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Nutritional assessment of the critically ill patient

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Abstract

Nutritional status screening, assessment and monitoring is essential in the critically ill patient to reduce morbidity and mortality and to decrease hospitalisation costs. We in South Africa should establish where we are in terms of hospital-acquired malnutrition, perform a gap analysis and define a strategy to correct our shortcomings. We need to set a mission and vision for where we want to be. Elements to be addressed will include promoting a greater awareness of the negative consequences of existing and acquired malnutrition in the critically ill patient introducing an appropriate screening tool(s) based on our local patient demographics and financial resources, and sensitise the relevant role players. Adequate nutrition is a vital part of successful treatment, and should be sold as such.

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Introduction

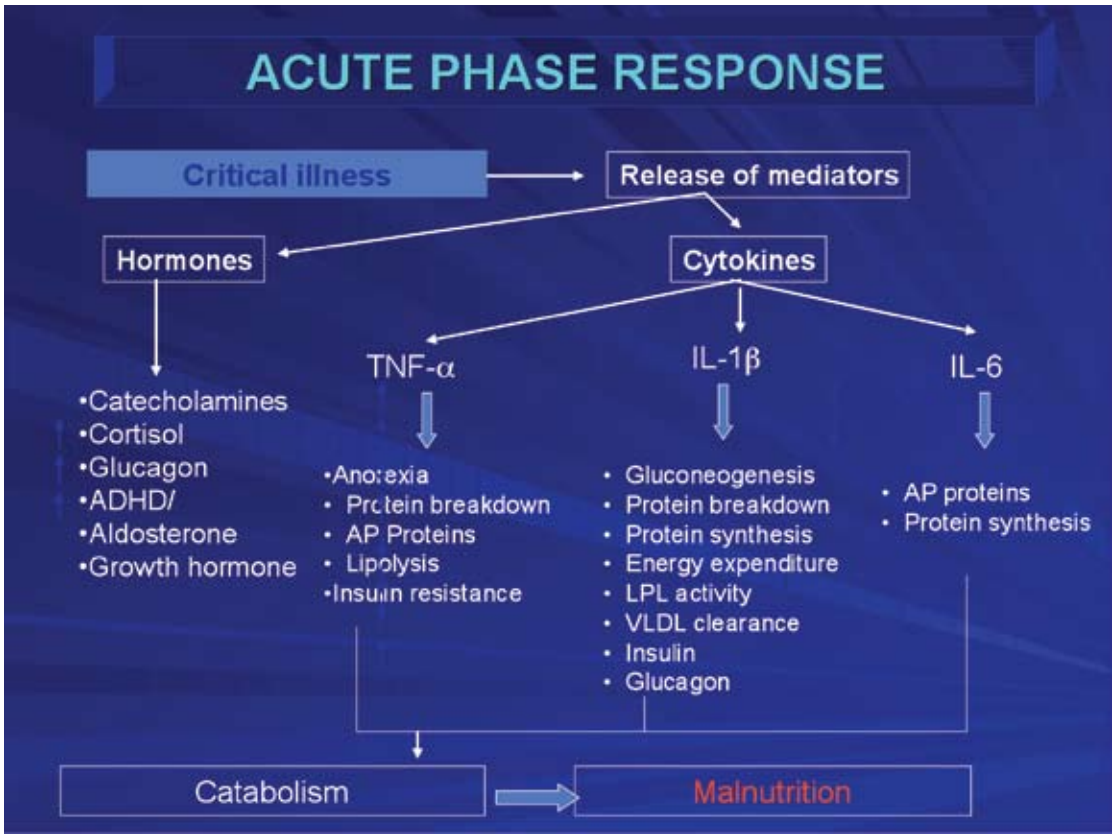
Nutritional status assessment of the critically ill patient is performed to classify nutritional status, identify nutritional risk and to serve as a baseline for monitoring nutrition support adequacy. Identification of nutritional risk indicates the need for nutrition support to maintain body functions and to facilitate recovery. It aids in preventing malnutrition by identifying patients who require more aggressive intervention and closer monitoring. Identifying the patients who are already malnourished on admission helps us to assess the level of treatment required, to anticipate complications and to allocate scarce resources where it is most needed.

