

THE ROLE OF NUTRITION IN INJURED MILITARY PERSONNEL AT ROLE 4: CURRENT PRACTICE

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Introduction

Nutrition at Role 4 plays an important part in promoting the recovery and aiding the rehabilitation of military patients. Patients are transferred from field hospitals to University Hospital Birmingham NHS Foundation Trust (UHBFT) with multiple and severe injuries that may require multiple complex surgeries and procedures. It is important to optimise nutritional intervention early to aid a patient's recovery.

Currently military patients present with injuries such as a burns, head injury and major trauma. These injuries increase the body's metabolic demands, and increase a patient's nutritional requirements. Ensuring an adequate provision of nutrients has been shown to lower the incidence of metabolic abnormalities, reduce septic morbidity, improve survival rates and can decrease length of hospital stay [1].

There is only a limited amount of research that has been carried out on the changes in nutritional status, nutritional care, nutritional requirements and body composition of injured military personnel or the impact this has on their rehabilitation. Often conclusions have to be drawn from research undertaken with civilian patients with similar injuries. Research has been proposed to investigate nutritional issues for military patients and this will contribute to improving the nutritional care of military patients. The information that follows in this paper provides a summary of the nutritional care that military personnel currently receive at the UHBFT.

Nutritional Screening

Critical care

All military patients on critical care are screened by a Dietitian. Sedated and ventilated patients are assessed for the most appropriate route of feeding and then if appropriate started on enteral feed.

For extubated patients who are tolerating small amounts of oral diet but have repeated episodes of being placed nil by mouth (NBM) for theatre or dressing changes, or patients whose appetite or food intake is poor, enteral feeding as an overnight (10-14 hour) feed is often used to supplement their oral (food) intake.

For those patients that enteral or oral nutrition is not indicated Parenteral Nutrition (PN) will be considered.

Wards

On transfer to a ward at UHBFT nursing staff complete a nutrition screening tool on all patients to identify those patients at high risk of malnutrition. The Malnutrition Universal Screening Tool (MUST) is completed on admission and repeated weekly during a patient's in-patient stay [2].

Screening on admission to the ward highlights any patient presenting malnourished or patients at risk of becoming malnourished. Weekly screening highlights individuals whose clinical condition or weight is changing during their in-patient stay, allowing nutritional problems to be highlighted early. The aim is to prevent or treat malnutrition early thus reducing the complications of malnutrition [2].

The MUST tool involves taking nutritional measurements, weight and height, and recording a patient's body mass index (BMI), it also takes into account previous weight loss and the acute disease effect to provide a classification of malnutrition. The screening tool is unique [2] as it provides surrogate measures that can be taken if a patient cannot be weighed e.g. mid upper arm circumference (MUAC) or ulnar length if their height is not able to be measured. MUST provides an overall score that categorises patients as low, medium or high risk of malnutrition allowing the nursing staff to set up an appropriate nutritional care plan. Patient's highlighted as high risk are referred to the Dietitian for a full dietary assessment and advice.

Nutritional Assessment

To be able to provide military patients with an individualised nutritional plan a detailed dietetic assessment needs to be undertaken. Nutritional advice is not given on one individual result but multiple factors (listed below) are taken into account before nutritional advice is provided. These factors are then regularly monitored throughout a patient's in-patient stay and the nutritional advice is adapted depending on the Dietitians findings.

Anthropometric measurements

Weight

A patient's weight provides a limited amount of information when used on its own. When used with an individual's height it can identify whether a patient is under or overweight and monitoring weight allows trends to be tracked to assess whether an individual is losing or gaining weight. Weight should be taken within a day of admission [3] and repeated on a weekly basis [2].

Oedema, plaster casts and fluid balance all have to be taken into account to assess the accuracy of a measured weight. For example, severe peripheral oedema can account for up to 10kg of weight gain in some patients [4] and data collected by the British Association for Parenteral and Enteral Nutrition (BAPEN) on the weight of different plaster casts and frames can be subtracted from a patient's measured weight to provide a more accurate weight [2]. For patients who have undergone amputations calculations by Osterkamp [5] can be used to ensure nutritional requirements are not underestimated.

Military personnel on deployment may have a change in body composition prior to injury. Weight loss can be as a result of decreased fat stores and changes in lean body (muscle) mass. As

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a result, after an injury military patients may have depleted fat and glycogen stores to mobilise as an energy source. This can lead to an increase in muscle catabolism and further weight loss. Unfortunately no data is currently available to assess the change in body mass for UK military personnel on deployment but work in this area has been proposed.

