Malnutrition and undernutrition

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Abstract

The term 'malnutrition' is used to describe a deficiency, excess or imbalance of a wide range of nutrients, resulting in measurable adverse effects on body composition, function and clinical outcome. As such, it can refer to individuals who are either over- or undernourished, although it is usually used synonymously with undernutrition, as here. Although it is well known that malnutrition is common in the developing world, the fact that it occurs quite frequently in UK health settings as a consequence of either psychosocial circumstances or the effects of illness or injury is not widely appreciated. Furthermore, because malnutrition has direct effects on clinical outcomes and is associated with massive healthcare expenditure, better recognition and treatment would result in improved patient outcomes, reduced costs and decreased medico-legal risks. It is therefore the responsibility of all doctors to recognize the fundamental importance of proper nutritional care. The focus of this article is primarily concerned with malnutrition and its consequences in the UK.

Keywords Clinical outcome; health economics; malnutrition; MRCP; MUST score; nutritional care; refeeding syndrome

Key points

- Malnutrition is a common, under-recognized and undertreated condition in hospital patients
- Disease-related malnutrition arises from reduced dietary intake, malabsorption, increased nutrient losses or altered metabolic demands
- Wide-ranging changes in physiological function occur in malnourished patients, leading to increased rates of morbidity and mortality
- Refeeding syndrome is a serious and potentially fatal complication, which is avoidable by careful consideration of nutritional treatment
- Routine nutritional screening should be undertaken in all patients admitted to hospital using a validated tool such as the Malnutrition Universal Screening Tool (MUST)
- Healthcare costs are significantly increased in malnourished patients
- The diagnosis of malnutrition is vital for medical, social and medico-legal reasons

Introduction

The term 'malnutrition' is used to describe a deficiency, excess or imbalance of a wide range of nutrients, resulting in measurable adverse effects on body composition, function and clinical outcome. It is the responsibility of all doctors to recognize the importance of proper nutritional care for good clinical practice.[1] Worldwide >3.5 million mothers and children <5 years of age die unnecessarily each year owing to malnutrition, and around 178 million children have stunted growth. Micronutrient deficiencies affect huge numbers: iodine deficiency alone is thought to affect about 2 billion people.

Malnutrition is both a common cause and consequence of disease, yet, in the UK, it remains an under-recognized problem facing patients, clinicians and wider society.[1] It is not only frequently seen in hospital and institutional care settings, but is also widespread in the community. Approximately 2% of the UK adult population are underweight – defined as a body mass index (BMI) <18.5 kg/m^2. However, this is an underestimate of malnutrition, because those unintentionally losing weight from a position of relative excess are also at potential nutritional risk whatever their BMI. The prevalence of malnutrition in free-living elderly individuals and those with chronic diseases is increased at least 2-fold, and individuals in institutional care have a prevalence of malnutrition around 30–40%.[2] UK hospital patients are particularly likely to be malnourished for reasons summarized in Table 1.

In a series of large national surveys conducted by the British Association for Parenteral and Enteral Nutrition (BAPEN) between 2007 and 2011, around 30% of patients admitted in hospital were at risk, as indicated by a high score on the Malnutrition Universal Screening Tool (MUST); there was a particularly high prevalence, around 50%, in admissions from care homes.[2] Many patients also see a further decline in their nutritional status during their hospital admission, which can then increase their risk of complications and length of stay.

***Micronutrient deficiencies*:** in the UK, specific micronutrient deficiencies are also surprisingly common, especially in elderly people. Folate deficiency has been described in 29% of

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Causes of malnutrition and further deterioration in nutritional status among hospital inpatients

Medical causes of inadequate and/or poor quality oral intake	• Anorexia of disease • Nausea and vomiting • Gastrointestinal dysfunction • Reduced absorption of macro- and/or micronutrients • Increased nutrient loses • 'Nil-by-mouth' for investigation or medical reasons • Physical disability and inability to feed self
Environmental causes of inadequate and/or poor quality oral intake	• Inadequate food quality • Inadequate food availability • No protected mealtimes • Missed meals when going for investigations • Inadequate training and knowledge of medical and nursing staff
Altered requirements	• In critical illness, there are altered substrate demands, and several patient subgroups have an increased energy expenditure

