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Medical Nutrition Therapy (MNT)

Guidelines for Critically Ill Adults

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MEDICAL NUTRITION THERAPY GUIDELINES FOR CRITICALLY ILL ADULTS WORKING GROUP 2017

Chairperson:

L. Mageswary A/P Lapchmanan
Dietitian
Selayang Hospital

Secretary:

Chong Mei Kee
Dietitian
National Heart Institute

Committee Members (Alphabetical Order):

Assoc. Prof. Dr. Hazreen Bin Abd Majid
Academician and Consultant Dietitian
University of Malaya

Dr. Ong Shu Hwa
Lecturer
International Medical University

Khor Ban Hock
Dietitian
National University of Malaysia

Rosli Bin Mohd Sali
Dietitian
Kuala Lumpur Hospital

Lee Zheng Yii
Dietitian
Universiti Putra Malaysia

Siti Hawa Binti Mohd Taib
Dietitian
University of Malaya Medical Centre

Nor Hafizatul Huda Binti Abd. Razak
Dietitian
Selayang Hospital

Tan Hooi Yen
Dietitian
Sunway Medical Centre

Internal Reviewers:

Dr. Shanti Rudra Deva
Consultant Intensivist
Kuala Lumpur Hospital

Dr. Mohd Shukri Bin Jahit
Upper GI Surgeon
Sungai Buloh Hospital

External Reviewers:

Dr Liesl Wandrag
Principal ICU Dietitian
Guy's and St Thomas' NHS Foundation Trust
and
Honorary Clinical Research Fellow
Imperial College London

Emma Ridley
ICU Nutrition Research Program Manager,
PhD Candidate
Australian and New Zealand Intensive Care Research Centre, Monash University, Australia
and
Senior Dietitian
Alfred Health

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Disclaimer

All committee members declare no competing interests

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LIST OF DEFINITIONS

Bolus feeding	Feeding is administered via a syringe or gravity drip over a short period of time at a specified interval
Continuous feeding	Feeding is administered via an electric enteral feeding pump continuously for 24 hours
Cyclic intermittent feeding	Feeding is administered via an electric enteral feeding pump for less than 24 hours
Critical Illness	A life-threatening process that, in the absence of medical intervention, is expected to result in mortality or significant morbidity. It may be the product of one or more underlying pathophysiological processes; however, the end result is a multisystem progression that ultimately involves respiratory, cardiovascular and neurological compromise[1]
Intensive Care/Critical Care	A multidisciplinary and inter-professional specialty dedicated to the comprehensive management of patients having, or at risk of developing, acute, life-threatening organ dysfunction. The primary goal is to prevent further physiologic deterioration while the underlying disease is treated and resolved[2]
Enteral Nutrition	Nutrition is provided through the gastrointestinal (GI) tract *via* a tube, catheter, or stoma that delivers nutrients distal to the oral cavity[3]
Parenteral Nutrition	The administration of nutrients intravenously[3]
Supplemental Parenteral Nutrition	Supplementation of nutrition through the parenteral route when enteral nutrition delivery is inadequate[4]
Post-Pyloric	Enteral Nutrition is delivered beyond the pylorus and directly into the small bowel (duodenum or jejunum)[5,6]
Actual Body Weight	Body weight measured by using the built-in bed scale, also known as the measured body weight or current body weight[7]
Usual Body Weight	Body weight before admission to the hospital or prior to fluid resuscitation
Dry Weight	Measure body weight corrected for cumulative fluid balance calculated from the ICU admission[7]
Ideal Body Weight	Body weight calculated based on a reference body mass index of 22.5 kg m^{-2} according to patients' height[7]

LIST OF ABBREVIATIONS

AKI	Acute Kidney Injury
ALI	Acute Lung Injury
APACHE II	Acute Physiologic and Chronic Health Evaluation II
ASPEN	American Society for Parenteral and Enteral Nutrition
ARDS	Acute Respiratory Distress Syndrome
BCAAs	Branched Chained Amino Acids
BMI	Body Mass Index
CCPG	Canadian Clinical Practice Guidelines
CHO	Carbohydrate
COPD	Chronic Obstructive Pulmonary Disease
CV	Coefficient Variation
CVVH	Continuous Venovenous Haemofiltration
CVVHDF	Continuous Venovenous Haemodiafiltration
ECMO	Extracorporeal Membrane Oxygenation
EN	Enteral Nutrition
ERAS	Enhanced Recovery After Surgery
ESPEN	European Society for Clinical Nutrition and Metabolism
GCS	Glasgow Coma Score
GI	Gastrointestinal
GRV	Gastric Residual Volume
HD	Haemodialysis
IBW	Ideal Body Weight
IC	Indirect Calorimetry
ICU	Intensive Care Unit
IV	Intravenous
LOS	Length of Stay
MAP	Mean Arterial Pressure
MUAC	Mid-Upper Arm Circumference
MV	Mechanical Ventilation
NA	Not Applicable
NBM	Nil by Mouth
NG	Nasogastric
NJ	Nasojejunal
NTT	Nutrition Therapy Team
NUTRIC	NUTrition Risk in the Critically ill
ONS	Oral Nutritional Supplement
PN	Parenteral Nutrition
PONV	Post-Operative Nausea Vomiting
PSU	Penn-State University Equation
qSOFA	Quick SOFA
RCT	Randomised Controlled Trial
RQ	Respiratory Quotient
RRT	Renal Replacement Therapy
SGA	Subjective Global Assessment
SOFA	Sequential Organ-Failure Assessment
SPN	Supplemental Parenteral Nutrition
TBI	Traumatic Brain Injury
TPN	Total Parenteral Nutrition
VAP	Ventilator-associated Pneumonia

CHAPTER 1: INTRODUCTION

This is an updated and revised medical nutrition therapy guideline for critically ill adult patients admitted into the ICU. This guideline supersedes the previous medical nutrition therapy guidelines published in 2005.

1.1 STATEMENT OF INTENT

This guideline is intended to guide dietitians involved in providing medical nutrition therapy to critically ill adult patients admitted into the ICU. Best current available evidence and recommendations, expert opinion and clinical practice aspects were reviewed in developing this guideline. Adherence to this guideline alone may not necessarily guarantee any specific benefit in outcome or survival in every case. Individual patient presentations, precise nutrition diagnosis and clinical judgment are the paramount aspects in clinical practice decisions and management.

1.2 OBJECTIVES

The aim of this guideline is to provide evidence-based recommendations to assist dietitians in providing medical nutrition therapy to critically ill adult patients admitted into the ICU.

1.3 CLINICAL QUESTIONS

The clinical questions were developed and divided into subtitles and members of the working group were assigned topics within these subtitles.

The clinical questions of this guideline were:

a) What nutrition screening or assessment should be performed?
b) When should EN and PN be initiated?
c) What are the recommendations of nutrition therapy?
d) How to select the appropriate EN and PN formula?
e) How to progress and monitor EN and PN tolerance?
f) What are the strategies to optimise nutrition therapy?
g) How and when to transit feeding routes?
h) What are the evidence for adjunctive therapies (vitamins, trace elements, immunonutrients, probiotics, prebiotics and fibre)?
i) What are the recommendations of nutrition therapy in organ failure/specific conditions?
j) What are the ethical considerations in nutrition therapy in critically ill patients?

1.4 TARGET POPULATION

The recommendations in this guideline are applicable to adult patients admitted into the ICU. It is not intended for patients admitted to ICU for temporary monitoring or those with minimal metabolic or traumatic stress.

1.5 TARGET GROUP

This guideline is designed mainly for dietitians who are involved in provision of nutrition therapy to critically ill adult patients. Other professionals including doctors, nurses and pharmacists may use this guideline as reference.

1.6 LEVELS OF EVIDENCE

The recommendations in this guideline were mainly adapted from international guidelines on nutrition therapy for critically ill patients such as ASPEN 2016[8], CCPG 2015[9] and ESPEN 2009[10]. The locally available intensive care clinical practice guideline[11] was referred to whenever necessary. When there are clinical questions not answered by these guidelines, additional literature search through electronic database such as PubMed, EMBASE™, CINHAL, Web of Science and Cochrane was performed to identify relevant articles. The literature search of this guideline was updated until 31st December 2016. Evidence in the guidelines and literatures were discussed, tabulated in the

evidence table and suitable statements and recommendations were formulated. Consensus from the working group was used in the areas of inconclusive or insufficient evidence.

In addition to the evidence-based practices, other factors such as cultural practices, individual patient conditions, preferences, availability of resources and cost were critically appraised in the process of decision-making.

The Evidence Grading System used is shown in Table 1 and 2. The level of evidence is based on the study design and the grade or recommendation of A, B or C is given based on the level of evidence. Grading will not be put forward if there is insufficient or inconclusive evidence.

Table 1: Levels of Evidence

Level	Type of Evidence
1a	Evidence from meta-analysis of randomised controlled trials
1b	Evidence from at least one randomised controlled trial
IIa	Evidence from at least one well-designed controlled study without randomisation
IIb	Evidence from at least one other type of quasi-experimental/cohort study
III	Evidence from well-designed non-experimental descriptive studies such as comparative studies, correlation studies and case control studies
IV	Evidence from expert committee reports or opinions and/or clinical experiences of respected authorities

Source: *U.S. Preventive Services Task Force, 2012; Canadian Task Force on Preventive Health Care, 2011*

Table 2: Grades of Recommendation

Level	Type of Evidence	Action Words
Grade A Level 1a, 1b	At least one meta-analysis, systematic review, or randomised controlled trial, or evidence rated as good and directly applicable to the target population.	Recommended
Grade B Level IIa, IIb and III	Evidence from well-conducted clinical trials, directly applicable to the target population, and demonstrating overall consistency of results; or evidence extrapolated from meta-analysis, systematic review, or non-randomised controlled trial.	Encouraged
Grade C Level IV	Evidence from expert committee reports or opinions and/or clinical experiences of respected authorities; indicates absence of directly applicable clinical studies of good quality.	Should be considered

Source: *Modified from Scottish Intercollegiate Guidelines Network (SIGN), 2001*

1.7 ETHICS OF NUTRITION THERAPY IN ICU PATIENTS

Artificial nutrition and hydration (ANH) are considered medical interventions. They are used as standard therapy in critically ill patients in the ICU. The decision to provide ANH should be carefully weighed based on evidence, best practice, expected benefits, clinical experience and judgement with priority for patient autonomy and dignity. A clear communication with the patient, family, and/or authorised surrogate decision maker is essential. Dietitian should participate in the decision-making process with other ICU team members. ANH is not obligatory in cases of futile care or end-of-life situations.[8,12,13] (Appendix 1)

CHAPTER 2: NUTRITION SCREENING AND ASSESSMENT

2.1. Nutrition Screening

Recommendation

- Nutritional risk screening (by using NUTRIC or modified-NUTRIC) is encouraged for all patients admitted into the ICU. **Grade B**

2.1.1. NUTRIC Score

a. Nutrition Risk in Critically Ill (NUTRIC) score is the only nutrition screening tool developed and validated specifically in the critically ill population.[14] (Appendix 2)
b. The original NUTRIC score has a score range from 1−10 and a score of ≥6 indicates high nutrition risk.[14] (Table A 2.2)
c. The modified-NUTRIC score, which excludes IL-6 has been re-validated and has a score range from 1−9. A score of ≥5 indicates high nutrition risk.[15] (Table A 2.3)
d. Patients identified with a high nutrition risk are more likely to benefit from early full enteral nutrition therapy.[14,15]
e. An observational study done in Singapore suggested that higher nutritional adequacy was associated with lower 28 day mortality among mechanically ventilated critically ill patients with high nutrition risk (high modified-NUTRIC score), but this was not observed in patients with low nutrition risk (low modified-NUTRIC score).[16] However this does not preclude the clinical importance of nutrition therapy in critically ill patients with low nutrition risk.

2.2. Nutrition Assessment

Recommendation

- Nutrition assessment for critically ill patients should include an evaluation of comorbid conditions, GI tract function, and risk of aspiration. **Grade C**
- Use of traditional nutrition monitoring parameters should be considered to prevent further deterioration of patients' nutritional status. **Grade C**
- IC is the gold standard for estimating energy requirement. The use of IC is encouraged whenever available and feasible. **Grade B** However**,** in the absence of IC, there is insufficient evidence to recommend any specific predictive equation.
- The use of any predictive equation or simplistic weight based equation (25−30 kcal/kg/d) should be based on clinician familiarity, ease of use, and data availability. **Grade C**
- In general, protein requirement in the critically ill patients should range from 1.2−2.0 g/kg actual body weight per day and on-going evaluation of adequacy of protein provision should be performed **Grade B**

a. Traditional nutrition monitoring parameters such as anthropometric and serum protein markers could be affected by several factors such as acute phase response, fluid status, and disease severity rather than representation of nutritional status or adequacy of nutrition therapy.[8]
b. These parameters are not consistently associated with patients' clinical outcomes such as mortality, LOS and infectious complications.[17]
c. The strength of clinical utility of physical assessments such as BMI, MUAC and SGA (for fat and muscle assessment) in critically ill patients remained unclear.[18]
d. However, in order to keep track on the progress of patients' nutritional status, traditional nutrition monitoring parameter should still be evaluated. This allows prompt nutrition intervention to be taken prior to further deterioration in patients' nutritional status.
e. It is recommended to include an evaluation of co-morbid conditions, GI tract function, and risk of aspiration as part of the nutrition assessment.8 (Appendix 3)

2.2.1. Energy Requirement

a. The use of IC to determine energy requirement is encouraged when available and in the absence of factors that influence the accuracy of measurement.[8] (Appendix 4)
b. In the absence of IC, several predictive equations or weight-based simplistic equation are available to determine energy requirement. The accuracy of predictive equations in comparison with IC is summarised in a systematic review. (Appendix 5)
c. There is no strong evidence for the use of any of the predictive equations. Therefore, factors such as clinician familiarity, ease of use, and availability of the data needed for the equation impact equation selection.[19] In fact, using either weight-based simplistic equation or predictive equation may not affect patients' clinical outcomes.[20]
d. Simplistic weight-based equation (Table 3), or any published predictive equation (Table 4) may be used to generate comparative standard to determine the best possible energy prescription.
e. If height and/or weight is unavailable, predictive equation for height and weight may be used. (Appendix 6 and 7). Body weight may need to be adjusted for amputee, paraplegic and quadriplegic patients (Appendix 8).

Table 3: BMI Category and Suggested Body Weight for Calculation of Energy Requirement

Patients' BMI Category	Suggested Body Weight to be Used in Predictive Equation or Simplistic Weight-based Equation
Underweight (BMI: <18.5 kg/m^2)	• Use actual body weight[#] for predictive equation and ideal or usual body weight for simplistic weight-based equation[21] • Refer to the refeeding syndrome protocol if patients are at high risk of developing refeeding syndrome
Normal weight (BMI: 18.5−24.9 kg/m^2)	Use actual body weight[#]
Overweight (BMI: 25.0−29.9 kg/m^2)	Use ideal body weight (at BMI 22.5) or actual body weight[#7]
Obese (BMI ≥30.0 kg/m^2)	• Use actual body weight[#22] for Penn State 2003b[23] (<60 years old) or Penn State (m)[24] (≥60 years old), and provide 50%−70% of calculated caloric requirements. • Use actual body weight[#] in the formula 11−14 kcal/kg if BMI 30−50 kg/m^2 • Use ideal body weight in the formula 22−25 kcal/kg if BMI >50 kg/m^2

Definitions: Actual body weight = patients' current weight; Usual body weight = patients' baseline weight prior to fluid resuscitation; Dry weight = patients' normal weight without any extra fluid in the body; Ideal body weight = patients' weight at BMI 22.5 kg/m^2.
[#]In all critically ill patients following aggressive volume resuscitation or presented with oedema, anasarca or ascites, use dry or usual body weight where possible.[8]

Table 4: List of Predictive Equations for Calculation of Energy Requirement

Name of Equation	Formula Equations
Ireton-Jones equations	Ventilator-dependent IJEE(v) = 1925 − 10(A) + 5(W) + 281 (G) + 292 (T) + 851 (B) [Original][25] IJEE(v) = 1784 − 11(A) + 5(W) + 244 (G) + 239(T) + 804(B) [Revised][26] Spontaneously Breathing IJEE(s) = 629 − 11 (A) + 25 (W) − 609 (O)[25,26] IJEE: kcal/day IJEE=kcal/day; A=age (years); W=actual weight (kg); G=gender (male=1, female=0); T=trauma, B=burn, O=obesity (if present=1, absent=0)
Faisy Equation	REE (kcal/d) = 8(weight) + 14(height) + 32(Ve) + 94 (T) − 4834[27] W=weight (kg), H=Height (cm), Ve=minute ventilation (litres per minute), T=temperature in °C
Penn-State University equations* **It was noted that the accuracy for PSU equation is reduced when BMI is <20.5 or >45* [28]	PSU (2003b): Normal Weight (all age) OR <60 years old & Obese (BMI ≥30)[23] RMR = Mifflin-St Jeor(0.96) + Tmax(167) + Ve(31) − 6212 PSU (m): ≥60 years old & Obese (BMI ≥30)[24,29] RMR = Mifflin-St Jeor(0.71) + Tmax(85) + Ve(64) − 3085 *Mifflin St-Jeor equation for PSU[30] Male: 10 (weight) + 6.25(height) – 5(age) + 5 Female: 10 (weight) + 6.25(height) – 5(age) – 161 Note: Estimated Energy in kcal/day; Weight=Actual Body Weight in Kg; H=Height in cm; A=Age in years; G=Gender (male=1, female=0); T=trauma, B=burn, O=obesity [BMI >27] (if present=1, absent=0); Tmax=maximum body temperature in the previous 24 hours (°C); Ve=minute ventilation (litres per minute) at the time of measurement (read from the ventilator)

2.2.2. Protein Requirement

a. Observational studies and small clinical trials suggested that protein adequacy was closely associated with positive clinical outcomes in critically ill patients.[8,31–33] Adequate protein provision is important to improve body protein economy in order to enable new protein synthesis, optimise immune function and regulate the inflammatory response in critically ill patients.[31]
b. Protein requirements of critically ill patients are expected to be in the range of 1.2−2.0 g/kg actual body weight per day and even higher in burn or multi-trauma patients.[8] (*Refer Chapter 5 for protein requirement in organ failure or specific conditions*)
c. Weight-based equations (e.g. 1.2−2.0 g/kg/d) or nitrogen balance studies can be used to monitor adequacy of protein provision.[8]

CHAPTER 3: NUTRITION INTERVENTION

Nutrition intervention for the critically ill patients refers to the provision of energy, macronutrients, micronutrients and fluid via the GI tract or intravenously. The route, timing of initiation, dose and formulation of nutritional therapy may influence clinical outcomes differently based on nutrition risk (Table 5). These will be reviewed in this chapter.

