of the disease and whether rapid weight loss associated with severe starvation, either alone or in association with catabolic disease, produces more detrimental effects than when the same weight is lost more slowly. '*MUST*' classifies a patient as being at high risk of malnutrition if there has been, or is likely to be, no nutritional intake for more than five days (see section B.8.1 for rationale). This criterion will generally only apply to a small proportion of all patients admitted to General Hospitals (although a high proportion in some units, such as intensive care, gastrointestinal or certain surgical/neuro-surgical units), and rarely to free-living individuals.

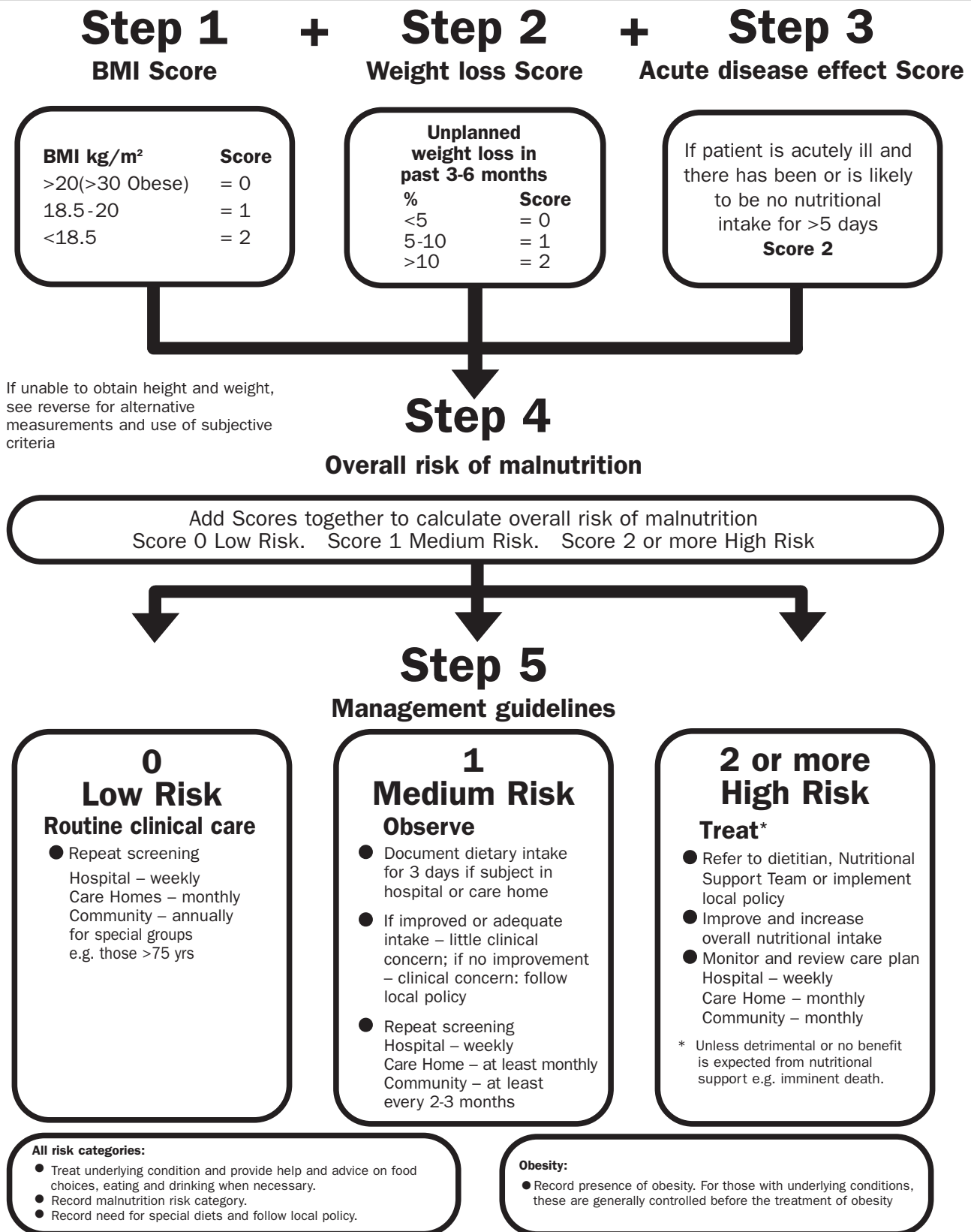
B.2.2 Variations in care plan and resources

To deal with severe acute diseases in hospital and more chronic diseases in the community, each healthcare setting is equipped with different resources and expertise. For example, treatment in hospital may require artificial nutrition, which is often implemented by nutrition teams that are only based there. In addition, since changes in nutritional status are likely to occur much more rapidly during a severe acute illness in hospital than in chronic illness in the community, it is reasonable to re-assess nutritional status more frequently in hospitalised patients.

'*MUST*' recommends that nutritional screening should generally be repeated more frequently in hospitals (e.g. at weekly intervals) than in nursing homes (e.g. at monthly intervals) and general practice (from less than one month to more than six months) depending on the circumstances and nutritional risk. The tool is amenable to adaptation according to local resources and policy.

B.2.3 Other items

2.3.1 Obesity: Although the original community tool incorporated the measurement



Re-assess subjects identified at risk as they move through care settings

Fig 3.1 The 'MUST' flowchart

of BMI, it did not specifically highlight the presence of obesity when it was identified (BMI >30 kg/m²).

2.3.2 Surrogate measures for BMI and percent change in body weight:

- a) *BMI* When it is not possible to measure weight and height and use them to calculate BMI, realistic values of recalled weight and height can be used. When only a weight measurement is available, surrogate measures of height, such as knee height and demispan can be used. Although these are probably the two most widely used surrogate measures of height, they have not always been easy to perform, particularly on patients with difficulties in moving their limbs to the correct measurement positions. Therefore, it was considered necessary to assess alternative surrogate measures of height, such as ulna length.
- b) *% change in body weight (or percent change in BMI)* In the original community tool it was suggested that, when BMI cannot be established through direct measurement of weight or height, clinical judgment should be used to identify obvious malnutrition (presence of wasting, history of loosely fitting clothes and jewellery, and loss of appetite). However, it was felt that the potential use of additional more objective surrogate measures of BMI and change in BMI (or weight) should be explored e.g. by measuring mid-upper arm circumference (MUAC). 'MUST' includes charts and tables to facilitate identification and recording of obesity, and surrogate measures for establishing height, weight, BMI and weight change, when it is not possible to measure these directly.
- c) *Surrogate measures of BMI*
- i) *Height* When height cannot be measured (but weight is available), BMI can be calculated using realistic measurements of self-reported (recalled) height or other surrogate measures of height, such as knee height, demispan or ulna length, which is usually easier to undertake than the other measurements, particularly in bed-ridden patients. (refer to section C)
 - ii) *Body weight* When body weight cannot be measured, recently documented weight or recalled weight can be used to calculate BMI.
 - iii) *Measured or recalled weight* When measured weight, or a realistic recalled value of weight, is not available, the risk of underweight and obesity can be established, albeit with some uncertainty, using single cut-off values for MUAC for men and women, as follows:
 - BMI < 20 kg/m² is likely when MUAC is <23.5 cm
 - BMI > 30 kg/m² is likely when MUAC is >32.0 cm

Since these criteria are only approximate, MUAC should only be used to establish tentative BMI categories e.g. low risk or medium/high risk (or obesity) in association with subjective categorisation (see below).

- d) *Surrogate measures for change in body weight* A change in body weight (or BMI) of 10% or more is likely to have occurred when the MUAC has changed by more than 10%. Repeat measurements may be possible in some institutionalised patients, such as those in long-term care facilities, but since this surrogate measure is only an approximate index of weight change, it should only be used to tentatively establish a high risk category (preferably by the same observer using duplicate measurements on each occasion), in association with a single overall subjective assessment of malnutrition risk.

B.3 Validity of 'MUST'

B.3.1 Face validity and content validity

In the absence of a 'gold' reference standard for malnutrition, it is difficult to establish the validity of nutrition screening tools. Nevertheless, 'MUST', developed by a multidisciplinary group after reviewing a wide range of physiological and clinical literature on malnutrition, appears to have content validity (comprehensiveness of the tool) face validity (issues which are relevant to the purpose of the test), and internal consistency.

A large body of information was used to support the choice of the BMI and weight loss cut-off points that were used in the original community tool¹. However, it did not formally incorporate the acute disease effect (no dietary intake for more than 5 days), which generally applies to acutely/critically ill patients, who are most likely to be managed in hospital and not the community. This issue is considered in some detail in B.8 Annexe 1.

B.3.2 Concurrent (correlational) validity

The tool has concurrent or correlational validity since it shows good to excellent agreement with many other tools and with a dietitian's assessment of malnutrition risk^{82, 154-159, 160}. Table B.1 summarises these results using the kappa statistic, which is a chance corrected measure of agreement, with a value of 1 denoting perfect agreement, and a value of 0, no agreement (see B.9 Annexe 2 for interpretation). In general, 'MUST' did not significantly or systematically over- or under-categorise patients' nutritional risk relative to other tools, even when the disagreements were large. One exception to this (see Table B.1) involved the comparison of the British Association for Parenteral and Enteral Nutrition (BAPEN) tool, which categorises patients into 2 categories (BAPEN2) using four questions⁸², and a simplified two-category 'MUST' tool, in which low risk formed one category and a combination of medium/high risk formed the other category ('MUST'2, see footnote to Table B.1). The BAPEN tool placed significantly more patients into the higher risk category than 'MUST' in medical/elderly hospital wards. A reason for this is that 'MUST' allocates a score on the basis of the amount of weight loss, whereas the BAPEN tool allocates a score on the basis of only qualitative changes in weight, with the result that subjects with little or minimal weight loss (<5%) were placed in the higher risk category by BAPEN2. Another exception concerned the comparison of the Mini Nutritional Assessment (MNA) tool (short version - screening procedure), which categorised significantly more elderly patients in medical wards into higher risk categories than 'MUST'. Systematic over-categorisation of malnutrition risk by MNA relative to other screening tools has been reported by other workers¹⁶¹.

In a study¹⁵⁷ involving the same group of free-living patients, 'MUST' was compared with the Medical Resource Centre's (MeReC) tool¹⁶² and Hickson & Hill

Table B.1. Concurrent validity between 'MUST'† and other nutritional screening procedures††

Tool comparisons +	Agreement‡			Location	'MUST' risk		
	N*	n*	% kappa		se¶	Low %	Medium + high** %
Hospital							
'MUST'3 v Nutritional Risk Score3	75	67	89	0.775	0.072	72	28 (11 + 17)
'MUST'3 v Dietitian3	100	80	80	0.771	0.060	65	35 (20 + 1)
'MUST'3 v Doyle3	51	35	69	0.251	0.108	82	18 (10 + 8)
'MUST'3 v Subjective Global Assessment3	50	36	72	+	+	72	28 (8 + 20)
'MUST'2 v Nutrition Risk Score2	75	69	92	0.813	0.073	72	28
'MUST'2 v Malnutrition Screening Tool2	75	66	88	0.707	0.091	72	28
'MUST'2 v Doyle2	51	39	76	0.400	0.134	82	18
'MUST'2 v BAPEN2 (4 questions)	100	87	87	0.728	0.069	65	35
'MUST'2 v Dietitian2	100	91	91	0.804	0.062	65	35
'MUST'2 v Mini Nutritional Assessment2	86	66	77	0.551	0.081	56	44
'MUST'2 v Mini Nutritional Assessment2	85	68	80	0.605	0.083	40	60
'MUST'2 v Subjective Global Assessment2	50	46	92	0.783	0.102	72	28
Community							
'MUST'3 v MeReC3	50	46	92	0.893	0.077	70	30 (18 + 12)
'MUST'3 v Hickson & Hill3	50	42	84	0.711	0.105	70	30 (18 + 12)

† MUST3 refers to the 3 categories of 'MUST' and 'MUST'2 to two categories (low and medium+high categories combined)

†† In these studies the chance corrected measures of agreements (kappa) were established by comparing 'MUST' with alternative tools or methods: Nutritional Risk Score¹⁶³ (comparison undertaken by Stratton et al¹⁶⁰), dietitian's opinion (Weekes E et al¹⁵⁴), Doyle¹⁵⁵ (Dixon R et al), Subjective Global Assessment (Joseph K et al), Mini Nutritional Assessment (Hackston A, Price S, et al)²⁷⁷, MeReC tool¹⁶² (Stratton, RJ & Ella, M¹⁵⁷), Hickson & Hill¹⁵⁶ (Stratton, RJ & Ella, M¹⁵⁷)

* N = number of subjects participating in study; n = number of subjects who were placed in the same malnutrition risk category by the two observers

** The two values in parentheses show the percentage of patients in the medium and high risk groups respectively

‡ The disagreements were not systematically biased, except for the BAPEN2 (4 questions)⁸², which categorised significantly more patients in the higher risk category and fewer patients in the lower category compared to 'MUST'2 (p<0.022; binomial test for disagreements)

se¶ = standard error of kappa

+ The observer did not categorise any patients as high risk with the Subjective Global Assessment Tool, and therefore the kappa value was not calculated. The results are computed using two categories ('MUST'2 v Subjective Global Assessment2, in which the medium and high risk groups were combined)

++ Gastrointestinal outpatients

tool¹⁵⁶ (adapted from Reilly et al¹⁶³), which also have three categories. The agreement was found to be better with the MeReC tool (kappa, 0.893) than with the Hickson & Hill tool (kappa, 0.711). This may be because 'MUST' and the MeReC tool use similar and simpler criteria (BMI and weight loss) than the Hickson and Hill tool, which employs a greater number of criteria and more subjective criteria (5 versus 3) (or 2 criteria since the acute disease effect of 'MUST' did not apply to the community patients involved in this study).

The number and type of criteria used to assess malnutrition risk varies substantially between different tools, with some employing only indices of chronic protein-energy status (e.g. ref^{12, 59}), or changes in protein-energy status, e.g. ref⁶⁰, and others, including 'MUST', a combination of both. Therefore, the extent to which different tools agree with each other depends on the initial choice of criteria for comparison, as well as on their simplicity and objectivity. Poorer agreement might occur when 'MUST' is compared to tools based on different principles, using complicated items and predominantly subjective or poorly validated criteria.

B.3.3 Predictive validity

'MUST' has some predictive validity in hospital and community settings.

B.3.3.1. Hospital (Table B.2):

- i) *Length of hospital stay* Table B.2 shows that malnutrition risk calculated by 'MUST' predicts length of hospital stay in trauma patients admitted to orthopaedic wards. The length of stay was two-fold longer in those with high risk of malnutrition than in those with low risk (median, 12 v 6 days; mean 13.8 v 7.9 days). It was also found to be two-fold greater in medical/elderly wards¹⁵⁴ in one hospital (median 8 v 4 days; mean 13.3 v 5.8 days) and two-fold greater in elderly wards in another hospital¹⁶⁴.
- ii) *Mortality* In an elderly care ward, mortality was found to be four-fold higher in patients with high risk of malnutrition than low risk of malnutrition using 'MUST', with a significant linear trend across the three malnutrition risk categories¹⁶⁴.
- iii) *Discharge destination* Malnutrition risk with 'MUST' predicted discharge destination of orthopaedic patients, so that a smaller proportion of high risk patients were discharged to their own homes and a greater proportion to other destinations, such as care homes¹⁶⁵.

B.3.3.2. Community (Table B.3): A secondary analysis of data from the National Diet and Nutrition Survey for subjects aged 65 years and over²⁰ was carried out using similar malnutrition risk categories as 'MUST'. Malnutrition risk predicted the rate of hospital admissions and GP visits (Table B.3)¹⁹.

- i) *Hospital admissions* The rate of hospital admissions were significantly greater in the high risk group than in low and medium risk groups, both with respect to the number of patients admitted (% within the categories) as well as the number of admissions per patient.
- ii) *GP visits* GP visits were also more frequent in those with medium/high risk of malnutrition than low risk.

Table B.2 Predictive validity of 'MUST' tool in hospital†						
	N	Malnutrition risk‡			p value	
		Low	Medium	High		
Length of hospital stay						
Ward		Days: median (interquartile range)			Kruskal-Wallis	Rank ANCOVA (controlling for age)
Orthopaedic (elective + trauma)	194	5 (3.9-9.0)	4 (4.0-9.0)	8 (4.8-19.0)	<0.02	<0.006
Orthopaedic (trauma)	92	5 (3.0-10.5)	4 (4.0-7.0)	12 (5.0-21.8)	<0.008	<0.009
Orthopaedic (elective)	102	6 (3.0-9.0)	7 (1.8-12.3)	8 (3.3-9.3)	NS	NS
Medical/Elderly	100	4 (2.0-7.0)	5.5 (3.0-13.0)	8 (3.0-25.0)	<0.043	<0.014
Elderly*	118	13 (8.0-26.0)	19 (15.0-35.0)	23 (15.0-44.5)	< 0.009	<0.008
Mortality						
Ward		Mortality: %			Chi squared	Logistic regression (controlling for age)
Elderly	147	8	12	32	<0.002	<0.001
Discharge destination						
Ward		Home: % (n/totalN) (controlling for age)			Chi squared	Rank ANCOVA
Orthopaedic	194	10	21	25	<0.03	<0.01

† These studies were undertaken by different workers on different wards: orthopaedic wards (Wood C et al) and elderly wards (King, C et al)^{164, 165}.

‡ The prevalence of medium + high risk of malnutrition ranged from 30-60% in all groups except the elective orthopaedic group, in which it was 18%.

* Length of hospital stay (LOS) was calculated after excluding 28 patients who died. The excluded patients in different 'MUST' categories had similar LOS (NS by Kruskal-Wallis ANOVA). Application of the Kaplan-Meier procedure, to take into account mortality up to the time of death, and Cox regression, to also control for age, gave very similar results¹⁶⁴.

Table B.3 Predictive validity of the 'MUST' tool in the community: utilisation of healthcare resources (based on Stratton & Elia¹⁹)

	'MUST' risk category			p value
	Low	Medium	High	
Hospital inpatient in previous 12 months (%)	19	24	55	<0.001¶
Hospital stays (number/patient)†	1.02	1.39	1.47	<0.04*+
GP visits in previous 3 months (%)	57	72	84	<0.001¶
GP visits in previous 3 months (number/patient)†	1.55	1.78	2.34	<0.001*+

¶ Pearson Chi squared
* Univariate ANOVA (+ with linear contrasts)
† Refers only to patients who visited outpatients or GP

B3.3.3. Response to treatment (hospital and community): Large scale intervention trials based on 'MUST' risk categories have not yet been carried out. However, clinical response to nutritional supplements (morbidity, tissue/body function) in community patients is more likely to occur in underweight individuals with a BMI <20 kg/m² than in those with a BMI >20 kg/m². In hospitalised patients, benefits following nutritional support - including a reduction in mortality, disease complications and length of hospital stay - were also more likely to occur when recent dietary intake was substantially reduced e.g. before and after major surgery and other serious illnesses, regardless of BMI in some circumstances²⁹.

B3.3.4 Relative importance of weight loss, acute disease, and BMI categorisation in predictive validity: This topic is discussed in section B.8.2. Equal weightings of weight loss, acute disease effect, and BMI categorisations in 'MUST'.

B.3.4 Criterion validity and internal consistency (internal validity)

Weight loss and BMI, obtained from measurements of weight and height, are key components of 'MUST'. These items can be used as reference criteria to validate surrogate indices (criterion validity). The appropriate application of indices that accurately reflect the measurement, and therefore the final malnutrition risk, ensures that internal consistency (internal validity) is established. These indices are considered below under the BMI and weight loss categories, which form two of the three components of 'MUST'

B.3.4.1 BMI category: The choice of surrogate measure (Tables B.4 and 5) depends on whether the missing measurement is height, or weight, or a combination of both. However, simple clinical observation (subjective assessment) can also be valuable.

a) When standing height cannot be measured: In this situation the following can be used to estimate standing height.