Mid arm muscle circumference (MAMC)

A patient's MAMC can be calculated using mid upper arm circumference (MUAC) and triceps skinfold (TSF) measurements. This measurement is used as an estimation of muscle mass and can show changes in protein stores during a patient's hospital stay [6].

Hand grip dynamometry

Hand grip dynamometry is used to assessment a patient's grip strength. This provides an assessment of functional changes in muscle strength [7] and often responds more quickly to a patients nutrition support than MAMC which shows a more gradual increase as patient's nutrition improves [8].

Nitrogen balance

In critically ill and very catabolic patients measuring urinary urea nitrogen, in a 24 hour urine collection, allows nitrogen losses to be estimated taking into account nitrogen lost from skin, sweat, aspirates, fistula losses, dialysate fluid and faeces. Nitrogen balance is used to assess and monitor trends in total body protein and trends in catabolism.

Biochemistry

The Dietitian will use biochemical parameters (Table 1) as part of their nutritional assessment and it contributes towards the Dietitians recommendations for the type of feed and fluid volume required.

Temperature

A patient's temperature is monitored as ongoing pyrexia often indicates an infection or sepsis and as a result will cause an increase in the energy, protein and fluid requirements of the patient.

Medications

A patients current medication is monitored as some may have an impact on a patients nutrition:

- Sedation or opioid analgesics such as morphine and fentanyl slow gastric emptying [14] and if a patient's bowels are not opening regularly nausea and vomiting may result, leading to a reduction of food intake, or decreased tolerance of enteral feed.
- Antibiotics, in some patients, can give gastrointestinal symptoms such as nausea, vomiting or diarrhoea, and this may result in a reduction in food intake.
- Sedation agents e.g. propofol, provides an additional source of calories and when used for prolonged periods of time need to be taken into account when adjusting a feeding regimen.
- Anticonvulsant medication such as oral phenytoin, but not intravenous, requires a 2 hour break in enteral feed pre- and post phenytoin administration. This is due to the calcium and protein in enteral feed binding to the phenytoin, reducing the absorption of the drug. Therefore patients on oral phenytoin should only be fed over a maximum of 20 hours [15]. Water can be run if needed during the four hour break from feed.

Nutritional intake

For all patients on oral diet a detailed 24 hour dietary recall is taken to allow the Dietitian to estimate the patient's current energy and protein intake. If a patient is unable to provide this, detailed food record charts are requested. A patient's food intake is then compared to their estimated nutritional

Parameter	Role
Urea and Electrolytes (U+E's)	Daily estimations of sodium, potassium and urea along with fluid balance charts and clinical observations allow assessment of hydration.
Creatinine	Increasing creatinine can reflect changes in muscle mass in individuals with stable renal function.
Albumin	Albumin is a poor indicator of nutritional status as it is often low as a result of non-nutritional changes such as trauma, burns, sepsis, and recent surgery. Albumin levels can be affected by a patient's hydration status. During periods of high stress the liver reduces its synthesis of albumin. Albumin results are always interpreted with the C-reactive protein (CRP) result to distinguish between malnutrition and the effects of illness. Low albumin levels can also indicate the body's impaired ability to cope with major illness/surgical intervention or sepsis [9] and have been shown to indicate an increased morbidity and mortality [10,11].
White blood cells (WBC)	Changes in WBC levels reflect the changes in an individual's infection and inflammation state. This is taken into account when calculating nutritional requirements as prolonged infection and/or inflammation can have a negative impact on a patient's nutritional status if their nutritional requirements are not being met. WBC results are monitored and interpreted in conjunction with temperature and CRP results.
C-reactive protein (CRP)	CRP is used as an indicator to detect the presence of inflammation and is essential in the interpretation of protein results [12]. Trends in CRP are used to monitor acute phase responses and this information is used when assessing a patient's nutritional requirements.
Phosphate (PO ₄), Calcium (Ca ²⁺) and Magnesium (Mg ²⁺)	These electrolytes are taken with U+E's prior to commencement of feeding and should be monitored daily in patients at risk of re-feeding syndrome e.g. malnourished patients or patients starved for 5 days or more [2]. (See re-feeding syndrome below)
Glucose	Hyperglycaemia is common in critically ill patients due to an increase in catecholamine, glucagons, cortisol and growth hormone levels. Maintaining a tight blood glucose control with insulin improves the mortality and morbidity of critically ill patients [13].

