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Use of parenteral nutrition in term and late preterm infants: an Australian and New Zealand survey

Kwi Moon[1,2,3]*, Shripada Rao[2,4], Sanjay Patole[2,5] and Karen Simmer[2,3]

[1]*Perth Children's Hospital, Pharmacy Department, Nedlands, WA, Australia*
[2]*The University of Western Australia, Medical School, Perth, WA, Australia*
[3]*Telethon Kids Institute, Nedlands, WA, Australia*
[4]*Perth Children's Hospital, Department of Neonatology, Nedlands, WA, Australia*
[5]*King Edward Memorial Hospital, Department of Neonatology, Subiaco, WA, Australia*

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Abstract

There is limited information regarding the use of parenteral nutrition (PN) in term and late preterm infants. We conducted a survey to study the current clinical practices within Australia and New Zealand (ANZ). A fifteen-question online survey was distributed to 232 neonatologists and fifty-five paediatric intensivists across ANZ between September and November 2019. At least one neonatologist from twenty-seven out of thirty tertiary neonatal intensive care units responded (90 %). Responses were received from sixty-nine neonatologists (30 %) and seven paediatric intensivists (13 %). The overall response rate was 26 % (76/287). Thirty-three percent (25/76) commenced PN within 24 h of admission, 27 % (20/75) between 24 and 48 h, 24 % (18/75) between 48 and 72 h, 9 % (7/75) between 72 and 96 h and 4 % (3/75) between 96 h and 7 days. None of the respondents commenced PN after 7 d of admission. Sixty-one percent (46/75) aimed for 1·5–3 g/kg per d of parenteral amino acids, whereas 27 % (20/75) aimed for 2–3 g/kg per d. Renal failure (59 %; 38/64) and high plasma urea (44 %; 28/64) were the major indications for withholding/decreasing the amino acid intake. Eighty-three percent (63/76) aimed for a dose of 2·5g–3·5 g/kg per d of parenteral lipids; about 9 % (7/76) targeted a dose of 1–2·5 g/kg per d and 4 % (3/76) for > 3·5 g/kg per d. Thirty-two percent (24/74) reported that they would withhold/decrease the dose of parenteral lipids in infants with sepsis. The variations in clinicians' practices with respect to the use of PN in term and late preterm infants highlight the need for high-quality research in this population.

Key words: **Parenteral nutrition: Amino acids: Lipids**

During periods of acute illness in term and late preterm infants born after 34 weeks of gestation, provision of sufficient enteral nutrition (EN) is unachievable, which necessitates the use of parenteral nutrition (PN) with amino acids, lipids and micronutrients.

In very preterm infants (gestation < 32 weeks), the standard practice is to commence PN within 24 h of birth[1–6]. However, there is a lack of evidence regarding the optimal time to commence PN in term and late preterm infants. It is inappropriate to extrapolate the nutritional practices of very preterm infants to late preterm and term infants.

Early parenteral amino acids may have beneficial effects in preventing catabolism, reducing hyperglycaemia and improving growth and neurodevelopmental outcomes[1,7] but may lead to hyperammonaemia, azotaemia[8], metabolic acidosis, free radical injury[9] and slower growth of head circumference[7]. Early parenteral lipids can prevent essential fatty acid deficiency, increase long-chain PUFA (LCPUFA) levels and have the potential to improve neurodevelopmental outcomes[3,10]. However, parenteral lipids may increase the risk of oxidative stress[9], sepsis, respiratory distress and bilirubin encephalopathy[3,7].

A subgroup analysis in the paediatric multicentre randomised controlled trial (RCT) (2018) that evaluated early *v.* late PN in term infants concluded that early commencement of PN was associated with worse short-term clinical outcomes[11]. However, a recent Cochrane review (2020) has concluded that the evidence in this field was limited and the overall quality was low on GRADE analysis[7]. Furthermore, there are significant differences between the ESPGHAN and NICE guidelines in this area[1,2], highlighting the urgent need for further research.

Whilst there are published surveys on PN practice in neonates[12,13], they are not specifically focused on term and late

Abbreviations: EN, enteral nutrition; NICU, neonatal intensive care units; PN, parenteral nutrition; PICU, paediatric intensive care units; RCT, randomised controlled trial.