Table B.4. Differences and relationships between measured and self-reported (recalled) values of weight, height and body mass index (BMI) in hospital in-patients in surgical, medical and medical elderly wards						
	Measured or recalled measurement	Measured - recalled measurement	Regression equation	r	see	N
Body mass index						
	(kg/m ²)	(kg/m ²)	(kg/m ²)		(kg/m ²)	
<65 years						
BMI(measured)	27.32 + 6.04					
BMI(recalled ht)	27.01 + 5.94	0.31 + 0.92*	BMI(measured) = 0.182 + 1.005 BMI(recalled ht)	0.988	0.98	206
BMI(recalled wt)	27.19 + 5.91	0.13 + 1.44	BMI(measured) = 0.323 + 0.993 BMI(recalled wt)	0.972	1.41	206
BMI(recalled wt & ht)	26.88 + 5.82	0.44 + 1.71*	BMI(measured) = 0.594 + 0.994 BMI(recalled wt & ht)	0.959	1.71	206
≥65 years						
BMI(measured)	26.21 + 4.61					
BMI(recalled ht)	25.09 + 4.58	1.12 + 0.95*	BMI(measured) = 1.125 + 0.948 BMI(recalled ht)	0.979	0.95	109
BMI(recalled wt)	25.95 + 4.34	0.26 + 2.16	BMI(measured) = 1.834 + 0.939 BMI(recalled wt)	0.885	2.16	109
BMI(recalled wt & ht)	24.84 + 4.36	1.37 + 2.38*	BMI(measured) = 3.601 + 0.910 BMI(recalled wt & ht)	0.881	2.35	109
All ages						
BMI(measured)	26.93 + 5.60					
BMI(recalled ht)	26.34 + 5.57	0.59 + 1.01*	BMI(measured) = 0.891 + 0.989 BMI(recalled ht)	0.984	1.01	315
BMI(recalled wt)	26.76 + 5.45	0.17 + 1.72	BMI(measured) = 0.710 + 0.980 BMI(recalled wt)	0.953	1.71	315
BMI(recalled wt & ht)	26.18 + 5.44	0.76 + 2.01*	BMI(measured) = 1.776 + 0.961 BMI(recalled wt & ht)	0.934	2.00	315

Table B.4 continued over page

Table B.4 continued : (Differences and relationships between measured and self-reported (recalled) values of weight, height and body mass index (BMI) in hospital in-patients in surgical, medical and medical elderly wards)

	Measured or recalled measurement	Measured - recalled measurement	Regression equation	r	see	N
Weight	(kg)	(kg)	(kg)		(kg)	
<65 years						
Weight(measured)	77.39 + 18.15					
Weight(recalled)	77.00 + 17.81	0.38 + 4.14	Wt(measured) = 0.956 + 0.993 Wt(recalled)	0.974	4.14	211
≥65 years						
Weight(measured)	70.44 + 15.36					127
Weight(recalled)	69.93 + 14.23	0.50 + 5.88	Wt(measured) = 0.644 + 0.998 Wt(recalled)	0.924	5.90	127
All ages						
Weight(measured)	74.78 + 17.46					338
Weight(recalled)	74.35 + 16.88	0.43 + 4.86	Wt(measured) = 0.903 + 0.994 Wt(recalled)	0.961	4.86	
Height	(m)	(m)	(m)		(m)	
<65 years						
Height(measured)	1.682 + 0.083					212
Height(recalled)	1.687 + 0.088	-0.010 + 0.026*	Ht(measured) = 0.157 + 0.91 Ht(recalled)	0.962	0.024	
≥65 years						
Height(measured)	1.641 + 0.088					120
Height(recalled)	1.692 + 0.094	-0.037 + 0.033*	Ht(measured) = 0.174 + 0.875 Ht(recalled)	0.929	0.031	
All ages						
Height(measured)	1.667 + 0.089					332
Height(recalled)	1.687 + 0.092	-0.020 + 0.031*	Ht(measured) = 0.144 + 0.903 Ht(recalled)	0.941	0.030	

* P<0.001; r= correlation coefficient; see= standard error of the estimate; N= number of subjects

Table B.5. Measured height and surrogate measures of height in patients on general medical and surgical wards

	< 65 years				> 65 years			
	Measured Height	Surrogate measurement	Regression		Measured height	Surrogate measurement	Regression	
			r†	se† (m)			r†	se† (m)
Recalled height*	(m)				(m)			
Men	1.740 + 0.070	1.752 + 0.070	0.922	0.027	1.691 + 0.056	1.731 + 0.058	0.860	0.029
Women	1.624 + 0.063	1.631 + 0.071	0.948	0.020	1.580 + 0.069	1.613 + 0.076	0.885	0.033
Men+women	1.662 + 0.088	1.691 + 0.094	0.962	0.024	1.641 + 0.083	1.678 + 0.088	0.929	0.031
Knee height								
	(m)	(cm)			(m)	(cm)		
Men	1.741 + 0.069	54.29 + 2.97	0.763	0.045	1.692 + 0.056	53.78 + 2.37	0.739	0.038
Women	1.621 + 0.062	50.40 + 3.20	0.669	0.046	1.557 + 0.066	49.70 + 3.21	0.817	0.039
Men+women	1.684 + 0.088	52.37 + 3.64	0.806	0.052	1.636 + 0.084	51.82 + 3.46	0.866	0.042
Demispan								
	(m)	(cm)			(m)	(cm)		
Men	1.740 + 0.070	81.31 + 4.16	0.780	0.044	1.690 + 0.056	79.54 + 3.43	0.694	0.040
Women	1.624 + 0.062	75.23 + 3.83	0.748	0.041	1.579 + 0.063	73.26 + 4.19	0.808	0.037
Men+women	1.682 + 0.088	78.30 + 5.02	0.858	0.045	1.637 + 0.081	76.52 + 4.93	0.862	0.041
Ulna length +								
	(m)	(cm)			(m)	(cm)		
Men	1.742 + 0.068	26.42 + 1.37	0.714	0.048	1.690 + 0.057	25.83 + 1.34	0.624	0.045
Women	1.626 + 0.062	24.08 + 1.42	0.646	0.041	1.578 + 0.068	23.45 + 1.72	0.812	0.040
Men+women	1.685 + 0.087	25.26 + 1.82	0.818	0.050	1.635 + 0.084	24.66 + 1.91	0.845	0.045
Arm length								
	(m)	(cm)			(m)	(cm)		
Men	1.747 + 0.075	59.40 + 4.9	0.496	0.066	1.691 + 0.058	58.49 + 3.82	0.330	0.055
Women	1.620 + 0.058	53.61 + 5.00	0.209	0.057	1.578 + 0.067	51.95 + 4.62	0.551	0.056
Men+women	1.681 + 0.092	56.38 + 5.73	0.575	0.076	1.628 + 0.085	54.92 + 5.36	0.685	0.062

* Recalled height is significantly better than other surrogate measures of height (binomial test, paired t-test of residuals when regressed against measured height and comparison of regression coefficients when regressed with measured height), except for regression coefficient with demispan in women

+ Ulna length not significantly different from knee height or demispan in predicting measured height, except for knee height in men, which was better with borderline significance

† N refers to the number of subjects used in the regression equation, r to the regression coefficient, and se to the standard error of the estimate

i) Self-reported (recalled) height

- For the clinical purpose of assigning patients to a malnutrition risk category, self-reported height generally provides a good estimate of height in hospitalised patients (Tables B.4 and B.5). In a study of 332 adult patients in general medical and surgical wards, recalled height (Table B.4) was found to be highly predictive of measured height ($r = 0.941$; standard error of the estimate (see) 3.0 cm). The discrepancy between measured and self-reported height was not significantly related to age or measured height. However, the mean self-reported height was slightly higher (2.0 cm) than the measured height, so that BMI calculated using recalled height was slightly lower (0.59 kg/m²) than that calculated using measured height. Despite this, use of self-reported height in place of measured height allows excellent overall categorisation of malnutrition risk (>95% agreement with malnutrition risk categorisation using actual measurements of height; kappa values usually >0.9 (Tables B.6 & B.7)). Such agreement was found to be the case even when self-reported values of both weight and height were used to predict malnutrition risk (Tables B.6 & B.7). Use of self-reported height instead of measured height tends to alter the final categorisation of malnutrition risk to a lesser extent than BMI categorisation because height influences only one of the three components of 'MUST'. A BMI score has no effect on the overall malnutrition risk in patients who are already categorised as being at high risk on account of >10% weight loss in the previous 3-6 months or an acute disease effect. The discrepancies between measured and self-reported estimates of height observed in hospitalised patients are mirrored by studies in the community. In the Welsh Heart Study involving 1622 adults aged 18-64 years, height was over-reported by 1.4 cm in men and 0.7 cm in women, and there was little or no bias in reported weight¹⁶⁶. The 4th Scottish Monica cross-sectional study, involving 1836 adults, aged 25 to 64 years, found that the discrepancy between self-reported and measured weight and height were small, so that recalled BMI varied from measured BMI by only +0.19 (standard deviation, 1.4) kg/m² in men and +0.17 (standard deviation, 1.34) kg/m² in women. The result is that sensitivity and specificity for identifying obesity (BMI >30kg/m²) were 83% and 96% respectively for men and 89% and 97% for women¹⁶⁷.
- Self-reported height in hospitalised patients was found to overestimate height to a greater extent in older than younger adults (1 cm in those aged <65 years and 3.7 cm in those > 65 years), but the overall effect of recalled height on the malnutrition risk category was again small (Tables B.6 & B.7). Use of correction factors (1 cm in those <65 years, and 3 or 4 cm in those over 65 years) produced little or no improvement in the final categorisation of malnutrition risk, but the disagreements became less biased in one direction (i.e. more balanced distribution between over and under-categorisations) (Table B.6). Detection of obesity (BMI >30 kg/m²), using self-reported height instead of measured height, (agreement between the two was 94%; kappa, 0.85; sensitivity 79% and specificity 91%; n = 330), was effected to an extent which was greater in those aged 65 years and over, than under 65 years. There was little advantage in using correction factors for self-reported height. Therefore, for simplicity, it is suggested that correction factors for recalled height are not generally necessary, although workers should feel free to use them for particular groups of patients. The same applies to

Table B.6 Agreement (% and kappa) between 'MUST' categories (separately for 'MUST'3 and 'MUST'2) obtained using actual measurement of weight and height and self reported measurements of weight and/or height, and sensitivities and specificities associated with the two category classification ('MUST'2)

Comparison+	N	Agreement		Sensitivity		Specificity	
		%	kappa	%	%	%	%
<65 years							
'MUST'3 v 'MUST'3 (recalled wt & ht)	203	94.6	0.833*				
'MUST'3 v 'MUST'3 (recalled wt)	206	95.1	0.896				
'MUST'3 v 'MUST'3 (recalled ht)	209	96.7	0.927				
'MUST'3 v 'MUST'3 (recalled ht - 0.01m)	208	96.6	0.926				
'MUST'3 v 'MUST'3 (recalled wt & ht - 0.01 m)	202	96.1	0.916				
'MUST'2 v 'MUST'2 (recalled wt & ht)	203	96.1	0.906*	95.0	96.5		
'MUST'2 v 'MUST'2 (recalled wt)	206	96.1	0.908	92.5	97.2		
'MUST'2 v 'MUST'2 (recalled ht)	209	97.6	0.942	95.2	98.6		
'MUST'2 v 'MUST'2 (recalled ht - 0.01 m)	208	97.6	0.942	95.1	98.6		
'MUST'2 v 'MUST'2 (recalled wt & ht - 0.01 m)	203	97.0	0.929	95.0	97.9		
≥ 65 years							
'MUST'3 v 'MUST'3 (recalled wt & ht)	109	93.6	0.880				
'MUST'3 v 'MUST'3 (recalled wt)	115	98.3	0.966				
'MUST'3 v 'MUST'3 (recalled ht)	120	95.0	0.907				
'MUST'3 v 'MUST'3 (recalled ht - 0.04m)	120	96.7	0.937				
'MUST'3 v 'MUST'3 (recalled ht - 0.03m)	120	95.8	0.922				
'MUST'3 v 'MUST'3 (recalled wt & ht - 0.04 m)	109	96.6	0.929				
'MUST'3 v 'MUST'3 (recalled wt & ht - 0.03 m)	109	97.5	0.947				
'MUST'2 v 'MUST'2 (recalled wt & ht)	109	95.4	0.902	100.0	93.0		
'MUST'2 v 'MUST'2 (recalled wt)	115	99.1	0.981	97.6	100.0		
'MUST'2 v 'MUST'2 (recalled ht)	120	97.5	0.947	100.0	96.1		
'MUST'2 v 'MUST'2 (recalled ht - 0.04m)	120	98.3	0.984	97.8	98.7		
'MUST'2 v 'MUST'2 (recalled ht - 0.03m)	120	97.5	0.946	97.7	97.4		
'MUST'2 v 'MUST'2 (recalled wt & ht - 0.04 m)	109	99.1	0.980	100.0	98.6		
'MUST'2 v 'MUST'2 (recalled wt & ht - 0.03 m)	109	99.1	0.980	100.0	98.6		

Table B.6 continued over page

Table B.6 continued. Agreement (% and kappa) between 'MUST' categories (separately for 'MUST3 and 'MUST2) obtained using actual measurement of weight and height and self reported measurements of weight and/or height and sensitivities and specificities associated with the two category classification ('MUST2)

Comparison +	N	Agreement		Sensitivity		Specificity	
		%	kappa	%	%	%	%
All ages							
'MUST3 v 'MUST3 (recalled wt & ht)	312	96.8	0.882*				
'MUST3 v 'MUST3 (recalled wt)	321	96.3	0.923				
'MUST3 v 'MUST3 (recalled ht)	329	96.0	0.919				
'MUST2 v 'MUST2 (recalled wt & ht)	312	97.1	0.905	96.9	95.3		
'MUST2 v 'MUST2 (recalled wt)	321	97.2	0.936	95.1	98.2		
'MUST2 v 'MUST2 (recalled ht)	329	97.6	0.945	97.2	97.8		

+ 'MUST3 refers to the 3 categories of 'MUST' and 'MUST2 to two categories (low and medium+high categories combined)
 * 'MUST3 (recalled wt (weight) & ht (height)) places the small number of disagreements into higher rather lower risk category relative to 'MUST3 (measured wt (weight) & ht (height)) (p<0.05; binomial test)

Table B.7. Agreement (kappa) between 'MUST categories obtained using actual measurement of weight and/or height and recalled weight and/or height in patients less than 65 years****

Comparison*	Surgical ward (n=80)		Surgical ward (n=70†)		Medical ward (n=64)		Medical ward (n=78)		Medical elderly (n=50‡)	
	(%)	kappa	(%)	kappa	(%)	kappa	(%)	kappa	(%)	kappa
'MUST3 v 'MUST3(recalled wt & ht)	98.7	0.953	94.7	0.915	93.8	0.838	94.8	0.898	84.4	0.735
'MUST3 v 'MUST3(recalled wt)	98.7	0.953	98.4	0.975	92.2	0.829	93.6	0.871	89.1	0.810
'MUST3 v 'MUST3(recalled ht)	98.7	0.953	97.1	0.953	93.8	0.838	100.0	1.000	89.8	0.834
'MUST2 v 'MUST2(recalled wt & ht)	100.0	1.000	96.5	0.929	96.9	0.913	94.8	0.886	88.9	0.775
'MUST2 v 'MUST2(recalled wt)	100.0	1.000	98.4	0.968	96.9	0.909	93.6	0.857	89.8	0.796
'MUST2 v 'MUST2(recalled ht)	100.0	1.000	98.6	0.971	96.9	0.913	100.0	1.000	90.0	0.800

* 'MUST3 refers to the 3 categories of 'MUST' and 'MUST2 to two categories (low and medium+high categories combined)
 ** Data obtained on medical and surgical wards at Southampton (Longmore D et al and Dixon R et al²⁷⁸; Hackston A et al; Price S et al; and Joseph K et al)
 † n= 63 for comparison with recalled weight and 57 with recalled weight + recalled height
 ‡ n= 49 for comparison with recalled weight and 45 with recalled weight and height

patients in the community.

The EPIC study¹⁶⁸ involving 5140 participants from Oxfordshire, aged 35 to 77 years, found that self-reported height overestimated measured height by only 0.68 cm in those aged 35-49 years, 0.82 cm in those aged 50-59 years and 1.05 in those over 60 years (overall sd 2.0-2.5 cm). Weight was underestimated by less than 2 kg in all age groups (overall sd 2.0-2.5kg). A number of other community based studies have found greater overestimation of height in elderly subjects, generally by 2-4 cm, as in a study of older individuals aged 62-96 years involved in a meal programme, where self-reported height overestimated measured height by 2.4 (sd 3.56) cm. This was virtually identical to that reported for a group of 2482 subjects aged 65-74 years who participated in the second National Health and Nutrition Survey in the USA (2.4 (sd 3.2) cm)¹⁶⁹.

- Self-reported height in hospitalised patients was found to be a significantly better predictor of height than all of the surrogate procedures assessed (see below and Table B.5). This is consistent with results of a community study which found that self-reported height was a better predictor of measured height than arm span¹⁷⁰.
- Self-reported height remains a good predictor of height even in patients with some cognitive impairment. Our study (Tables B4-B6) of hospitalised patients included patients with cognitive impairment, who provided good estimates of weight and height (not patients with advanced dementia). These results are consistent with the Canadian Study of Health and Aging¹⁷¹, which found that self reported BMI (weight and height recall) had excellent sensitivity (>93%) in detecting underweight in cognitively intact, cognitively impaired, and demented subjects (although the discrepancy with actual measurements was greater in the last category of patients). Self reported height may be unreliable or unobtainable in patients with severe confusion and dementia, and is obviously unobtainable from unconscious patients.

ii) Family informant estimates of weight and height:

- Family informants can provide useful proxy measures of weight and height, when measured or self reported heights and weights are not available. In a study involving 374 first degree relatives, informant estimates were highly predictive of measured heights ($r=0.95$) and weights ($r=0.94$) with height estimates generally being within 1% of measured height, and weight measures within 3-5% of measured weight¹⁷².

iii) Recumbent height

- For bedridden patients, measurement of height can be made in the recumbent position. In a study of 108 ambulatory patients, recumbent height was found to be as precise as standing height but 2% higher, which was not considered to be clinically significant in most circumstances¹⁷³. Although the effect of recumbent height was not measured in our trials, the above study suggests that recumbent height is likely to have little effect in altering malnutrition risk categorisation and identification of obese individuals.

iv) Surrogate procedures

- All the surrogate procedures used to estimate height (knee height (without use of knee calipers¹), demispan, ulna length, arm length) were found to be inferior to

self-reported height (Table B.5).

- Ulna length, demispan, and knee height generally predicted height equally well, and significantly better than arm length. This was mainly because it was often difficult to get the arm in the correct measurement position (straight arm by the side of the body with palm facing inwards).
- The ulna length was usually easier and quicker to measure than demispan and knee height, especially in those with disabilities and difficulties in moving their limbs into the correct measurement positions. Therefore, on practical grounds, ulna length is recommended, but since it is the smallest limb length, any measurement error is magnified. In addition, it did not offer any advantages over demispan or knee height in the accuracy of the predictions.
- Established equations for converting knee height and demispan to height (age and sex specific equations - see section C.2.1.2) were applied to a group of over 300 hospitalised patients. The overall bias was less than 0.5 cm when height was estimated from knee height and 2.7 cm when demispan was used, possibly because of oversimplification of the demispan formula (section C.2.1.2). However, when these conversions were used to categorise patients into malnutrition risk, using either measured or self-reported weight, the results agreed very well with malnutrition categorisation based on measured weight and height (agreement >95%; kappa >0.9; sensitivities and specificities for 'MUST'2 >95%) (Table B.6).

b) When weight cannot be measured: Self-reported weight was found to be an unbiased overall predictor of measured weight, and therefore of BMI, in hospitalised patients ($r = 0.961$; standard error of the estimate (see), 4.86 kg; $n=338$) (Table B.4). Use of self-reported weight instead of measured weight infrequently altered the final malnutrition risk category (see Table B.6 & B.7 for agreement, kappa values, and sensitivity/specificity). This is despite the tendency for self-reported weight to underestimate measured weight as weight increases (the discrepancy between measured and self-reported weight was significantly related to measured weight; $p<0.01$; $r^2 = 0.066$). A number of community studies also show little or no overall bias in self-reported weight, although some report a certain amount of underestimation in the obese and overestimation in the underweight^{166, 169} (including studies with anorexia nervosa¹⁷⁴). The standard deviation of the difference between measured and self-reported weight in the hospitalised patients reported here (4.86 kg), which was disproportionately influenced by some outlying values, was found to be larger than those generally reported in community studies (<3 kg)^{166, 169}, including those involving recipients of meals-on-wheels (3.1 kg)¹⁷⁵.

i) Self reported weight to categorise patients into overall malnutrition risk

Although self reported weight altered the BMI categorisation in a proportion of hospitalised patients, the overall effect on malnutrition risk was small, affecting only about 5% of categorisations (kappa values remaining as high as ~0.9). This occurred despite the tendency for underweight individuals ($BMI < 20 \text{ kg/m}^2$) to overestimate their weight by a mean of 1.6 kg ($p < 0.07$). With the two category classification (underweight/not underweight) the specificities and sensitivities of the final malnutrition risk were found to be about 95% for each, even when recalled height was added to the prediction (Table B.6).

ii) *Self-reported weight to categorise patients as obese/not obese* Classification of patients as obese (BMI >30 kg/m²) or non-obese using self-reported weight and measured height agreed well with the classification based on actual measurements of weight and height (97% agreement; kappa 0.833; specificity 82%, sensitivity 98%). This occurred despite a tendency for weight to be underestimated in the obese (1.6kg; p<0.02).

c) ***When weight and height cannot be measured:*** In the absence of measured weight and height, two alternative methods can be used to estimate BMI categories. The first method involves use of both self-reported weight and height. In a group of over 200 hospitalised patients, this method produced a discrepancy with measured BMI and a weak but significant relationship ($r^2 = 0.066$) between the discrepancy and measured BMI. Obese individuals (n=81) significantly underestimated their BMI ($1.35 + 2.60$ kg/m²), but underweight individuals did not significantly overestimate their BMI ($-0.30 + 1.44$ kg/m²). Despite these observations, the final categorisation of malnutrition risk was altered in less than 5% of cases and yielded acceptable kappa values and sensitivity/specificity (Tables B.6 & B.7). The second method for estimating BMI categories involves the use of MUAC, which can be particularly valuable when measured or recalled height cannot be obtained or when recalled weight is obviously unrealistic. Surrogate measures of height are of little value in calculating BMI and establishing BMI categories in the absence of an actual or surrogate measurement of weight. For simplicity, in the use of 'MUST', MUAC is used to establish two BMI cut-off values (at 20 kg/m² to help detect underweight, and at 30 kg/m² to help detect obesity). The two methods did not differ significantly in classifying a group of hospitalised patients into obesity/no obesity classification. The recalled weight and height method was better than MUAC in classifying patients into underweight/not underweight categories only in those aged <65 years (see below). The choice of cut-off values of MUAC and their application to clinical practice is discussed below.

(i) *Choice of MUAC cut-off points* A secondary analysis of data obtained from individuals aged 65 years and over, who participated in the National Diet and Nutrition Survey²⁰, established the following linear relationships between MUAC and BMI: $r = 0.727$ and see 2.7 kg/m² for men; $r = 0.81$ for women, see 2.9 kg/m²; and $r = 0.77$, see 2.9 for men and women combined. Virtually identical r values were obtained using non-linear regression analyses logarithmic, inverse, exponential and, although the curves were almost identical over much of the BMI range, they deviated from each other at the extremes of the BMI range (e.g. close to a BMI of 18.5 kg/m²). These observations suggest firstly, that it is difficult to use regression analysis to predict an appropriate MUAC cut-off point for 'MUST' (e.g. to choose an optimal value of MUAC to identify individuals with a BMI <18.5 kg/m²), and secondly, the variability in BMI predictions from a single value of MUAC is substantial, even when only one statistical procedure is used. A study in hospital has reported a similar relationship between BMI and MUAC to the present study and also showed that age and sex did not significantly improve the prediction of BMI from MUAC⁷⁴.

To obtain quantitative insights into the significance of MUAC values, the following tables are provided: Table B.8, which shows centiles of MUAC

Centile*											
	2.5	5	10	25	50	75	90	95	97.5		
MUAC (cm)											
<i>Free-living</i>											
Men ≥65 years (n = 583)	23.1	24.6	25.8	27.9	30.0	32.0	34.0	35.6	37.4		
Men 65-75 years (n =252)	24.1	26.1	27.0	29.0	31.0	32.7	34.9	36.7	38.1		
Men 78-85 years (n=199)	23.2	24.5	25.6	27.6	29.6	31.5	33.8	35.8	36.7		
Men >85 years (n=67)	19.6	22.5	25.2	25.6	27.5	29.8	31.4	32.2	33.9		
Women ≥65 years (n = 577)	22.0	23.1	24.6	26.6	29.2	31.9	34.8	36.0	37.4		
Women 65-75 years (n=204)	23.1	24.3	25.5	27.6	30.2	30.0	35.6	36.6	37.8		
Women 75-85 years (n=168)	22.5	23.1	24.8	26.9	29.2	31.4	34.0	35.4	36.2		
Women >85 years (n=124)	21.1	21.9	22.9	25.0	27.5	30.1	32.4	34.9	35.2		
<i>Institutions</i>											
Men ≥65 years (n = 183)	21.1	21.5	22.6	24.5	26.95	29.3	32.1	33.0	35.1		
Women >65 years (n = 177)	18.7	20.2	21.25	23.8	27.1	29.3	32.1	34.4	36.3		
BMI (kg/m²)											
<i>Free living</i>											
Men ≥65 years (n = 574)	19.4	20.5	21.6	23.9	26.0	28.5	31.2	32.2	34.0		
Women ≥65 years (n = 564)	17.9	19.2	20.9	23.5	26.2	29.6	32.9	35.3	37.4		
<i>Institutions</i>											
Men ≥65 years (n = 127)	16.9	17.6	18.9	21.0	24.0	27.3	30.5	35.2	37.1		
Women ≥65 years (n= 123)	17.7	18.3	19.0	20.9	24.9	28.5	32.3	35.7	37.7		

* Centiles or percentiles refer to a set of 100 divisions in a series of continuous values, in this case MUAC and BMI. Thus, a person with a MUAC lower than the 5th centile has a MUAC that is less than 5% of other recorded values.

