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***** Refer to HSE National Framework for developing Policies, Procedures, Protocols and Guidelines (PPPGs)***

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# Intensive Care Nutrition Support Algorithm (Adults)
# September 2020

This document is a: Guideline Algorithm

## Critical Care Programme (CCP)

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|---|---|
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**Table of Contents:** **Page number**

**PART A: INTENSIVE CARE NUTRITION SUPPORT ALGORITHM (ADULTS)**.....4

**PART B: DEVELOPMENT CYCLE**.....9

**1.0 INITIATION**

1.1 Purpose.....9
1.2 Scope.....9
1.3 Objectives.....9
1.4 Outcome.....9
1.5 Intensive Care Nutrition Support Algorithm Development Group.....10
1.6 Intensive Care Nutrition Support Algorithm Governance Group.....10
1.7 Supporting evidence.....10
1.8 Glossary of terms and abbreviations.....10

**2.0 DEVELOPMENT OF THE INTENSIVE CARE NUTRITION SUPPORT ALGORITHM**

2.1 Key questions.....15
2.2 Literature search strategy.....15
2.3 Appraising evidence.....15
2.4 Process used to formulate algorithm.....15
2.5 **Summary of evidence:**.....16
2.5.1 Introduction 16
2.5.2 Impact of an intensive care dietitian 17
2.5.3 Nutrition screening for nutrition risk in intensive care 17
2.5.4 Assessment and requirements in intensive care 17
2.5.5 Feeding the malnourished patient 20
2.5.6 Feeding the obese critically ill patient 23
2.5.7 Nutrition support implications for patients with acute kidney injury on renal replacement therapy 23
2.5.8 Enteral nutrition 24
2.5.9 Parenteral nutrition 30
2.5.10 Glycaemic control 32
2.5.11 Other considerations 32
2.5.12 Monitoring of nutrition support 35
2.5.13 Swallow assessment and Speech and Language Therapist (SLT) input 37
2.6 Resources to implement the Intensive Care Nutrition Support Algorithm.....38
2.7 Development steps.....38

**3.0 GOVERNANCE AND APPROVAL**

3.1 Governance arrangements.....39

3.2 Development standards 39
3.3 Copyright/permission....39
3.4 Approval and sign-off....40

**4.0 COMMUNICATION AND DISSEMINATION**
4.1 Communication and dissemination plan ....40

**5.0 IMPLEMENTATION**
5.1 Implementation plan and facilitators/barriers....40
5.2 Education requirements to implement the Intensive Care ....40
Nutrition Support Algorithm
5.3 Lead person(s) responsible for implementation....40
5.4 Roles and responsibilities....40

**6.0 MONITORING, AUDIT AND EVALUATION**
6.1 Monitoring....41
6.2 Audit....41
6.3 Evaluation ....41

**7.0 REVISION/UPDATE**
7.1 Procedure for the update of the Intensive Care Nutrition Support....41
Algorithm
7.2 Amending the Intensive Care Nutrition Support Algorithm ....41
if new evidence emerges
7.3 Version control update ....41

**8.0 REFERENCES ....42**

**9.0 APPENDICES ....48**
Appendix I Signature Sheet ....49
Appendix II Membership of the Intensive Care Nutrition Support....50
Algorithm Development Group
Appendix III Declaration of interest Form ....51
Appendix IV Membership of the Approval Governance Group....52
Appendix V Clinical questions in PICO format ....53
Appendix VI NUTRIC score ....54

# PART A: CRITICAL CARE PROGRAMME INTENSIVE CARE NUTRITION SUPPORT ALGORITHM (ADULTS): Process 1

Patient admitted to Intensive Care Unit (ICU)

Assess need for Nutrition Support in all patients daily
**Screen** all patients - **see Note 1**

**Does patient require Nutrition Support? See Note 1**

**Refer** to dietitian for full nutritional assessment - **see Note 2**
***Follow resultant patient-specific nutritional care plan***

**Yes**

**Is enteral nutrition (EN) possible?**
- Is gut accessible and functioning AND
- Is gut capable of absorbing enough nutrition AND
- Is the patient haemodynamically stable?

*EN is recommended over PN and should be commenced if indicated within 24-48hr once stable*

**Consider total or supplemental parenteral nutrition**

**No**

Consider total PN +/- trickle EN or supplemental PN – **See Process 2**

**Yes**

**Can gastric feeding commence?**

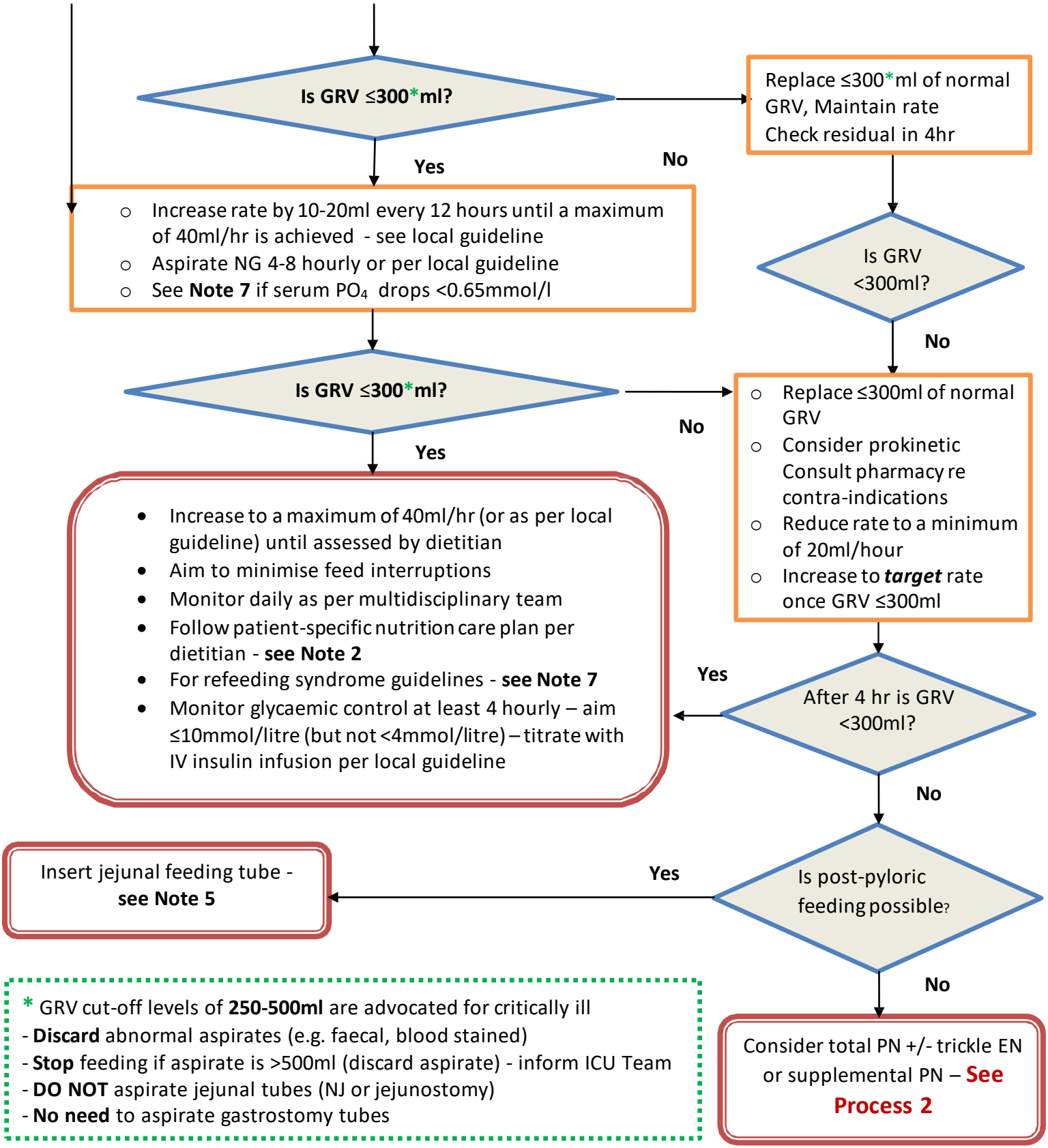
**Yes**

- Place wide bore feeding tube or use existing gastric drainage tube - **see Note 3**
- Confirm tube position prior to feeding, daily or more often, if any signs of tube dislodgement - **see Note 3**
- Commence standard enteral feeding (see local guidelines) at, e.g. 10-20ml/hour - **See Note 4**
- Aspirate NG after 4 hours for Gastric Residual Volume (GRV)

**No**

Is post-pyloric feeding possible?

**Yes**




* GRV cut-off levels of **250-500ml** are advocated for critically ill
- **Discard** abnormal aspirates (e.g. faecal, blood stained)
- **Stop** feeding if aspirate is >500ml (discard aspirate) - inform ICU Team
- **DO NOT** aspirate jejunal tubes (NJ or jejunostomy)
- **No need** to aspirate gastrostomy tubes

**Patients at risk of dysphagia** (e.g. with a tracheostomy, or post-prolonged intubation, or with an underlying medical/surgical diagnosis known to increase risk of dysphagia) should be referred to the **speech and language therapist for a swallow assessment** before PO diet is considered

## PART A: CRITICAL CARE PROGRAMME INTENSIVE CARE NUTRITION SUPPORT ALGORITHM (ADULTS): Process 2

Patient admitted to Intensive Care Unit (ICU) and identified as needing nutrition support **(see process 1)** - and EN is not possible or has failed

- In malnourished or high nutrition risk patients - consider PN initiation within 24-48hr
- In lower nutrition risk patients – consider PN on day 3-4

**Refer** to dietitian
**Inform** specialist parenteral nutrition nurse where available
**Inform** pharmacist - **see Note 6**

- Use dedicated port on existing CVAD (central venous access device), or place new CVAD - confirm position before use
- Avoid femoral vein for PN access where possible

- Commence standard PN regimen- see local guideline
- Infuse over 24 hours
- Commence daily intravenous vitamins and trace elements if not part of PN regimen
- Start PN at low rate, if haemodynamically unstable, or refeeding risk - **see Note 7**
- Increase PN to target rate as clinical condition allows – per dietetic plan or see local out-of-hours guideline
- Adjust PN prescription based on nutritional, biochemical and metabolic monitoring by the multidisciplinary team
- Consider lipid source - avoid pro-inflammatory lipids where possible
- Check lipid profile and liver function tests – monitor triglycerides (weekly or more often)
- Consider additional micronutrient supplementation if high requirement, or excess loss, e.g. large drain outputs, fistula losses, large wounds, renal replacement therapy, or high output stomas
- Avoid micronutrient toxicity e.g. if significant hepatic and renal insufficiency
- **Monitor glycaemic control at least 4 hourly** – aim ≤10mmol/litre – titrate with IV insulin infusion per local protocol

Combine PN with low rate enteral feeding where possible
**Reassess daily for enteral feeding eligibility** - **See Process 1**

- **Once appropriate to commence EN, transition from PN to EN**, weaning down PN while increasing EN, as per dietitian's patient-specific nutrition care plan
- **Avoid overfeeding** during transition from PN to EN
- **Discontinue** PN once **full** EN target rate is achieved

**Note 1: Nutrition screening for all ICU patients**

Screen all ICU admissions to assess nutrition risk and need for nutrition support. NUTRIC or NRS 2002 are suitable screening tools to use. Screening should be performed by a multidisciplinary team member. Consider nutrition support for: malnourished, or hypercatabolic patients, or those at risk of malnutrition; ill patients with expected ICU stay of ≥3 days; PO diet not expected for ≥5 days.

**Note 2: Refer to dietitian**

Nutritional intervention by dietetic staff as part of the intensive care multidisciplinary team has been associated with better provision of nutrition support, and may be associated with improved patient outcomes.

**Note 3: Confirming enteral feeding tube position**

- Only use radio-opaque tubes for enteral feeding. Use ENFit compliant wide bore NG tubes where possible, or use ENFit adapters to connect radio-opaque NG drainage tubes to feed administration sets.
- Obtain radiographic confirmation that any blindly-placed tube (small or large bore) is properly positioned in the GI tract prior to its initial use for administration of feed or medications.
- Bedside pH checks can also be used to check position – **see local guidelines**. Gastric acid suppression therapy may affect pH readings. The NPSA recommends radiological confirmation of NG tubes if pH >5.5.
- Mark the exit site of a feeding tube at the time of initial placement. Observe for a change in the external tube length during feeding.

