

Singapore clinical guideline on parenteral nutrition in adult patients in the acute hospital setting

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ABSTRACT

Introduction: The primary objective of this guideline is to establish evidence-based recommendations for the clinical use of parenteral nutrition (PN) in adult patients within the acute hospital setting in Singapore.

Method: An expert workgroup, consisting of healthcare practitioners actively involved in clinical nutrition support across all public health institutions, systematically evaluated existing evidence and addressed clinical questions relating to PN therapy.

Results: This clinical practice guideline developed 30 recommendations for PN therapy, which cover these key aspects related to PN use: indications, patient assessment, titration and formulation of PN bags, access routes and devices, and monitoring and management of PN-related complications.

Conclusion: This guideline provides recommendations to ensure appropriate and safe clinical practice of PN therapy in adult patients within the acute hospital setting.

Keywords: adult, guideline, hospital, nutrition, parenteral

CLINICAL IMPACT

What is New

- This is the clinical practice guideline focused on the practice of parenteral nutrition therapy within Singapore or across the region.

Clinical Implications

- The guideline provides recommendations for consistent, safe, effective and evidence-based practice for parenteral therapy in adult patients within the acute hospital setting.

INTRODUCTION

Parenteral nutrition (PN) is an intravenous nutrition therapy used when oral and/or enteral nutrition (EN) is not possible or is insufficient for complete nutrition. It is an admixture formulation containing essential

nutrients, including dextrose, amino acids, lipid emulsion, electrolytes, vitamins and trace elements, for the maintenance of life. The use of PN is well-established in the acute care setting in Singapore. Most hospitalised patients on PN therapy require it for a short period of time over days or weeks. Although PN can be a beneficial and life-saving therapy, its use is not without risks and it can result in potentially serious complications. Additionally, administration of PN involves significant resource use, including a specialised team of trained healthcare professionals (HCPs) and specialised

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Accepted: 28 May 2025

Published Online First: 17 June 2025

medical supplies and equipment.¹ The cost of PN can be high due to expenses on of PN bags, blood tests and other associated costs. For example, in an acute care hospital in Singapore, the cost for PN and manpower is approximately SGD1.2 million for 2791 PN days.²

The PN market within the Asia-Pacific region was valued at approximately USD861 million in 2022 and is expected to reach USD1.471 million by 2030.³ Key factors contributing to this growth include the rising incidence of chronic diseases, such as cancer and gastrointestinal disorders. In a study conducted at the largest acute care hospital in Singapore, 182 patients received 194 courses of PN over a year, with a median age of 62 years.⁴ The majority of these patients were surgical patients (82%), followed by medical patients (18%). Common indications included anticipation of non-functioning gut postoperatively, postoperative complications and postoperative ileus. As the prevalence of chronic diseases and complex medical conditions continues to rise, the role of PN in clinical practice in Singapore is likely to expand, making the development of clear and evidence-based clinical practice guidelines essential for optimising patient care.

There is currently no consensus to guide the practice of PN therapy in the local setting or neighbouring regions. Hence, with increasing knowledge from the literature, there is a pressing need to develop a clinical practice guideline to ensure the safe provision of PN. While existing international guidelines, such as those from the American Society for Parenteral and Enteral Nutrition (ASPEN) and the European Society for Clinical Nutrition and Metabolism (ESPEN), provide valuable insights, it may not fully account for regional variations in disease prevalence, healthcare delivery and patient demographics. Developing a local clinical practice guideline for the use of PN in acute care settings in Singapore is crucial for several reasons. First, Singapore's healthcare practices and infrastructure differ from those in other regions. A region-specific guideline ensures that recommendations are practical and applicable within the local context, considering available resources, clinical workflows and resource constraints within the healthcare system. Second, a tailored guideline ensures that clinical practice is standardised and provides consistent care, regardless of healthcare provider. It promotes evidence-based practice, optimises resource use and streamlines training, which can lead to better patient outcomes by ensuring that PN therapy is administered safely and effectively, reducing the risk of complications and improving overall patient care. This current guideline aims to provide evidence-based recommendations to ensure appropriate, safe, efficient and cost-effective clinical

practice of PN therapy in adult patients in the acute care setting within the local context, intended for HCPs (e.g. gastroenterologists, intensivists, dietitians, pharmacists, nurses); policymakers; researchers and educators to ensure comprehensive relevance and applicability across all professionals involved in the administration and regulation of PN therapy. Nevertheless, recommendations provided in this guideline should not substitute the need for HCPs to exercise clinical judgement.

METHOD

The proposal to develop the present guideline was initiated by the Society for Parenteral and Enteral Nutrition (Singapore) (SingSPEN). In May 2021, a workgroup consisting of healthcare experts from the nutrition support services across all 8 public acute care hospitals in Singapore was formed. The group of experts represents different professions, and it included 6 general physicians, 3 pharmacists, 2 surgeons, 2 dietitians and a nurse. The aim was to provide clear and easy-to-follow evidence-based recommendations to practising HCPs who are involved in the prescribing, compounding and administering of PN in the acute care setting.

Clinical questions (CQs) relating to PN therapy were first defined and then divided into 5 domains by the committee members of the workgroup. The 5 domains were indications for PN, assessment of PN patients, titration and formulation of PN, PN access routes and devices, and monitoring and management of PN-related complications. CQs for each domain were allocated to different subgroups based on their expertise. Each subgroup was led by a committee member. A literature search on PubMed/MEDLINE database to identify meta-analyses, systematic reviews and original studies relevant to the assigned CQs was then performed by each group. Examples of the search terms used in each CQ are included in Supplementary Fig. S1. Based on the evidence from the literature, statements of recommendation were proposed, and commentaries detailing the important findings and rationale of the proposed recommendations were documented. The quality of evidence and strength of recommendation were graded using the Grading of Recommendations, Assessment, Development and Evaluation methodology (Supplementary Table S1).

A total of 30 recommendations were formulated to answer all the CQs. Between August 2022 and November 2022, 6 virtual meetings were conducted and the modified Delphi technique was employed to achieve a formal consensus. All members were invited to agree or disagree, to comment and to provide feedback on each recommendation statement. Further revisions were undertaken when deemed necessary.

The strength of the recommendations was based on Arbeitsgemeinschaft der Wissenschaftlichen Medizinischen Fachgesellschaften (Association of the Scientific Medical Societies in Germany) guidelines where “strong consensus” is defined as >90% agreement and “consensus” is defined as >75–90% agreement. Detailed commentaries and references supporting each recommendation are provided in

Supplementary Table S2. The completed work on the different domains of the clinical practice of PN therapy was subsequently compiled, edited and finalised before it was circulated to all members in the work-group for review and final agreement of this clinical guideline. The recommendation statements, executive summary, checklist and flowchart are detailed in Tables 1, 2, 3 and Fig. 1, respectively.

Table 1. Summary of clinical questions and recommendation statements.