Table 1 Biochemical Parameters used to aid Nutritional assessment

requirements, so a nutritional plan can be devised. An assessment of a patient's food intake also highlights their individual food preferences, as well as any allergies or intolerances. If a patient is enterally fed, the Dietitian compares what is documented on fluid charts to establish if a patient is receiving their prescribed feeding regimen.

Nutritional requirements

A patient's nutritional requirements are calculated on an individual basis and will vary depending on if they are in an acute or recovery phase of their injury, the severity and type of the injury and their nutritional status prior to injury. The body's individual response to trauma differs but there are 3 documented phases the ebb phase, the flow phase and the anabolic or recovery phase [16].

The ebb phase occurs just after injury and can last up to 24 hours. The body's metabolic rate decreases to preserve energy and allow the individual to react to the injury. Energy reserves are mobilised, glycogen from the liver is converted to glucose and free fatty acids are released from tissues. As this phase occurs just after an injury and the effects are short lived it is unusual for the Dietitian at Role 4 to review the patient during this phase.

This is followed by the flow phase which can last from several days to several months depending on the type and severity of injury. The body's metabolic rate and temperature increase to deal with the stress of the injury. There is a large increase in hormones (catecholamines, glucagon, cortisol) and cytokine levels that results in catabolism and increase tissue breakdown to provide energy for the body to use [16]. This phase leads to a rapid loss of muscle, and can be identified in military patients by a significant and often visible decrease in body weight. The Dietitian will provide nutritional recommendations during this catabolic phase. The aim of nutritional intervention is to provide an adequate energy intake to minimise muscle and weight loss.

The anabolic or recovery phase occurs as catabolism declines and is normally seen at a ward or rehabilitation level. Patients normally have an increase in appetite and food intake and at this time the aim of nutritional intervention is to gradually improve a patient's nutritional status, promoting the regain of weight and muscle mass lost during the ebb and flow phase.

In addition to the injury, during periods of starvation the body again adapts by using itself as an energy source. An injury in addition to starvation, increases the rate in which glycogen stores are mobilised from the liver and muscle, gluconeogenesis releases amino acids from muscle, and fatty acids are broken down to produce ketone bodies used by the brain and red blood cells [16]. During this time micronutrients, mineral and electrolytes are used. Early initiation of nutritional support is recommended to minimise these losses and to minimise muscle and weight loss.

Calculating nutritional requirements

Energy requirements

Current UK practice recommends a patient's energy requirements are calculated using Schofield equations [17]. This prediction equation calculates a patient's basal metabolic rate (BMR) which accounts for between 45-70% of total energy expended per day. The Schofield equations use age, weight and gender to calculate BMR. An activity factor and stress factors are then added to the BMR to provide estimated energy requirements.

Clinical judgement and interpretation of a patient's condition are used by the Dietitian when estimating a patient's nutritional requirements. Examples of stress factors added to BMR are given in Table 2.

Protein requirements

The Department of Health [25] recommends the average healthy adult needs 0.75g of protein per kilogram (kg) of body weight per day (d). However large nitrogen losses are known to occur in patients with sepsis, major trauma and burns. When the body is catabolic nitrogen balance post injury is difficult to achieve and the aim is to minimise muscle mass losses. Some evidence suggests the body is unable to utilise excess nitrogen when a patient is critically ill therefore it is not recommended to exceed 1.25g protein/kg/d (0.2gN/kg/d) [26], however up to

Injury	Stress factor added
Head injury (acute)	30% [18,19]
Head injury (recovery)	30-50% [18,19]
Long bone fracture	10% [20]
Polytrauma	30-50% [21]
Burns	1% increase in stress factor for every 1% full thickness burn [17,22]
Surgery	5 % for uncomplicated surgery through to 25% for an extensive and complicated surgery [23,24]

Table 2. Stress factors added to BMR

1.87g protein/kg/d (0.3gN/kg/d) can be given during the anabolic phase [22].

Fluid requirements

For maintenance fluid requirements in patients aged 16-60 years 35mls/kg is used as a guide. If a patient is pyrexial, 2 - 2.5mls/kg is added for each °C rise in temperature above 37°C. Fluid charts, U+E's, fluid losses via drains, aspirates, exudate and fluid restrictions are all monitored and taken into account when adjusting a patient's fluid intake.

Electrolytes

Electrolytes are calculated or the Department of Health [25] lower reference nutrient intake (LRNI) to reference nutrient intake (RNI) range can be used to provide a target intake (Table 3). Patients with severe burns or trauma will require a higher intake of electrolytes but this will be assessed on an individual basis, taking into account their clinical condition and whether losses are occurring e.g. from fistulae's, exudate or diarrhoea.