Malnutrition

Upon admission to hospital, about 15–70% patients are under- or malnourished.[1,2,3,4,5,6] Furthermore, it has been reported that malnutrition remains undiagnosed in up to 70% of patients admitted to hospital and about 70–80% of the admitted malnourished patients enter and leave the hospital without receiving any nutritional support and the diagnosis of malnutrition does not appear on their discharge sheet.[7] Ill health combined with hospital stay, therefore, may result in malnutrition, which, in itself, places a further burden on resources.[3] The prevalence of malnutrition also varies with socio-economic status as well as duration and severity of the underlying disease. Furthermore, the acute phase response in critical illness induces catabolism, through a cascade of reactions, which, if left untreated, accelerates the precipitation or worsening of malnutrition and is associated with death (Figure 1).

It is also important to bear in mind that weight loss during hospitalisation is due to a variety of causes and includes reduced food intake, malabsorption, modified metabolism, increased nutrient and energy requirements, lack of early nutritional assessment and treatment, drug-nutrient interactions, mechanical reasons, and the disease/infection *per se*. Internal medicine patients have been reported to be more prone to malnutrition because of their co-morbidities.[8]

In this regard, a patient group particularly predisposed to malnutrition is the elderly. Up to 55% of elderly hospitalised patients are undernourished or malnourished on admission.[2] A recent study showed that the prevalence of undernutrition in hospitalised and institutionalised elderly is 23 ± 0.5% (mean ± SE, range 1–74%; 35 studies, n = 8596) and 21 ± 0.5% (mean ± SE, range 5–71%; 32 studies, n = 6821) respectively.[9] In the same study, corresponding statistics for the prevalence of at-risk elderly was even higher, 46 ± 0.5% and 51 ± 0.6% respectively . The prevalence of malnutrition in the cognitively impaired elderly was 15 ± 0.8% (mean ± SE, range 0–62%) and those at risk of malnutrition was 44 ± 1.1% (range 19–87%). These findings are of serious concern since the undernourished elderly are known to have longer periods of illness, longer duration of hospital stay, higher infection rates, delayed wound healing, reduced appetite, and increased mortality.[2] More spefically, the elderly admitted with chronic obstructive pulmonary disease (COPD), chronic cardiac failure (CCF) and falls have a significantly poorer nutritional status than those admitted with other diseases and they had a high readmission rate 52% COPD, 39% CCF when compared with the readmission prevalence (35%) of other such patients.[10] With regards to fractures, patients with femur neck fractures are also likely to be malnourished on admission with a further decline in nutritional status during hospitalisation.[11] In a 5-year prospective cohort study in elderly patients with age-related hip fractures 71% of patients were sarcopaenic, 58% undernourished



(ADHD = antidiuretic hormone, AP proteins = acute phase proteins, LPL = lipoprotein lipase, VLDL = very low density lipoprotein, TNF-α = tumour necrosis factor-α, IL1-β = interleukin-1β, IL-6 = interleukin-6) (Adapted from various sources)