**Note 4: Feed type, feed administration guidelines and miscellaneous**

- Standard whole protein feeds can be used for most ICU patients. Standard ICU feeds can be 1kcal/ml up to 1.5kcal/ml. Consider use of more specialised feeds, as clinically indicated, such as a renal feed for patients with AKI and CKD that have electrolyte abnormalities.
- Consider additional micronutrient supplementation.
- Closed enteral feeding systems should be used where possible.
- Administration sets for closed system enteral nutrition formulas should be changed per manufacturer guidelines. Giving sets for open systems should be changed at least every 24 hours.
- Use sterile water for flushing tubes or for enteral water infusion.
- Sterile liquid formulas should be used in preference to powdered reconstituted feeds.
- Closed-system enteral nutrition formulas can hang for 24 hours.
- Sterile decanted formulas should have a maximum 8 hour hang-time.
- Reconstituted powdered feeds should have a maximum 4 hour hang-time.
- Store unopened liquid enteral feeds as per manufacturer's guidelines and use before expiry date.
- Consider fine bore NG when patient is stable on NG feeds and all aspirates are normal.
- Enteral nutrition prescriptions should include: patient identifiers, the feed formula, the enteral access device/site, and the administration method and rate.
- A head-of-bed elevation of 30-45$^{o}$ is recommended during feeding, unless contra-indicated.
- Enteral nutrition can commence in surgical patients without waiting for flatus or a bowel motion.
- For bowel management issues – see local guidelines.
- For fasting times for procedures and surgery – see local guidelines.
- For glycaemic control monitoring – see local guidelines.
- For drug administration via enteral feeding tubes – see local guidelines.

**Note 5: Post-pyloric feeding**

- Do not aspirate jejunal tubes. Otherwise follow the feeding guidelines above, or see local guidelines.
- Watch for abdominal distension, or significant feed appearance in *gastric* output, as signs of feed intolerance when feeding via post-pyloric route.
- Nasoenteric feeding tubes can be placed via endoscopy or fluoroscopy. Bedside placement with or without aids, such as an electromagnetic guidance system, should only be performed by clinicians/ health care professionals with experience in the method of bedside NJ placement. X-ray confirmation of position is essential.

**Note 6: Inform pharmacist**

- Manufacture and supply of PN should be co-ordinated with pharmacy staff.
- Early liaison with a pharmacist will help ensure that provision of PN to a patient is optimised, especially with regard to supplementation with macro/micronutrients.
- Pharmaceutical input may be required for supply and administration of specific micronutrient supplements.

**Note 7: Refeeding syndrome:** is a life threatening condition encompassing acute micronutrient deficiencies, fluid and electrolyte imbalances, and disturbances of organ function and metabolic regulation that may result from over-rapid or unbalanced nutrition support provision to malnourished patients.

**NICE 2006 and Friedli et al. 2018: Criteria for determining which patients are at high risk of developing refeeding problems**

| Major risk factors | Minor risk factors | Very high risk factors |
|---|---|---|
| BMI <16 kg/m$^2$ | BMI <18.5 kg/m$^2$ | BMI <14kg/m$^2$ |
| Unintentional weight loss >15% in 3–6 months | Unintentional weight loss >10% in 3–6 months | Unintentional weight loss >20% in 3–6 months |
| Little/no nutritional intake for >10 days | Little/no nutritional intake for >5 days | Little/no nutritional intake for >15 days |
| Low levels of potassium, phosphate, or magnesium prior to feeding | History of alcohol abuse, or drugs including chemotherapy | |
| **Specific patient populations at high risk** | | |
| - Hunger strike, severe dieting<br>- History of bariatric surgery, short bowel syndrome<br>- Tumour patients, frail elderly patients with chronic debilitating disease | | |

**Nutrition support in patients at high risk of refeeding syndrome (NICE 2006; Friedli et al. 2018)**

- Start nutrition support at 10-15kcal/kg/day, increase levels slowly to target over first feeding week (consider 5-10kcal/kg/day in very high risk cases).
- Restore circulatory volume and monitor fluid balance and overall clinical status closely.
- Provide immediately before and during nutrition support:
  - oral thiamine 200–300 mg daily for the first 5-10 days, or
  - full dose daily intravenous vitamin B preparation, Pabrinex® 1and 2, one to two pairs once to three times daily for 3 to 5 days (use the higher more frequent dose for chronic alcohol abusers). Equal volumes of the contents of Pabrinex® ampoules number 1 and 2 should be added to 50 ml to 100 ml physiological saline or 5% glucose and infused over 30-60 minutes.
- Give a balanced multivitamin/trace element supplement once daily for 10 days.
- Consider prophylactic phosphate supplementation if serum phosphate level is in the low normal range. Low electrolyte levels must be supplemented as they occur throughout refeeding per local guidelines.

# PART B: Critical Care Programme Intensive Care Nutrition Support Algorithm (Adults) Development Cycle

## 1.0 INITIATION

### 1.1 Purpose

The purpose of this guideline is to provide the evidence supporting the Critical Care Programme Intensive Care Nutrition Support Algorithm (Adults) – see Part A. This algorithm deals with initial nutrition support provision to Intensive Care Unit (ICU) patients, and is particularly relevant for out-of-hours decision making, or until a full nutritional assessment by an ICU dietitian and the ICU Multidisciplinary Team (MDT) is possible. This is an update of a previously published guideline.

### 1.2 Scope

This reference guideline provides a brief overview of nutrition support provision in ICU, and covers some key considerations that promote the initiation of safe and effective nutrition support in adult patients presenting to ICU. The guideline does not deal with all facets of disease specific nutrition support, with nutrition support provision in long stay ICU patients, or with nutrition support in paediatric patients. This document does not replace clinical judgement or local nutrition support guidelines.

**1.2.1** Target users: This reference guideline and algorithm is developed for the multidisciplinary team involved in providing initial nutritional care to intensive care adult inpatients.

**1.2.2** Population to whom guideline applies: all adult (>16 year old) patients in intensive care units in Ireland.

### 1.3 Objective

The objective of the nutrition support algorithm and reference guideline is to assist and support the ICU clinician and MDT in decision making with respect to nutrition support provision to adult ICU patients, particularly to patients presenting to ICU out-of-hours, and particularly in the absence of any local out-of-hours feeding guideline. It is hoped that this reference guideline and algorithm will support development of local guidelines for ICU, and will motivate clinicians to investigate further the important role of nutrition support in Irish ICUs.

<u>Specific objectives:</u>

1. To provide the rationale for nutrition support provision in ICU.
2. To emphasise the importance of screening for nutrition risk and the individual nutritional assessment of patients.
3. To give an overview of nutritional requirements of ICU patients – including the malnourished, the obese, and patients on renal replacement therapy.
4. To promote the safe management of ICU patients at refeeding syndrome risk.
5. To guide the provision of enteral nutrition (EN) and parenteral nutrition (PN).
6. To outline the importance of the MDT in the nutritional management of ICU patients.

## 1.4 Outcome

The expected outcome is that Irish ICUs will use the algorithm to support local PPPG development. The document promotes the identification of nutrition risk and should lead to more appropriate goal driven nutrition support in those who need it most. This should result in better outcomes for high nutrition risk ICU patients, such as morbidity, mortality, improved rehabilitation, and potential for better quality of life after discharge.

## 1.5 Intensive Care Nutrition Support Algorithm Development Group

See Appendix II for Membership of the Intensive Care Nutrition Support Algorithm Development Group.

See Appendix III for Declaration of Interest form used.

## 1.6 Intensive Care Nutrition Support Algorithm Governance Group

1.6.1 See Appendix IV for Membership of the Approval Governance Group.

## 1.7 Supporting Evidence

1.7.1 International nutrition support guidelines for feeding critically ill patients in intensive care used to inform this reference document:

| |
|---|
| American Society for Parenteral and Enteral Nutrition (ASPEN) 2016 |
| Canadian Clinical Practice Guidelines (CPG) 2015 |
| European Society for Clinical Nutrition and Metabolism (ESPEN) 2019 - which were informed by European Society of Intensive Care Medicine (ESICM) clinical practice guidelines 2017 |

1.7.2 This replaces the previous version of the algorithm and reference document developed in 2012 and updated in 2013.

1.7.3 This complements the Critical Care Programme Model of Care 2014.

## 1.8 Glossary of Terms and abbreviations

### Glossary of terms

**Adult:** This refers to a patient admitted to an adult ward in Hospital. In Irish Hospitals this could mean patients 16 years of age or older. More often, this means patients who are 18 years of age or older.

**Appraisal of Guidelines, Research and Evaluation (AGREE):** An international collaboration of researchers and policy makers whose aim is to improve the quality and effectiveness of clinical practice guidelines (http://www.agreecollaboration.org). The AGREE II tool, developed by the group, is designed to assess the quality of clinical guidelines (NICE, 2006).

**Anthropometry:** The measurement of the human body - includes weight, height and measurement of body composition.

**Audit:** Audit is another means of measuring if compliance with the NCEC National Clinical Guideline has occurred. It can occur at any level, local, regional or national and is measured using agreed audit criteria (DOH, 2019).

**Body Mass Index (BMI):** BMI is a simple index of weight-for-height. It is defined as a person's weight in kilograms divided by the square of their height in meters.

**Clinical question:** In guideline development, this term refers to the questions about treatment and care that are formulated to guide the development of evidence-based recommendations.

**Consensus methods:** Techniques that aim to reach an agreement on a particular issue. In the development of clinical guidelines, consensus methods may be used where there is a lack of strong research evidence on a particular topic. Expert consensus methods will aim to reach agreement between experts in a particular field.

**Dysphagia:** Any impairment of eating, drinking and swallowing.

**Enteral tube feeding/enteral nutrition:** Use of a tube to deliver a feed directly into the stomach or gut.

**Implementation:** This is the carrying out of specific planned, intentional activities undertaken with the aim of making evidence-informed policies and practices work better for people. It can be thought of as the 'how' as well as the 'what' (DOH, 2018).

**Implementation plan:** This comprises of a list of key activities, responsibilities, assumptions, resource requirements, risks and other information required to achieve the desired outcomes from guidelines (DOH, 2018).

**Intervention:** Healthcare action intended to benefit the patient, for example, drug treatment, surgical procedure, psychological therapy.

**Key performance indicators:** Performance indicators are specific and measurable elements of

practice that can be used to assess quality of care. Indicators are quantitative measures of structures, processes or outcomes that may be correlated with the quality of care delivered by the healthcare system (DOH, 2019).

**Monitoring:** Monitoring can be defined as a systematic process of gathering information and tracking over time. Monitoring provides a verification of progress towards achievement of objectives and goals (DOH, 2019).

**Macronutrients:** Nutrients that are used or can be used to supply energy to the body: carbohydrate, protein and fat.

**Malnutrition:** Malnutrition (undernutrition form) is a state of nutrition in which a deficiency of energy, protein and other nutrients causes measurable adverse effects on body structure and function and clinical outcome. Reduced food intake or reduced nutrient absorption, combined with acute or chronic inflammation, leading to altered body composition and diminished function, characterises malnutrition associated with disease or injury (adapted from Elia, 2003; Cederholm et al., 2019; Jensen et al., 2019).

**Micronutrients:** Essential nutrients required by the body in small quantities: vitamins, minerals and trace elements.

**Nutrition assessment:** Nutrition assessment should be performed in all subjects identified as being at risk by nutrition screening for risk of malnutrition, and will give the basis for the diagnosis decision, as well as for further actions including nutritional treatment (Cederholm et al., 2017). It is a comprehensive approach to diagnosing nutritional problems that uses a combination of medical, nutritional and medication histories; physical examination; anthropometric measurements; and laboratory data (Mueller et al., 2011).

**Nutrition care plan:** A nutrition care plan is developed by a dietitian outlining the individual nutritional interventions and outcomes to be monitored. The nutrition intervention chosen is directed to the root cause of the nutrition problem identified by nutrition assessment and is aimed at alleviating the signs and symptoms of the problem (HSE, 2018).

**Nutrition Focused Physical Examination (NFPE):** This is a methodical head-to-toe examination of a patient's physical appearance and function to help determine nutritional status by uncovering signs of malnutrition, nutrient deficiencies and excesses. This forms part of the nutrition care process (NCP).

**Nutrition screening:** In this document nutrition screening refers to malnutrition risk screening. This is a rapid process performed to identify subjects at nutritional risk, and should be performed using an appropriate validated tool in all subjects that come in contact with healthcare services (Cederholm et al., 2017).

**Nutrition support:** The provision of nutrients and any necessary adjunctive therapeutic agents to patients orally and/or enterally by administration into the stomach or intestine and/or by intravenous

infusion (parenterally) for the purpose of improving or maintaining a patient's nutrition status (NICE, 2006).

**Overweight and obesity:** Overweight and obesity can be defined as abnormal or excessive fat accumulation that may impair health. Classification of overweight and obesity in adults is achieved through the use of body mass index (BMI) (Cederholm et al., 2017).

**Parenteral nutrition:** Nutrition provided intravenously, typically involving an infusion of amino acids, glucose, fat, vitamins, trace elements and electrolytes.

**Refeeding syndrome:** Refeeding syndrome refers to biochemical and clinical symptoms and abnormalities caused by shifts in electrolyte and fluid balance in malnourished patients upon recommencement of feeding, both enteral (including oral) and parenteral (IrSPEN, 2013).