* **Corresponding author:** Kwi Moon, email kwi.moon@health.wa.gov.au

preterm infants. Therefore, we conducted a survey to describe the current practice of clinicians regarding the timing of commencement of PN in term and late preterm infants in the neonatal (NICU) and paediatric intensive care units (PICU) in Australia and New Zealand. In addition, we collected information about other aspects of PN practices such as target doses for parenteral amino acids and lipids and contraindications/precautions. We also invited clinicians' opinions on what they consider would be the optimal time to commence PN in this population.

Methods

We developed a fifteen-question web-based questionnaire using Research Electronic Data Capture (REDCap) to collect information on the clinicians' practice regarding the: (1) timing of commencement of PN; (2) target doses of parenteral amino acids and lipids and (3) indications for ceasing and withholding/decreasing the administration of parenteral amino acids and lipids in term and late preterm infants. We also collected clinicians' opinion on the optimal time to commence parenteral amino acids and lipids. See Table 1.

The questions in the survey were piloted among three neonatologists at Perth Children's Hospital to ensure that they were easy to understand and respond. The piloting also gave us confidence that the survey process works well without any glitches.

Feedback and comments were reviewed, and the wordings of questions were updated to minimise ambiguities. The number of questions was reduced to minimise the burden on busy clinicians invited to participate in the survey.

Neonatologists and paediatric intensivists practising in Australia and NZ were invited to participate in this online survey using the mailing lists of the Australia and New Zealand Neonatal Network (ANZNN) and the Australian and New Zealand Intensive Care Society (ANZICS) between 24 September 2019 and 26 November 2019. The email invitation contained a link to the online-survey questionnaire built in REDCap. In the email invitation, participants were informed about the research purpose and the estimated time to complete the survey. It was conveyed that proceeding with the survey indicates consent to participate and their responses will be anonymous and confidential. Furthermore, it was clarified that all survey responses will be aggregated and not used outside the needs of the current study.

All participants were assigned a unique study identification number on completion of the questionnaire, and the data collected were de-identified to maintain their confidentiality. Two reminder emails were sent at 3-week intervals to those who had not responded. Survey responses were exported into a Microsoft Excel spreadsheet and analysed using descriptive statistics.

The study was approved by the Human Research Ethics Committee of Child Adolescent Health Service, Western Australia (EC00268; approval number-RGS 1468) and conducted according to the CHERRIES recommendations[14].

Results

Demographics

A total of 232 neonatologists and fifty-five paediatric intensivists were invited to participate in this online survey. At least one neonatologist from twenty-seven out of thirty tertiary NICU responded (90 %). A total of sixty-nine neonatologists (30 %) and seven paediatric intensivists (13 %) responded resulting in an overall response rate of 26 % (76/287).

Responses were obtained from neonatologists practising in New South Wales (NSW) ($n = 19$), NZ ($n = 13$), Victoria ($n = 12$), Queensland (QLD) ($n = 9$), Western Australia (WA) ($n = 12$) and South Australia ($n = 3$). Two paediatric intensivists from WA, two from QLD and three from NSW responded. One participant submitted an incomplete response.

Timing of commencement of PN

Thirty-three percent (25/76) commenced PN within 24 h of admission, 27 % (20/75) between 24 and 48 h, 24 % (18/75) between 48 and 72 h, 9 % (7/75) between 72 and 96 h and 4 % (3/75) between 96 h and 7 d of admission. None of the respondents commenced PN after 7 days of admission. One respondent was unsure of the practice. While infants were not on PN, trace elements and vitamins were not routinely given by the majority of respondents (93 %; 70/75).

Parenteral amino acid administration

Sixty-one percent (46/75) followed ESPGHAN/ESPEN/ESPR/CSPEN guidelines[1] of administering 1·5–3 g/kg per d amino acids and 27 % (20/75) followed ASPEN guidelines[15] of administering 2–3 g/kg/d amino acids. Eight respondents (11 %) were unsure about their practice and one (1·3 %) reported using local guidelines developed by the dietitian.