Table 5: Summary of Nutrition Interventions Based on Nutrition Risk

	Low Nutrition Risk	High Nutrition Risk
a. Timing of EN Initiation	24−48 hours	
Energy provision during 1st week	1/3−2/3 of energy requirement	80−100% of energy requirement within 3 days while monitoring for refeeding syndrome
Protein provision during 1st week	1.2−2 g/kg BW	
b. Timing and Dose of PN Initiation	After 7 days if EN is not feasible	Within 3 days if EN is not feasible. Provide 80% of energy requirement or ≤20kcal/kg with adequate protein (≥1.2g/kg)
Energy & protein provision after 1st week	Full feeding	
c. Timing of SPN Initiation	After 7−10 days if EN alone is unable to meet >60% of energy and protein requirement	

Note

- *For all patients fed with PN, attempt to provide trophic feeding at 10−20 ml/hour and review daily for the possibility to advance to EN.*
- *For severely underweight patients (BMI <16), refer to the refeeding protocol.*
- *For obese patients (BMI ≥30), provide high protein hypocaloric feeding as per Table 6.*

3.1. Enteral Nutrition (EN)

3.1.1. Route of Nutrition Therapy

Recommendation

- In critically ill patients with an intact and functional GI tract, the use of EN over PN is recommended. **Grade A**

a. Meta-analyses have shown that EN, as compared with PN, was significantly associated with reduced infectious complications and LOS, without affecting mortality rate.[8,34,35]
b. A recent multicentre pragmatic RCT has found no significant differences in clinical outcomes (mortality, infectious complications, ICU LOS and ventilator-free-days) and nutritional adequacy in critically ill patients receiving either early EN or PN route.[36]
c. Based on a meta-analysis by the CCPG 2015, EN was significantly associated with a lower number of infection and shorter ICU LOS as well as trend toward reduced hospital LOS, although no mortality difference can be found.[9]
d. The most recent meta-analysis demonstrated that EN, as compared with PN, reduced infectious complications and ICU LOS without mortality difference. However, the benefit of EN observed may be explained by the lower macronutrient provision rather than the enteral route itself.[37]
e. The possible mechanistic benefits of EN in patients with an intact GI tract may be attributed to maintaining gut structural and functional integrity, modulating metabolic response, attenuating oxidative stress and the inflammatory response, and supporting the humoral immune system.[38]

3.1.2. Initiation of EN

Recommendation

- Initiation of EN within 24−48 hours of ICU admission in haemodynamically stable patients is recommended. **Grade A**

a. The benefits of early EN in critically ill patients (started within 24-48 hours of ICU admission/haemodynamic stability) has been consistently reported over time, including reduction in mortality,[9,39–41] and lowering the incidence of pneumonia[41] and infectious complications.[8,9]
b. In critically ill patients presented with haemodynamic instability, early EN ought to be started when the patient is on stable or declining doses of vasopressors.[42] Haemodynamic instability is a clinical state represents either a perfusion failure with clinical manifestations of circulatory shock and/or heart failure, or one or more out-of-threshold hemodynamic monitoring values, which may not necessarily be pathological.[43] (Appendix 9)

3.1.3. Dose and Mode of EN

Recommendation

- For patients with low nutrition risk, hypocaloric EN (1/3−2/3 of energy requirement) for 5−7 days is recommended. **Grade A** Progression of feeding towards goal after approximately 5−7 days should be considered. **Grade C**
- For patients with high nutrition risk, full EN as tolerated over 24−72 hours while monitoring for refeeding syndrome should be considered. **Grade C**
- Provision of adequate protein (1.2−2.0 g/kg/day) during hypocaloric EN throughout the entire ICU stay regardless of nutrition risk status is encouraged. **Grade B**

a. During the acute phase of critical illness (5−7 days), hypocaloric EN (1/3−2/3 of energy requirement) is suggested in critically ill patients with normal baseline nutritional status, low nutrition risk and disease severity as it is associated with lower mortality rate.[44–46] Feeding should be increased towards goal (≥80% of target energy requirement) approximately after 5−7 days when the catabolic storm is abated and anabolism restored.[47,48]
b. Hypocaloric feeding refers to low-calorie, high protein, micronutrient-rich nutritional support, with potentially important benefit. Hypocaloric feeding should not be regarded as permissive underfeeding (deliberate starvation for all nutrients without regard to the patient's muscle mass or catabolic state, to their possible detriments).[48]
c. During hypocaloric feeding, micronutrient supplementation may be required to achieve micronutrient needs.[49] Optimal dose of micronutrient requirement for critically ill patients has yet to be established; therefore the combined dosage from EN/PN and supplements should not exceed the Tolerable Upper Intake Level as in Appendix 10(a) and Appendix 10(b).
d. In patients with high nutrition risk or severely malnourished, EN should be increased towards goal (≥80% of target energy and protein) as quickly as tolerated over 24−72 hours while monitoring for refeeding syndrome.[8]
e. Sufficient protein (≥80% of requirement) should be provided to all critically ill patients regardless of nutrition risk and modular protein supplement may be necessary to achieve protein need during hypocaloric EN.[8]
f. Hypocaloric, high protein feeding should be provided to critically ill obese patients. (Table 6)

Table 6: Energy and Protein Prescription for Critically Ill Obese Patients

BMI (kg/m^2)	Energy	Protein*
30−40	• Indirect calorimetry or predictive equations: 50%−70% of energy requirements[22] • 11−14 kcal/kg ABW[8]	2.0 g/kg ideal body weight per day[8]
40−50		2.5 g/kg ideal body weight per day[8]
>50	• Indirect calorimetry or predictive equations: 50%−70% of energy requirements[22] • 22−25 kcal/kg IBW[8]	

**Protein provision may be commenced with 1.2 g/kg actual weight or 2−2.5 g/kg ideal body weight, and the goal protein intake may be adjusted based on the results of nitrogen balance studies.*[22]

3.1.4. Strategies to Optimise EN

Recommendation

Strategies to optimise EN delivery are:

- Elevation of head of bed to 30°−45° is recommended during EN feeding. **Grade A**
- Cessation of EN is not necessary when the GRV is less than 500 ml in the absence of other signs of intolerance. If the GRV is between 250−500 ml, strategies to optimise EN tolerance should be implemented. **Grade A**
- Intermittent/continuous infusion should be considered when intolerant to bolus EN feeding. **Grade C**
- In patients who are experiencing or at risk of feed intolerance, the use of prokinetic agents (metoclopramide and/or erythromycin) is recommended. **Grade A**
- In patients who are at high risk for aspiration, repeatedly demonstrated high gastric residual or not tolerating adequate amount of EN via gastric feeding, the use of post-pyloric feeding is recommended. **Grade A**
- Use of a feeding protocol that incorporates strategies to optimise EN delivery is recommended. **Grade A**

a. Elevate Head of Bed
   - In critically ill patients receiving EN, elevation of head of bed to 30°−45° is recommended to reduce risk of aspiration pneumonia. Where this is not possible, attempts to raise the head of the bed as much as possible should be considered.[8,9]

b. Gastric Residual Volume Monitoring
   - Although the ASPEN 2016 guidelines recommend abandoning the practice of routine GRV measurement, safety concerns were raised for abandoning the use of GRV in all critically ill patients.[8] *(Refer Section 4.2)*
   - The CCPG 2015 recommend a threshold of GRV between 250−500 ml and frequency of checking GRV either 4 hourly or 8 hourly.[9] The threshold for GRV may be set higher in medical ICU patients as compared to surgical ICU patients.[50,51]
   - There is insufficient data to recommend returning gastric residual volumes up to a certain threshold. An RCT reported returning of GRV up to 250 ml led to a lower incidence and severity of delayed gastric emptying episodes without significant improvement in clinical outcomes. [9,52]

c. EN Feeding Mode
   - There is insufficient evidence on modes of feeding (bolus, intermittent, cyclic or continuous feeding) in relation to patients' clinical outcomes.[9] However, early aggressive EN via bolus feeding is not recommended due to the concern of increased risk of aspiration pneumonia.[9]
   - Compared to bolus feeding, continuous EN infusion has shown greater EN volume delivery and fewer interruptions.[8]
   - Continuous/cyclic EN administration mode is required for post-pyloric tube feeding due to loss of stomach reservoir capability.

d. Prokinetic Agents
   - Prokinetic agents (metoclopramide and/or erythromycin) has been shown to improve gastric emptying and EN tolerance in critically ill patients who are experiencing or at risk of feeding intolerance (high gastric residual volume, emesis).[8]
   - The local ICU protocol recommend to use IV metoclopramide 10 mg every 6−8 hours and/or IV erythromycin 125 mg every 6 hours or 250 mg every 12 hours.[11]
   - In order to limit side effects, a slow infusion rate and dosages not exceeding a daily dose of 10 mg metoclopramide every 6 hours is recommended, and the dosage should be adjusted in case of renal failure.[53]
   - If EN intolerance persists with the use of metoclopramide, 200 mg erythromycin every 12 hours should be added because the combination therapy (metoclopramide and erythromycin) is more effective.[53]
   - Due to the concern of tachyphylaxis and safety, a maximum duration of 7 days is recommended for either drug or combination.[53]
   - In the situation of treatment failure using prokinetic agents, post-pyloric EN should be considered.[53]

e. Post-pyloric EN
   - The routine use of post-pyloric feeding for critically ill patients is not recommended. There is no clear evidence of benefit in improving clinical outcomes such as mortality, duration of MV and ICU LOS, although the risk of pneumonia and/or VAP is reduced.[6,54–56]
   - Post-pyloric feeding should be considered for patients at high risk of EN intolerance, regurgitation or aspiration (Table 7).[9]
   - In ICU where obtaining small bowel access is not feasible, post-pyloric feeding should be considered for those patients who are not tolerating adequate amounts of EN intragastrically and repeatedly demonstrate high gastric residuals.[9]

Table 7: Risk of Aspiration/Feeding Intolerance

High risk for intolerance to EN	• on inotropes • continuous infusion of sedatives or paralytic agents • patients with pre-existing high nasogastric drainage • postoperative ileus • gastroparesis
High risk for regurgitation and aspiration	• nursed in supine position

f. Feeding Protocol (*Refer Chapter 6*)
   - Given the favourable safety, feasibility considerations and low cost, a feeding protocol should be incorporated to promote implementation of strategies to optimise delivery of enteral nutrition and minimise risk associated with EN.[9]

g. Other recommendations to reduce risk of aspiration:[8]
   - Use chlorhexidine mouthwash twice a day.
   - Reduce the level of sedation/analgesia whenever possible.
   - Minimise the duration of diagnostic tests and procedures to limit propagation of ileus and to prevent insufficient nutrient delivery.

3.1.5. Selection of EN Formulation

a. EN Formula

Recommendation

- A standard polymeric formula should be considered for EN initiation. **Grade C**
- Routine use of specialty formulas and disease-specific formulas should not be considered. **Grade C**

- A standard polymeric formula provides adequate nutrients and will be well tolerated by most critically ill patients. There is limited evidence that demonstrate the clear benefits of the routine use of specialty formulas. The use of condition-specific formula should be on case-by-case basis due more to physiologic benefits, such as electrolyte profile and fluid restriction.[8]

b. Arginine

Recommendation

- The use of EN supplemented with arginine and other selected immunonutrients in critically ill patients is not recommended. **Grade A**

- A meta-analysis reported that immune-modulating formula with arginine and other selected nutrients has no effect on mortality and hospital LOS, but has favourable effect in reducing new infectious complications among critically ill, burn, and trauma patients.[57] However, the beneficial effects of lowering infectious complications and hospital LOS were diminished when studies with fish oil were excluded in the subgroup analysis of ICU patients.[57] The beneficial effect of fish oil studies were confounded by the lipid concentration used in the control group, larger treatment effect was found in trials using high-fat control formula.[57–59]
- The recent meta-analysis by the CCPG 2015 showed that EN supplemented with arginine and other selected nutrients have no effect on overall mortality, infectious complications, and ICU as well as hospital LOS, but may possibly reduce duration of MV.[9]
- Given the lack of treatment benefit and the potential of harm among patients with severe sepsis,[60–63] EN supplemented with arginine and other selected nutrient are not recommended to be used for critically ill patients.

c. Glutamine

Recommendation

- The routine use of EN glutamine in critically ill patients is not recommended. **Grade A**

- There is insufficient evidence on the beneficial effect of enteral glutamine in critically ill patients[64] and potential harm has been reported in patients with shock and multi-organ failure in the REDOX study.[9,65]

d. Fish Oils

Recommendation

- There is insufficient evidence to make a recommendation on the supplementation of fish oils alone in critically ill patients. *(Refer Chapter 5, recommendation for patients with ARDS/ALI, TBI and Trauma)*

- There is insufficient data on favourable clinical outcomes in critically ill patient receiving fish oils alone in EN.[9]

e. Probiotics

Recommendation

- The addition of probiotics to EN appears to be safe and may be used for critically ill patients, especially in patients with high risk of infections, pneumonia or VAP. **Grade A** However, there is insufficient evidence to recommend on specific probiotic strain or combination of strains, dosage, frequency and duration of administration.
- The use of *Saccharomyces boulardii* in critically ill patients is not encouraged given the safety concern. **Grade B**
- The use of probiotic in the prevention/treatment of diarrhoea in critically ill patients appears to be inconclusive.

- The use of probiotic/symbiotic was associated with a significant reduction in pneumonia and VAP,[66–71] but inconclusive findings on infectious complications[66,68,70,71] and no favourable effects on ICU and hospital mortality, hospital LOS and incidence of diarrhoea.[9,66–72]
- Administration of probiotics alone may be more effective in reducing infections than symbiotic mixtures, as limited symbiotic trial currently exists.[71]
- Generally, the administration of studied probiotic strains appeared to be safe in the ICU population with the exception of *Saccharomyces boulardii*, which has been reported to cause fungaemia in critically ill patients.[73]
- An RCT in Malaysia found that the administration of 3 x 10^{10} CFU of *Lactobacillus. acidophilus, L. casei, L. lactis, Bifidobacterium bifidum, B.longum*, and *B. infantis* with EN at a frequency of 2 times daily for 7 days to critically ill patients (n = 60) was associated with improvement of feeding tolerance, and reducing ICU LOS and duration of MV by 31% and 40%, respectively.[74]

f. Prebiotics and Fibre

Recommendation

- There is insufficient evidence to recommend the usage of prebiotics/fibre in the prevention or treatment of diarrhoea among critically ill patients.
- However, the use of fermentable soluble fibre as an adjunctive therapy to treat diarrhoea should be considered in situation appears to be applicable based on clinical judgement**. Grade C**

- Although prebiotics/fibre has been shown to improve diarrhoea in non-critically ill patients, this favourable effect has not been observed in critically ill patients.[75–77]
- Several factors such as severity of illness, antibiotics therapy, GI dysfunction, abnormal motility patterns and impaired barrier integrity in critically ill patients may hinder the beneficial effect of prebiotics/fibre.[77]
- On the contrary, the ASPEN 2016 guidelines recommend the routine use of fermentable soluble fibre additive (such as FOS and inulin) in haemodynamically stable patients on standard fibre free EN formula and provision of 10−20 g fermentable soluble fibre supplement in divided doses over 24 hours as adjunctive therapy if there is evidence of diarrhoea.[8,78] However, additional prebiotics to EN products that has already contained fibre/prebiotics remain inconclusive to minimise diarrhoea in critically ill patients.[79]

3.2. Parenteral Nutrition (PN)

3.2.1. Initiation of PN and SPN

Recommendation

- For patients with absolute contraindication to EN and who require long-term PN, continuation of PN in the ICU should be considered. **Grade C**
- For patients with a relative contraindication to early EN, nutrition risk status may be used to determine when to use PN:
  - Low nutrition risk: Initiation of PN after 7 days of ICU admission is recommended. **Grade A**
  - High nutrition risk or severely malnourished: Initiation of PN as soon as possible (within 3 days) following ICU admission should be considered. **Grade C**
- Patients with inadequate EN, the timing of SPN:
  - The use of early SPN and high dose IV glucose in critically ill patients with low nutrition risk and expected short ICU length of stay is not recommended. **Grade A**
  - If patient is unable to meet >60% of energy and protein requirement by EN alone after 7−10 days, the use of SPN is encouraged. **Grade B**
- In patients who are intolerant to EN or unable to achieve requirement via EN, initiation of PN/SPN should be considered only after all strategies to maximise EN has been attempted. **Grade C**

a. Indication for PN[80]
   - massive small bowel resection (with or without colonic resection)
   - proximal high-output fistulae
   - perforated small bowel

b. Relative indication for PN[80] (early EN may be contraindicated or not tolerated temporarily. However, EN should be attempted whenever feasible)
   - severe diarrhoea
   - severe emesis/intractable vomiting
   - substantial abdominal distension
   - partial or complete bowel obstruction
   - severe GI bleeding
   - severe hemodynamic instability

c. For patients who require PN due to pre-existing medical conditions before ICU admission (e.g. short bowel), the use of PN can be continued in the ICU unless bacteraemia is suspected.[8]

d. For patients with an intact GI tract and a relative contraindication to early EN, the decision of using early PN should be based on patients' nutrition risk:
   - Low nutrition risk: initiate PN after 7 days of ICU admission.[8] High dose IV glucose should not be used.[9,81]
   - High nutrition risk or severely malnourished: initiate PN as soon as possible (within 3 days) following ICU admission.[8,82]

e. The use of SPN should be considered after 7−10 days if EN alone is unable to meet >60% of energy and protein requirements, regardless of nutritional risk status.[8,81,83]

f. Initiating SPN prior to this 7−10 days period in critically ill patients on some EN does not improve outcomes and may be detrimental to the patient.[8,81]

g. For patients who are intolerant to EN (such as persistent elevated GRV, regurgitation, vomiting, abdominal distension and diarrhoea), PN or SPN should not be initiated until all strategies to optimise EN delivery have been attempted.[9] (*Refer 3.1.4*).

h. Efforts to initiate EN should be attempted daily.

3.2.2. Dose of PN

Recommendation

- For critically ill patients with high nutrition risk or severely malnourished who require PN during the first week of hospitalisation, PN dosing (≤20 kcal/kg/d or 80% of estimated energy needs) with adequate protein (≥1.2 g protein/kg/d) is recommended. **Grade A**
- The minimal amount of carbohydrate required is about 2 g/kg of glucose per day and the maximum rate of glucose infusion should not exceed 5 mg/kg/min. **Grade C**
- Administration of lipid-injectable emulsions at a rate of 0.7 g/kg up to 1.5 g/kg over 12−24 hours should be considered. **Grade C**
- Withholding soybean oil-based lipid-injectable emulsions is recommended in critically ill patients who are not malnourished, tolerating some EN, or when PN is indicated for short term use (<10 days). **Grade A**
- If there is a concern for essential fatty acid deficiency, limiting soybean oil-based lipid-injectable emulsions to a maximum of 100 g/week (often divided into 2 doses/week) during the first week following initiation of PN in critically ill patients should be considered. **Grade C**
- Alternative lipid-injectable emulsions (MCT, olive oil, or fish oil) that reduce the load of omega-6 fatty acids/soybean oil emulsions should be considered. However, there is insufficient evidence to recommend on the type of alternative lipid-injectable emulsions. **Grade C**

a. Low dose PN may optimise the efficacy of PN by reducing the risk of hyperglycaemia and insulin resistance in the early phase of critical illness. Once the patient stabilises, PN may be advanced gradually to achieve the goals.[8]

b. Practitioners should weigh the safety and benefits of low dose PN on an individual case-by-case basis.[9]

c. Carbohydrates are the main source of calories in most PN formulations and play a major role in energy and protein metabolism. The basal requirement of glucose is estimated to be 2 g/kg/day for an adult and the maximum oxidation rate of glucose in stressed patient is 4−7 mg/kg/min, hence the maximum rate of glucose infusion should probably not exceed 5 mg/kg/day.[10]

d. Lipid-injectable emulsions (formerly known as IV fat emulsion) are an integral part of PN regimen as the source of energy and essential fatty acids. However, the omega-6 fatty acids in the soybean oil-based emulsions may promote inflammatory processes by being the substrate for synthesis of inflammatory eicosanoids.[10] Alternative lipid injectable emulsions such as MCT, olive oil and fish oil that reduce the load of omega-6 fatty acids/soybean oil emulsions should be considered whenever available, but there is insufficient evidence to recommend the type of alternative lipid injectable emulsions to be used.[8,9]

3.2.3. Selection of PN Formulation

a. Standardised or compounded PN

Recommendation

- There is insufficient evidence to recommend the routine use of standardised commercially available PN or compounded PN admixtures in critically ill patient.

- Both standardised commercially available PN or compounded PN admixtures do not offer favourable clinical outcomes over each other. The use of standardised commercially available PN may be considered when the formulation meets the metabolic needs of the patient.[8] Compounded PN admixtures should be considered in patients with specific macro and micronutrient requirements such as renal/hepatic dysfunction, fluid restrictions, and/or electrolyte imbalances.[8]

b. PN Glutamine

Recommendation
- The routine use of PN glutamine in critically ill patients is not recommended. **Grade A**
- In situation where PN glutamine appears to be applicable based on clinical judgement, PN glutamine supplementation is recommended only in highly selected patients, with at least the conditions below fulfilled **Grade A**:
  - Dosage: 0.2−0.5 g/kg/day
  - Patient is not having hepatic or renal failure
  - Patient is not in a state of hemodynamic instability
  - After full PN nutrition (energy and protein) is achieved

- Several recent trials and meta-analyses have raised concerns on the safety and efficacy of PN glutamine supplementation in critically ill patients.[8]
- However, a recent meta-analysis proposed that PN glutamine dipeptide supplementation may confer clinical benefits (reduced infectious complications, ICU LOS, Hospital LOS, and duration of MV) if it is delivered together with adequate parenteral energy and protein so that the administered glutamine serves as precursor in various biosynthetic pathways rather than simply as a fuel.[84]
- In situation that provision of PN glutamine appears to be applicable based on clinical judgement, it should be given in dose between 0.2−0.5 g/kg/d.[84–87] It should not be given to patients in the acute phase of critical illness, with multi-organ failure (i.e. liver failure or kidney failure) or un-resuscitated shock requiring significant vasopressor support.[84,87]

c. Fish oil lipid-injectable emulsions or IV fish oil

Recommendation
- There is insufficient evidence to recommend the routine use of fish oil lipid-injectable emulsions in PN and/or IV fish oil as a pharmaconutrient strategy in enterally fed critically ill patients.