Table B.9. Mid-upper arm circumference (MUAC) according to body mass index (BMI) in men and women aged 65 years and over (based on secondary analysis (Elia M, Stratton, RJ) of The National Diet & Nutrition Survey²⁰)

BMI category	Men + Women			Men			Women			
	mean (range) (kg/m ²)	mean (cm)	sd (cm)	(n)	mean (cm)	sd (cm)	(n)	mean (cm)	sd (cm)	(n)
18 (17.50 - 18.49)										
18.5 (18.00 - 18.99)*		23.03	1.66	(29)	23.29	1.03	(12)	22.85	2.00	(17)
19 (18.50 - 19.49)		23.81	2.02	(35)	23.71	1.58	(15)	23.88	2.33	(20)
20 (19.50 - 20.49)*		24.53	2.35	(44)	24.69	2.24	(21)	24.41	2.49	(23)
21 (20.50 - 21.49)		25.88	2.38	(74)	26.76	2.55	(38)	24.95	1.79	(36)
22 (21.50 - 22.49)		26.53	2.15	(86)	27.04	2.27	(46)	25.94	1.86	(40)
23 (22.50 - 23.49)		27.31	2.41	(92)	27.76	2.67	(51)	26.74	1.92	(41)
24 (23.50 - 24.49)		27.98	2.02	(119)	28.37	1.95	(57)	27.63	2.04	(62)
25 (24.50 - 25.49)		28.86	1.98	(135)	29.03	1.81	(75)	28.64	2.18	(60)
26 (25.50 - 26.49)		29.17	2.18	(143)	29.42	1.90	(80)	28.85	2.48	(63)
27 (26.50 - 27.49)		30.25	2.75	(123)	30.51	2.71	(74)	29.87	2.79	(49)
28 (27.50 - 28.49)		30.25	2.24	(114)	30.56	2.33	(60)	29.92	2.10	(54)
29 (28.50 - 29.49)		31.32	2.45	(88)	31.74	2.70	(48)	30.81	2.02	(40)
30 (19.50 - 30.49)*		32.15	2.57	(74)	32.92	2.63	(34)	31.49	2.35	(40)
31 (30.50 - 31.49)		32.66	2.62	(57)	33.36	2.72	(29)	31.93	2.32	(28)
32 (31.50 - 32.49)		33.09	2.29	(44)	33.07	2.18	(22)	33.10	2.45	(22)
33 (32.50 - 33.49)		33.58	3.04	(30)	34.01	2.34	(8)	33.42	3.29	(22)
34 (33.50 - 34.49)		34.62	3.21	(20)	34.66	2.53	(8)	34.61	3.70	(12)
35 (3.50 - 35.49)		35.66	3.01	(18)	36.08	2.55	(4)	35.54	3.20	(14)

* BMI cut-off points 18.5, 20 and 30 kg/m² are used in 'MUST'

Table B.10 Sensitivity (sens) and specificity (spec) of using mid-upper arm circumference (MUAC) to predict underweight (BMI <20 and <18.5 kg/m²) and obese (BMI >30 kg/m²) men and women living at home and institutions (based on secondary analysis (Ella M, Stratton, RJ) of The National Diet & Nutrition Survey²⁰)

		BMI <18.5 kg/m ²						BMI <20 kg/m ²						BMI >30 kg/m ²																	
		men		women		men+women		men		women		men+women		men		women		men+women													
MUAC (cm)	spec (%)	sens (%)	spec (%)	sens (%)	spec (%)	sens (%)	spec (%)	MUAC (cm)	sens (%)	spec (%)	sens (%)	spec (%)	MUAC (cm)	sens (%)	spec (%)	sens (%)	spec (%)	MUAC (cm)	sens (%)	spec (%)	sens (%)	spec (%)									
Home (free-living)																															
22.0	71	>99	47	>99	54	>99	22.0	30	>99	29	>99	28	>99	30.0	95	59	91	72	93	66											
22.5	71	>99	52	98	58	99	22.5	37	>99	33	99	36	>99	31.0	87	73	83	83	84	78											
23.0	71	99	57	97	58	98	23.0	45	>99	47	98	45	99	31.5	81	79	79	88	80	83											
23.5	100	98	68	96	77	97	23.5	65	>99	58	97	60	98	32.0	74	84	72	89	73	87											
24.0	100	98	74	94	80	96	24.0	70	99	62	96	64	98	32.5	58	90	65	93	63	91											
24.5	100	97	74	93	81	95	24.5	75	99	73	95	73	97	33.0	52	92	60	95	57	93											
Institutions																															
22.0	27	95	67	95	48	95	22.0	25	98	48	98	36	97	30.0	86	84	77	96	81	88											
22.5	46	94	70	93	57	94	22.5	39	97	60	96	48	97	31.0	67	91	55	94	59	93											
23.0	46	91	70	89	57	90	23.0	44	95	67	93	54	94	31.5	67	93	55	96	59	95											
23.5	73	90	80	88	76	89	23.5	61	94	78	92	68	93	32.0	52	93	48	97	51	95											
24.0	73	87	90	83	81	86	24.0	65	92	82	89	73	91	32.5	33	96	41	98	38	97											
24.5	82	81	100	77	91	79	24.5	83	88	89	81	85	85	33.0	31	98	30	99	30	99											
Home + Institutions																															
22.0	44	99	55	>99	50	99	22.0	26	>99	35	99	30	>99	30.0	94	64	89	75	91	69											
22.5	55	98	58	99	57	98	22.5	37	>99	44	99	41	99	31.0	85	76	78	85	81	80											
23.0	56	97	65	98	60	97	23.0	44	99	40	98	49	98	31.5	79	82	75	89	77	85											
23.5	83	97	72	98	77	96	23.5	63	98	64	97	64	97	32.0	72	86	69	91	70	88											
24.0	83	96	76	96	81	94	24.0	67	98	70	95	69	96	32.5	59	91	62	94	60	92											
24.5	89	94	83	90	80	97	24.5	80	97	78	93	78	95	33.0	75	93	57	96	54	94											
																			34.0	37	95	45	98	41	97						

Table B.11 Agreement between 'MUST'2† classification obtained using either actual measurement of weight and height, or mid-upper arm circumference ('MUST'2 (muac)* and self reported weight and height ('MUST'(recalled weight & height)).

Comparison†	N	Agreement		Sensitivity	Specificity	'MUST' risk category	
		%	kappa			Low %	Medium + high %
'MUST'2 v 'MUST'2(muac)							
<65 years:	209	96.2	0.906	89	99	70	30
≥65 years:	129	95.3	0.900	96	95	63	37
All ages:	337	95.8	0.904	92	98	68	32
'MUST'2 v 'MUST'2(recalled wt & ht)							
<65 years:	203	96.1	0.906	95	96	70	30
≥65 years:	109	95.4	0.902	100	93	65	35
All ages:	203	96.1	0.906	97	95	69	31

† 'MUST'2 refers to two categories (low and medium+high categories combined)
 * Mid-upper arm circumference values below and above 23.5 cm are used to classify individuals with BMI <20 kg/m² and >20 kg/m² respectively

obtained from subjects aged 65 years and over; Table B.9 (based on a secondary analysis of a national dataset²⁰), which shows the mean and standard deviation of MUAC of these individuals with increasing BMI within the range 18 to 37 kg/m²; and Table B.10, which tabulates the sensitivities and specificities associated with the use of MUAC to predict a BMI <18.5, <20 and >30 kg/m². In choosing cut-off values consideration needs to be given not only to the sensitivities and specificities associated with different MUAC values, but also to the proportion of underweight and obese individuals in different care settings, since these influence the overall positive and negative predictive value of the test. Therefore, Table B.10 is provided to allow local judgments to be made according to the type and proportion of underweight and obese subjects. However, it is suggested that a general cut-off value of <23.5 cm is used for identifying underweight individuals (BMI < 20 kg/m² (and for <18.5kg/m²)), and a value of >32 cm for identifying obese individuals (BMI > 30 kg/m²).

- (ii) *MUAC to categorise patients into underweight/no underweight and overall malnutrition risk* A MUAC cut-off value of 23.5 cm was used to establish BMI categories (above and below BMI of 20 kg/m²) in a group of over 300 individuals aged 16-94 years. 'MUST'2 established in this way ('MUST'2(muac)), showed excellent agreement with 'MUST'2 established using measurements of weight and height (agreement 95.8% kappa 0.904; sensitivity 92% and specificity 98%). The use of MUAC to categorise patients into 2 categories was as good as using measurements of self-reported height and weight in hospitalised patients, both in those aged under and over 65 years (Table B.11). Application of the same cut-off point (23.5 cm) to that of another dataset of over 2,000 measurements obtained from a variety of patients, aged 18 to 85 years (provided by B Strauss), revealed a sensitivity (for detecting underweight, BMI <20 kg/m²) of 76% and specificity of 96% in those aged >65 years (68% and 98% respectively for those <65 years; (n =1957)). No 'MUST' scores were available with this dataset. In another study of patients admitted to medical,

surgical and orthopaedic wards, a cut-off point of 23.5 cm was associated with a sensitivity of 86% for identifying individuals with a BMI below 20 kg/m² and a specificity of 98.6% (calculations based on summary data from 591 patients⁷⁴).

No 'MUST' scores or prevalence of obesity were reported in the paper.

- (iii) *MUAC to categorise patients into obese/not obese* Application of a MUAC value of 32 cm to the same dataset for the purposes of detecting obesity (BMI > 30 kg/m²) was associated with a sensitivity of 95% and specificity of 84% in those aged < 65 years (94% and 82% respectively for those > 65 years). Application of the MUAC cut-off value of 32 cm to 340 hospital in-patients (medical, medical elderly, and surgical wards) revealed a sensitivity of 59% and specificity of 93% in those aged > 65 years (n = 128) and 87% and 83% respectively in those aged < 65 years (79% and 85% respectively for all ages). In this group of patients overall agreement was better using recalled weight and height than MUAC (comparison of the area of the Receiver Operating Characteristic (ROC) curve), although not significantly so for those aged 65 years and over.

B.3.4.2 Weight loss category (percent change in weight (or BMI))

- Although many patients are able to accurately report their weight (see above) and change in weight, this may not be possible in some patients. Therefore, alternative means of predicting BMI and change in BMI (or change in body weight) are necessary. By combining results of starvation studies involving lean^{87,176, 177} and obese individuals¹⁷⁷, a linear relationship was found between percent change in MUAC and percent change in body weight. The percent change in both variables was similar, with for example a 10% change in MUAC corresponding to approximately a 10% change in body weight (95% prediction interval 6.2-15.9% body weight). Similar linear relationships and similar regression equations have been found in a group of non-oedematous patients with lung cancer¹⁷⁸, and a group of over a thousand patients with a variety of diseases (data provided by B Strauss), although the prediction intervals were large, suggesting caution in the use of these measurements. Duplicate measurements are recommended.
- An alternative and complementary approach is a clinical approach, which involves enquiring and observing if clothes and jewellery have recently become looser (to indicate weight loss) or tighter (to indicate weight gain, if not oedematous). Such observations contribute to the overall subjective clinical assessment of malnutrition risk.

B.3.4.3 Overall subjective assessment (two categories: low risk and medium/high risk)

Subjective evaluations of risk of malnutrition can be valuable, but the results may be variable. Subjective evaluations were made by a doctor in an outpatient clinic, without knowledge of weight or height of the patients (Refer to Table B.12). The results were compared with malnutrition categories obtained objectively by a healthcare assistant. Similarly, a medical student subjectively rated patients (n = 25) on medical wards and compared his ratings with objective measurements obtained independently by another medical student on the same patients. The roles of the

Table B.12 Agreement between objective and subjective components of the 'MUST'

Comparison†	N*	Agreement			Location	'MUST' risk		Investigators
		n*	%	kappa		low	medium+high	
'MUST'2 objective v 'MUST'2 subjective	75	73	97	0.934	medical wards	54	21 (8 + 13)	Medical students
'MUST'2 objective v 'MUST'2 subjective	80	72	90	0.633	surgical wards	83	12 (6 + 6)	Medical students
'MUST'2 objective v 'MUST'2 subjective	50	49	98	0.951	gastro- intestinal outpatients (GIT)	35	15 (9 + 6)	Doctor/ nurse

† 'MUST'2 refers to two categories (low and medium+high categories combined)
* N refers to the number of subjects involved in the study, whilst n refers to the number of agreements

students were reversed in a surgical ward so that the first one undertook the objective scoring and the second one the subjective scoring (n = 25). These students had previously shown perfect agreement when rating a group of 50 medical and surgical patients for malnutrition risk using the objective components of 'MUST'. The agreement between the subjective and objective ratings in the above studies varied from 87- 98%, with kappa values ranging from 0.587 to 0.951 (Table B.12) (see B.9 Annexe 2 for interpretation of kappa values). The data suggest that good/excellent agreement can be obtained between subjective and objective categorisation with 'MUST'. It is not surprising that the agreement was variable between studies. Even greater variability would be expected with different raters and groups of patients, at least partly because subjective results depend on the training, experience and type of health workers involved in the categorisation procedure. For this reason it is generally recommended that objective measurements are made whenever possible.

When it is not possible to establish weight loss or BMI categories by objective measurements, surrogate measurements can be used (Tables B.4-B.7), but the choice of surrogate measure may depend on the specific circumstance.

B.4 Reliability and internal consistency of 'MUST'

B.4.1 Inter-rater agreement

B. 4.1.1 'MUST' The reliability of the tool was established by assessing the extent to which the malnutrition risk categorisation obtained independently by different healthcare workers on the same group of patients agreed with each other (inter-rater agreement).

A series of studies were undertaken in different healthcare settings (medical and surgical wards, outpatient clinics, and a GP surgery) by a range of healthcare workers or student healthcare workers (nurses, student nurses, health care assistants, a doctor, and medical students). The results were checked and corrected for very

Table B.13 Inter-rater agreement using the 'MUST' in hospital and the community

Setting	Raters	N*	Agreement			Location (investigator)
			n*	%	weighted kappa+	
Hospital inpatients [†]						
surgical ward	healthcare assistant v nurse	69	66	96	0.898	Rotherham (Ward J et al)
surgical/medical wards	medical student v medical student	47	47	100	1.000	Southampton (Longmore D et al)
Resident in community (Hospital outpatients and GP surgery) ^{††}						
outpatients	nurse v healthcare assistant	44	42	95.5	0.888	Dundee (Baxter J et al)
outpatients	nurse v healthcare assistant	60	59	98.3	0.948	Rotherham (Ward J et al)
outpatients	nurse v student nurse	60	60	100	1.000	Rotherham (Ward J et al)
outpatients	student nurse v healthcare assistant	60	59	98.3	0.948	Rotherham (Ward J et al)
general practice	doctor v nurse	50	50	100	1.000	Stockport (Sanders J et al)
nursing + residential home	healthcare assistant v healthcare assistant	26	24	92	0.809	Bassetlaw (Todorovic et al)
residential home	healthcare assistant v healthcare assistant	40	40	100	1.000	Bassetlaw (Todorovic et al)
nursing home	healthcare assistant v nurse	24	24	100	1.000	Bassetlaw (Todorovic et al)

* N refers to the number of subjects involved in the study, whilst n refers to the number of agreements.

+ See annex

† The diagnoses in surgical wards included abdominal cancer, Crohn's disease, gall stones and appendicitis. The main problems in medical wards were haematemesis/melaena due to peptic ulcer, chest pain due to myocardial infarction, chest infections, pneumonia, diabetes, epilepsy and cancer.

†† The main diagnosis in the outpatient clinics, which were mainly gastroenterological, was inflammatory bowel disease. Other diagnoses included coeliac disease, irritable bowel syndrome and arthritis. In the care homes the main diagnoses were stroke, arthritis, Parkinson's disease and dementia.

Table B.14 Inter-rater reliability associated with the use of a variety of screening toolst (excluding 'MUST')†‡

Tool	Raters	Patient type	N*	Agreement		Reference
				(%)	kappa	
Hospital						
Subjective global assessment	clinician v clinician	surgical	49	81	0.72	66
	nurse v 3 clinicians	surgical	109	91	0.784 (0.6-1.0)	180
	clinician v clinician	medical/surgical	175	79	0.66	181
	dietitian v dietitian	liver transplant	20	80	0.570	182
	clinician v researcher	elderly	90	78	0.56	279
	dietitian v dietitian	various	23	96	0.88	184
	(acute hospital)					
	dietitian v assistant	various	29	93	0.84	184
	nurse v dietitian	elderly (day hospital)	15	87	0.73	185
	nurses v dietitians	medical/surgical/elderly	100	92	-	186
Derby nutritional score	nurses v nurses (10 pairs)	70		0.7 (0.6-0.9)	187	
Community						
Nutritional risk screening tool	nurse1 v nurse2	mainly elderly	<31		0.709	188
	nurse1 v dietitian	mainly elderly	<27		0.036	188
	nurse2 v dietitian	mainly elderly	<27		0.173	188

† Other statistical procedures have been used to assess inter-rater agreement in other studies

(i) correlation coefficient: 0.68-0.69 in general medical and geriatric outpatients using the Nutritional Risk Index²⁸⁰, and no significant correlation between nurse and dietitian in hospitalised elderly patients⁶³

(ii) Intra-class correlation: 0.72 nurse v nurse in dialysis patients¹⁹⁰

(iii) Reliability coefficients: 0.3-0.71 for different components of the tool assessed by nurses v dietitians in staffed houses (long-stay hospitals)¹⁹¹

‡ Inter-rater reliability involving 'MUST' is shown on the preceding table (kappa values of 0.89-1.00 in hospital, and 0.90-1.00 in the community).

* N refers to the number of subjects involved in the study, whilst n refers to the number of agreements.

with kappa values ranging from 0.90 to 1.00. These results are well above the cut-off values of 0.75, which Landis and Koch¹⁷⁹ suggested represent excellent agreement beyond chance.

B.4.1.2 Other tools Most other tools have not been tested for inter-rater agreement, and those that have, have generally yielded less good results than 'MUST', probably because they tend to be more complicated and contain more subjective elements (Table B.14)^{63, 66, 180-191}. Some tools have reported results of inter-rater agreement as correlations or intra-class correlations (e.g. Shrout and Fleiss random effect model 2,1)¹⁹² (typically $r < 0.75$; footnote to Table B.14), which are again generally substantially less good than those obtained for 'MUST' (typically $r > 0.9$).

B.4.2 Precision of measured weight, height and surrogate measurements of height

The precision (technical error of measurement (TEM)) associated with measurements of height was assessed in hospitalised patients in medical and surgical wards using portable stadiometers and weighing machines that had been calibrated against reference standards. The studies were undertaken by two observers, who measured each patient twice. As expected, the intra-observer precision was better than the inter-observer precision (Table B.15). The results for height and weight were generally within the range reported by other workers¹⁹³, but the interindividual TEM for demispan and MUAC was greater than values obtained in non-hospitalised patients. The %TEM of height was found to be better than the %TEM of surrogate measurements (knee height demispan, and ulna length), which generally yielded similar results to each other. However, ulna length has to be multiplied by a larger number to obtain height than the other surrogate measurements. From this information on TEM, and the much larger residual variation obtained on regressing height on surrogate measures of height (Table B.4), it appears that most of the discrepancy between measured height and that predicted from surrogate measurements is due to biological differences in bony proportions between individuals rather than measurement errors.

Table B.15* Intra and interobserver technical error of measurement (TEM) and %TEM for weight, height, surrogate indices of height, and mid-upper arm circumference (MUAC)*

	Mean + sd (cm or kg)	Intraobserver		Interobserver		Intra & interobserver	
		TEM (cm or kg)	%TEM (%)	TEM (cm or kg)	%TEM (%)	TEM (cm or kg)	%TEM (%)
Weight	77.21 ± 14.87	0.17	0.22	0.66	0.85	0.68	0.88
Height	68.4 ± 8.1	0.12	0.07	0.43	0.26	0.45	0.27
Knee height	52.56 ± 3.24	0.16	0.30	0.90	1.71	0.91	1.73
Demispan	79.51 ± 5.15	0.50	0.63	1.30	1.64	1.39	1.75
Ulna length	25.39 ± 1.70	0.10	0.39	0.44	1.73	0.45	1.77
MUAC	31.25 ± 3.25	0.11	0.35	0.94	3.01	0.95	3.04

* n= 42-46 for all measurements and comparisons

Table B.16 Ease of using 'MUST' tool to establish malnutrition risk

	Investigators (number) †	Ease of establishing malnutrition risk †
Hospital		
Medical ward	Dietitian (1)	easy (1)
Medical ward	Nurse (1)	easy (1)
Medical ward	Medical students (2)	very easy (2)
Medical ward	Nutrition student (1)	easy (1)+
Surgical ward	Dietitian (1)	easy (1)
Surgical ward	Nurse (1)	easy (1)
Surgical ward	Healthcare assistant (1)	easy (1)
Surgical ward	Medical students (2)	very easy (2)
Surgical ward	Nutrition student (1)	easy (1)
Elderly ward	Research dietitian (1)	easy (1)*
Orthopaedic wards	Dietitians (1)	very easy (2)
Resident in community		
Out-patient clinic	Healthcare assistant (1)	easy (1)
Out-patient clinic	Doctor (1)	easy (1)
Out-patient clinic	Nurse (1)	very easy (1)
Out-patient clinic	Student nurse (1)	easy (1)
GP surgery	Doctor (1)	easy (1)
GP surgery	Nurse (1)	easy (1)
GP surgery‡	Nurse (3)	easy (3)
Nursing home	Nurse (4)	easy (1) difficult (3)*
Nursing home	Healthcare assistant (1)	very difficult (1)*

† The number in parentheses refer to the number of investigators and the distribution of their grades about the ease of using 'MUST' to establish malnutrition risk category.

‡ Annual check of individuals aged 75 years and over.

* Involved measurement of knee height, which was difficult in some cases.

+ Difficulty was experienced with elderly patients with severe mobility problems when the equipment and support from another person were not readily available.

Table B.17 Time required for 'Nutritional Screening' using different tools

Tool	Type of patients	Time (min)	Reference
Mini-nutritional assessment	Elderly	<20	158
Mini-nutritional assessment	Elderly orthopaedic	>30	72
Subjective global assessment (modified)	Dialysis patients	12.0 + 3.5 (5-20)	281
Subjective global assessment (modified)	HIV infected patients	2	282
Nutritional assessment screening	Medical/surgical	10-15	283
Nutritional assessment score	Medical/surgical	5	284
Cleveland screen for nutritional status	Acute hospital admissions (various wards)	10	285
Nutritional screening	Acute hospital admissions	5†	286
Nutritional risk	Elderly in acute wards	5-10	218
'MUST'	Hospital and community	<4 (often ~2)	1 & this report

† Requires serum albumin concentration

obvious calculation or transcription errors. Table B.13 shows that the agreement in malnutrition categories between two raters was >95% in all studies, and associated

B.5 Practical aspects of 'MUST'

B.5.1 Ease of use

A variety of healthcare workers, or workers in training, were asked to categorise the ease of using the tool into one of the following four categories: very easy, easy, difficult, and very difficult. The health workers were instructed in the use of the tool before they applied it to patients. Table B.16 shows that students and healthcare workers found the tool easy or very easy to use, but in care homes it was found to vary from easy to very difficult. However, these results in nursing homes were obtained during a pilot study involving knee height measurements, which were found to be difficult in some cases, especially in patients who were immobile or stiff (procedures for measuring ulna length were not available at the time). In addition, the charts used in the pilot studies have since been improved to make the categorisation easier and quicker. Much more positive feedback was obtained during field testing with the new charts and procedures.