Electrolyte	Base line requirements
Sodium	1 mmol/kg/d
Potassium	1 mmol/kg/d
Magnesium	LRNI – RNI Men 7.8 – 12.3 mmol/d LRNI – RNI Women 6.2 – 10.9 mmol/d
Phosphate	LRNI – RNI 10 – 17.5 mmol/d

Table 3 Target electrolyte requirements

Trace Elements

Burns patients have increased requirements for trace elements due to increased losses in urine, plasma exudate, skin and eschar. At UHBFT patients with a greater than 30% burn receive an 8 day supply of IV supplementation of copper, zinc and selenium. Ideally this is administered via a central line, but a peripheral line can be used. In burns of between 20- 30% oral supplementation of copper, zinc and selenium is given. A patient's trace element levels are regularly monitored.

A patient's nutritional requirements are regularly re-calculated as their clinical condition changes thought out their treatment. After estimated nutritional requirements have been calculated a nutritional plan can be prepared. Enteral feeding rates can be calculated, or recommendations for oral diet and oral nutritional supplements type and volume can be made.

Aim of Nutritional Intervention

Feeding of critically ill patients is a current topic of debate. Appropriate nutritional feeding is seen as supportive therapy and common benefits such as reduced rates of nosocomial infection, reduction in length of critical care and hospital stay, improved wound healing and reduction in muscle wasting can result. Adequate feeding prevents a reduction in respiratory muscles and prevents an increased weaning time from mechanical ventilation. It also decreases complication rates, commonly quoted as being important in the early introduction of enteral feeding [27, 28].

Traditionally there has been a tendency to attribute large stress factors to ongoing illness when calculating energy requirements based on recommendations from 1979 that hospital patients had higher requirements than their healthy counterparts and increased energy expenditure and hypermetabolism increased depending on severity of illness and degree of stress the body was under [29]. However, as more research has become available, it has been recognised that these stress factors have generally tended to overfeed patients. There has been a body of evidence produced showing that overfeeding patients can be just as problematic as underfeeding, particularly in the critical care setting.

The consequences of overfeeding a critically ill patient can be increased physiological stress leading to azotemia, hepatic steatosis, hypercapnia, which may lead to prolonged weaning from mechanical ventilation, hyperglycemia, hyperlipidemia and fluid overload [27, 30].

Ventilator settings, renal replacement therapy and insulin therapy can be altered to correct for hypercapnia, azotemia and hyperglycemia respectively. However underfeeding will cause loss of lean body mass, including cardiac and respiratory muscles, prolonged weaning from mechanical ventilation, delayed wound healing, impaired host defences, and increased infections [31-33]. Therefore the current practice at UHBFT is to aim to feed patients in critical care to their energy requirements and meet protein requirements while being careful not to over or underfeed patients.

Enteral nutrition is used when oral intake on nutritional support is unpractical, not sufficient, inadequate or unsafe [26]. It is used as it provides a physiological and immunologically beneficial way of feeding patients. Feeding regimens are designed to fit patient's requirements, e.g. 24 hour feeding is used when patients are sedated and ventilated or critically ill to provide nutrition at a steady lower rate of feed to provide better fluid balance and blood glucose control. On the wards a 16-18 hour feed may be recommended or a supplemental overnight feed may be used to encourage oral intake during the day.

Early nutrition support has also been associated with a reduction in the body's catabolic response to injury, providing improved clinical outcomes including decreased complication rates, improved wound healing and promoting graft and donor site healing by assisting cell renewal and growth [34].

For critically ill patients, enteral nutrition should ideally be initiated within 12 - 48 hours after injury for all patients unlikely to meet their full oral diet within 3 days [32]. For major burns enteral nutrition should be started as soon as possible and ideally within 6 hours of burn injury. This has been proven to be beneficial [35] with the aim of having established enteral feeding by 72 hours [36]. Early enteral feeding in critically ill patients has been shown to be beneficial [37,38] as it prevents excessive muscle protein breakdown, improves immune function and reduces mortality and morbidity in traumatic brain injury patients [1,39]. Early enteral feeding in polytrauma patients has shown a reduction in infection rate, shorter hospital stay and an improved outcome [40].