**Texture Modified Diet:** Foods that have been physically altered to change their texture/consistency. Within the International Dysphagia Diet Standardisation Initiative framework, there are 5 levels of food textures (Levels 3-7) which include Regular diet (Level 7), Soft Diet (Level 6), Minced and Moist Diet (Level 5), Pureed Diet (Level 4) and Liquidised Diet (Level 3) (HSE, 2018).

**Abbreviations**

| | |
|---|---|
| AGREE II | Appraisal of Guidelines for Research and Evaluation |
| AKI | Acute kidney injury |
| ASPEN | American Society for Parenteral and Enteral Nutrition |
| BMI | Body mass index |
| CKD | Chronic kidney disease |
| CRP | C-reactive protein |
| CRRT | Continuous renal replacement therapy |
| CT | Computerised tomography |
| DHA | Docosahexaenoic acid |
| DOH | Department of Health |
| ECMO | Extracorporeal membrane oxygenation |
| EEN | Early enteral nutrition |
| EN | Enteral nutrition, i.e. enteral tube feeding |
| EPA | Eicosapentaenoic acid |
| ESICM | European Society of Intensive Care Medicine |
| ESPEN | European Society for Clinical Nutrition and Metabolism |

| | |
|---|---|
| FEES | Fiberoptic endoscopic evaluation of swallowing |
| GPICS | Guidelines for the provision of intensive care services |
| GRV | Gastric residual volume |
| HSCP | National Health and Social Care Professions |
| HSE | Health Service Executive |
| IASLT | Irish Association of Speech and Language Therapists |
| ICU | Intensive care unit |
| IDDSI | International Dysphagia Diet Standardisation Initiative |
| INDI | Irish Nutrition and Dietetic Institute |
| IrSPEN | Irish Society for Clinical Nutrition and Metabolism |
| NCEC | National Clinical Effectiveness Committee |
| NG | Nasogastric tube |
| NICE | National Institute for Health and Care Excellence |
| NJ | Nasojejunal feeding tube |
| NFPE | Nutrition focused physical examination |
| NPO | Nil by mouth |
| NRS-2002 | Nutrition Risk Score 2002 |
| NUTRIC | Nutrition risk in the critically ill |
| PICO | Population, intervention, comparator, outcome |
| PN | Parenteral nutrition |
| PSI | Pharmaceutical Society of Ireland |
| PPPG | Policies, procedures, protocols and guidelines |
| RCT | Randomised controlled trial |
| RFS | Refeeding syndrome |
| SGA | Subjective global assessment |
| SIGN | Scottish Intercollegiate Guidelines Network |
| SLT | Speech and Language Therapist |
| VFU | Videofluoroscopy |

## 2.0 DEVELOPMENT OF ALGORITHM

### 2.1 Key clinical questions – See Appendix V for more details.

| | |
|---|---|
| **Key question 1** | ***Q:*** *What nutrition screening tool should be used to diagnose nutritional risk and identify adverse outcomes in adults in intensive care setting?* |
| **Key question 2** | ***Q:*** *What are the indications for, and outcome benefits of using nutrition support (enteral and parenteral), on mortality, ICU readmissions, length of ICU and hospital stay, complications/ morbidity, quality of life, nutritional status and functional status in adult intensive care patients considered at risk of malnutrition?* |
| **Key question 3** | ***Q:*** *What methods of assessment should be used to monitor efficacy and effectiveness of enteral and parenteral nutrition in adult patients in intensive care?* |
| **Key question 4** | ***Q:*** *What is the preferred timing, content and dosing of nutrition support that is associated with better outcomes in adult patients in intensive care?* |

### 2.2 Literature search strategy

The group did not have access to an information specialist. Research questions were developed by the Irish ICU Dietitians Group in PICO (population, intervention, comparator, outcome) format. Four subgroups were formed. Existing international guidelines on nutrition support in ICU, already used to guide practice in Ireland, were checked against these questions. Members of subgroups reviewed the recent literature for randomised controlled trials (RCTs), systematic reviews and other guidelines of relevance.

### 2.3 Appraising evidence

An AGREE II tool was applied to the three existing international guidelines (ESPEN 2019; ASPEN 2016; Canadian Practice Guidelines updated 2015). Subgroups of four ICU dietitians applied the tool to each guideline. This was collated by one individual and results were presented to the full group. All guidelines scored well on rigour of development and were considered suitable as sources of evidence for the current document.

Any additional systematic reviews or RCTs used in this document were assessed for risk of bias using the Scottish Intercollegiate Guidelines Network (SIGN) quality checklist for systematic reviews and randomised controlled trials. This was applied independently by two dietitians.

### 2.4 Process used to formulate algorithm recommendations

The algorithm was based on recommendations from the identified international guidelines, giving consideration to the evidence base, the quality of evidence outlined, that were feasible and acceptable in the Irish healthcare setting, with consideration

given to potential harms and benefits. Consensus was reached at subgroup level. The recommendations were then discussed at full group level and unanimous consensus was reached for the algorithm.

## 2.5 Summary of the evidence

### 2.5.1 Introduction

Critically ill patients have complex nutritional needs and require intensive nutritional input. As part of the metabolic response to injury, resting energy expenditure may be altered, leading to extensive catabolism, hyperglycaemia, progressive lean body mass loss, changes in serum trace element levels, fluid retention, and reduced synthesis of visceral proteins such as albumin. Contributing to poorer outcome is the previously reported high prevalence of malnutrition in Intensive Care Unit (ICU) patients (Sheean et al., 2010).

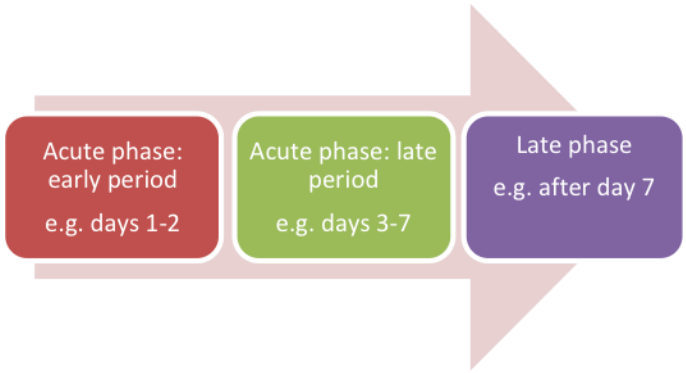
Catabolism combined with malnutrition can lead to several unwanted clinical sequelae:

- Impaired wound healing.
- Impaired immune response.
- Impaired coagulation capacity.
- Impaired gut function.
- Muscle wasting.
- Reduced respiratory muscle function.

Evidence suggests that nutrition support can slow catabolism in ICU patients (Singer et al., 2019). Cumulative caloric debt is associated with poorer outcomes (Singer et al., 2019). The use of evidence-based nutrition support guidelines has been associated with better outcomes (Martin et al., 2004; Alberda et al., 2009; Heyland et al., 2010a; McClave et al., 2016; Berger et al., 2018).

The recent ESPEN guidelines (Singer et al., 2019) highlight the importance of recognising different phases of critical illness when considering route, timing and dose of nutrition support. Phases include: early acute phase, late acute phase and rehabilitation or chronic phase (i.e. post-acute phase) – see Figure 1.

**Figure 1:** Phases of critical illness




The early acute phase is defined by metabolic instability and severe increase in catabolism. The late acute phase is defined by significant muscle wasting and stabilisation of metabolic disturbances. The duration of the early and late acute phase will vary from patient to patient. The post-acute phase,

known as the late phase, follows with improvement and rehabilitation or persistent inflammatory /catabolic state and prolonged hospitalisation. Chronically critically ill patients are defined as patients with persistent organ dysfunction requiring ICU care for greater than 21days (McClave et al., 2016).

The overall goal of feeding ICU patients is to provide nutrition support to those who need it, consistent with their medical condition, nutritional status, metabolic capability and available route of administration, while avoiding the adverse effects of underfeeding or overfeeding. Minimising further nutritional deterioration while avoiding complications of nutrition support such as overfeeding, especially in the early acute phase of critical illness, is a vital consideration for every ICU patient (Singer et al, 2019).

### 2.5.2 Impact of an intensive care dietitian

The dietitian is considered central to the provision of nutrition support and is best placed to provide nutritional advice to the multi-professional team on the optimal way to manage the nutritional needs of critically ill patients (Alberda et al., 2009). Data from international multicentre prospective observational studies show a direct correlation between the total number of funded dietitians in intensive care and improved patient care (Alberda et al., 2009; Heyland et al., 2010b; Soguel et al., 2012). The presence of a dietitian was associated with top performance (Heyland et al., 2010a), and was considered a primary enabling factor that affected adherence to internationally recognised nutrition guidelines in ICU (Heyland et al., 2010c; Cahill et al., 2010).

Inserting feeding tubes, using indirect calorimetry to determine energy expenditure and supplementary prescribing where appropriate, have been put forward as considerations for extended scope of practice for experienced ICU dietitians (Guidelines for the Provision of Intensive Care Services, 2019). See Section 5 for guidance on roles and responsibilities.

### 2.5.3 Nutrition screening for nutrition risk in intensive care

All patients should be screened on admission to ICU to assess their nutrition risk and the need for nutrition support. ESPEN (Singer et al., 2019) puts forward a pragmatic approach to determine risk, which includes patients:

- Staying in ICU for more than two days.
- Undergoing mechanical ventilation.
- Underfed for more than five 5 days.
- With a severe chronic disease.

Nutrition screening tools for use in ICU patients should ideally consider an injury severity score (McClave et al., 2016), such as:

- The “nutrition risk in the critically ill” score (NUTRIC score) (Heyland et al, 2011) – validated in ICU – see Appendix 1.
- Nutritional Risk Score 2002 (NRS-2002) (Kondrup et al, 2003) – awaits validation in ICU.

### 2.5.4 Assessment and requirements in intensive care

Initial assessment is a diagnostic process to identify and quantify risk/presence of malnutrition and risk of associated complications. Before initiating nutrition support, a nutritional assessment should be carried out. This should consider (White et al., 2012):

- Goals of nutrition support.
- Nutritional requirements.
- Clinical diagnosis, history and co-morbidities.
- Nutrition focused physical examination.
- Body composition and anthropometry.
- Laboratory indices.
- Previous nutritional intake.
- Functional assessment (if applicable).
- Evaluation of nutrient losses and gains.

In the critical care setting, the traditional protein markers such as albumin, prealbumin, transferrin and retinol binding protein are a reflection of the acute phase response and do not accurately represent nutritional status. Requirements should be assessed individually and provided according to tolerance and phase of critical illness. Overfeeding critically ill patients can have detrimental effects on outcome. Conversely, persistent underfeeding has been associated with increasing complications. Over aggressive feeding during the early acute phase of critical illness may also promote adverse outcome effects.

ESPEN (Singer at al., 2019) recommends slow increase in the dose of nutrition support for the first 48hr or early acute phase of critical illness, with increase to full feeding progressively from day three. See Table 1 for proposed nutritional management according to phase of illness. In contrast to this, ASPEN (Mc Clave et al., 2016) suggests that high nutrition risk patients should reach >80% of calculated goal energy and protein targets within 48-72hours, while monitoring for refeeding syndrome.

A summary of macronutrient requirements (full feeding) are summarised in Table 2. Validated equations used to calculate energy requirements in the critically ill are shown in Table 3. ESPEN (Singer et al., 2019) recommends use of indirect calorimetry over predictive equations. In the absence of indirect calorimetry, using $VO_2$ (oxygen consumption) from a pulmonary artery catheter, or $VCO_2$ (carbon dioxide production) from certain ventilator types, are considered superior to using predictive equations (Singer at al., 2019).