B.5.2 Time taken to establish malnutrition risk category and comparison with other tools

The screening procedure can be performed in 2 minutes when there is ready access to weighing scales and a stadiometer and the raters have previously been trained in the use of the tool. When self-reported weight and height are used instead of measured weight and height, the time taken to establish the malnutrition score is usually shortened. In frail elderly people, such as those in care homes who are slow, disabled, and have difficulties in standing up to be weighed and measured, the tool was found to take longer e.g. up to 5 minutes. Since adult height does not normally change during the period of an illness, subsequent screenings are quicker for using the same height measurement. Many workers also stated that the time taken to categorise patients shortens with increasing experience and familiarity with the tool. Table B.17 shows that the reported times to complete nutritional screening using a number of other tools is considerably longer than with 'MUST'.

B.5.3 Acceptability

Typically 'MUST' was found to be acceptable to hospital and community nurses, as well as patients, who were often interested to know their current weight, height, and thinness/obesity status. In some frail elderly patients, help with standing for weight and height measurements can speed up the procedure, ensure that falls do not occur, and make screening more acceptable to the patient.

A potential problem with nutritional screening in the community is the lack of stadiometers and scales for use by health workers who undertake home visits. However, portable weighing scales and stadiometers are available. It is also possible to use lightweight portable infrared instruments, which measure height by reflecting a beam of light on the floor (see first MAG report¹ for validation). Height can be

Item	Grading
Nutritional screening	
BMI as an index of chronic protein energy status (and cut-off points)	B, C, X
Unintentional weight loss to screen for acute onset protein-energy status	B, C
Subjective criteria of tool	B
Surrogate measures for establishing height and BMI	X
Acute disease effect	B
Overall risk of malnutrition and obesity	B, C
Treatment	
General	
Establish potential benefits and goals of nutritional support	Y
Treat or alleviate underlying condition	Y
Nutritional intervention	
Correct specific identifiable deficiencies of trace elements, minerals and vitamins and improve protein energy status	A,Y
Food availability and presentation	B,Y
Modification of food texture (e.g. increased viscosity of liquids in patients with dysphagia)	Y
Help with eating in patients with eating difficulties	B, C, Y
Oral liquid mixed macro and micronutrient supplements*	A
* see Stratton & Elia for detailed discussion of a series of meta-analyses on different groups of patients ²⁹	

measured against the wall using a book to indicate the top of the head. The visiting worker should then have a tape to measure the distance to the floor. The tape measure is also useful for surrogate measurements.

B. 5.4 Local policy and resources

Policy decisions are required to implement 'MUST' and associated care plans, according to local resources. After introduction of 'MUST', total referrals may increase or decrease (as has been found in some settings, where unnecessary referrals appear to have decreased), depending on the previous local organisational infrastructure and policy. Decisions about referrals or alternative care plans need to be considered at senior managerial level. The need for education and training using appropriate resources is clear (see sections A.9 and C.5)

B.6 Grading of evidence for the components of 'MUST' and associated care plans

The previous MAG report¹ graded its recommendations using the classification system indicated in section A.5.4.7 of this report¹⁰⁷. Since this classification system focuses on clinical trials, especially randomised controlled clinical trials, which are unethical in some groups of patients requiring nutritional support²⁹, it is difficult to apply it to these patients. Furthermore, there is no need to provide trial-based evidence for obvious or common sense issues (graded as Y in Table B.18).

Established relationships are graded as X. A summary of grades, which also apply to 'MUST' are summarized in Table B.18.

There is no large scale randomised controlled trial of the effect of 'MUST' or any other screening tool on 'all comers' (e.g. treatment versus no treatment in an entire hospital population) with respect to clinical outcome. This is partly because of ethical problems. However, there is substantial evidence²⁹ (Table A.9) of the beneficial clinical effects of nutritional supplements containing a mixture of macro- and micro-nutrients on particular groups of patients in the hospital and community, and of greater benefit in individuals with a BMI <20 kg/m² than >20 kg/m², particularly patients in the community (Grade A recommendation). Therefore, in these groups of patients there is fairly robust evidence that the benefits of this form of treatment outweighs the harm.

B.7 Conclusion

'MUST' is a reliable and valid tool that can be used to screen for risk of malnutrition in different groups of adult patients in different healthcare settings. It is linked to a care plan, which may be modified according to local policy. It is hoped that the use of a single tool such as 'MUST' across different healthcare settings, will improve the detection and management of malnutrition, and allow the establishment of common internally consistent benchmarks to monitor progress. The evidence base provided in this and the previous MAG report¹ continues to grow. However, the ultimate success of the tool will depend on the experience obtained by a wide range of health workers routinely using the tool on a wide range of patients in different geographic locations.

B.8 Annexe 1: Further evidence based considerations

The first MAG report¹ provided an evidence base for the choice of BMI and weight loss cut-off points. The BMI cut-off points were predominantly based on clinical considerations and loss of physiological function as BMI decreased. The weight loss cut-off points were also based on a combination of loss of body function during weight loss, normal intraindividual variation in unintentional weight change, and use of weight loss as a marker of underlying disease process, which if unchecked, is likely to produce malnutrition. Here further consideration is given to acute disease effects that result in no dietary intake and rapid weight loss and the choice of BMI cut-off values in the elderly.

B.8.1 Acute disease effect

B.8.1.1 Approaches to acute disease effects: Two general approaches have been used to account for the effect of acute diseases on assigning patients to malnutrition risk categories. The approaches have been incorporated into a variety of hospital screening tools, either alone or in combination.

i) Diagnoses and/or specific signs and symptoms It seems reasonable to include diagnoses, signs and symptoms of various diseases which may cause mal-

nutrition in screening tools, since they highlight the need to treat underlying conditions. But because some tools include > 50 diagnoses¹⁹⁴, they can become cumbersome. They may also inadvertently omit important items (e.g., burns, trauma, sepsis, and specific gastrointestinal, neurological, cardiovascular, and respiratory conditions). The same applies to specific symptoms or signs (and their weightings), which are variably incorporated into nutritional screening tools, sometimes in large numbers and often without adequate justification.

There are potential difficulties in always using the same weighting factor for a given diagnosis without considering the phase, severity, and consequences of the disease. For example, a cerebrovascular accident may be transient and have minor effects on body function and nutritional status, or it may be major and have important prolonged consequences on nutritional status, affecting consciousness and/or swallowing. Use of the same weighting factor for all stroke patients does not allow for these important variations. The same applies to other acute conditions, such as cancer, inflammatory bowel disease, multiple sclerosis, and specific renal and hepatic diseases, which may vary considerably in their severity and nutritional consequences.

ii) *Inadequate dietary intake* A poor dietary intake is an important common cause of malnutrition. It may result from anorexia, inability to eat or swallow (e.g. unconsciousness or neurological swallowing disorders), or from the clinical need to abstain from food e.g. when there is intestinal obstruction or ileus. Prolonged anorexia, resulting from severe or complicated illness can lead to a major reduction in body weight, which adversely affects physical, psychological and behavioural function, and clinical outcome. There are drawbacks to the approach of using inadequate dietary intake as an indicator of malnutrition. One of them is that, although acute diseases do not normally increase the total energy requirement^{29, 195}, they may increase requirements for other nutrients, such as certain vitamins and minerals. Another issue is the practical difficulty of accurately assessing dietary intake, especially by staff not trained to undertake such measurements. However, this is not usually a problem when intake is zero as a result of severe head injury, critical illness requiring artificial ventilation, and when patients are deliberately kept nil by mouth over many days, as for example following certain types of major gastrointestinal surgery. The ASPEN Board of Directors¹⁹⁶ suggested that lack of oral intake for over 5 days (or less than half of required intake over 7-10 days) is an indication for enteral tube feeding. The same applies to parenteral nutrition, which is used when other forms of nutritional support are not possible. Accordingly, artificial nutritional support is likely to be needed in patients with severe extensive burns, severe multiple injuries, severe head injury likely to lead to prolonged unconsciousness, and critically ill patients expected to have a prolonged stay in the intensive therapy unit. A variety of national and international societies have provided guidelines or statements about selection of patients with severe acute disease for nutritional support. Among the criteria are the presence of severe acute disease per se, lack of dietary intake, low BMI¹⁹⁷, and history of prior weight loss¹⁹⁸. A recent study of intensive care units across Europe reported that the nutritional

state of patients was evaluated clinically in the majority of patients, and that anthropometry and functional parameters were used in about a quarter of patients¹⁹⁹. The criteria for nutritional support indicated below, focus of dietary intake, and vary in both strictness and type.

- European Society of Intensive Care Medicine²⁰⁰: fasting for >3 or 4 days in a well nourished patient unable to resume oral nutrition, or supplementation of insufficient oral intake for >3-4 days (evidence based elements demonstrate clinical efficacy after a delay as long as 7 days, but clinical practice and experimental evidence strongly suggest that earlier intervention is warranted); present malnutrition in a patient unable to eat; patients with severe burns or trauma.
- The American College of Chest Physicians¹⁹⁷: adult patients requiring at least 4 days of intensive care unit confinement.
- French Speaking Society for Enteral and Parenteral Nutrition¹⁹⁸: patients with weight loss of more than 10% of body weight and those unable to revert to 'normal' nutrition within a week after an acute episode.
- Italian Society for Parenteral and Enteral Nutrition²⁰¹: urine N loss >15 g N/day; 10-15 gN/day if unable to eat less than half basal requirements for 7 days; >10 gN/day in presence of malnutrition.
- American Society of Parenteral and Enteral Nutrition together with the American Society of Clinical Nutrition²⁰²: patients with critical illness who are not expected to resume oral feeding for 7-10 days.
- The American Society of Parenteral and Enteral Nutrition²⁰³: specialised nutritional support should be initiated when it is anticipated that critically ill patients will be unable to meet their nutrient needs orally for a period of 5-10 days.

However, the scientific basis of these recommendations has not always been adequately expressed, and to some extent the recommendations reflect opinions and clinical experience of committee members and the limited information available from the literature. A brief evaluation of the scientific basis of the criteria incorporated in 'MUST' is provided below by considering the effects of varying degrees and duration of dietary restriction on body weight/composition and body function in both the presence and absence of disease.

B.8.1.2 The extent and composition of weight loss during dietary restriction:

a) In the absence of disease A large literature exists about changes in body weight during dietary restriction, ranging from mild restriction to total starvation. The absolute rate of weight loss tends to occur faster in taller and heavier individuals, and in men than in women, who are generally shorter and lighter. Although initial adiposity has relatively little effect on the absolute rate of weight loss, the percentage weight loss is greater in lean subjects. After five days of total starvation, subjects with an initial BMI of 17.5-18.0 kg/m² lose close to 10% of body weight²⁰⁴, those between 20-25 kg/m² lose about 6-8% body weight¹⁷⁶, and those with a BMI of ~35 kg/m² lose about 5% body weight^{177, 205}. The result of Benedict's classic starvation study²⁰⁶, in which there was 7.1% loss of body weight after 5 days of

starvation in an inactive subject with an initial BMI of 20.8 kg/m², is typical of that observed in individuals with a BMI of 20-25 kg/m² undergoing starvation for a similar period of time. (For comparison, a dietary intake about a quarter of normal (~ 600 kcal/day) is likely to produce a loss of 5% body weight in about 8-9 days in healthy lean individuals (BMI 20-25 kg/m²) and 10-12 days in obese individuals (BMI ~35 kg/m²). The composition of weight loss varies with the duration of starvation and initial adiposity. Loss of glycogen (4.2 kcal/g) in association with three times the weight of water, explains much of the rapid weight loss during early total starvation or severe dietary restriction, and the slower weight loss after the first two days of starvation, when glycogen stores are largely depleted. After this early phase of starvation, the proportion of energy derived from fat and fat-free body influences the rate of weight loss. This is because the energy density of endogenous fat (9.4 kcal/g) is ten-fold greater than that of the fat-free body, which consists of about 80% water and only ~20% protein (4.4 kcal/g protein)²⁰⁷. During more prolonged starvation/semistarvation, lean individuals derive a greater proportion of energy from the fat-free body (and less from fat) than obese individuals. Rapid weight loss of 5% body weight in healthy lean individuals (BMI of 20-25 kg/m²) occurs mainly through loss of fat-free mass.

b) In the presence of acute disease Acute diseases (e.g. trauma, infection) often increase basal metabolic rate (BMR) and simultaneously reduce physical activity. The net result is that most acute conditions do not usually produce an increase in total energy expenditure, as assessed by 24-hour indirect calorimetry (ventilated patients) or the doubly-labelled water technique²⁹. This means that the net loss of energy (mainly from fat) in starving individuals suffering from the effects of acute disease, is not usually greater than the amount lost from starving individuals without acute disease. On the other hand, acute diseases are often catabolic, increasing net protein oxidation, urine nitrogen excretion and proportion of energy derived from protein oxidation. Therefore, in the absence of fluid retention, the rate of weight loss is expected to be more rapid in the presence of disease, which may cause loss of an additional 5-10 g of nitrogen/day (~0.155-0.310 kg lean body mass/day). Indeed, observations suggest the rate of weight loss in individuals with major injury and infection ingesting half their normal dietary intake is comparable to the weight loss of healthy individuals fasting²⁰⁸. However, changes in weight in critically ill patients can be variable for a number of reasons, including:

- the acute injury response often favors retention of salt and water, which is associated with increased secretion of mineralocorticoids and anti-diuretic hormone,
- the amount and composition of fluid and electrolytes administered to patients, often intravenously, is variable
- renal, cardiac and hepatic dysfunction can complicate handling of fluid and electrolytes, sometimes leading to oedema
- development of hypoalbuminaemia can also lead to fluid retention and oedema,
- administration of drugs such as steroids can lead to water retention whilst diuretics lead to water loss

Sometimes the catabolic effects of disease are associated with little change and sometimes a substantial increase in body weight as a consequence of fluid retention.

Conversely, recovery may be associated with loss of body weight due to diuresis of the excess fluid. Therefore, daily changes in body weight are more likely to indicate changes in fluid balance than other body constituents.

B.8.1.3 Changes in body function: Changes in body function during weight loss have been summarised in the previous MAG report¹. Here, some consideration is given to the possible additional effects produced by rapid weight loss. Recent studies in healthy subjects suggest that after 5% weight loss, there are more pronounced changes in metabolic function (e.g. protein and glutathione kinetics), and more detrimental effects on physical function (muscle fatigue, physical activity level, certain aspects of taste sensation), and psychological function (energy, fatigue, sleepiness, contentedness) in those losing weight rapidly (through total starvation) than those losing a similar amount of weight more slowly^{176, 177, 209}. Several studies have reported functional changes as a result of rapid weight loss of about 5% body weight induced by dietary intake of 0-40% of normal intake, whereas the same weight loss over 6 months can be regarded as part of the normal intraindividual variation in weight, which is associated with normal body function. Measured or likely loss of weight close to 5% body weight has been reported to produce the following changes: reduced treadmill endurance in lean subjects²¹⁰; adverse changes in maximal force and relaxation following electrical muscle stimulation in obese subjects²¹¹; abnormalities in intestinal permeability to mannitol in lean and obese subjects; and reduced ventilatory responses to hypoxaemia²¹², which may be important in those at risk of respiratory failure. Even 24 hours of fasting has been reported to produce poorer performance on a low processing load tapping test (although other cognitive function tests were preserved²¹³). However, in the presence of stress, such as military evasion exercises, cessation of nutritional intake is followed by performance decrements and psychological changes within 24 hours²¹⁴. Changes in immune function tests are demonstrable after 5-10% of rapid weight loss²¹⁵⁻²¹⁷.

Clinical studies also suggest that wound healing is affected more by a reduction in recent dietary intake of up to a week (associated with rapid weight loss) than chronic protein-energy status²⁹. Furthermore, the reported benefits of perioperative nutritional supplements in reducing complications such as wound infections in patients with a BMI >20 kg/m², can be explained by effects on tissue/cell function (e.g. immune and inflammatory function) that are not entirely dependent on changes in the fat-free mass.

B.8.2 Weightings of weight loss, acute disease effect and BMI categories in 'MUST'

In 'MUST', BMI, weight loss, and acute disease effect categories are given equal weighting. This requires justification not only on qualitative grounds (section A of this report), but also on quantitative grounds.

- Weight loss, BMI, and acute disease effect can be viewed as reflecting the 'journey' of the patient from the past (weight loss), to the present (current BMI) and into the future (likely effect of disease). This 'journey' is analogous to the temporal framework of thinking used in making diagnoses and dealing with

clinical problems. Optimal assessment and care are achieved when all three components of the journey are considered.

- Each of the three components of 'MUST' can occur independently as indicated by the following three examples: *i) Low BMI* A person with anorexia nervosa and very low BMI, who is weight stable and has no acute disease *ii) Weight loss* A person with unintentional loss of 15% body weight which is continuing but has not yet resulted in a BMI <20 kg/m² (the underlying disease process will result in malnutrition if it has not already done so) *iii) Acute disease effect* A person admitted to hospital with a normal BMI, and no history of weight loss, who has been unable to, or prevented from, eating or swallowing for a week (and is likely to remain in this state) and has probably already developed or is at risk of developing malnutrition. Since each of the three components of 'MUST' can have important detrimental effects on physiological function and clinical outcome (see below, section B.3 and previous MAG report¹), which can be demonstrated statistically (see next bullet point), it is reasonable to assign an important weighting to all of them.
- Each of the three components of 'MUST' can be shown to have statistically significant effects when considered individually or together. The components appear to vary in importance according to patient group, outcome variable, and healthcare setting (e.g. an acute disease effect does not normally apply for patients attending GP clinics, outpatients or in the community). Therefore, a broad range of considerations needs to be given to the scoring system of general screening tools. Examples of the independent predictive value of the individual components of 'MUST' are given below using sub-category analysis of data presented in Tables B.2 and B.3. In all of these examples, 'MUST' categorisation was found to be significantly related to mortality and length of stay in hospital, and number of GP visits by non-hospitalised patients. The individual components had variable predictive value depending on the circumstance.
 - (i) Outcome according to scores of individual factors* Mortality in wards for the elderly was significantly affected by BMI, weight loss, and acute disease effect categorisations (Chi square test and binary logistic regression). In contrast, only the acute disease categorisation predicted length of hospital stay in the same ward (using the Kaplan Meier procedure to take into account any confounding effects of mortality). In orthopaedic wards, length of hospital stay was found to be independently related to BMI, weight loss and acute disease categories. The most significant results were obtained using the BMI category and the least significant using the weight loss category (not significant when only two weight loss categories were considered, according to whether weight loss was greater or less than 5% of body weight). A secondary analysis of the National Diet and Nutrition Survey of non-hospitalised individuals aged 65 years and over revealed that more than half of the subjects visited their GP in the previous three months. Of those who did, the number of visits was significantly related to both BMI and weight loss categories, (e.g. BMI less or greater than 20 kg/m²; and weight loss greater or less than 3.3 kg (7 lb) in the previous 3 months) (analysis of variance). In all the above examples, the outcome measures were significantly

related to malnutrition risk category (both 'MUST'3 and 'MUST'2), which incorporates all the individual components described above.

(ii) *Outcome according to categories of more than one factor considered simultaneously* Using multivariate models in which two or more factors can be considered simultaneously, mortality in the elderly ward was significantly related to both acute disease and weight loss categorisation (binary logistic regression). BMI categorisation was not significantly related to mortality in a model that already included acute disease categories and weight loss categories. In contrast, length of stay in the same ward was significantly related only to acute disease category, even when BMI and weight loss categories were already taken into account (Cox regression to take into account the confounding effect of mortality on length of hospital stay). In the orthopaedic ward, length of hospital stay was related only to acute disease categorisation. BMI and weight loss categorisation had no significant additional effects. In contrast, in the community study, both BMI and weight loss categorisation had independent predictive effects (and no significant interaction) on the number of GP visits (two way analysis of variance).

In summary, the assignment of equal weightings to the three components of 'MUST' can be justified on the basis of an overall consideration of the clinical, physiological and statistical issues raised above. The MAG committee decided to use equal weightings in order to simplify application of the tool. This decision was reinforced by considering the type of criteria used and results obtained by other screening procedures, which are summarised below.

Some screening tools, even those that apply to the same setting, focus only on anthropometry (typically BMI or a weight-for-height index), whilst others focus only on changes in anthropometry (e.g. changes in body weight or arm circumference). Others emphasise the diagnosis and disease effect. Presumably this reflects the importance assigned to these individual items by the authors. It would seem reasonable to attempt to combine all three components in general screening tools. The Mini Nutritional Assessment (MNA) and Subjective Global Assessment (SGA) tools are amongst the most well tested with respect to prediction validity, such as complications after surgery, discharge destination, and mortality. Using the MNA, Murphy et al⁷² found that in a group of older orthopaedic patients, BMI was the best predictor of the overall score (accounting for 52% of the variance) and weight loss was the next best predictor, accounting for an additional 10% of the variance, with other items making much smaller contributions. Using the SGA in a group of surgical patients, depletion of subcutaneous fat and muscle wasting (both contributing to thinness) were found to be the best predictors of the overall SGA class¹⁵⁹. In liver transplant patients¹⁸² the final SGA score was found to agree better with muscle and fat depletion than weight change. In dialysis patients aged 35-75 years¹⁹⁰ the SGA results again correlated well with BMI ($r = 0.77$) and MUAC ($r = 0.71$). In a group of patients admitted to medical and surgical gastroenterology services¹⁸¹, weight loss and the underlying illness were reported to have the greatest influence on the final score, although anthropometry was also related to the final

score (% ideal body weight, % ideal MUAC, % ideal triceps thickness). Using another tool in the elderly, Nikolaus²¹⁸ reported that weight loss correlated with the results, although BMI was not included in the assessment. In a more recent study⁷⁴, involving patients admitted as an emergency to medical, surgical and orthopaedic wards, weight loss of >10% in the previous 3 months was found to be a significant predictor of mortality. MUAC was also a significant predictor of mortality, whereas BMI was not. This is probably partly because patients with missing BMI values had a worse outcome than those with measured BMI values, and partly because there were two-fold more patients with MUAC than BMI measurements, which provided more statistical power when MUAC was used. In this study none of the above indices (weight loss, BMI and MUAC) were found to be good predictors of length of hospital stay.

