7.1 Respiratory disease

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Key points

- Malnutrition is common in patients with chronic obstructive pulmonary disease (COPD) and tuberculosis (TB).
- Routine nutritional screening using a validated screening tool should be carried out in all patients to identify those at risk and to initiate treatment.
- Nutritional requirements in COPD and TB have yet to be fully established.
- Nutritional support is an effective treatment in the management of malnutrition in COPD, but its role in the management of TB has yet to be determined.

Many conditions affect the lungs (Table 7.1.1), which impact on breathing ability and cause mortality and morbidity (British Thoracic Society, 2006). In the UK, one person in seven is affected by chronic respiratory disease, most commonly chronic obstructive pulmonary disease (COPD) or asthma. Globally, it is estimated that about 3 million deaths were caused by COPD in 2015, and this prevalence is likely to increase due to higher smoking prevalence and aging populations (WHO, 2016). The WHO (2016) predicts that COPD will become the third leading cause of death worldwide by 2030.

A number of symptoms that result from respiratory disease can affect nutritional intake and nutritional status, e.g. dyspnoea, cough and excess sputum production. At any stage in the illness, these symptoms may be compounded by acute exacerbations and infection, and influenced by age, the social and psychological effects of chronic illness, and the presence of comorbidities. Any patient with respiratory disease may present with malnutrition; however, two respiratory conditions strongly associated with a high prevalence of malnutrition are COPD (Vermeeren *et al.*, 2006) and tuberculosis (TB) (Schwenk & Macallan, 2000). While adequate pharmacological treatment of TB often results in a cure and subsequent improvement in nutritional status (Schwenk *et al.*, 2004), the chronic nature of COPD means that it is often progressively debilitating with an increasing impact on nutritional status. All respiratory diseases affect lung function to varying degrees, but some, particularly COPD and TB, are also associated with chronic systemic inflammation that can have profound effects on skeletal muscle (sarcopenia and cachexia) and bone (osteoporosis).

Chronic obstructive pulmonary disease

The term COPD, applies to emphysema, bronchitis or a combination of both. It was recently defined as '*…a common preventable and treatable disease, characterized by persistent airflow limitation that is usually progressive and associated with an enhanced chronic inflammatory response in the airways and the lung to noxious particles or gases. Exacerbations and comorbidities contribute to the overall severity in individual patients*' (Vestbo *et al.*, 2013).

Patients usually present with a history of increasing dyspnoea over several years, chronic cough, muscle weakness and poor exercise tolerance secondary to muscle wasting; recurrent bronchial infections or weight loss may also be reported. Although COPD is incurable, early diagnosis and treatment can alleviate respiratory symptoms that compromise nutritional intake. The aetiology of malnutrition and respiratory decline in COPD is complex, and the exact causality is yet to be established. The progressive nature of the disease, leading to worsening respiratory function and nutrition impact symptoms, is one cause for worsening nutritional status. Conversely, poor nutritional status resulting in fat-free mass (FFM) losses and weakness, particularly in muscles associated with breathing, could result in an impaired ability to expectorate. This could increase the risk of recurrent pulmonary infections and hasten the progression of the

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Table 7.1.1 Characteristics of respiratory disease

	Examples
Chronic respiratory diseases	
Obstructive	COPD
	Asthma
Restrictive	Pulmonary fibrosis
	Sarcoidosis
Vascular	Pulmonary embolism
	Pulmonary hypertension
	Cor pulmonale
Infective	TB
Environmental	Pneumoconiosis
	Asbestosis
Genetic	Cystic fibrosis
	Alpha-1-antitrypsin deficiency
Acute respiratory disease	
Multiple causes	Adult respiratory distress syndrome (ARDS)
Infective	Pneumonia

Table 7.1.2 Grading of chronic obstructive disease (COPD) obstruction severity

COPD severity classification	Lung function
GOLD I: mild	$FEV_1 \geq 80\%$ predicted
GOLD II: moderate	$FEV_1 \leq 50–80\%$ predicted
GOLD III: severe	$FEV_1 \leq 30–<50\%$ predicted
GOLD IV: very severe	$FEV_1 < 30\%$ predicted[a]

[a] Or $FEV_1 < 50\%$ predicted in the presence of chronic respiratory failure (GOLD, 2017; NICE, 2010); FEV_1, forced expiratory volume in 1 second; FVC, forced vital capacity.

disease. More recently, a small, randomised trial investigating a dietary shift to a higher consumption of antioxidant-rich foods found a preserved respiratory function in COPD patients (Keranis *et al.*, 2010); larger studies are required to confirm this effect.