- The use of fish oil lipid-injectable emulsions in PN and/or IV fish oil as a pharmaconutrient strategy in enterally fed critically ill patients may reduce hospital LOS, but it has no mortality benefits[88–90] and the effect on infectious complications was inconsistent.[88,90]

3.2.4. High-dose Antioxidant Supplementation

Recommendation
- Supplementation of high-dose antioxidant nutrients to critically ill patients (via EN, PN or IV) is not recommended. **Grade A**

a. Earlier meta-analyses have reported high-dose antioxidant supplementation including selenium (via EN, PN or IV) was associated with significant reduction in mortality, infectious complications and duration of MV.[91,92] Selenium monotherapy (via PN/IV) was also shown to reduce mortality in sepsis and mixed ICU patients.[93–95]
b. However, the CCPG 2015 has included recent large trials such as REDOX,[65] METAPLUS,[96] and SISPCT[97] in the most recent meta-analysis and recommend not to supplement antioxidant nutrients (combined vitamins and trace elements, including PN/IV Selenium monotherapy) due to the lack of significant treatment effect and the emerging safety concerns, particularly in patients with renal failure.[9]
c. There are insufficient data to recommend the use of PN Zinc (either alone or in combination with other antioxidant) and IV Vitamin C.[9]

3.2.5. Strategies to Optimise PN

Recommendation
- Introduction of PN protocol and nutrition therapy team should be considered to maximise efficacy and reduce associated risk of PN. **Grade C**

a. Critically ill patients who are receiving PN should be monitored for the advancement of PN infusion rate, adverse metabolic effects (such as glycaemic control and hypertriglyceridaemia), electrolyte profile, duration of PN, and transition to EN as feasible.[8]
b. The use of PN protocol and nutrition therapy team may help to reduce inherent risk of complications associated with the use of PN such as hyperglycaemia, electrolyte imbalances, immune suppression, increased oxidative stress, and potential infectious morbidity.[8]

3.3. Trophic Feeding and Overfeeding

3.3.1. Trophic Feeding

Recommendation
- Trophic feeding (10−20 ml/hour) should be considered whenever possible for critically ill patients whom EN is not feasible. **Grade C**
- Overfeeding (provision of >110 % of energy requirement) in critically ill patients is detrimental and should be avoided. **Grade C**

a. Trophic or "trickle" feeding (usually defined as 10−20 mL/hour or 10−20 kcal/hour) is a small volume of balanced EN insufficient for the patient's nutritional needs but producing some positive GI or systemic benefit.[8,98]
b. Trophic feeding may have the benefit in preserving intestinal epithelium, stimulating secretion of brush border enzymes, enhancing immune function, preserving epithelial tight cell junctions, and preventing bacterial translocation, despite not meeting daily caloric needs.[99]
c. It may be sufficient to prevent mucosal atrophy and maintain gut integrity in patients with low- to moderate- nutrition risk but may be insufficient to confer desired clinical outcomes for EN therapy in high-risk patients.[8]
d. It may be considered when patient has a relative contraindication to early EN. *(Refer Relative Indication for PN)*

3.3.2. Overfeeding

a. Overfeeding is deleterious and may be life-threatening and all efforts should be made to prevent overfeeding.
b. Clinical signs of overfeeding are non-specific, including but not limited to hyperglycaemia, azotaemia, hypertriglyceridemia, electrolyte imbalance, immunosuppression, alteration in hydration status, hepatic steatosis, and difficulty weaning from MV.[100]
c. Clinician should pay extra caution on energy contribution from non-nutritive energy source from IV dextrose solution, lipid-based medication (e.g. propofol), or RRT (Table 8 and 9). Calorie-dense formula (1.5 kcal/ml or 2 kcal/ml) should also be used cautiously.
d. Patients on both EN and PN need to be monitored daily to prevent risk of overfeeding as calories are infused through both route.

Table 8: Contribution of Obligatory Calories from IV Drips and Medications

Non-nutritive Energy Source	Approximate Calorie Contribution (kcal/ml)
Dextrose • IV Dextrose 5% • IV Dextrose 10%	1 g = 3.4 kcal • 5 g dextrose / 100 ml water * 3.4 kcal = 0.17 kcal/ml • 10 g dextrose / 100 ml water * 3.4 kcal = 0.34 kcal/ml
IV Propofol 1%	1 ml = 1.1 kcal

Amphotericin B is prepared in lipid formulations, however, the calorie contribution is negligible[101]

Table 9: Contribution of Obligatory Calories from RRT

Mode of RRT	Rate of Absorption Based on Glucose Content in Dialysate
Acute peritoneal dialysis[102]	40−50 %
Automated peritoneal dialysis[103]	40 %
Continuous ambulatory peritoneal dialysis[103]	60 %
Icodextrin[103]	40 %
CVVHDF[104]	43 % for 1.5% dextrose dialysate 45 % for 2.5 % dextrose dialysate
Intermittent HD & CVVH	Not applicable

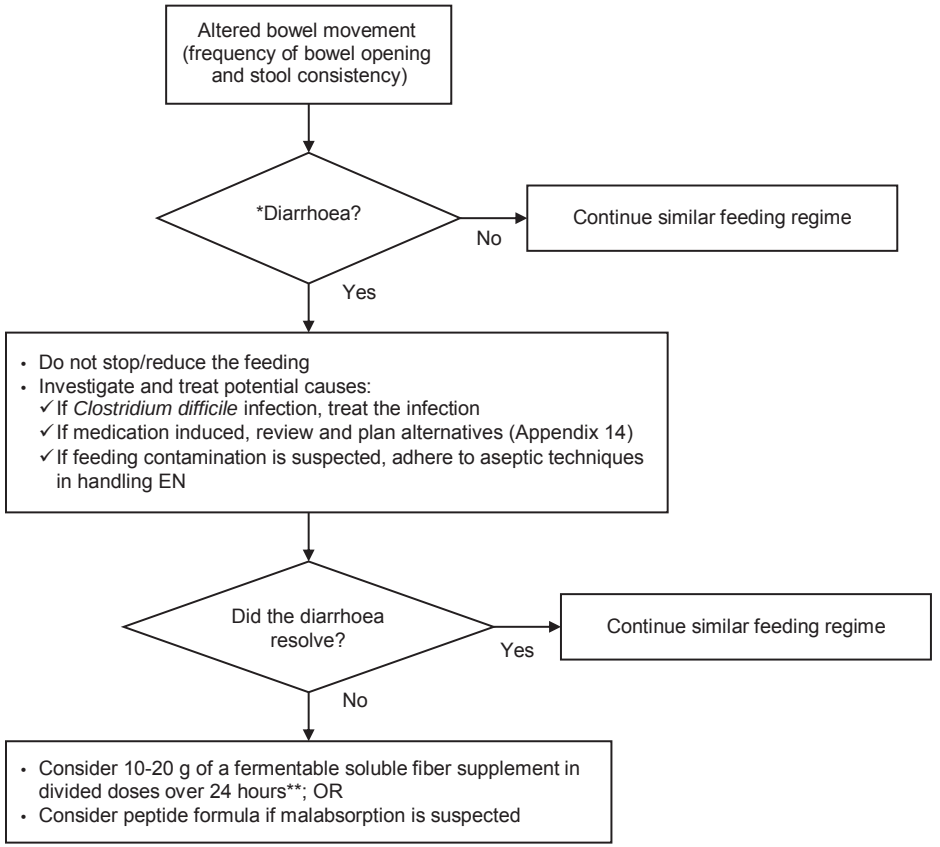
CHAPTER 4: Monitoring and Evaluation

Patients on EN or PN are at risk for gut dysfunction and metabolic complications. Monitoring and evaluation following nutrition intervention is important to manage the complications associated with EN or PN in order to ensure optimal delivery of nutrition therapy.

4.1 Diarrhoea

Recommendation

- EN should not be interrupted in patients experiencing diarrhoea, the aetiology of the diarrhoea should be established first. **Grade C**



**Definition of diarrhoea: daily faecal score above 15 by using the Kings' Stool Chart (Appendix 15)*[105]

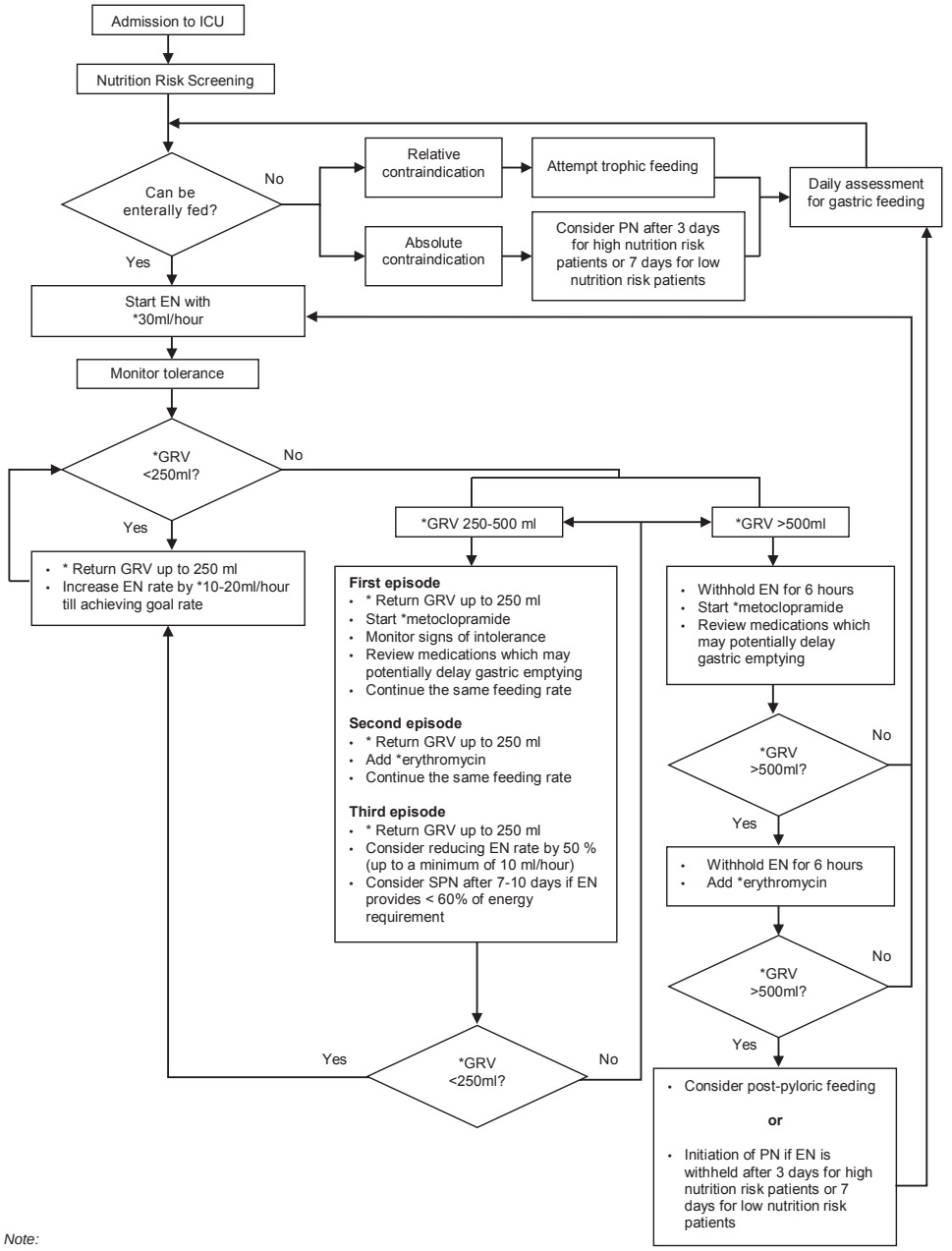
***The efficacy of soluble fibre with prebiotics in managing diarrhoea in non-critically ill patients has been demonstrated, but the evidence in critically ill patients remains inconclusive.*[77]

Figure 1: Flow Chart of Diarrhoea Management in Critically Ill Patients

(Reference: Whelan et al., 2008,[105] *Kamaruzzaman et al., 2015,*[77] *McClave et al., 2016,*[8] *and de Brito-Ashurst 2016*[106]*)*

4.2 Gastric Residual Volume (GRV)

a. GRV does not correlate with the risk of pneumonia, regurgitation or aspiration.[51,107,108].
b. In fact, pneumonia and bacterial colonisation of the upper respiratory tract was more closely linked to aspiration of contaminated oropharyngeal secretions than regurgitation and aspiration of contaminated gastric contents.[8,109,110]
c. GRV (between 150−400 ml) has been shown to be a poor marker of aspiration, with a sensitivity of 1.5−4.5%, a specificity of 94.1−98.7%, a positive predictive value of 17.4−27.3%, and a negative predictive value of 77.1−77.4%.[108]
d. RCTs have shown that raising the cut-off value of GRV up to 250−500 ml did not increase the incidence of aspiration, regurgitation, vomiting or pneumonia.[51,107,108]
e. Further evidence from an open-label RCT (NUTRIREA1) demonstrated no significant increase in the incidence of VAP, other ICU-acquired infections, MV duration, ICU LOS and mortality in patients receiving early EN without monitoring GRV, though the incidence of vomiting was reported to be higher.[50] Nevertheless, one before-after study[111] and one smaller RCT[112] have found no difference in the incidence of vomiting between groups.
f. Monitoring of GRV was associated with inappropriate cessation of EN and reduced EN volume delivered.[50,111,112] Routine withdrawal of GRV may increase the incidence of occlusion of enteral feeding tube (especially in small-bore feeding tube).[113]
g. In institutes where GRV monitoring is still used to monitor EN tolerance, the acceptable GRV levels should be decided based on the available evidence and consensus among ICU team members. (Figure 2)



Note:
- *This protocol may be adapted and modified based on each institutional setting*
- *(*) indicates parameters may be altered depending on the consensus of the multidisciplinary team involved in critically ill patients' management.*

Figure 2: Flow Chart of GRV Management

(Reference: McClave et al., 2016[8] and Montejo et al., 2010[51])

4.3 Refeeding Syndrome

Recommendation

- Gradual introduction and advancement of nutritional therapy should be considered in patients at high risk of developing refeeding syndrome. **Grade C**
- Evidence-based caloric restriction protocol is recommended as a therapeutic option for critically ill patients who developed refeeding syndrome. **Grade A**

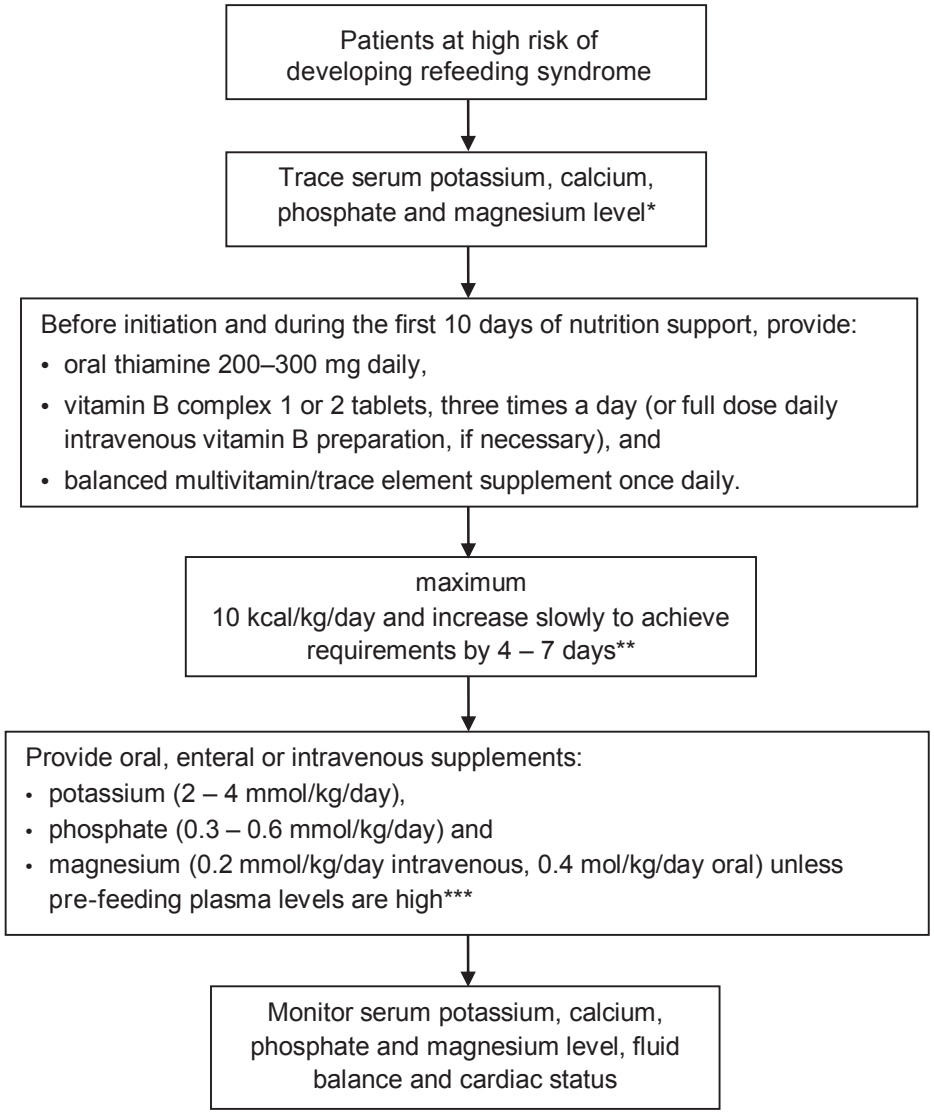
a. Refeeding syndrome is defined as shifts in fluids and electrolytes that may occur in malnourished patients receiving nutritional therapy (via oral, EN or PN).[114]
b. The potential clinical consequences are volume overload with risk of heart failure and peripheral oedema, spasm or cardiac arrhythmias, muscle weakness, rhabdomyolysis, and impaired haematopoiesis with symptoms of anaemia and reduced oxygen supply.[115]
c. Refeeding syndrome should be prevented by identifying high risk patients before nutritional therapy (Table 10). Gradual initiation and advancement of nutrition therapy should be considered in high risk patients. (Figure 3)
d. In patients who developed refeeding syndrome (Table 11), a multicentre RCT has reported that adherence towards a caloric restriction protocol (Figure 4) led to significant longer overall survival time, lower mortality rate at day-60, lower incidence of major infection, and lower incidence of airway or lung infections as compared with continued standard caloric intake.[116]

Table 10: Criteria for Determining Patients at High Risk of Developing Refeeding Syndrome[114]

a. Patient has **one or more** of the following: - BMI <16 kg/m^2 - Unintentional weight loss of >15 % within the previous 3−6 months - Very little or no nutrient intake for >10 days - Low level of potassium, phosphate or magnesium prior to any feeding
b. Patient has **two or more** of the following: - BMI <18.5 kg/m^2 - Unintentional weight loss >10 % within the previous 3−6 months - Very little or no intake for >5 days - A history of alcohol abuse or some drugs including insulin, chemotherapy, antacids or diuretics