Renal failure (59 %; 38/64) and plasma urea level > 15 mmol/l (44 %; 28/64) were the most common reasons for withholding or decreasing parenteral amino acids. Twenty percent (13/64) and 5 % (3/64) of respondents indicated withholding or decreasing parenteral amino acids for urea levels between 10–15 mmol/l and 7–10 mmol/l, respectively. Thirteen percent (8/64) withheld/decreased parenteral amino acids during sepsis. Four respondents commented that they rarely withhold or decrease parenteral amino acids in term and late preterm infants.

Parenteral lipid administration

Eighty-three percent (63/76) aimed to achieve 2·5 g–3·5 g/kg per d of lipids; about 9 % (7/76) targeted a dose of 1–2·5 g/kg per d and 4 % (3/76) targeted a dose > 3·5 g/kg per d.

Thirty-two percent (24/74) indicated that they would withhold or decrease the dose of parenteral lipids during sepsis.

Twenty percent (15/74) of the respondents reported withholding or decreasing lipid emulsions if plasma triglyceride (TG) levels were >5 mmol/l. Twelve percent (9/74) and 8 % (6/74) also indicated withholding or decreasing parenteral lipids for TG levels between 3·5 and 5 mmol/l and < 3·5 mmol/l, respectively. Five respondents (7 %) commented that they

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Table 1. Parenteral nutrition practice survey questions

Questions	Multiple choice options
1. What is your profession?	a. Neonatologist b. Paediatric intensivist
2. Your unit admits term and/or late preterm infants with-	a. Medical conditions only b. Surgical conditions only c. Medical and surgical conditions
3. At what point of an admission do you commence parenteral amino acids in term and late preterm infants in whom enteral nutrition (EN) is contraindicated or not tolerated?	a. ≤ 24 h b. > 24 h and ≤ 48 h c. > 48 h and ≤ 72 h d. > 72 h and ≤ 96 h e. > 96 h (4 d) and ≤ 7 d f. > 7 d g. Don't know
4. At what point of an admission do you commence parenteral lipids in term and late preterm infants in whom EN is contraindicated or not tolerated?	a. ≤ 24 h b. > 24 h and ≤ 48 h c. > 48 h and ≤ 72 h d. > 72 h and ≤ 96 h e. > 96 h (4 d) and ≤ 7 d f. > 7 d g. Don't know
5. During the time parenteral nutrition (PN) is NOT administered, do you provide micronutrients such as trace elements and vitamins in addition to glucose/Na-containing IV fluids?	a. No b. All the time, regardless of enteral nutrition intake c. Only when minimal enteral feeds d. Don't know
6. When do you stop parenteral amino acids in term and late preterm infants?	a. If EN provides 100 % target nutrition b. If EN provides > 80 % of target nutrition c. If EN provides > 50 % of target nutrition d. Don't know e. Others If 'e.' selected: When do you stop parenteral amino acids in term and late preterm infants?
7. When do you stop parenteral lipids in term and late preterm infants?	a. If EN provides 100 % target nutrition b. If EN provides > 80 % of target nutrition c. If EN provides > 50 % of target nutrition d. Don't know e. Others If 'e.' selected: When do you stop parenteral amino acids in term and late preterm infants?
8. Parenteral amino acid target intake for term and late preterm infants that you follow is closest to the following guideline.	a. ASPEN (2–3 g/kg/d) b. ESPGHAN 2018 (1·5–3 g/kg/d) c. National Recommended Daily Allowances (RDA) d. Don't know e. None of the above If 'e.' is selected: What is your parenteral amino acid target intake for term and late preterm infants?
9. When do you withhold or decrease parenteral amino acids in term and late preterm infants receiving PN? You may tick more than one box.	Urea 7–10 mmol/l Urea 10–15 mmol/l Urea > 15 mmol/l Renal failure Sepsis Others If selected 'others': What circumstances do you withhold or decrease parenteral amino acids in term and late preterm infants receiving PN?
10. What is your parenteral lipid emulsion target intake for term and late preterm infants receiving PN?	a. ≤ 1g/kg/d b. > 1 g and ≤ 2·5 g/kg/d c. > 2·5 g/kg/d and ≤3·5g/kg/d d. > 3·5 g/kg/d d. Don't know f. None of the above If selected 'e.', what is your parenteral lipid emulsion target intake for term and late preterm infants receiving PN?
11. When do you withhold or decrease parenteral lipid emulsion administration in term and late preterm infants receiving PN? You may tick more than one box	Triglycerides > 5mmol/l Triglycerides 3·5–5 mmol/l Triglycerides < 3·5 mmol/l Sepsis