No.	Clinical questions and recommendation statements	Strength of recommendation	Quality of evidence	Level of agreement
Indications for parenteral nutrition (PN)				
1	What are the indications for PN? • PN is indicated in patients who are unable to meet their nutritional needs orally and/or enterally as a result of suboptimal function of the gastrointestinal tract (GIT) or in whom the GIT is not accessible.	Strong	High	100%
2a	When should PN be initiated? • For patients who are well-nourished on initial assessment, initiating PN can be considered after 5–7 days of not achieving 60% or more of estimated total energy requirement.	Strong	Low	93%
2b	• For patients who are severely malnourished or at high risk of malnutrition, consider initiating PN earlier than 5 days of not achieving 60% or more of estimated total energy requirement.	Strong	Low	93%
3a	What are the contraindications of PN? • Contraindications to PN include patients with critical electrolytes abnormalities, specifically serum potassium <2.5 mmol/L, serum sodium <125 mmol/L, serum phosphate <0.4 mmol/L or serum magnesium <0.5 mmol/L.	Weak	Very low	100%
3b	• Contraindications to PN include patients who have suffered irreversible brain injury or terminal illness where there is a lack of therapeutic goal to prolong life in the inevitable death.	Strong	Moderate	100%
3c	• Contraindications to PN include patients who have no suitable venous access for PN.	Strong	Very low	100%
Assessment of PN patients				
4	Who should assess and manage patients prescribed with PN? • Patients on PN support in hospital should be managed by a nutrition support service consisting of a team of trained physician, nurse, dietitian and pharmacist.	Strong	Low	100%
5a	How often should biochemical parameters be assessed for patients on PN? • All patients should have a baseline biochemical assessment prior to initiation of PN.	Strong	Very low	100%
5b	• After establishing a patient on PN, the frequency of biochemical monitoring should be adjusted according to the patient's clinical progress, nutritional status and stage of PN therapy.	Strong	Very low	100%
6a	What are the nutritional requirements for patients on PN? • Energy expenditure for patients requiring PN should ideally be measured using indirect calorimetry. However, if indirect calorimetry is not available, providing 25–30 kcal/kg/day or using validated predictive equations, taking into account physical activity and stress factor, are acceptable to calculate energy requirement.	Strong	Moderate	100%
6b	• Protein requirements for patients requiring PN should be tailored to individual needs, ranging from 1 to 2 g/kg/day. Higher protein doses may be required for the critically ill, cancer and elderly patients.	Strong	Low	87%

Table 1. Summary of clinical questions and recommendation statements. (Cont'd)

No.	Clinical questions and recommendation statements	Strength of recommendation	Quality of evidence	Level of agreement
7	Which nutritional assessment tool should be used for patients requiring PN? There is currently no nutritional assessment tool developed specifically for patients requiring PN. Validated assessment tools, such as Subjective Global Assessment, are recommended for the diagnosis and determination of the severity of malnutrition.	Strong	Very low	100%
Titration and formulation of PN				
8	How fast should PN be introduced and progress? It is recommended to start at 15–20 kcal/kg/day on day 1 and increasing it progressively to target for non-critically ill patients. Patient's nutritional status and risk of refeeding should be considered when initiating and advancing PN infusion rate.	Weak	Moderate	100%
9	When should PN be discontinued? PN can be reduced and discontinued when the patient is receiving more than 60% of target energy requirement from enteral nutrition and/or oral diet.	Weak	Very low	100%
10	What is the recommended type of lipid emulsion used to compound PN? Fish oil containing injectable lipid emulsion should be used as part of the lipid component of PN.	Strong	High	100%
11a	Should multivitamin and trace elements be added in PN bags? Multivitamins are recommended in patients initiated on PN. In patients at risk of refeeding syndrome, additional intravenous thiamine supplementation for 3–5 days is recommended.	Strong	High	100%
11b	Trace elements are recommended in patients initiated on PN.	Weak	Low	100%
12a	Under what circumstances would additional vitamin or mineral supplementation be required? Additional supplementation of vitamin C is recommended for patients who are critically ill and patients who have had gastrectomy or colorectal resection.	Strong	High	100%
12b	Additional supplementation of zinc (Zn) is recommended for patients with high GIT losses. For every 1L of GIT losses via fistula or stoma, an additional 12–17 mg of Zn should be provided.	Strong	High	100%
13	Are there benefits in adding glutamine in PN bags? Additional supplementation of glutamine is not recommended in patients initiated on PN.	Weak	Low	100%
PN access routes and devices				
14	What types of venous access device should be used for PN? Peripherally inserted central catheter with a dedicated lumen is recommended for PN administration. However, an existing central venous access device (CVAD) in the internal jugular vein can be used for up to 14 days.	Strong	Moderate	100%
15	How should the patency of CVADs be maintained? CVADs should be flushed using normal saline after each use, or weekly if not in use, to maintain catheter patency.	Strong	Moderate	100%
16a	Under what circumstances should peripheral PN (PPN) be considered? PPN can be used as supplemental PN where oral or EN is suboptimal.	Weak	Low	100%
16b	The duration of PPN therapy should not exceed 14 days due to an increased risk of complications related to peripheral intravenous catheters.	Strong	Low	100%

Table 1. Summary of clinical questions and recommendation statements. (Cont'd)

No.	Clinical questions and recommendation statements	Strength of recommendation	Quality of evidence	Level of agreement
17	What osmolarity of PN admixture is safe for peripheral venous use? • Osmolarity of PPN therapy should be maintained at less than 900 mOsm/L to minimise the risk of catheter-related complications.	Strong	Low	93%
Monitoring and management of PN-related complications				
18a	How should patients at risk of refeeding syndrome be managed? • Patients who are at risk of refeeding syndrome are required to have their serum electrolytes monitored daily for the first few days, following which frequency of monitoring can be reduced when serum electrolytes stabilise.	Strong	Moderate	100%
18b	• Serum electrolyte abnormalities should be promptly recognised and corrected.	Strong	High	100%
19	How often should blood glucose be monitored? • Blood glucose levels should be measured every 6 hours at least for the initial 48 hours after initiation of PN therapy.	Weak	Low	100%
20	What is the target blood glucose range? • A target blood glucose ranging 7.8–10 mmol/L is recommended for patients receiving PN.	Strong	Moderate	100%
21	Should insulin be added to PN bags? • Subcutaneous insulin is preferred over the addition of insulin to PN admixtures for glycaemic control. At the discretion of the nutrition support team and guided by local institution practices, short-acting insulin may be added to PN admixture in patients whose clinical conditions and PN requirements are stable.	Weak	Low	100%
22	How often should liver function tests (LFTs) be monitored? • Baseline LFTs should be obtained prior to initiation of PN. LFTs should be monitored on a weekly basis, with a reduction in frequency of monitoring subsequently depending on clinical progress.	Weak	Moderate	100%
23	How should deranged LFTs be managed? • Non-PN-related causes of abnormal LFTs should first be identified and managed accordingly. Overfeeding of PN may also cause abnormal LFTs, hence adjustment of dextrose and/or lipid content of PN admixture may be necessary.	Weak	Moderate	100%
24	How should PN transition from continuous to cyclical infusion? • Cyclic PN can be started when patient is clinically stable and satisfactory glycaemic control is maintained during a fasted state without PN.	Weak	Moderate	100%
25	What is the target serum triglyceride level? • Serum triglyceride should be maintained below 4.6 mmol/L.	Weak	Moderate	100%
26	How should hypertriglyceridaemia be managed? • If serum triglyceride is more than 4.6 mmol/L, dextrose load in PN should be reduced followed by a reduction in injectable lipid emulsion if serum triglyceride level does not improve. PN should be discontinued if serum triglyceride is more than 11.4 mmol/L.	Weak	Moderate	100%
27	How should catheter-related thrombosis (CRT) be managed? • The use of thrombolytic agents and anticoagulation treatment is recommended for CRT, with removal of CVAD if complete resolution from these measures is not achieved.	Strong	Moderate	100%