Table 1

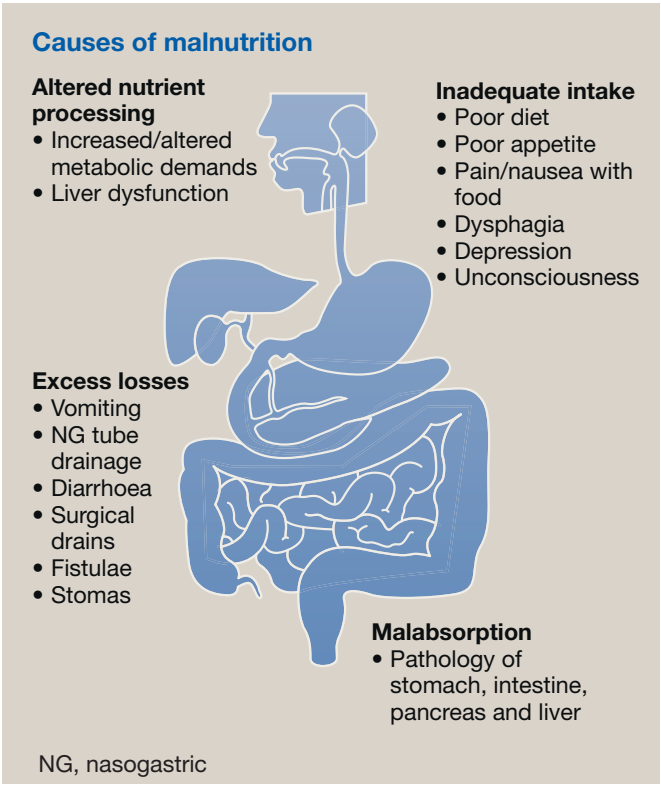

Figure 1

independent adults >65 years old and 35% of those in institutions, while vitamin C deficiency affects 40% of individuals in institutional care.

Causes of malnutrition

Although a proportion of malnutrition in developed countries is associated with poverty, social isolation and substance misuse, exacerbating the health inequalities in vulnerable populations, most adult malnutrition in the UK is associated with disease arising from several sources (Figure 1).

Reduced dietary intake is probably the single most important aetiological factor. It results from many factors, including age, depression and dementia. In illness or injury, there is often a marked reduction in appetite, usually caused by modified secretion of cytokines, glucocorticoids, peptides, insulin and insulin-like growth factors. For hospital inpatients, these problems may be compounded by a failure to provide regular nutritious meals, missed meals because of clinical investigations, and lack of help with feeding when required.

Among patients undergoing abdominal surgical procedures, varying degrees of intestinal failure (short-term or more sustained) add further nutritional risks, and some other groups (e.g. haemato-oncology patients) also experience intestinal failure from chemotherapy/radiotherapy-induced damage.[3] Although there may be a rebound of appetite after recovery that helps restore lost weight and function, this is often suppressed by continued inflammation or early recurrence of the original illness (e.g. with chronic obstructive pulmonary disease).

Although for many years it was thought that increased energy expenditure was predominantly responsible for disease-related malnutrition, total energy expenditure in many disease states is actually less than that measured in normal health; this is because any basal hypermetabolism from disease is offset by reduced physical activity. Studies in intensive care patients therefore demonstrate that energy expenditure is usually <2000 kcal/day. Patients with injury, inflammation or neoplasia may also have altered demands for specific amino acids, which are met by a catabolic draw on reserves, causing excess lean tissue wasting.[3] This sarcopenia is very evident as cachexia in a thin patient, but more difficult to detect in overweight patients.

Consequences of malnutrition

Malnutrition affects the function and recovery of every organ system (Figure 2).[3]

Muscle and bone: weight loss caused by depletion of fat, particularly muscle and lean organ mass, is often the most obvious clinical consequence of malnutrition, although significant lean loss may be hidden in obese patients. Muscle function declines before changes in muscle mass occur, suggesting that nutrient deficits have detrimental functional effects independent of muscle mass. Similarly, improvements in muscle function with nutrition support often occur more rapidly than can be accounted for by restoration of muscle mass alone. Bone mass also declines with weight loss, especially if intakes of calcium, magnesium and/or vitamin D are insufficient. Bones are slow to re-form during recovery, and fracture risk is high.

