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Laporan Kes / Case Report

Managing Nutritional Transition from Total Parenteral Nutrition to Enteral Nutrition in a Paediatric Patient

Pengurusan Peralihan Pemakanan daripada Nutrisi Parenteral Total ke Nutrisi Enteral dalam Pesakit Pediatrik

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ABSTRACT

This case report discusses the nutritional challenges and management strategies in a 2-year-old boy with gastrointestinal issue that is severe enterocolitis, experiencing complications such as perforated ileus, hence needing an ileostomy. Nutrition assessment revealed that the patient's highest recorded weight was under the 3rd percentile, with no recent measurements available. The growth status was assessed using the WHO Child Growth Standards (2006), weight for age. On the day of the stoma closure procedure, the patient experienced high stoma output and was reliant on both total parenteral nutrition (TPN) and enteral nutrition (EN). EN was first introduced at minimal volumes alongside TPN, and later increased as tolerated. At the time of assessment, EN provided 47% and TPN provided 53% of total energy. The nutrition diagnosis was identified as inadequate energy intake related to severe enterocolitis with postoperative recovery (stoma closure) and co-existing HIE leading to increased metabolic demands and feeding limitations, as evidenced by current intake meeting only 69% of energy requirements. Nutrition intervention included increasing the amount of catch-up formula to optimize energy and protein intake and introducing solid foods when deemed safe by the speech and language pathologist (SLP). This case highlights the complexities of nutrition management in pediatric patients with gastrointestinal conditions, particularly the transition from TPN to EN, requiring careful planning, monitoring and collaborations from other healthcare professionals.

Keywords: gastrointestinal function, severe enterocolitis, total parenteral nutrition, transition.

ABSTRAK

Laporan kes ini membincangkan cabaran dan strategi pengurusan pemakanan bagi seorang kanak-kanak lelaki berumur 2 tahun dengan masalah gastrousus yang teruk, iaitu enterokolitis, yang mengalami komplikasi seperti ileus perforasi dan memerlukan ileostomi. Penilaian pemakanan menunjukkan berat badan tertinggi yang direkodkan berada di bawah peratus ke-3, dan tiada ukuran terkini didapati. Status pertumbuhan dinilai menggunakan Standard Pertumbuhan Kanak-Kanak WHO (2006), berat mengikut umur. Pada hari prosedur penutupan stoma, pesakit mengalami pengeluaran stoma yang tinggi dan bergantung kepada nutrisi parenteral (TPN) dan nutrisi enteral (EN). EN diperkenalkan pada jumlah minima bersama TPN, dan kemudian ditingkatkan mengikut kemampuan pesakit. Pada masa penilaian, EN menyumbang 47% manakala TPN menyumbang 53% daripada jumlah tenaga. Diagnosis pemakanan adalah pengambilan tenaga yang tidak mencukupi disebabkan oleh enterokolitis teruk dengan pemulihan selepas pembedahan (penutupan stoma) dan HIE yang wujud bersama, menyebabkan peningkatan keperluan metabolik dan had pemakanan, seperti yang dibuktikan oleh pengambilan semasa hanya memenuhi 69% keperluan tenaga. Intervensi pemakanan termasuk meningkatkan jumlah susu

formula untuk pertumbuhan semula bagi mengoptimumkan pengambilan tenaga dan protein serta memperkenalkan makanan pejal apabila dimaklumkan selamat oleh ahli patologi pertuturan dan bahasa (SLP). Kes ini menekankan kerumitan pengurusan pemakanan dalam kalangan pesakit pediatrik dengan masalah gastrousus, terutamanya peralihan dari TPN ke EN, yang memerlukan perancangan, pemantauan dan kerjasama rapi dengan profesional kesihatan lain.

Kata Kunci: fungsi gastrousus, enterokolitis teruk, nutrisi parenteral, peralihan.