Diagnostic criteria and classification

Diagnosis relies on medical history and an assessment of symptoms at presentation, together with the identification of comorbidities, and requires post bronchodilator spirometry to establish lung function (forced expiratory volume in one second (FEV_1) and forced vital capacity (FVC)) (Vestbo *et al.*, 2013). Lung function results are compared with age-specific and gender-specific standards to determine disease severity using the GOLD criteria (see Table 7.1.2).

Disease processes

While exposure to tobacco smoke (either active smoking or second-hand smoke) is the primary cause of COPD, other risk factors include exposure to indoor and outdoor air pollution and occupational dusts and fumes. (WHO, 2016). Genetic predisposition also plays a role (Lomas & Silverman, 2001). In addition to airflow limitation, pathological changes and inflammation-induced damage in the lungs can lead to excess mucus secretion, ciliary dysfunction, pulmonary hyperinflation and gas exchange abnormalities, and may result in pulmonary hypertension and cor pulmonale. Patients with COPD have an increased susceptibility to infection and often suffer acute recurrent exacerbations of the disease, the majority of which are infective by nature (IECOPD).

Burden of disease

In the UK, 1.2 million individuals have been diagnosed with COPD (British Lung Foundation, 2016); however, it is estimated 3 million have the disease (NICE, 2010). Around 30,000 people die as a result of COPD each year (British Thoracic Society, 2006). With an ageing population, increasing awareness of the disease and improved diagnostic methods, the number of individuals diagnosed with COPD in the UK has recently risen (Adeloye *et al.*, 2015). COPD is the second largest cause of emergency admissions to UK hospitals, accounting for 130,000 admissions/year (British Lung Foundation, 2007), placing a huge operational burden on hospitals by taking up 1 million bed days annually (British Thoracic Society, 2006). A recent study involving an Australian cohort of COPD patients found malnutrition to be independently associated with this increased healthcare use (Hoong *et al.*, 2017). Although a burden to hospital systems, patients with COPD are primarily managed in the community and account for 1.4 million GP consultations/year (Healthcare Commission, 2006). While the incidence of COPD has been associated with levels of deprivation, social deprivation has also been found to be a significant predictor of malnutrition in COPD (Collins *et al.*, 2018). The disease also has a profound effect on patients' quality of life, which significantly declines as disease severity increases (Rutten-van Mölken *et al.*, 2006), with the presence of malnutrition compounding this effect (Arslan *et al.*, 2016).

Nutritional impact

In epidemiological studies, a diet low in fruit and vegetables and high in meat and potatoes has been associated with an increased likelihood of developing COPD (Kaluza *et al.*, 2017; McKeever *et al.*, 2010). There is a lack of studies investigating the potential benefits of dietary interventions to prevent the development of COPD in at-risk populations. Following the study by Keranis *et al.* (2010), another small randomised controlled trial investigated the impact of increasing the intake of fruit and vegetables on outcome in patients with COPD (Baldrick *et al.*, 2012). The intervention group, patients with moderate to severe COPD, were provided with a variety of fruit and vegetables for 12 weeks. However, there was no impact on airways, systemic oxidative stress or inflammation. The effects of such interventions require

longer-term, adequately powered trials in order to allow to control for significant lifestyle and behavioural confounders.

Weight loss and being underweight are associated with poor prognosis and increased mortality, independent of disease severity (Landbo *et al.*, 1999). While malnutrition has been found to be independently associated with increased healthcare use and costs (Hoong *et al.*, 2017), it was suggested, until recently, to be an inevitable part of the disease progression and, as such, unresponsive to nutritional intervention. However, it is now recognised that the weight loss observed in COPD is reversible, and that weight gain is associated with a number of functional improvements (Collins *et al.*, 2012, 2013; Ferreira *et al.*, 2012), as well as reduced mortality (Schols *et al.*, 1998).