**Table 1** Proposed nutrition therapy according to phase of critical illness (to be used as a guide and not to replace clinical judgement)

| | Days* in ICU | Kcal Goal | Protein Goal | Considerations |
|---|---|---|---|---|
| **Early Acute** | 0-2 | ≤15-20 kcal/kg | ≤1g/kg | **Energy:**<br>Include non-nutritional energy sources.<br>Consider endogenous energy production and patient's capacity to mount this response. Unclear whether a very malnourished patient/starved patient will produce as much endogenous glucose as a well-nourished acutely unwell patient.<br>Consider refeeding syndrome risk.<br>Consider contraindications to feeding/feeding other than trickle feeding. |

| | | | | |
|---|---|---|---|---|
| | | | | **Protein:**<br>Unknown whether patients with high losses, e.g. on CRRT, or with large wounds need more in first 2 days. |
| **Late Acute** | 2-7 | 20-25 kcal/kg | 1.2-1.5g/kg | **Energy:**<br>Include non-nutritional kcal sources.<br>Consider refeeding syndrome risk.<br>Consider patients clinical status, more caution in patients who are sicker/not improving/deteriorating compared to less caution in patients who are improving.<br>**Protein:**<br>Progressive increase to target. Aim for more protein in patients with losses (e.g. CRRT, wounds, steroids, high drain outputs).<br>Consider renal function if not on CRRT. |
| **Post-acute chronic phase** | 7+ | 25-30 kcal/kg | 1.5-2g/kg | **Energy:**<br>Progressive increase to target.<br>Monitor for signs of overfeeding.<br>**Protein:**<br>Protein targets in ICU patients remain unclear.<br>Aim for more protein in patients with losses (e.g. CRRT, wounds, steroids, high drain outputs).<br>Consider renal function if not on CRRT. |
| **Post-acute rehabilitation phase** | 7+ | 25-30+ kcal/kg | 1.5-2g/kg | **Energy:**<br>Monitor for overfeeding.<br>Consider activity level, amount and type of physiotherapy.<br>Monitor dry weight; functional status e.g. hand dynamometry and physical status (NFPE/SGA) if trained.<br>**Protein:**<br>Consider renal function if not on CRRT.<br>Consider activity level, amount and type of physiotherapy.<br>Monitor functional status e.g. hand dynamometry and physical status (e.g. NFPE/SGA) if trained. |

***Key:*** *CRRT – continuous renal replacement therapy; NFPE – nutrition focused physical examination; SGA – subjective global assessment.*

**Number of days is only a guide, each patient's critical illness journey will differ. Critical illness may have commenced prior to ICU admission, or a few days into ICU admission. Acute phases may recur, e.g. new sepsis in a previously stable patient.*

**Table 2** Macronutrient requirements in ICU

| Nutrient | Recommendation | Guideline Source |
|---|---|---|
| **Energy** | Use 25-30kcal/kg, or predictive equations, or indirect calorimetry | ASPEN 2016 |
| | Hypocaloric feeding in early acute phase:<br>- ≤20kcal/kg<br>- ≤70% of requirements | ESPEN 2019 |
| | 20-25kcal/kg<br>Carbohydrate provision should not exceed 5mg/kg/minute<br>Fat provision should not exceed 1.5g fat/kg and should be adapted to individual tolerance | ESPEN 2019 |
| | Consider hypocaloric feeding in critically ill obese (BMI >30kg/m$^2$), e.g. not | ASPEN 2013 |

| | | |
|---|---|---|
| | greater than 65-70% of target energy requirements, or 11-14kcal/kg actual body weight, or 22-25kcal/kg ideal weight if BMI >50kg/$m^2$ | ASPEN 2016 |
| | Use indirect calorimetry in critically ill obese<br>In absence of indirect calorimetry, consider adjusted body weight or ideal body weight at BMI of 25kg/$m^2$ | ESPEN 2019 |
| **Protein** | 1.3/kg delivered progressively<br>Aim 1.5-2g/kg in trauma<br>Physical activity may improve the beneficial effects of nutrition support | ESPEN 2019 |
| | 1.2-2g/kg | ASPEN 2016 |
| | In critically ill obese 1.2g/kg or 2-2.5g/kg ideal weight<br>2.5g/kg ideal weight if BMI >40kg/$m^2$<br>In critically ill obese, use urinary nitrogen loss as a guide or lean body mass determination (using CT or other tools), or 1.3g/kg adjusted body weight or ideal body weight at BMI of 25kg/$m^2$ | ASPEN 2013<br>ASPEN 2016<br>ESPEN 2019 |
| | Caution with excess nitrogen in severely ill | NICE 2006 |
| **Protein in AKI** | 1.2-2g/kg** | ASPEN 2016 |
| | Upto 2.5g/kg if on CRRT | ASPEN 2016 |
| | Protein should not be restricted | ASPEN 2016 |

***Key:*** *ASPEN – American Society for Parenteral and Enteral Nutrition; ESPEN – European Society for Clinical Nutrition and Metabolism; NICE – National Institute for Health and Care Excellence; AKI – acute kidney injury; BMI – body mass index; CT – computerised tomography; CRRT – continuous renal replacement therapy.*

**__Adjusted body weight:__ add 20-25% of excess weight (actual-ideal weight) to ideal body weight. The use of adjusted body weight for obese patients is not validated. **In conservative management of AKI, consider initial provision of protein in lower range - titrate up depending on clinical condition and tolerance.*

**Table 3** Sample validated energy requirement equations used in the ICU (Mifflin, 1990; Ireton Jones, 1992 and 2002; Faisy, 2003; Frankenfield 2004, 2009 and 2011)

| Author and Year | Equation |
|---|---|
| **Ireton-Jones 1992**<br>*for spontaneously breathing patients* | EEE (s) = 629 - 11(A) + 25(W) - 609(O) |
| **Ireton-Jones 2002 (revised 1997)**<br>*for ventilated patients* | EEE (v) = 1784 - 11(A) + 5(W) + 244(G) + 239(T) + 804(B) |
| **Penn State 2003**<br>*using Mifflin St. Jeor* | RMR= Mifflin-St Jeor (0.96) + $T_{max}$(167) + $V_E$(31) - 6212 |
| **Modified Penn State 2010**<br>*for ≥60year olds with BMI ≥30kg/$m^2$* | RMR = Mifflin-St Jeor (0.71) + $T_{max}$(85) + $V_E$(64) - 3085 |
| ***Mifflin St. Jeor 1990***<br>*for use with Penn State equation* | *Men: 10(weight) + 6.25(height) – 5(age) + 5*<br>*Women: 10 (weight) + 6.25(height) ) – 5(age) - 161* |
| **Faisy Fagon (2003)**<br>*for more stable patients* | Weight (8)+Height (14) +$V_E$(32) +Temperature(94) -4834 |

***Key:*** *EEE is estimated energy expenditure (kcal/24hr.); v is ventilator dependent; s is spontaneously breathing; A is age (years); W is body weight (kg); G is gender (male=1, female=0); T is diagnosis of trauma (present=1, absent=0); B is diagnosis of burn (present=1, absent=0); O is obesity (>30% above IBW from Metropolitan Life Insurance Tables, present=1, absent=0); RMR= Resting Metabolic Rate; Tmax is maximum body temperature in the previous 24 hours (degrees Celsius); Ve is expired minute volume (litres per minute)at the time of measurement read from the ventilator. Height in cm.*

### 2.5.5 Feeding the malnourished patient

Refeeding syndrome (RFS) is a life threatening condition encompassing acute micronutrient deficiencies, fluid and electrolyte imbalances, and disturbances of organ function and metabolic regulation that may result from over-rapid or unbalanced nutrition support provision to malnourished patients.

Effects of RFS (Boland et al., 2014; Friedli et al., 2018) include:

- Hypophosphatemia.
- Sodium and water retention.
- Hypokalaemia.
- Hypomagnesaemia.
- Altered glucose metabolism - hyperglycaemia.
- Thiamine deficiency.
- Cardiac failure, pulmonary oedema and dysrhythmias.
- Risk of death.

Diagnostic criteria for RFS:

***Imminent RFS*** *(Friedli et al., 2018):* where a shift in electrolytes (decrease in $PO_4$ from baseline of >30% or <0.6mmol/l, or any two other electrolyte shifts below normal range), occurs within 72hr after start of nutrition therapy.

***Manifest RFS*** *(Friedli et al., 2018):* where any electrolyte shifts occurs in conjunction with typical clinical symptoms, including tachycardia, tachypnoea and peripheral oedema. Other manifestations of RFS include hyperglycaemia (related to hypophosphatemia), and those related to thiamine deficiency including: congestive cardiac failure, pulmonary oedema, lactic acidosis, GI disturbances, and neurological disturbances.

***Risk criteria specific to ICU*** *(Singer et al., 2019):* ESPEN suggests that refeeding hypophosphatemia is a warning signal for refeeding syndrome in ICU patients. This is defined as a drop in phosphate to below 0.65mmol/l, or a drop of 0.16mmol/l within 72 hours of refeeding. Other reasons for hypophosphatemia should be considered, including continuous renal replacement therapy, and the use of insulin to achieve tight glycaemic control.

***Other suggested diagnostic criteria*** *(da Silva et al., 2020):* ASPEN proposes that RFS diagnostic criteria be stratified as follows: a decrease in any 1, 2, or 3 of serum phosphorus, potassium, and/or magnesium levels by 10%–20% (mild), 20%–30% (moderate), or >30% and/or organ dysfunction resulting from a decrease in any of these and/or due to thiamine deficiency (severe), occurring within 5 days of reintroduction of calories.

***RFS Risk Factors:*** See Table 4 for RFS risk factors.

***High risk***: defined as 1 major or two minor risk factors; ***Low risk:*** defined as 1 minor risk factor.

**Table 4** Initial risk assessment (adapted from NICE 2006 and Friedli et al., 2018)

| Major risk factors | Minor risk factors | Very high risk factors |
|---|---|---|
| BMI <16 kg/m$^2$ | BMI <18.5 kg/m$^2$ | BMI <14kg/m$^2$ |
| Unintentional weight loss >15% in 3–6 months | Unintentional weight loss >10% in 3–6 months | Unintentional weight loss >20% in 3–6 months |
| Little/no nutritional intake for >10 days | Little/no nutritional intake for >5 days | Little/no nutritional intake for >15 days |
| Low levels of potassium, phosphate, or magnesium prior to feeding | History of alcohol abuse, or drugs including chemotherapy | |
| **Specific patient populations at high risk** | | |
| - Hunger strike, severe dieting<br>- History of bariatric surgery, short bowel syndrome<br>- Tumour patients, frail elderly patients with chronic debilitating disease | | |

***Key:*** *BMI – body mass index.*

Nutrition support in patients at risk of RFS

Protocolised caloric restriction has been shown to be a suitable therapeutic option for critically ill patients in ICU who develop refeeding issues. A randomized, parallel-group, multicentre, single-blind controlled trial comparing restricted vs standard caloric intake for the management of refeeding syndrome in ICU adult patients (Doig et al., 2015), demonstrated that caloric restriction was associated with improved clinical outcomes. This was further supported by a retrospective study by Olthof et al (2017).

Nutrition support in patents at low RFS risk (NICE 2006; Friedli et al., 2018)

Introduce nutrition support at no more than 15-25 kcal/kg/24 hours initially (Friedli et al., 2018). Increase to target if clinical and biochemical monitoring reveals no refeeding issues.

Nutrition support in patients at high RFS risk (NICE 2006; Boland et al., 2014; Friedli et al., 2018)

- Start nutrition support at approximately 10-15 kcal/kg/day, increase levels slowly to target over first feeding week. Consider 5-10 kcal/kg/day in extreme cases.
- ESPEN (Singer at al., 2018) recommends reduced energy supply for 48 hours with a gradual increase for ICU patients with refeeding hypophosphatemia.
- Restore circulatory volume and monitor fluid balance and overall clinical status closely.
- Provide immediately before and during nutrition support: oral thiamine 200–300 mg daily for the first 5-10days, or full dose daily intravenous vitamin B preparation, Pabrinex® 1and 2, one to two pairs once to three times daily for 3 to 5 days (use the higher more frequent dose for chronic alcohol abusers). Equal volumes of the contents of Pabrinex® ampoules number 1 and 2 should be added to 50 ml to 100 ml physiological saline or 5% glucose and infused over 30-60 minutes.
- Give a balanced multivitamin/trace element supplement once daily for 10days.
- Provide oral, enteral or intravenous supplements of potassium, phosphate and magnesium unless pre-feeding plasma levels are high (in accordance with local hospital policies/protocols on electrolyte replacement). Low electrolyte levels must be supplemented as they occur throughout refeeding as per local Hospital PPPG.

### 2.5.6 Feeding the obese critically ill patient

There is an increasing prevalence of obesity in hospitalised patients. The obese, critically ill patient may be expected to have a greater number of underlying co-morbidities and subsequently more complications than lean counterparts. The effect of obesity on ICU and hospital mortality is both controversial and uncertain (Choban et al., 2013). Specialised equipment should be acquired to manage the unique impact of obesity on delivery of care in the ICU. ASPEN critical care guidelines (McClave et al., 2016) provide guidance on the management of obese critically ill patients, based on expert consensus. ASPEN guidance suggests that:

1. Early EN start within 24 to 48 hours of admission to the ICU for obese patients who cannot sustain volitional intake.
2. Nutrition assessment of the obese ICU patient focus on biomarkers of metabolic syndrome, an evaluation of comorbidities, and a determination of level of inflammation, in addition to those parameters described for all ICU patients.
3. A high protein enteral formulation to be considered in the adult obese ICU patient.
4. Additional monitoring to assess worsening of hyperglycaemia, hyperlipidaemia, hypercapnia, fluid overload, and hepatic fat accumulation in the obese.
5. The obese ICU patient with a history of bariatric surgery, receive supplemental thiamine prior to initiating dextrose-containing IV fluids or nutrition therapy. In addition, evaluation for and treatment of micronutrient deficiencies such as calcium, thiamine, vitamin B12, fat soluble vitamins (A, D, E, K), and folate, along with the trace elements iron, selenium, zinc, and copper, should be considered.