Figure 1: The acute phase induced catabolism

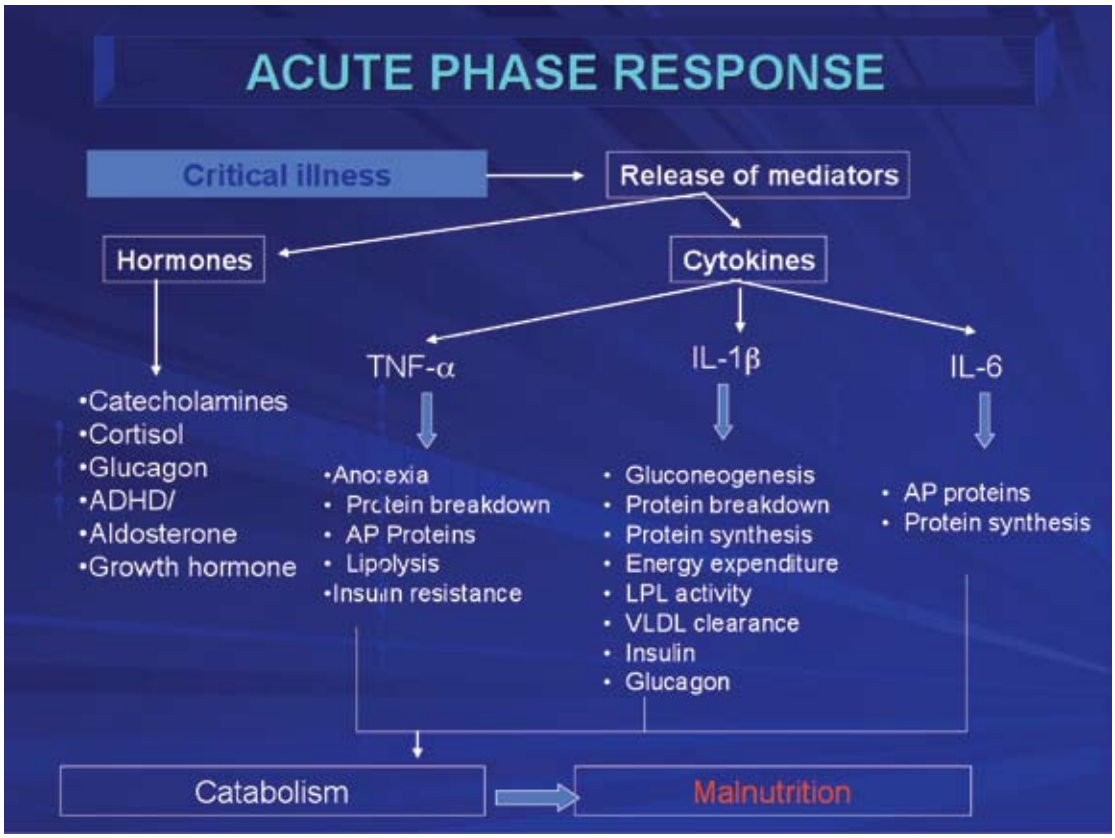


Figure 2: The effect of malnutrition on hospitalisation cost[17]

and 55% were vitamin D deficient.[12] Another high risk group is elderly patients who suffered a central venous incident (CVI). Nitrogen balance in such patients was reported to have been reached only after five days, which was thought to be due to underfeeding, as a consequence of using inappropriate methods, such as the Harris Benedict formula which has no stress factor for CVI, to calculate energy requirements, or it may have been due to inadequate intake due to swallowing difficulties.[13]

Protein-energy malnutrition (PEM) is an independent risk factor for morbidity and mortality (Figure 2). PEM is associated with significantly higher risk of infectious and post-operative complications, reduced ability to prevent and fight infection, increased mortality, decreased wound healing, increased length of stay (LOS) in ICU and in the hospital, with a consequent increased total cost of hospitalisation.[1,3,6,14,15,16,17] Reilly et al (1988) documented a major escalation in costs with malnutrition (Figure 2).[17] More recently, it was estimated that in 1992 malnutrition cost the NHS in excess of £266 million annually through increased LOS , readmissions and treatment costs.[18]

Identifying the patient at risk

The guidelines for the identification of patients at high risk of malnutrition, simple as they may be (Table I), are often insufficiently brought in mind.

Table I: Patients at risk of malnutrition[19,20]

- Being grossly underweight (< 80% ideal body weight)
- Being grossly overweight (> 120% ideal body weight)
- Recent weight loss (> 10% over 3 months)
- Being alcoholic/substance dependent
- Nil per mouth for > 5 days

- Increased nutrient losses
  - Malabsorption
  - Short bowel syndrome
  - Fistulae
  - Draining abscesses or wounds/burns
  - Renal dialysis
- Increased nutrient requirements
  - Trauma
  - Burns
  - Sepsis
- Taking medication with anti-nutrient properties

In the presence of nutritional support, the refeeding syndrome with its potentially fatal shifts in fluids and electrolytes that may occur in malnourished patients is a risk that should not be overlooked. The hallmark of refeeding syndrome is hypophosphataemia. Other characteristics include: abnormal sodium and fluid balance, changes in blood glucose, protein and fat metabolism, thiamin deficiency, hypokalaemia and hypomagnesaemia.[21] It is therefore essential to identify the patients at risk of refeeding syndrome (Table II) through close monitoring the high risk patient with a view to prevention (Table III).