The exact prevalence of malnutrition in COPD is unknown since an accepted definition of malnutrition does not exist. However, in a recent study of 121 hospitalised patients with COPD (Ingadottir *et al.*, 2017), 21% met the ESPEN criteria for malnutrition (Cederholm *et al.*, 2015). Reported prevalence rates vary considerably from 9 to 63%, depending on the criteria used to define malnutrition, e.g. <90% ideal body weight (Metropolitan Life Insurance Company, 1959) or >5% recent weight loss, and the population studied, e.g. inpatients or outpatients (Weekes, 2005). Compared with chronic bronchitis, patients with emphysema are more likely to have a BMI and to report unintentional weight loss (Guerra *et al.*, 2002). Little has been reported on the pattern of weight loss; however, Weekes and Bateman (2002) reported significant unintentional weight loss (>5%) in 22% of COPD outpatients. In those who unintentionally lost weight, 41% reported a recent chest infection. Although many patients describe gradual weight loss over a number of years, in a subgroup of patients, weight loss and muscle wasting follows a stepwise pattern related to acute illness (Schols & Brug, 2003). In contrast to observations in the healthy population, survival in COPD appears to be improved in those who are overweight or obese (Landbo *et al.*, 1999; Vestbo *et al.*, 2006). This *obesity paradox* extends beyond reduced mortality in COPD, with one study finding that overweight patients had lower early readmission rates (Steer *et al.*, 2010), and another that overweight and obese patients had fewer emergency hospital admissions and shorter lengths of stay (Collins *et al.*, 2011a).

Assessment of body weight alone is unlikely to be sensitive enough to detect all of those at nutritional risk, since a subgroup of COPD patients demonstrate loss of FFM despite maintaining normal weight (De Benedetto *et al.*, 2000; Schols *et al.*, 1993). Depletion of FFM may have more profound effects on functional measures than depletion of body weight *per se* (Schols *et al.*, 1993). The proportion of patients with FFM depletion increases with disease severity (Schols *et al.*, 1993; Vermeeren *et al.*, 2006). Altered body composition can be attributed to a number of factors, including the disease process itself (systemic inflammation), energy imbalance (positive or negative), medication treatment (oral corticosteroids) and lifestyle (inactivity). Loss of FFM, which often occurs with ageing, can be accelerated in the presence of chronic inflammatory disease.

Nutritional screening and nutritional assessment

As COPD patients readily pass between primary and secondary care, routine nutritional screening should be performed in all patients across both settings. Outpatients with COPD identified as at risk of malnutrition using a validated tool are at increased risk of hospitalisation, longer hospital stays and increased mortality (Steer *et al.*, 2010; Weekes *et al.*, 2007). Studies are needed to establish whether prompt identification and nutritional intervention in these patients reduce their poor clinical outcomes.

Anthropometry

Guidelines for the management of COPD recommend the anthropometric assessment of patients to determine BMI. Unfortunately, the guidelines make no recommendation for formal nutritional screening and the assessment of unintentional weight change (NICE, 2010). Anthropometric assessment in COPD is not straightforward, owing to changes in body composition and the presence of oedema, which is challenging since there are no agreed adjustment factors for oedema. In the presence of severe oedema, assessment of upper-arm anthropometry is useful. A mid-upper-arm circumference (MUAC) of <23 cm often indicates a BMI of <20 kg/m^2 (Powell-Tuck & Hennessy, 2003). Mid-arm muscle area (MAMA) of the non-dominant arm has been reported to be a better predictor of mortality in COPD than BMI (Soler-Cataluña *et al.*, 2005). Bioelectrical impedance analysis is increasingly being used in COPD to assess changes in FFM and as an illness indicator to help predict prognosis. Currently, there is no universal reference population for COPD using this technique, and research is ongoing in this area.

Biochemistry

Hospitalised patients should be assessed for hydration status, clinical condition (e.g. raised C-reactive protein, white cell count and low serum albumin levels), and nutritional markers. Patients could be at risk of refeeding syndrome (see Chapter 6.4, Enteral nutrition) if dietary intake has been poor for a prolonged period or there is a history of excessive alcohol consumption, and phosphate, potassium, calcium and magnesium levels should be reviewed prior to implementation of nutritional support in all patients with known risk factors (NICE, 2006a).

Clinical

Patients with COPD often present with several nutritionally relevant comorbidities (e.g. diabetes, gastro-oesophageal reflux, osteoporosis or depression) whose management may require a large number of different drugs (polypharmacy). Assessment of clinical condition should take account of any relevant changes in either

comorbidities or pharmacological interventions. Altered swallowing physiology in COPD, particularly around the time of IECOPD, may increase aspiration risk (Teramoto *et al.*, 2002).