There is currently insufficient information to make confident universal judgments about the severity of malnutrition according to overall 'MUST' scores between 2 and 6, all of which classify the patient into the high risk category. A higher score would be expected to indicate higher severity or risk of malnutrition than a lower score, but this is not always the case. This is because individual components of 'MUST' can only contribute a maximum score of 2 irrespective of the severity of the abnormality. Individuals with very severe malnutrition due to one component may have zero score contributions from the other two components (see also section C.4.4).

B.8.3 Lower boundary BMI values for the elderly

The criteria used to establish the lower BMI cut-off point for malnutrition risk have been presented in some detail in the first MAG report¹. They are consistent with a WHO report on loss of physiological function in relation to BMI², and are largely based on loss of pathophysiological function and wellbeing as BMI decreases. However, a wide range of BMI cut-off points have been used to indicate malnutrition in older subjects, ranging from <17 to <24 kg/m². This makes an enormous difference to the prevalence of malnutrition in the general population (from ~1% to 35-40% respectively), its management, and its associated healthcare costs. Therefore, there is a need to consider the reasons for the apparent confusion.

B.8.3.1 Different clinical and public health perspectives: This confusion appears to have arisen from two major sources: difficulties associated with establishing a lower boundary BMI cut-off value and inappropriate extrapolations to clinical practice of BMI cut-off values obtained from some public health initiatives.

- The BMI cut-off values for public health purposes are primarily intended for groups of subjects without overt disease, whilst in clinical practice they are primarily intended for individuals with established disease.
- In public health, BMI is typically used to aid prediction and prevention of mortality, often over many years (e.g. 10 or even more than 20 years later)²¹⁹, mainly from cardiovascular disease. In clinical practice BMI is typically used to aid prediction of current nutritional status and body function, and likely response to treatment, often over a much shorter time frame.
- The public health and clinical/physiological approaches may not necessarily yield the same BMI cut-off values. Furthermore dietary advice to patients with disease may be very different from that given to healthy subjects, both in

quantitative and qualitative terms. It may take a conscious effort to recommend energy dense foods, which are often rich in fat, to underweight individuals, or even a high salt diet to patients with gastrointestinal effluents, because these are not generally recommended for healthy individuals.

The clinical and public health perspectives reflect different approaches to BMI cut-off points. In addition, establishing a lower boundary BMI using the public health epidemiological approach has been particularly problematic, with the result that the values (to indicate underweight or malnutrition) have ranged from about 19 to as high as 27 kg/m²²²⁰, not only in those aged over 65 years, but also in those less than 65 years²²¹. Among the variables that contribute to the uncertainty are the following:

- Some studies consider the overall combined mortality from cardiovascular and non-cardiovascular diseases (all cause mortality), whilst others consider only cardiovascular disease (or myocardial infarctions)²²². The BMI-mortality characteristics of cardiovascular diseases may be different from those of non-cardiovascular diseases^{223, 224}.
- Racial differences exist, for example black Americans are reported to have a higher mortality at a given BMI than Caucasians²²⁵, and Pima Indians a flatter BMI-mortality curve than Caucasians²²⁶. There has also been increasing demand to lower the acceptable range of BMI to 18.5-23 kg/m² for Asians²²⁷, so that those with a BMI >23 kg/m² can be classified as overweight, and >27 or 27.5 kg/m² as obese.
- The period of study has ranged from 1 year to more than 20 years²¹⁹.
- A variable 'washout' period ranging from 1 to 7 or more years has been included in some studies^{220, 228}, with the expectation that existing or latent disease may manifest itself and be eliminated before measurements are started. However, such a 'washout period' has not been a feature of other studies.
- Confounding variables^{229, 230}, such as smoking and pre-existing disease, drug and alcohol ingestion, and poverty, have been considered and controlled for in some studies but not others, which may produce artefacts and flawed results²³⁰.
- Flat BMI mortality curves have been commonly reported in older subjects particularly those in whom mortality has been assessed only after many years. This makes identification of a BMI cut-off point difficult or impossible²²⁹.
- A positive relationship has been observed between BMI and mortality²³¹, morbidity²³²⁻²³⁴, and metabolic risk factors²³⁴, within the range of 19 and 25 kg/m², making identification of a BMI cut-off point difficult.
- A number of studies report the BMI or BMI category associated with the lowest mortality, but these may not be significantly different from lower or higher BMI values that might be used more generally²³⁵.
- BMI-mortality curves in initially healthy subjects living in the community may be different from those with established disease admitted to hospital²³⁶, discharged from hospital^{237, 238}, and resident in nursing homes, or combined long-stay hospital and municipal homes²³⁹.
- The power of the studies has varied considerably because of the variable number of subjects per study e.g. from 214²⁴⁰ to 1.7 million²⁴¹.

Workers have emphasised that the scientific rationale (empirical justification) for

establishing lower boundary BMI cut-off points from public health studies is rather inadequate²⁴² (but perhaps better for the upper boundary BMI value). The application of some of these cut-off points, which were intended for initially healthy individuals involved in public health surveys, to clinical practice, which involves treatment of patients with existing disease, makes the scientific rationale even weaker, as does the selective extrapolation and application of some of the high BMI cut-off points which have been established without controlling for confounding variables. However, public health surveys have influenced clinical practice, with the result that some nutritional screening or assessment procedures carried out in older patients to determine the need for nutritional support, include a lower boundary BMI value within the range 20 to 24 kg/m²²⁴³⁻²⁴⁵. On the other hand, values between 18.5 and 20 kg/m² are much more commonly used in clinical practice (see below). It should also be noted that in the UK, public health surveys such as those undertaken by the Office of Population Census and Surveys, have resisted using elevated lower boundary BMI values. These have consistently used a BMI <20 kg/m² to indicate underweight in adults, including individuals aged >65 or >75 years. In the USA, the 1990 edition of Dietary Guidelines for Americans suggested age-specific BMI reference ranges, but these were withdrawn in the 1995 edition. This means that, apart from the 1990 edition, lower and upper boundary BMI values of about 19 kg/m² and about 25 kg/m² respectively have been consistently recommended.

B.8.3.2 Lower boundary BMI values in clinical practice: Many organisations, agencies, and workers involved with nutritional care recommend a BMI cut-off value between 18.5 and 20 kg/m² for a range of ages, including older subjects (>65 years) who account for up to about half the population in general hospitals and more than 90% of the population in nursing homes.

In the UK these recommendations include those provided by an independent Consumers Association, which has separately reported on the management of malnutrition in hospital²⁴⁶ and community²⁴⁷, the Royal College of Physicians of London⁴⁰, and the National Prescribing Centre¹⁶². This is echoed by recommendations outside the UK. For example the ASPEN Board of Directors in America suggests a BMI <18.5 kg/m² to indicate underweight in their report on evidence-based best approach to practice of nutritional support²⁴⁸. There are also a large number of nutrition screening tools, which incorporate BMI cut-off values between 18.5 and 20 kg/m², and are commonly used in the elderly. Furthermore, a wide range of healthcare professionals working in different countries and different healthcare settings also use a BMI cut-off value within the range 18.5-20 kg/m², either alone or in combination with other criteria for detecting malnutrition. Therefore, these BMI cut-off values have been applied either exclusively to older subjects or groups of subjects that include older individuals^{12, 16, 34, 59, 64, 81, 156, 249-262}. Some workers recommend or use even lower cut-off values for the elderly e.g. 17 kg/m² for geriatric patients in general²⁶³, or 18 kg/m² in nursing homes²⁶⁴. The Mini Nutritional Assessment (MNA), which was originally developed for older subjects, but subsequently applied to younger subjects, uses a BMI <19 kg/m² as a marker of severe underweight. However, it also incorporates increasing risk of

malnutrition between a BMI of 23 and 19 kg/m²¹⁵⁸, and also mid-upper arm circumference values of <22 and <21cm (which are normally obtained from subjects with a BMI <20 kg/m²) as cut-off points for malnutrition. Other workers use a single BMI cut-off value of <21 kg/m²²⁶⁵ and sometimes higher values (see above) to indicate malnutrition in the elderly.

In concert with a large body of clinical recommendations, opinions, and clinical practice, and for the sake of simplicity, the MAG tool uses a lower boundary BMI value of 20 kg/m² to indicate the clinical risk of underweight, which becomes even greater below 18.5 kg/m². These cut-off values are based on physiological and clinical observations on loss of body function as BMI decreases, the apparently normal body function in many older subjects with a BMI above 20 kg/m² (e.g. 20-24 kg/m²), and randomised controlled trials showing benefits of nutritional supplementation with feeds containing energy, protein, and a mixture of other nutrients. These trials suggest that benefits are much more likely in older subjects with a BMI <20 kg/m² than >20 kg/m², especially in the community²⁹. Since BMI is a weight-for-height index, it is obviously a better measure of thinness or wasting than weight alone. Subcutaneous fat and muscle wasting has long been used as a marker of poor body function and clinical outcome. Severe forms of wasting are easy to identify clinically; less severe forms may be less easy to identify, especially since different observers obtain different subjective impressions. However, simply noting the presence of wasting can complement objective weight-for-height indices of thinness. The limitations to obtaining and interpreting BMI are discussed in section C.3 of this report.

B.9 Annexe 2: Kappa (Cohen's kappa)

This is a chance corrected measure of agreement that can be applied to two or more categories obtained by two or more observers, although most studies involve only two observers. Therefore, it is measure of reliability, with a value of 1 denoting perfect agreement, a value of 0, no agreement, and a value of -1, perfect disagreement. Because agreement between observers can occur by chance, the kappa values are lower than the observed proportion of agreements. Unlike kappa, weighted kappa takes into account the extent of disagreement. Weighted kappa has been used in this report to take into account the extent to which malnutrition risk categories disagree with each other, when the same patients are assessed by two different observers. For example, when there are three possible categories, disagreement may vary by either one or two categories i.e. either low/medium or low/high risk of malnutrition. The greater discrepancy (low/high) will produce a lower weighted kappa statistic than the smaller discrepancy (low/medium), whereas the kappa statistic will remain the same. When the discrepancy involves only one category, weighted kappa is typically slightly greater than kappa. Landis and Koch¹⁷⁹ have suggested the following interpretation of kappa (and weighted kappa): kappa <0.4, poor agreement beyond chance; kappa 0.4-0.75, fair to good agreement beyond chance; and >0.75, excellent agreement beyond chance. Other guidelines for interpretation are also available, but if kappa values are >0.80, the agreement can be taken to be very good or excellent.

Calculations can be undertaken to establish appropriate sample sizes in studies involving

kappa²⁶⁶. For example, to obtain a kappa value that is 0.3 units higher than 0.50, with 80% power and significance of $p < 0.05$, a sample size of 50 subjects will be required (using two observers and two categories, and a prevalence of malnutrition (medium+high risk) of 20%). The number of subjects required becomes larger when the hypothesised differences in kappa values or the prevalence of malnutrition are smaller.

C

Guidance on undertaking and interpreting measurements obtained using ‘MUST’

C.1 Aims

The aim of this section of the report is to provide guidance on undertaking measurements, and in using and interpreting 'MUST' when it is applied to a wide range of circumstances.

C.2 Undertaking measurements

C.2.1 Establishing BMI category

C.2.1.1 Weight: A wide range of weighing machines are available (standard stand-on scales, chair scales, wheel chair scales, and 'harness' scales for individuals who are bed bound), and the weighing procedure varies with the machine. Whenever possible, it is advisable to use clinical scales that are regularly calibrated (e.g. annually) (see footnote to table A.8), and the same weighing machine for repeat measurements on the same patient. The operator should check if the machine is calibrated to zero before the subject is weighed. (See also 'MUST' Explanatory Booklet).

Surrogate 'measure' Self-reported (recalled) weight can be used as a surrogate for measured weight, and its use is supported by hospital and community studies (see section B.3.4.1). However, a study of free-living individuals in the USA suggests that distortions in self-reported weight can occur, affecting obese individuals to a greater extent than lean individuals²⁶⁷. This was not found to be a particular problem in hospitalised patients in medical, surgical and elderly wards in England (see also section B.3.4.1). Obvious problems in recalling weight can occur in confused patients.

C.2.1.2 Height: The subject should stand with feet flat on the base plate (no shoes), heels against the rod and body straight and stretched. Ideally, the measurement should be made with the head in the Frankfort plane. This is achieved by tilting the head forward until the top of the external ear canal and the top of the lower bone of the eye socket are in a horizontal plane, parallel to the floor. The head-plate is lowered until it gently touches the top of the head. It is possible to measure height using a lightweight, portable, infrared measuring device. This involves placing the device over the head of the subject, who stands on a reflective surface, so that the infra-red radiation can be reflected back to the detector of the instrument. Details of this procedure and its validity have been described in the previous MAG report¹. It is also possible to measure the length of bed-bound patients on a firm bed, whilst lying flat on their back with a straight body. Height and surrogate measures of height are of little value in establishing BMI or BMI categories, if weight is not available (see alternative procedure below for establishing BMI from mid-upper

arm circumference (MUAC)).

Surrogate measures When height measurement is not possible, recalled height can be used, and, although it tends to overestimate measured height (~2 cm in hospitalised patients; see also section B.4), this makes little difference to the BMI categorisation (and for simplicity, a correction can generally be avoided). Ulna length, knee height, and demispan, can also be used as surrogate measures of height, although ulna length is generally the easiest and quickest to perform in sick patients. The surrogate measurements are made on the left side, because they were validated on the left side, with the exception of demispan, which was validated on the right side⁹¹. However, since no systematic differences have been found between the left and right side, either side can be used.

(i) *Ulna length* This measurement is facilitated by bending the arm diagonally across the chest with palm facing inwards and the fingers pointing towards the shoulder. If this is not possible, other positions can give the same or virtually the same results. A measurement is taken between the central and most prominent parts of the styloid process and the centre (tip) of the bony prominence (olecranon) at the elbow. Tentative equations obtained from 229 subjects aged <65 years (117 men, 107 women) and a further 210 subjects aged > 65 years (112 men, 98 women) are as follows:

Men <65 years:	Predicted height (cm) = 79.2 + 3.60 ulna length (cm)
Men >65 years:	Predicted height (cm) = 86.3 + 3.15 ulna length (cm)
Women <65 years:	Predicted height (cm) = 95.6 + 2.77 ulna length (cm)
Women >65 years:	Predicted height (cm) = 80.4 + 3.25 ulna length (cm)

(ii) *Knee height* The person sits on a chair with their leg supported so that the knee and ankle are each bent to a 90° angle (no footwear). The observer places the flat of their hand along the thigh perpendicular to the shaft of the fibia, with a tape measure between their fingers so that a vertical height can be measured to the floor (bottom of heel) on the lateral side of the leg in the same plane as the lateral malleolus (bony prominence above the aspect of the ankle). Bed-bound patients should lie supine with the knee and ankle each bent to a 90° angle. The procedure with the tape measure is an adaptation of a technique that employs a caliper. The observer places the fixed blade of the caliper under the heel of the foot. The shaft of the caliper is positioned so that it passes over the lateral malleolus and just posterior to the head of the fibula. The movable blade (or a tape - see below) is placed over the anterior surface of the thigh above the condyles of the femur, about 4 cm proximal to the patella. The shaft of the caliper is held parallel to the shaft of the tibia and pressure is applied to compress the tissues. The procedure is carried out with a simple tape measure instead of the caliper, with little loss of accuracy.

The following equations have been developed for estimating height (cm) for white Americans aged 60-90 years^{90, 268} and 18-60 years²⁶⁹:

Men 18-60 years:	Predicted height (cm) = 71.85 + (1.88 x knee height (cm))
Men 60-90 years:	Predicted height (cm) = 59.01 + (2.08 x knee height (cm))

Women 18-60 years: Predicted height (cm) = 70.25 + (1.87 x knee height (cm)) - 0.06 x age (years)

Women 60-90 years: Predicted height (cm) = 75.00 + (1.91 x knee height (cm)) - 0.17 x age (years)

The equations for women include age as a variable, whereas those for men do not. If for simplicity a typical 'midpoint' age is used (40 years for the 18-60 year age range, and 75 years for the 60-90 year age range), the equations become:

Women 18-60 years: Predicted height (cm) = 67.85 + (1.87 x knee height (cm))

Women 60-90 years: Predicted height (cm) = 62.25 + (1.91 x knee height (cm))

The first and second equations are biased by 0.6cm and 1.7 cm for each decade deviation in age from these 'midpoint' values.

A quick and simple way of estimating height in both men and women aged 60-90 years involves using the following equation (double knee height (cm) and add 60 cm):

Men and women: Predicted height (cm) = 60 + (2 x knee height (cm))

This equation tends to give values that are 2.5-3.0 cm higher than those obtained by the specific equation for women, and 2.5-3.0 cm lower than those obtained by the specific equation for men.

(iii) *Demispan* The measurement technique, adapted from the Office of Population Censuses and Surveys⁹¹, can be undertaken on patients sitting on a chair or lying in bed, but formal comparisons with the original one, which is carried out against a wall, (see below) do not appear to have been published. There is little point in measuring demispan against the wall in patients who can stand because they can have their height measured directly (unless there is no stadiometer).

Eligibility: All adults are eligible except those who cannot straighten either arm and those with severe curvature of the spine, in whom the normal height-demispan relationships do not apply. *Preparing the subject:* Remove clothes or other items that might interfere with measurement. Find a wall where there is room for the subject to stretch his/her arm, and ask him/her to stand with weight evenly on both feet, head facing forward. The subject should raise the right arm until it is horizontal with the wrist in neutral rotation and neutral inflection. The observer's left arm is rested against the wall allowing the subject's right wrist to rest on the experimenter's left wrist. *Marking the sternal notch:* With the subject standing in the correct position the centre of the sternal notch is marked. *Taking the demispan measurement:* Place the hook of the tape measure (or the end of the tape measure if a hook is not available) between the middle and ring fingers so that the tape runs smoothly along the arm. Ensure the arm is horizontal with the wrist in natural flexion and rotation. Extend the tape to the sternal notch. Take the measurement, checking that there is no flexion at the wrist or shoulder. Ask the subject to relax, and repeat the measurement. Further details are found in Annexe B of OPCS⁹¹.

Reference equations from the UK population⁹¹:

Men (16-54 years): Predicted height (cm) = $68 + (1.3 \times \text{demispan (cm)})$
 Men (>55 years): Predicted height (cm) = $71 + (1.2 \times \text{demispan (cm)})$

Women (16-54 years): Predicted height (cm) = $62 + (1.3 \times \text{demispan (cm)})$
 Women (>55 years): Predicted height (cm) = $67 + (1.2 \times \text{demispan (cm)})$

It is possible to average the constants from the above equations so that the same equations can be used for both age ranges and/or sexes. However, they are associated with greater errors.

Men & women 16-54 years: Predicted height (cm) = $65 + (1.3 \times \text{demispan (cm)})$
 Men & women >55 years: Predicted height (cm) = $69 + (1.2 \times \text{demispan (cm)})$
 Men >16 years: Predicted height (cm) = $69.5 + (1.25 \times \text{demispan (cm)})$
 Women >16 years: Predicted height (cm) = $64.5 + (1.25 \times \text{demispan (cm)})$
 Men & women >16 years: Predicted height (cm) = $67 + (1.25 \times \text{demispan (cm)})$

This last equation underestimates by 2.5 cm the values obtained by the equation for men >16 years, and overestimates by 2.5 cm the values obtained by the equation for women >16 years. There are also, of course, extra errors associated with prediction of individual values.

There are currently no guidelines about the extent of spinal curvature that would invalidate the measurement of height, but it should not be estimated in this way in individuals with severe or obvious kyphosis and scoliosis. In this situation, the BMI that would exist in the absence of spinal curvature ("BMI") can be estimated using surrogate measures of height or self-reported maximum height achieved during adult life (assuming spinal curvature was absent for part of adult life - for discrepancy between self-reported and measured height, see also section B.3.4.1(i)). Measurements of MUAC can also be used to establish "BMI" categories in this situation without the need to estimate height. The equations that convert surrogate measurements to height in the elderly already take into account the small decrease in height that occurs as a result of minor kyphosis/scoliosis and reduction in joint space during their lifetime. Therefore, age specific equations relate to actual height rather than maximum height achieved during adult life. The surrogate measures of height may also be difficult to undertake in uncooperative patients, such as confused or demented individuals, but ulna length can be carried out with least difficulty.

C.2.1.3 BMI: (i) *BMI (weight (kg)/height² (m²)) and BMI categories* These can be obtained using the BMI chart provided with the tool (Fig B.1). The tables provided also allow a quick and exact classification of subjects into BMI categories.

(ii) *Surrogate measures* Ideally, measured weight and height should be used to establish BMI and BMI categories, but surrogate measures of weight and height can also be used (see above). When none of these procedures is possible, BMI categories can be estimated using MUAC. Since this measurement provides an approximate guide, only cut-off values for underweight (BMI <20 kg/m²) and obese (BMI >30 kg/m²) are provided (MUAC < 23.5 cm and >32 cm respectively).

Mid-upper-arm circumference (MUAC)²⁰: This measurement is made with the participant standing or sitting, with the arm bare, and the elbow placed across the body, at right angles to the upper arm. The top of the shoulder (acromial process) and the tip of the elbow (olecranon process) are identified and the mid-point between these is also identified and marked. The subject's arm is then allowed to hang loosely by the side, and the circumference is measured at the marked mid-point. In undertaking the measurement, the tape is in contact with the upper arm around its entire circumference, perpendicular to the length of the arm. The tape is not pulled tightly enough to compress the underlying tissue.

C.2.2 Establishing weight loss category

The technique for measuring weight is described in *The 'MUST' Explanatory Booklet* and section C.2.1.1 (see also www.bapen.org.uk). When weight measurements are not possible, a history of weight change may be valuable (see section B of report), although it is recognised that some patients recall their weight with uncertainty and inaccuracy. It is also possible to obtain a subjective impression of weight loss or gain from recent history of either loosely fitting or tightly fitting clothes and jewellery. Consistent and careful measurements of MUAC, indicating at least a 10% reduction, also suggests significant weight loss.

C.3 Interpretation of BMI, weight loss and acute disease categories, and overall risk of malnutrition

C.3.1 BMI category

The categorisation of 'risk', as indicated by 'MUST', can be overridden by clinical judgment.

C.3.1.1 Constitution: Some perfectly healthy adults are constitutionally thin and have a BMI <20 kg/m² (this is most common in young adults up to 25 years¹³). It is also possible for a very muscular individual (body builder) to have a BMI of 30 kg/m², which is at the lower end of the obese range, and not have excess per cent body fat.