Another high, but insufficiently appreciated, risk group is the obese patient since current screening tools focus only on the identification of the undernourished.[22] The latter has been proposed to predispose such patients to inappropriate nutrition support and contribute to increased mortality.[22] The metabolic response to stress in this patient

Table II: Patients at risk from refeeding syndrome[21]

- Anorexia nervosa
- Chronic alcoholism
- Oncology
- Postoperative
- Elderly
- Uncontrolled diabetes mellitus
- Chronic malnutrition
  - Marasmus
  - Prolonged fasting or low energy diet
  - High stress patient underfed for > 7 days
  - Malabsorption syndromes
- Long-term users of antacids (bind phosphate)
- Long-term users of diuretics (loss of electrolytes)

With permission (Mehanna et al, 2008)

Table III: The NICE criteria for identification of patients at high risk of refeeding syndrome[21]

Either the patient has *1 or more* of the following:	Or *2 or more* of the following:
– Body mass index < 16 – Unintentional weight loss > 15% in the past 3–6 months – Little or no nutritional intake for > 10 days – Low levels of K, PO, Mg	– BMI < 18.5 – Unintentional weight loss > 10% in the past 3–6 months – Little or no nutritional intake for > 5 days – History of misuse or use drugs, including insulin, chemotherapy, antacids or duiretics

With permission (Mehanna et al, 2008)

group is more complex due to existing metabolic and endocrine abnormalities.[23] Protein metabolism is more pronounced with consequently higher morbidity and mortality.[23] Lean body mass loss occurs due to catabolic disease, protracted ventilator dependence, cancer (therapy) and involuntary weight loss. Obesity is known to have an influence on the outcome of patients with critical illness. There is a higher prevalence of wound and nosocomial infections, hernias, as well as a higher prevalence of respiratory, cardiac and thrombo-embolic complications.

In summary, the available evidence consistently indicates that pitfalls in identifying the patient at risk (Table IV) should be avoided, and that i) malnutrition, irrespective of the presence of injury/stress, is an independent risk factor for morbidity and mortality, therefore early identification and appropriate action is critical, and ii) appropriate nutrition support results in decreased LOS in ICU and hospital, decreased duration of ventilation, decreased complications and decreased costs.[3]

Table IV: Some pitfalls in identifying the patient at risk

PITFALLS
- Failure to identify patients at risk for malnutrition
- Failure to identify malnourished patients
- Failure to identify at risk/malnourished elderly and obese patients
- Failure to identify patients at risk for refeeding syndrome

Assessment versus screening

Screening

In nutritional status assessment, available data and assessments are used to plan a detailed care plan, while screening is a quick

assessment of selected basic data in a large group of patients to identify those who may require nutrition support.[14,24]

Various tools are used for screening such as the Malnutrition Universal Screening Tool (MUST), Subjective Global Assessment (SGA), Mini Nutritional Assessment (MNA), (Malnutrition Screening Tool (MST), Nutritional Risks Screening 2002 (NRS-2002), Nutrition Risk Index (NRI) and the Short Nutritional Assessment Questionnaire (SNAQ). When choosing a screening tool, factors that should be taken into consideration include the patient population, available resources such as staff and the level of training of the staff. It is also important to consider whether these tools were validated, for which populations and for which type of care setting in order to make an appropriate selection.[25]

In terms of predicting outcomes, some screening tools may well be more appropriate in specific disease states.[25] For instance, some studies indicate that the value of SGA as a predictor of outcome is uncertain.[26,27] A comparison of SGA and NRS-2002 showed that NRS-2002 was a better predictor of complications than SGA in orthopaedic surgery,[16] whereas the NRI has been shown to capture both nutritional risk and outcome. The NRS-2002 has been reported to predict the incidence and severity of complications in GIT surgery (better so than NRS, NRI and bioimpedance).[28,29] One study, however, found no significant difference in predictive value in major surgery between NRI, MI, SGA and MNA.[30]

Assessment

Medical status

The patient's medical status needs to be assessed in terms of current diagnosis, organ function [heart, liver, kidneys, brain, gastro-intestinal (GIT), lungs], underlying diseases (e.g. diabetes mellitus, hypertension, HIV/AIDS, renal failure) that may influence requirements, previous operations, medical management (particularly those that hasve an impact on requirements e.g. continuous venous venous haemodialysis (CVVHD), level of sedation, medication, intravenous (IV) fluids, stability/inotropes, sepsis/infection and hydration status.

Nutritional status

Data from four assessement tools needs to be carefully considered and correctly interpreted in order to make a nutritional diagnosis, namely dietary and fluid intake, clinical assessment, anthropometry and biochemistry.