Dietary

Stable patients with COPD consume close to recommended daily amounts for both energy and protein (Vermeeren *et al.*, 1997; Weekes *et al.*, 2009); however, intake is compromised during IECOPD (Slinde *et al.*, 2003; Vermeeren *et al.*, 1997). Low intakes of calcium and vitamin D have been found in outpatients (Andersson *et al.*, 2007; Weekes, 2005), with a reported non-starch polysaccharide intake of <15 g/day (Weekes, 2005). This, together with a sedentary lifestyle and limited fluid intake, might predispose to constipation.

Economic and social status

Strong links exist between social deprivation and both the development of COPD and clinical outcome (Prescott *et al.*, 1999). Deprivation is a significant independent risk factor for malnutrition in outpatients with COPD, and should be a consideration in their nutritional management (Collins *et al.*, 2018). Many patients with COPD are unable to continue in employment as their disease progresses or have to decrease their working hours (Eisner *et al.*, 2002). Financial resources may therefore be limited and compromise ability to purchase food. A significant proportion of patients with COPD are housebound (Bestall *et al.*, 1999), which may be accompanied by social isolation and limited access to affordable food. Strategies for improving nutritional intake may need to include the use of meals-on-wheels-type services and socialised eating opportunities such as lunch clubs.

Clinical management

Available treatments rely almost exclusively on symptom management and should be relevant to the patient's clinical condition on presentation (Vestbo *et al.*, 2013). The recent GOLD strategy document recognises the following three conditions and makes treatment recommendations accordingly: stable COPD; acute exacerbations; and management of comorbidities such as cardiovascular disease, skeletal muscle dysfunction, osteoporosis and depression (Vestbo *et al.*, 2013). Infective exacerbations of the disease are usually treated with inhaled and/or oral corticosteroid medication and antibiotics. The increased appetite and food intake that often accompanies courses of oral steroids is usually short term, since patients are put on reducing doses as soon as possible to avoid complications of long-term therapy. Many patients take medications to counteract osteoporosis. Gastrointestinal disturbances are known complications of antibiotic therapy and may impact on nutritional intake during and immediately after IECOPD.

Recent interest has focused on the levels of vitamin D in COPD patients as the vitamin is not only involved with bone physiology but also plays an important role in muscle function and adaptive immunity (Janssens *et al.*, 2009). Vitamin D deficiency is common in COPD and correlates with disease severity (Janssens *et al.*, 2010). In COPD patients waiting for lung transplantation, 50% were found to be vitamin D deficient (Forli *et al.*, 2004). Immobility, reduced sunlight exposure, reduced capacity of ageing skin to synthesise vitamin D, and medications used to manage COPD all influence the osteoporosis risk in COPD. Vitamin D and calcium intakes should be considered in all COPD patients due to the high prevalence of both osteoporosis and vitamin D deficiency.

In patients receiving home oxygen therapy, consideration should be given to the possible effects on mobility, access to food and social life, all of which might impact adversely on nutritional intake. Prolonged periods on oxygen can cause dry mouth, and this may affect the ability to taste, chew and swallow foods. Smoking cessation is a major aim of COPD management. Current smoking status has been shown to be a significant predictor of malnutrition risk (Collins *et al.*, 2011b). An average weight gain of 3.8 kg in females and 2.8 kg in males has been observed in individuals who successfully stopped smoking for >1 year (Williamson *et al.*, 1991). Baseline weight in males did not affect the level of weight gained; however, in underweight females, the likelihood of gaining 13 kg or more was increased fourfold in those who stopped smoking.

An increasing number of patients have lung volume reduction surgery, and this has been shown to result in spontaneous weight gain (Christensen *et al.*, 1999), possibly due to a combination of reduced work of breathing, improved gas exchange and reduced post-prandial dyspnoea.

Nutritional requirements

Nutritional requirements will depend on nutritional status, clinical condition, physical activity level, nutritional goals and likely duration of nutritional support (NICE, 2006a).