Table 1. (*Continued*)

Questions	Multiple choice options
	None of the above Other If selected 'Other', what circumstances do you withhold or decrease parenteral lipid emulsions in term and preterm infants receiving PN?
12. What parenteral amino acid strategy do you think is optimal for late preterm and term infants?	a. Early commencement (within 24 h of admission) b. Late commencement (after 72 h of admission) c. Very late commencement (after one week of admission) d. No parenteral amino acids are required e. Others If selected 'e.': Describe the strategy for parenteral amino acid management that you believe is beneficial for term and late preterm infants.
13. What parenteral lipid emulsion strategy do you think is optimal for late preterm and term infants?	a. Early commencement (within 24 h of admission) b. Late commencement (after 72 h of admission) c. Very late commencement (after one week of admission) d. No parenteral amino acids are required e. Others If selected 'e.': Describe the strategy for parenteral lipid emulsion management that you believe is beneficial for term and late preterm infants.
14. Do you have anything to add to this survey?	
15. In what state/country do you practise?	a. New South Wales b. Victoria c. Queensland d. ACT e. South Australia f. Tasmania g. Western Australia h. Northern Territory i. New Zealand

would withhold or decrease parenteral lipids if TG > 2·8 mmol/l. Furthermore, 12 % (9/74) commented that they visually assessed the blood samples for lipaemia rather than being guided by TG levels. Thirtytwo percent (31/74) selected 'none of the above' indicating that the TG levels used for the multiple choice options and sepsis were not the reasons for withholding or decreasing parenteral lipids. Three respondents commented that they never withheld/decreased parenteral lipid emulsions.

Cessation of parenteral amino acids and lipids

A majority of respondents (83 %; 62/75) ceased parenteral amino acids when EN reached more than 80 % of the target intake, while 7 % ceased parenteral amino acids when EN reached 50 % of the target nutrition. Six respondents commented that parenteral amino acids were ceased when EN intake is 100–120 ml/kg per d.

A majority of the respondents (75 %; 56/74) ceased parenteral lipids when EN provided > 80 % of the target nutrition, while 13 % (10/75) ceased parenteral lipids when EN provided > 50 % of the target nutrition. Five respondents commented that they will cease parenteral lipids when EN intake is 100 to 120 ml/kg per d.

Clinicians' opinions on optimal time to commence parenteral amino acids and lipids

Forty three percent (32/74) thought that commencing parenteral amino acids 'within 24 h of admission' is beneficial, while 32 % (24/74) felt that late commencement 'after 72 h' is optimal for term and late preterm infants. None of the respondents thought 'after 7 days of admission' was the optimal time to commence amino acids. See Fig. 1.

Forty one percent (31/75) thought that commencement of parenteral lipids 'within 24 h of admission' is optimal, whereas 35 % felt late commencement 'after 72 h' to be beneficial. Only one respondent thought 'after 7 days of admission' was an optimal time to commence lipids. See Fig. 1.

Other strategies were suggested by 20 % (15/75) of the respondents. They included commencing parenteral amino acids/lipids between 48 and 72 h, between 24 and 72 h, after 120 h or based on an individual clinical scenario.

Discussion

The results of our survey show variations in clinicians' practices and beliefs with respect to the use of PN in term and late preterm infants in Australia and NZ, reflecting the lack of high-quality evidence in this area.

In Australia and New Zealand, standardised indications for preterm infants < 32 weeks are available[16]. Whilst there are no established guidelines for late preterm and term infants,

PN is widely used in Australian hospitals in these infants who are not fed enterally[16].