Dietary and fluid intake

The following aspects should be included in the assessment of dietary and fluid intake:

- Current and past dietary intake – if possible
  - When was the last meal taken?
  - Known allergies
- Special diets?
  - Self-imposed/prescribed
- Oral/nasogastric (NG)/percutaneous endoscopic gastrostomy (PEG)/jejunal percutaneous endoscopy (JPE)
- Texture of food/fluids
- IV
  - Nutrients supplied by IV fluids
- Propofol – fat
- Maintenance – glucose
- Nutrients supplied by dialysis fluids
- Medication (oral and/or IV)
  - Note daily
  - Nutrient-medication interactions
- Blood en blood products
- Appetite, nausea, vomiting, satiety
- Constipation, diarrhoea, cramping, flatus
- Pain, fatigue, depression
- Religion
- Preferences, likes/dislikes

Swallowing and chewing assessment is essential in those patients in the ICU who are able to eat and the assistance of a speech therapist is essential in this regard. Poor appetite plus chewing/swallowing difficulties will, in the longer-term, result in malnutrition.[2] Poor dietary and fluid intake is common among elderly patients, with oral lesions, anorexia, confusion, mood disturbances/anxiety and dysphagia being the primary contributing factor when intake is poor.[31] Eating difficulties can be divided into three main categories: ingestion, deglutition and energy. Assessment of all three aspects will help to determine whether consistency adaptations in foods that can be eaten and/or supplementary foods/specialised enteral products need to form part of the nutrition care plan.[32] For instance, toxic epidermal necrolysis (Steven-Johnson syndrome) is characterised by mucosal involvement resulting in odynophagia, poor oral intake, a better tolerance of fluids than solids and an increased risk for aspiration.[33] The role of the speech therapist in identifying these problems has been confirmed. It is also known that thermal injury patients with facial burns, inhalation injury, pneumonia, and a prolonged ICU stay are at increased risk for dysphagia. A bedside assessment by a speech therapist of the ability to swallow has also been shown to be predictive of an abnormal/modified barium swallow in such patients.[34]

PITFALLS

- Failure to identify chewing/swallowing problems in patients in the ICU who receive a ward diet
- Misinterpretations of what constitutes a good intake

Clinical assessment

The clinical assessment should include a physical examination for nutrient deficiencies, the detection of the presence of oedema/dehydration, fluid balance, vital signs [blood pressure, breathing rate (if applicable), temperature, pulse rate], pressure ulcers (see for risk factors) and assessment of GIT function (Table V).

Table V: Patients at risk of pressure ulcers[19]

- Poor nutritional status and oedema
- Impaired intake (chewing and swallowing difficulties)
- Decreased protein intake
- Impaired ability to feed self
- Recent weight loss, particularly involuntary/unintentional
- Impaired wound healing process
- Catabolic illness induced protein energy malnutrition (PEM)
- Chronic illness and PEM (COPD, diabetes, morbid obesity, cardiovascular disease, renal disease, alcoholism and substance abuse, chronic infections, age-related frailty)
- Immobilisation/inactivity and muscle loss
- Spinal cord injuries

Adapted from Demling and De Santi, 2003[19]

When assessing fluid balance charts, the following basic considerations should be borne in mind:

- Assess fluid balance over a few past days, not just only one day
- Note the effect of medications (e.g. diuretics)
- Add 500 ml for insensible losses (of limited value in thermal injury as additional losses occur through wounds)
- Remember clinical factors which may influence input or output
- Use due care in interpreting fluid balance in the septic patient

Central venous pressure (CVP) is an indirect measure of hydration (Normal: 3–15 cmH_2O) and should be interpreted in consultation with a physician since factors other than hydration status, such as for instance pulmonary stenosis and right ventricular failure may also result in abnormal values.

GIT function and tolerance should be assessed daily to determine initiation of appropriate feeding and tolerance of feeding. GIT function should be assessed in terms of bowel sounds, tympany, nasogastric/fistula drainage and abdominal distension (measure circumference), abdominal x-ray/sonar, failure to pass flatus/stool, vomiting and diarrhoea (test for *C. difficile*) or constipation. Clearly it is important to identify the patient at risk of enteral feeding intolerance (Table VI).