Energy

The energy requirements have yet to be fully characterised, and studies of COPD have reported considerable individual variation in total energy expenditure (TEE) (Slinde *et al.*, 2006). While published prediction methods may provide adequate estimates of requirements for groups of patients, they have a poor predictive value for individuals (see Chapter 6.1, Nutritional requirements in clinical practice). Weight-stable outpatients with COPD may have requirements similar to others of their age and gender, but if their physical activity levels are compromised, energy requirements may be lower than for healthy individuals of the same age and gender (Slinde *et al.*, 2011). In stable outpatients, a modest increase in energy intake of 200–300 kcal/day has been shown to result in weight gain (Collins *et al.*, 2012; Weekes *et al.*, 2009), and therefore energy requirements are unlikely to be much above normal.

In IECOPD, resting energy expenditure (REE) may be up to 15–20% above predicted basal metabolic rate

(BMR) (Schols *et al.*, 1991; Nguyen *et al.*, 1999; Vermeeren *et al.*, 1997), but since acute illness is usually accompanied by a decrease in physical activity, TEE may be similar to, or even slightly lower than, normal. During IECOPD, some patients may be identified as at high risk of refeeding syndrome; however, this is less likely with oral nutritional support than enteral or parenteral nutrition since acute illness is usually accompanied by a loss of appetite that limits spontaneous dietary intake. Practitioners should, however, take care not to overprescribe nutritional support (NICE, 2006a) and to follow national or evidence-based local protocols for the management of refeeding in those patients identified as at high risk.

There is little evidence that disease-specific oral nutritional supplements (ONS) are more effective than standard ONS in this group of patients. There is a growing body of evidence demonstrating the effectiveness of immune modulatory enteral feeds in patients with acute respiratory distress syndrome (Gadek *et al.*, 1999) and acute lung injury (Singer *et al.*, 2006) who are ventilated. However, the efficacy of such feeds outside of intensive care in COPD patients hospitalised for IECOPD remains to be established.

Protein

While elevated protein turnover rates have been reported in COPD (Engelen *et al.*, 2000), there is currently no evidence to support prescribing protein intakes above general recommendations for chronic or acute illness (Table 7.1.3). It has been suggested that protein intakes at the upper end of those recommended by NICE (2006a), i.e. 1.5 g/kg/day, might be optimal during IECOPD (Vermeeren *et al.*, 1997). Indeed, these levels would be more in line with the recommendations of the PROT-AGE group for individuals aged 65 years and over (Bauer *et al.*, 2013).

Micronutrients

Micronutrient intake is likely to be compromised in individuals who have diets deficient in energy and protein. Prescriptions for nutritional support should provide adequate electrolytes, minerals and other micronutrients, accounting for pre-existing deficits, excessive losses or increased demands (NICE, 2006a). It may therefore be necessary to recommend the use of a multivitamin and mineral supplement if intake from diet and/or ONS is unlikely to be adequate.

Nutritional support

The reversibility of weight loss in COPD is dependent on the ability to address the underlying cause. An imbalance between energy intake and expenditure, which commonly occurs during IECOPD and is accompanied by significant worsening of nutrition impact symptoms (e.g. anorexia, early satiety, dry mouth), should be amenable to targeted nutritional support. However, during

Table 7.1.3 Nutritional management of chronic obstructive pulmonary disease (COPD)

Condition	Treatment goals	Requirements	Interventions
Stable COPD (outpatient)	Maintain nutritional status *or* improve nutritional status (e.g. post-IECOPD).	25–35 kcal/kg/day. 0.8–1.5 g protein/kg/day. 30–35 mL of fluid/kg/day (NICE, 2006a)[a]. *For patients who are not severely ill or injured, nor at risk of refeeding syndrome*. Alternatively, use PENG guidelines (Todorovic & Micklewright, 2011).	Patients identified as at risk of malnutrition or as malnourished should either be managed by referral to a dietitian or by staff using protocols drawn up by dietitians, with referral as necessary (NICE, 2006a); provision of ONS should be considered in those with a BMI of <20 kg/m^2 (Collins *et al.*, 2012; NICE, 2010).
Acute exacerbation (inpatient)	Minimise effects on nutritional status.	No specific recommendations can be made for energy due to the heterogeneity of the patient group and the changing clinical course during the acute phase. Intakes up to 1.5 g of protein/kg/day may be justified in exacerbating COPD patients (Vermeeren *et al.*, 1997).	Maximise oral intake within limits of patient's clinical condition using low-volume ONS between meals (Anker *et al.*, 2006). Consider supplementary tube feeding if unlikely to meet requirements for more than 5 days (NICE, 2006a).
Mechanical ventilation (ICU/HDU)	Minimise effects on nutritional status while avoiding complications of overfeeding.	No specific recommendations can be made in this setting as conditions leading to the requirement for ventilation are often highly changeable. Monitoring in this setting is vital in order to meet the nutritional needs of the patient. In patients requiring prolonged ventilation, avoid overfeeding (see PENG guidelines (Todorovic & Micklewright, 2011) for maximal energy and macronutrient profiles for ventilated patients).	Commence enteral tube feeding as soon as possible; if high risk of delayed gastric emptying and aspiration, use post-pyloric feeding (Heyland *et al.*, 2001). In acute respiratory distress disorder (ARDS) and acute lung injury (ALI), consider formulas containing n-3 fatty acids and antioxidants (Kreymann *et al.*, 2006).