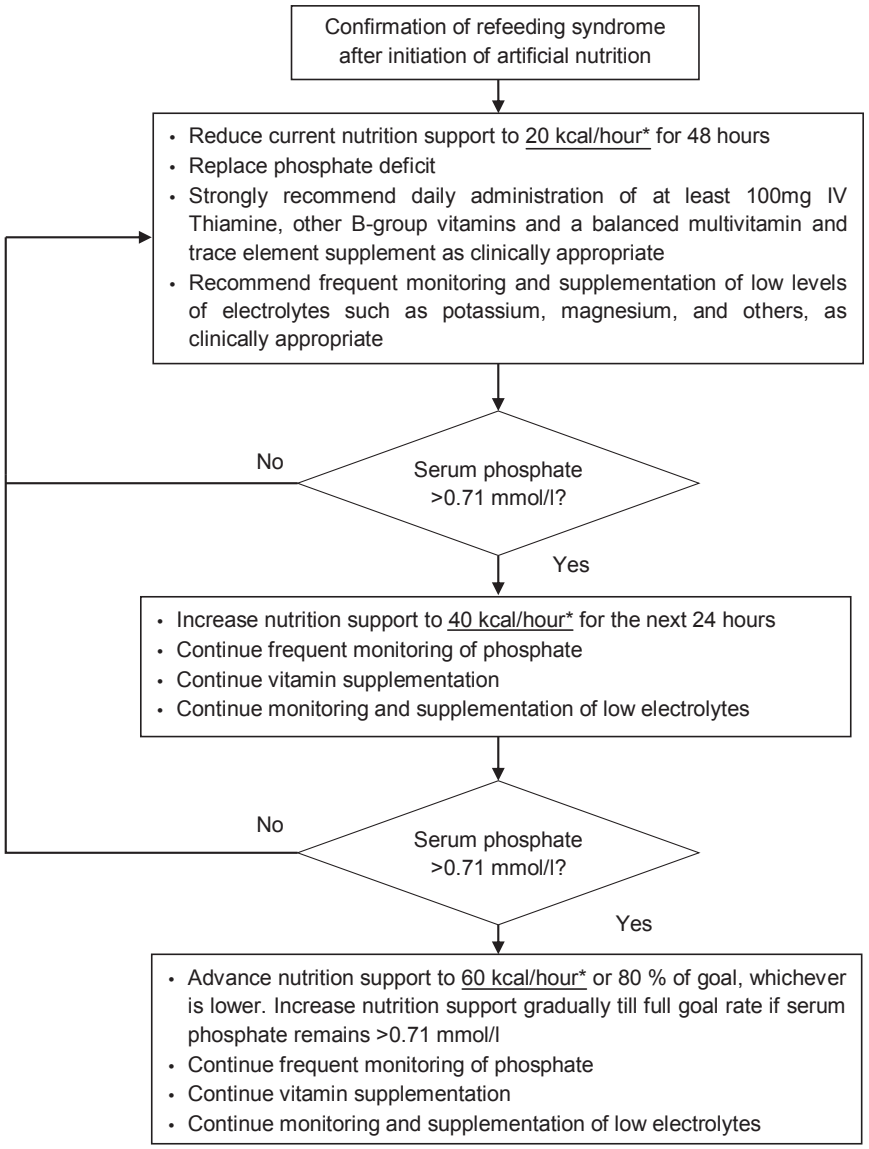
Table 11: Criteria for Confirmation of Refeeding Syndrome from the Start of Artificial Nutrition Support[117]

a. Electrolytes−severely low electrolyte concentrations - Potassium <2.5 mmol/l - Phosphate <0.32 mmol/l - Magnesium <0.5 mmol/l
b. Peripheral oedema or acute circulatory fluid overload
c. Disturbance to organ failure including respiratory failure, cardiac failure and pulmonary oedema



Note:
** Patient with normal pre-feeding levels of potassium, calcium, phosphate and magnesium is still at high risk and might have whole body depletion*
*** Provide only 5 kcal/kg/day in extreme cases (e.g. BMI less than 14 kg/m^2 or negligible intake for more than 15 days)*
**** Pre-feeding correction of serum electrolytes is unnecessary. Replacement should be done in parallel with feeding intervention*

Figure 3: Nutrition Management for Patients at High Risk of Refeeding Syndrome
(Source: Mehanna et al., 2008[114] and NICE CG32[118])



**Feeding rate recommended is based on continuous feeding for 24 hours a day. Therefore, it may be adjusted based on feeding practices of each institution* [116]

Figure 4: Caloric Management Protocol of Refeeding Syndrome
(Reference: Doig et al., 2015[116]*)*

4.4 Other Gastrointestinal (GI) Complications

Other common GI complications associated with EN in critically ill patients include nausea, vomiting and constipation. It is important to identify possible causes and provide management accordingly to prevent inappropriate cessation of EN (Table 12).

Table 12: Management of GI Complications[119]

Complications	Possible Causes	Suggestions
Nausea and Vomiting (Definition: vomit >1 time in 12 hours)	Rapid administration of EN	Reduce feeding rate
	Excessive volume of EN	• Consider using energy-dense formula • Consider smaller more frequent bolus feeds or intermittent feeding
	Medication induced	Review medications as possible causes and substitute with other medications where clinically appropriate
Constipation (Definition: absence of stool for 3 or more consecutive days without mechanical obstruction regardless of bowel sounds)	Insufficient fluid intake	Increase fluid intake
	Low residue feeding formula	Use a fibre-enriched formula
	Decreased intestinal motility	• Rule out intestinal obstruction, ileus, or colonic pseudo-obstruction • Treat with laxatives
	Medication induced	Review medications (e.g. opioids, dopamine, sedatives, anticholinergics)

4.5 Monitoring and Evaluation of PN

Monitoring critically ill patient who requires parenteral nutrition (PN) on a daily basis is recommended (Table 13). Daily review on electrolytes, nutrient provision and fluid balance is important when establish a new patient on PN.

Table 13: Monitoring and Evaluation of PN

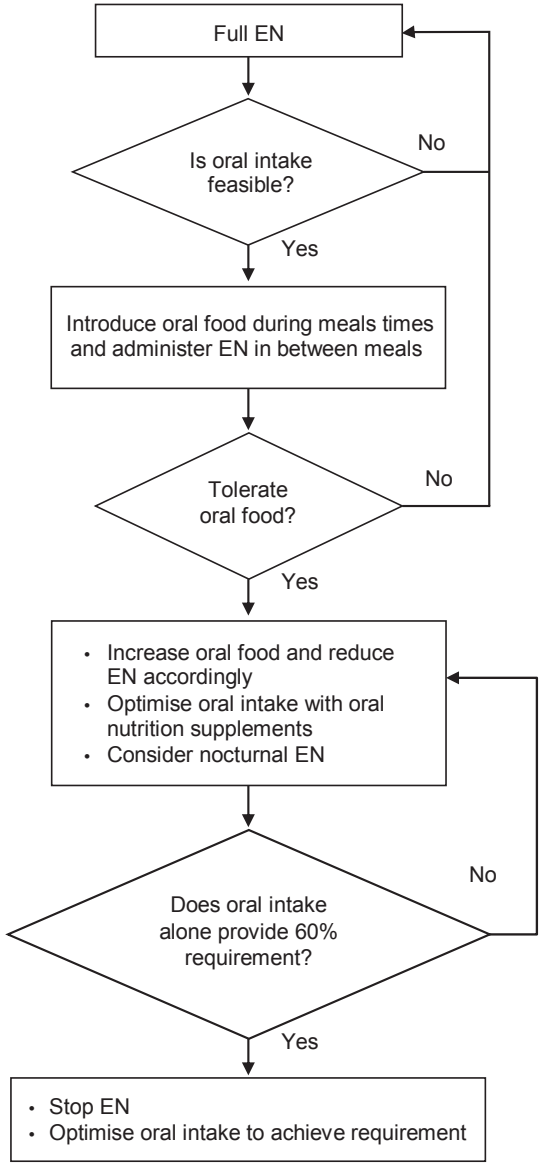
Parameter	To Monitor[120]	Frequency[120]		Action and Prevention
		Daily	Weekly	
Weight	Fluid balance and nutritional status	+		• Sudden weight gain may indicate hypervolemia−to restrict total fluid intake and monitor input and output.
BMI	Nutritional status		+	
Temperature	Signs of sepsis and fluid requirement	+		
Fluid balance	Hydration status and compare nutrition prescribed vs delivered	+		
Blood glucose	Glycaemic control Blood glucose target level <10mmol/L[10]	1-2 times/day for non-diabetic For diabetic, follow local practice		• Gradual initiation and advancement of PN • Check glucose infusion rate • Reduce dextrose concentration in PN • Use insulin
Electrolytes (Sodium, Potassium & Magnesium)	Electrolytes disturbances or refeeding syndrome			• Supplement electrolytes if serum levels are low • Monitor serum levels
Phosphate	Electrolytes disturbances or refeeding syndrome	+		• Supplement phosphate into PN if serum levels are low • Gradual initiation and advancement of PN for patients with refeeding syndrome • Monitor serum levels
Liver function Test (LFT)	Risk of fatty liver, intrahepatic cholestasis, cholecystitis and cholelithiasis.	+		• Reduce calories if the patient is overfed • Reduce dextrose infusion if exceed the maximum oxidation rate • Replace part of the calories from dextrose with lipid
Triglycerides	Risk of hypertriglyceridemia Triglyceride target level <4.6 mmol/L[121]		+	• Reduce lipid infusion rate • Lengthen lipid infusion time
Infection markers (C-reactive protein, white blood cells)	Signs of infection	+		• Strict protocol for prevention of catheter related infections • Avoid hyperglycaemia • Reduce the omega-6 content of PN

4.6 Feeding Transition

Recommendation

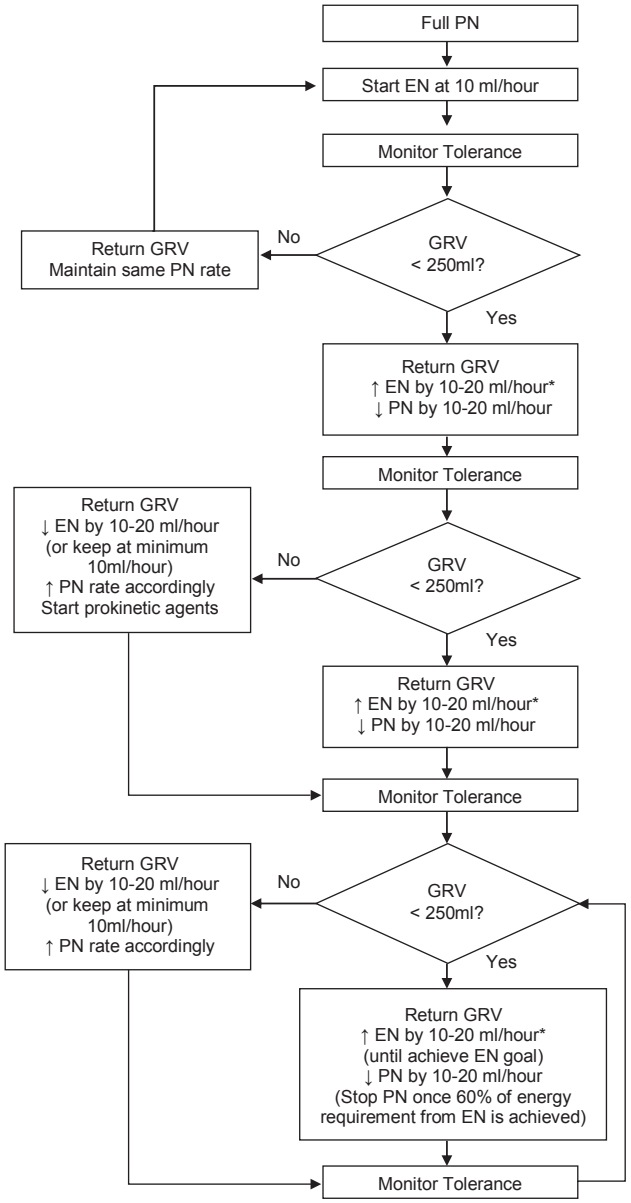
- Reduction of EN energy should be considered as tolerance to oral intake improves and finally discontinued when the patient is receiving >60% of target energy requirements from oral intake. **Grade C**
- Reduction of PN energy should be considered as tolerance to EN/oral intake improves and finally discontinued when the patient is receiving >60% of target energy requirements from EN/oral intake. **Grade C**

a. Feeding transition is the shifting from one route of nutrition therapy to another, typically from PN to EN (Figure 5), PN to oral (Figure 6) or EN to oral (Figure 7). Feeding transition should be planned and monitored appropriately in order to avoid under- or overfeeding.
b. There is insufficient evidence to recommend the initial rate during transition feeding. However, it should be commenced gradually in order to assess tolerance.[122]
c. As the energy provision from the new route of nutrition therapy increases, the infusion rate of the pre-existing route of nutrition therapy should be reduced accordingly and be discontinued once the calorie from the new route of nutrition therapy achieve >60% of target energy requirement.[8]



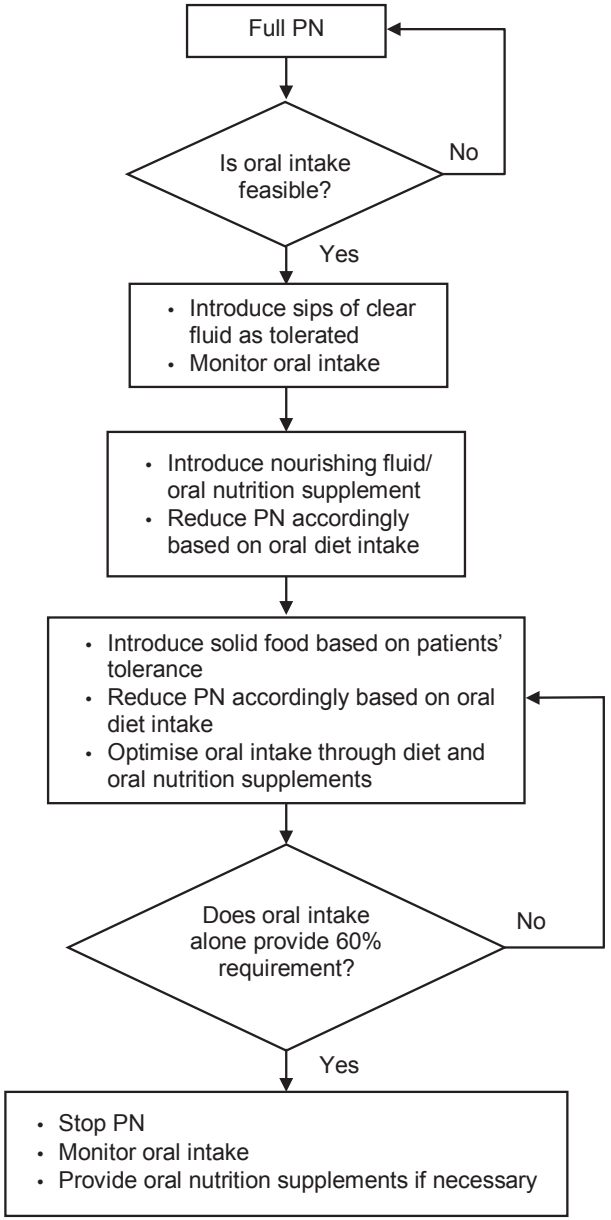
Note:
- *Ensure adequate hydration during feeding transition.*
- *Premature cessation of EN before adequate oral intake is established should be avoided.*

Figure 5: Flow Chart of Feeding Transition from Tube Feeding to Oral
(*Reference: Ferrie et al., 2015)*[119]



Note:
- *The transition from PN to EN should be commenced at a low rate and increased gradually in order to ensure nutritional adequacy and avoid overfeeding. The initial infusion rate and GRV threshold should be individualised based on patients' condition.*
- *GRV >500ml may prompt EN cessation. Refer flowchart for GRV management.*
- *If GRV is persistently elevated despite the use of combination of prokinetic agents for 4-7 days, consider post-pyloric feeding*
- *In this flow chart, EN 1 kcal/ml is used. Readjust feeding rate according to EN calorie density.*

Figure 6: Flow Chart of Feeding Transition from PN to EN
(*Reference: Dervan et al., 2012)*[123]



Note:
- *Premature cessation of PN before adequate oral intake is established should be avoided.*

Figure 7: Flow Chart of Feeding Transition from PN to Oral

CHAPTER 5: SPECIAL CONSIDERATIONS

5.1. Acute Kidney Injury (AKI)

Recommendation
- Energy recommendation for critically ill patients with AKI should be ranging between 20−30 kcal/kg body weight. **Grade C**
- Protein restriction in patients with renal insufficiency as a mean to avoid or delay initiating dialysis therapy should not be considered. **Grade C**
- The use of standard EN formula in AKI patients should be considered. **Grade C**
- However, a specialty formulation designed for renal failure should be considered in case of significant electrolyte abnormalities. **Grade C**
- Vitamin C supplementation not exceeding 50−100 mg per day should be considered. However higher intakes (up to 150−200 mg) may be needed when undergoing CRRT. **Grade C**

Nutrition Management	Nutrition Recommendations
a. Energy Requirement	• 20−30 kcal/kg body weight.[124] (any stage of AKI)
b. Protein Requirement	• Protein should not be restricted in patients with renal insufficiency as a mean to avoid or delay initiating dialysis therapy.[8,124] • Protein provision in critically ill patients with AKI should be tailored individually and monitored closely based on the patient's overall status, underlying comorbidities and medical treatment. • Up to 10−15 g amino acids (0.2 g amino acids per litter of ultrafiltrate) and 5−10 g protein are loss through extracorporeal circulation of RRT/CRRT.[125,126] Higher protein provision in AKI patients undergoing CRRT led to positive nitrogen balance[127] • However, high protein should be provided with caution as it may be associated with acidosis, azotaemia and increase dialysis dose requirements.[124]
c. CHO Requirement	65−70 % non-protein calories (3−5 g/kg body weight)[128]
d. Fat Requirement	30−35 % non-protein calories (0.8−1.2 g/kg body weight)[128]
e. Electrolyte & Fluid	Fluid and electrolyte provision is dependent on the urine output, extraction during dialysis treatment, and serum electrolyte levels.
f. Micronutrients Requirement	• Standard EN formula should be used in AKI patients. If significant electrolyte abnormalities develop, a specialty formulation designed for renal failure (with appropriate electrolyte profile) may be considered. [8] • Vitamin C supplementation in patients with AKI should not exceed 50−100 mg per day, however higher intakes (up to 150−200 mg) may be needed when undergoing CRRT.[129] • Fat-soluble vitamins supplementation is usually not necessary.[129]

Table 14: Protein Provision in Critically Ill Patients with AKI

	ASPEN 2016[8]	KDIGO[124]
Non-dialysis	1.2−2.0 g/kg	0.8−1.0 g/kg (non-catabolic AKI)
Dialysis	Additional 0.2 g/kg up to 2.5 g/kg	1.0−1.5 g/kg for RRT up to maximum of 1.7 g/kg for CRRT

5.2. Acute Pancreatitis

Recommendation

- Mild acute pancreatitis: specialised nutrition therapy should only be considered when unable to advance to oral diet within 7 days. **Grade C**
- Moderate to severe acute pancreatitis: EN commencement within 24−48 hours of admission is encouraged. **Grade B**
- EN is recommended over PN. **Grade A**
- Either Nasogastric or nasojejunal tube is safe and well-tolerated in patients with acute pancreatitis. **Grade A**
- Continuous EN infusion should be considered in patients with severe pancreatitis. **Grade C**
- Either polymeric or semi-elemental formula can be used in patients with acute pancreatitis. **Grade A**
- Energy and protein recommendation of 25−35 kcal/kg/d and 1.2−1.5 g/kg/d, respectively, should be considered. **Grade C**
- The use of probiotics may be safe in patients with acute pancreatitis who are receiving early EN. However, caution may need to be taken in patients who are older (>60 years) or with more severe acute/advanced stage of pancreatitis due to limited data on safety in these population and an RCT showed signal of harm. The committee decided not to put forward the recommendation to use probiotics in patients with acute pancreatitis due to the limited data on the benefit of clinical outcome and the heterogeneity with regard to the type, dose and treatment duration of probiotics.