Cardiovascular and respiratory: reduced cardiac muscle mass is also recognized in malnourished individuals, and the resulting decrease in cardiac output reduces renal perfusion and

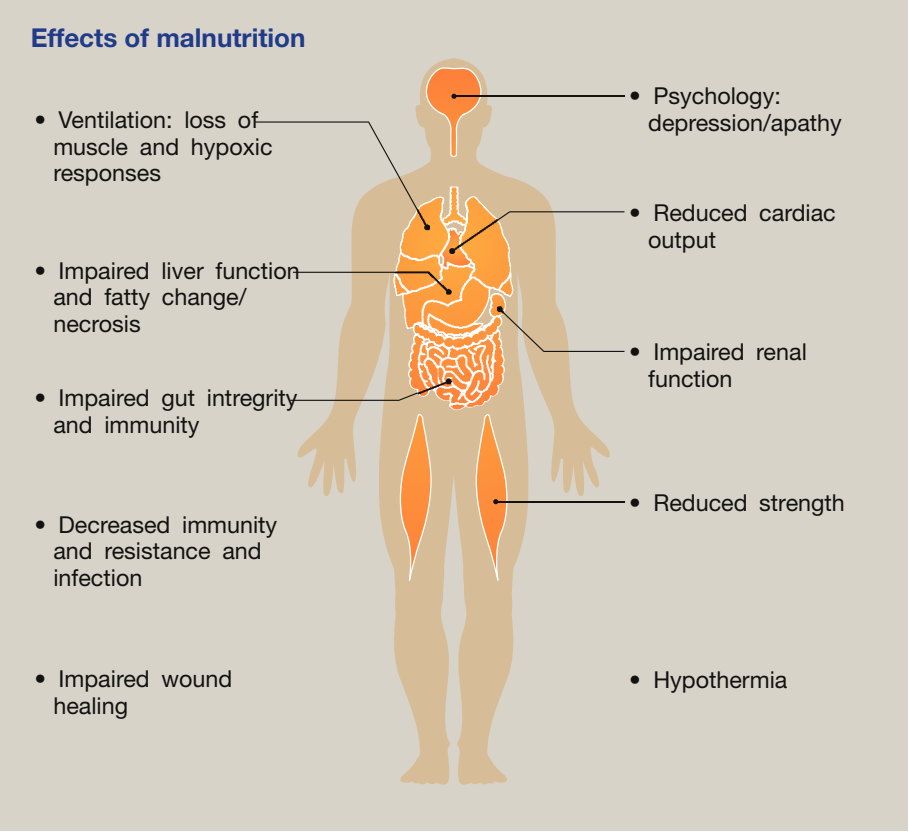

Figure 2

glomerular filtration rate. Micronutrient (e.g. thiamine) and electrolyte deficiencies may also affect cardiac function, particularly during refeeding. Poor diaphragmatic and respiratory muscle function reduces cough pressure and expectoration of secretions, increasing propensity to (and delaying recovery from) respiratory tract infections.

***Gastrointestinal*:** adequate nutrition is important for preserving gastrointestinal function: chronic malnutrition results in changes in pancreatic exocrine function, intestinal blood flow, villous architecture and intestinal permeability. Loss of digestive enzymes occurs early with dietary energy restriction, and commonly leads to secondary lactose intolerance, with diarrhoea. The colon loses its ability to reabsorb water and electrolytes, and secretion of ions and fluid occurs in the small and large bowel. This may also result in diarrhoea, which is associated with a high mortality rate in severely malnourished patients.

***Immunity and tissue repair*:** immune function is suppressed early with inadequate nutrition as a result of impaired cell-mediated immunity and reduced cytokine, complement and phagocyte functions. This increases risks of infection. Malnourished patients are at particular risk from respiratory tract infections, and any bacterial or parasitic infection is liable to progress rapidly. Fever and usual markers of acute inflammation (white blood cells, C-reactive protein) may be suppressed in malnutrition; therefore a high index of suspicion is needed when a malnourished patient becomes acutely unwell for no apparent reason, with careful consideration of the early instigation of antibiotics. Delayed wound healing is also well described in malnourished surgical patients.

***Endocrine*:** most endocrine functions are suppressed by malnutrition. Specifically, concentrations of T4 and T3 are reduced, while reverse T3 rises. Thyroid-stimulating hormone is usually normal, unless iodine status is impaired. Gonadotropins are suppressed, and testosterone and oestrogen/progesterone concentrations fall. Secondary amenorrhoea is common. Insulin secretion is reduced, but insulin sensitivity rises during undernutrition, so blood glucose remains low-normal. Hypoglycaemia is a very late pre-terminal development but may also indicate occult sepsis. During refeeding, insulin resistance may result in a form of 'malnutrition-related diabetes mellitus'.