### 2.5.7 Nutrition support implications for patients with acute kidney injury (AKI) on renal replacement therapy (RRT)

- Nutritional status is considered a significant contributor to outcome in ICU patients with acute kidney injury (AKI). Concurrent stress, degree and duration of renal impairment and treatment modality effect nutritional status in these patients.
- Oedema-free/dry weight should be used for assessing requirements where possible.
- ASPEN (2016) guidance suggests that standard ICU recommendations for protein and energy provision should be followed for patients with AKI.
- A standard feeding solution should be used in AKI and for patients on continuous renal replacement therapy (CRRT). If significant electrolyte abnormalities develop, a renal feed is indicated (McClave et al., 2016).
- Continuous RRT is commonly used in ICU. Citrate CRRT or heparin CRRT may be used and will impact nutritional status – see Table 5.
- Filter type, CRRT dose, blood flow rate, CRRT mode, anticoagulation agent, and type of replacement and dialysate fluids should be considered when devising a nutrition support regimen (Nystrom and Nei, 2018).

**Table 5** Nutritional impact of Continuous Renal Replacement Therapy (CRRT)

| Nutrient | Impact |
|---|---|
| **Energy** | Lower temperature reduces energy expenditure (Maursetter et al., 2011)<br>CRRT buffering and anticoagulant agents provide energy:<br>- Lactate: 8 kcal per 30 mmol<br>- Citrate: 0.59 kcal per mmol |
| **Protein** | Loss of 10-17% of centrally infused amino acid infusion (Wooley, 2005) |
| **Glucose** | Dialysate with concentration of >1% dextrose results in net glucose absorption (Wiesen et al., 2011)<br>With glucose poor solutions (Wooley, 2005; Maursetter et al, 2011; Wiesen et al, 2011)<br>- Loss of 40-80 g glucose/day possible<br>- Loss reduced by tight glycaemic control |
| **Electrolytes** | Hypocalcaemia is a major complication of citrate CRRT (Wooley, 2005)<br>Hypomagnesaemia is a complication of citrate CRRT (Wooley, 2005)<br>Hypokalaemia and hypophosphatemia are common with all forms of CRRT<br>Protocol-based orders for potassium, magnesium, and phosphate supplementation while on CRRT, and separate calcium infusion (if on citrate CRRT) is recommended (Nystrom and Nei, 2018) |
| **Micronutrients** | Loss of micronutrients can occur in association with all forms of CRRT and should be supplemented* (Cano et al., 2006; Cano et al., 2009; Brown et al., 2010; Berger et al., 2018) |

*Key: CRRT, continuous renal replacement therapy.*

*Suggested daily additional supplementation if CRRT (INDI, 2015): 1mg folate, 10mg pyridoxine, 25-100mg thiamine, maximum of 200mg vitamin C, 100ug selenium. Consider copper status if on CRRT >2weeks (Berger 2018).

### 2.5.8 Enteral Nutrition (EN)

Enteral feeding is the preferred route of feeding for ICU patients if PO diet is not possible or insufficient (McClave et al., 2016; Singer et al., 2019; Canadian Clinical Practice Guidelines, 2015). Evidence suggests enteral feeding helps to:

- Maintain gut integrity.
- Prevent gut stasis.
- Maintain gut mass.
- Maintain gut associated lymphoid tissue.
- Prevent stress ulceration.
- Modulate the stress response.
- Reduce mortality and infection rates.

Early enteral nutrition (EEN) (within 24-48 hours of ICU admission) benefits ICU patients (McClave et al., 2016; Singer et al., 2019; Canadian Clinical Practice Guidelines, 2015). See Table 6 for general principles recommended for EEN in critically ill patients. See Table 7 for a list of distinct circumstances where EN may need to be delayed, commenced at low rate only and where it should be attempted prior to use of PN.

**Table 6** General principles for early enteral nutrition (EEN) adapted from ESICM clinical practice guidelines (Reintam-Blaser et al., 2017) and ESPEN monitoring guidelines (Berger at al., 2018)

| General principles and precautions for using EEN in critically ill patients at risk of intolerance | |
|---|---|
| **Starting and continuing EEN** | See Table 7. |
| **Energy target during EEN** | Do not aim to cover full energy target with EEN. The optimal energy and protein target in the early phase of acute critical illness is not known. EEN that exceeds actual energy expenditure appears harmful and should be avoided, whereas hypocaloric EEN may be safe. |
| **Monitoring and protocolised management of GI dysfunction during EEN** | In case of gastric retention without other new abdominal symptoms use prokinetics and/or postpyloric feeding in a protocolised way.<br>Measurement of intra-abdominal pressure (IAP) provides an additional numeric value to detect incipient abdominal hypertension during EN. It is used in patients with severe abdominal pathology, hypoperfusion or fluid overload. Increasing values should not lead to automatic discontinuation of EN unless it is evolving into a clear abdominal compartment syndrome, rather a signal to be cautious with increasing EN rate. Values of 20mgHg should be considered as a limitation to EN starting/progressing. |
| **Individualised approach** | For patients with diminished consciousness and inadequate swallowing, precautions to prevent aspiration of gastric contents may be useful, including considering postpyloric feeding.<br>Premorbid health and course of the acute illness may differ between patients with similar diagnoses; therefore an individual approach should always be applied. |

**Table 7** Guidance on delaying, commencing low dose or commencing early progressive enteral nutrition (EN) adapted from ESICM guidelines (Reintam-Blaser et al., 2017) and ESPEN guidelines (Singer at al., 2019)

| Contraindications to EN/consider delaying EN | Consider giving only low dose EN initially | EN should be attempted prior to PN in: |
|---|---|---|
| Uncontrolled shock/tissue perfusion goals not met/high and rising vasopressor requirement (high vasopressors not clearly defined in literature but generally >0.5mcg/kg/min or >30mcg/min (Arabi and McClave, 2018); persistent lactic acidosis may help identify uncontrolled shock | When shock is controlled with fluids and stable or decreasing doses of vasopressors | Sepsis (after haemodynamic stabilisation) |
| Uncontrolled life-threatening hypoxaemia, hypercapnia and acidosis | Patients receiving therapeutic hypothermia, increase dose after re-warming | Stable hypoxaemia and compensated or chronic/subacute/permissive hypercapnia and acidosis |
| Active GI bleeding (but start EN | Acute liver failure where acute, | GI bleeding during the first 24-48h after |

| | | |
|---|---|---|
| during first 24-48h after bleeding has stopped/no signs of re-bleeding) | immediately life-threatening metabolic derangements are controlled with or without liver support strategies, independent of grade of encephalopathy (arterial ammonia levels should be monitored) | the bleeding has stopped and no signs of re-bleeding are observed. Prolonged postponement may be harmful because of increased risk of stress ulceration. There is no evidence that fine bore nasogastric tubes cause variceal bleeding. |
| Overt bowel ischaemia (patients with endoscopic evidence of mild to moderate large bowel ischaemia, without signs of transmural ischaemia or bowel distension, might profit from low dose EN) | Patients with endoscopic evidence of mild to moderate large bowel ischaemia, without signs of transmural ischaemia or bowel distension, might profit from low dose EN | Absent bowel sounds (unless bowel ischaemia or obstruction suspected) |
| Abdominal compartment syndrome | | Intra-abdominal hypertension without abdominal compartment syndrome but consider temporary reduction or discontinuation of EN if intra-abdominal pressure values further increase on EN |
| Bowel obstruction/suspected bowel obstruction | | Traumatic brain injury |
| High output fistula if not able to feed distal to fistula (EN intolerance, increasing fistula output causing skin breakdown or fluid/electrolyte imbalance are reasons to decrease or discontinue EN) | | Stroke (haemorrhagic or ischaemic) |
| GRV>500ml/6h (consider post-pyloric feeding unless bowel ischaemia or obstruction is suspected) | | Spinal cord injury |
| | | ECMO |
| | | Prone position therapy (consider early use of prokinetics followed by post-pyloric feeding in case of persisting gastric retention) |
| | | Neuromuscular blocking agents such as atracurium, rocuronium |
| | | GI surgery including anastomosis or re-anastomosis, unless bowel discontinuity |
| | | Abdominal aortic surgery unless bowel ischaemia is suspected |

| | |
|---|---|
| | Severe acute pancreatitis |
| | Abdominal trauma where bowel continuity is confirmed/restored |
| | Open abdomen |
| | Diarrhoea (analyse cause and treat appropriately) |
| | In jejunostomy feeding use continuous feeding rather than bolus feeding, and slow build-up of feeding rate |

***Key:*** *EN – enteral nutrition; h – hour(s); ECMO - extracorporeal membrane oxygenation.*

**Enteral access choice**

- Use gastric access as standard (McClave et al., 2016; Singer et al 2019).
- If gastric feeding intolerance is not solved by prokinetics, use postpyloric feeding (McClave et al., 2016; Singer et al 2019).
- In those at high risk of aspiration consider postpyloric feeding, mainly jejunal feeding (Canadian Clinical Practice Guidelines, 2015; Singer et al., 2019).
- Consider percutaneous feeding with prolonged feeding (Berger et al., 2018).

**Confirming nasogastric tube position**

- Radiographic confirmation of correct positioning of any blindly-placed tube (small or large bore) should be obtained prior to its initial use for administration of feed or medications (Boullata et al., 2017; Ukleja et al., 2018).
- Bedside pH checks can also be used to check position using pH strips (Duggan et al., 2008). Gastric acid suppression therapy may affect pH readings. The National Patient Safety Agency (NPSA) recommends that a pH of <5.5 confirms gastric position (NPSA, 2005). The NPSA recommend radiological confirmation of nasogastric tubes if pH is >5.5. Refer to local policy.
- The exit site of a feeding tube should be marked at the time of initial placement. Observe for a change in the external tube length during feeding (Boullata et al., 2017).
- In adult patients the auscultatory method should not be relied upon to differentiate between gastric and respiratory placement of feeding tubes (Boullata et al., 2017).

**Enteral feeds**

- Enteral feeds are better metabolically handled, and cost less than parenteral nutrition.
- Standard feeds, rather than disease-specific feeds, are appropriate for most ICU patients (McClave et al., 2016; Canadian Clinical Practice Guidelines, 2015).
- An energy dense enteral feeding regimen improved energy delivery, but did not improve or worsen outcomes in the TARGET trial (TARGET Investigators, for the ANZICS Clinical Trials Group, 2018).
- Arginine supplemented feeds are not recommended in severely septic patients due to possible adverse effects on outcome (Rhodes et al., 2017). Immune modulating feeds are not recommended (Van Zanten et al., 2014; McClave et al., 2016).

- Standard feed formulations, rather than low electrolyte or renal-specific feeds are appropriate for the majority of patients with AKI on CRRT (Cano et al., 2006; McClave et al., 2016). Consider renal feeds if uncontrolled electrolyte derangements (Cano et al., 2006; McClave et al., 2016).
- The routine addition of enteral glutamine is not recommended routinely in critically ill patients. Consider in burns and trauma patients (Singer et al., 2019).
- There is insufficient data to recommend the use of hydoxyl methyl butyrate (HMB), IV branch chain amino acids (BCAAs), ornithine ketoglutarate (Canadian Clinical Practice Guidelines, 2015).
- Omega-3 enriched EN within nutritional doses (500mg/day) can be given. Enteral omega-3 should not be given by bolus. High dose omega-3 enriched EN should not be given routinely (Singer et al., 2019).

**Feed administration guidelines**

- Closed enteral feeding systems should be used where possible (Ukleja et al., 2018).
- Use continuous rather than bolus EN (Singer et al. 2019).
- ENFit compliant administration sets and syringes for closed system enteral nutrition formulas should be changed per manufacturer guidelines. Giving sets for open systems should be changed at least every 24 hours. Consider safety benefits of using ENFit compliant enteral feeding tubes.
- Use sterile water for flushing tubes or for enteral water infusion. Flush feeding tubes regularly (Boullata et al., 2017).
- Sterile liquid formulas should be used in preference to powdered reconstituted feeds (Boullata et al., 2017).
- Closed system enteral nutrition formulas can hang for 24 hours (Boullata et al., 2017).
- Sterile decanted formulas should have a maximum 8 hour hang-time (Boullata et al., 2017).
- Reconstituted powdered feeds should have a maximum 4 hour hang-time (Boullata et al., 2017).
- Store unopened liquid enteral feeds as per manufacturer's guidelines and use before expiry date.
- Enteral nutrition prescriptions should include: patient identifiers, the feed formula, the enteral access device/site, and the administration method and rate (Ukleja et al., 2018).
- A head-of-bed elevation of 30 to 45$^{o}$ is recommended during feeding, unless contra-indicated (Ukleja et al., 2018).

**Strategies to improve enteral feeding tolerance**

<u>Gastric residual volumes (GRV) monitoring</u>:

Traditionally in the ICU setting, a measurement of EN tolerance using GRV monitoring is carried out at regular intervals and feed rate is reduced or suspended if levels are above an agreed cut-off. Abandoning this practice as routine care has been suggested in the ASPEN guidelines (2016). GRV measurement correlates poorly with gastric emptying, as well as incidence of regurgitation and aspiration (Reignier et al., 2013), and has been shown to contribute to reduced EN delivery (Montejo et al., 2010). However, evidence for omission of GRV measurement is largely based on one trial

where difficult to feed patients, i.e. multi-organ failure, surgical patients were under-represented. For this reason, the Canadian Clinical Practice Guidelines (2015) and ESPEN (2019) still recommend a GRV cut off level between 250-500ml and that measurement is done at 4-8 hourly intervals – see Table 8. When EN is established continued GRV monitoring may not be necessary.