INTRODUCTION

Hypoxic-ischemic encephalopathy (HIE) refers to a type of brain injury caused by insufficient oxygen supply to the brain, often occurring around the time of birth (Campellone 2022). This condition primarily affects the central nervous system and can result in neurological and developmental issues. Babies born with HIE may experience long-term challenges such as motor and cognitive impairments, affecting their overall development and quality of life (Campellone 2022). HIE in early life can compound feeding intolerance and growth faltering, often necessitating staged transitions between TPN and EN. In this patient, severe enterocolitis secondary to rotavirus AGE, together with HIE and postoperative status, created sustained challenges to achieving adequate intake and growth.

Severe enterocolitis secondary to rotavirus acute gastroenteritis (AGE) is a common condition in pediatric populations, often resulting in significant morbidity. Enterocolitis is a medical condition that causes inflammation of the small intestine and colon. This inflammation may result from a variety of causes, including infections, autoimmune diseases, or inflammatory conditions. The most common causes of enterocolitis are bacterial or viral infections, which often lead to complications such as diarrhea, fever, nausea, vomiting, and abdominal pain (Sharmin 2023). This condition can be particularly serious for individuals in vulnerable populations, including infants, the elderly, and those with weakened immune systems. The inflammation associated with enterocolitis can disrupt the normal functioning of the gastrointestinal system, leading to significant discomfort and potential long-term health problems if not treated promptly and effectively (Sharmin 2023). The condition of enterocolitis can either be acute or chronic. The complications of severe enterocolitis in this case includes septic and hyponatraemic hypovolemic shock, disseminated intravascular coagulation (DIVC), acute kidney injury (AKI), and even perforated ileum. Additionally, the patient developed a pressure sore over the occipital region as a consequence of prolonged immobility and critical illness.

Intestinal perforation, defined as a loss of continuity in the bowel wall, is one of the more serious complications of enterocolitis and other gastrointestinal conditions (Hafner et al. 2020). The perforation, in this case is perforation in the ileum, requiring an ileostomy to divert the intestinal contents and allow for healing, reducing the risk of further complications, including infection and systemic shock (Hafner et al. 2020). TPN is one of the options for nutrition management as feeding and absorption could be affected.

Carbapenem-resistant Enterobacterales (CRE) infections present a significant challenge in healthcare settings, particularly in hospitals and intensive care units (ICUs) (Yin et al. 2021). These infections are caused by bacteria that have developed resistance to a broad spectrum of antibiotics, including carbapenems, which are considered the drugs of last resort for treating severe bacterial infections. CRE infections are often associated with high morbidity and mortality rates, particularly in immunocompromised patients and those with underlying medical conditions (Yin et al. 2021).

CASE BACKGROUND

The patient is a 2-year-old Malay boy with the date of birth on 6/11/2022 and was admitted under the paediatric unit of a government hospital in Kuala Lumpur on 9/8/2024 for ongoing management of multiple complex medical issues. This case represents his seventh follow-up visit. The patient's current issue was severe enterocolitis secondary to AGE, which was complicated with septic and hyponatraemic hypovolemic shock, DIVC, AKI, and a perforated ileum. He also developed a pressure sore over the occipital region. The patient was currently post-operative day 7 following stoma closure surgery on 5/11/2024, performed after an ileostomy for the perforated ileum in August 2024. Additionally, the patient had a history of severe HIE during infancy, with early signs of left hemiplegia noted in the current admission. Underlying medical conditions include a complex congenital heart defect comprising double outlet right ventricle, transposition of the great arteries, pulmonary stenosis, and a criss-cross heart with a single ventricle pathway. He was also a known CRE colonizer. Current medications include oral spironolactone 6.25 mg twice daily, intravenous (IV) omeprazole twice daily, IV metronidazole three times daily, IV cefotaxime three times daily, and zinc

oxide cream applied topically three times daily. During this visit, the patient was in an isolation room. The patient's mother, who accompanied him, was called out from the room to discuss his condition as direct interaction with the patient was not possible.