***Psychological*:** in addition to these physical consequences, malnutrition also results in psychosocial effects, such as apathy, depression, anxiety and self-neglect.

***Reductive adaptation*:** a down-regulation of energy-dependent cellular membrane pumping (Na/K-ATPase) and other basic cellular metabolic functions is one explanation for the consequences of malnutrition. In complete starvation, the process begins very early. It is less striking when dietary intake is simply insufficient to meet requirements and the body has time to draw on functional tissue reserves within muscle, adipose tissue and bone; however, this then leads to detrimental changes in body composition. Both reductive adaptation and tissue wasting have direct consequences on tissue function, with loss of functional capacity and a potentially brittle metabolic state. Rapid decompensation occurs with insults such as infection and trauma.

***Refeeding syndrome*:** this describes the potentially life-threatening consequences that occur as a result of acute

micronutrient deficiencies, fluid and electrolyte imbalance, and organ dysfunction caused by administration of unbalanced or over-rapid nutritional support in patients at risk (Table 2).[3] Patients particularly at risk are those with little or no oral intake for protracted periods and those who are severely malnourished (Table 3).

Patients with limited nutritional intake, altered metabolic demands and/or increased losses undergo reductive adaptation and, as a result, are deficient in vitamins, trace elements and electrolytes. There is a whole-body and intracellular depletion of potassium, magnesium and phosphate, and a consequential increase in intracellular sodium and water. There is also a switch away from carbohydrate to lipid metabolism as the predominant source of energy. The provision of nutrients reverses these changes, but administration that is either too rapid or in an unbalanced form can result in dangerous shifts in electrolytes and micronutrient deficiencies. Patients most at risk are those being given enteral tube feeding or parenteral nutrition, but care should also be taken with oral nutritional supplements.

Clinical features of classical refeeding syndrome

Cardiovascular	Cardiac failure
	Pulmonary oedema
	Dysrhythmias
	Peripheral oedema
Electrolyte disturbance	Hypophosphataemia
	Hypokalaemia
	Hypomagnesaemia (rarely hypocalcaemia)
Metabolic	Hyperglycaemia
Neurological	Wernicke's encephalopathy
	Confusion
	Seizures
Hepatological	Abnormalities of liver function
Musculoskeletal	Rhabdomyolysis
Haematological	Bone marrow dysfunction

Table 2

Criteria for determining patients at high risk of developing refeeding problems

The patient has one or more of the following	• BMI <16 kg/m^2 • Unintentional weight loss of $>15\%$ within the last 3–6 months • Little/no nutritional intake for >10 days • Low levels of potassium, phosphate or magnesium before feeding
The patient has two or more of the following	• BMI <18.5 kg/m^2 • Unintentional weight loss of $>10\%$ within the last 3–6 months • Little/no nutritional intake for >5 days • History of alcohol abuse or drugs including insulin, chemotherapy, antacids or diuretics

Table 3

The National Institute for Health and Care Excellence (NICE) has published specific guidance for managing these complex patients;[3] a joint working group of the Royal College of Psychiatrists and Physicians has produced 'MARSIPAN' (Management of Really Sick Patients with Anorexia Nervosa) guidelines on the medical and psychiatric management of very severely malnourished individuals with anorexia nervosa.[4]

Assessment of nutritional status and diagnosis of malnutrition

Nutritional status is a composite concept, incorporating dietary intake (what we eat), body composition (what we are) and functional capacity (what we can do). Information about all these components is needed.

Screening

Identification of patients at risk of malnutrition at an early stage of hospital admission, or during outpatient clinic attendance, is a screening step to determine which patients need formal assessment of nutritional status by a qualified trained person, with a view to early intervention with nutritional therapy. MUST is a simple, rapid and easy method to screen patients and has been shown to be reliable and valid.[5] It aims to identify those at risk by incorporating simple information that is collected routinely for other reasons:

- current weight and height (BMI)
- history of recent unintentional weight loss
- likelihood of future weight loss.

Figure 3 provides a guide for using MUST. The total score has been shown to be a better predictor of outcome than the individual component scores used in isolation, and identifies most patients with malnutrition.

The screening process identifies patients who require a more detailed assessment and formulation of an individualized stepwise management plan. Re-screening of inpatients at 7-day intervals throughout hospital admission alerts clinicians to those who have lost weight and require greater intervention.