Table 1. Summary of clinical questions and recommendation statements. (Cont'd)

No.	Clinical questions and recommendation statements	Strength of recommendation	Quality of evidence	Level of agreement
28a	How should catheter-related blood stream infection (CRBSI) be managed? • In the event that CRBSI is suspected, 2 sets of blood cultures should be obtained from both the CVAD and peripheral vein before initiation of antimicrobial therapy.	Strong	Moderate	100%
28b	• In complicated CRBSI, the CVAD should be removed for source control. In uncomplicated CRBSI or in patients with limited vascular access, discussion with an infectious disease specialist is recommended to explore possibility of CVAD salvage.	Strong	Low	100%
29	Should PN be withheld when patient undergoes surgery? • It is not necessary to withhold PN during surgery.	Weak	Low	87%
30	Is tapering of PN and dextrose drip necessary after termination of PN? • Tapering of PN or administration of intravenous dextrose solution after abrupt termination of PN may not be necessary unless the patient is on insulin therapy.	Weak	Low	80%

CLINICAL QUESTIONS AND RECOMMENDATIONS

Indications for parenteral nutrition (PN)

1. What are the indications for PN?

Recommendation 1

PN is indicated in patients who are unable to meet their nutritional needs orally and/or enterally as a result of suboptimal function of the gastrointestinal tract (GIT) or in whom the GIT is not accessible.

Strength of recommendation: Strong

Quality of evidence: High

Level of agreement: 100% (strong consensus)

Commentary: PN provides essential nutrients intravenously and bypasses the GIT. It should only be considered when it is not possible to meet individuals' nutritional needs orally and/or enterally due to suboptimal function of the GIT or when GIT is not accessible. The 5 broad categories of conditions that may require PN are impaired absorption and/or loss of nutrients, mechanical bowel obstruction, clinical need for bowel rest, bowel motility disorders and inability to achieve or maintain enteral access.⁵

Oral and/or EN should be optimised before initiating PN as they are physiologically more advantageous, cost-effective and associated with fewer complications. PN should not be started until all pragmatic approaches to improve tolerance to oral or EN have been attempted.

2. When should PN be initiated?

Recommendation 2a

For patients who are well-nourished on initial assessment, initiating PN can be considered after 5–7 days of not achieving 60% or more of estimated total energy requirement.

Strength of recommendation: Strong

Quality of evidence: Low

Level of agreement: 93% (strong consensus)

Recommendation 2b

For patients who are severely malnourished or at high risk of malnutrition, consider initiating PN earlier than 5 days of not achieving 60% or more of estimated total energy requirement.

Strength of recommendation: Strong

Quality of evidence: Low

Level of agreement: 93% (strong consensus)

Commentary: The optimal time to initiate PN remains debated and unclear. Although some studies^{6–8} found no significant difference in mortality when comparing early PN and late PN, the EPaNIC study⁹ observed that late PN initiation 7 days after admission was associated with lower incidence of infections, earlier recovery from organ failure and shorter hospital stay compared to early PN initiation before 7 days. On the other hand, findings of a recent

retrospective analysis where surgical patients were stratified based on their nutritional risk⁹ revealed that those with high risk of malnutrition who received early supplemental PN within 48 hours after emergency surgery had a better survival when compared to those who did not receive PN earlier.

Hence, taking all the above-mentioned into consideration, we recommend initiating PN after 5–7 days for well-nourished patients who have not been able to achieve 60% or more of estimated total energy requirement and earlier than 5 days for patients who are severely malnourished or at high risk of malnutrition.

3. What are the contraindications of PN?

Recommendation 3a

Contraindications to PN include patients with critical electrolytes abnormalities, specifically serum potassium (K) <2.5 mmol/L, serum sodium (Na) <125 mmol/L, serum phosphate (PO4) <0.4 mmol/L or serum magnesium (Mg) <0.5 mmol/L.

Strength of recommendation: Weak
Quality of evidence: Very low
Level of agreement: 100% (strong consensus)

Commentary: Metabolic complications can occur during PN administration due to intracellular shifts of glucose, electrolytes and fluid. Refeeding syndrome is a potentially fatal condition that may occur when artificial nutrition is introduced after prolonged starva-tion or minimal nutrient intake. It is not recommended to start PN for patients who have critical electrolytes abnormalities until it has been adequately corrected.^{10,11} PN should only be initiated

after electrolytes are at an acceptable level after replacement.

Recommendation 3b

Contraindications to PN include patients who have suffered irreversible brain injury or terminal illness where there is a lack of therapeutic goal to prolong life in the inevitable death.

Strength of recommendation: Strong
Quality of evidence: Moderate
Level of agreement: 100% (strong consensus)

Commentary: PN is not encouraged for patients with irreversible brain injury or terminal illness due to its potential complications, cost and futility. Besides, PN therapy may lead to unnecessary prolongation of suffering. PN may, however, be considered in a subgroup of terminally ill cancer patients who have reasonable functional status (Eastern Cooperative Oncology Group <3, Karnofsky Performance Status >50) and with an expected survival of more than 3 months when oral and/or EN is not feasible due to intestinal obstruction or high output fistula.¹²

Recommendation 3c

Contraindications to PN include patients who have no suitable venous access for PN.

Strength of recommendation: Strong
Quality of evidence: Very low
Level of agreement: 100% (strong consensus)

Commentary: The preferred delivery of PN is through central venous access.^{13,14} Delivery of PN through

Table 2. Executive summary.

Subject	Recommendation
Indications of parenteral nutrition (PN)	• Patients who are unable to meet their nutritional needs orally and/or enterally as a result of suboptimal function of the gastrointestinal tract (GIT) or in whom where the GIT is not accessible.
Contraindications of PN	• Patients with critical electrolytes abnormalities, such as severe hypokalaemia, hypophosphataemia, hypomagnesaemia or hyponatraemia. • Patients with irreversible brain injury or terminal illness where there is a lack of therapeutic goal to prolong life in the inevitable death. • Patients who have no suitable venous access for PN.
Monitoring of parameters	• Baseline biochemical assessment prior to initiation of PN. • Daily biochemical monitoring and adjusted according to the patient’s clinical progress, nutritional status and stage of PN therapy.
Nutritional assessment	• Start at 15–20 kcal/kg/day on day 1 and increase it progressively to target providing 25–30 kcal/kg/day or using validated predictive equations, taking into account physical activity and stress factor.

central venous access allows solutions of higher osmolality and volume to be infused as compared to delivery of PN through peripheral venous access. However, if all possible routes for central venous access have been exhausted, PN delivery through the peripheral route may be considered.