**Table 8** Cut-off values for gastric residual volumes (GRV)

| GRV cut-off recommendation for enteral feeding in ICU | Source of recommendation |
|---|---|
| GRV measurement not recommended for routine care.<br>If measuring GRV - do not withhold feed unless >500ml or there are other signs of intolerance. | American Society for Parenteral and Enteral Nutrition (ASPEN) Guidelines 2016 |
| 250ml - 500ml | Canadian Clinical Practice (CPG) Guidelines 2015 |
| GRV measurement may help identify intolerance to EN during initiation and progression. It may not be necessary when EN is established.<br>Delay EN if GRV >500ml/6hr | European Society for Clinical Nutrition and Metabolism (ESPEN) guidelines 2019 |

<u>For patients with inadequate feed tolerance:</u>

- Minimise the time patient spends NPO. To limit propagation of ileus and prevent inadequate feed delivery, avoid unnecessary fasting and feed interruptions.
- Consider use of prokinetics, e.g. metoclopramide (Canadian Clinical Practice Guidelines, 2015) and/or erythromycin (Singer et al., 2019), unless contraindicated. Efficacy declines after 2-3 days when prescribed alone, or after 6 days when prescribed as a combination (Fraser and Bryant, 2010). Routine use of prokinetics is not recommended unless signs of feed intolerance are present (Singer et al., 2019). Significant side-effects can occur with use of either prokinetic - seek advice from a pharmacist.
- Consider use of laxatives if no bowel motion, where there is no contraindication (Btaiche et al., 2010).
- Reduce use of opiates where possible.
- Consider patient positioning. Ensure head of patient is elevated to 30 to 45 degrees where possible (McClave et al., 2016; Canadian Clinical Practice Guidelines 2015).
- Consider post-pyloric access for feeding (McClave et al., 2016; Singer et al., 2019; Canadian Clinical Practice Guidelines 2015).
- Control hyperglycaemia if present (McClave et al., 2016).
- Correct abnormal electrolytes and avoid hypokalaemia, where possible (Btaiche et al., 2010).

**Post-pyloric feeding**

- Routine nasojejunal feeding in ICU patients is not required unless gastric feeding intolerance is present (Singer et al., 2019). Critically ill patients at high risk of aspiration, or who have demonstrated gastric feed intolerance, should be fed via post-pyloric route (McClave et al., 2016; Singer et al., 2019; Canadian Clinical Practice Guidelines 2015).
- Small bowel nasoenteric feeding tubes can migrate upward into the stomach. Monitor changes in external tube length, and changes in gastric residuals (Boullata et al., 2017). Check X-rays to confirm location of feeding tube tip initially, and as needed (Boullata et al., 2017).
- Success rates with nasoenteric tube placement are high via endoscopic (96%) and fluoroscopic

techniques (94%) (Foote et al., 2004). Blind or unguided bedside placement has low to high reported success rates, including an Irish study reporting an 86% success rate (Duggan et al., 2009).

- High success rates have been demonstrated when an electro-magnetic naso-enteric tube placement device has been used by trained individuals. Several case reports, however, describe clinicians as being unable to recognise tube misplacements in the respiratory tract using an electro-magnetic tube placement device (Bryant et al., 2015; Methany and Meert, 2017). Do not rely on the electro-magnetic naso-enteric tube placement device monitor to confirm position of tube. Radiography is the accepted gold standard to confirm correct tube placement.

### 2.5.9 Parenteral Nutrition (PN)

Consider parenteral nutrition (PN) when enteral nutrition (EN) is not possible or adequate (McClave et al., 2016; Singer et al., 2019; Canadian Clinical Practice Guidelines 2015). Standard bags can be tailored to the individual by adjusting infusion rates. Daily micronutrients should be provided routinely in PN regimen or as a separate intravenous infusion (NICE, 2006; Singer et al., 2019). Micronutrients above the normal recommendation may be needed in case of excess loss/need (Canadian Clinical Practice Guidelines, 2015).

Timing of initiation of parenteral nutrition remains controversial. ASPEN (2016) guidelines suggest withholding exclusive PN for the first seven days of ICU admission in patients at low nutrition risk if early EN is not feasible. For patients at high nutrition risk or severely malnourished patients ASPEN advocates PN initiation as soon as possible following ICU admission when EN is not feasible. The Canadian Clinical Practice Guidelines (2015) recommend that PN not be used routinely, but that early PN be considered in nutritionally high risk patients with a contraindication to EN.

ESPEN guidelines (2019) recommend that in the case of a contraindication to oral and EN, PN should be implemented within 3 to 7 days but early full PN in critically ill patients should be avoided. The exception to this is in the severely malnourished patient, when early and progressive PN should commence, if EN is contraindicated (Singer et al., 2019). Two large randomised controlled trials – the CALORIES trial (Harvey et al., 2014) and NUTRIREA-2 trial (Reignier at al., 2018), confirmed the safety of early PN usage in critical illness. They failed, however, to demonstrate a mortality benefit when starting early parenteral nutrition compared with early enteral nutrition. These studies do not make a recommendation on the optimum timing of PN initiation.

When used to supplement insufficient enteral feeding, late parenteral nutrition (day 8) was associated with improved outcomes compared with early PN initiation in one study (Casaer et al., 2011). Other studies found that supplemental PN on day 4 of insufficient enteral feeding, to reach 100% of nutrition needs, had significant outcome benefits (Heidegger et al., 2011). ASPEN guidelines (2016) recommend that in patients at either low or high nutritional risk supplementary PN (SPN) be considered after 7-10 days if unable to meet >60% of energy and protein requirements by the enteral route alone. The Canadian Clinical Practice Guidelines (2015) recommend that critically ill patients, who are not malnourished, are tolerating some EN, or when PN is indicated for short term use (<10 days) low dose PN should be considered. Practitioners are advised to weigh the safety and benefits of low dose PN on an individual case by case basis. Similarly ESPEN (Singer et al., 2019) recommend that in patients who do not tolerate full dose EN in the first week in ICU the safety and benefits of

initiating PN should be considered on a case by case basis. PN should not be started until strategies to maximise EN tolerance have been attempted.

In light of conflicting evidence a pragmatic approach to commencing PN in ICU patients would be to start on day 3-4 when enteral feeding has failed, or is contraindicated. Patients at high nutrition risk or severely malnourished should start PN early and increase progressively following ICU admission when EN is contraindicated (Singer et al., 2019).

**PN Central venous access device (CVAD)**

The use of femoral vein for PN is relatively contraindicated, since this is associated with a high risk of contamination at the exit site, and a high risk of venous thrombosis (Pittiruli et al., 2009).

**Intravenous Glutamine**

Routine glutamine supplementation is not recommended in mechanically ventilated critically ill patients, as evidenced by Heyland et al (2013) which demonstrated an increase in mortality across all time points with the use of high dose IV and enteral glutamine supplementation. More research on the safety and efficacy of glutamine is needed before considering treatment recommendations.

**Addition of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) to lipid emulsions in PN regimens used in ICU**

- High circulating levels of inflammatory mediators such as eicosanoids, cytokines and reactive species, are seen in very critically ill patients and have been associated with poor outcomes (Waitzberg et al., 2006). Intravenous fish oil can decrease synthesis of inflammatory mediators and can improve EPA and DHA levels in cell membranes. This may be associated with improved outcomes (Manzanares et al., 2015; Manzanares et al., 2016). Lipid emulsions with enriched with fish oil or olive oil may confer benefit (Singer et al., 2019)
- Lipid emulsions should be an integral part of PN in ICU for energy and to ensure essential fatty acid provision, (Singer et al., 2019). A lipid emulsion that limits the amount of omega-6 fatty acids/soybean oil is recommended in ICU (Canadian Clinical Practice Guidelines, 2015; Singer et al., 2019). Parenteral lipid emulsions enriched with EPA and DHA can be provided to patients receiving PN (Singer et al., 2019). Commercially available lipid emulsions in Ireland are mixed emulsions which include varying combinations of soybean oil, MCT, olive oil and fish oil.
- Triglyceride levels should be measured to assess lipid clearance (Berger et al., 2018) - see local guidelines.

**Macronutrients**

- ESPEN (2019) guidelines recommend the amount of glucose in PN administered to ICU patients should not exceed 5mg/kg/min.
- Intravenous lipid, including non-nutritional lipid sources such as propofol, should not exceed 1.5g/kg/day and should be adapted to individual tolerance (Singer et al., 2019). This is to prevent excess provision of macronutrients which could lead to overfeeding.

### 2.5.10 Glycaemic control

- All intensive care units should have a standardised blood glucose monitoring and insulin administration guideline in place which will detect hyperglycaemia, hypoglycaemia and that will minimise glycaemic variability (Jacobi et al., 2012). Feeding over 24 hours may aid glycaemic control in ICU.
- Based on 26 studies, current international guidelines recommend a blood glucose target of between 8 mmol/L and 10mmol/L for all general ICU patients (Canadian Clinical Practice Guidelines, 2015).
- Stringent safety measures are suggested for brain injury, whereby blood glucose levels of < 5.6mmol/L should be avoided (Jacobi et al., 2012).
- There is currently insufficient evidence to support the administration of subcutaneous insulin over IV insulin (Canadian Clinical Practice Guidelines, 2015).

### 2.5.11 Other considerations

**Additional micronutrients:**

Evidence supporting routine supplementation of micronutrients in addition to meeting recommended daily intakes by nutrition support, is unclear. There is uncertainty about the optimal composition and dose of supplementation of combined vitamins and trace elements in critically ill patients. There is lack of significant treatment effect and emerging safety concerns regarding the use of supplemental antioxidants in critically ill patients. Below are a summary of the current recommendations – see Table 9. Avoid toxicity in patients with hepatic and renal insufficiency (Sriram and Lonchyna, 2009).

**Vitamin C**

A systematic review and meta-analysis by Langlois et al. (2019) examined the effects of administering enteral or parenteral vitamin C to intensive care patients on mortality (primary outcome). Eleven randomised controlled trials were included. No statistically significant effects were found, but a trend towards reduced mortality was seen with use of high dose intravenous vitamin C monotherapy.

The CITRIS-ALI trial (Fowler et al., 2019) aimed to assess the effects of intravenous vitamin C infusion (50mg/kg) for 96h on outcomes in ICU patients with sepsis and ARDS. Plasma vitamin C levels were low in all patients at enrolment. The primary outcome of organ failure was not significantly improved. Of note from this study was the improved mortality rate at 28d (secondary outcome) reported in the treatment group (29.8% vs 46.3%) (p=0.03). Controversy exists as mortality differences may have compromised the validity of the primary outcome, given that organ failure scores were recorded only in survivors. Further analysis and research is warranted.

**Table 9** Micronutrient supplementation in ICU

| Additional micronutrient supplementation | Source of recommendation |
|---|---|
| • The use of supplemental combined vitamins and trace elements in critically ill patients is not recommended.<br>• The use of IV/PN selenium supplementation alone or in combination with other antioxidants is not recommended.<br>• There is insufficient data to make a recommendation regarding Vitamins D and C. | Canadian Clinical Practice Guidelines (CPG) 2015 |
| • In critically ill patients with measured low plasma levels (25 hydroxy-Vitamin D <12.5ng/ml, or 50nmol/l) vitamin D3 can be supplemented.<br>• In critically ill patients with measured low plasma levels (25 hydroxy-Vitamin D <12.5ng/ml, or 50nmol/l) a high dose of Vitamin D3 (500,000 IU) as a single dose can be administered within a week of admission.<br>• Antioxidants as high dose monotherapy should not be administered without proven deficiency. | European Society for Clinical Nutrition and Metabolism (ESPEN) Guidelines 2019 |
| • A combination of antioxidant vitamins and trace minerals in doses reported to be safe in critically ill patients be provided to those patients who require specialised nutritional therapy.<br>• Cannot make a recommendation regarding selenium, zinc and antioxidant supplementation in sepsis due to conflicting results. | American Society for Parenteral and Enteral Nutrition (ASPEN) Guidelines 2016 |

**Infusions commonly used in ICU with nutritional implications:** Table 10 outlines commonly used medication infusions in ICU and potential nutritional implications. When significant amounts of nutrients are provided or lost through means other than the nutrition support formula (e.g. intravenous infusions, drugs, dialysis mode), the nutrition care plan should be adjusted.