It is also essential that gastric residual volumes (GRV) are assessed since high GRV increase the risk for aspiration, and patients with high GRV may be less likely to tolerate enteral feeding.[35,36] Recent evidence cast some doubt on the relationship between high GRV and aspiration risk and incidence of pneumonia.[37,38] Nevertheless, there are of course major methodological issues with the use of GRV as an indication of bowel function and feeding tolerance which has led to very variable interpretation(s)[35] (Table VII). The most recent recommendations for GRV are much higher than previously believed, namely 400–500 ml taking into account both the trend and pattern consistency (2 consecutive x 250 ml volumes). These recommdnations are in line with those of the North American Summit on Aspiration in critically ill patients (Table VIII).

PITFALLS

- Failure to identify pressure ulcers
- Not taking all aspects into consideration when interpreting fluid balance
- GRV misinterpretation

Table VI: Patients at risk of feeding intolerance[35]

• Clinical history Diabetes mellitus Renal insufficiency Endocrine diseases Prior GIT surgery	• Biochemical abnormalities Hyperglycaemia Hypokalaemia
• Admission diagnosis Head injury/spinal cord inury Central nervous system diseases Major surgery Pancreatitis Sepsis Burns	• Formula related issues Osmolality Large volume/rapid infusion of formula Formula pH Infusion of very cold formula High-fat formula/ type of fat Bacterial or fungal infection of formula Inappropriate formula
• Drugs Opioids (particularly pentobarbital) Hypnotics Inotropes Sedatives Analgesics Anticholenergics	• Others Pain Anxiety Infection

Adapted from Gonzales, 2008[35]

Table VII: Recommended GRV guidelines[35]

Author/study	Year	GRV Recommendation (mL)
McClave et al	1992	200 (NG) 100 (gastrostomy)
Lin et al	1997	500
COMGINE study	1999	200
Pinilla et al	2001	250 (+ prokinetics)
ASPEN guidelines	2002	200 (2 consecutive)
USA Aspiration Conference	2002	200–500
Canadian guidelines	2003	250
McClave et al	2005	400–500 (consider trend)
Kattelman et al	2006	250 (2 consecutive)
REGANE study	2007	500

With permission Gonzales, 2008[35]

Table VIII: Recommendations for GRV interpretation[35]

GRV	Recommendation
	GRVs should always be used together with clinical assessments
> 500 ml	Withhold feeds and reassess the patient's tolerance
200–500 ml	Maintain feeding Careful bedside evaluation
< 200 ml	Maintain feeding

(GRV = gastric residual volume)

With permission Gonzalez, 2008[35]

Biochemistry

Protein status

For appropriate interpretation, biochemical assessment of protein status should take in consideration the metabolic response to

stress and its effect(s) on serum proteins. In this regard, certain serum proteins such as albumin, transferrin, pre-albumin and retinol-binding protein (RBP) are the so-called negative acute phase proteins, wheras C-reactive protein (CRP), ceruloplasmin and various others are positive acute phase proteins.[39] It should also be borne in mind that nitrogen balance assessment is the only biochemical parameter that truly reflects visceral and somatic protein pools.[40]

When utilising plasma protein for the assessment of protein status (Table IX), the non-nutritional factors that are known to affect plasma proteins concentration need to be considered. Such factors include biological variation, physiological function, hydration status, patient posture at phlebotomy, hepatic and renal function and the acute phase response.

Table IX: Selected factors that affect plasma protein concentration[40, 45,46]

Factor	Albumin	Transferrin	RBP	Pre-albumin
Fluid disturbances	✓	✓	✓	✓
Therapeutic administration	✓			
Loss due to vascular permeability	✓			
APR	✓			
Negative acute phase protein	✓	✓	✓	✓
Half life (t½)	18–20d	8d	12h	2d
Iron pool		✓		
Zinc deficiency			✓	✓
Vitamin A deficiency			✓	
Renal failure / nephrotic syndrome	✓	✓	✓	✓
Liver disease	✓	✓	✓	✓

Albumin, although a poor indicator of nutritional status in the critically ill patient, is a sensitive indicator of morbidity, mortality and length of hospitalisation[41,42] and, in the short term, can be used as a marker of injury and metabolic stress during the acute phase response.[42] In trauma patients an albumin of ≤ 26 g/L has been shown to be a significant independent predictor of mortality and morbidity. The combination of a low albumin level and increased age was the most predictive of infection and mortality.[43] Pre-albumin correlates with short term changes in PEM and is a marker of protein intake. Two recent studies though indicate that pre-albumin does not respond sensitively to nutrition support,[4,44] particularly during the early period of the acute phase response[44] due to the delayed return to anabolic status.[44] It is, however, a good marker of the systemic inflammatory response.[44] Only in the presence of stable inflammatory parameters does pre-albumin reflect adequacy of nutrition support.[45] The same difficulties in interpretation emerged in a study on retinol-binding protein.[46]

In order to assess the effect of the acute phase response on these parameters it is necessary to monitor CRP. Bi-weekly measurements of a combination of pre-albumin and an acute phase response protein may provide a picture on the metabolic status (anabolism versus catabolism).[45] Pro-calcitonin is also an indicator of infections, SIRS, sepsis and MOF.