Assessment of PN patients

- Who should assess and manage patients prescribed with PN?

Recommendation 4

Patients on PN support in hospital should be managed by a nutrition support service consisting of a team of trained physician, nurse, dietitian and pharmacist.

Strength of recommendation: Strong

Quality of evidence: Low

Level of agreement: 100% (strong consensus)

Commentary: PN is a complex and specialised form of nutrition support. Consulting a multidisciplinary team of HCPs dedicated to PN support has been demonstrated to enhance the quality of care, promote appropriate use of PN, improve clinical outcomes and reduce the incidence of adverse PN-related complications.^{15,16}

- How often should biochemical parameters be assessed for patients on PN?

Recommendation 5a

All patients should have a baseline biochemical assessment prior to initiation of PN.

Strength of recommendation: Strong

Quality of evidence: Very low

Level of agreement: 100% (strong consensus)

Recommendation 5b

After establishing a patient on PN, the frequency of biochemical monitoring should be adjusted according to the patient's clinical progress, nutritional status and stage of PN therapy.

Strength of recommendation: Strong

Quality of evidence: Very low

Level of agreement: 100% (strong consensus)

Commentary: Biochemical monitoring is essential for the detection of potential metabolic complications.¹⁰ Before initiating PN, it is essential to conduct baseline tests assessing renal function (including sodium, potassium, creatinine, urea, bicarbonate and chloride levels), bone metabolism (e.g. calcium, phosphate, magnesium), liver function (including alkaline phosphatase, alanine aminotransferase, aspartate aminotransferase, gamma-glutamyl transferase, bilirubin) and lipid profile.

The time interval for biochemical surveillance after PN initiation depends on the patient's clinical progress and nutritional status, as well as the stage of PN therapy that he/she is at.

Biochemical parameters should be reviewed daily for the first few days, and subsequent monitoring can be less frequent depending on patient's clinical status and stability of the biochemical parameters measured.

- What are the nutritional requirements for patients on PN?

Recommendation 6a

Energy expenditure for patients requiring PN should ideally be measured using indirect calorimetry. However, if indirect calorimetry is not available, providing 25–30 kcal/kg/day or using validated predictive equations, taking into account physical activity and stress factor, are acceptable to calculate energy requirement.

Strength of recommendation: Strong

Quality of evidence: Moderate

Level of agreement: 100% (strong consensus)

Commentary: Inappropriate delivery of PN can have detrimental effects on patients' clinical outcomes. Excessive PN has been associated with complications, such as hyperglycaemia, liver dysfunction and weight gain. On the other hand, inadequate PN can lead to macro- and micro-nutrient deficiencies and weight loss. Hence, accurate measurement or calculation of energy requirement is important so that adequate calories can be provided.

Indirect calorimetry is the gold standard for determining resting energy expenditure (REE). In the absence of indirect calorimetry, predictive equations such as Harris-Benedict, Schofield and Mifflin-St Jeor can be used to estimate REE. A practical alternative using standard caloric intake, ranging 25–30

kcal/kg/day with adjustments based on individual clinical conditions, has also been recommended by ESPEN as a reasonable estimate of energy requirement.¹⁷

Recommendation 6b

Protein requirements for patients requiring PN should be tailored to individual needs, ranging from 1 to 2 g/kg/day. Higher protein doses may be required for the critically ill, cancer and elderly patients.

Strength of recommendation: Strong

Quality of evidence: Low

Level of agreement: 87% (consensus)

Commentary: Protein requirements for patients requiring PN vary depending on the clinical condition, nutritional status and metabolic stress. The protein requirement for adults in the acute care setting typically ranges from 1.0 to 2.0 g/kg/day, with higher amounts for patients in severe catabolic states.

In a randomised control trial (RCT)¹⁸ that evaluated the effect of protein intake through PN on muscle strength and clinical outcomes in critically ill patients, those who received higher protein intake (1.2 g/kg/day) showed improved handgrip strength, greater muscle thickness and less fatigue during the first week of intensive care unit (ICU) as compared to those who received less protein intake (0.8 g/kg/day). Similarly, in a large retrospective observational study¹⁹ that assessed the association between protein intake and mortality in non-critically ill older patients receiving PN, higher protein intake (≥ 0.8 g/kg/day) was found to be significantly associated with better survival outcomes. These findings highlight the importance of ensuring adequate protein provision in this vulnerable population to improve clinical outcomes.

In summary, protein requirements should be individualised, with higher protein goals for patients with higher catabolic states such as critical illness, malnutrition or cancer.

7. Which nutritional assessment tool should be used for patients requiring PN?

Recommendation 7

There is currently no nutritional assessment tool developed specifically for patients requiring PN. Validated assessment tools, such as Subjective Global Assessment (SGA), are recommended for

the diagnosis and determination of the severity of malnutrition.

Strength of recommendation: Strong

Quality of evidence: Very low

Level of agreement: 100% (strong consensus)

Commentary: Commonly used nutritional assessment tools, such as SGA, Patient-Generated SGA and Mini Nutritional Assessment, have been validated in both hospital and community settings.^{20,21} However, no specific nutritional assessment tool has been developed or validated among patients requiring PN thus far. Based on current literature, SGA can be used until other validated nutritional assessment tools become available. In addition, the nutrition support team should perform a comprehensive assessment of the patient's baseline anthropometry, biochemistry, clinical signs and symptoms and diet history as part of the nutrition care process for all patients requiring PN.

Titration and formulation of PN

8. How fast should PN be introduced and progress?

Recommendation 8

It is recommended to start at 15–20 kcal/kg/day on day 1 and increasing it progressively to target for non-critically ill patients. Patient's nutritional status and risk of refeeding should be considered when initiating and advancing PN infusion rate.

Strength of recommendation: Weak

Quality of evidence: Moderate

Level of agreement: 100% (strong consensus)

Commentary: Multiple studies^{6,22–26} were included in the analysis of this question. There were vast differences in methodological quality and intervention design among these studies. In the critical care setting, most of these studies^{6,22–24} did not find any significant difference in mortality, length of stay in hospital and in ICU, number of mechanically ventilated days, incidence of organ failure and infection rate when comparing patients in the high-calorie group and patients in the low-calorie group. On the other hand, in the non-ICU setting, little insight could be gained due to the heterogeneity of studies.^{25,26} Therefore, based on our consensus, calorie intake may start with 15–20 kcal/kg/day on day 1 and increase progressively to target by day 3 or day 4 for non-critically ill patients, while

Table 3. Checklist table.