IECOPD, infective exacerbations of chronic obstructive lung disease; ONS, oral nutritional supplements; ICU, intensive care unit; HDU, high dependency unit; PENG, Parenteral and Enteral Nutrition Group.

the acute phase, in the face of significant inflammation, improvements with nutritional support are hard to achieve. Studies have shown that ONS are able to overcome energy and protein deficits at this time, while not affecting oral intake (Vermeeren *et al.*, 2004), and lead to significant improvements in respiratory function and a tendency for improved general well-being (Saundy-Unterberger *et al.*, 1997).

At different periods during the course of their disease, patients may experience one or any number of symptoms that could adversely affect intake. The most frequently reported symptoms likely to affect nutritional intake in COPD are anorexia, early satiety and dyspnoea (Cochrane & Afolabi, 2004). Patients with anorexia and post-prandial dyspnoea may benefit more from low-volume, high-energy/protein ONS and/or advice on food fortification. In the presence of early satiety, small, frequent meals and snacks and/or energy-dense ONS are recommended (Anker *et al.*, 2006).

While some symptoms experienced by patients with COPD may be amenable to nutritional intervention alone, others may require a combination of nutritional intervention and other therapeutic and/or pharmacological strategies. For example, in the management of eating-related dyspnoea, liaison with the medical team or respiratory nurse could optimise oxygen therapy if appropriate, while nutritional interventions should be tailored to minimise the effects on dyspnoea of preparing and eating food.

Since most patients report experiencing several symptoms that affect dietary intake at any time, a range of dietetic strategies may be required to achieve an increase in intake. In a progressive, debilitating disease such as COPD, strategies may have to change over time to avoid taste fatigue and/or take into account changes in clinical, psychological or social status (Table 7.1.4).

Evidence base for nutritional support

Recent systematic reviews and meta-analyses suggest that nutritional support in COPD is effective in terms of increasing energy and protein intake, promoting weight gain and improving anthropometric and functional status (Collins *et al.*, 2012, 2013; Ferreira *et al.*, 2012; Schols *et al.*, 2014). Further trials are required to examine the cost-effectiveness of nutritional support in improving clinical outcomes. The current evidence for nutritional support is almost entirely based on ONS and is lacking for other forms of nutritional intervention. There is a need for trials comparing different nutritional intervention strategies, and their effects on mortality, clinical outcomes and cost-effectiveness (Schols *et al.*, 2014). Since ONS presumably produce clinical benefits through increased nutrient intake, a similar increase in nutrient intake achieved by dietary counselling and/or food fortification should result in similar benefits (NICE, 2006a). Confirmation of this should be a priority in dietetic research as it underpins many of the principles of the profession (Baldwin & Weekes, 2011). There is a particular need for robust trials around food fortification and dietary counselling, as these are often recommended as a first-line treatment for malnutrition in COPD despite a paucity of evidence.

One randomised trial showed individualised dietary counselling by a dietitian together with a 6-month supply of whole-milk powder (WMP) to be effective in improving intake and body weight in COPD (Weekes *et al.*, 2009). An important finding from this trial was that simply providing patients with dietary advice literature, without dietetic-input-tailoring advice, failed to result in any improvements. The efficacy of tailored dietary advice delivered by a dietitian and the provision of supportive literature in the absence of WMP remains unknown and urgently needs addressing. A post hoc cost analysis suggests that it might be cost-effective for a dietitian to provide dietary counselling to individuals with COPD (Weekes *et al.*, 2006), but this needs to be supported by larger, adequately powered studies.