Nutrition Management	Nutrition Recommendations
a. Feeding Initiation	• EN commencement within 48 hours of admission reduces risk of multi-organ failure, pancreatic infectious complications and mortality of acute pancreatitis patient.[8,130–132] • For patients with mild acute pancreatitis, oral diet should be initiated as tolerated. If there is failure to advance to oral diet within 7 days, then specialised nutrition therapy should be considered.[8] • For patients with moderate to severe acute pancreatitis, EN should be started at a trophic rate and advanced to goal as soon as fluid resuscitation is completed (within 24−48 hours of admission).[8]
b. Feeding Route	• Traditionally, patients with acute pancreatitis were treated with bowel rest or PN to minimise pancreatic secretion that may aggravate pancreatic inflammation. • However, studies showed that EN, as compared to PN, is associated with fewer infectious complications and reduction of hospital LOS, multi-organ failure and mortality.[8,133–136] • Use of PN as initial nutrition therapy should be avoided in patients with moderate to severe acute pancreatitis.[8]
c. Nasogastric vs Nasojejunal	• Nasogastric or nasojejunal tubes may be used for EN administration to patient with severe acute pancreatitis. • Nasogastric appeared to be safe and well-tolerated. There is no difference between EN infusion via nasogastric or nasojejunal to pain sensation, diarrhoea or energy provision.[8,133,135–137]
d. Continuous Feeding vs Bolus/Cyclic Feeding	Continuous EN infusion is preferred over cyclic or bolus administration in severe pancreatitis.[133,138]
e. Formula Selection	Either semi elemental or polymeric EN formulations can be used in acute pancreatitis as there is no difference in terms of feeding tolerance, infectious complications and mortality.[139]
f. Macronutrients Requirement	• Energy requirement: 25−35 kcal/kg/d[133] • Protein requirement: 1.2−1.5 g/kg/d[133]

Nutrition Management	Nutrition Recommendations
g. Probiotics	• Meta-analysis by Zhang et al (2010) showed a trend towards reduction of infectious complications and a significant shortening of hospital LOS when probiotic was administered in acute pancreatitis patients.[140] However, a more recent meta-analysis by Gou et al (2014) showed no effect in the clinical outcomes of patients with predicted severe acute pancreatitis.[141] • A recent RCT by Wang et al (2013) showed use of EN added with two probiotic organisms (*Bacillus subtilus* and *Enterococcus faecium*) in patients with severe acute pancreatitis was associated with a significant reduction in pancreatic sepsis and multiple-organ dysfunction (both $p<0.05$) as compared to use of EN alone. However, it was noted that the subjects in this study was relatively young (Age: 41−43) and of low disease severity (APACHE II: 12-14).[142] This study was not included in the meta-analysis by Gou et al (2014).[141] • The ASPEN 2016 guidelines suggested that the use of probiotics may be considered in patients with severe acute pancreatitis who are receiving early EN,[8] however extra caution need to be taken in patients who are older (>60 years) or more severely ill given the signal of harm from the PROPATRIA study.[143]

5.3. Burns

Recommendation

- EN is recommended over PN. **Grade A**
- Early EN initiation within 12 hours of injury is recommended. **Grade A**
- The use of IC to assess energy needs in burns patients with weekly repeated measures should be considered. **Grade C** In situations where IC is not available, energy requirements estimated by formulas that use variables such as burn size and age, and weight should be considered. **Grade C**
- Higher protein recommendation of 1.5−2.0 g/kg should be considered, especially in patients with burns >20% TBSA. **Grade C**
- Moderate glycaemic control (6−8 mmol/L) is encouraged. **Grade B**
- Limiting carbohydrates delivery from nutrition and non-nutritional sources to 60% of total energy intake should be considered. **Grade C**
- Limiting total fat delivery to <35% of total energy delivery should be considered. **Grade C**
- Enteral glutamine supplementation at 0.3−0.5 g/kg/day is recommended. **Grade A**
- Supplementation of micronutrients including zinc, copper, selenium, as well as Vitamin B1, C, D and E should be considered among patients with major burns. **Grade C**

Nutrition Management	Nutrition Recommendations
a. Feeding Initiation	• EN initiation within 12 hours of injury is recommended.[144] • Early EN is associated with reduced rates of complications, infectious morbidity and mortality.[145] Early EN may also decrease intestinal permeability, preserve the intestinal mucosal barrier and have a beneficial effect on the reduction of enterogenic infection.[146]
b. Feeding Route	• EN should be attempted first, PN is an alternative that is indicated only in case of EN failure or contraindicated.[144] • Providing early EN, as compared with PN, is associated with improved structure and function of the GI tract, as evidenced by a significantly greater contractility, less ischemia/reperfusion injury, and reduced intestinal permeability among burn patients.[8,147] • An RCT conducted in 82 severe burned patients showed that the overall

Nutrition Management	Nutrition Recommendations
	complications and mortality was significantly lower in patients who received early EN as compared with the parenteral group.[148]
c. Energy requirements and Predictive Equations	• The use of IC to assess energy needs in burns patients with weekly repeated measurement should be considered. [8] • When IC is not available, energy requirements should be estimated by formulas that use variables such as burn size, patient's age and weight.[8,149,150] (Appendix 11)
d. Protein Requirement	Protein requirements are higher and should be 1.5−2.0 g/kg in adults,[8,144,151] especially in patients with burns >20% TBSA.[150]
e. Glucose and Glycaemic Control	• Insulin resistance and related hyperglycaemia result in major complications in burn patients; moderate glycaemic control (6−8 mmol/L) with continuous insulin was shown to be safe in adults, with less hypoglycaemia events and no impact on mortality.[152] • Carbohydrate delivery from nutrition and non-nutritional sources (IV drips, medications, etc.) should be limited to 60% of total energy intake.[144]
f. Fat Requirement	Total fat delivery (prescribed for nutritional and propofol) should be limited to <35% of total energy intake.[144]
g. Glutamine	• Enteral glutamine supplementation at 0.3−0.5 g/kg/day may be considered in burn patients in addition to protein requirement.[8,153] • A meta-analysis of four RCT involving 155 burn patients demonstrated that glutamine supplementation was associated with a reduction in hospital mortality and complications due to gram-negative bacteraemia.[154]
h. Micronutrients Requirement	Patients with major burns have increased micronutrients requirements (zinc, copper and selenium, as well as of vitamin B1, C, D and E) and may require supplementation.[144] (Appendix 12)

5.4. Hyperglycaemia

Recommendation

- The recommended optimal blood glucose range for majority of the critically ill patients is between 7.8−10.0 mmol/L. **Grade A**
- Efforts to prevent hyperglycaemia (blood glucose level >10 mmol/L) and hypoglycaemia (blood glucose <3.9 mmol/L) are recommended. **Grade A**
- There is insufficient data to recommend the routine use of diabetes-specific formula to manage hyperglycaemia in critically ill patients.

Nutrition Management	Nutrition Recommendations
a. Glycaemic Control	• A blood glucose range of 7.8−10 mmol/L (140−180 mg/dL) is recommended for the majority of critically ill patients.[8,155]
b. Formula Selection	• One recent open-label RCT among hyperglycaemic mechanically ventilated critically ill patients receiving EN showed that diabetes-specific formula may lower insulin requirements, improved glycaemic control and reduced risk of acquired infections (incidence of tracheobronchitis and VAP), as compared with standard formula. However, no difference was observed between group in ICU and hospital LOS, days on MV and mortaltiy.[156] • Diabetes-specific formulas vary in nutrients composition such as type and amount of carbohydrate, fat and fibre. Therefore, the beneficial outcomes may not be generalised to other diabetes-specific formulas.

Nutrition Management	Nutrition Recommendations
	• Recommendations on the routine use of diabetes-specific formulas to manage hyperglycaemia in critically ill patients cannot be made at this time since there are insufficient data to support this practice.[9,157]

5.5. Liver Failure

Recommendation

- The use of EN to provide nutrition therapy to ICU patients with liver disease should be considered. **Grade C**
- The use of dry or usual body weight when determining energy and protein requirement in patients with liver failure should be considered. **Grade C**
- Restriction of protein should not be considered. **Grade C** Protein recommendation similar as for other critically ill patients should be considered. **Grade C**
- Standard EN formulation should be considered in ICU patients with liver diseases. **Grade C** The use of BCAAs formulation in patients with hepatic encephalopathy who is already receiving first-line therapy with luminal-acting antibiotics and lactulose should not be considered. **Grade C**
- In patients with hepatic encephalopathy, protein restriction should not be considered. **Grade C** Protein recommendation at 1.2−1.5 g/kg body weight should be considered. **Grade C**
- Protein may be reduced for a short period of time to 0.5 g/kg/day in patients with severe protein intolerant (hepatic encephalopathy grade III−IV), but this should be avoided at all cost. **Grade C**
- Early postoperative nutrition should be considered after liver transplantation. **Grade C** The use of EN over PN should be considered. **Grade C**

Nutrition Management	Nutrition Recommendations
a. Feeding Route	The use of EN is preferred when providing nutrition therapy in ICU patients with acute and/or chronic liver disease.[8]
b. Energy Requirement	When determining energy and protein in patients with liver failure by using a predictive equations, dry or usual weight should be used instead of actual weight due to conditions affecting the accuracy of actual weight such as ascites, intravascular volume depletion, oedema, portal hypertension, and hypoalbuminaemia.[8]
c. Protein Requirement	Protein restriction should be avoided and the same recommendations for protein requirement as general critically ill patients should be used.[8]
d. Formula Selection	• Standard EN formulation should be used in ICU patients with liver diseases[8] • The rationale for use of BCAAs in the treatment of hepatic encephalopathy in liver failure is based on their reduced concentrations in liver failure, competing for binding sites in the central nervous system with aromatic amino acids, and their stimulatory effect on ammonia detoxification to glutamine.[8] • However, in patients with hepatic encephalopathy already receiving first-line therapy (luminal-acting antibiotics and lactulose), there is no evidence to date that adding BCAAs will further improve mental status or coma grade.[8]
e. Hepatic Encephalopathy	• An RCT divided patients with hepatic encephalopathy to low protein (n=10) and normal protein group (1.2 g/kg/day; n=10) showed that there is no benefit of limiting protein intake on the evolution of hepatic encephalopathy, while the administration of low-protein exacerbates protein breakdown. Both groups were given early EN and received similar amount of calories.[158]

Nutrition Management	Nutrition Recommendations
	• Protein restriction may worsen nutrition status, decrease lean muscle mass, and lead to less ammonia removal. Therefore, protein should not be restricted as a management strategy aimed at reducing hepatic encephalopathy.[8] • Protein restriction should be avoided and that protein be maintained between 1.2 and 1.5 g of proteins per kg of body weight per day.[159,160] • In patients with severe protein intolerant (hepatic encephalopathy grade III-IV), protein may be reduced for a short period of time to 0.5 g/kg/day, but protein restriction should be avoided at all cost.[159,160]
f. Liver Transplant	• Early postoperative EN, as compared with maintenance IV fluid, was associated with a trend towards lower rate of infections and improvement of nitrogen balance.[161,162] • Post-operative nutrition in transplant recipients is superior to the infusion of fluid and electrolytes with regard to time on the ventilator and LOS in ICU.[161,163]

5.6. Pulmonary Failure

Recommendation

- There is inadequate evidence to recommend EN fish oil alone in patients with ARDS/ALI.
- No recommendation can be made at this time for the use of EN fish oils, borage oils and antioxidants in patients with ARDS/ALI due to conflicting data.
- Energy-dense EN formulations (1.5−2 kcal/mL) should be considered for patients with acute respiratory failure, especially if in a state of volume overload. **Grade C**
- The same energy and protein recommendation as the general critically ill patients should be considered in patients with ARDS/ALI. **Grade C**

Nutrition Management	Nutrition Recommendations
a. Formula Selection	• There is inadequate evidence to recommend EN fish oil alone for ARDS/ALI.[9] • Although the CCPG 2015 suggested that EN fish oils, borage oils and antioxidants should be considered among patients with ARDS/ALI,[9] however the beneficial effect of mortality may be affected by the lipid concentration used in the control group, whereby larger treatment effect was found in trials using high-fat control formula.[58,59] Hence, no recommendation can be made at this time due to conflicting data.[8] • Energy-dense EN formulations (1.5−2 kcal/mL) should be considered for patients with acute respiratory failure, especially if in a state of volume overload.[8]
b. Dose of Feeding	Patients with ARDS/ALI should not be fed selectively, although the EDEN studies[99,164] observed no difference in clinical outcomes in patients receiving either full or trophic feeding. The recommendation for general critically ill patients should be applied.

5.7. Sepsis

Recommendation

- Early EN within 24−48 hours of diagnosis of sepsis or as soon as haemodynamic stability is achieved should be considered. **Grade C**
- The use of PN or SPN early in the acute phase of severe sepsis of septic shock is not recommended. **Grade C**
- Either simplistic weight-based equations or published predictive equations may be used to predict energy requirement. **Grade C** Protein recommendation of 1.2−2.0 g/kg/day should be considered. **Grade C**
- The routine use of immune-modulating formula is not recommended for patients with severe sepsis. **Grade A**

Nutrition Management	Nutrition Recommendations
a. Feeding Initiation	Early EN should be given within 24−48 hours as soon as resuscitation is completed and the patient is hemodynamically stable.[8]
b. Feeding Route	The use of PN or SPN early in the acute phase of severe sepsis or septic shock is not recommended, regardless of patients' degree of nutrition risk[8] as this may result in longer hospital LOS, ICU LOS and durations of organ support, and increased ICU-acquired infection.[81] Furthermore, it may also result in increased mortality.[165,166]
c. Energy Requirement	Simplistic weight-based equations (25 kcal/kg/d) or published predictive equations may be used to predict energy requirement.[8]
d. Protein Requirement	1.2−2.0 g/kg/day.[8]
e. Formula Selection	Immune-modulating formula should not be used routinely in patients with severe sepsis.[8]

**Refer to Appendix 13 for the definition of sepsis and septic shock and identifying patients with sepsis and septic shock.*

5.8. Trauma

Recommendation

- Early EN is recommended within 24−48 hours of injury once the patient is haemodynamically stable. **Grade A**
- Energy and protein recommendation in the range of 20−35 kcal/kg/d and 1.2−2.0 g/kg/day, respectively, should be considered. **Grade C**
- No recommendation can be made at this time for the use of immune-modulating formula in patients with severe trauma given the lack of favourable effect in clinical outcome.

Nutrition Management	Nutrition Recommendations
a. Feeding Initiation	Early EN within 24−48 hours of injury with a high protein polymeric diet is recommended in the immediate post trauma period once the patient is haemodynamically stable.[8,40,167]
b. Energy Requirement	Energy goals should be in the range of 20−35 kcal/kg/day, depending on the phase of trauma. In the early resuscitative phase, lower energy provision is suggested, and energy provision should be increased gradually as the patient enters into the rehabilitation phase.[8]
c. Protein Requirement	Protein requirements are similar as the general critically ill patients but may be at the higher end of the provision range, from 1.2−2.0 g/kg/day.[8]
d. Formula Selection	Although the ASPEN 2016 guidelines suggested that immune-modulating formula containing arginine and fish oil be considered in patients with severe trauma,[8] the meta-analysis by Marik & Zaloga (2008)[57] clearly showed that these formula confers no benefit in all clinical outcome including mortality,

Nutrition Management	Nutrition Recommendations
	infectious complications and hospital LOS, compared to the control group receiving standard enteral formula. Therefore, we decided not to put forward this recommendation until more data are available.

5.9. Traumatic Brain Injury

Recommendation

- Early EN should be initiated within 24−48 hours of injury once patient is haemodynamically stable. **Grade C**
- Energy and protein recommendation should be ranging between 25−30 kcal/kg/d and 1.5−2.5 g/kg/day, respectively, should be considered. **Grade C**
- No recommendation can be made at this time for the use of arginine-containing immune-modulating formulations or EPA/DHA supplement with standard enteral formula in patients with TBI due to limited amount of evidence.

Nutrition Management	Nutrition Recommendations
a. Feeding Initiation	Early enteral feeding should be initiated in the immediate post-trauma period (within 24−48 hours of injury) once the patient is haemodynamically stable.[8]
b. Energy Requirement	25−30 kcal/kg/day.
c. Protein Requirement	1.5−2.5 g/kg/day.[8]
d. Formula Selection	The ASPEN 2016 guidelines suggested to use arginine-containing immune-modulating formulations or EPA/DHA supplement with standard enteral formula in patients with TBI.[8] However, given the limited evidence on the benefits of immune-modulating formula or EPA/DHA supplement on outcomes in TBI populations,[168,169] this recommendation cannot be put forward.

CHAPTER 6: NUTRITION THERAPY TEAM AND PROTOCOLS

The ASPEN 2016 guidelines recommend incorporating use of protocols and nutrition therapy team as part of strategies to maximise nutrition therapy efficacy and reduce PN associated risk among critically ill patients in ICU.[8]

6.1 Nutrition Therapy Team

a. Nutrition Therapy Team (NTT) should include at least physicians, dietitians, pharmacists and nurses who are trained in clinical nutrition.[170] (Table 15)
b. In general, functions of a NTT are to:
   - conduct nutrition assessment, determination of macro and micronutrient needs, recommendations for appropriate EN/PN therapy, management of nutrition therapy, develop and conduct continuous education.[170]
   - manage specialised nutrition therapy program and quality improvement activities by educating other healthcare professionals, students, patients, and caregivers.
   - design and conduct nutrition-related research or participate in research activities.
c. The evidence supporting the benefits for NTT in the ICU is limited. One retrospective study in South Korea reported that the implementation of nutrition therapy team in the ICU was associated with shorter length of hospital stay, reduction in days of fasting and improve nutritional adequacy. In addition, PN usage was reduced and had cost-saving.[171]

Table 15: Nutrition Therapy Team Members and Potential Roles

Practitioner	Potential Roles in Nutrition Therapy Team
Physicians	Familiar with all aspects of nutrition care, including: a) Patient nutrition assessment, development and implementation of nutrition care plan, patient monitoring, and termination of therapy b) Surgeons/radiologists may participate in placement of central venous lines and gastrostomies c) Pre- and postsurgical nutrition care and management d) Coordinate nutrition therapy with overall treatment of disease/conditions and patient management
Dietitians	a) Conduct individualised nutrition screening and assessment b) Develop and implement nutrition care plans* c) Monitor patient's response to the nutrition care delivered d) Manage nutrition therapy related complications e) Develop transitional feeding care plan or termination of nutrition therapy
Pharmacists	a) Compound parenteral nutrition formulation prescribed b) Monitor patient's response to the parenteral nutrition care delivered c) Manage parenteral nutrition therapy related complications
Nurses	Varies with the educational background, position, and practice environment. May include: a) Direct patient care and provision of nutrition therapy b) Manage enteral and intravenous access c) Recognise side effects and complications of stomas/central lines d) Provide education to patients and caregivers
Speech/language therapist	Advice on desensitization and safety of oral feeding and swallowing

**Refer to Appendix 17 for suggested Nutrition Care Process*
(Adapted from DeLegge & Kelley, 2013[170])

6.2 Nutrition Therapy Protocols

a. Protocols are standard operating procedures based on complex guidelines or recommendations. Nutrition therapy protocols are useful as reference to harmonise practices among healthcare professionals in a particular institution or setting. Compliance to such protocols with institution-specific strategies increases efficiency of patients care among healthcare professionals with varying level of experience and competency in nutrition therapy. Nutrition therapy protocols also provide structure and accountability in patient care, facilitate continuous quality improvement and decrease the clinical practice variance and errors in the nutrition care process.

b. The use of evidence-based feeding protocols had been shown to result in a significant shorter hospital LOS and a trend toward reduce hospital mortality,[172] although such results were inconsistent.[173] The presence of an ICU dietitian significantly facilitates the implementation of a feeding protocol.[174]

c. Feeding protocols with appropriate feeding algorithms such as in Figure 8 should be designed and implemented to improve the percentage of patients achieving the recommended goal of nutritional therapy.