Detailed nutritional assessment

Full nutritional assessment to diagnose malnutrition is based on clinical history and examination, with rather less emphasis on laboratory investigations than is usual for most diagnostic processes.

Medical history

- Has there been normal and varied recent dietary intake? An overview of daily food intake, pattern of meals and portion size should be recorded, as should food intolerance, allergies and religious or other restrictions. Specialist dietetic input is appropriate where concern has been raised.
- Is there a history of recent intentional or unintentional weight loss? Weight loss in obesity or in patients with oedema can be more challenging to assess.
- Is the patient able to eat, swallow, digest and absorb sufficient amounts of food to meet their requirements?
- Are any physical, medical, psychiatric or treatment limitations preventing patients meeting their requirements and leading to weight loss?

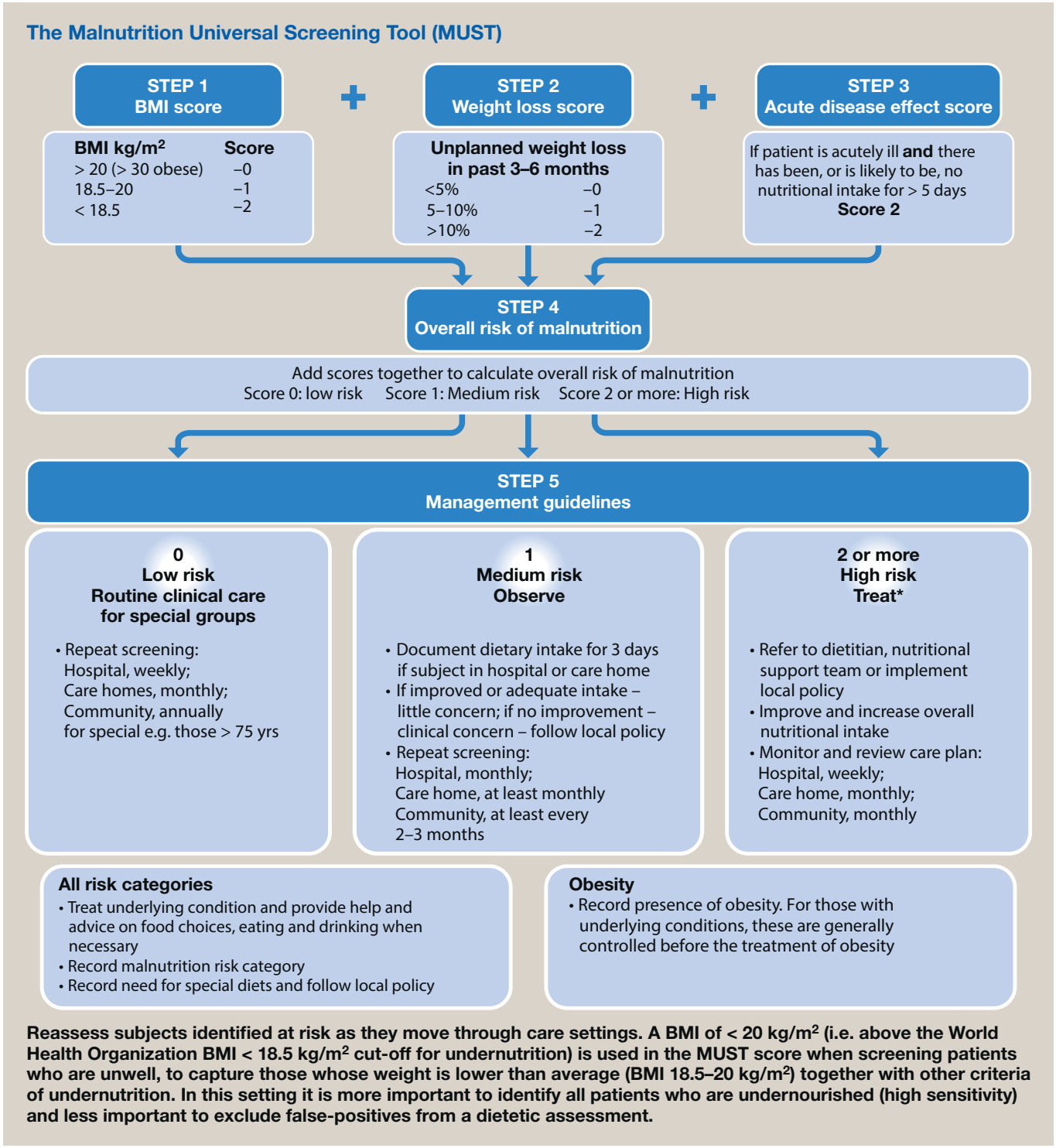

Figure 3

- Does the patient have particularly high requirements for certain nutrients (e.g. in burns patients)?
- Does the patient have excessive nutrient losses (e.g. persistent diarrhoea, enterocutaneous fistula)? Chronic pancreatitis can cause malabsorption without steatorrhoea.
- Psychosocial history (e.g. recent social stress, social isolation, previous eating disorders, alcohol consumption, prescription or recreational drugs) should be noted.

Examination

A focused examination should include:

- weight and BMI
- muscle wasting (e.g. appearance of the temporalis muscle)
- skin condition: fragile, dry or with a rash suggestive of specific nutrient deficiencies
- general condition of the mouth, and the presence of angular cheilitis, mouth ulcers or a sore/red tongue

- hydration status
- assessment of oedema.

Investigations

Most biochemical nutrient measures are acute-phase reactants so are difficult to interpret. There are no specific laboratory tests to 'diagnose malnutrition'. Blood tests can diagnose some specific nutrient deficiencies (e.g. iron, folate, vitamin B_{12}) and provide supportive information for monitoring and assessing specific electrolytes (e.g. magnesium).

Low serum albumin is still commonly listed as an indicator of malnutrition, but starvation alone, even if severe, does not suppress serum albumin. Instead, malnourished individuals are simply more likely than normally nourished individuals to develop systemic inflammatory responses to illness or injury (particularly hidden infection), with consequent extravasation of albumin from the microvasculature triggered by circulating endotoxins. The low albumin concentration will therefore not be improved by increased provision of protein or amino acids until the underlying cause has been corrected.

Bedside tests (e.g. mid-arm muscle circumference, hand-grip strength, indirect calorimetry) can be useful in assessing malnutrition but are usually reserved for clinical studies or departments with specialist interests, owing to the costs of equipment and the expertise and time involved.

Management

The diagnosis of malnutrition is very important. It must be documented, together with a management plan, coded and included in discharge letters and other clinical correspondence.