Prolonged ileus and stress ulcers in burns patients have been largely eliminated by early enteral feeding. Some evidence suggests that in burn patients early enteral feeding may decrease hypermetabolism, decrease catabolic hormones and improve nitrogen balance. Enteral nutrition also prevents bacterial translocation and gastrointestinal function and structure is maintained, reducing incidence of diarrhoea and length of hospital stay [41-44].

Therefore the initiating of early enteral feeding at a low rate (up to 50mls per hour of standard feed) has been proposed for injured military personnel on deployment prior to their transfer back to the UK to bring their nutritional intervention in line with NHS civilians in the UK.

The aim of nutritional intervention is to maintain normal body weight or in critically ill patients minimise weight loss, preserve lean body mass and promote optimal wound healing and skin graft take. Without appropriate nutrition, depletion of muscle mass is accelerated with some patients losing up to 1.5kg per day [16].

The aim of nutritional support is to:

1. maintain nutritional status in normally nourished patients
2. minimise weight and muscle losses in catabolic patients and to improve a patients nutritional status once the patient is not catabolic
3. improve nutritional status in malnourished patients
4. ensure adequate macro and micronutrients intake to meet an individual's requirements
5. maintain fluid balance.

Enteral Feeding

Possible indications for enteral nutrition [26] are:

- Unconscious patient e.g. head injury or sedated and ventilated patient
- Increased nutritional requirements e.g. head injury, multiple fractures, burn injury
- Neuromuscular swallowing disorder e.g. stroke or brain injury
- Specific treatment to correct malnutrition e.g. weight loss of greater than 10%, muscle wasting
- Inadequate or little or no food intake for more than 5 days or unlikely food intake for next 5 days or patient unsafe for oral intake.

Tubes

In critical care at UHBFT there are 3 main types of tubes used for short term enteral feeding:

Nasogastric tubes (NGTs)

These are the most commonly used for artificially feeding patients. Fine bore polymethane tubes 12FG are recommended for use rather than wide bore Ryles type tubes made from PVC. The 12FG contains the same internal diameter as a Ryles tube. This allows for gastric aspirates to be drawn easily and for medication to be given without blocking the tube.

Once feeding is established and the patient is absorbing their feed, for patient comfort the tube can be changed to a Merck Co-flo 8FG. The use of polymethane tubes overcomes the need for Ryles tubes to be changed. Ryle's tubes should be changed before 14 days as the PVC can plasticize in a reaction with gastric contents causing the tube to become brittle, increasing gastric ulceration and erosion [45, 46]. Wide bore Ryles tubes are also linked with rhinitis, pharyngitis, oesophageal strictures, increased reflux, as well as discomfort and difficulty in swallowing for patients [47].

Orogastric tubes (OGTs)

OGTs are placed in sedated and ventilated patients with a suspected or confirmed skull fracture, head injuries and for some maxillofacial traumas. Before a patient is extubated a plan needs to be formulated for the patient to meet their nutritional requirements, as an OGT will not be tolerated by a conscious patient. OGT are normally replaced with an NGT, passed with care by the medical team, to meet a patients nutritional requirements until oral diet can be established.

Nasojejunal tubes (NJTs)

NJTs are placed beyond the ligament of Treitz to allow feed to be delivered below the stomach into the jejunum. They are used in critically ill patients who have problems with delayed gastric emptying [48], post operative gastric stasis and gastroparesis. Patients after gastrointestinal surgery, or with liver or pancreatic damage often require post pyloric feeding. Insertion of NJT can

take place during laparotomy or endoscopically. At UHBFT most tubes are placed endoscopically and a single or double lumen tube can be used. Currently at UHBFT single lumen Cook 10FG NJT or Medicina double lumen tubes are used. A double lumen NJT allows for feeding down one port and the second allows for gastric aspiration.

Potential complications of NJTs are abdominal distension, migration of NJT into stomach (less likely if the tube is in jejunum rather than duodenum) which can cause reflux, increased aspiration and vomiting. Pharmacy advice should be sought on the most appropriate route of administering medication when tubes are in place as some medication may need to be absorbed in the stomach.

On the wards Merck Co-flo 8FG NGTs are placed or if gastric emptying was a problem an NJT single lumen Cook 10FG NJT or Medicina double lumen tubes would be placed endoscopically.