d. The ASPEN 2016 guidelines recommend several feeding protocols, which includes:
   - Volume-based feeding protocol
     - Volume-based feeding is a strategy in which 24 hours volumes are targeted instead of hourly rates. Nurses are empowered to increase feeding rates to compensate for volume lost while EN is held.[175,176]
     - The use of volume-based feeding protocol had been shown to be safe and increase volume of nutrition delivered.[175–177]
     - The target calorie for volume-based feeding should be based on nutritional risk status.
   - Top-down multi strategy protocols
     - Using multiple different strategies simultaneously at the time of EN initiation to enhance tolerance and increase delivery of EN, removing individual strategies as tolerance improves over the first few days of infusion.[8]
     - The strategies typically include the use of volume-based feeding, prophylactic prokinetic agents and early supplementation of modular protein, with discontinuation of prokinetic agents in patients who demonstrate lack of need.[8,175]
   - The use of nurse-driven EN protocols to increase EN delivery has been shown to reduce the incidence of nosocomial infections.[8,178]

e. Feeding protocol should address:[8]
   - Indication for EN and PN
   - Goal EN/PN infusion rate
   - Feeding progression guide
   - Handling of GRVs
   - Feeding transitions
   - Amount and frequency of flushes
   - Feeding related complication management guide
   - Strategies to improve feeding delivery

6.3 Guide for Fasting/Nil by Mouth (NBM)

a. Inappropriate cessation of EN should be avoided. Every order of fasting must be provided with a justifiable reason with nutrition risk assessment. All attempts should be made to minimise the duration of fasting.

b. Feeding in the 24 hours following surgery helps to reduce postoperative complications and attenuate the magnitude of the inflammatory response and nitrogen losses postoperatively.[179]

c. Fasting for diagnostic tests or procedures should be minimised to limit propagation of ileus and to prevent inadequate nutrient delivery. (Table 16)[8]

Table 16: Fasting/NBM Guide for Surgery/Procedures

Surgery/Procedure	Feeding Guide
Pre-operative	• Allow clear fluid until 2 hours before procedure[180] • Allow nourishing fluid, enteral formula or solid until 6 hours before procedure[180–183]
Post-operative	• Provide EN within 24 hours of postoperative period except when noted presence of continued obstruction of GI tract, bowel discontinuity, increased risk for bowel ischemia, or on-going peritonitis[8,180] • EN may be feasible and managed individually in the presence of high-output fistulas, severe malabsorption, shock, or severe sepsis if the patient remains stable for at least 24−36 hours[8]
Procedures/diagnostic tests	No fasting unless involving airway or GI tract[11]
Planned extubation	No fasting except high risk for re-intubation/anticipated difficult airway[11]

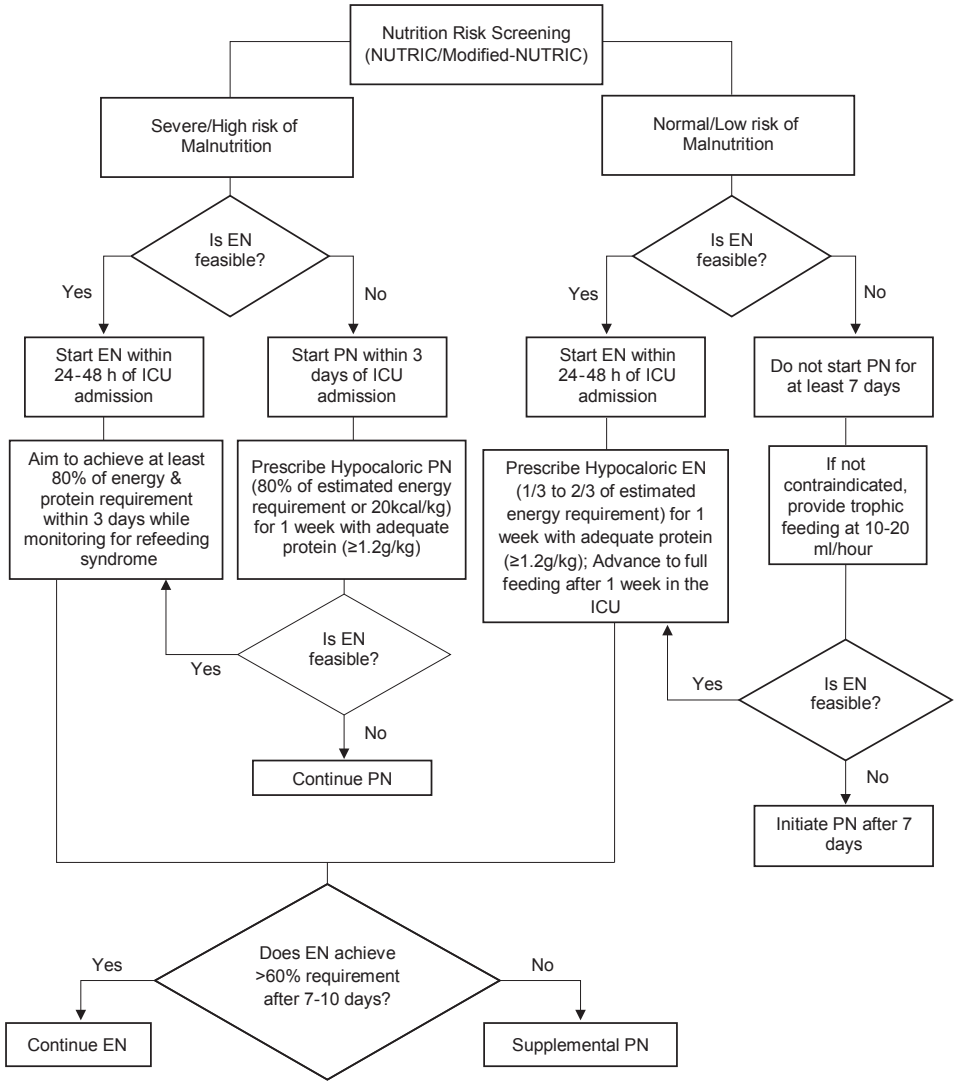
Note:[180]
- Clear fluids include water, pulp-free juice, clear tea, black coffee and clear carbohydrate-rich drinks
- Solids include solid food or light meal, sweets, nonhuman milk (including milk in tea and coffee)

6.4 Enhanced Recovery After Surgery (ERAS)

a. ERAS is a multimodal perioperative care pathway designed to reduce the patient's stress response in reaction to surgical procedure, facilitates maintenance of preoperative body compositions and organ function, and, in doing so, achieves early recovery.[184]

b. A meta-analysis of RCT for Enhanced Recovery Program in Colorectal Surgery showed that the ERAS pathway was associated with reduction of overall morbidity and shortened hospital stay without increasing admission rate. A significant reduction in nonsurgical complications was noted, while the effect on surgical complications was less pronounced.[185]

c. Refer to Appendix 16 for the components of nutrition management strategies in ERAS.



Note:

- *For all patients fed with PN, attempt to provide trophic feeding at 10−20 ml/hour and review daily for the possibility to advance EN.*
- *For severely underweight patients (BMI <16), refer to the refeeding protocol.*
- *For obese patients (BMI ≥30), provide high protein hypocaloric feeding as per Table 6*

Figure 8: Flow Chart for EN, PN, SPN and Trophic Feeding Initiation

APPENDICES

Appendix 1: Suggested Ethical Considerations on Artificial Nutrition and Hydration[12]

Requirement	Prerequisites of artificial nutrition and hydration are: a) an indication for a medical treatment and b) the definition of a therapeutic goal to be achieved and c) the will of the patient and his or her informed consent. In all cases, however the treating physician has to take the final decision and responsibility. [Strong Consensus]
Intensive Care Unit	a) Artificial nutrition and hydration are standard therapies in critically ill patients. In this setting, as well as in other settings, it applies that when there is no treatment goal anymore, i.e. therapies are not indicated anymore (futile), they have to be withheld or withdrawn. [Consensus] b) Hydration and artificial nutrition should not be necessarily continued in ICU patients in the dying phase. Artificial nutrition and hydration can have adverse effects such as catheter complications and infections. In addition, hydration may even prolong and aggravate the dying phase c) It is to be emphasised that if a therapy is being stopped, standard care or palliative care comfort still has to be provided to the patient
Terminal Illness	There are no clear criteria to ascertain the beginning of the dying phase. Therefore, a nutritional intervention in this phase of life should be followed in an individualised manner. [Consensus]
Nursing Care	Artificial nutrition should never be used for the purpose of reducing the workload and effort of nursing. [Strong Consensus]
Difficult Decision and Ethical Dilemmas	a) In the absence of an indication and lack of achieving a treatment goal or in the absence of consent, nutritional therapy should be discontinued. This may lead to individual emotional and/or ethical conflicts among family members or team members (doctors, nursing staff and members of other therapeutic professions). [Consensus] b) Caregivers who do not agree with the discontinuation of artificial nutrition for reasons of conscience or religion cannot be forced to do this. In such cases they must shift the responsibility to another person to ensure that the patients will is observed. c) Voluntary cessation of nutrition and hydration is a legally and medically acceptable decision of a competent patient, when chosen in disease conditions with frustrating prognosis and at the end life. [Strong Consensus] d) Providing nutrition against the will of the patient who is able to give his/her consent or make judgments (enforced feeding) is generally prohibited. [Strong Consensus] (This recommendation does not apply to patients suffering from anorexia nervosa) e) There should be awareness and obligatory education for medical personnel to enable them to treat patients appropriately to their spiritual needs. Respect for religious, ethnic and cultural background of patients and their families have to be granted. [Strong Consensus]

(Source: Druml et al., 2016[12])

Appendix 2: The NUTRIC and Modified-NUTRIC Score and Forms Needed for Scoring

Table A 2.1 The NUTRIC Score Variables

Variable	Range	Points
Age (year)	<50	0
	50−74	1
	≥75	2
Acute physiology and chronic health evaluation II (APACHE II)	<15	0
	15−19	1
	20−28	2
	≥28	3
Sequential organ-failure assessment (SOFA)	<6	0
	6−9	1
	≥10	2
Number of Co-morbidities	0−1	0
	≥2	1
Days from hospital to ICU admission	0−<1	0
	≥1	1
Interleukin-6 (IL-6) (pg/ml)	0−<400	0
	≥400	1

Table A 2.2: NUTRIC Score Scoring System (With IL-6)

Sum of Points	Category	Explanation
6−10	High Score	• Associated with worse clinical outcome (mortality, ventilation) • These patients are the most likely to benefit from aggressive nutrition therapy
0−5	Low Score	• These patients have a low malnutrition risk

Table A 2.3: The Modified-NUTRIC Score Scoring System (Without IL-6)

Sum of Points	Category	Explanation
5−9	High Score	• Associated with worse clinical outcome (mortality, ventilation) • These patients are the most likely to benefit from aggressive nutrition therapy
0−4	Low Score	• These patients have a low malnutrition risk

(Source: http://www.criticalcarenutrition.com/resources/nutric-score. Accessed on 3rd December 2016)

Table A 2.4: Acute Physiologic and Chronic Health Evaluation II (APACHE II)

No	A. Physiologic Variable	High Abnormal Range				Normal Range	Low Abnormal Range				Score
	Severity Point *(First 24 hours, use the **worst** possible score)*	**+4**	**+3**	**+2**	**+1**	**0**	**+1**	**+2**	**+3**	**+4**	
1.	**Temperature**−rectal, °C (add 0.5 if oral, 1.0 if auxiliary)	≥41	39-40.9		38.5-38.9	36-38.4	34-35.9	32-33.9	30-31.9	≤29.9	
2.	**MAP**, mm Hg	≥160	130-159	110-129		70-109		50-69		≤49	
3.	**Heart rate** (ventricular response)	≥180	140-179	110-139		70-109		55-69	40-54	≤39	
4.	**Respiratory Rate**, per minute (non-ventilated or ventilated)	≥50	35-49		25-34	12-24	10-11	6-9		≤5	
5.	**Oxygenation** a. FiO_2 ≥0.5, record A-a DO_2	≥500	350-499	200-349		<200					
	b. FiO_2 <0.5, record only PaO_2					>70	61-70		55-60	<55	
6.	**Arterial pH** (if no ABG, use HCO_3)#	≥7.7	7.6-7.69		7.5-7.59	7.33-7.49		7.25-7.32	7.15-7.24	<7.15	
7.	**Serum Sodium**, mmol/L	≥180	160-179	155-159	150-154	130-149		120-129	111-119	≤110	
8.	**Serum Potassium**, mmol/L	≥7	6-6.9		5.5-5.9	3.5-5.4	3-3.4	2.5-2.9		<2.5	
9.	**Serum Creatinine**, µmol/L (double point score if ARF)	≥309.4	176.8-309.3	132.6-176.7		53-131.5		<53			
10.	**Haematocrit**, %	≥60		50-59.9	46-49.9	30-45.9		20-29.9		<20	
11.	**White Blood Count**, x10^3/µL	≥40		20-39.9	15-19.9	3-14.9		1-2.9		<1	
12.	**Glasgow Coma Scale (GCS) score** (the ***BEST*** GCS in the first 24H): Score = 15 – actual GCS										
								A=TOTAL ACUTE PHYSIOLOGY SCORE (APS):			
	#HCO_3 (venous-mmol/L)	≥52	41-51.9		32-40.9	22-31.9		18-21.9	15-17.9	<15	

***MAP** = [(2 x diastolic + systolic] / 3* ***A-aDO2** = [(FiO_2 (713) – ($PaCO_2$ / 0.8)] – PaO_2* *ARF: acute renal failure*

Total APACHE II Score (A + B + C):

B. Age (year)	Points
≤44	0
45−54	2
55−64	3
65−74	5
≥75	6

C. Chronic Health Points (If the patient has a history of severe organ system insufficiency/immuno-compromised)	Points
For non-operative/emergency post-operative patients	5
For elective post-operative patients	2
Pt does NOT have history of severe organ system insufficiency and is NOT immuno-compromised	0

Organ insufficiency or immuno-compromised state must have been evident **prior** to this hospital admission and conform to the following criteria:

LIVER	Biopsy proven cirrhosis & documented portal hypertension; past upper GI bleeding attributed to portal hypertension; or prior episodes of hepatic failure/encephalopathy/coma
CARDIOVASCULAR	New York Heart Association Class IV
RESPIRATORY	Chronic restrictive, obstructive, or vascular disease resulting in severe exercise restriction, i.e., unable to climb stairs or perform household duties; or documented chronic hypoxia, hypercapnia, secondary polycythaemia, severe pulmonary hypertension (>40 mm Hg), or respirator dependency
RENAL	Receiving chronic dialysis
IMMUNO-COMPROMISED	The patient has received therapy that suppresses resistance to infection, e.g., immuno-suppression, chemotherapy, radiation, long term/recent high dose steroids, or has a disease that is sufficiently advanced to suppress resistance to infection, e.g., leukaemia, lymphoma, AIDS

(Source: Knaus et al., 1985[16])

Table A 2.5: Sequential Organ Failure Assessment (SOFA)

Score		0	1	2	3	4
Organ system	**Variable**					
Respiration	PaO_2/FiO_2, mm Hg (kPa)	≥400 (53.3)	<400 (53.3)	<300 (40)	<200 (26.7) with respiratory support	<100 (13.3) with respiratory support
Coagulation	Platelet, $10^3/\mu L$	≥150	<150	<100	<50	<20
Liver	Bilirubin, µmol/L (mg/dL)	<20 (1.2)	20-32 (1.2-1.9)	33-101 (2.0-5.9)	102-204 (6.0-11.9)	>204 (>12.0)
Cardiovascular	Blood Pressure Status	MAP ≥70 mm Hg	MAP <70 mm Hg	Dopamine < 5, or Dobutamine (any dose) [b]	Dopamine 5.1-15, or Epinephrine ≤0.1, or Norepinephrine ≤0.1[b]	Dopamine >15, or Epinephrine >0.1, or Norepinephrine >0.1[b]
Central nervous system	Glasgow Coma Scale score[c]	15	13-14	10-12	6-9	3-5
Renal	Creatinine, µmol/L (mg/dL) or	<110 (1.2)	110-170 (1.2-1.9)	171-299 (2.0-3.4)	300-440 (3.5-4.9)	>440 (5.0)
	Total Urine Output (ml/24h)				<500	<200

Abbreviations: FiO2, fraction of inspired oxygen; MAP, mean arterial pressure; PaO2, partial pressure of oxygen
*(*Source: Vincent et al.,*1996*[186] *and Singer et al.,2016*[187]*)*

[b] Catecholamine doses are given as µg kg^{-1} min^{-1} for at least 1 h
[c] Glasgow Coma Scale score range from 3-15; higher score indicates better neurological function

Table A 2.6: List of Co-morbidities

Co-morbidities: ☐ Yes ☐ No

If Yes, check all that apply:

Myocardial
- ☐ Angina
- ☐ Arrhythmia
- ☐ Congestive heart failure (or heart disease)
- ☐ Myocardial infarction
- ☐ Valvular

Vascular
- ☐ Cerebrovascular disease (Stroke or TIA)
- ☐ Hypertension
- ☐ Peripheral vascular disease or claudication

Pulmonary
- ☐ Asthma
- ☐ Chronic obstructive pulmonary disease (COPD, emphysema)

Neurologic
- ☐ Dementia
- ☐ Hemiplegia (paraplegia)
- ☐ Neurologic illnesses (such as Multiple sclerosis or Parkinson)

Endocrine
- ☐ Diabetes Type I or II
- ☐ Diabetes with end organ damage
- ☐ Obesity and/or BMI >30 [weight in kg / (height in meters)^2]

Renal
- ☐ Moderate or severe renal disease

Gastrointestinal
- ☐ Gastrointestinal Disease (hernia or reflux)
- ☐ Gastrointestinal Bleeding
- ☐ Inflammatory bowel
- ☐ Mild liver disease
- ☐ Moderate or severe liver disease
- ☐ Peptic ulcer disease

Cancer/Immune
- ☐ AIDS
- ☐ Any Tumour
- ☐ Leukaemia
- ☐ Lymphoma
- ☐ Metastatic solid tumour

Psychological
- ☐ Anxiety or Panic Disorders
- ☐ Depression

Musculoskeletal
- ☐ Arthritis (Rheumatoid or Osteoarthritis)
- ☐ Connective Tissue disease
- ☐ Degenerative Disc disease (back disease or spinal stenosis or severe chronic back pain)
- ☐ Osteoporosis

Substance Use
- ☐ Heavy alcohol use or binge drinking history
- ☐ Current smoker
- ☐ Drug abuse history

Miscellaneous
- ☐ Hearing Impairment (very hard of hearing even with hearing aids)
- ☐ Visual Impairment (cataracts, glaucoma, macular degeneration)

(Source: http://www.criticalcarenutrition.com/images/Comorbidity_list.jpg. Accessed on 3rd December 2016)

Appendix 3: List of GI Symptoms

The definition of GI symptom which may be indicative of GI dysfunction

GI symptom	Definition
High GRV	maximum GRV above 500 ml at least once
Vomiting/regurgitation	visible vomiting or regurgitation in any amount
Diarrhoea	diagnosis based on the King's Stool Chart[105]
Bowel distension	suspected or radiologically confirmed bowel dilatation in any bowel segment
GI bleeding	visible appearance of blood in vomits, nasogastric aspirate, or stool
Intra-abdominal hypertension	mean intra-abdominal pressure of the day ≥12 mmHg
Abdominal compartment syndrome	mean intra-abdominal pressure 20 mmHg with new organ dysfunction or failure, with intra-abdominal pressure measured in the supine position with zero-point at mid-axillary line with a maximal instillation volume of 25 ml

(Adapted from Reitnam Blaser et al., 2013[188])

Appendix 4: Checkpoints for Successful IC Measurement for Mechanically Ventilated Patients