We found that PN was generally commenced either on day 1, 2 or 3 of admission in term and late preterm infants which was different to the results of Tan et al[12]. In their survey of forty-five

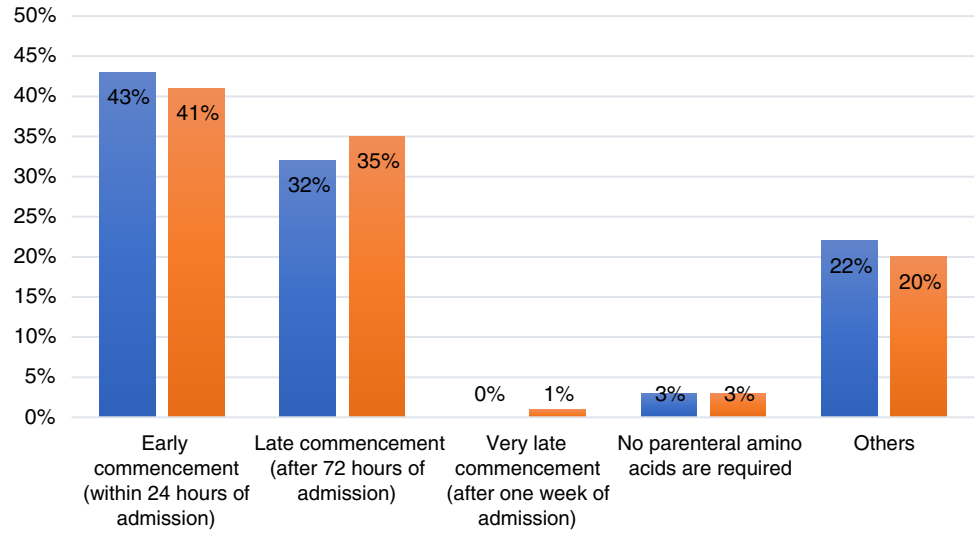

Fig. 1. Clinicians' opinions on optimal time to commence parenteral amino acids and lipids. ■, Parenteral amino acids; ■, Parenteral lipids

units across Australia, New Zealand, Malaysia and India, Tan et al found that >75 % of infants (birth weight > 1500 g) were commenced PN between day 3 and day 7[12]. In the worldwide survey of twenty-five PICU/NICU involving critically ill children and term infants, Kerklaan et al.[13] found that 55 % of respondents commenced PN 'early' (i.e. within 48 h of admission), which was comparable with our results. Subsequent to the survey, a large multicentre paediatric RCT (RCT: PEPaNIC)[17] concluded that withholding PN for 7 d was clinically superior than providing early PN (< 24 h of admission). The late PN group had lower odds of infection, shorter duration of mechanical ventilation, shorter duration of PICU and hospital stay[17]. When another worldwide survey was conducted by van Puffelen et al[18], 1 year after the publication of the PEPaNIC trial[17], only five units (12 %) reported changing their practice from early to late commencement of PN[18]. Although the short timeframe between the publication of the RCT and the survey may be the main reason for the low rate of change in clinical practice, concerns about the risk of hypoglycaemia and the perceived limited external validity of the PEPaNIC trial may also have prevented clinicians from changing their clinical practice[19–22]. Experts have suggested that results of the PEPaNIC trial should be interpreted with caution and recommended against extrapolating its results to all critically ill patients[19–22]. They pointed out issues such as heterogeneity of the study population with regard to age and diagnoses, lack of standardised nutrition and glucose management protocols across study sites, potential overuse of PN irrespective of the nutritional status of the patients, use of inadequately validated malnutrition assessment tools and the possibility of caloric overfeeding in the early PN group due to the use of equations to estimate caloric requirements[19–22]. Furthermore, in the previous surveys[12,13], no subgroup analysis for term and late preterm population was undertaken. Hence, it is difficult to compare their results with ours.

A recent Cochrane review has evaluated the benefits and safety of early *v.* late PN in critically ill term and late preterm infants[7]. The only RCT (*n* 209 term infants)[11] included in this systematic review was from the subgroup of neonates from the PEPaNIC trial[17]. The results showed that 'Late PN' group had significantly lower risk of 'In-hospital all cause- mortality' (RR 0·35, 95 % CI 0·14, 0·87), but there were no significant differences in health care-associated infections, growth parameters and duration of hospital stay between the early and late PN groups. Neurodevelopmental outcomes were not reported[7]. The quality of evidence was considered low on GRADE analysis. The authors concluded that there is insufficient evidence in this area[7].