During this visit, it is the patient's seventh dietetic follow-up since admission. Nutritional management began on 12/8/2024, during the first dietetic visit, when the patient was transitioning from TPN to EN. At that time, he was on perfusor feeding with a catch-up formula at 30 ml/hour, 3 hours run and 1 hour rest (3+1). This provides a total of 810 kcal/day and 21 g of protein/day, with a fluid intake of 80 ml/kg/day. The feeding plan during this visit involved continuing this regime 4 hourly, 6 times per day. By the first follow-up on 13/8/2024, the patient tolerated the previous feeding plan well, and the perfusor rate was increased to 35 ml/hour at 1.5 kcal/ml of dilution. This provides 950 kcal/day and 24.7 g of protein/day, with a total fluid intake of 90 ml/kg/day.

The second follow-up was on 21/8/2024 where the plan was to further increase the feeding rate to 40 ml/hour which give the dilution of 1.45 kcal/ml, providing 1055 kcal/day and 27.3 g of protein/day, while maintaining a total fluid intake of 90 ml/kg/day. By the third follow-up on 23/9/2024, the patient continued to tolerate the feeding regimen, prompting a transition from perfusor to bolus feeding. The new regime involved 90 ml per bottle for every three hours, equal to 8 times daily. This provides 1065 kcal/day, 27.6 g of protein/day and 720 ml/day of total fluid.

At the fourth follow-up on 30/9/2024, the patient passed bowel movements 5 times daily (including two episodes of soft stools) without vomiting. A lactose-free formula was introduced at 20 ml/hour via perfusor feeding with plans to increase to 30 ml/hour if gastrointestinal losses stabilized. This regimen provided 1065 kcal/day and 27.6 g of protein/day. By the fifth follow-up on 23/10/2024, the patient was nil by mouth (NBM) and dependent on TPN at 80% maintenance. During the visit in the evening on the same day, the plan was a gradual introduction of feeding with 1 ml of Neocate every 3 hours using standard dilution.

At the sixth follow-up on 5/11/2024, the primary concern was high stoma output, although the patient showed no signs of vomiting. He remained NBM and on TPN in preparation for stoma closure on the same day. Previously, the patient had tolerated 9 ml/hour of Neocate, providing 108 kcal/day and a total fluid volume of 162 ml/day.

CASE REPORT

The patient's latest recorded weight was 7.6 kg, placing him below the 3rd percentile for his age. His highest recorded weight was 8 kg, which, despite being used as the reference weight for nutritional requirement calculations, remains under the 3rd percentile. Since admission, the patient's weight has fluctuated, reflecting the complexities of his medical condition and the challenges in achieving consistent nutritional stability. No recent anthropometric data were available at the time of this follow-up. Recent biochemical investigations revealed a hemoglobin (Hb) level of 16.4 g/dL, indicating a high reading, while the white cell count (WCC) was within normal range at 9.1 x 10^9/L. Renal profile (RP) results showed a low urea level of 3 mmol/L and sodium (Na) at 137 mmol/L, while potassium (K) and creatinine (Cr) were within normal limits at 4.6 mmol/L and 18 µmol/L, respectively. Liver function tests (LFT) highlighted a high total protein (TP) of 89 g/L, though albumin (Alb) was normal at 45 g/L. Electrolyte analysis revealed a low magnesium (Mg) level of 0.82 mmol/L, with calcium (Ca) and phosphate (PO_4) levels within normal limits at 2.58 mmol/L and 1.44 mmol/L, respectively. The high Hb (16.4 g/dL) may reflect hemoconcentration meanwhile the low urea (3 mmol/L) may indicate low protein intake. The Mg level is low (0.82 mmol/L), which may affect gastrointestinal tolerance and neuromuscular function. Sodium, potassium, creatinine, calcium and phosphate are within acceptable ranges. In addition, the albumin level is normal despite high total protein, which may also reflect hemoconcentration. For this patient, electrolyte repletion (Mg) and close trend monitoring alongside feeding advancement are planned.