Subject	Recommendation
Parenteral nutrition (PN) initiation	• Indication of initiating PN • Baseline laboratory values • Nutritional assessment
Monitoring	• Baseline tests including renal function tests (sodium, potassium, bicarbonate, urea, creatinine, chloride), bone metabolism (calcium, phosphate), liver function tests (alkaline phosphatase, alanine aminotransferase, aspartate aminotransferase, gamma-glutamyl transferase, bilirubin) and lipid profile • Daily biochemical monitoring and adjusted according to the patient's clinical progress, nutritional status and stage of PN therapy • Blood glucose levels every 6 hours for the initial 48 hours of initiating PN therapy • Monitoring of triglyceride levels
Discontinuing	• Achieving 60% of target energy requirement from enteral nutrition and/or oral diet

critically ill patients may necessitate a more cautious approach to calorie progression.

9. When should PN be discontinued?

Recommendation 9

PN can be reduced and discontinued when the patient is receiving more than 60% of target energy requirement from enteral nutrition and/or oral diet.

Strength of recommendation: Weak

Quality of evidence: Very low

Level of agreement: 100% (strong consensus)

Commentary: There is no available data thus far to determine the cut-off point when PN can be discontinued. Clinical judgement is still required, especially for malnourished patients and patients with a complicated hospital course. These patients may require a longer period of PN support and should demonstrate a higher enteral and/or oral intake before PN is discontinued.

The ASPEN and Society of Critical Care Medicine guideline²⁷ suggested that when tolerance to EN is evident, PN should be weaned off when more than 60% of the patient's needs are met orally or enterally.

10. What is the recommended type of lipid emulsion used to compound PN?

Recommendation 10

Fish oil (FO) containing injectable lipid emulsion (ILE) should be used as part of the lipid component of PN.

Strength of recommendation: Strong

Quality of evidence: High

Level of agreement: 100% (strong consensus)

Commentary: ILE should be included in PN formulation to provide a dense source of non-protein energy as well as a source of essential and conditionally essential fatty acids to prevent essential fatty acid deficiency.

Multiple studies²⁸⁻³⁰ were evaluated to determine the most favourable type of ILE to be used in PN therapy. Among the benefits of FO demonstrated in these studies were improvements in biochemical parameters indicating preservation of liver functions,^{28,29} as well as improvement in clinical outcomes such as shorter length of hospital stay²⁹ and reduced rate of nosocomial infections.³⁰

Most of the studies, which were of moderate to high quality of evidence,^{31,32} demonstrated that the use of FO-ILE was associated with reduced mortality, shorter length of hospital stay, fewer mechanical ventilated days and lower infection rate compared to non-FO-ILE. However, there were conflicting data suggesting that there was no mortality advantage with FO-ILE.³³ Taking into consideration the strengths and limitations of the studies included, the authors recommended using FO-ILE as part of the lipid component of PN.

11. Should multivitamin and trace elements be added in PN bags?

Recommendation 11a

Multivitamins are recommended in patients initiated on PN. In patients at risk of refeeding syndrome, additional intravenous thiamine supplementation for 3–5 days is recommended.

Strength of recommendation: Strong

Quality of evidence: High

Level of agreement: 100% (strong consensus)

Commentary: Vitamins are essential micronutrients required for normal cell function, growth and development. The addition of multivitamins to PN formulation for postoperative patients has been found to reduce traumatic stress and improve the metabolic transition from catabolism to anabolism.³⁴ Due to a nationwide shortage of multivitamins in the US in 1997, multiple cases of adverse clinical outcomes related to vitamin deficiency were also reported.^{35,36} Therefore, daily supplementation of multivitamins should be provided to all patients on PN support, especially to those who are malnourished with/without underlying acute illness.

Recommendation 11b

Trace elements are recommended in patients initiated on PN.

Strength of recommendation: Weak

Quality of evidence: Low

Level of agreement: 100% (strong consensus)

Commentary: Most of the available studies³⁴⁻³⁸ suggested that all adult patients on PN support should receive daily supplementation of trace elements. While all adult patients on PN are recommended to receive daily supplementation of trace elements, this should be guided by clinical judgement, particularly in the first month of therapy for patients without pre-existing deficits or critical illness.

12. Under what circumstances would additional vitamin or mineral supplementation be required?

Recommendation 12a

Additional supplementation of vitamin C is recommended for patients who are critically ill and patients who have had gastrectomy or colorectal resection.

Strength of recommendation: Strong

Quality of evidence: High

Level of agreement: 100% (strong consensus)

Commentary: Vitamin C is an antioxidant that protects the body cells from harmful free radicals. Two RCTs^{39,40} had reported that high-dose supplementation of vitamin C was associated with decreased postoperative oxidative stress and improved wound healing among patients who had undergone gastric or colorectal resection. Therefore, special consideration for additional supplementation of intravenous vitamin C of up to 500 mg/day, on top of a standard

dose of multivitamins, should be given to critically ill patients and those who have undergone gastric or colorectal resection.

Recommendation 12b

Additional supplementation of Zinc (Zn) is recommended for patients with high GIT losses. For every 1L of GIT losses via fistula or stoma, an additional 12–17 mg of Zn should be provided.

Strength of recommendation: Strong

Quality of evidence: High

Level of agreement: 100% (strong consensus)

Commentary: In a study of patients with gastrointestinal disease,⁴¹ a Zn replacement equation was derived using a regression analysis. Based on the equation, Zn replacement can be accurately calculated using measured GIT losses. In studies with burns patients,⁴²⁻⁴⁴ it was observed that these patients experienced significant exudative Zn losses, hence higher dosage of Zn should be added to PN.

13. Are there benefits in adding glutamine in PN bags?

Recommendation 13

Additional supplementation of glutamine is not recommended in patients initiated on PN.

Strength of recommendation: Weak

Quality of evidence: Low

Level of agreement: 100% (strong consensus)

Commentary: Several studies had reported that PN with glutamine supplementation was associated with a reduction in infection rates, length of hospital stay and days on mechanical ventilation in critically ill and post-surgical patients.⁴⁵⁻⁴⁸ Subsequent high-quality, large sample multicentre RCT study⁴⁹ showed that glutamine supplementation was associated with increased mortality for critically ill patients with multi-organ failure. Other studies and reviews with moderate to high methodological quality^{47,48} also did not show mortality benefits. Thus, in view of conflicting data and high heterogeneity of studies as well as a lack of recommendations in the international guidelines, the authors do not recommend additional glutamine supplementation in PN.

PN access routes and devices

14. What types of venous access device should be used for PN?

Recommendation 14

Peripherally inserted central catheter (PICC) with a dedicated lumen is recommended for PN administration. However, an existing central venous access device (CVAD) in the internal jugular vein can be used for up to 14 days.

Strength of recommendation: Strong

Quality of evidence: Moderate

Level of agreement: 100% (strong consensus)

Commentary: The choice of venous access for the administration of PN is of paramount importance.⁵⁰ PN should be delivered through a CVAD. PICC is the preferred choice of vascular access for PN therapy as it is cost-effective and is associated with fewer catheter-related complications such as infection, obstruction, dislocation and venous thrombosis.^{50,51}

Femoral catheters, on the other hand, are not recommended for the administration of PN due to their association with increased risk for contamination, infection and venous thrombosis. Hence, PICC is a relatively safe device for the administration of long-term PN as it preserves the integrity of the venous system.⁵²

15. How should the patency of CVADs be maintained?

Recommendation 15

CVADs should be flushed using normal saline after each use, or weekly if not in use, to maintain catheter patency.