Position of feeding tube

Confirming the feeding tube is in the correct position is essential. There have been 5 deaths reported in 2007 to the National Patient Safety Agency (NPSA) [49] due to misplaced NGTs delivering feed into the patient's lungs. Unconscious, sedated and ventilated or patients without a swallow reflex are at high risk from tubes being incorrectly positioned in the trachea or bronchus. Proton pump inhibitors, H₂ antagonists and antacids and 24 hour feeding will all affect the pH of the stomach. Therefore UHBFT's enteral feeding guidelines recommend all fine bore feeding tubes are x-rayed on insertion in critically ill or head injury patients and the position is confirmed and documented in the patient's notes before feed is commenced.

Confirming NGT position on the wards is completed by using the pH method and is recommended by the Medical and Healthcare Products Regulatory Agency [50]. This involves aspirating a small amount of fluid from the tube and using pH paper, ensuring the pH is 5 or below. Blue litmus paper should not be used [49,50] nor should the tube position be checked by the 'whoosh test' pushing air down the NGT as this does not differentiate between whether the tube being in the patient's stomach, oesophagus or lungs [49].

NJT position can be verified with an abdominal x-ray.

Enteral Feed

Whole protein polymeric feeds are used to meet a patient's requirements:

- Standard feeds (1 kcal/ml) e.g. Nutricia Nutrison Standard (Figure 1), Abbott Osmolite, Fresenius Kabi Fresubin Original are used to meet requirements when patients can tolerate larger volumes.
- High energy feeds (1.5kcal/ml) are used with patients who need to meet requirements without providing large volumes of fluid (i.e. those patients on CVVH), or patients on overnight feeds, e.g. Nutricia Nutrison Energy, Abbott Ensure Plus, Fresenius Kabi Fresubin Energy.
- High energy, high protein feeds (1.5kcal/ml) provides further protein and is used for patients with high protein requirements (i.e. polytrauma or burns patients), e.g. Fresenius Kabi Fresubin HP Energy.
- Low electrolyte feeds, can also be used when patients are not on renal replacement therapy and need a strict fluid restriction or need a low electrolyte feed e.g. Nutricia Nutrison Concentrated, Abbott Nepro.

The standard and high energy feeds all come in a high fibre version. This is used for patients that are prone to constipation, for example patients on high amounts of pain relief or patients that are bedbound and immobile.



Figure 1

Immune modulated enteral feeds

Currently there is no evidence to support the use of feeds supplemented with arganine, dietary nucleotide or fish oils. More evidence is needed in this area before these type of feeds should be used with patients [40,51-54]. These are currently not used at UHBFT.

Glutamine is a conditionally essential amino acid in trauma and burns patients needed to provide fuel for rapidly dividing cells. Studies have shown that enteral glutamine can improve biochemical markers (increased plasma glutamine and prealbumin levels), improve wound healing rates, morbidity, length of stay, and suggest that it helps maintain mucosal integrity in patients who have severe burns [32,55]. The

European Society for Parenteral and Enteral Nutrition (ESPEN) guidelines [32] suggest its use for burns and trauma patients in which it has been proven to be beneficial. In critically ill general surgical and head injured patients supplementation of glutamine is not recommended. At present it is not standard practice to supplement glutamine at UHBFT however it can be given. 5g glutamine sachets are mixed with water and flushed down the enteral feeding tube over the day. Studies recommend using for a minimum of 5 days to a maximum of 14-30 days depending on inflammatory markers (CRP, WCC).

Monitoring an enteral feed

There have been no clinical trials assessing monitoring of enteral feeding but NICE [26] recommends:

- Ensuring short and long term goals are met
- Ensuring feed prescribed is delivered
- Monitoring weight, weight loss or other anthropometrics measures
- Monitoring biochemistry and haematology
- Monitoring fluid balance, taking into account effects of temperature on fluid requirements
- Ensuring the correct tube position prior to feeding and ensuring tube fixed in place appropriately
- Monitoring for gastrointestinal symptoms, e.g. nausea, vomiting, diarrhoea, constipation
- Assessing changes in patient's clinical condition and adjusting their nutritional requirements and feeding regimen as appropriate.
- Monitoring drug therapy.

The Dietitian includes these during their nutrition review of patients.

Complications of Enteral Nutrition

Re-feeding syndrome

Before enteral feeding is commenced a patient should be assessed for risk of re-feeding syndrome. This is unlikely in military patients but common amongst local UK civilians and in host nationals.

Re-feeding syndrome is described by Soloman and Kirby [56] as "the metabolic and physiological consequences of the depletion, repletion, component shifts and interrelationships of the following: phosphate, potassium, magnesium, glucose metabolism, vitamin deficiency and fluid restriction."