C.3.1.2 Fluid disturbances (oedema/dehydration): It is difficult to quantify the amount of excess extracellular fluid on clinical grounds, but the following can act as a very approximate guide: clinical detection of oedema is generally believed to require ~2kg extra fluid (3% body weight in a 70kg person); moderate oedema (or ascites), more than 5 kg extra fluid; and severe oedema, more than 10kg extra fluid. A low BMI in the presence of oedema indicates that the patient may be substantially more underweight than the actual BMI would indicate. Since oedema generally affects the upper limbs to a smaller extent than the lower limbs and trunk, MUAC can be a valuable aid in indicating risk of malnutrition even in the presence of oedema (see section B.3.4.1 for suggested cut-off values). However, in the presence of severe oedema, the upper arms are also affected, limiting the value of MUAC to predict underweight. Signs (and symptoms) of dehydration can also present after > 3% change in body weight (> 2kg fluid loss in a 65-70 kg person)²⁷⁰, usually in association with decreased urine output, unless the dehydration is induced by

Table C.1 Recommended total weight and weight gain ranges for pregnancy according to pre-pregnancy body mass index (BMI) and deviations in weight gain that require further evaluation‡

BMI category (pre-pregnancy) (kg/m ²)	Recommended total weight gain Mean range		Recommended weight weight gain in 2nd & 3rd trimesters (kg/week) (kg/week)	Weight gain in 2nd & 3rd trimesters requiring further evaluation (kg/month)
	(kg)	(kg)		
Single pregnancy ^{110 287}				
BMI <19.8	15.3	12.5- 18.0	0.5	<1 & >3
BMI 19.8-26.0	13.8	11.5-16.0	0.4	<1 & >3
BMI 26.0-29	9.3	7.0-11.5	0.3	
BMI >29.0	> 6.8†			<0.5† & >3
Twin pregnancy ^{287 288}				
	22.7		0.7-0.75	

‡ (i) Pre-pregnancy BMI: the pre-pregnancy weight categories recommended by the Institute of Medicine for the purposes of pregnancy, are similar to those used by 'MUST' in other situations

(ii) Weight change during pregnancy: The Institute of Medicine^{110, 287} recommends a) the weight gains indicated, which are endorsed by the American Dietetic Association²⁸⁹ b) that young adolescents and black women should aim for gains at the upper end of the recommended range. Short women (<157 cm) should strive for gains at the lower end of the range c) that slightly lower or higher rates of weight gain than those indicated should not cause alarm, as long as there is a progressive increase in weight that approximately equals the recommended rate of weight gain. In general, weight loss, especially persistent unintentional weight loss during the second trimester of pregnancy, is a cause of concern. (Weight gain during the first trimester is small (approximately 2 kg on average)). These recommendations have important limitations and should be considered as approximate and tentative, since manipulation of the mother's diet to obtain 'optimal weight gain' has not, as far as we aware, been demonstrated by experimental evidence to produce optimal perinatal outcome (considered problematic by some workers). It is also recognised that a desirable maternal weight gain does not ensure adequate fetal growth, which can be assessed by ultrasound. Assessment of placental function can also be valuable.

(iii) Acute disease effects: acute disease effects are especially relevant in pregnancy.

(iv) MUST: By analogy to 'MUST' ('MUST'2 - 2 categories, low and medium/high risk) categories, women who are underweight initially and deviate in weight gain by a greater amount than indicated, should generally be evaluated further. A more detailed scrutiny should also be made for women who are overweight before or during early pregnancy (especially if obese, although management may vary according to local policy), when there is an acute disease effect, and when there is clinical concern.

† It is recognised that many obese women with good pregnancy outcomes gain less weight than 6.8 kg.

diuretics. Death from dehydration occurs after a weight loss of more than ~15% body weight. Short-term changes in body weight (e.g. over a day) reflect changes in fluid status rather than nutritional status. Correction of dehydration or overhydration can allow a more accurate measurement of BMI. A more subjective judgment of weight status can also be made by inspection of the patient so that they can be classified as thin, acceptable weight and overweight (including obese).

C.3.1.3 Muscle wasting due to prolonged immobility and neurological conditions:

Loss of muscle can occur as a result of neurological diseases, even in the presence of adequate nutrition. Muscle is the single largest tissue of the body (40% of body weight in the reference 70 kg man and 29% body weight in the reference 58 kg woman²⁷¹). Wasting from immobility and severe neurological diseases can produce a weight loss of up to, and sometimes in excess of, 5-10% body weight over 6

months.

C.3.1.4 Pregnancy: Pre-pregnancy weight and BMI Pre-pregnancy BMI categories recommended by the Institute of Medicine¹¹⁰ are similar to those used in 'MUST' (Table C.1). The Institute of Medicine also acknowledges that it is difficult to establish BMI cut-off points specifically for pregnancy, especially since the relationship between pre-pregnancy weight and various fetal and maternal outcomes is generally considered to be linear, with no striking threshold at either ends of the weight distribution. Therefore women in the lowest BMI category (<19.8 kg/m²) prior to or during early pregnancy tend to have the lowest birth weight infants. A WHO report suggests that some consideration should also be given to population specific references, especially in those with marginal protein-energy status. In situations where pre-pregnancy weight is not available, self-reported pre-pregnancy weight can be used with good effect (correlation with documented weight was found to be 0.98), although overweight girls tend to underestimate their pre-pregnancy weight²⁷². Another approach is to use MUAC to establish BMI category. This is because it is relatively stable throughout pregnancy, including late pregnancy (total increase usually less than 0.5cm), according to a study reported by the Pan American Health Organization¹¹¹. A World Health Organisation report also acknowledges that MUAC is largely independent of gestational age and can be regarded as a proxy for the maternal pre-pregnancy (or early pregnancy) value¹⁰⁸. MUAC is also affected less by excess fluid than lower limb circumferences. Individual studies have used cut-off values of 21-24 cm to predict neonatal outcome^{108 111}. One study in Brazil used a cut-off value of 23.5 cm to predict low birth weight with a sensitivity of 77% and specificity of 71%. The relative stability of MUAC during pregnancy is associated with the preferential deposition of fat at sites other than the arm²⁷³, such as upper thighs and back, a pattern that has been observed in different populations¹⁰⁸. A US study reported virtually no change in triceps skinfold thickness during pregnancy in a group of over 500 women²⁷³ in any of the BMI categories, which ranged from underweight to overweight. A smaller study of 29 normal weight women in England confirmed this (BMI 19.8-26.0 kg/m²)²⁷⁴, but also noted a small increase in triceps and biceps skinfold thicknesses (about 0.4 and 0.8 cm respectively at 36 weeks of pregnancy - NB skinfold thickness measured by a caliper is essentially equivalent to twice skin + subcutaneous fat thickness in vivo). This is not likely to be a problem when MUAC measured during pregnancy is used to predict pre-pregnancy underweight. MUAC obtained from overweight or obese individuals at the beginning of pregnancy (and whose MUAC increases further during pregnancy) are unlikely to be classified as underweight before or at any stage during pregnancy. In 'MUST', MUAC is not used to establish BMI, but to establish BMI category (especially BMI <20 or 19.8 kg/m²). The combination of BMI, weight change, and acute disease categories (section C.3.2.4) is considered in Table C.1. Care should be taken when using 'MUST' in pregnancy.

C.3.1.5 Amputations: The approximate weights of limb segments as a proportion of body weight, based on cadaver analysis²⁷⁵ are indicated below. The values for upper and lower limbs agree closely with those obtained by whole body scanning techniques, such as dual energy X-ray absorptiometry.

Name of Cast	Notes	POP* (kg)	Synthetic (kg) †	POP & Synthetic (kg) †
Arm				
Below elbow backslab	Half a cast usually immediately post surgery. For neutral or volar positions	0.3	-	-
Below elbow	Full cast for neutral position	0.4	0.2	-
Bennetts / Colles		0.45	0.25	-
Smiths / Scaphoid	Similar to below elbow	0.4	0.2	-
Above elbow complete backslab		-	-	0.4
Above elbow backslab	Half a cast	0.6	-	-
Above elbow cylinder backslab		0.6	-	-
Above elbow	Full cast	0.7	0.4	-
U slab	If used, usually in elderly. Goes over the shoulder	0.6	-	-
Leg				
Below knee complete backslab		-	-	1.1
Below knee backslab	Half a cast	1.1	-	-
Below knee	Includes wt & non-wt bearing, full-equinus, semi-equinus casts	1.2-1.5	0.5	-
Above knee complete backslab		-	-	2.1-3.1
Above knee backslab	Half a cast	2.0-4.0	-	-
Above knee	Includes wt & non-wt bearing, cylinder)	2.4-4.4	0.9-1.1	-
Cast brace	POP including hinges	3.0	-	-
Back				
Jacket (standing, cotrel table)		2.8	-	-
Hip spica		2.8	-	-
*POP - Plaster of Paris				
† Some variation in weight occurs depending on the manufacturer.				
This table was devised to aid the estimation of weight of patients with a cast in situ, using the materials as would be used by the plaster room technicians. If ranges are given, these are for an average to heavy patient. Materials prepared by Sarah Knight (Orthopaedic technician Southampton General Hospital) and Claire King (research fellow)				

Upper limb: 4.9% (upper arm 2.7%; forearm, 1.6%; hand, 0.6%)

Lower limb 15.6% (thigh 9.7%; lower leg 4.5%; foot 1.4%)

Therefore, a man without an entire lower limb would weigh 1.18 times more if he had the limb, and a person without an entire upper limb would weigh 1.05 times more if he/she had the limb. However, amputations usually involve loss of variable sections of limbs (e.g. below knee amputation) and, although estimation of the missing weights may be difficult to estimate accurately, the above figures can be used as an approximate and, for most purposes, adequate guide.

C.3.1.6 Patients with plaster casts: The extent to which body weight is overestimated by the presence of casts in orthopaedic patients depends on the size and type of cast. The cast-free weight of such patients can be calculated approximately using table C.2. The synthetic casts for various types of body fractures generally weigh less than 1 kg and are unlikely to alter the BMI category. The Plaster of Paris casts for the upper limbs also generally weigh less than 1 kg,

although some of the casts for the lower limb and back weigh between 1 and 4.5 kg (Table C.2).

C.3.2 Weight loss category

Cut-off values for percent weight loss are provided with 'MUST' (see also Figures B.1 and B.2). Categorisation of individuals according to percent weight loss can be confounded by several variables:

C.3.2.1 Intentional weight loss: Continuous or intermittent intentional weight loss for obesity invalidates this classification.

C.3.2.2 Rate and direction of weight change: There is greater immediate risk of malnutrition when 10% of weight loss has occurred rapidly, for example over 1-3 months, than when the same amount of weight is lost more slowly over 6 months. Furthermore, a patient who has lost weight during an illness and has begun to regain it during recovery, has a lower future risk of malnutrition than one who is continuing to lose weight. Similarly, an obese person who is persistently increasing in weight is at greater risk of developing co-morbidity and complications than one with the same BMI who is weight stable.

C.3.2.3 Fluid disturbances: When there are disturbances in fluid balance, a history of changes in appetite and presence of conditions likely to lead to weight change can be used as part of an overall subjective assessment of malnutrition risk which categorises patients into one of two categories (low or medium/high risk) (see also interpretation of BMI in presence of fluid disturbances - section C.3.1.2). Large day to day changes in body weight are useful indicators of changes in fluid balance.

C.3.2.4 Pregnancy: The standard weight changes indicating malnutrition risk in general nutrition screening tools, including 'MUST', should not be employed during pregnancy for reasons indicated in section A.7. The average weight gain at 12 weeks of gestation is only about 2 kg. After the first 12 weeks the increase in weight is almost linear until the end of pregnancy, but the rate of weight gain depends on the initial BMI¹⁰. Table C.1 indicates deviations that generally require further evaluation (other locally approved charts that relate to particular populations may also be used for this purpose). It is also suggested that the other components of 'MUST', such as underweight, obesity, and acute disease effects (see footnote to table C.1) also require attention, according to local policy. Caveats to the recommendation of the Institute of Medicine are indicated as footnotes to Table C.1.

C.3.2.5 Lactation: The weight changes during the first 6 months of lactation are large and variable and, in the absence of intraindividual reference data, it is suggested that alternative approaches should be used to assess risk of malnutrition from other causes. A history of changes in appetite and presence of conditions likely to lead to weight loss can be used, as for situations where there are fluid disturbances. The presence of an acute disease effect can also be included in forming an overall clinical judgment of risk, as in other situations. In this way, the same 'MUST' framework is used. Such a subjective approach is used by other general nutritional screening tools, either with or without anthropometric measurements. This and other issues of nutritional concern should be assessed in more detail by a specialist in nutrition.

C.3.2.6. Amputations and plaster casts: If changes in body weight involve loss of a

limb/limb segment or loss/acquisition of a plaster cast, corrections can be applied using information in section C.3.1.5, C.3.1.6 and Table C.2.

C.3.3 Acute disease effect (no or unlikely to have dietary intake for > 5 days)

C.3.3.1 Disease: Absence of dietary intake for more than 5 days is a consequence of an acute serious illness or an acute exacerbation of a more chronic illness. This is usually obvious from a reliable history/observation, and from the expected course of a disease. Examples include patients who are expected to remain unconscious for prolonged periods of time, patients with prolonged ileus or swallowing difficulties, and those who are instructed to take 'nil by mouth'. Such a criterion is rarely met in the community and in only a small proportion of the overall population of patients admitted to general hospitals. Patients who fulfill such criteria (e.g. patients in intensive care units and surgical wards undertaking major gastrointestinal surgery) are often treated with artificial nutrition (enteral or parenteral). Patients with prolonged partial reduction in dietary intake may also be at risk of developing malnutrition. This risk may be detected by repeat screening (e.g. at weekly intervals in hospital or earlier if there is concern and deterioration in the clinical condition), but specialised units such as burns, intensive care, and neurosurgical units, that manage such patients often have protocols for artificial nutritional support. In the acute phase of the disease, nutritional support generally attenuates loss of lean tissue, but repletion can take place in the recovery or convalescent phase. The treatment aims to reduce loss of body tissue and maintain body function so that recovery can occur more quickly with fewer complications. Most patients admitted to typical intensive care units in the UK (e.g. those with severe disease leading to multi-organ failure and those requiring artificial ventilation) have a high risk of malnutrition because they are unlikely to be able to eat over the next 5 days. They can therefore be categorised as being at high risk of malnutrition irrespective of any difficulties in assessing BMI in the presence of major fluid disturbances. However, some patients who are admitted to intensive care units for observation or ventilation for short periods of time (e.g. patients who have overdosed with sedatives or following major elective surgery, such as aortic aneurism repair) are able to eat in less than 5 days, and are not categorised as being at high risk of malnutrition on these grounds.

C.3.3.2 Hunger strikes and voluntary starvation Although in 'MUST' the absence of dietary intake for more than 5 days is taken to be disease-related, total starvation in the absence of disease can also have detrimental effects (see B.8 Annexe 1), which are usually less severe in nature. Total starvation for reducing body weight is now no longer recommended, and many health professionals do not consider obesity to be a disease, although this view is not shared by everyone (see B.8 Annexe 1 for effects of starvation in lean and obese subjects).

C.4 Establishing overall risk of malnutrition

C.4.1 Components of overall risk

For the overall risk of malnutrition, which takes into account all items of the tool,

see Figures B.1 and B.2 and 'MUST' Explanatory Booklet.

C.4.2 Risk

The categorisation is for the degree of 'risk' of malnutrition rather than for 'diagnostic labeling'.

C.4.3 Rate of weight loss

Weight loss developing slowly may have more detrimental effects in a lean individual than an obese individual, even when the same percent weight loss occurs (when dietary intake is reduced, lean subjects tend to lose a greater proportion of weight as lean tissue). Therefore, an individual with a BMI 18.5-20.0 kg/m², who has lost 5-10% body weight, may be at greater risk of malnutrition than an obese individual who has lost the same proportion of body weight. In such a situation, the thin patient is placed in an overall 'high risk' category of malnutrition, whilst the obese patient is placed in a 'medium risk' category.

C.4.4 'MUST' scores

'MUST' scores between 2 and 6 are all categorised as high risk. A higher score within this category does not always imply higher risk. For example, a patient with anorexia nervosa and a BMI of 11 or 12 kg/m² is severely malnourished, even if there is no acute disease effect or a history of 10% weight loss in the previous 3-6 months. However, in general a score of 6 is more likely to carry a higher risk than a score of 2.

C.4.5 Clinical judgment

Clinical judgment is important (see notes on BMI, weight loss, and acute disease effect categories), particularly when measurements to establish BMI and weight loss categories are not possible. Subjective assessment may be the only means of categorising the patient. 'MUST' places emphasis on the following:

- Appearance (thin, acceptable weight, and overweight) which is relevant to weight status. Obvious wasting (very thin) and obvious obesity (very overweight) should be noted.
- Development of loosely fitting or tight clothes/jewellery, which is relevant to changes in weight. Changes in appetite and other risk factors likely to produce weight change are also important (e.g. physical or psychosocial diseases or conditions such as poverty, social isolation and disabilities that lead to difficulties in acquiring, eating and digesting food).
- Acute disease effect (no, or unlikely to have, dietary intake for more than 5 days).

Details of this are often elicited during clinical and nutritional assessment of the patient.

Individual patient considerations may override any general guidelines (e.g. about active nutritional support in a patient who is imminently expected to die, or when the clinical course of a patient is expected to suddenly change). Furthermore, adequate care for malnutrition and obesity can be provided through different

operational pathways, so it is necessary to take into account local policy and availability of resources.

C.5 Training and competency

Like a variety of other procedures, it is necessary to train individuals to use 'MUST' at a proven level of competency (see Recommendations in section A.9.2). Such training should begin at an early stage in a career structure (e.g. undergraduate training) and be reinforced later (section A.9.2). Appropriate training resources for this purpose should be available (section B.5.4).

D

References

D.1 References

1. Elia M. (chairman & editor). Detection and management of undernutrition in the community. A report by The Malnutrition Advisory Group (A standing committee of The British Association for Parenteral and Enteral Nutrition). ISBN 1 899 467 459. Maidenhead, 2000.
2. Shetty PS, James WPT. Body mass index: a measure of chronic energy deficiency in adults. *FAO Food and Nutrition Paper* 56 1994;56:1-57.
3. Marton KI, Sox HC, Krupp JR. Involuntary weight loss: Diagnostic and prognostic significance. *Annals of Internal Medicine* 1981;95:568-574.
4. Rabinovitz M, Pitlik SD, Leifer M, Garty M, Rosenfeld JB. Unintentional weight loss. A retrospective analysis of 154 cases. *Archives of Internal Medicine* 1986;146:186-187.
5. Barker DJP. Fetal and infant origins of adult disease. *British Medical Journal (Latimer Trend & Co. Ltd (ISBN 0 7279 0743 3))* 1993.
6. O'Brien PMS, Wheeler T, Barker DPJ. Fetal programming. Influences on development and disease in later life. *Royal College of Obstetricians and Gynaecologists Press* 1999.
7. Department of Health. First Report of the National Screening Committee: Health Departments of the United Kingdom, 1998.
8. Department of Health. Second Report of the National Screening Committee: Health Departments of the United Kingdom, 2001:1-29.
9. Fomon SJ. Nutritional disorders of children. Prevention, Screening and Follow-up. Rockville, Maryland: U.S. Department of Health, Education, and Welfare, 1977.
10. National Audit Office. Tackling Obesity in England. London: The Stationery Office, 2001:1-66.
11. Stratton R, Elia M. How much undernutrition is there in British Hospitals? *British Journal of Nutrition* 2000;84:257-259.
12. McWhirter JP, Pennington CR. Incidence and recognition of malnutrition in hospital. *British Medical Journal* 1994;308:945-948.
13. Erens B, Primatesta P. Health Survey for England. Cardiovascular Disease '98. The Stationery Office London. 1999.
14. Edington J, Kon P, Martyn CN. Prevalence of malnutrition after major surgery. *Journal of Human Nutrition and Dietetics* 1997;10:111-116.
15. Shaw A, McMunn A, Field J. The Scottish Health Survey 1998. Volume 1: Findings. Edinburgh. The Stationery Office, 2000.
16. Edington J, Kon P, Martyn CN. Prevalence of malnutrition in patients in general practice. *Clinical Nutrition* 1996;15:60-63.
17. Clinical Resource and Audit Group (CRAG). National Nutritional Audit of Elderly Individuals in Long-Term Care. 2000.
18. Government Statistical Service - The National Assembly for Wales. Welsh Health Survey 1998, 1999.
19. Stratton RJ, Thompson RL, Margetts BM, Stroud M, Jackson AA, Elia M. Health care utilisation according to malnutrition risk in the elderly: an analysis of data from the National Diet and Nutrition Survey. *Proceedings of the Nutrition Society* 2002;61:20A.
20. Finch S, Doyle W, Lowe C, Bates CJ, Prentice A, Smithers G, et al. National Diet and Nutrition Survey: people aged 65 years and over. *The Stationery Office, London* 1998.
21. Department of Health. Tackling Health Inequalities: Consultation on a plan for delivery. London, 2001:1-40.
22. Chohan PS, Weireter LJ, Maynes C. Obesity and increased mortality after blunt trauma. *Journal of Trauma* 1991;31:1253-1257.
23. Chohan PS, Heckler R, Burge JC, Flancbaum L. Increased incidence of nosocomial infection in obese surgical patients. *Annals of Surgery* 1995;61:1001-1005.
24. Rose DK, Cohen MM, Wiggleworth DF, DeBoer DP. Critical respiratory events in the postanaesthesia care unit. *Anaesthesiology* 1994;81:410-418.
25. Rudolf MCJ, Sahota P, Barth JH, Walker J. Increasing prevalence of obesity in primary school children. *British Medical Journal* 2001;322:1094-1095.
26. Royal College of Physicians. Clinical management of overweight and obese patients, with particular reference to the use of drugs. *Royal College of Physicians ISBN 1 86016 098 0* 1998.