**Table 10** Medication infusions used in ICU and possible nutritional implications

| Medication | Possible nutritional implications |
|---|---|
| Inotropes/vasopressors, e.g. noradrenaline, adrenaline, vasopressin, dopamine | - Increasing levels indicate severity of illness/unstable patient.<br>- Inotropes can lead to hyperglycaemia.<br>- Inotropes can increase energy requirements.<br>- Avoid overfeeding patients with raised or increasing inotropic requirements.<br>- Dopamine decreases proximal gastric tone and decreases contractions in gastric antrum.<br>- Ischaemic bowel is a rare complication associated with EN. For patients on vasopressor therapy, monitor all signs of enteral feeding intolerance closely, including (but not limited to) abdominal distension, increased GAV/GRVs, decreased passage of stool, hypoactive bowel, increased metabolic acidosis and/or base deficit. If suspect gut ischaemia, EN may need to be withheld until symptoms and interventions are stabilised (McClave et al. 2016). |
| Sedatives e.g. midazolam infusion, propofol infusion, dexmedetomidine, sodium thiopentone | - Sedatives reduce energy requirements.<br>- Sedatives reduce gut motility by relaxing visceral smooth muscle.<br>- Propofol contains lipid which must be considered when devising nutrition support prescription, e.g. Lipuro contains MCT/LCT fat (0.01g fat/ml) and 1.058kcal/ml; Diprivan and Propofol 1% contain LCT fat (0.01g fat/ml) and 1.1kcal/ml. Propofol 2% contains 0.1g fat/ml and 1.1 kcal/ml (but lower volume needed compared with Propofol 1%). |
| Muscle relaxants that are not sedatives, e.g. atracurium, vecuronium | - Neuromuscular blocking agents can also effect visceral smooth muscle and reduce gut motility. |
| Opioid analgesics, e.g. morphine infusion, fentanyl, remifentanil | - Reduce gastric emptying and lead to disordered motility in the duodenum. Ensure adequate laxatives. |
| Gastric acid reducing agents | - Can stimulate gastrin which inhibits gastric emptying. |
| Intravenous 5% Dextrose<br>Intravenous 10% glucose<br>Intravenous 20% glucose<br>Intravenous 50% glucose | - Gives 50g carbohydrate per litre, equivalent to 200kcal per litre.<br>- Gives 100g carbohydrate per litre, equivalent to 400kcal per litre.<br>- Gives 200g carbohydrate per litre, equivalent to 800kcal per litre.<br>- Gives 500g carbohydrate per litre, equivalent to 2000kcal per litre. |
| Dialysate | - Consider energy derived from glucose containing dialysates. |
| Citrate | - Net energy absorption from citrate during CVVH is not known but can be estimated if 50% absorption is assumed, as follows:<br>[concentration of citrate containing solution in mmol/l x volume in ml/hr] x 0.59kcal x 0.50 = estimated energy provision (kcal). |
| Amiodarone (anti-arrythmic drug) | - Metoclopramide (prokinetic) is contraindicated when on amiodarone infusion. Amiodarone also interacts with erythromycin. |

### 2.5.12 Monitoring of Nutrition Support

An interdisciplinary approach is advised when monitoring nutrition support (Ukleja et al., 2018). Local guidelines should be in place in all intensive care units to ensure safe practice. See Table 7 for factors to consider. Monitoring should include (but not be limited to):

- Nutrition focused physical examinations and monitoring of nutritional status of all patients in ICU.
- Impact of findings of medical/surgical/health and social care professionals tests and procedures including Speech and Language Therapist (SLT) assessments.
- Clinical assessment, such as gastrointestinal function, changes in clinical condition that may influence requirements, fluid status, presence of organ failure, mode of dialysis, and mode of ventilation.
- Measurement and interpretation of relevant biochemistry and haematological parameters – see Table 12.8.
- Nutrition support assessment including percentage of daily protein, calorie and micronutrient requirements achieved and tolerance of nutrition support.
- When monitoring tolerance, consider physical examination, abdominal distension, gastric residual volumes (GRVs), IAP (intra-abdominal pressure), presence or absence of abdominal pain.
- Dietary assessments should be carried out if applicable.

Additional patient specific factors may need to be considered depending on the patient's clinical condition.
Consider monitoring micronutrients for:

- Patients who remain in ICU for more than two weeks, with particular attention to copper, selenium and vitamin D levels.
- Patients with major burns, intestinal failure, high output stomas and those requiring renal replacement therapy for more than two weeks.

Note: Close monitoring of CRP is necessary to ensure correct interpretation of micronutrient results.

**Table 11** Factors to consider in daily nutritional assessment (adapted from O'Hanlon et al., 2015)

| Daily nutritional assessment considerations (alphabetical order) |
|---|
| Changes in medical management and planned procedures.<br>Changes in medications with nutritional implications and drug-feed and/or drug-tube interactions.<br>Feeds missed and underlying reason(s).<br>Glycaemic control and use of insulin.<br>Indicators of feed tolerance, e.g. gastric residual volumes, emesis, diarrhoea.<br>Haemodynamic stability/instability.<br>Laboratory results – see Table 12.8 for details.<br>Nutritional adequacy: nutrition delivered vs prescribed – include all nutrition sources.<br>Nutritional requirement estimation/measurement.<br>Organ function and need for support, e.g. renal replacement therapy.<br>Outputs, e.g. drains, urine, gastrointestinal, fistula, wound.<br>Presence of sepsis/infection.<br>Route of nutrition support and appropriateness:<br>• If EN – type of tube and access, e.g. assess if nasojejunal access is needed.<br>• If PN – check access site and assess possibility of transitioning to, or combining with EN.<br>Surrogate measures of nutritional status, e.g. wound healing, pressure ulcer development, signs of micronutrient deficiency.<br>Swallow assessment results (per SLT) – if applicable. |

**Table 12** Biochemical monitoring suggestions adapted from ESPEN guidelines (adapted from Singer et al., 2019)

| Parameter to be measured | Frequency of measurement |
|---|---|
| **Glucose** | Initial period: at least every 4-6h<br>Later period: at least twice daily |
| **Phosphate** | Initially on admission<br>At least once daily |
| **Potassium** | Initially on admission<br>Laboratory: at least once daily<br>When doing blood gas, e.g. every 6h |
| **Urea, creatinine, sodium, chloride** | Once daily |
| **Liver function tests** | At least twice weekly |
| **Triglyceride** | Twice weekly |
| **C-Reactive Protein** | Daily or as indicated |
| **Full blood count** | Daily or as indicated |

### 2.5.13 Swallow impairment in critical care

It is recognised that patients in critical care frequently present with eating, drinking and swallowing difficulties. The consequences of dysphagia in critical care patients include increased length of hospital stay, increased morbidity and increased mortality (Macht et al., 2011).

Dysphagia may present in this patient cohort for a variety reasons including the following. It is often multifactorial in nature:

- *Underlying medical diagnosis* such as CVA, traumatic brain injury, spinal cord injury (Chaw et al., 2012), chronic progressive diseases such as Parkinsons disease, Motor Neurone Disease, COPD (Bordon et al 2011; Siska et al., 2011) and frailty (Laan et al., 2017; Ponfick et al., 2015).
- *Post-surgery:* e.g. head and neck surgery (Ward and van-As Brooks, 2014), or upper GI surgery. Cardiac surgery is also reported to be a high risk factor for dysphagia (Daly et al., 2016).
- *Post-extubation:* Dysphagia is increasingly recognised in critical care patients extubated following a period of oral intubation for mechanical ventilation. Skoretz et al (2010) reported that incidence rate ranges from 3 to 62%. Dysphagia is reported to persist well beyond the patient's critical care stay. Length of intubation is a significant factor (Zuercher et al., 2019; Brodsky et al., 2017; Malandraki et al., 2016).
- *Post-tracheostomy:* The UK National Confidential Enquiry into Patient Outcomes and Death (2014) reported that 52% of patients post-tracheostomy presented with dysphagia. The nature of this dysphagia is complex and may also relate to other co-morbidities. Silent aspiration is common in this patient group (Leder, 2002). Swallow difficulties have been shown to persist post de-cannulation.
- Alteration in alertness/cognition associated with medication/polypharmacy, delirium, dementia or altered cognition secondary to acquired brain injury.
- Physiological changes secondary to critical illness neuropathy (Ponfick et al., 2015).

Communication difficulties frequently co-occur in these patient groups, resulting in vulnerability associated with understanding medical needs and impacting on ability to participate in decision making and/or comprehension of enteral feeding systems. Patients with communication difficulties have been noted to be at high risk for preventable adverse events (Bartlett et al., 2008).

Depending on the severity of dysphagia symptoms, patients may require to be nil by mouth, may require a combination of oral and non-oral feeding or may be taking modified oral intake. Modified food and drinks where indicated, will be provided in accordance with the IDDSI framework (International Dysphagia Diet Standardisation Initiative 2016). Out of hours, it is important to be aware that patient swallow function may disimprove if there is a deterioration in medical status. Speech and Language Therapy (SLT) assessment of swallow in conjunction with the MDT is an essential model of care for optimum management of these patients.

### 2.6 Resources to implement the Intensive Care Nutrition Support Algorithm

*Essential:*

- Multidisciplinary team resources as outlined in the 'Model of care for adult critical care' (HSE, 2014). This includes 0.12 full-time-equivalent senior or clinical specialist grade dietitian per ICU bed, that is, 1 dietitian per 8 beds.
- Access to weighing and height measuring equipment.
- Nutrition support access insertion devices.
- Access to radiology and theatre.
- Nutrition support access and administration equipment and ancillaries for EN and PN.
- Nutrition support feeding solutions for EN and PN.
- Access to laboratory.
- Access to blood gas analyser.

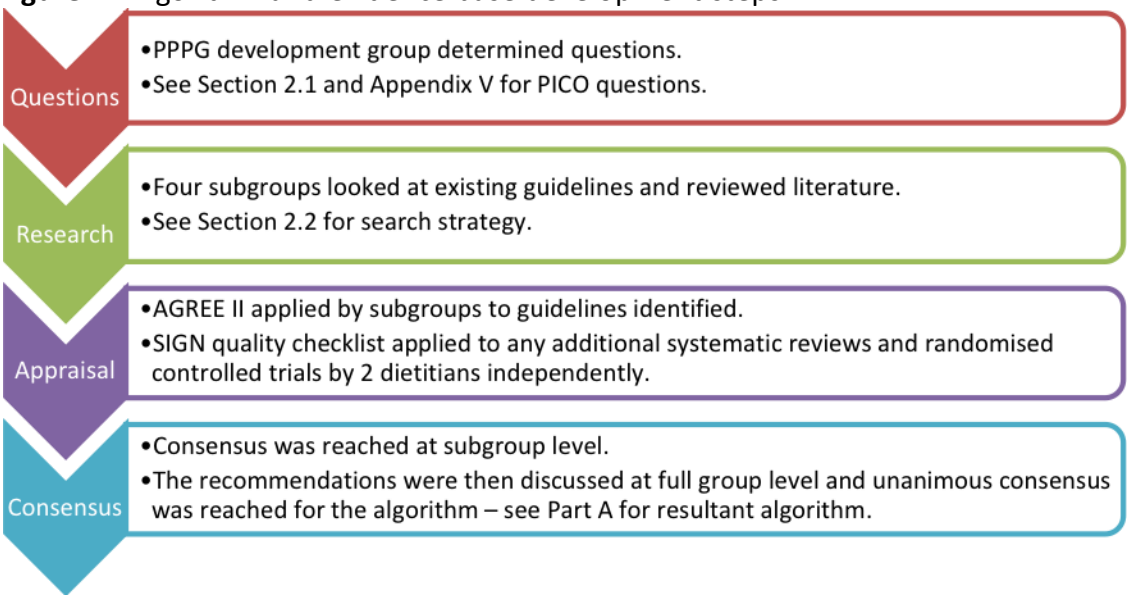
*Desirable:*

- Access to an indirect calorimeter.

### 2.7 Development steps

See Figure 2 below for an outline of development steps. Key clinical questions were identified by the Intensive Care Nutrition Support Algorithm Development Group. Subgroups were formed to search existing guidelines and highlight literature of relevance. Subgroups applied the AGREE II appraisal tool to assess guideline quality. The SIGN checklist was used to assess additional literature for bias. Subgroups presented results to the full development group and unanimous consensus was achieved. Input was sought from the multi-disciplines through consultation with the Clinical Advisory Group and the HSCP Office. Feedback was sought from key stakeholders. See Part A for resultant algorithm with notes and Section 2.5 for evidence base.

**Figure 2:** Algorithm and evidence base development steps



## 3.0 GOVERNANCE AND APPROVAL

### 3.1 Governance arrangements

The Critical Care National Clinical Programme (CCP) launched a Model of Care for Adult Critical Care in October 2014. This programme defines the critical care delivery, training and education, workforce planning, audit, clinical guidelines and the clinical governance structures needed to improve critical care service quality and safety in Ireland. Nutrition support is a key element of this care. Even before the model of care was published, the Critical Care Programme Lead identified a need to develop an evidence based algorithm to help guide best practice in the provision of nutrition support to critically ill adult patients and to support local protocol development. An algorithm and supporting evidence base was produced in 2012 (and updated in 2013), by a multidisciplinary collaboration led by a group of ICU dietitians. This included representatives from the CCP Clinical Advisory Group. With further evidence based international guidelines on nutrition support in intensive care being published in recent years, this algorithm was due for updating and a decision was made to use the HSE PPPG development format and process.