During the latest follow-up, direct physical examination of the patient was not possible as the patient remained in isolation. Communication with the patient's mother revealed that the patient exhibited poor sucking ability, requiring milk feeding via a Ryle's tube (RT) if unable to finish orally. Input-output (I/O) monitoring showed a positive balance of +366 mL, with a total intake of 1000 mL and output of 634 mL. On 30/9/2024, the patient passed bowel movements 5 times/day (two soft stools). In contrast, during the last 24 hours of this assessment, there was one large bowel movement. In addition, the patient had no episodes of vomiting, and maintained a blood pressure of 108/64 mmHg and heart rate of 131 beats per minute. Oxygen saturation (SpO_2) was recorded at 85% under room air, consistent with the clinical goal to maintain levels above 75%.

TABLE 1 Summary of TPN/EN/Bottle Feeding Across Visits.

Date (2024)	Regimen	Energy (kcal/day)	Protein (g/day)	Fluid	Notes
12/8	Perfusor Catch-up formula 30 mL/h, (3+1)	810	21.0	80 mL/kg/day	Start EN while transitioning off TPN.
13/8	Perfusor 35 mL/h, 1.5 kcal/mL	950	24.7	90 mL/kg/day	Tolerated escalation.
21/8	Perfusor 40 mL/h, 1.45 kcal/mL	1055	27.3	90 mL/kg/day	Continued tolerance
23/9	Bolus 90 mL/bottle, 3 hourly, 8x/day	1065	27.6	720 mL/day	Transition to bolus
30/9	Perfusor Lactose-free formula 20 mL/h (plan to increase to 30 mL/h)	1065	27.6	-	BO 5x/day (two soft stools)
23/10	NBM, TPN 80% maintenance, Trial Neocate 1 mL, 3 hourly	-	-	-	Re-initiate minimal EN
5/11	High stoma output, TPN ongoing, Previously Neocate 9 mL/h	108	-	162 mL/day	High stoma output, day of stoma closure
Current 24 hours	TPN 24 mL/h (445 kcal, 22.8 g protein) + Dugro Sure Plus 1.5 scoops, 8x/day (388 kcal, 10.1 g protein)	833.3	32.9	-	EN:TPN = 47:53 by energy

The patient is currently on a combination of bottle feeding, RT feeding, and TPN, all of which are being well-tolerated. The mother prepares the catch-up formula using a dilution of 2 scoops in 90 ml water which the mother has diluted the milk accordingly as concerned for constipation. She plans to increase the volume to 120 ml per feed using standard dilution, waiting for approval from the medical team. If the patient is unable to finish feeding orally due to fatigue or refusal, the mother will administer the milk via the RT. For the past 24 hours, the patient received TPN at 24 ml/hour, delivering 445.01 kcal/day and 22.8 g/day of protein. Additionally, the patient consumed 1.5 scoops of Dugro Sure Plus mixed with water (30 ml per feed), 8 times daily, providing 388.3 kcal/day and 10.12 g/day of protein. The combined intake from TPN and enteral nutrition (EN) totaled to 833.32 kcal/day (104 kcal/kg body weight/day), meeting 69% of energy requirements. Other than

that, 32.92 g/day of protein (4 g/kg body weight/day), meeting 100% of protein requirements. The current EN-to-PN ratio is 47:53. Solid food intake remains restricted as awaiting assessments by the speech therapist. Table 1 shows the summary of feeding across visits.

NUTRITION DIAGNOSIS

The nutrition diagnosis for this patient in this session was:

[New] Inadequate energy intake related to severe enterocolitis with postoperative recovery (stoma closure) and co-existing HIE leading to increased metabolic demands and feeding limitations, as evidenced by total intake meeting ~ 69% of energy requirements over the last 24 hours (833.3/1200 kcal/day).