27. Green C. Existence, causes and consequences of disease-related malnutrition in the hospital and the community, and clinical and financial benefits of nutritional intervention. *Clinical Nutrition* 1999;18 (Supplement 2):3-28.
28. Stratton RJ, Elia M. A critical systematic analysis of the use of oral nutritional supplements in the community. *Clinical Nutrition* 1999;18 (Supplement 2):29-84.
29. Stratton RJ, Green CJ, Elia M. *Disease-related malnutrition. An evidence-based approach to treatment*. Oxford: CABI Publishing (CAB International), 2003.
30. Department of Health. Statistical Bulletin 1998. NHS hospital activity statistics: England 1987-88 to 1997-98. 1998.
31. Lennard-Jones JE, editor. *A positive approach to nutrition as treatment*. London: King's Fund Centre (Available from the King's Fund Centre, 126 Albert Street, London NW1 7NF), 1992.
32. Office of Health Economics. Compendium of Health Statistics, 10th Edition. 1997.
33. Chima CS, Barco K, Dewitt MLA, Maeda M, Teran JC, Mullen KD. Relationship of nutritional status to length of stay, hospital costs, and discharge status of patients hospitalised in the medicine service. *Journal of the American Dietetic Association* 1997;97:975-978.
34. Martyn CN, Winter PD, Coles SJ, Edington J. The effect of nutritional status on the use of health care resources by patients with chronic disease living in the community. *Clinical Nutrition* 1998;17:119-123.
35. Van Nes M-C, Herrmann FR, Gold G, Michel J-P, Rizzoli R. Does the Mini Nutritional Assessment predict hospitalization outcomes in older people? *Age and Ageing* 2001;30:221-226.
36. Friedmann JM, Jensen GL, Smiciklas-Wright H, McCamish M. Predicting early nonelective hospital readmission in nutritionally compromised older adults. *American Journal of Clinical Nutrition* 1997;65:1714-1720.
37. Wynn M, Wynn A. Reducing waiting lists for hospital admission: community nutrition services reduce the need for hospital beds. *Nutrition and Health* 2001;15:3-16.
38. Lennard-Jones JE. Ethical and legal aspects of clinical hydration and nutritional support. A report for the British Association for Parenteral and Enteral Nutrition (BAPEN) (ISBN 1 899467 25 4). 1999.
39. British Medical Association. Withholding and withdrawing life-prolonging medical treatment. Guidance for decision making. *BMJ Books, ISBN 0-7279-1456-1* 1999.
40. Royal College of Physicians. Nutrition and patients: a doctor's responsibility. A report of a working party of the Royal College of Physicians. London, 2002.
41. Council of Europe. Food and nutritional care in hospitals: how to prevent undernutrition. Report and recommendations of the committee of experts on nutrition, food safety and consumer protection. Strasbourg: Council of Europe Publishing (ISBN 92-871-5053-2), 2002.
42. Department of Health. Care Homes for Older People: National Minimum Standards. 2001.
43. Department of Health. National Service Framework for Older People. 2001.
44. Department of Health. Essence of Care. 2001.
45. Audit Commission. Acute Hospital Portfolio: hospital catering report. London, 2001:1-17.
46. Davis AM, Bristow A. Managing nutrition in hospital: a recipe for quality. London: The Stationery Office, 2000.
47. Bond S. *Eating matters: A resource for improving dietary care in hospital*. Newcastle: Centre for Health Services Research, University of Newcastle upon Tyne, 1997.
48. Association of Community Health Councils for England and Wales. Hungry in hospital? *Health News Briefing, Association of Community Health Councils for England & Wales, London. pp1-29*. 1997.
49. The British Dietetic Association. Position Paper. Malnutrition in Hospital. 1996.
50. Audit Commission. Hidden talents: education, training and development for healthcare staff in NHS Trusts. London: Audit Commission, 2001.
51. NHS Quality Improvement Scotland. Food, Fluid and Nutritional Care (ISBN 1-84404-194-8 Edinburgh, 2003: pp 44.
52. Welsh Assembly Government. Fundamentals of care. Quality of care for adults. Cardiff, 2003:18.
53. Burnham P. Nourishing Knowledge. *Nursing Times* 1996;92:78-79.
54. UKCC. Registrar's Letter. 1997.
55. Elia M, (chairman and editor), Russell CA, Stratton RJ, Scott DW, Shaffer JL, Micklewright A,

- et al. Trends in home artificial nutritional support in the UK during 1996-1999. The British Artificial Nutrition Survey (BANS). A report of the British Association for Parenteral and Enteral (BAPEN). 2000.
56. Green SM, McLaren SG. Nutritional assessment and screening: instrument selection. *British Journal of Community Nursing* 1998;3(5):233-242.
 57. Arrowsmith H. A critical evaluation of the use of nutrition screening tools by nurses. *British Journal of Nursing* 1999;8(22):1483-1490.
 58. Jones JM. The methodology of nutritional screening and assessment tools. *Journal of Human Nutrition and Dietetics* 2002;15:59-71.
 59. Kelly IE, Tessier S, Cahil A, Morris SE, Crumley, A., McLaughlin D, MCKee RF, et al. Still hungry in hospital: identifying malnutrition in acute hospital admissions. *Quarterly Journal of Medicine* 2000;93:93-98.
 60. Guo C-B. Applicability of the general nutritional status score to patients with oral and maxillofacial malignancies. *International Journal of Oral Maxillofacial Surgery* 1994;23:167-169.
 61. National Prescribing Centre (National Health Service). Oral nutritional support (part 1). *MeReC Bulletin* 1998;7:25-30.
 62. Ward J, Close J, Little J, Boorman J, Perkins A, Coles SJ, et al. Development of a screening tool for assessing risk of undernutrition in patients in the community. *Journal of Human Nutrition and Dietetics* 1998;11:323-330.
 63. Pattison R, Corr J, Ogilvie M, Farquhar D, Sutherland D, Davidson HIM, et al. Reliability of a qualitative screening tool versus physical measurements in identifying undernutrition in an elderly population. *Journal of Human Nutrition and Dietetics* 1999;12:133-140.
 64. McCall R, Cotton E. The validation of a nursing nutritional assessment tool for use on acute elderly wards. *Journal of Human Nutrition and Dietetics* 2001;14:137-148.
 65. Wolinsky FD, Coe RM, Chavez MN, Prendergast JM, Miller DK. Further assessment of the reliability and validity of a nutritional risk index: analysis of a three-wave panel study of elderly adults. *Health Services Research* 1986;20:977-990.
 66. Baker JP, Detsky AS, Wesson DE, Wolman SL, Stewart S, Whitewell J, et al. Nutritional assessment: a comparison of clinical judgment and objective measurements. *New England Journal of Medicine* 1982;306:969-972.
 67. Royal College of General Practitioners (Clinical guidelines working group). The development and implementation of guidelines. Report from General Practice 26. *Royal College of General Practitioners* 1995.
 68. Shekelle PG, Woolf SH, Eccles M, Grimshaw J. Clinical guidelines: developing guidelines. *British Medical Journal* 1999;18:593-596.
 69. Scottish Intercollegiate Guideline Network. Royal College of Physicians Edinburgh. 1999.
 70. Hannaman KN, Penner SF. A nutrition assessment tool that includes diagnosis. *Journal of the American Dietetic Association* 1985;85:607-608.
 71. Noel MB. Nutrition screening for long-term-care. *Journal of the American Dietetic Association* 1987;87.
 72. Murphy MC, Brooks CN, New SA, Lumbers MA. The use of the Mini-Nutritional Assessment (MNA) tool in elderly orthopaedic patients. *European Journal of Clinical Nutrition* 2000;54:555-562.
 73. Vlaming S, Biehler A, Hennessey EM, Jamieson CP, Chattopadhyay S, Obeid OA, et al. Should the food intake of patients admitted to acute hospital services be routinely supplemented? A randomized placebo controlled trial. *Clinical Nutrition* 2001;20:517-526.
 74. Powell-Tuck J, Hennessey EM. A comparison of mid upper arm circumference, body mass index and weight loss as indices of undernutrition in acutely hospitalised patients. *Clinical Nutrition* 2003;22:307-312.
 75. Weekes E. The incidence of malnutrition in patients admitted to hospital in south London. *Proceedings of the Nutrition Society* 1999;58:126A.
 76. Gall MJ, Harmer JE, Wanstall HJ. Prescribing of oral nutritional supplements in Primary Care: can guidelines supported by education improve prescribing practice? *Clinical Nutrition* 2001;20:511-515.
 77. Nightingale JMD, Reeves J. Knowledge about the assessment and management of

- undernutrition: a pilot questionnaire in a UK teaching hospital. *Clinical Nutrition* 1999;18:23-27.
78. Department of Health. Core curriculum for nutrition in the education of health professionals. The Health of the Nation, 1994.
 79. Widhalm K, Lackner B, Bauernfried M. Medical education in nutrition in Europe. Workshop. *Annals of Nutrition & Metabolism* 1997;41:66-68.
 80. Jackson AA. Human nutrition in medical practice: the training of doctors. *Proceedings of the Nutrition Society* 2001;60:257-263.
 81. Edington J, Boorman J, Durrant ER, Perkins A, Giffin CV, James R, et al. Prevalence of malnutrition on admission to four hospitals in England. *Clinical Nutrition* 2000;19:191-195.
 82. Lennard-Jones JE, Arrowsmith H, Davison C, Denham AF, Micklewright M. Screening by nurses and junior doctors to detect malnutrition when patients are first assessed in hospital. *Clinical Nutrition* 1995;14:336-340.
 83. Miller DK, Morley JE, Rubenstein LZ, Pietruszka FM, Stome LS. Formal geriatric assessment instruments and care of older general medical outpatients. *Journal of the American Geriatric Society* 1990;38:645-651.
 84. Abbasi A, Rudman D. Observations on the prevalence of protein-calorie malnutrition in older persons? *Journal of the American Geriatric Society* 1993;41:117-121.
 85. Wright CM, Callum J, Birks E, Jarvis S. Effect of community based management in failure to thrive: randomised controlled trial. *British Medical Journal* 1998;317:571-574.
 86. Batchelor JA. Has recognition of failure to thrive changed? *Child: Care, Health and Development* 1996.
 87. Keys A, Brozek J, Henschel A, Mickelsen O, Taylor HL. The biology of human starvation: *University of Minnesota Press*, Minneapolis, MN, 1950:81-535.
 88. Ballentyne FC, Smith J, Fleck A. Albumin metabolism in fasting obese subjects. *British Journal of Nutrition* 1973;30:585-592.
 89. Dowd PS, Kelleher J, Walker BE, Gouillou PJ. Nutritional and immunological assessment of patients with anorexia nervosa. *Clinical Nutrition* 1983;2:79-83.
 90. Chumlea WC, Roche AF, Steinbaugh ML. Estimating stature from knee height for persons 60 to 90 years of age. *Journal of the American Geriatric Society* 1985;33:116-120.
 91. Office of Population Censuses and Surveys. Health Survey for England 1991. Her Majesty's Stationery Office, London 1993.
 92. Akner G, Cederholm T. Treatment of protein-energy malnutrition in chronic nonmalignant disorders. *American Journal of Clinical Nutrition* 2001;74:6-24.
 93. Ferreira IM, Brooks D, Lacasse Y, Goldstein RS. Nutritional support for individuals with chronic obstructive pulmonary disease: a meta-analysis. *Chest* 2000;117:672-678.
 94. Lewis SJ, Egger M, Sylvester PA, Thomas S. Early enteral feeding versus 'nil by mouth' after gastrointestinal surgery: systematic review and meta-analysis of controlled trials. *British Medical Journal* 2001;323:773-776.
 95. Potter J, Langhorne P, Roberts M. Routine protein energy supplementation in adults: systematic review. *British Medical Journal* 1998;317:495-501.
 96. Potter JM. Oral supplements in the elderly. *Current Opinion in Clinical Nutrition and Metabolic Care* 2001;4:21-28.
 97. Potter JM, Roberts MA, McColl JH, Reilly JJ. Protein energy supplements in unwell elderly patients: a randomized controlled trial. *Journal of Parenteral and Enteral Nutrition* 2001;25:323-329.
 98. Stubbs RJ, Johnstone AM, O'Reilly LM, Barton K, Reid C. The effect of covertly manipulating the energy density of mixed diets on ad libitum food intake in 'pseudo free-living' humans. *International Journal of Obesity* 1998;22:980-987.
 99. Brown KH, Sanchez-Grinan M, Perez F, Peerson JM, Ganoza L, Stern JS. Effects of dietary energy density and feeding frequency on total daily energy intakes of recovering malnourished children. *American Journal of Clinical Nutrition* 1995;62:13-18.
 100. Odlund-Olin A, Osterberg P, Hadell K, Armyr I, Jerstrom S, Ljungqvist O. Energy-enriched hospital food to improve energy intake in elderly patients. *Journal of Parenteral and Enteral Nutrition* 1996;20:93-97.
 101. Odlund-Olin A, Armyr I, Soop M, Ljungqvist E, Jerstrom S, Classon I, et al. Energy enriched

- meals improve energy intake in elderly residents in a nursing home. *Clinical Nutrition* 1998;17:P09.
102. Kondrup J, Bak L, Hansen BS, Ipsen B, Ronneby H. Outcome from nutritional support using hospital food. *Nutrition* 1998;14:319-321.
 103. Barton AD, Beigg CL, Macdonald IA, Allison SP. A recipe for improving food intakes in elderly hospitalized patients. *Clinical Nutrition* 2000;19:451-454.
 104. Turic A, Gordon KL, Craig LD, Ataya DG, Voss AC. Nutrition supplements enables elderly residents of long-term-care facilities to meet or exceed RDAs without displacing energy or nutrient intakes from meals. *Journal of the American Dietetic Association* 1998;98:1457-1459.
 105. Elmstahl S, Blabolil V, Fex G, Kuller R, Steen B. Hospital nutrition in geriatric long-term care medicine I. Effects of a changed meal environment. *Comprehensive Gerontology* 1987;16:73-80.
 106. Department of Health, editor. The National Health Service recipe book. London: The Stationery Office, 2001.
 107. US Department of Health and Human Services Public Health Service AfHPaR. Acute pain management: operative and medical procedures and trauma. Agency for Health Care Policy and Research Publications, Rockville, MD 1992; Pub 92-0038.
 108. WHO. Physical status: the use and interpretation of anthropometry. WHO Technical Report Series 854. WHO, Geneva 1995.
 109. Susser M. Maternal weight gain, infant birth weight, and diet: causal links. *American Journal of Clinical Nutrition* 1991;53:1384-1396.
 110. Institute of Medicine. Nutrition during pregnancy. *National Academy of Sciences Press*, Washington DC. 1990.
 111. Krasovec K, Anderson MA. Maternal nutrition and pregnancy outcomes: anthropometric assessment. Washington DC: Pan American health Organization, 1991.
 112. Hytten FE, Leitch I. The Physiology of Human Pregnancy. 2nd ed. Oxford: *Blackwell Scientific Publications*, 1971.
 113. Norman RJ, Clark AM. Obesity Fertility and Development. 1998;10:55-63.
 114. Shaw GM, Velie EM, Schaffer D. Risk of neural tube defect-affected pregnancies among obese women. *JAMA* 1996;10:1127- 1128).
 115. Galtier-Dereure F, Boegner C, Bringer J. Obesity and pregnancy: complications and cost. *American Journal of Clinical Nutrition* 2000:1242S-1248S.
 116. Whitaker RC, Dietz WH. 1998. Role of prenatal environment in the development of obesity ;132:768-776.
 117. Hilson JA, Rasmussen KM, Kjolhede CL. Maternal obesity and breast-feeding success in a rural population of white women. *American Journal of Clinical Nutrition* 1997;66:1371-1378.
 118. Loveland JB, McClamrock H, Manilow AM, Shahara FI. Increased body mass index has a deleterious effect on in vitro fertilization outcome. *Journal of Assisted Reproduction and Genetics* 2001;18:382-386.
 119. United States Department of Agriculture, The Human Development Network of the World Bank, UNICEF. Technical Consultation on Low Birthweight. 2002.
 120. Adair LS, Pollit E, Mueller WH. The Bacon-Chow study: effect of nutritional supplementation on maternal weight and skinfold thicknesses during pregnancy and lactation. *British Journal of Nutrition* 1984;51:357-369.
 121. McDonald EC, Pollitt EC, Mueller W, Hsueh AM, Sherwin R. The Bacon Chow study: maternal nutrition supplementation and birth weight of offspring. *American Journal of Clinical Nutrition* 1981;34:2133-2144.
 122. Kramer MS. Balanced protein-energy supplementation in pregnancy (Cochrane Review), Cochrane Library: Update Software, Oxford, 2002:CD 000032.
 123. Merialdi M, Carroli G, Villar J, Abalos E, Gulmezoglu AM, Kulier R, et al. Nutritional interventions during pregnancy for the prevention or treatment of impaired fetal growth: an overview of randomized controlled trials. *Journal of Nutrition* 2003;133:1626S-1631S.
 124. Naef RW, Chauhan, S.P., Roach H, Roberts WE, Travis KH, Morrison JC. Treatment of hyperemesis gravidarum in the home: an alternative to hospitalization. *Journal of Perinatology* 1995;15:289-292.
 125. Hytten FE. Nutrition. In: Hytten FE, Chamberlain, G., editor. *Clinical Physiology in Obstetrics*.

- Oxford: *Blackwell Scientific Publications*, 1980:163-192.
126. Prentice AM, Goldberg G, Prentice A. Body mass index and lactational performance. *European Journal of Clinical Nutrition* 1994;48 (Suppl.):S78-S89.
 127. Butte NF, Hopkinson JM. Body composition changes during lactation are highly variable among women. *Journal of Nutrition* 1998;38 (Suppl 2):381S-385S.
 128. Sampsel CM, Seng J, Yeo S, Killion C, Oakley D. Physical activity and post-partum well-being. *J Obstet Gynecol Neonatal Nurs* 1999;28:41-49.
 129. Gigante DP, Victora CG, Barros FC. Breast-feeding has a limited long-term effect on anthropometry and body composition in Brazilian mothers. *Journal of Nutrition* 2001;131:78-84.
 130. Chandra RK. Immunity and infection. In : *Nutrition and metabolism in patient care*. ed. JM Kinney, KN Jeejeebhoy, G. Hill, OE Owen. 1988:598-604.
 131. Elia M. Artificial nutritional support in clinical practice in Britain. *J. Roy. Coll. Phys.* 1993;27:8-15.
 132. Elia M. Tissue distribution and energetics in weight loss and undernutrition. In: Kinney JM, Tucker HN, editors. *Physiology, stress and malnutrition: Functional correlates and nutritional intervention.*: *Lippcott-Raven*, 1997.
 133. Leyton GB. The effects of slow starvation. *Lancet* 1946;ii:73-79.
 134. Grant JP. Nutrition care of patients with acute and chronic respiratory failure. *Nutrition in Clinical Practice* 1994;9:11-17.
 135. Arora NS, Rochester DF. Respiratory muscle strength and maximal voluntary ventilation in undernourished patients. *American Review of Respiratory Diseases* 1982(126):5-8.
 136. Braun NM, Arora NS, Rochester DF. respiratory muscle and pulmonary function in polymyositis and other proximal myopathies. *Thorax* 1983;38:616-623.
 137. Allison SP. Impaired thermoregulation in malnutrition. In: *Physiology, stress and malnutrition: Functional correlates, nutritional intervention* ed. JM Kinney, HN Tucker. *Lippincott-Raven Publishers* 1997:571-593.
 138. Moore FD, Brennan MF. Surgical injury: body composition, protein metabolism and neuro-endocrinology. In: *Manual of Surgical Nutrition*. American College of Surgeons. Philadelphia. WB Saunders and Company. 1975:208-209.
 139. Haydock DA, Hill GL. Impaired wound healing in surgical patients with varying degrees of malnutrition. *British Journal of Surgery* 1987;74:320-323.
 140. Henry CJK, Ulijaszek SJ. Long-term consequences of early environment: growth, development and the lifespan developmental perspective. Cambridge: *Press Syndicate of the University of Cambridge*, 1996.
 141. Brozek J. Effects of generalized malnutrition on personality. *Nutrition* 1990;6:389-396.
 142. Pollitt E. (guest editor). The relationship between undernutrition and behavioural development in children (a report of the International Dietary Energy Consultative Group (IDECG) workshop on malnutrition and behavior). *Journal of Nutrition* 1995;125 (Suppl.):2211S-2284S.
 143. Elia M. Tissue distribution and energetics in weight loss and undernutrition. In: *Physiology, Stress and Malnutrition. Functional correlates and nutritional intervention*. Eds. JM Kinney and HN Tucker. *Lippincott-Raven Publishers*, Philadelphia, New York 1997:pp383-412.
 144. Spurr GB, Barac-Nieto M, Maksud MG. Productivity and maximal oxygen consumption in sugar cane cutters. *American Journal of Clinical Nutrition* 1977;30:316-321.
 145. Chandra RK. Food allergy and nutrition in early life: implications for later health. *Proceedings of the Nutrition Society* 2000;59:273-277.
 146. Cole TJ, Freeman JV, Preece MA. Body mass index reference curves for the UK, 1990. *Archives of Diseases in Childhood* 1995;73:25-29.
 147. WHO. WHO global database on child growth and malnutrition. Programme of Nutrition (WHO/NUT/97.4), WHO, Geneva 1997.
 148. Freeman JV, Cole TJ, Chinn S, Jones PRM, White EM, Preece MA. Cross sectional stature and weight reference curves for the UK. *Archives of Diseases in Childhood* 1995;73:17-24.
 149. Wright CM, Matthews JNS, Waterston A, Aynsley-Green A. What is the normal rate of weight gain in infancy? *Acta Paediatrica* 1994;83:351-356.
 150. Wright C, Avery A, Epstein M, Birks E, Croft D. New chart to evaluate weight faltering. *Archives of Diseases in Childhood* 1998;78:40-43.

151. Cole TJ. A chart to link child centiles of body mass index, weight and height. *European Journal of Clinical Nutrition* 2002;56:1194-1199.
152. Lamb A, Ogilvie M, Davidson I, Morss K, Richardson R. An Introduction to Nutritional Screening. Edinburgh: *Partnerships in Active Continuous Education (PACE)*, 1999:1-65.
153. Richardson R, Davidson I. Working effectively in clinical nutrition: fundamental nutritional care of hospitalised patients. Edinburgh: *Partnership in Active Continuous Education (PACE)*, 2001:1-81.
154. Weekes CE, Elia M. Identifying patients with nutritional problems: a comparison of two nutrition screening tools. *Proceedings of the Nutrition Society* 2002;61:4A.
155. Doyle MP, Barnes E, Moloney M. The evaluation of an undernutrition risk score to be used by nursing staff in a teaching hospital to identify surgical patients at risk of malnutrition on admission: a pilot study. *J Hum Nutr Dietet* 2000;13:433-441.
156. Hickson M, Hill M. Implementing a nutritional assessment tool in the community: a report describing the process, audit and problems encountered. *Journal of Human Nutrition and Dietetics* 1997;10:373-377.
157. Stratton RJ, Elia M. Concurrent validity of three nutrition screening tools for use in the community. *Proceedings of the Nutrition Society* 2002;61:19A.
158. Guigoz Y, Velles B, Garry PJ. Mini-nutritional assessment: a practical assessment tool for grading the nutritional state of elderly patients. *Facts and Research in Gerontology* 1994;4 (Suppl. 2):15-59.
159. Detsky AS, McLaughlin JR, Baker JP, Johnston N, Whittaker S, Mendelson RA, et al. What is subjective global assessment of nutritional status? *Journal of Parenteral and Enteral Nutrition* 1987;11:8-13.
160. Stratton RJ, Longmore D, Elia M. Concurrent validity of a newly developed malnutrition universal screening tool (MUST). *Clinical Nutrition* 2003;22 (Suppl 1):S34: 034-P.
161. Cotton E, Zinober B, Jessop J. A nutritional assessment tool for older patients. *Professional Nurse* 1996;11:609-610.
162. National Prescribing Centre. Oral nutritional support (part 1). *MeReC Bulletin* 1998;9(7):25-30.
163. Reilly HM, Martineau JK, Moran A, Kennedy H. Nutritional screening -- Evaluation and implementation of a simple Nutrition Risk Score. *Clinical Nutrition* 1995;14:269-273.
164. King CL, Elia M, Stroud MA, Stratton RJ. The predictive validity of the Malnutrition Universal screening Tool (MUST) with regard to mortality and length of hospital stay in elderly inpatients. *Clinical Nutrition* 2003;22 (Suppl 1):S4: 014-P.
165. Wood S, Stubbs S, Warwick H, Dunnachie A, Elia M, Stratton RJ. Malnutrition risk and health care utilisation in orthopaedic patients. 2003.
166. Roberts RJ. Can self-reported data accurately describe the prevalence of overweight? *Public Health* 1995;1995:275-284.
167. Bolton-Smith C, Woodward M, Tunstall-Pedoe H, Morrison C. Accuracy of the estimated prevalence of obesity from self-reported height and weight in an adult Scottish population. *Journal of Epidemiology and Community Health* 2000;54:143-148.
168. Spencer EA, Appleby PN, Davey GK, Key TJ. Validity of self-reported height and weight in 4808 EPIC-Oxford participants. *Public Health Nutrition* 2002;5:561-565.
169. Rowland ML. Self-reported weight and height. *American Journal of Clinical Nutrition* 1990;52:1125-1133.
170. Brown JK, Feng JY, Knapp TR. Is self-reported height or arm span a more accurate predictor of height? *Clinical Nursing Research* 2002;11:417-432.
171. Payette H, Kergoat MJ, Shatenstein B, Boutier V, Nadon S. Validity of self-reported height and weight estimates in cognitively-intact and impaired elderly individuals. *Journal of Human Nutrition and Aging* 2000;4:223-228.
172. Reed DR, Price RA. Estimates of the heights and weights of family members: accuracy of informant reports. *International Journal of Obesity and Related Disorders* 1998;22:827-835.
173. Gray DS, Crider DS, Kelley C, Dickinson LC. Accuracy of recumbent height measurement. *Journal of Parenteral and Enteral Nutrition* 1985;9:712-715.
174. McCabe RE, McFarlane T, Polivy J, Olmsted MP. Eating disorders, dieting, and the accuracy of self-reported weight. *International Journal of Eating Disorders* 2001;29:59-64.