The Irish ICU Dietitians Group put together four subgroups tasked with updating the guideline. The resultant HSE formatted draft algorithm was developed. Through consultation with the CCP Clinical Lead, CCP Clinical Advisory Group, National Health and Social Care Professions (HSCP) Office, Pharmaceutical Society of Ireland, Irish Nutrition and Dietetic Institute, Irish Society for Clinical Nutrition and Metabolism and the Irish Association of Speech and Language Therapists, the document was completed. See Appendix IV for Membership of the Approval Governance Group. Final approval rests with the CCP Clinical Advisory Group with sign-off by the CCP Clinical Lead.

### 3.2 Development standards

This policy was developed within the template of HSE National Framework for developing Policies, Procedures, Protocols and Guidelines (HSE, 2016) and adhered to standards set out therein.

### 3.3 Copyright/permission

Permission was given by Professor Daren Heyland to use the NUTRIC score in Appendix VI.

### 3.4 Approval and sign-off

The completed Intensive Care Nutrition Support Algorithm (Adults) was submitted for approval to the Critical Care Programme Clinical Advisory Group. This was accompanied by the signed PPPG Checklist (refer to Appendix VII) to confirm that all the required stages in the development of the policy had been completed and met the HSE National Framework for developing Policies, Procedures, Protocols and Guidelines (PPPGs) 2016.

## 4.0 COMMUNICATION AND DISSEMINATION

Staff will be made aware of this algorithm through the Critical Care Programme and relevant professional bodies. This document will be available on the Critical Care Programme section of the HSE website. ICU Directors will be notified via the Critical Care Programme. The Critical Care Programme Newsletter will also be used to increase awareness. ICU dietitians will disseminate at local ICU level.

## 5.0 IMPLEMENTATION

### 5.1 Implementation plan and facilitators and/or barriers

ICU Directors, ICU Clinical Nurse Managers, ICU dietitians and other members of the multidisciplinary team are responsible for implementation. Collaboration between key stakeholders is needed. Individual ICUs can use the algorithm in Part A of this document to develop local nutrition support protocols, particularly with respect to out-of-hours feeding regimens. The evidence base provided in Part B can be used to inform local protocol development. The succinct provision of tables and text in the evidence summary (see Section 2.5) highlights key messages to enable and support local protocol development.

### 5.2 Education requirements to implement the Intensive Care Nutrition Support Algorithm (Adults) or to adapt for local protocol development

It is recommended that each local ICU will identify the educational requirements of each discipline involved in the provision of nutrition support to ICU patients. This will differ between staff categories and therefore different models of training will be required such as: in-service education sessions, continuous professional development updates, Hospital Grand Rounds and post-graduate education presentations.

### 5.3 Identify lead person(s) responsible for the implementation

ICU Directors are ideally placed to identify the need for local nutrition support protocols. ICU dietitians are key personnel to lead the development of local protocols using the evidence base and algorithm provided in this document. Local protocols developed apply to all staff involved in the provision of nutrition support to ICU patients.

### 5.4 Specific roles and responsibilities

See the Critical Care National Clinical Programme Model of Care for Adult Critical Care (2014) for a clear outline of the roles and responsibilities of the professions involved in the care of patients in ICU, including those professions involved in the provision of nutrition support to ICU patients.

## 6.0 MONITORING, AUDIT AND EVALUATION

### 6.1 Monitoring

Individual ICUs should develop local strategies for monitoring appropriate use of nutrition support in ICU, such as out-of-hours nutrition support protocols. ICU Directors and ICU dietitians play a key role in monitoring nutrition support practices in ICU.

### 6.2 Audit

Audit using key performance indicators should be undertaken to identify where improvements are required. Audit should also provide evidence of continuous quality initiatives. ICU doctors, nurses, dietitians, speech and language therapists and pharmacists all play a role in audit. Existing national and local audit structures can be used for audit where available.

### 6.3 Evaluation

Evaluation of the effectiveness of local nutrition support protocols using the Intensive Care Nutrition Support Algorithm (Adults) and evidence base presented in this document should be undertaken by individual ICUs.

## 7.0 REVISION/UPDATE

### 7.1 Procedure for the update of this algorithm and evidence base

This will be updated three years from publication. The procedure for update will be aligned to the HSE PPPG Policy (2016). A subgroup of the algorithm development group will reconvene to assist in this update under the governance of the Critical Care Programme Lead.

### 7.2 Method for amending this algorithm and evidence base

If there is a major change in evidence, prior to the planned review, a rapid update will be conducted. A working group will be convened to revise and amend the algorithm and evidence base if warranted.

### 7.3 Version control

The version tracking box on the front cover will be updated with each revision regardless of amendments made.

## 8.0 REFERENCES


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## 9.0 APPENDICES


Appendix I Signature Sheet

Appendix II Membership of the Algorithm Development Group

Appendix III Conflict of Interest Declaration Form Template

Appendix IV Membership of Approval Governance Group

Appendix V Glossary of terms

Appendix VI Clinical questions in PICO format

Appendix VII NUTRIC Score

**Appendix I: Signature Sheet**

*I have read, understand and agree to adhere to this Policy, Procedure, Protocol or Guideline:*

| Print Name | Signature | Area of Work | Date |
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## Appendix II: Membership of the Intensive Care Nutrition Support Algorithm Development Group

**Table 13** Development Group Members

| Name *(alphabetical order)* | Job title and/or affiliation |
|---|---|
| **Ms. Jenny Caffrey** | Senior Dietitian, St. Vincent's University Hospital |
| **Ms. Deirdre Gilchriest** | Senior Speech and Language Therapist, St. James's Hospital |
| **Ms. Aine Kelly** | Senior Dietitian, Tallaght University Hospital |
| **Ms. Nicola Hamill** | Senior Dietitian, Midland Regional Hospital Mullingar |
| **Ms. Carmel O'Hanlon*** | Clinical Specialist Dietitian, Beaumont Hospital, Co-ordinator |
| **Ms. Aideen O'Riordan** | Senior Speech and Language Therapist, University Hospital Cork |
| **Ms. Carmel Quinn** | Senior Dietitian, University Hospital Limerick |
| **Ms. Marcella Richardson** | Senior Dietitian, University Hospital Limerick |
| **Ms. Geraldine Sexton** | Senior Dietitian, Midland Regional Hospital Tullamore |
| **Ms. Lisa Shanahan** | Clinical Specialist Dietitian, Mater Misericordiae University Hospital |
| **Ms. Marie Sheahan** | Senior Dietitian, University Hospital Cork |
| **Mr. Damodar Solanki*** | Chief II Pharmacist, Beaumont Hospital |
| **Ms. Clare Twomey** | Senior Dietitian, University Hospital Cork |
| **Ms. Deirdre Walsh** | Senior Dietitian, Beaumont Hospital |
| **Consulting to group** | |
| **Critical Care Programme Clinical Advisory Group – See Appendix IV** | |
| **ICU Dietitians Group of Ireland** | |

**Members of the Critical Care Programme Clinical Advisory Group.*

## Appendix III: Conflict of Interest Declaration Form




**CONFLICT OF INTEREST DECLARATION**

This must be completed by each member of the PPPG Development Group as applicable

**Title of PPPG being considered:**

_____

**Please circle the statement that relates to you**

**1. I declare that I DO NOT have any conflicts of interest.**

**2. I declare that I DO have a conflict of interest.**

**Details of conflict (Please refer to specific PPPG)**

_____
_____
_____
_____
_____

**(Append additional pages to this statement if required)**

**Signature**

**Printed name**

**Registration number (if applicable)**

**Date**

The information provided will be processed in accordance with data protection principles as set out in the Data Protection Act. Data will be processed only to ensure that committee members act in the best interests of the committee. The information provided will not be used for any other purpose.

A person who is covered by this PPPG is required to furnish a statement, in writing, of:

(i) The interests of the person, and

(ii) The interests, of which the person has actual knowledge, of his or her spouse or civil partner or a child of the person or of his or her spouse which could materially influence the person in, or in relation to, the performance of the person's official functions by reason of the fact that such performance could so affect those interests as to confer on, or withhold from, the person, or the spouse or civil partner or child, a substantial benefit.

## Appendix IV: Membership of the Critical Care Programme Clinical Advisory Group

**Table 14** CCP Clinical Advisory Group Members

| Critical Care Programme Clinical Advisory Group | | |
|---|---|---|
| **Chair** | Dr. Michael Power | Clinical Lead for the Critical Care Programme |
| **Members** | Dr. John Bates | Dean of the Joint Faculty of Intensive Care Medicine (JFICMI) |
| | Mr. Derek Cribbin | Nurse Lead for the Critical Care Programme |
| | Dr. Catherine Motherway | President of the Intensive Care Society of Ireland |
| | Ms. Carmel O'Hanlon | Clinical Specialist Dietitian, Health and Social Care Professions representative |
| | Ms. Una Quill | Programme Manager for the Critical Care Programme |
| | Mr. Damodar Solanki | Chief II Pharmacist, Pharmacy representative |

**Appendix V: Clinical questions in PICO format**

| | |
|---|---|
| **Key question 1** | What nutrition screening tool should be used to diagnose nutritional risk and identify adverse outcomes in adults in intensive care setting? |
| **P** (Population) | Hospitalised adult patients in intensive care |
| **I** (Intervention) | Screening for nutrition risk |
| **C** (Comparison/control) | No screening |
| **O** (Outcomes) | Survival, mortality, ICU readmissions, length of ICU and hospital stay, complications/ morbidity, quality of life, effects on nutritional status and functional status |
| **Key question 2** | What are the indications for, and outcome benefits of using nutrition support (enteral and parenteral), on mortality, ICU readmissions, length of ICU and hospital stay, complications/ morbidity, quality of life, nutritional status and functional status in adult intensive care patients considered at risk of malnutrition? |
| **P** (Population) | Hospitalised adult patients in intensive care |
| **I** (Intervention) | Use of nutrition support (enteral and parenteral) |
| **C** (Comparison/control) | No nutrition support |
| **O** (Outcomes) | Survival, mortality, ICU readmissions, length of ICU and hospital stay, complications/ morbidity, quality of life, improved nutritional status and functional status. |
| **Key question 3** | What methods of assessment should be used to monitor efficacy and effectiveness of enteral and parenteral nutrition in adult patients in intensive care? |
| **P** (Population) | Hospitalised adult patients in intensive care on enteral and/or parenteral nutrition |
| **I** (Intervention) | Monitoring and assessment methods |
| **C** (Comparison/control) | Standard care |
| **O** (Outcomes) | Efficacy and effectiveness indicators, such as GI symptoms, aspiration, ventilator associated pneumonia, catheter related blood stream infections, hyperlipidaemia, hyperglycaemia, electrolyte problems |
| **Key question 4** | What is the preferred timing, content and dosing of nutrition support that is associated with better outcomes in adult patients in intensive care? |
| **P** (Population) | Hospitalised adult patients in intensive care |
| **I** (Intervention) | Timing, content and dose of enteral nutrition and parenteral nutrition |
| **C** (Comparison/control) | Standard care |
| **O** (Outcomes) | Survival, mortality, ICU readmissions, length of ICU and hospital stay, complications/ morbidity, quality of life, improved nutritional status and functional status. |

**Appendix VI: NUTRIC Score**

The NUTRIC Score is designed to quantify the risk of critically ill patients developing adverse events that may be modified by aggressive nutrition therapy. The score of, 1-10, is based on 6 variables that are explained below in Table 1 and 2.

**Table 15** NUTRIC Score variables

| Variable | Range | Points |
|---|---|---|
| Age | <50 | 0 |
| | 50 - <75 | 1 |
| | ≥75 | 2 |
| APACHE II | <15 | 0 |
| | 15 - <20 | 1 |
| | 20-28 | 2 |
| | ≥28 | 3 |
| SOFA | <6 | 0 |
| | 6 - <10 | 1 |
| | ≥10 | 2 |
| Number of Co-morbidities | 0-1 | 0 |
| | ≥2 | 1 |
| Days from hospital to ICU admission | 0 - <1 | 0 |
| | ≥1 | 1 |
| IL-6 | 0 - <400 | 0 |
| | ≥400 | 1 |

**Table 16** NUTRIC Score scoring system: if no IL-6 available*

| Sum of points | Category | Explanation |
|---|---|---|
| 5-9 | High score | • Associated with worse clinical outcomes (mortality, ventilation).<br>• These patients are the most likely to benefit from aggressive nutrition therapy. |
| 0-4 | Low score | • These patients have a low malnutrition risk. |

*It is acceptable to not include IL-6 data when it is not routinely available; it was shown to contribute very little to the overall prediction of the NUTRIC score.

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