NUTRITION INTERVENTION

The primary objectives of the nutrition intervention were to optimize the patient's energy and protein intake to support growth and development, as well as to promote overall growth progression. Based on the patient's best weight of 8 kg, and using the guidelines from *Dorothy E.M. Francis, Diet for Sick Children* (1987), for children aged 1-3 years, the estimated daily requirements for the patient are 1200 kcal/day (150 kcal/kg body weight/day), 24-36 g of protein/day (3-4.5 g/kg body weight/day), and 760 mL of fluid (100 mL/kg body weight/day). To meet these nutritional goals, the feeding plan was adjusted to provide an adequate balance of calories, protein, and fluid.

Firstly, the feeding strategy involves administering 32 scoops of catch-up formula mixed with water, which will provide 960 ml of milk per day. This volume is then divided into 8 bottles, each containing 120 ml of formula to be fed every 3 hours throughout the day. This feeding regimen will provide the patient with 1130 kcal/day (141 kcal/kg body weight/day), which meets approximately 94% of the patient's estimated energy requirements (ER). Additionally, this plan provides 29.44 g of protein/day (3.7 g/kg body weight/day), meeting 100% of the patient's protein requirements. Fluid intake will be 960 ml/day (130 ml/kg body weight/day), which is above the required fluid intake, ensuring adequate hydration.

Secondly, the mother was advised on the importance of using the standard dilution for the formula, as diluting the milk further is not recommended. It was explained to the mother that standard dilution should not cause constipation, addressing her concerns about the patient's bowel movements. This clarification aims to reassure the mother and prevent any future adjustments that may compromise the patient's nutritional intake. Thirdly, the patient was currently awaiting a swallowing assessment, which will determine whether the introduction of solid foods can be considered. If the swallowing assessment is successful, a plan will be made to introduce mixed porridge as part of the diet. However, solid food intake will not be introduced until the speech therapist provides approval, ensuring that the patient's swallowing function is adequately assessed for safety.

Lastly, in the event that the patient can tolerate full enteral feeding and consume the required amounts orally, it is suggested to discontinue TPN. This would further support the patient's long-term growth and nutritional status. If the patient is unable to consume the full amount of milk orally due to fatigue or refusal, the mother is allowed to continue using the RT to ensure that the required amounts of formula are administered. This approach will provide flexibility in feeding while ensuring that the patient receives the full nutritional support needed for recovery and growth. For nutrition monitoring and evaluation, it is important to monitor the patient's feeding tolerance towards the regime planned and his growth progression to ensure there is no decrease in weight.

DISCUSSION

In many cases, enterocolitis is caused by infections that affect the gastrointestinal tract, either through bacterial or viral pathogens. The symptoms of enterocolitis vary, but they typically include abdominal pain, diarrhea, nausea, vomiting, and fever (Sharmin 2023). This could directly affect dietary intake where it causes low appetite and low energy and protein intake. In the case of this patient, enterocolitis is secondary to AGE. The condition was further complicated by septic shock, hyponatremic hypovolemic shock, DIVC, AKI, and a perforated ileum. Intestinal perforation, defined as a loss of continuity in the bowel wall, allows for the leakage of intestinal contents into the abdominal cavity, which could lead to peritonitis, a life-threatening infection of the abdominal lining (Hafner et al. 2023). In the case of a perforated ileum, prompt surgical intervention is required to manage the perforation and prevent further deterioration which is ileostomy. Other medical issues such as severe HIE with early signs of left hemiplegia, MRCONS bacteremia, heart problems and CRE colonizer could also directly or indirectly affect the patient's nutritional status as each issue has their own complications.