All hospitals should have an established multidisciplinary nutrition support team for managing patients with complex nutritional problems. Within each organization, there should also be a nutrition steering committee to develop policies for nutritional care, which should be regularly audited as part of clinical governance frameworks.[3]

Individual patients' needs vary enormously, depending on their circumstances. The aim of nutrition support is to ensure that total nutrient intake provides enough energy, protein, fluid and micronutrients to correct deficits and meet the patients' continuing needs. In practice, most patients are managed by clinicians, nursing staff, ward catering staff and dietitians, with more complex patients having input from nutrition support teams.

In vulnerable patient groups, the simple provision of regular meals or food with better nutritional content may be enough to address nutritional risk. Additional measures include broader menu choices and providing assistance with feeding. Where these 'social' interventions are insufficient to ensure nutritional requirements are met, patients need oral supplementation.

Supplementation is sometimes achieved using 'food fortification'; however, the common practice of essentially supplementing energy alone, by adding calorie-dense foodstuffs such as butter and cream, risks further compromising protein and micronutrient intake through suppression of appetite, hence compromising the intake of better balanced foodstuffs. Supplementation with balanced oral nutritional supplements is therefore more logical in most individuals with illness- or injury-related appetite suppression. This is because these contain protein/amino acids and micronutrients, and have been shown not to suppress intake from other food sources. Enteral tube feeding or parenteral nutrition is required if the gastrointestinal tract cannot be safely accessed or is non-functioning.

Management of severe malnutrition includes initial resuscitation, to restore hydration, and at least an initial replacement of the inevitable whole-body electrolyte and micronutrient deficits. Before feeding starts, thiamine must be provided to avoid Wernicke's encephalopathy when carbohydrate is consumed or delivered to the patient via artificial means (especially with a history of alcohol excess). Severely malnourished patients are also at risk of refeeding syndrome and death. This risk is reduced if feeding is commenced at low levels and electrolytes are monitored closely, with the provision of extra phosphate, potassium and magnesium.[3]

Nutritional replenishment will only be successful in restoring body composition and functional capacity sustainably if the underlying cause is removed or controlled. A persisting inflammatory state (high white blood cell count, C-reactive protein or tumour necrosis factor-α) is a major obstacle to synthesis and regrowth of lean tissue, so surplus energy is stored as fat, with little functional gain. Excess energy supply leads rapidly to ectopic fat deposition, especially in the liver, with potentially fatal results. Attempts to increase appetite pharmacologically are seldom effective.