Strength of recommendation: Strong

Quality of evidence: Moderate

Level of agreement: 100% (strong consensus)

Commentary: Most CVADs can be safely flushed and locked with normal saline solution when not in use. Although the use of heparin flush to maintain CVAD patency has been recommended in some nursing guidelines, the evidence to support this practice was based on low-quality studies.⁵³ Several systematic reviews^{52,54} have shown that heparin flushes have no significant benefit over normal saline flushes in maintaining catheter patency. Therefore, considering all the above-mentioned reasons, the flushing of CVADs with normal saline solution is recommended.

Current recommendations pertaining to how frequent CVADs should be flushed are conflicting and based on weak evidence.^{55,56} The most appropriate flushing frequency is after each use or weekly if not in use.

16. Under what circumstances should peripheral PN (PPN) be considered?

Recommendation 16a

PPN can be used as supplemental PN where oral or EN is suboptimal.

Strength of recommendation: Weak

Quality of evidence: Low

Level of agreement: 100% (strong consensus)

Recommendation 16b

The duration of PPN therapy should not exceed 14 days due to an increased risk of complications related to peripheral intravenous catheters.

Strength of recommendation: Strong

Quality of evidence: Low

Level of agreement: 100% (strong consensus)

Commentary: In view of the high volume and low nutritional content of PPN, PPN alone is unlikely to be adequate to meet individual's nutritional requirement. Therefore, PPN can be used as a short-term therapy to bridge the nutritional gap during transition periods until CVAD is inserted or as a supplement to oral and/or EN until GIT regains full function.

Peripheral intravenous catheters typically have a short dwell time as the risk of complications increases for every day it is left in place.^{57,58} Thus, the authors do not recommend the use of PPN for more than 14 days.

17. What osmolarity of PN admixture is safe for peripheral venous use?

Recommendation 17

Osmolarity of PPN therapy should be maintained at less than 900 mOsm/L to minimise the risk of catheter-related complications.

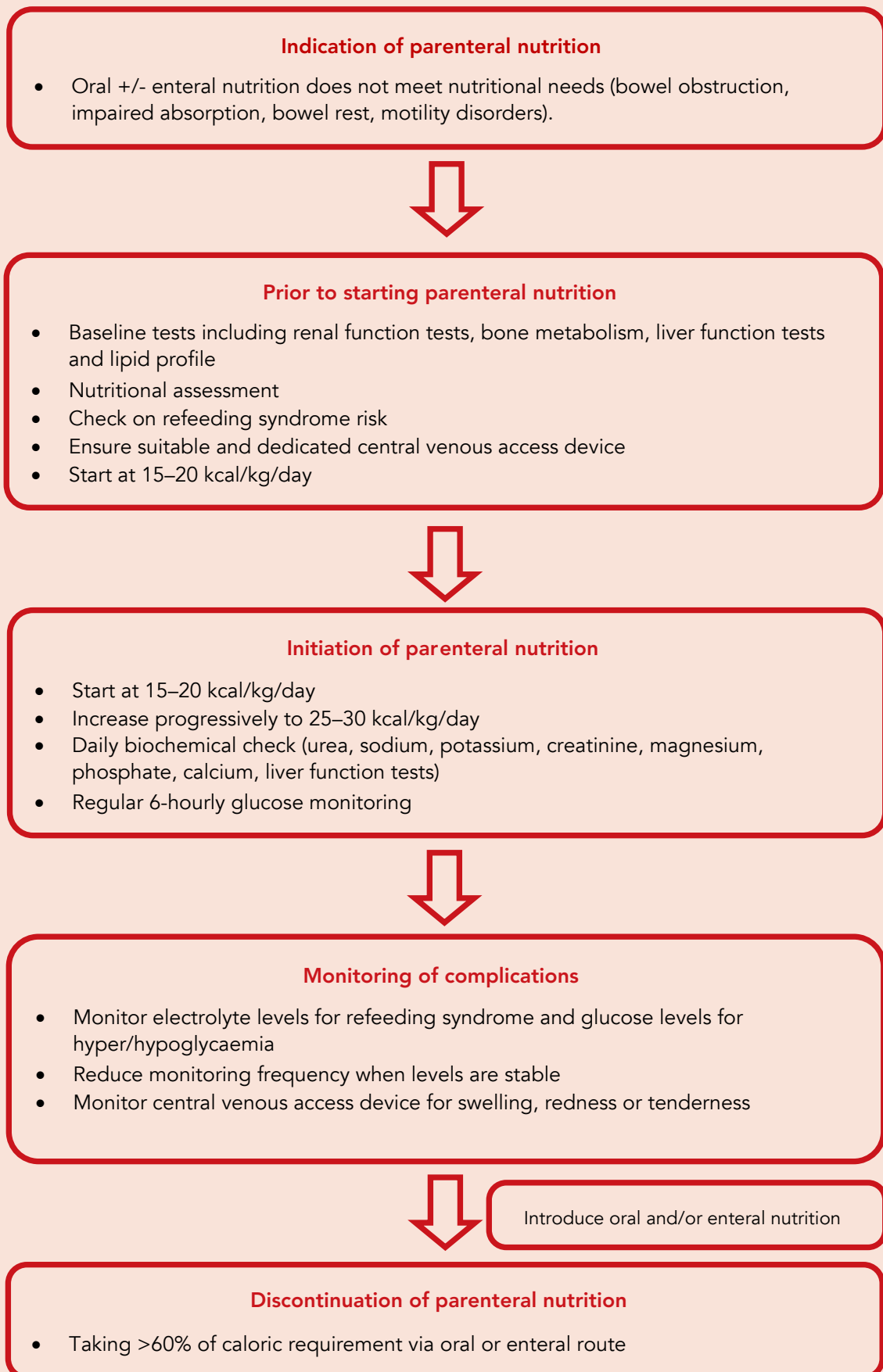
Strength of recommendation: Strong

Quality of evidence: Low

Level of agreement: 93% (strong consensus)

Commentary: PPN is usually reserved for short-term use because the infusion of hypertonic solution into peripheral veins may cause phlebitis and thrombosis. Hence, the osmolarity of the solution should be kept low and this can be achieved by lowering nutrient content and increasing fluid volume of the PPN solution. The osmolarity of less than 900 mOsm/L in PPN has been shown to be well tolerated.^{59,60}

Fig. 1. Flowchart on decision tree on parenteral nutrition in adult patients in the acute hospital setting.



Monitoring and management of PN-related complications

18. How should patients at risk of refeeding syndrome be managed?

Recommendation 18a

Patients who are at risk of refeeding syndrome are required to have their serum electrolytes monitored daily for the first few days, following which frequency of monitoring can be reduced when serum electrolytes stabilise.

Strength of recommendation: Strong

Quality of evidence: Moderate

Level of agreement: 100% (strong consensus)

Recommendation 18b

Serum electrolyte abnormalities should be promptly recognised and corrected.