Patients at risk of re-feeding syndrome can be identified as those who have had very little or no food for greater than 5 days, along with severely malnourished patients. If a patient is suspected to have re-feeding syndrome, feed should be started slowly, NICE [26] recommend at 10kcal/kg for the first 24 hours. Electrolytes listed below need to be checked and

corrected as appropriate. A patient's feed rate is not increased if electrolyte levels are depleted.

Electrolytes potassium (K^+), phosphate (PO_4), calcium (Ca^{2+}) and magnesium (Mg^{2+}) should be checked prior to feeding and daily until levels are stable. Replacement should be provided for patients who have depleted levels.

- K^+ can be corrected by using Sando K or IV K^+ replacement.
- PO_4 can be corrected by phosphate polyfusor if levels of PO_4 are below 0.32 mmol/l, if greater than 0.32 mmol/l but below normal range, effervescent phosphate tablets can be given.
- Mg^{2+} levels should be corrected using IV magnesium sulphate if below 0.5mmol/l, oral supplementation should not be used as it is poorly absorbed and gives gastrointestinal side effects in large doses.

All levels should be checked daily after they are corrected and monitored until levels have established and patient is established on their full nutritional requirements.

Aspiration

Delayed gastric emptying can be caused by sedation, opiate use, metabolic state and raised intracranial pressure (ICP). It may also be a result of the body's response to critical illness or trauma by conserving plasma volume and providing essential organs with sufficient oxygen and nutrients. This can lead to a reduced blood flow to non-essential organs such as the gut.

Vomiting and reflux can result in aspiration into the lungs which can in some cases lead to increased risk of pneumonia. Aspiration risk can be reduced by ensuring patient's head is at 30-45° and by ensuring tube position is confirmed by checking the pH before every use.

It is common practice to aspirate NGT or OGTs every 4 hours to assess gastric emptying when patients are on critical care. An aspirate greater than 200ml is indicative of delayed gastric emptying [57,58]. If aspirates are repeatedly above 200ml the patient is not absorbing or tolerating feed and feed rate should be reduced and prokinetics started. Currently at UHBFT metoclopramide IV 10mg three times per day and oral erythromycin 125mg four times per day are used to promote gastric emptying. If the aspirates remain elevated post-pyloric feeding should be considered.

Diarrhoea

Diarrhoea is often referred to as being a result of the enteral feeding. It is however more commonly a result of antibiotic use or clostridium difficile overgrowth [59,60]. The sorbitol content of liquid medications can also cause loose stools. Adjusting the fibre content of a patient's feed or reducing feed rate can help provide symptomatic relief.

Blocked tubes

The blocking of tubes often occurs as a result of failure to flush the enteral feeding tube at the end of the feed delivery or inadequate water flushing after medications have been administered. This can be prevented by adequate and timely water flushes, also by using medications in syrup or suspension form rather than crushable tablets.

Blocked tubes can be unblocked by using warm water and 50ml catheter tip enteral syringe in a push/pull plunger technique. The tube can be rolled between fingers to move blockages. The UHBFT enteral feeding guidelines does not recommend the use of fruit juices or carbonated drinks (e.g. cola or lemonade) to unblock tubes as these products are likely to curdle the feed further [61].

Medications

When patients are nil by mouth, medication is often administered through feeding tubes. The opening or crushing of a tablet prior to administration changes the medication to an

unlicensed medication and where possible syrups or suspensions should be used. Medications that are modified release, enteric coated, hormonal, cytotoxic or steroidal should never be crushed or opened and an alternative should be sought.

Fluid Balance

All patients should have their fluid balance monitored to prevent dehydration and hypernatremia or prevent a patient from becoming fluid overloaded. If a patient has a raised sodium and urea, dehydration is likely even in patients with severe oedema, additional oral or NG water can help reduce these levels. A raised urea with a normal sodium level can occur if a patient is dehydrated and losing both sodium and fluid, e.g. in a patient with diarrhoea. Urinary sodium can be measured in patients with large fluid losses e.g. burns patients to check for salt depletion.

Oral Nutrition

For ward patients or patient's extubated on critical care, oral nutrition support is encouraged. Patients that have been enterally fed have their feeding regimen altered to an overnight or 12-14 hour regimen and a light diet is trialled to ensure they can tolerate oral diet. If a patient has a tracheostomy or any swallowing difficulties such that coughing or choking on oral intake is noticed, a referral is made to the Speech and Language Therapist (SLT). SLT complete a swallowing assessment and advise on the most appropriate texture of food and fluids to prevent aspiration.