The uncertainty about the evidence on the optimal time to commence PN is reflected in the different opinions expressed by clinicians participating in our survey. A substantial and similar proportion of respondents advocated for either early ('within 24 h of admission') or late commencement of PN ('after 72 h of admission'). Furthermore, none of the respondents believed in delaying the commencement of parenteral amino acids until 7 d. Only one clinician preferred delaying parenteral lipids by more than 1 week. These results suggest that such extremes in the timing of commencement of PN are unlikely to be appealing to clinicians if proposed in future neonatal RCT. Moreover, the latest recommendations from international guidelines on the timing of commencement of PN for term infants are conflicting and add to the challenges faced by clinicians. The NICE guidelines recommend commencement of PN within 72 h after birth if no progress is made in term and late preterm infants[2]. In contrast, the ESPGHAN/ESPEN/ESPR/CPEN guidelines recommend clinicians to consider withholding parenteral amino acids for 1 week in critically ill term infants[1] and do not provide recommendations on the timing of parenteral lipids[3]. Both guidelines acknowledge that their recommendations are based on limited evidence and that further research is needed. We are currently conducting a small RCT comparing early *v.* late PN in term and late preterm infants (ACTRN12620000324910) to address this issue.

The target doses of parenteral amino acids in term and late preterm infants amongst our survey respondents were in

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accordance with the recommendations from the international guidelines. Most respondents reported using the ESPGHAN/ESPEN/ESPR/CPEN[1]and ASPEN recommendations of maximum 3 g/kg per d of parenteral amino acids[15]. This is somewhat different to the Tan et al survey results, which reported that 74 % of respondents used 3·5 to 4·5 g/kg per d of amino acids in infants > 1500 g[12]. Our findings are comparable to the survey by Kerklaan et al who reported that a majority of paediatric intensive care specialists (67 %) across 156 PICU followed the ASPEN and ESPEN/ESPGHAN guidelines[13].

The amino acid intake of 1·5g–3 g/kg per d is an estimated amount necessary for term infants to achieve positive nitrogen balance and growth that are similar to breastfed full term infants[1]. While there is a general consensus on the dosing of parenteral amino acids, there are only two small RCT comparing different amino acid dose strategies (i.e. high *v.* low amino acids) in term and late preterm infants[23,24]. Whilst both studies found that amino acid doses did not affect liver function, they did not report on important clinical outcomes such as mortality, growth and neurodevelopment.

In our survey, the target dose of parenteral lipids in term and late preterm infants was between 2·5–3·5 g/kg per d for majority of respondents. Our results were similar to Tan et al.[12], who reported that 95 % of clinicians administered parenteral lipids at a maximum dose of 3 g/kg per d. In the worldwide survey of PICU, lipids were predominantly used at a dose of 1·5–2·5 g/kg per d. Our results are in line with the international consensus guidelines that recommend parenteral lipid intake of maximum 4 g/kg per d[2,3,15].

To prevent deficiency of essential fatty acids, 0·5–1 g/kg per d of lipid emulsion is required[3]. An intake of parenteral lipids at the upper limit (3–4 g/kg per d) quoted in the guidelines have been used safely in RCT involving preterm infants[2]. There are three RCT comparing high *v.* low-dose lipids in neonates[25–27] but only one has included late preterm and term infants[25]. In that pilot RCT, thirty-six infants (> 36 weeks GA) with gastrointestinal disorders were randomised to 1 g/kg per d or 3 g/kg per d of parenteral soya bean-based lipids. No differences in the incidence of cholestasis were reported after the first 7 d[25].