The most effective setting for nutritional intervention in COPD is likely to be in outpatients, as these patients tend to be metabolically stable, less acutely unwell and more mobile. The nutritional enhancement of pulmonary rehabilitation (PR) is an area that is receiving increasing interest as multimodal therapy has been found to result in significant improvements not only in malnourished

Table 7.1.4 Factors influencing progression from latent to active TB (source: adapted from Bates *et al.*, 2004)

Individual	Household/community	Environmental
Age	Socioeconomic status	Availability of health services
Gender	Migrant status	Quality of healthcare
Nutritional status	Place of residence	Availability of appropriate treatment
Immune status	Access to health services	Drug resistance
Genetic predisposition	Access to treatment	Public policy
Behaviour	Informal care arrangements	Public awareness
Poverty	Access to formal care services	
Education		
Knowledge and attitudes		
Diet		
Employment status		

patients but also in adequately nourished patients with COPD, suggesting a role for nutrition beyond simply treating malnutrition (Schols *et al.*, 2014). The British Thoracic Society guidance on pulmonary rehabilitation notes that the optimal approaches for addressing malnutrition, sarcopenia or obesity in COPD are uncertain; however, the guideline group concluded that attendance at a pulmonary rehabilitation course presents an ideal opportunity to screen and educate patients on nutrition (Bolton *et al.*, 2013).

Tuberculosis

Tuberculosis (TB) is an infectious bacterial disease caused by *Mycobacterium tuberculosis* and is transmitted via droplets from the throat and lungs of people with active TB. It most commonly affects the lungs but can affect almost any part of the body, with infections of the central nervous system and abdomen being the most severe. The global prevalence of TB was 14 million in 2004, with >60% of cases in sub-Saharan Africa and Asia (WHO, 2008). Although active TB cases have declined in Europe over the past 50 years, there has been an increase in some countries since the 1990s, including in the UK (Health Protection Agency, 2010). Globally, 9.2 million new cases and 1.7 million deaths from TB occurred in 2006, and, while the number of new cases per capita is falling in some regions of the world, this is not the case in Africa and Europe (WHO, 2008).

Diagnostic criteria

TB is diagnosed by sputum smear microscopy followed by culture testing (NICE, 2006b). Patients with active TB usually present with symptoms of persistent cough, fever, night sweats, dyspnoea, haemoptysis (coughing up blood), weight loss and chest pain.

Disease processes

Following TB exposure, healthy individuals mount a cell-mediated immune response involving T cells, macrophages and cytokines, which usually controls the infection. The majority of individuals remain in this asymptomatic (latent) phase, and only about 10% go on to develop active TB, usually when their immunity is compromised. Worldwide, more than 13 million individuals are coinfected with HIV and TB, and, in many individuals infected with HIV, development of active TB is the first sign of AIDS. A number of individual factors such as genetic predisposition (Malik & Godfrey-Faussett, 2005) interact with community and environmental factors (e.g. poverty and poor housing) to influence susceptibility to infection and progression to active TB (Table 7.1.4).

Disease consequences

TB is among the top 10 causes of illness, disability and death, and is the leading cause of death from a curable infectious disease (WHO, 2008). It is currently estimated that about one-quarter of the world's population is infected. The main burden of disease in the UK is concentrated in certain urban areas, with 38% of cases in London (Health Protection Agency, 2010). The majority of cases occur in young adults and among non-UK-born black African and South Asian ethnic groups. Since most cases occur during the economically productive years of life (19–49 years), the earning capacity of patients can be severely compromised (Frieden *et al.*, 2003). With the advent of effective anti-TB therapy in recent decades, mortality rates have decreased dramatically in industrialised countries.

Clinical investigations and management

In confirmed smear positive cases, the standard treatment is short-course chemotherapy for 6–8 months. A combination of drugs and high adherence is necessary to achieve a cure, and treatment usually takes place in two phases. The initial phase lasts 2–3 months and aims to kill active and dormant bacilli, and is followed by the continuation phase, which usually lasts 4–6 months. Patients with HIV coinfection will also be prescribed a variety of antiretroviral drugs that will significantly increase the pill burden, potentially impacting negatively on adherence.