Insulin-like growth factor (IGF) is particularly sensitive to protein intake, responds rapidly to protein energy status[46] and has a half-life of only 4 h, but it is very expensive and unavailable in the country for routine use.

The most commonly used somatic protein status indicators include urinary creatinine, the creatinine-height index and 3-methylhistidine excretion. The body's somatic protein pool is directly proportional to the amount of creatinine excreted. Various factors such as renal failure may make such an assessment invalid. Furthermore, the limitation with using the creatinine-height index is that creatinine derived from dietary sources can not be distinguished from endogenously produced creatinine. There is also significant intra-individual variability in creatinine excretion. 3-Methylhistidine assessment is a labour intensive procedure and it is difficult to assess the amount supplied by the diet apart from not being available in the country for routine use.

Nutritional anaemias

The full blood count should be assessed for anaemia of chronic disease and the nutritional anaemia (iron deficiency anaemia and the anaemias due to vitamin B12 and folate deficiency). In the case of suspicion of the presence of a nutritional anaemia, confirmation of such diagnoses should be sought by investigating iron status (serum ferritin levels are also increased during inflammation), and vitamin B12 and folate (serum and red blood cells) concentrations.

Other tests

The assessment of biochemical status may also include other diagnostic investigations such as lipograms or tests GIT permeability as dictated by the patient's specific condition. Other more routine laboratory data should also be interpreted with caution (Table X).

Table X: Use and interpretation of routine laboratory data

Physiological fluid	Comment
• Serum	
• Calcium	– correct for low albumin
• Magnesium	– correct for low albumin
• Phosphate	– refeeding syndrome
• Urea, creatinine and electrolytes	– presence of renal failure
• Liver functions (LFTs)	– presence of liver failure, TPN induced
• Glucose	– Glucose intolerance
• Osmolality	– Inappropriate ADH secretion
• Urine	
• Osmolality	– Inappropriate ADH secretion
• Sodium	– Inappropriate ADH secretion
• Creatinine clearance	– Renal impairment
• Protein	– Proteinuria
• Glucose	– Glycosuria

Aberrations in calcium homeostasis occur frequently in trauma patients (27%).[47] Predictive methods for estimated ionised and corrected calcium levels are considered inaccurate since they lack the sensitivity to predict hypocalcaemia with a high rate of false negatives, and they overestimate hypercalcaemia.[48] Thus, measured ionised calcium levels should be determined in critically ill patients.[48,49,50] Serum magnesium and phosphate are often low in

critically ill patients due to, among other factors, nutrient-medication interactions, ATP synthesis, losses and increased metabolism.[40]

With regards to urea, creatinine and electrolyte status, assessment, monitoring is particularly important in the elderly who are very vulnerable to acute renal failure. Urinalysis should also be assessed for osmolality, proteinuria and haematuria.[51] If patients in renal failure are treated with continuous renal replacement therapy (CRRT) the protein equivalent of nitrogen appearance (PNA) assessment provides an estimation of protein needs.[52] Low serum sodium levels necessitate the assessment of urinary and serum osmolalities to assess the presence of inappropriate ADH secretion.[53] Plasma pyridoxal 5' phosphate was significantly associated with immune response status in one study.[54]

White blood cell, total lymphocyte and differential white blood cell count

These measurements can be used as an indicator of nutritional status in uncomplicated malnutrition, but not in critically ill patients. It should, however, still be assessed for other reasons such as indication of sepsis, inflammation, infection and immune response.[40]