Malnutrition, clinical outcome and the health economics

The consequences of malnutrition for physiological function have an important impact on clinical outcome. Malnourished surgical patients have complication and mortality rates 3–4 times higher than normally nourished patients, with longer hospital admissions, and incur up to 50% greater costs. Similar findings have also been described in medical patients, particularly elderly individuals. It is often difficult to separate the deleterious effects of malnutrition from the underlying disease process itself, especially because each can be a cause and consequence of the other. However, there is clear evidence that nutrition support significantly improves outcomes in these patients, and it is vital that malnutrition is identified through screening.

Malnutrition is also a major resource issue for public expenditure. BAPEN has calculated that the costs associated with disease-related malnutrition in 2011–2012 in the UK were £19.6 billion (far greater than those associated with obesity), or about 15% of the total expenditure on health and social care. The potential cost savings associated with the prevention and treatment of malnutrition are therefore considerable because a saving of just 1% represents £196 million per year. In specific situations, treating malnutrition produces cost savings of 10–20% or more. Furthermore, interventions to combat malnutrition as set out by NICE clinical guidelines and quality standards on nutritional support in adults save rather than cost money. The estimated annual net cost saving published by BAPEN was £172.2–229.2 million.

Nutritional education

The importance of training medical students and junior doctors in nutrition has been widely recognized; a report from a working

party of the Royal College of Physicians stated, 'Every doctor should recognize that proper nutritional care is fundamental to good clinical practice'.

Learning objectives for human nutrition within medical training have previously been published by the Intercollegiate Group on Nutrition, through its position within the Academy of Royal Medical Colleges. A detailed review of undergraduate and postgraduate nutrition training and education is currently being undertaken by the Association for Nutrition. ◆

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TEST YOURSELF

To test your knowledge based on the article you have just read, please complete the questions below. The answers can be found at the end of the issue or online here.

Question 1

A 25-year-old man presented with an 8-week history of vomiting and intermittent colicky abdominal pain as a result of small bowel obstruction caused by a Crohn's stricture.

On clinical examination, his heart rate was 95 beats/minute, and blood pressure was 105/60 mmHg. Weight was 65 kg, with a body mass index (BMI) of 18.5 kg/m^2. There was angular cheilitis and multiple mouth ulcers.

Investigations

Haemoglobin 98 g/litre (130–180)
Platelets 652 × 10^9/litre (150–400)
Albumin 27 g/litre (37–49).
C-reactive protein 125 mg/litre (<10)

What is the best assessment of his nutritional status?

A. BMI
B. Malnutrition Universal Screening Tool
C. Mid-arm muscle circumference
D. Weight in kilograms
E. Serum albumin concentration

Question 2

A 23-year-old woman with anorexia nervosa was admitted acutely after assessment by the community eating disorders team for a period of planned nasogastric feeding. She had had no meaningful nutritional intake for >3 weeks and her BMI had reduced to 11.2 kg/m^2. There was evidence of postural hypotension, hypokalaemia and hypophosphataemia. These were corrected intravenously and, along with blood glucose, were monitored. She was started on appropriate nasogastric feeding as recommended by the dietitian. After 24 hours she became confused and ataxic and developed an ophthalmoplegia.

What is the most likely diagnosis?

A. Cerebral oedema
B. Hypoglycaemia
C. Non-epileptiform attack
D. Septicaemia
E. Wernicke's encephalopathy

Question 3

An 84-year-old man presented with a 3-month history of recurrent vomiting after solid food, a 10 kg weight loss and increasing frailty.

On clinical examination, he was mildly dehydrated but able to tolerate liquids. A gastroscopy showed an obstruction in the second part of the duodenum. A staging CT scan showed a 5 cm cancer in the head of the pancreas resulting in duodenal obstruction, and liver and lung metastasis.

What is the best way to manage his nutrition before stenting the duodenum?

A. Monitor a normal diet for 72 hours and then refer to a dietitian
B. Nasogastric tube feeding
C. Nasojejunal tube feeding
D. Oral nutritional supplements
E. Refer for total parenteral nutrition