175. Vailas LI, Nitzke SA. Self-reported versus measured weight in an older adult meal program population. *Journal of Gerontology* 1998;53A:M481-M483.
176. Gibney RG. The physical, psychological and metabolic effects of nutritional depletion and subsequent repletion [Ph.D.]. University of Cambridge, 2002.
177. Johnstone AM. Weight loss and human obesity (PhD thesis). University of Aberdeen, 2001.
178. Kramer JA. Nutritional status in inoperable lung cancer (PhD thesis). University of Cambridge, 1999.
179. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics* 1977;33:159-174.
180. Detsky AS, Smalley PS, Chang J. Is this patient malnourished? *Journal of the American Medical Association* 1994;271:54-58.
181. Hirsch. Subjective global assessment of nutritional status: further validation. *Nutrition* 1991;7:35-37.
182. Hasse J, Strong S, Gorman MA, Liepa G. Subjective global assessment: alternative nutrition-assessment technique for liver-transplant candidates. *Nutrition* 1993;9:339-343.
183. Ek AC, Larsson J, von Schenck H, Thorslund S, Unosson M, Bjurulf P. The correlation between anergy, malnutrition and clinical outcome in an elderly hospital population. *Clinical Nutrition* 1990;9:185-189.
184. Ferguson M, Capra S, Bauer J, Banks M. Development of a valid and reliable malnutrition screening tool for adult acute hospital patients. *Nutrition* 1999;15:458-464.
185. Mackintosh MA, Hankey CR. Reliability of a nutrition screening tool for use in elderly day hospitals. *Journal of Human Nutrition and Dietetics* 2001;14:129-136.
186. Burden ST, Bodey S, Bradburn YJ, Murdoch S, Thompson AL, Sim JM, et al. Validation of a nutrition screening tool: testing the reliability and validity. *Journal of Human Nutrition and Dietetics* 2001;14:269-275.
187. Goode DR, Williams A, Pinnington LL. Development, validity and reliability of the Derby Nutritional Score. *Journal of Human Nutrition and Dietetics* 1998;11:411-421.
188. Gilford A, Khun RK. Development of nutritional risk screening in the community. *British Journal of Community Health Nursing* 1996(6):335-339.
189. Prendergast JM, Coe RM, Chavez MN, Romeis JC, Miller DK, Wolinsky FD. Clinical validation of a nutritional risk index. *Journal of Community Health* 1989;14:125-134.
190. Visser R, Dekker FW, Boeschoten EW, Stevens P, Krediet T. Reliability of the 7-point subjective global assessment scale in assessing nutritional status of dialysis patients. *Advances in Peritoneal Dialysis* 1999;15:222-225.
191. Bryan F, Jones JM, Russell L. Reliability and validity of a nutrition screening tool to be used with clients with learning difficulties. *Journal of Human Nutrition and Dietetics* 1998;11:41-50.
192. Shrout PE, Fleiss JL. Intraclass correlations: uses in assessing rater reliability. *Psychological Bulletin* 1979;86:420-428.
193. Ulijaszek SJ, Kerr DA. Anthropometric measurement error in the assessment of nutritional status. *British Journal of Nutrition* 1999;82:165-172.
194. Nagel MR. Nutrition screening: Identifying patients at risk for malnutrition. *Nutrition in Clinical Practice* 1993;8:171-175.
195. Elia M. Changing concepts of nutrient requirements in disease : implications for artificial nutritional support. *Lancet* 1995;345:1279-1284.
196. ASPEN Board of Directors. Guidelines for the use of enteral nutrition in the adult patient. *Journal of Parenteral and Enteral Nutrition* 1987;11:435-439.
197. Cerra FB, Benitez MR, Blackburn GL, Irwin RS, Jeejeebhoy K, Katz DP, et al. Applied nutrition in ICU patients. A consensus statement of the American College of Physicians. *Chest* 1997;111:769-778.
198. Nutrition de L'Agresse Conference de consensus. *Nutrition Clinique et Metabolisme* 1998; 12 (suppl).
199. Preiser JC, Berre J, Carpentier Y, Jolliet P, Pichard P, van Gossum A, et al. Management of nutrition in European intensive care units: results of a questionnaire. *Intensive Care Medicine* 2002;25:95-101.
200. Jolliet P, Pichard C, Biolo G, Chioloro R, Grimble G, Leverve X, et al. Working Group on nutrition on Nutrition and Metabolism, ESICM. Enteral nutrition in intensive care patients. A

- practical approach. *Intensive Care Medicine* 1998;24:848-859.
201. Bozzetti F, Braga M, Dionigi P. Linee guida per l'impiego della nutrizione parentale ed enterale nei pazienti adulti ospedalizzati. *Riv Ital Nutr Parenter Enteral* 1995;2 (Suppl):39-42.
 202. Klein S, Kinney J, Jeejeebhoy K, Alpers D, Hellerstein M, Murray M, et al. Nutrition support in clinical practice: Review of published data and recommendations for future research directions. Summary of a conference sponsored by the National Institute of Health, American Society for Parenteral and Enteral Nutrition, and the American Society of Clinical Nutrition. *Journal of Parenteral and Enteral Nutrition* 1997;21:133-156.
 203. August D, Teitelbaum D, Albina J, Bothe AL, Guenter P, Heikemper M, et al. Guidelines for the use of parenteral and enteral nutrition in adult and pediatric patients. *Journal of Parenteral and Enteral Nutrition* 2002;26:1SA-138SA.
 204. Takahira H. Metabolism during fasting and subsequent re-feeding. Imperial Govt. Institute for Nutrition 1925;1:63-82.
 205. Runchie J, Hilditch TE. Energy provision, tissue utilisation, and weight loss in prolonged starvation. *British Medical Journal* 1974;ii:352-356.
 206. Benedict FG. A study of prolonged fasting. Washington, DC, 1915.
 207. Elia M, Livesey G. Energy expenditure and fuel selection in biological systems: the theory and practice of calculations based on indirect calorimetry and tracer methods. *Int. Rev. Nutr. Diet* 1992;70:68-131.
 208. Kinney JM. Surgical diagnosis, patterns of energy, weight and tissue change. In: A.W. Wilkinson & D C, editor. *Metabolism and the response to injury*. London: Pitman Medical, 1976:121-134.
 209. Faber P, Johnstone AM, Gibney AM, Elia M, Stubbs RJ, Duthie GG, et al. The effect of rate of weight loss on erythrocyte glutathione concentration and synthesis on healthy obese men. *Clinical Science* 2002;102:569-577.
 210. Bender PR, Martin BJ. Ventilatory and treadmill endurance during acute semistarvation. *Journal of Applied Physiology* 1986;60:1823-1827.
 211. Russell M, Leiter LA, Whitwell J, Marliss EB, Jeejeebhoy KN. Skeletal muscle function during hypocaloric diets and fasting: a comparison with standard nutritional assessment parameters. *American Journal of Clinical Nutrition* 1983;37:133-138.
 212. Doekel RC, Zwillich CW, Scoggin CH, Kryger M, Weil JV. Clinical semistarvation: depression of hypoxic ventilatory drive. *New England Journal of Medicine* 1976;295:358-361.
 213. Green MW, Ellman NA, Rogers PJ. Lack of effect of short-term fasting on cognitive function. *Journal of Psychiatric Research* 1995;29:245-253.
 214. Phillips WJ. Starvation and survival: some military considerations. *Military Medicine* 1994;159:513-516.
 215. Holm G, Palmblad J. Acute energy deprivation in man: effect on cell-mediated immunological reactions. *Clinical and Experimental Immunology* 1976;25:207-211.
 216. Palmblad J. Fasting (acute energy deprivation) in man: effect on polymorphonuclear granulocyte function, plasma iron and transferrin. *Scandinavian Journal of Haematology* 1976;17:217-226.
 217. Savendahl L, Underwood LE. Decreased interleukin-2 production from cultured peripheral blood mononuclear cells in human acute starvation. *Journal of Clinical Endocrinology and Metabolism* 1997;82:1177-1180.
 218. Nikolaus T, Bach M, Siezen S, Volkert D, Oster P, Sclierf G. Assessment of nutritional risk in the elderly. *Annals of Nutrition and Metabolism* 1995;39:340-345.
 219. Lindstead K, Singh PN. Body mass and 26-year risk of mortality among women who never smoked: findings from the Adventist Mortality Study. *American Journal of Epidemiology* 1997;146:1-11.
 220. Tayback M, Kamanyika S, Chee E. Body weight as a risk factor in the elderly. *Archives of Internal Medicine* 1990;150:1065-1072.
 221. Seccareccia F, Lanti M, Menotti A, Scanga M. Role of body mass index in the prediction of all cause mortality in over 62,000 men and women. The Italian RIFLE Pooling Project. Risk factor life expectancy. *Journal American Geriatric Society* 1998;43:329-337.
 222. Spataro JA, Dyer AL, Stamler J, Shekelle RB, Greenlund K, Garside D. Measures of adiposity

- and coronary heart disease mortality in the Chicago Western Electric Company Study. *Journal of Clinical Epidemiology* 1996;49:849-859.
223. Rissanen A, Helliövaara M, Knekt P, Aromaa A, Reunanen A, Maatela J. Weight and mortality in Finnish men. *Journal of Clinical Epidemiology* 1989;42:781-789.
224. Calle EE, Thun MJ, Petrelli JM, Rodriguez C, Heath CW. Body-mass index and mortality in a prospective cohort of U.U. adults. *New England Journal of Medicine* 1999;341:1097-1105.
225. Stevens J, Plankey MW, Williamson DF, Thun MJ, Rust PF, Palesch Y, et al. The body mass index-mortality relationship in white and African American women. *Obesity Research* 1998;6:268-277.
226. Petitt DJ, Lisse JR, Knowler WC, Bennett PH. Mortality as a function of obesity and diabetes mellitus. *American Journal of Epidemiology* 1982;115:359-366.
227. James PT, Leach R, Kalamara E, Shayeghi M. The worldwide obesity epidemic. *Obesity Research* 2001;Vol.9, Suppl 4:228S-233S.
228. Cornoni-Huntley JC, Harris TB, Everett DF, Albanes D, Micozzi MS, Miles TP, et al. An overview of body weight of older persons including impact on mortality. *Journal of Clinical Epidemiology* 1991;44:733-753.
229. Elia M. Obesity in the Elderly. *Obesity Research* 2001;Vol.9, Suppl 4.:244S-248S.
230. Willett WC, Stampfer M, Manson J, VanItallie T. New weight guidelines for Americans: justified or injudicious? *American Journal of Clinical Nutrition* 1991;153: 1102-1103.
231. Stevens J, Cai J, Pamuk ER, Williamson DF, Thun MJ, Wood JL. The effect of age on the association between body-mass index and mortality. *New England Journal of Medicine* 1998;338:1-7.
232. Ford E, Williamson D, Liu S. Weight change and diabetes incidence: findings from a national cohort of US adults. *American Journal of Epidemiology* 1997;146:214-222.
233. National Institutes of Health. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults - the evidence report (published correction appears in *Obesity Research* 1998;6:464). *Obesity Research* 1998;6 (Suppl 2):51S - 209S.
234. Ashton W, Nanchahal K, Wood D. Body mass index and metabolic risk factors for coronary heart disease in women. *European Heart Journal* 2001;22:46-55.
235. Dey DK, Rothenberg E, Sundh V, Bosaeus I, Steen B. Body mass index, weight change and mortality in the elderly. A 15 y longitudinal study of 70 y olds. *European Journal of Clinical Nutrition* 2001;55:482-492.
236. Potter M, Schafer DF, Bohi RL. In-hospital mortality as a function of body mass index: an age dependent variable. *Journal of Gerontology* 1988;43:M59-M63.
237. Flodin L, Svensson S, Cederholm T. Body mass index as a predictor of 1 year mortality in geriatric patients. *Clinical Nutrition* 2000;19:121-125.
238. Liu L, Bopp MM, Robertson PK, Sullivan DH. Undernutrition and risk of mortality in elderly patients within 1 year of hospital discharge. *Journal of Gerontology Series A : Biological Sciences and Medical Sciences* 2002;57:M741-M746.
239. Rajala SA, Kanto AJ, Haavisto MV, Kaarela RH, Koivunen MJ, Heikinheimo RJ. Body weight and three-year prognosis in the very old. *International Journal of Obesity* 1990;14:997-1003.
240. Landi F, Zuccala G, Gambassi G, Incalzi RA, Manigrasso L, Pagano F, et al. Body mass index and mortality among older people living in the community. *Journal of the American Geriatric Society* 1999;47:1072-1076.
241. Waaler HT. Hazard of obesity - the Norwegian experience. *Acta Medica Scandinavica* 1988;723 (Suppl.):17-21.
242. Willett WC, Dietz WH, Colditz GA. Guidelines for healthy weight. *New England Journal of Medicine* 1999;341:427-434.
243. Posner BM, Jette AM, Smith KW, Miller DR. Nutrition and health risks in the elderly: the nutrition screening initiative. *American Journal of Public Health* 1993;83:972-978.
244. Gray-Donald K, Payette H, Boutier V. Randomized clinical trial of nutritional supplementation shows little effect on functional status among free living elderly. *Journal of Nutrition* 1995;125:2965-2971.
245. Coulston AM, Craig L, Voss AC. Meals-on-wheels applicants are a population at risk for poor nutritional status. *Journal American Dietetic Association* 1996;96 (6):570-573.

246. Consumer's Association. Malnourished inpatients: overlooked and undertreated. *Drugs and Therapeutics Bulletin* 1996;8:57-60.
247. Consumer's Association. Helping undernourished adults in the community. *Drugs and Therapeutics Bulletin* 1999;37:93-95.
248. ASPEN Board of Directors and the Clinical Guidelines Task Force. Section III. Nutritional assessment -Adults Guidelines for the use of parenteral and enteral nutrition in adult and pediatric patients. *Journal of Parenteral and Enteral Nutrition* 2002;26:138SA-138SA.
249. Wright L. A nutritional screening tool for use by nurses in residential and nursing homes for elderly people: development and pilot study results. *Journal of Human Nutrition and Dietetics* 1999;12:437-443.
250. Nightingale JMD, Walsh N, Bullock ME, Wicks AC. Three simple methods of detecting malnutrition on medical wards. *Journal of the Royal Society of Medicine* 1996;89:144-148.
251. Keller HH. Malnutrition in institutionalized elderly: How and why? *Journal of the American Geriatrics Society* 1993;41:1212-1218.
252. Thomas AJ, Gill CL. Malnutrition in the elderly. *Prescriber's Journal* 1998;38:249-254.
253. Comi MM, Palmo A, Brugnani M, D'Amicis A, Costa A, D'Andrea F, et al. The hospital malnutrition Italian study. *Clinical Nutrition* 1998;17:S2.
254. Corish C, Flood P, Mulligan S, Kennedy NP. Prevalence of undernutrition and weight loss changes during the course of hospitalization among patients admitted to two Dublin hospitals. *Proceedings of the Nutrition Society* 1998;57:10A.
255. Kyle UG, Morabia A, Slosman DO, Nensi N, Unger P, Pichard C. Contribution of body composition to nutritional assessment at hospital admission in 995 patients: a controlled population study. *British Journal of Nutrition* 2001;86:725-731.
256. Thorsdottir I, Eriksen B, Eysteinsdottir S. Nutritional status at submission for dietetic services and screening for malnutrition at admission to hospital. *Clinical Nutrition* 1999;18:15-21.
257. Klipstein-Grobusch K, Reilly JJ, Potter J, Edwards CA, Roberts MA. Energy intake and expenditure in elderly patients admitted to hospital with acute illness. *British Journal of Nutrition* 1995;73:323-334.
258. Watson JL. The prevalence of malnutrition in patients admitted to Care of the Elderly wards. *Proceedings of the Nutrition Society* 1999;58(3):139A.
259. Mowé M, Böhmer T, Kindt E. Reduced nutritional status in an elderly population (> 70y) is probable before disease and possibly contributes to the development of disease. *American Journal of Clinical Nutrition* 1994;59:317-324.
260. Faxén Irving GE, Olsson BA, Cederholm T. Nutritional and cognitive status in elderly subjects living in service flats and the effect of nutrition education on personnel. *Gerontology* 1999;45:187-194.
261. Sahebajami H, Doers JT, Render ML, Bond TL. Anthropometric and pulmonary function test profiles of outpatients with stable chronic obstructive pulmonary disease. *The American Journal of Medicine* 1993;94:469-474.
262. Wigmore SJ, Plester CE, Richardson RA, Fearon KCH. Changes in nutritional status associated with unresectable pancreatic cancer. *British Journal of Cancer* 1997;75:106-109.
263. Wilson MMG, Morley JE. Undernutrition. In: Sadler MJ, Strain JJ, Caballero B, editors. *Encyclopedia of Human Nutrition*. San Diego: Academic Press, 1998:1485-1495.
264. Lowik MR, Schneijder P, Hulshof KF, Kistemaker C, Sleutel L, van Houten P. Institutionalized elderly women have lower food intake than do those living more independently (Dutch Nutrition Surveillance System). *Journal American College of Nutrition* 1992;11 (4):432-40.
265. Incalzi BA, Gemma A, Capparella O, Cipriani L, Landi R, Carbonin P. Energy intake and in-hospital starvation. A clinically relevant relationship. *Archives of Internal Medicine* 1996;156:425-429.
266. Cantor AB. Sample size calculations for Cohen's kappa. *Psychological Methods* 1996;1:150-153.
267. Pirie P, Jacobs D, Jeffery R, Hannan P. Distortions in self-reported height and weight data. *Journal of the American Dietetic Association* 1981;78:601-606.
268. Chunlea WC, Guo S. Equations for predicting stature in white and black elderly individuals. *Journal of Gerontology: MEDICAL SCIENCES* 1992;47:M197-M203.

269. Chumley WC, Guo SS, Steinbaugh ML. Prediction of stature from knee height for black and white adults and children with application to mobility-impaired or handicapped persons. *Journal of the American Dietetic Association* 1994;94:1388-1391.
270. Vellas B, Albardere JL, Garry PJ. Hydration and Aging. New York: *Springer Publishing Company*, 1998.
271. Snyder WS, Cook MJ, Nasset ES, Karhausen LR, Parry-Howells G, Tipton IH. Report of the task group on reference man. International Commission on Radiological Protection No. 23. Oxford.: Pergamon Press, 1975.
272. Stevens-Simon C, McAnarney ER, Coulter MP. How accurately do pregnant adolescents estimate their weight prior to pregnancy? *Journal of Adolescent Health Care* 1986;7:250-254.
273. Sidebottom AC, Brown JE, Jacobs DR. Pregnancy -related changes in body fat. *European Journal of Obstetrics and Gynecology and Reproductive Biology* 2001;94:216-223.
274. Soltani H, Fraser RB. A longitudinal study of maternal anthropometric changes in normal weight, overweight and obese women during pregnancy and postpartum. *British Journal of Nutrition* 2000;84:95-101.
275. Smith LK, Weiss EL, Lehmkuhl LD. Mechanical Principles: kinetics. *Brunnstrom's clinical kinesiology* (fifth edition). Philadelphia: F A Davies Company, 1996:20-68.
276. The British Dietetic Association. Malnutrition in Hospital: BDA Position Paper. 1996.
277. Stratton RJ, Hackston AJ, Price S, Joseph K, Elia M. Concurrent validity of the newly developed 'Malnutrition Universal Screening Tool' ('MUST') with Mini Nutritional Assessment and Subjective Global Assessment tools. (in press) 2003.
278. Stratton RJ, Dixon R, Longmore D, Stroud MA, Elia M. Effect of recalled weight and height on malnutrition risk. *Clinical Nutrition* 2003;22 (Suppl 1):S9: 033-P.
279. Ek AC, Unosson M, Larsson J, Ganowiak W, Bjurulf P. Interrater variability and validity in subjective nutritional assessment of elderly patients. *Scandinavian Journal of Caring Science* 1996;10:163-168.
280. Prendergast JM, Coe RM, Chavez MN, Romeis JC, Miller DK, Fredric D, et al. Clinical validation of a nutritional risk index. *Journal of Community Health* 1989;14:125-135.
281. Kalantar-Zadeh K, Kleiner M, Dunne E, Lee GH, Luft F. A modified quantitative subjective global assessment of nutrition for dialysis patients. *Nephrology Dialysis Transplantation* 1999;14:1732-1738.
282. Bowers JM, Dols CL. Subjective global assessment in HIV-infected patients. *Journal of the Association of Nurses in AIDS Care* 1996;7:83-89.
283. Brown KH, Stegman MR. Nutritional assessment of surgical patients. *Quality Review Bulletin* 1988;14:302-306.
284. Oakley C, Hill R. Nutrition assessment score validation and the implications for usage. *Journal of Human Nutrition and Dietetics* 2000;13:343-352.
285. Christensen KS, Gstundtner KM. Hospital-wide screening improves basis for nutrition intervention. *Journal of the American Dietetic Association* 1985;85:704-707.
286. Hunt DR, Maslovitz A, Rowlands BJ, Brooks B. A simple screening procedure for hospital patients. *Journal of the American Dietetic Association* 1985;85(332-335).
287. Institute of Medicine. Nutrition During Pregnancy and lactation: an implementation guide. Washington D.C.: *National Academic Press*, 1992.
288. Brown JE, Carlson M. *Journal of American Dietetic Association* 2000;100:343-348.
289. Kaiser L, Allen L. Position of the American Dietetic association: Nutrition and lifestyle for a healthy pregnancy outcome. *Journal of the American Dietetic Association: Nutrition and lifestyle for a healthy pregnancy outcome* 2002;102:1479-1490.

E

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E.1 MAG (Malnutrition Advisory Group) committee membership

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F

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