As a patient's food intake improves the volume of feed via their NGT is reduced. Enteral feeding is stopped when a patient can meet their nutritional requirements consistently using food and oral nutritional supplements.

Patients transferred directly to the wards and who do not require enteral feeding or SLT input are started on the high protein menu. Advice is given to patients on eating foods that are energy, protein and nutrient dense to promote recovery. Patients are encouraged to initially eat and drink as able with the aim of building up to three meals and three snacks per day as tolerated. Larger portions of hospital meals, a cooked breakfast and meal vouchers are provided to ensure patients are meeting their nutritional requirements. If a patient cannot meet their nutritional requirements solely from food, nutritional supplements are recommended. Patients are advised on the type and number of supplements to drink depending on the calculated deficit between their food intake and their nutritional requirements taking into account the dietary aims of treatment.

Military patients often want to optimise their food intake and learn of the importance of nutrition and the role food plays in preventing muscle and weight loss. The Dietitian has found increased compliance to nutritional recommendation when patients are aware of their nutritional requirements and detailed discussions are held with patients on how they can meet their requirements through diet, nutritional supplements and/or enteral feeding.

The supplements that are used at UHBFT range from:

- high calorie supplements (Nutrica Fortisip Bottle 300kcal, 12 g protein per bottle) (Figure 2)
- high protein supplements (e.g. Nutrica Fortimel 200kcal, 20g protein per bottle or Nestle Build-up milkshakes 200kcal, 15g protein per drink)
- high calorie and high protein supplements (e.g. Nutrica Fortisip Extra 300kcal, 20g protein per bottle)
- energy only supplements (e.g. Nutrica Calogen 405kcal per 90mls)

While in hospital many factors can affect an individual's food intake making it difficult for them to meet their nutritional requirements. Loss of appetite, early satiety, tiredness, pain, nausea, vomiting or diarrhoea, dislike of hospital meals and



Figure 2

multiple periods of being made NBM for theatre or test and investigations all have an impact on a patient's nutrition.

Advice is given to the individual and the medical staff on ways to improve their oral intake through food and nutritional supplements. However if a patient continues to struggle to reach or maintain their nutritional requirements via food and supplement intake an overnight NGT feed will be commenced until their nutritional requirements can be met orally. This will promote a patient's recovery, promote wound healing and prevent weight loss.

Parenteral Nutrition (PN)

Enteral feeding is not suitable for all patients and clinical decisions should be made on an individual patient basis. Possible contraindications to enteral nutrition and indications for PN are [26,61,62]:

- Gut Failure e.g. severe obstruction, perforation, prolonged gastrointestinal ileus, dysmotility, fistulae or severe malabsorption
- Intestinal failure for greater than 5 days
- NBM following major surgery
- Proximal high out-put or enterocutaneous fistula
- Intractable vomiting
- Gastrointestinal tract is insufficient or inaccessible

PN is only indicated when it is not possible to meet a patient's nutrition enterally as a result of the gastrointestinal tract is not functioning or inaccessible. A patient will undergo a nutritional assessment as described previously and a recommended prescription of PN will be made for the doctors to prescribe.

Patients with PN need to be monitored closely for complications. These can include metabolic complications such as fluid overload, hyperglycaemia, electrolyte abnormalities, deranged liver function tests, hypertriglyceridemia, cholestasis and hepatic steatosis [16, 26]. The complications of feeding line insertion, which is commonly a central venous or long term peripheral indwelling line should also be considered such as air embolism, pneumothorax, central venous thrombosis, cardiac arrhythmias and nerve injury as well as catheter related sepsis [63]. Weaning from PN should start as soon as an enteral route can be established to meet the patient's nutritional requirements.

Monitoring of nutritional intervention

With any nutritional intervention (oral, enteral or parenteral) monitoring is just as important as the nutritional assessment. The discussed items in the nutritional assessment section are monitored at each review. Monitoring is used to assess the effectiveness of the nutritional support ensuring dietary aims are being met. Timely and effective monitoring can reduce or minimise incidence of complications, reduce electrolyte and metabolic disturbances and ensure that a patient's nutritional requirements are being met [64].

Conclusion

Nutrition plays a vital part in promoting the recovery of military personnel at all stages of their injury from acutely ill thought to rehabilitation on the ward. The aim of nutritional intervention is to preserve muscle mass and physical strength, promote wound and graft healing and promote recovery from injuries. Optimising a patient's nutrition can help reduce their risk of complications allowing a patient to progress, to Headley Court, for their ongoing intensive rehabilitation.

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