In our survey, the most common reasons for withholding parenteral amino acids were renal impairment and high plasma urea levels. These findings are similar to results of the survey and observational studies involving PICU[13,28].The current international guidelines do not provide guidance on when and how to adjust the dose of parenteral amino acids in the context of renal impairment, other comorbidities and biochemical derangements[1,2,15]. Furthermore, there are no specific guidelines for infants with acute kidney injury (AKI). The current practice of decreasing or withholding parenteral amino acids in the context of renal impairment may be due to perceived concerns about potential protein intolerance and accumulation. Nevertheless, some authors suggest that children with AKI are in a state of 'protein energy wasting', where wasting of lean body mass and depletion of fat mass occur[29,30]. Protein turnover is thought to be high with a redistribution of amino acids from skeletal muscle to liver and other tissues involved in the inflammatory response, leading to increased blood urea nitrogen production and a net negative nitrogen balance[29,30]. Hence, in times of AKI, infants may not benefit from withholding amino acid intake. Future clinical studies should investigate optimal parenteral amino acid strategies for term and late preterm infants with renal impairment.

Our results show that plasma urea levels are used as a biomarker in clinical practice. A substantial proportion of clinicians in our survey preferred withholding parenteral amino acids at various levels of elevated plasma urea levels, demonstrating their concerns about potential toxicity associated with excess parenteral amino acids. However, currently, there is no evidence suggesting such an association in term and late preterm infants.

Our survey revealed that parenteral lipids were withheld during an episode of sepsis by approximately one-third of respondents. Such practice may be due to the concerns associated with soybean oil-based lipid emulsions that are rich in *n*-6 fatty acids, the precursors of arachidonic acid metabolised to proinflammatory prostaglandins and leukotrienes, which may worsen the outcomes in sepsis[31–33]. On the other hand, olive oil-based lipid emulsions that are rich in the monounsaturated fatty acids with lower amounts of *n*-6 fatty acids are thought to be immune neutral[34]. Composite intravenous lipid emulsions (ILE) such as SMOF (30 % soybean oil, 30 % MCT, 25 % olive oil and 15 % fish oil) provide alternative ILE that are rich in *n*-3 fatty acids and associated with potential anti-inflammatory and immunomodulatory benefits[35].

Given their potential benefits, alternative ILE (e.g. CLinOleic and SMOF) are currently the preferred ILE in Australia and New Zealand NICU[35]. However, the recent Cochrane review reported that there was no significant difference in incidences of sepsis between infants receiving fish oil and non-fish oil-bases ILE[36].

Various cut-off levels of plasma TG were reported in our survey for monitoring lipid intolerance and adjusting parenteral lipid administration. Some neonatologists reported visual inspection of the blood sample for lipaemia rather than monitoring the TG levels. Our findings were different to the survey by Kerklaan et al in which a majority (69 %) of paediatric intensivists decreased ILE when TG were 3·5–5·5 mmol/l[13]. The current ESPGHAN guidelines recommend reducing the dose of ILE if TG level are > 3 mmol/l in infants or > 4·5 mmol/l in older children[3]. The NICE guidelines recommend daily monitoring of TG levels while increasing the dose of lipids or when the infant is at risk of hypertriglyceridaemia[2]. They also recommend weekly monitoring of TG levels for infants on maintenance ILE. Whilst studies in very preterm infants found that growth, morbidities and neurodevelopment outcomes may not be affected by hypertriglyceridaemia (level > 2·8mmol/l)[37,38], effects of TG levels or hypertriglyceridaemia on clinical outcomes in term and late preterm infants are unclear[3].

The main strength of our survey is that we identified the actual clinical practices of neonatologists and paediatric intensivists by obtaining individual responses rather than focusing on their unit's policy/guidelines. As highlighted by Kerklaan et al., applied nutritional practices may deviate from local protocols and hence hospital guidelines may not be the true representation of the actual practice[13]. The limitation of our survey was the low response rate. Although at least one neonatologist from

twenty-seven out of thirty tertiary NICU responded, the overall response rate of 26 % is low and hence further variations in practices may be occurring across NICU and PICU in Australia and NZ. Another limitation of our survey was that we did not ask questions related to indications for PN.

Conclusions

The results of our survey highlight the variations in PN practices in term and late preterm infants admitted to the NICUs and PICUs in Australia and NZ, especially on the timing of commencement and indications for withholding/stopping PN highlighting the urgent need for high quality research in this area.

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