Nutritional impact

The nutritional consequences of active TB are well recognised; yet, little is understood of the complex interactions between TB treatment and nutritional status. Many patients experience severe weight loss and vitamin and mineral deficiencies. People with TB/HIV coinfection have a worse nutritional status, as TB worsens malnutrition and malnutrition weakens immunity, thereby increasing the likelihood of progressing from latent to active disease. Similar to other chronic diseases, a consistent relationship exists between TB incidence and BMI, with one review reporting that TB incidence increases exponentially as BMI decreases (Lönnroth *et al.*, 2010). Patients presenting with active TB are more likely to be wasted or to have a lower BMI than healthy controls (Paton & Ng, 2006). Nutritional status usually improves with anti-TB therapy, although recent evidence suggests that those who fail to put on weight during the early phase of treatment are more likely to suffer poorer outcomes, including death (Bernabe-Ortiz *et al.*, 2011; Khan *et al.*, 2006).

Nutritional management

The evidence surrounding best practice for nutritional management of TB is very limited, particularly in developed countries. However, the recent WHO guideline on nutritional support and care for patients with TB describes nutritional assessment as an essential prerequisite for treatment and makes recommendations for screening, nutritional counselling and management (WHO, 2013). Patients with HIV/TB coinfection face

particular challenges and poorer outcomes than those with either infection alone. For more information on the nutritional management of HIV/TB coinfection, see Houtzager *et al.* (2010) and Chapter 7.11.3 (Human immunodeficiency virus). In patients with active TB, dietary intake is likely to have been poor for some time prior to diagnosis, and in those with disordered lifestyles (e.g. substance abusers) or limited access to food and drink (e.g. the shelter living homeless), nutritional intervention will need to include strategies for ensuring adequate intake throughout the treatment period. Similarly, exploration of the diet of recent immigrants and their potential access to traditional versus native foods may be necessary in order to provide appropriate advice to which patients are likely to adhere.

Nutritional requirements

Energy

There is a lack of adequately powered studies designed to determine the energy requirements of patients with TB, and it is therefore not possible to draw any firm conclusions about the energy needs of patients with TB (Raj *et al.*, 2006; WHO, 2013). Pragmatically, in the early acute phase of illness, any increase in BMR secondary to the inflammatory response is likely to be accompanied by a decrease in physical activity; thus, TEE may be similar to, or even slightly lower than, normal.

Protein

Protein loss occurs due to the catabolism induced by infection, and this loss should be made good through the provision of additional protein. The capacity to retain protein is enhanced during the recovery phase of infection, and it is essential that needs are met during this time (NICE, 2006a). There is no evidence to suggest that patients with TB require a significantly greater protein intake than patients with other acute infectious conditions, i.e. up to 1.5 g protein/day.

Micronutrients

At the time of diagnosis, patients with active TB may have low levels of several micronutrients, including vitamins C and E, retinol, zinc, iron and selenium (Papathakis, 2008). Daily micronutrient supplementation may be beneficial in those who have deficiencies, especially during the early months of therapy (Abba *et al.*, 2008), but, in the case of vitamin D, possibly only those with specific genotypes will benefit (Martineau *et al.*, 2011). In a recent Cochrane review, the authors concluded that, although blood levels of some vitamins may be low in people starting treatment for active TB, there is currently no reliable evidence that routinely supplementing micronutrients above recommended daily amounts has clinical benefits (Grobler *et al.*, 2016).

Nutritional support

Benefits in terms of weight gain and increased energy intake have been reported (Kennedy *et al.*, 1996; Paton *et al.*, 2004; Schwenk *et al.*, 2004; Sudarsanam *et al.*, 2011). However, it is difficult to distinguish whether the improvement in nutritional status was due to control of the disease or to nutritional support, since nutritional status is related to both effective TB treatment and increased dietary intake. Currently, there is a lack of good-quality evidence regarding the effects of nutritional support in patients with active TB on outcomes such as hospitalisation, quality of life or functional measures. In a recent systematic review, it was concluded that there was moderate-quality evidence that macronutrient supplementation provided during the treatment of active TB resulted in weight gain (Grobler *et al.*, 2016). However, the authors of the review emphasised that all studies were too small to reliably prove or exclude clinically important benefits on mortality, cure or treatment completion.

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