Planning Measurement	
a) Frequency	• Conduct calorimetry within 3−4 days after admission • Repeat calorimetry every 2−3 days during ICU stay • Repeat calorimetry in case of changes in patient or disease conditions
Unsuitable Conditions	
b) Respiration	• FiO_2 >60% • PEEP >10 cm H_2O • Peak airway pressure >30 cm H_2O
c) Agitation	• Unstable sedation and/or analgesia • Uncontrolled seizure and/or involuntary movement
d) Treatments	• Air leaks from ventilator circuit and/or endotracheal tube cuff • Air leaks from chest drains • Special consideration: Renal replacement therapy, liver support therapy, ECMO
e) Immediate changes (<60 min before IC)	• >±1 ºC change of body temperature • Change of drug dose: catecholamine, sedatives, analgesics, etc. • Invasive procedures, mobilization, physical exercise
Before Measurement	
f) Device	• Warm up and calibration (as required) • Secure connections of tubes and components • Search for any air leaks
g) Feeding status	• Continuous feeding preferred • If fed, record: energy prescription and intake, duration (hours) since last meal
h) Environment	• Record: ventilation setting • Maintain room temperature at 20−25 ºC • Ensure comfortable body position
During and After Measurement	
i) Quality of Measurement	• Duration: 30 minutes or until stable state (calculated coefficient of variation, CV <5% for VO_2 and VCO_2 for >5 minutes, CV of <10% for 25 minutes) • RQ: <0.7 and >1.0 may suggest inadequate measurement • Record: o agitation and body movements o any events affecting breathing pattern o changes in vasoactive drugs
j) Disinfection	• Disinfect device and components in contact with patients • Discard single use components

(Source: Oshima et al,. 2016 [189])

Appendix 5: Accuracy of Predictive Equation in Relation to IC Measurement

From a systematic review comparing the accuracy of predictive equation with IC, the following results were shown:

Predictive Equation	Underestimation: Number of Estimates <90% of IC Values	Overestimation: Number of Estimate >110% of IC Values	Number of Predictive Equations Compared to IC Measurement
Fixed prescription	13 (39%)	4 (12%)	33
Harris-Benedict	31 (54%)	4 (7%)	57
Ireton-Jones	2 (20%)	4 (40%)	10
PSU	6 (27%)	0 (0%)	22
Other	8 (21%)	7 (18%)	38
Total	**60 (38%)**	**19 (12%)**	**160**

(Source: Tatucu-Babet et al., 2015[190])

Appendix 6: Equations for Height Prediction

Variables	Population Studied	Age Range	n	Equations	Reference
Demi-span (DS)	Malaysian adults	≥60 years old	328	Men: 67.51 + (1.29 x DS) – (0.12 x age) + 4.13 Women: 67.51 + (1.29 x DS) – (0-12 x age)	Ngoh, Sakinah & Harsa, 2012[191]
		≥30 years old	200	Men: 51.28 + (1.438 x DS) Women: 41.35 + (1.549 x DS)	Suzana & Ng, 2003[192]
	Malaysian adults	≥30 years old	200	Men: 47.56 + (0.681 x AS) Women: 18.78 + (0.851 x AS)	Suzana & Ng, 2003[192]
Arm-span (AS)	Hong Kong Chinese elderly with no vertebral deformity	70–83 years old	245[a] 80[b]	Men: 34.60 + (0.759 x AS) Women: 36.83 + (0.728 x AS)	Kwok et al., 2002[193]
	Indonesian Javanese elderly without spinal curvature	55–85 years old	812[a] 110[b]	Men: 23.247 + (0.826 x AS) Women: 28.312 + (0.784 x AS)	Fatmah, 2009[194]; Fatmah, 2010[195]
	Malaysian adults	≥30 years old	200	Men: 69.38 + (1.924 x KH) Women: 50.25 + (2.225 x KH)	Suzana & Ng, 2003[192]
Knee height (KH)	Indonesian Javanese elderly without spinal curvature	55–85 years old	812[a] 110[b]	Men: 56.343 + (2.102 x KH) Women: 62.682 + (1.889 x KH)	Fatmah, 2009[194]; Fatmah, 2010[195]
	Hong Kong Chinese elderly without spinal curvature	60–92 years old	253	Men: 51.16 + (2.24 x KH) Women: 46.11 + (2.46 x KH) – (0.12 x age)	Li et al.,2000[196]
	Joetsu City Japanese elderly	≥65 years old	79	Men: 71.16 + (2.61 x KH) – (0.56 x age) Women: 63.06 + (2.38 x KH) – (0.34 x age)	Knous & Arisawa, 2002[197]
	Korean adults	20–69 years old	4041[a] 1022[b]	Men: 74.63 + (1.95 x KH) – (0.09 x age) Women: Pre-menopausal Height = 66.13 + (1.99 x KH) – (0.07 x age) Postmenopausal Height = 70.87 + (1.96 x KH) – (0.14 x age)	Hwang et al., 2009[198]

Note: Height, arm-span (AS), knee height (KH) and demi-span (DS) are calculated in centimetres (cm); age is in years.
[a]Derivation [b]Validation

Appendix 7: Equations for Weight Prediction

Variables	Population Studied	Age Range	n	Equations	Reference
Ideal Body Weight (IBW)				Men: 48 kg for the first 152.4 cm + 1.1 kg for each additional cm. Women: 45 kg for the first 152.4 cm + 0.9 kg for each additional cm	Hamwi, 1964[199]
	Adults			Men: 50 kg + 2.3 kg x [height(in) – 60] Women: 45.5 kg + 2.3 kg x [height(in) – 60]	Devine, 1974[200]
				***1 inch = 2.54cm; 1 foot = 30.48cm; 1 pound = 0.45kg*	
Lean Body Weight	Adults			Men: 0.32810 W (kg) + 0.33929 H (cm) – 29.5336 Women: 0.29569 W (kg) + 0.41813 H (cm) – 43.2933	Hume 1966[201]
				FFM = ABW (kg) x 0.01 x (100 – [64.5 – 848 x height^2 / ABW+ 0.079 x age – 16.4 x sex + 0.05 x sex x age + 39.0 x sex x height^2 / ABW]) **FFM: fat-free mass in kg, ABW: actual body weight in kg, height in m, age in years, sex: male=1, female=0	Weijs, Sauerwein & Kondrup, 2012[202]
Actual Body Weight (ABW)					
Mid-arm circumference & height	United States adults weight at least 100 kg	≥18 years old	1012[a] 459[b]	Men: (3.29 x MAC) + (0.43 x height) – 93.2 Women: (2.15 x MAC) + (0.54 x height) – 64.6	Crandall et al., 2009[203]
Knee height & mid-arm circumference	White (55%), Hispanic (21%), Asian (11%), African American adults (3%)	18–97 years old	235	Men: (1.10 x KH) + (3.07 x MAC) – 75.81 Women: (1.01 x KH) + (2.81 x MAC) – 66.04	Ross Lab / Lin et al., 2009[204]
Abdominal & Thigh circumference	United States adults	≥18 years old	208[a] 99[b]	Men: (0.78 x AC) + (1.06 x TC) – 47.8 Women: (0.47 x AC) + (1.30 x TC) – 40.2	Buckley et al., 2011[205]

Note: Weight is calculated in kilograms (kg). Height, mid-arm circumference (MAC), knee height (KH), abdominal circumference (AC) and thigh circumference (TC) are calculated in centimetres (cm)

[a]Derivation [b]Validation

Appendix 8: Adjustment of Body Weight for Amputee, Paraplegic and Quadriplegic

a. Percentage of Total Body Weight Contributed by Individual Body Parts

Body Parts	Osterkamp, 1995[206]	BAPEN, 2011[207]
Hand	0.7%	0.6%
Lower arm (including hand)	2.3%	1.6%
Upper arm	2.7%	2.7%
Entire arm	**5.0%**	**4.9%**
Foot	1.5%	1.4%
Lower leg (including foot)	5.9%	4.5%
Thigh	10.1%	9.7%
Entire leg	**16%**	**15.6%**

BAPEN: British Association for Parenteral and Enteral Nutrition

b. Paraplegic and Quadriplegic[208]

To calculate the estimated body weight for individuals who are paralyzed, first determine the ideal body weight for the non-paralyzed individual then subtract the estimated percentage of weight based upon the degree of paralysis:

Condition	Percentage of Weight to be Subtracted
Paraplegics	5%–10%
Quadriplegics	10%–15%

Appendix 9: Haemodynamic Stability

a. Haemodynamic instability is a clinical state represents either a perfusion failure with clinical manifestations of circulatory shock and/or heart failure, or one or more out-of-threshold haemodynamic monitoring values, which may not necessarily be pathological.[43]
b. Various methods have been used for the clinical assessment of haemodynamically unstable patients.[43,209]
c. In a systematic review of haemodynamic goals used in clinical trials in patients with sepsis, the range of haemodynamic goals used were: MAP 60–100 mmHg, central venous pressure 6–13 mmHg, pulmonary artery occlusion pressure 13–17 mmHg, and cardiac index 3–6 l/min/m^2. All trials that used a systolic blood pressure goal used 90 mmHg as the aim.[209]
d. Local ICU guidelines recommend the following goals:[11]
   - MAP ≥65 mm Hg, with higher target for patients with hypertension and renal impairment
   - Urine Output > 0.5 ml/kg/h
   - ScVO2 (central venous oxygen saturation) ≥70%
   - Assess fluid responsiveness (Pulse pressure variation [PPV] >13% and Stroke Volume Variation [SVV] >10%)
   - To normalize serum lactate level in patients with elevated lactate levels
e. In critically ill patients presented with haemodynamic instability, early EN ought to be started when the patient is on stable or declining doses of vasopressors.[42]

Appendix 10 (a): Dietary Reference Intakes (DRIs): Tolerable Upper Intake Level, Vitamins

Life Stage Group	Vitamin A (µg/d)[a]	Vitamin C (mg/d)	Vitamin D (µg/d)	Vitamin E (mg/d)[b,c]	Vitamin K	Thiamine	Riboflavin	Niacin (mg/d)[c]	Vitamin B_6 (mg/d)	Folate (µg/d)[c]	Vitamin B_{12}	Panto-thenic Acid	Biotin	Choline (g/d)	Carote-noids[d]
Infants															
0 to 6 mo	600	ND[e]	25	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
6 to 12 mo	600	ND	38	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Children															
1–3 y	600	400	63	200	ND	ND	ND	10	30	300	ND	ND	ND	1.0	ND
4–8 y	900	650	75	300	ND	ND	ND	15	40	400	ND	ND	ND	1.0	ND
Males															
9–13 y	1,700	1,200	100	600	ND	ND	ND	20	60	600	ND	ND	ND	2.0	ND
14–18 y	2,800	1,800	100	800	ND	ND	ND	30	80	800	ND	ND	ND	3.0	ND
19–30 y	3,000	2,000	100	1,000	ND	ND	ND	35	100	1,000	ND	ND	ND	3.5	ND
31–50 y	3,000	2,000	100	1,000	ND	ND	ND	35	100	1,000	ND	ND	ND	3.5	ND
51–70 y	3,000	2,000	100	1,000	ND	ND	ND	35	100	1,000	ND	ND	ND	3.5	ND
>70 y	3,000	2,000	100	1,000	ND	ND	ND	35	100	1,000	ND	ND	ND	3.5	ND
Females															
9–13 y	1,700	1,200	100	600	ND	ND	ND	20	60	600	ND	ND	ND	2.0	ND
14–18 y	2,800	1,800	100	800	ND	ND	ND	30	80	800	ND	ND	ND	3.0	ND
19–30 y	3,000	2,000	100	1,000	ND	ND	ND	35	100	1,000	ND	ND	ND	3.5	ND
31–50 y	3,000	2,000	100	1,000	ND	ND	ND	35	100	1,000	ND	ND	ND	3.5	ND
51–70 y	3,000	2,000	100	1,000	ND	ND	ND	35	100	1,000	ND	ND	ND	3.5	ND
>70 y	3,000	2,000	100	1,000	ND	ND	ND	35	100	1,000	ND	ND	ND	3.5	ND
Pregnancy															
14–18 y	2,800	1,800	100	800	ND	ND	ND	30	80	800	ND	ND	ND	3.0	ND
19–30 y	3,000	2,000	100	1,000	ND	ND	ND	35	100	1,000	ND	ND	ND	3.5	ND
31–50 y	3,000	2,000	100	1,000	ND	ND	ND	35	100	1,000	ND	ND	ND	3.5	ND
Lactation															
14–18 y	2,800	1,800	100	800	ND	ND	ND	30	80	800	ND	ND	ND	3.0	ND
19–30 y	3,000	2,000	100	1,000	ND	ND	ND	35	100	1,000	ND	ND	ND	3.5	ND
31–50 y	3,000	2,000	100	1,000	ND	ND	ND	35	100	1,000	ND	ND	ND	3.5	ND

NOTE: A Tolerable Upper Intake Level (UL) is the highest level of daily nutrient intake that is likely to pose no risk of adverse health effects to almost all individuals in the general population. Unless otherwise specified, the UL represents total intake from food, water, and supplements. Due to a lack of suitable data, ULs could not be established for vitamin K, thiamin, riboflavin, vitamin B12, pantothenic acid, biotin, and carotenoids. In the absence of a UL, extra caution may be warranted in consuming levels above recommended intakes. Members of the general population should be advised not to routinely exceed the UL. The UL is not meant to apply to individuals who are treated with the nutrient under medical supervision or to individuals with predisposing conditions that modify their sensitivity to the nutrient.

[a] As preformed vitamin A only.
[b] As α-tocopherol; applies to any form of supplemental α-tocopherol.
[c] The ULs for vitamin E, niacin, and folate apply to synthetic forms obtained from supplements, fortified foods, or a combination of the two.
[d] β-Carotene supplements are advised only to serve as a provitamin A source for individuals at risk of vitamin A deficiency.
[e] ND = Not determinable due to lack of data of adverse effects in this age group and concern with regard to lack of ability to handle excess amounts. Source of intake should be from food only to prevent high levels of intake.

SOURCES: *Dietary Reference Intakes for Calcium, Phosphorous, Magnesium, Vitamin D, and Fluoride (1997); Dietary Reference Intakes for Thiamine, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline (1998); Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids (2000); Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc (2001); and Dietary Reference Intakes for Calcium and Vitamin D (2011).* These reports may be accessed via www.nap.edu.
(*Source: Food and Nutrition Board, Institute of Medicine, National Academies*[210])

Appendix 10 (b): Dietary Reference Intakes (DRIs): Tolerable Upper Intake Level, Elements

Life Stage Group	Arsenic[a]	Boron (mg/d)	Calcium (mg/d)	Chromium	Copper (µg/d)	Fluoride (mg/d)	Iodine (µg/d)	Iron (mg/d)	Magnesium (mg/d)[b]	Manganese (mg/d)	Molybdenum (µg/d)	Nickel (mg/d)	Phosphorus (g/d)	Selenium (µg/d)	Silicon[c]	Vanadium (mg/d)[d]	Zinc (mg/d)	Sodium (g/d)	Chloride (g/d)
Infants																			
0 to 6 mo	ND[e]	ND	1,000	ND	ND	0.7	ND	40	ND	ND	ND	ND	ND	45	ND	ND	4	ND	ND
6 to 12 mo	ND	ND	1,500	ND	ND	0.9	ND	40	ND	ND	ND	ND	ND	60	ND	ND	5	ND	ND
Children																			
1–3 y	ND	3	2,500	ND	1,000	1.3	200	40	65	2	300	0.2	3	90	ND	ND	7	1.5	2.3
4–8 y	ND	6	2,500	ND	3,000	2.2	300	40	110	3	600	0.3	3	150	ND	ND	12	1.9	2.9
Males																			
9–13 y	ND	11	3,000	ND	5,000	10	600	40	350	6	1,100	0.6	4	280	ND	ND	23	2.2	3.4
14–18 y	ND	17	3,000	ND	8,000	10	900	45	350	9	1,700	1.0	4	400	ND	ND	34	2.3	3.6
19–30 y	ND	20	2,500	ND	10,000	10	1,100	45	350	11	2,000	1.0	4	400	ND	1.8	40	2.3	3.6
31–50 y	ND	20	2,500	ND	10,000	10	1,100	45	350	11	2,000	1.0	4	400	ND	1.8	40	2.3	3.6
51–70 y	ND	20	2,000	ND	10,000	10	1,100	45	350	11	2,000	1.0	4	400	ND	1.8	40	2.3	3.6
>70 y	ND	20	2,000	ND	10,000	10	1,100	45	350	11	2,000	1.0	3	400	ND	1.8	40	2.3	3.6
Females																			
9–13 y	ND	11	3,000	ND	5,000	10	600	40	350	6	1,100	0.6	4	280	ND	ND	23	2.2	3.4
14–18 y	ND	17	3,000	ND	8,000	10	900	45	350	9	1,700	1.0	4	400	ND	ND	34	2.3	3.6
19–30 y	ND	20	2,500	ND	10,000	10	1,100	45	350	11	2,000	1.0	4	400	ND	1.8	40	2.3	3.6
31–50 y	ND	20	2,500	ND	10,000	10	1,100	45	350	11	2,000	1.0	4	400	ND	1.8	40	2.3	3.6
51–70 y	ND	20	2,000	ND	10,000	10	1,100	45	350	11	2,000	1.0	4	400	ND	1.8	40	2.3	3.6
>70 y	ND	20	2,000	ND	10,000	10	1,100	45	350	11	2,000	1.0	3	400	ND	1.8	40	2.3	3.6
Pregnancy																			
14–18 y	ND	17	3,000	ND	8,000	10	900	45	350	9	1,700	1.0	3.5	400	ND	ND	34	2.3	3.6
19–30 y	ND	20	2,500	ND	10,000	10	1,100	45	350	11	2,000	1.0	3.5	400	ND	ND	40	2.3	3.6
31–50 y	ND	20	2,500	ND	10,000	10	1,100	45	350	11	2,000	1.0	3.5	400	ND	ND	40	2.3	3.6
Lactation																			
14–18 y	ND	17	3,000	ND	8,000	10	900	45	350	9	1,700	1.0	4	400	ND	ND	34	2.3	3.6
19–30 y	ND	20	2,500	ND	10,000	10	1,100	45	350	11	2,000	1.0	4	400	ND	ND	40	2.3	3.6
31–50 y	ND	20	2,500	ND	10,000	10	1,100	45	350	11	2,000	1.0	4	400	ND	ND	40	2.3	3.6

NOTE: A Tolerable Upper Intake Level (UL) is the highest level of daily nutrient intake that is likely to pose no risk of adverse health effects to almost all individuals in the general population. Unless otherwise specified, the UL represents total intake from food, water, and supplements. Due to a lack of suitable data, ULs could not be established for vitamin K, thiamin, riboflavin, vitamin B12, pantothenic acid, biotin, and carotenoids. In the absence of a UL, extra caution may be warranted in consuming levels above recommended intakes. Members of the general population should be advised not to routinely exceed the UL. The UL is not meant to apply to individuals who are treated with the nutrient under medical supervision or to individuals with predisposing conditions that modify their sensitivity to the nutrient.

[a]Although the UL was not determined for arsenic, there is no justification for adding arsenic to food or supplements.

[b]The ULs for magnesium represent intake from a pharmacological agent only and do not include intake from food and water.

[c]Although silicon has not been shown to cause adverse effects in humans, there is no justification for adding silicon to supplements.

[d]Although vanadium in food has not been shown to cause adverse effects in humans, there is no justification for adding vanadium to food and vanadium supplements should be used with caution. The UL is based on adverse effects in laboratory animals and this data could be used to set a UL for adults but not children and adolescents.

[e]ND = Not determinable due to lack of data of adverse effects in this age group and concern with regard to lack of ability to handle excess amounts. Source of intake should be from food only to prevent high levels of intake.

SOURCES: *Dietary Reference Intakes for Calcium, Phosphorous, Magnesium, Vitamin D, and Fluoride (1997); Dietary Reference Intakes for Thiamine, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline (1998); Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids (2000); Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc (2001); and Dietary Reference Intakes for Calcium and Vitamin D (2011).* These reports may be accessed via www.nap.edu.