Blood glucose

Hyperglycaemia is common after trauma and in critical illness due to the activation of the counter-regulatory hormones during the stress response. It is associated with poorer outcomes, increased risk for infections, myocardial infarction, polyneuropathy and multi-organ failure.[55] Aggressive control (4.5–6.0 mmol/L) is associated with a significant reduction in ventilator support and renal replacement therapy with a significant cost saving.[56] The latter study led to widely practised strict blood glucose control in critically ill patients. More recently, however, the NICE-sugar study showed an increased 90-day mortality with strict blood glucose control in critically ill patients.[57] It is thus prudent to maintain blood glucose near or at around 10 mmol/L and avoid hypoglycaemia. One of the reasons for the higher mortality with aggressive control may be due to the limitations in measuring glucose using the point-of-care devices (glucometers), since the glucose concentration obtained by these devices differ significantly from those obtained by conventional laboratory methods.[58] In addition, many critically ill patients are anaemic and it has been shown that a haematocrit of < 34% produces systematic errors in glucometer measurements.[59] Pidcoke et al (2009) developed a correction formula which, when applied to device-derived glucose concentrations, was associated with a 78% decrease in hypoglycaemia in the presence of tight glucose control practices.[59]

Blood gasses

Blood gasses should be assessed daily. A low PO_2 count is a contra-indication for nutrition support and high PCO_2 counts, unrelated to pulmonary dysfunction or ventilation settings, may necessitate an alteration of carbohydrate to fat distribution during weaning.

PITFALLS
- Nutritional status misdiagnosis by not accounting for the effect of the APR on serum proteins
- Not observing change in trends
- Not using iCa
- Relying on point-of-care devices alone for blood glucose monitoring
- Forgetting refeeding syndrome

Anthropometry

Most anthropometric parameters are difficult to obtain in the critically ill patient due to bandages, catheters, line, patient lying positions and any other factors that limit access. In addition, most weight and skinfold measurements may be inaccurate in the presence of disturbed fluid status. If a bed scale is available the following guidelines need to be observed: use the same scale every time and the following aspects need to be taken into consideration: debridements, plaster of Paris, colostomy bags, amputations or other weight bearing implements. To assess height various methods, such as bed length, knee height and arm span, can be used depending on available equipment and status of the patient. From the estimated BMI, % of usual weight and % weight loss can be calculated. A low BMI has been shown to be an independent predictor of excess mortality in MOF.[60] Weight loss of more than 5% in one month or 10% in < 6 months indicates a high nutritional risk.[42] Assessment of body composition utilising skin folds and bioelectrical impedance is often impossible or influenced by fluid status. Upper mid-arm circumference (UMAC) has been shown to indicate a higher mortality in those patients with a circumference measurement below the 5th percentile. UMAC below the 15th percentile has been reported to predict mortality and major complications.[61]

PITFALLS
- Not taking fluid disturbances and the presence of oedema into consideration

Indices

Various indices/scoring systems exist to determine severity of illness/trauma and prognosis. Commonly used scores include Acute Physiology and Chronic Health Evaluation II & III (APACHE II & III), Mortality Predicting Model (MPM II), Simplified Acute Physiological Score (SAPS II), Prognostic Inflammatory and Nutritional Index (PINI) and many more. It is important to assess for which patient populations the scores have been validated and to choose scores that will not increase the financial burden of hospitalisation.

Measures of wellbeing

Measures of functional status are direct measurements of the patient's wellbeing and can indicate short term benefits of nutrition. Some measurements that can be used include grip strength,[62] coping with activities of daily living (ADLs) and the quality of life score (QOL).

Smoking habit

Current smokers have a lower body weight, MAC, plasma vitamin C compared to those who never smoked. Smoking is independently associated with poor nutritional status in hospitalised patients.[63]

Points to remember

- Nutritional status changes slowly
- Single time points data may be misleading – serial measurements are essential
- It is often difficult to assess the degree of malnutrition with acceptable certainty
- Integrate data from diet assessment, anthropometry, biochemistry and clinical assessment

Monitoring and evaluation

The same measurements used to screen and/or assess the patient initially should be used to monitor the patient and evaluate the need to make adjustments to the nutrition care plan. Feeding tolerance and assessment of goal attainment should be done daily in the critically ill patient and the nutrition care plan adapted accordingly. A critically ill patient's requirements are never static, thus a single measurement or assessment/requirement calculation is often insufficient.

In conclusion, the nutritional management of the critically ill patient, by necessity, is intensive and is best practised by interpreting data from many sources and the ability to distinguish between the effects of nutritional status from those of the inflammatory status, a distinction that is often difficult to make.

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