Strength of recommendation: Strong

Quality of evidence: High

Level of agreement: 100% (strong consensus)

Commentary: Refeeding syndrome is associated with severe and life-threatening complications. However, it is preventable through close monitoring, early detection and timely replacement of serum electrolytes and vitamins. Therefore, serum electrolytes should be monitored daily during the first few days of PN therapy and corrected promptly as refeeding syndrome tends to occur within the first 72 hours after initiation of nutrition therapy.^{61,62} The frequency of monitoring can be reduced subsequently depending on the clinical status, trend of serum electrolyte levels and fluid balance of the patient. Preventive measures through initial controlled hypocaloric feeding have also been found to be associated with reduced risk of refeeding syndrome and improved overall survival.^{24,63}

19. How often should blood glucose be monitored?

Recommendation 19

Blood glucose levels should be measured every 6 hours at least for the initial 48 hours after initiation of PN therapy.

Strength of recommendation: Weak

Quality of evidence: Low

Level of agreement: 100% (strong consensus)

Commentary: Hyperglycaemia and hypoglycaemia are common complications in hospitalised patients receiving PN and are independently associated with adverse clinical outcomes.⁶⁴ Hyperglycaemia is reported to occur in more than half of the patients receiving PN regardless of pre-existing diabetes mellitus.⁶⁴ The increase in blood glucose level results from a combination of factors such as increased stress hormones and insulin resistance due to underlying acute illness, surgery or trauma, as well as delivery of glucose and gluconeogenic substrates through PN.⁶⁶ Hypoglycaemia, on the other hand, tends to result from tight glycaemic control with insulin therapy, abrupt discontinuation of PN, tapering doses of corticosteroids or vasopressors, and improved glycaemic control upon recovery from acute illness or organ failure.⁶⁷

However, guidelines from various international societies^{27,68,69} recommended that blood glucose levels should be monitored every 6 hours for the first 48 hours after PN initiation. Glucose monitoring may be discontinued in non-diabetic patients who are normoglycaemic without insulin therapy after 48 hours of achieving target nutrition infusion.

20. What is the target blood glucose range?

Recommendation 20

A target blood glucose ranging 7.8–10 mmol/L is recommended for patients receiving PN.

Strength of recommendation: Strong

Quality of evidence: Moderate

Level of agreement: 100% (strong consensus)

Commentary: The NICE-SUGAR study⁷⁰ revealed that ICU patients with tight glycaemic control (4.5–6.0 mmol/L) had a higher mortality of 10.1% compared to those on conventional blood glucose control (<10 mmol/L). Subsequent meta-analyses and systemic reviews^{71–74} concurred that there was no evidence that tight glycaemic control with intensive insulin therapy reduced mortality but instead, it increased the risk of hypoglycaemia that was associated with worse outcomes.

Multiple international societies including ASPEN,⁷⁵ American Association of Clinical Endocrinologists,⁷⁶ American Diabetes Association⁷⁶ and Endocrine Society⁶⁷ recommended a target blood glucose ranging 7.8–10.0 mmol/L for adult patients admitted in the acute care setting.

21. Should insulin be added to PN bags?

Recommendation 21

Subcutaneous insulin is preferred over the addition of insulin to PN admixtures for glycaemic control. At the discretion of the nutrition support team and guided by local institution practices, short-acting insulin may be added to PN admixture in patients whose clinical conditions and PN requirements are stable.

Strength of recommendation: Weak

Quality of evidence: Low

Level of agreement: 100% (strong consensus)

Commentary: Insulin therapy is the choice of treatment to correct hyperglycaemia in both diabetic and non-diabetic patients receiving PN.⁷⁷ Insulin can be administered subcutaneously, intravenously or added to PN admixture. The addition of short-acting insulin into PN admixture has the advantage of delivering a steady rate of insulin, which has been reported to provide a smoother glycaemic control without increasing risk of hypoglycaemia.⁷⁸ On the other hand, subcutaneous administration of long-acting insulin is associated with reduced glycaemic variability and facilitates the transition to basal-bolus regimens when PN is reduced or discontinued.⁷⁹

There are concerns pertaining to insulin availability after it is added into PN admixtures with a reported range of 10–95%.⁸⁰ Hence, the addition of insulin to PN admixture is not recommended in patients whose medical conditions and PN requirements are unstable. For these patients, the use of subcutaneous insulin for glycaemic control while receiving PN is recommended.

22. How often should liver function tests (LFTs) be monitored?

Recommendation 22

Baseline LFTs should be obtained prior to initiation of PN. LFTs should be monitored on a weekly basis, with a reduction in frequency of monitoring subsequently depending on clinical progress.

Strength of recommendation: Weak

Quality of evidence: Moderate

Level of agreement: 100% (strong consensus)

Commentary: Derangement of LFTs is common among patients receiving PN. The aetiology is usually multi-factorial and frequently caused by non-PN-related factors, such as pre-existing liver disease,

sepsis, underlying acute illness and drugs. A study reported that 34% of patients had underlying abnormal LFTs prior to starting PN therapy.⁸¹ Hence, it is pertinent to obtain baseline LFTs before PN is initiated and it should be monitored on a weekly basis. Frequency of LFTs monitoring can subsequently be reduced if it is normal.

23. How should deranged LFTs be managed?

Recommendation 23

Non-PN-related causes of abnormal LFTs should first be identified and managed accordingly. Overfeeding of PN may also cause abnormal LFTs, hence adjustment of dextrose and/or lipid content of PN admixture may be necessary.

Strength of recommendation: Weak

Quality of evidence: Moderate

Level of agreement: 100% (strong consensus)

Commentary: PN-related deranged LFTs typically occur after 2 to 4 weeks of PN therapy.^{82,83} The initial management of abnormal LFTs should always include the identification and management of possible non-PN-related causes, such as biliary obstruction, hepatitis and sepsis.⁸⁴ The use of hepatotoxic drugs, especially antibiotics, should be minimised or avoided. Besides, overfeeding patients with PN therapy can also lead to liver dysfunction. Therefore, adjustments to dextrose and lipid content in PN admixture are necessary if liver dysfunction is related to overfeeding.

24. How should PN transition from continuous to cyclical infusion?

Recommendation 24

Cyclic PN can be started when patient is clinically stable and satisfactory glycaemic control is maintained during a fasted state without PN.

Strength of recommendation: Weak

Quality of evidence: Moderate

Level of agreement: 100% (strong consensus)

Commentary: PN is commonly administered through continuous infusion over 24 hours. The duration of PN infusion can gradually be reduced hourly over a period of days or weeks once the patient has achieved target nutritional goals and has remained clinically and biochemically stable.

Cyclic PN has been associated with a lower incidence of PN-related liver disease as it mimics the

physiological function of nutrient metabolism of oral feeding.^{85,86} Additionally, cyclic PN is advantageous for patients who require prolonged PN support as it also allows daytime ambulation and activities when they are not receiving PN.

25. What is the target serum triglyceride level?

Recommendation 25

Serum triglyceride should be maintained below 4.6 mmol/L.