(Source: Food and Nutrition Board, Institute of Medicine, National Academies[210])

Appendix 11: List of Predictive Energy Equations for Burns

Name of Equation	Formula Equations		
	REE (kcal) = -4343 + (10.5 x %TBSA burn injury) + (0.23 x kcals) + (0.84 x Harris Benedict) + (114 x T (°C)) – (4.5 x No. of days post-burn)		
	TBSA = Total body surface area burned *kcals = Calorie intake in past 24 hours* *Harris Benedict = Basal requirements in calories using the Harris Benedict equation with no stress factors or activity factors* *T = Body temperature in degrees Celsius* *No. of days post-burn = The number of days after the burn injury is sustained using the day of burn injury itself as day zero.*		
Toronto Formula[211]	*TORONTO FORMULA x 1.2 (activity factor)* if patient has dressing changes, physiotherapy, agitation, position changes, family visiting, suctioning, face and mouth care, and minor procedures.[211]		
	Energy Requirement = Basal Metabolic Rate x Injury Factor x Activity Factor		
	Age	**Basal Metabolic Rate (kcal/d)**	
		Female	**Male**
Modified Schofield Equation[149]	15-18 years	13.3W + 690	17.6W + 656
	18-30 years	14.8W + 485	15.0W + 690
	30-60 years	8.1W + 842	11.4W + 870
	Over 60 years	9.0W + 656	11.7W + 585
	W = weight in kg *Injury Factor:* • *Up to 10% burn: 1.0-1.1* • *10-25%: 1.1-1.3* • *25-90%: 1.2-1.7* *Activity Factor: including diet induced thermogenesis* • *Bed bound immobile: 1.1* • *Bed bound mobile/sitting: 1.15-1.2* • *Mobile in ward: 1.25*		

Appendix 12: Micronutrients Requirement for Burns Patients[149,212]

Vitamins/Minerals	Daily Dose	
	EN	PN
• Water-soluble Vitamins		
Thiamine (B1)	10 mg	10 mg
Riboflavin (B2)	10 mg	10 mg
Niacin (B3)	200 mg	200 mg
Pantothenic acid	100 mg	100 mg
Biotin	5 mg	5 mg
Pyridoxine (B6)	20 mg	20 mg
Folic acid	2 mg	2 mg
Cobalamin (B12)	20 µg	20 µg
Vitamin C (Ascorbic acid)	2000 mg	2000 mg
• Fat-soluble Vitamins		
Vitamin A (retinol)	25,000 U	10,000 U
β-carotene	50 mg	-
Vitamin E	40-1000 mg	-
• Minerals		
Copper	2−3 mg	
Manganese	25−50 mg	
Selenium	100 mg	
Zinc	50 mg	

Appendix 13: Systemic Inflammatory Response Syndrome, Sepsis and Septic Shock

a) Systemic Inflammatory Response Syndrome, Sepsis and Septic Shock

i. Systemic inflammatory Response Syndrome can be identified based on two or more of below criteria:[213]

> **SIRS Criteria:**
> Temperature >38 °C or <36 °C
> Heart rate >90/min
> Respiratory rate >20/min or $PaCO_2$ <32 mmHg (4.3kPa)
> White blood cell count >12 000/mm^3 or <4000/mm^3 or >10% immature bands

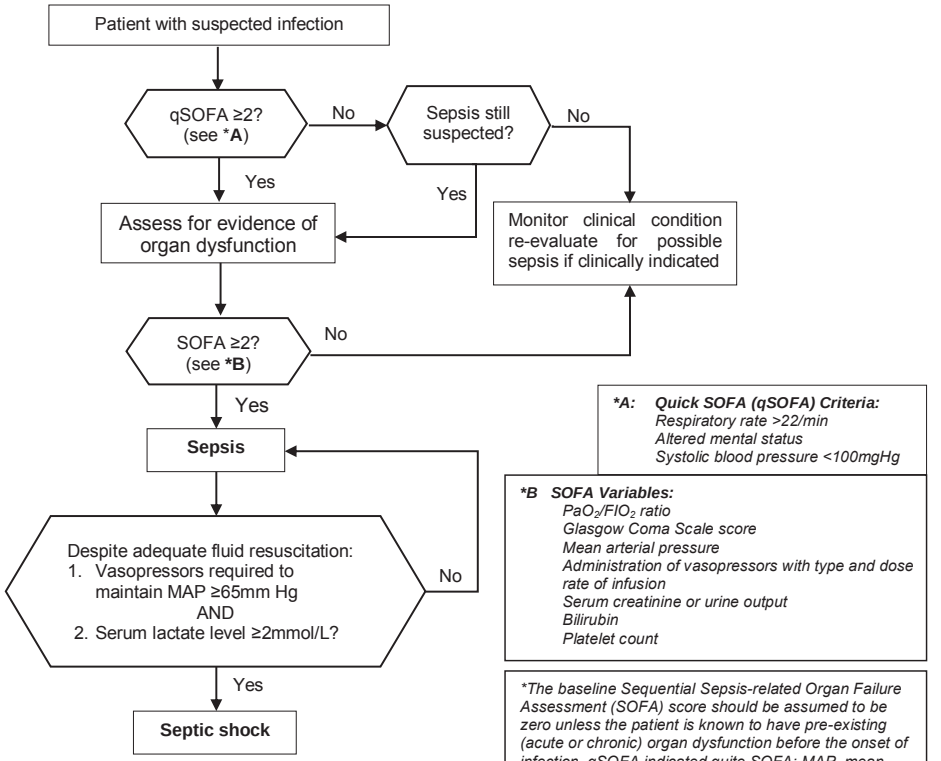
ii. Sepsis is life-threatening organ dysfunction caused by a dysregulated host response to infection or is a life-threatening condition that arises when the body's response to an infection injuries its own tissues and organs.[187]

iii. Organ dysfunction can be identified as an acute change in total SOFA score ≥2 point that caused by infection.[187]

iv. Septic Shock is a subset of sepsis in which underlying circulatory and cellular/metabolic abnormalities are profound enough to substantially increase mortality.[187]

v. Patient with septic shock can be identified with a clinical construct of sepsis with persisting hypotension requiring vasopressors to maintain MAP ≥65 mmHg and having a serum lactate level ≥2 mmol/L (18 mg/L) despite adequate volume resuscitation.[187]

b) Identifying Patients with Sepsis and Septic Shock[187]



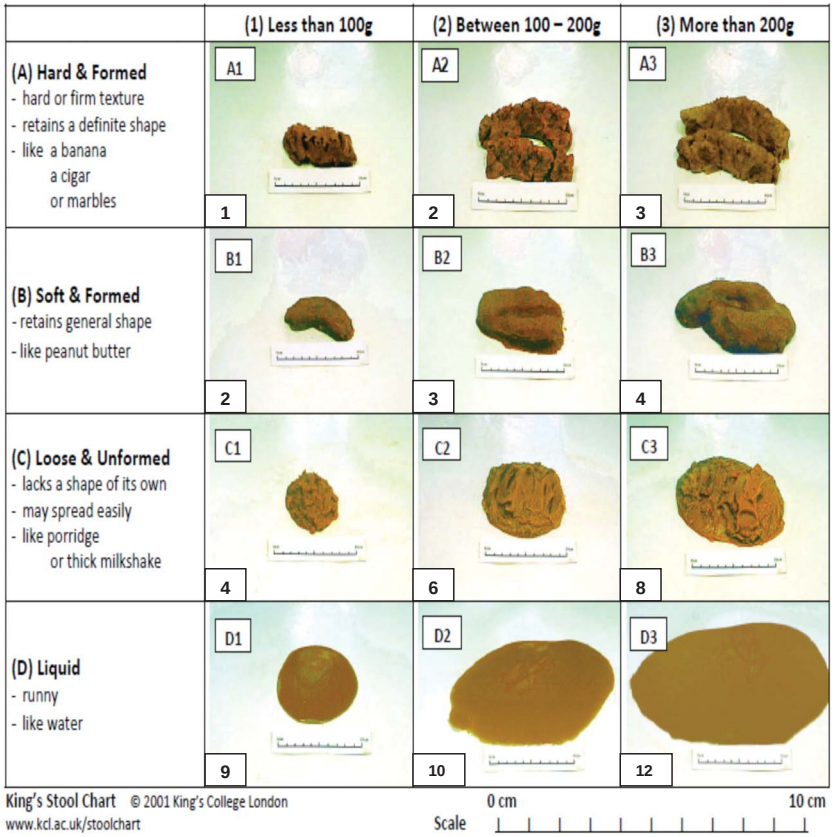
(Source: Singer et al. 2016[187])

Appendix 14: Common Medications Associated with Diarrhoea in Enterally Fed Patients

Drug	Examples (Scientific Name)
GI Agents	Proton-pump inhibitors: Omeprazole, Esomeprazole, Lansoprazole, Pantoprazole, Rabeprazole
	H-2 blockers: Ranitidine, Famotidine, Roxatidine
	Magnesium-containing antacids: Magnesium Oxide
	Others: Misoprostol
Antibiotics	Vancomycin (oral), Ampicillin, Amoxicillin, Cephalexin, Cefexime, Erythromycin, Azithromycin, Clarithromycin, Ciprofloxacin
Cholinergics	Donepezil, Rivastigmine, Galantamine, Bethanechol, Pyridostigmine
Antihypertensive	β-Blockers: Propranolol, Bisoprolol
Laxatives	Liquid paraffin, Castor oil, Bisacodyl, Senna leaf, Lactulose, Polyethylene glycol, Sorbitol, Magnesium Sulfate
NSAIDs	Indomethacin, Diclofenac, Ibuprofen, Tenoxicam, Nabumetone, Etodolac, Celecoxib
Potassium and Phosphorus Supplements	Neutral Phosphate
Prokinetics	Metoclopramide, Erythromycin, Mosapride, Domperidone
Sedatives	Zolpidem
Selective Serotonin Reuptake Inhibitors	Fluoxetine, Sertraline, Escitalopram, Citalopram, Paroxetine
Intestinal Anti-inflammatory Agents	Mesalamine, Balsalazide
Glucose-lowering Agents	Metformin, Acarbose, Glipizide, Actosmet (Pioglitazone+Glimepiride), Repaglinide
Others	Betahistine, Colchicine, Digoxin, Strontium Ranelate

(Source: Chang & Huang, 2013[214])

Appendix 15: King's Stool Chart



(Source: Whelan et al.,2008[105])

Appendix 16: Components of Nutrition Management Strategies in ERAS[181–183]

Component in ERAS	Nutrition Management Strategies
Preoperative Fasting	• Clear fluids are allowed up to 2 h and solids up to 6 h prior to induction of anaesthesia
Preoperative CHO Loading	• Preoperative 400 ml of 12.5% drink with mainly maltodextrin is recommended preoperatively (2−3 hours before surgery). • Evidence shows that preoperative CHO loading is associated with the following benefits: ➢ reduction in postoperative thirst, hunger, anxiety and insulin resistance ➢ accelerated recovery ➢ shorter hospital LOS (in major abdominal surgery patients)
Diabetic patients	• Carbohydrate treatment can be given along with the diabetic medication. • However, this recommendation is only given for elective colonic surgery; not for elective rectal or pelvic surgery or pancreaticoduodenectomy
Strategies to Reduce Postoperative Nausea and Vomiting (PONV)	• Risk factor for PONV are being female, non-smoker, history of motion sickness and given opioid postoperatively • Minimise preoperative fasting, CHO loading and adequate hydration
Perioperative Nutrition Care for Elective Colonic Surgery	• Preoperatively, conduct careful history-taking directed towards recent significant unplanned weight loss and reduced nutritional intake • Normal food is allowed before and after surgery • The use of ONS is recommended to achieve protein and energy targets during the very post-operative phase (at least for the first 4 days) • If patient is significantly malnourished, nutritional supplementation (oral and/or PN) has the greatest effect if started 7−10 days preoperatively, and is associated with reduction in prevalence of infectious complications and anastomotic leaks. • Postoperatively, patient is allowed to drink immediately after recovery from anaesthesia, followed by normal hospital food. It is safe to spontaneously consume ~1200−1500 kcal/day. • RCT of early EN or oral vs NBM showed early feeding reduces risk of infection and hospital LOS, and is not associated with increased risk of anastomotic dehiscence.
Perioperative Nutrition Care for Elective Pelvic or Rectal Surgery	• An oral ad-libitum diet is recommended 4 h after rectal surgery. • Delay oral intake after major surgery is associated with increased rates of infectious complications and delayed recovery • Early oral diet was shown to be safe in patients with a new non-diverted colorectal anastomosis • However, early oral intake had increased risk of vomiting, efforts must be made to prevent postoperative ileus and a risk of aspiration In addition to normal food intake, patients should be offered ONS to maintain adequate intake of protein and energy.
Perioperative Nutrition Care (Pancreaticoduoden-ectomy)	• Routine use of preoperative artificial nutrition is not warranted, but significantly malnourished patients should be optimised with oral supplements or enteral nutrition preoperatively. • Immunonutrition for 5−7 days perioperatively should be considered because it may reduce the prevalence of infectious complications in patients undergoing major open abdominal surgery.
Other Strategies	• Chewing gum is safe and beneficial in reducing time to first bowel movement by 1 day after GI surgery

Appendix 17: Nutrition Care Process (NCP)

(a) Nutrition Assessment

Component	Assessments
Food and Nutrition-Related History	i. History of nutrient intake (macro- and micronutrients) ii. Amount or type of nutrition/fluids intake via the GI tract iii. Amount or type of nutrition/fluids intake intravenously iv. Calories form non-nutritive source such as dextrose and propofol v. Adequacy of nutrient intake/nutrient delivery vi. Disease-specific nutrient requirements vii. Food allergies/intolerances viii. Appropriateness of nutrition support therapy for the patient ix. Medication and Complementary/Alternative Medicine use that may impact nutritional status
Anthropometric Measurements:	i. Weight (preadmission), dry weight, height ii. Weight change iii. BMI iv. Estimated weight after amputation/paralysis v. Estimation of weight/height based on predictive equations (if data on weight and height is not available)
Biochemical Data, Medical Tests and Procedures:	i. Biochemical indices (white blood counts, C-reactive protein, renal profile, glucose, electrolytes, arterial blood gases, lipid profile, serum protein profile, others as warranted by clinical condition) ii. Implications of diagnostic tests and therapeutic procedures (IC measurements, radiography for confirmation of feeding tube placement, other GI diagnostic tests)
Nutrition-Focused Physical Findings:	i. Nutrition-focused physical examination that includes, but is not limited to: fluid assessment, functional status, wound status, clinical signs of malnutrition/overnutrition and/or nutrient deficiencies ii. Intake and output including urine, stool and fistula output, and wound drainage iii. Existing or potential access sites for delivery of nutrition support therapy iv. GI-related examination including abdominal distension, diarrhoea, constipation, vomiting, regurgitation and gastric drainage volume v. Fluid status (oedema, ascites, dehydration) vi. Vital signs (hemodynamic status)
Client History:	i. Current and past information related to personal, medical, family, and social history ii. Surgical intervention

- Assessment of the above factors is needed to correctly diagnose nutrition problems and plan nutrition interventions. Inability to achieve optimal nutrient intake may contribute to poor outcomes.
- Critically ill patients are usually unable to communicate and to provide necessary information for nutritional assessment. Information may, however, be obtained from medical records, family members, nursing home or long-term care facility.

(Adapted from Academy of Nutrition and Dietetics Evidence Analysis Library 2012[215]*)*

Appendix 17: Nutrition Care Process (NCP)

(b) Nutrition Diagnosis

Sample nutrition diagnosis statements for critically ill patients

Problem	Aetiology	Signs and Symptoms
• Increased energy expenditure	Physiologic disease state, increased metabolic rate: • Increased work of breathing • Critically ill status	• Unintentional weight loss of ____% in ____ (duration) • Fever (elevated temperature ____°C)
• Inadequate energy intake • Inadequate oral intake • Predicted inadequate energy intake • Inadequate protein–energy intake • Inadequate protein intake • Increased nutrient needs (specify)	Decreased ability to consume sufficient energy/protein/nutrient (specify): • Inability to take sufficient oral intake • Total volume or fluid restriction	• Reports or observations of intake less than estimated needs • Nutrients (specify) intake at _____% of goal
	EN or PN infusion not yet optimised	Infusion providing _____% of goal
• Excessive energy intake • Excessive oral intake • Predicted excessive energy intake • Excessive protein intake • Predicted excessive nutrient intake (specify) • Decreased nutrient needs (specify) • Intake of types of proteins or amino acids inconsistent with needs (specify)	Intake that exceeds energy expenditure/established protein and/or other nutrients reference standards or recommendations.	Actual intake providing _____% of goals for energy and/or protein or other nutrients (specify).
• Inadequate enteral nutrition infusion • Inadequate parenteral nutrition infusion • Enteral nutrition administration inconsistent with needs • Parenteral nutrition composition inconsistent with needs	Physiological causes increasing nutrient needs	• Fever (elevated temperature ____°C) • Weight loss of ____% in ____ (duration)
	Intolerance of EN/PN	• EN: Nausea, vomiting, diarrhoea etc • PN: Hyperglycemia etc
	Infusion volume not reached due to fluid restriction or schedule for infusion interrupted	Actual intake providing _____% of goals for energy and protein.
• Excessive enteral nutrition infusion • Enteral nutrition composition inconsistent with needs • Excessive parenteral nutrition infusion • Parenteral nutrition administration inconsistent with needs	Excessive infusion volume	Actual intake providing _____% of goals for energy and protein

Problem	Aetiology	Signs and Symptoms
• Malnutrition • Starvation related malnutrition • Chronic disease or condition related malnutrition • Acute disease or injury related malnutrition	• Long term inadequate energy and protein intake related to above factors. • Previous chronic disease • Mismatch between energy needs and energy intake	• Weight loss of ____% in ____ (duration) • Underweight with muscle wasting, • Estimated energy intake less than estimated needs
Swallowing difficulty	• Neurological status • Prolonged intubation • TBI	• Coughing/choking on clear fluid/food • Intolerance towards oral intake • Continued requirement for EN
Altered GI function	Changes in digestion, absorption, or elimination. • Pancreatic insufficiency • Bowel mucosal damage • Surgical procedure	• Abnormal laboratory results (vitamin, mineral or anaemia profile) • Weight loss in the face of seemingly adequate intake • Persistent GI symptoms, including nausea, vomiting, diarrhoea, steatorrhea, protein-losing enteropathy, constipation, abdominal pain, reflux, or gas
Altered nutrition-related laboratory values (specify)	• Alterations in kidney, liver, cardiac function caused by medical complications or multi-system organ failure • Inadequate intake or impaired utilization of ingested nutrients	• Increased liver function tests, i.e. AST, ALT, total bilirubin, serum ammonia • Specific laboratory value below reference range indicative of deficiency
Impaired nutrient utilization	• Changes in ability to metabolize nutrients • Exocrine and/or endocrine pancreatic insufficiency • Corticosteroid use	Altered nutrition-related laboratory values: • Vitamin deficiency, steatorrhea • Hyperglycaemia, glycosuria • Osteoporosis/osteopenia
• Food–medication interaction (specify) • Predicted food–medication interaction (specify)	Potential for/or undesirable/harmful interaction(s) between food and medications and/or dietary supplements that diminishes, enhances, or alters the effect of nutrients and/or medications.	Nutrients affecting drug therapy: • Phenytoin • Quinolones • Tetracycline • Itraconazole • Warfarin • Alendronate

Appendix 17: Nutrition Care Process (NCP)

(c) Nutrition Evaluation & Monitoring

Following the nutrition intervention, monitoring and evaluation at each visit should be carried out in order to compare the desired individual outcomes relevant to the nutrition diagnosis and intervention as well as to diagnose nutrition problems that should be the focus of further nutrition interventions. This may include, but is not limited to the following:

Component	Assessments
Food and Nutrition-Related History	• Adequacy and appropriateness of nutrient intake/nutrient delivery • Actual daily intake from EN, PN and other nutrient sources • The appropriate use of prebiotics/probiotics, antioxidants and immunonutrition • Medications
Anthropometric Measurements	• Weight • Weight change
Biochemical Data, Medical Tests and Procedures	• Biochemical indices (white blood counts, C-reactive protein, renal profile, glucose, electrolytes, arterial blood gases, lipid profile, serum protein profile, others as warranted by clinical condition) • Implications of diagnostic tests and therapeutic procedures [IC measurements, radiography for confirmation of feeding tube placement, other GI diagnostic tests]
Nutrition-Focused Physical Findings	• Nutrition-focused physical examination that includes, but is not limited to: fluid assessment, functional status, wound status, clinical signs of malnutrition/overnutrition and/or nutrient deficiencies • Intake and output including urine, stool and fistula output, and wound drainage • GI-related examination including abdominal distension, diarrhoea, constipation, vomiting, regurgitation and gastric drainage volume • Fluid status (oedema, ascites, dehydration) • Vital signs (haemodynamic status)
Client History	• Updated information from family members

(Adapted from Academy of Nutrition and Dietetics Evidence Analysis Library 2012[215])

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