Nutritional assessment and intervention are crucial in critically ill patients, as they can significantly impact their recovery. Anthropometric assessment is conducted to evaluate growth progress, including weight gain and height increase. Biochemical data are analyzed to assess electrolyte balance and organ functions, such as liver and

kidney performance. Clinical assessment focuses on identifying nutrition-related symptoms, which in this case include bowel movements and other gastrointestinal functions. Lastly, dietary assessment is performed to evaluate the patient's nutritional intake and ensure it meets their requirements. Lian et al. (2023) highlighted that early nutritional treatment may be vital to the patient's recovery, especially in preventing complications such as surgical site infections. Malnutrition increases the risk of infections and impairs the immune response, making it essential for healthcare providers, especially dietitians, to evaluate and address nutritional needs immediately (Lian et al. 2023). TPN and EN are two ways to optimize nutritional intake among patients with these conditions where gastrointestinal tract functions were affected.

On 23/10/2024, the patient was kept NBM and was administered TPN at 80% maintenance. As Hamdan & Puckett (2023) explains, TPN is designed to provide essential nutrients when enteral feeding is not feasible. The decision to initiate TPN and the formulation of the TPN solution must be personalized based on the patient's diagnosis and nutritional status, to avoid both undernutrition and overnutrition (Hamdan & Puckett 2023). TPN serves as a vital intervention when the digestive system is non-functional or inaccessible and is typically indicated for patients with impaired gastrointestinal function or contraindications to EN (Hamdan & Puckett 2023). It is used to manage and treat malnutrition in critically ill patients when oral or enteral feeding cannot meet the nutritional requirements. Despite its benefits, TPN carries inherent risks such as metabolic disturbances, infections, and mechanical complications, underscoring the importance of careful monitoring during administration (O'Hanlon et al. 2015).

Transitioning from parenteral to enteral feeding is a crucial step in the recovery process, typically given once the patient is stable. However, using both routes simultaneously increases the risk of exceeding nutritional requirements, which can lead to overfeeding and its associated complications (O'Hanlon et al. 2015). While enteral feeding is generally preferred over parenteral nutrition due to its benefits for gut health, full nutritional support through the enteral route is not always achievable in critically ill patients, necessitating the continued use of parenteral nutrition in some cases (O'Hanlon et al. 2015). It is well-documented that prolonged bowel rest due to exclusive TPN use can negatively impact the intestinal mucosa's structure and function, further complicating the patient's condition (Perez Cordon et al. 2022). As such, transitioning to enteral feeding should be done gradually over 48–72 hours, with close monitoring of both caloric and protein intake to prevent overnutrition. This process should continue until the patient is able to tolerate at least 60–75% of their prescribed enteral diet for a minimum of 48–72 hours (Perez Cordon et al. 2022).

In this case, during transitioning from TPN to EN, the dietitian in charge suggested introducing a few products to the patient which are Neocate and Peptamen Junior. Neocate is a semi-elemental, infant formula (0-12 months old) administered for special medical purposes for diet management of severe or complex cow's milk allergy, multiple food protein allergy and other indications where an amino acid is recommended. On the other hand, Peptamen Junior is a peptide-based enteral nutrition product (1-10 years old) for diet management of gastrointestinal impairment. Peptide-based formulas were recommended as they are easier to digest and improve immune function, help to enhance nutritional status and reduce complications in critically ill patients (Lian et al. 2023).

CONCLUSION

This case emphasizes the importance of effective nutrition management, particularly when gastrointestinal conditions compromise a patient's ability to meet their nutritional needs. Complications such as reduced appetite, irregular bowel movements, or vomiting can significantly impact nutritional status, often requiring the use of EN to achieve dietary goals. In some cases, TPN becomes essential to fulfill unmet nutritional requirements. Transitioning from TPN to EN presents its own challenges, such as deciding on the appropriate product, determining the optimal quantity, and setting the duration of administration. This process must be personalized to meet the unique needs of each patient, as no two cases are alike. Continuous monitoring and adjustments based on the patient's current condition are vital to ensure successful nutritional management. Moreover, this effort requires a collaborative approach involving various healthcare professionals, including dietitians, doctors, and nurses, to address the patient's overall health and recovery comprehensively. By implementing a well-coordinated plan, patients can receive the nutrition they need to support their recovery and improve their quality of life.

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