Strength of recommendation: Weak

Quality of evidence: Moderate

Level of agreement: 100% (strong consensus)

Commentary: Hypertriglyceridaemia is a complication associated with the use of PN, with reported incidence ranging from 6% to 38%.^{87,88} As the risk of adverse effects increases when serum level exceeds 4.6 mmol/L, it is recommended that serum triglyceride should be maintained ≤ 4.6 mmol/L during PN therapy.⁸⁹

26. How should hypertriglyceridaemia be managed?

Recommendation 26

If serum triglyceride is more than 4.6 mmol/L, dextrose load in PN should be reduced followed by a reduction in ILE if serum triglyceride level does not improve. PN should be discontinued if serum triglyceride is more than 11.4 mmol/L.

Strength of recommendation: Weak

Quality of evidence: Moderate

Level of agreement: 100% (strong consensus)

Commentary: Dextrose overload is usually the primary cause of hypertriglyceridaemia in patients receiving PN. Therefore, when hypertriglyceridaemia develops, the amount of dextrose in PN should be reduced. Besides PN therapy, other non-PN-related causes should be considered when managing hypertriglyceridaemia. Clinical conditions that predispose patients to hypertriglyceridaemia are sepsis, diabetes, liver failure, renal failure, multiorgan failure, obesity, alcoholism and pancreatitis.⁹⁰⁻⁹² In cases of severe hypertriglyceridaemia where serum triglyceride level exceeds 11.3 mmol/L, PN should be withheld until level normalises.^{90,91}

27. How should catheter-related thrombosis (CRT) be managed?

Recommendation 27

The use of thrombolytic agents and anticoagulation treatment is recommended for CRT, with removal of CVAD if complete resolution from these measures is not achieved.

Strength of recommendation: Strong

Quality of evidence: Moderate

Level of agreement: 100% (strong consensus)

Commentary: CRT is a relatively common complication of CVAD use in PN therapy. Although the removal of blocked CVADs is common practice, some causes of catheter occlusion may be rectified through simple measures. Occluded CVAD caused by build-up of lipid emulsion residue may be cleared by instilling a solution of 70% ethanol into the catheter.⁹³ For occlusion caused by an intraluminal clot or fibrin sheath, thrombolytic agents such as urokinase or alteplase may be used to restore lumen patency.^{94,95} In symptomatic CRT, systemic anticoagulation for at least 3 months is recommended if the existing CVAD remains in situ. The treatment of CRT should include thrombolysis for acute symptomatic cases and anticoagulation therapy for subacute and chronic symptomatic cases. CVAD should be removed if all measures to achieve complete patency fails.

28. How should catheter-related blood (CRBSI) stream infection be managed?

Recommendation 28a

In the event that CRBSI is suspected, 2 sets of blood cultures should be obtained from both the CVAD and peripheral vein before initiation of antimicrobial therapy.

Strength of recommendation: Strong

Quality of evidence: Moderate

Level of agreement: 100% (strong consensus)

Recommendation 28b

In complicated CRBSI, the CVAD should be removed for source control. In uncomplicated CRBSI or in patients with limited vascular access, discussion with an infectious disease specialist is recommended to explore possibility of CVAD salvage.

Strength of recommendation: Strong
 Quality of evidence: Low
 Level of agreement: 100% (strong consensus)

Commentary: Paired blood cultures should be drawn from both the CVAD and a peripheral vein for suspected CRBSI before the initiation of antimicrobial therapy. The initial choice of antimicrobial therapy depends on the severity of the patient's clinical presentation, risk factors for infection and types of potential pathogens suspected.⁹⁶

Complicated CRBSI refers to those that are associated with severe suppurative thrombophlebitis, endocarditis and blood infection that continues despite more than 72 hours of appropriate antimicrobial therapy, or infection due to *Staphylococcus aureus*, *Pseudomonas aeruginosa*, fungi and mycobacteria.⁹⁶ Under such circumstances, CVAD should be removed to prevent undesirable complications such as septic shock and death.⁹⁶⁻⁹⁸

29. Should PN be withheld when patient undergoes surgery?

Recommendation 29

It is not necessary to withhold PN during surgery.

Strength of recommendation: Weak
 Quality of evidence: Low
 Level of agreement: 87% (consensus)

Commentary: Concerns regarding the safety of continuous administration of PN during operative procedures when patients are under metabolic stress of surgery have been raised. Excessive use of fluids intraoperatively can put patients at risk of fluid overload, acid-base imbalance, renal impairment and cardio-respiratory compromise. Currently, there are no studies that have examined the metabolic effects of intraoperative administration of PN and patient outcomes. In view of a lack of evidence to support withholding PN during surgery, the authors recommend that it is not necessary to practice it.

30. Is tapering of PN and dextrose drip necessary after termination of PN?

Recommendation 30

Tapering of PN or administration of intravenous dextrose solution after abrupt termination of PN may not be necessary unless the patient is on insulin therapy.

Strength of recommendation: Weak
 Quality of evidence: Low
 Level of agreement: 80% (consensus)

Commentary: Gradual tapering of PN before cessation is a common practice to prevent rebound hypoglycaemia. However, it has been shown that the body adapts quickly to decreased glucose levels and subsequent need for insulin.^{17,99,100}

Although ESPEN recommended that tapering of PN is not necessary,¹⁷ tapering of PN may be a safety precaution for patients who are susceptible to hypoglycaemia or on insulin therapy. PN infusion rate can be reduced by 50% for 1–2 hours before discontinuation with concurrent close monitoring of blood glucose levels.

CONCLUSION

Despite its life-saving potential as an artificial nutrition support for patients whom nutritional adequacy cannot be met orally and/or enterally, PN carries inherent risks such as infection, metabolic disturbances and catheter-related complications. This clinical practice guideline proposed 30 recommendations for PN support in adult patients within the acute care setting, which cover various aspects of PN, including indications, patient assessment, titration and formulation of PN bags, access routes and devices, and monitoring and management of complications. There are limitations in the current evidence due to the lack of high-quality trials assessing the outcomes of PN therapy in this specific population. While this guideline serves as a guide for HCPs, clinical judgement remains paramount. HCPs should tailor their approach based on individual patient needs, considering factors such as underlying conditions, severity of illness and nutritional status. Regular reassessment and interdisciplinary collaboration are crucial for optimising patient outcomes. Clinical indicators, including refeeding syndrome, hyperglycaemia, hypoglycaemia, catheter-related central line infection and CRT, should be monitored to maintain quality care and measurable outcomes in patients on PN therapy.

Supplementary materials

Fig. S1. Search terms and PRISMA flowchart used for each clinical question (CQ).

Table S1. Grading of Recommendations Assessment, Development and Evaluation.

Table S2. Detailed commentaries and references.

Ethics statement

Not applicable.

Declaration

The authors declare they have no affiliations or financial involvement with any commercial organisation with a direct financial interest in the subject or materials discussed in the manuscript. This research did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors. There was no conflict of interest among the members of the working group.

Acknowledgement

The authors thank SingSPEN office for the secretarial work.

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