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RESEARCH ARTICLE

Drug utilisation study of parenteral nutrition in neonate patients

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Abstract

Background: The neonatal period is an individual adaptation with a higher risk of death and complications. Using parenteral nutrition to meet nutritional imbalances in neonates requires close supervision to prevent complications caused by inappropriate administration. **Objective:** This study aims to examine the effectiveness of parenteral nutrition (PN) in weight changes, patient caloric balance, osmolarity, and side effects. **Methods:** This study used a prospective observation method and was carried out from April to June 2023 at Universitas Airlangga Hospital. Data were obtained through medical records and direct observation of the patient's condition after the patient's parents signed an informed consent. Data analysis was carried out descriptively. **Results:** PN was given centrally or peripherally to 71 patients. Of those, 21 were low birth weight patients. Caloric balance was achieved in almost all patients. All patients gained weight, although only 20.89% experienced a return to birth weight. Phlebitis occurred in 35.22% of patients. **Conclusion:** Parenteral nutrition is efficacious in increasing the patient's weight, depending on the suitability of the calculation between calories needed and calories obtained and the osmolarity of the preparation.

Introduction

The newborn period is a period of adaptation to life outside the womb, generally lasting up to one month after birth. According to UNICEF (2023), cases of death in children younger than one-month-old reached 2.3 million deaths globally. In Indonesia, cases of death in neonates reached 16.85/1,000 births (Ministry of Health, 2022). Death in neonates can be caused by failure to adapt organ systems and tissues that are still developing and not functioning optimally. Several factors can also affect the development and growth of infants, one of which is the type of birth.

In the neonatal period, the fulfilment of nutritional needs is generally obtained through breast or formula milk. However, in some neonates, nutrition is given parenterally and is a substitute for breast milk. According to the National Institute for Health and Care Excellence (2022), parenteral nutrition (PN) is the provision of nutrition directly through the blood vessels through either the peripheral or the central veins. Nutritional needs can be addressed through macronutrients (fats, proteins, and amino acids) and micronutrients (vitamins, electrolytes, and minerals) found in parenteral nutrition (Planus *et al.,* 2007). PN is considered in neonates in some conditions, such as premature births, necrotising enterocolitis, sepsis, or infection (Hendarto & Nasar, 2016). PN is optimal when used correctly and according to the patient's condition. Inadequate nutrition has been shown to increase the risk of complications up to death (Widiasa *et al.,* 2016). This study examines calorie adequacy, osmolarity, body weight changes, and side effects in neonates receiving parenteral nutrition.

Methods

Design

This prospective, observational study of parenteral nutrition drug utilisation in neonate patients was conducted at Universitas Airlangga Hospital from April to June 2023.

Data were collected daily and obtained through patient medical records, PN prescriptions, direct observation of the condition of patients treated in the neonatal intensive care unit (NICU), and perinatology. Data included patients' demographic features (age, sex, diagnosis, date of admission to NICU, date of discharge from NICU, and date of PN insertion), physical data (height and weight), caloric needs, length of stay, and duration of nutrition. PN side effects were directly recorded every day. Additionally, nurses reported patient conditions and laboratory results.

Assessment

The patients' caloric balances were adjusted according to their caloric needs; prematurely-born patients needed 80-100 kcal/kg, and full-term patients required 50-80 kcal/kg. Calorie intake was calculated from the macronutrient composition of PN, breast milk, and formula milk received by the patient. Protein contains 4 kcal/g, carbohydrates contain 3.4 kcal/gram, 20% lipid contains 11 kcal/gram, and 10% lipid contains 10 kcal/gram. Appropriate caloric needs are considered met if caloric intake matches caloric needs. Calorie intake (PN) was calculated using the formula:

$$Volume\ (mL) \times\ kcal/mL*$$

$$\left(\frac{(\text{Total Volume}-\text{retention})}{\text{Total Volume}} \times 100\%\right) \times\ \text{Total Volume}\ \times\ \text{Kcal}$$

*used if there's no retention in patient

The suitability of the route of administration was calculated based on the osmolarity of PN. PN with an osmolarity below 900 mOsm/l was administered peripherally, while PN with an osmolarity above 900 mOsm/l was given centrally. Osmolarity becomes a reference to determine the appropriateness of the PN administration route. Based on the American Society for Parental and Enteral Nutrition, osmolarity was calculated as follows:

$$\frac{\left(\frac{\text{volume (mL)}}{1000}\text{x osmolarity}\right)}{\text{Total Stock Volume}}\text{X } 1000$$

Patient weight changes could be seen during the administration of PN. Researchers directly observed side effects. Nurses/midwives reported patient conditions and laboratory results.

Data were calculated using Excel and then analysed descriptively.

Results

The total number of neonatal patients at Universitas Airlangga Hospital until June 2023 reached 71, with 37 patients treated in the NICU and 34 in perinatology. Table I describes patients' characteristics during the study period. PN was administered for various indications, which could occur more than once in each patient. The highest indication was low birth weight, with 21 patients (29.57%) receiving PN for this indication. Other indications included premature birth, patients with respiratory system disorders, and patients with infections (Table I).

Table I: Patients' characteristics

Patients' characteristics	N	Percentage (%)
Location		
NICU	37	52.11
Perinatology	34	47.89
Parenteral nutrition administration age (Days)		
0	41	57.74
1-7	23	32.39
8-14	5	7.07
15-21	1	1.40
22-28	1	1.40
Gender		
Male	34	47.89
Female	37	52.11
Gestational age		
Preterm (≤ 37 weeks)	28	39.44
Term (>37–41 weeks)	43	60.56
Breast milk feeding/Milk formula feeding*		
Milk formula	29	40.84
Breastfeeding	47	59.16
Indications		
Low Birth Weight (LBW)	21	29.57
Neonatal pretem	12	18.30
Very low birth weight	5	7.04
Patent Forume Ovale (PFO)	9	12.67
PDA	7	9.86
Atrium Septum Disease (ASD)	8	11.26
Heart failure	2	2.81
Respiratory disease syndrome	14	19.71
Asphxyia	12	16.90
Infection	13	18.30
Sepsis	5	7.04
Hyperbilirubine	7	9.86
Hypoglicemia	6	8.45

*Patient can get more than one

Caloric needs were determined based on the patient's condition, type of birth, and body weight. Neonates with respiratory problems and premature births require higher calories than those with normal births. Calorie intake through PN contributed to the patients' growth, as evidenced by the changes in their body weight. All patients gained weight during PN administration. However, within 1-7 days, changes in body weight related to birth weight occurred in 11 patients (16.41%) only, and within 8-14 days, this change occurred in three patients (4.47%) (Table II).

Table II: Calorie balance and weight changes in patients (n=71)

Gestational age	Mean (Min–Max)		Balance	Imbalance
	Calorie need (Kcal/kg)	Calorie supply (Kcal/kg)		
Preterm	97.56 (60.5 – 146)	137.07 (62 – 339)	21	7
Term	147.24 (75 – 236)	153.99 (71.6 - 280)	37	6
Weight change	**Duration of parenteral nutrition administration**			
	1–7 days	**8–14 days**	**(not change)**	
Weight gain	59	8	4	
Return to birth weight	11	3	57	

Of the total sample, 61 patients received PN peripherally, while five received it centrally either by umbilical venous catheter (UVC) or axially. Changes in the administration route occurred once in four patients and more than once in one patient, likely due to a change in the PN component, leading to changes in the osmolarity (Table III).

Table III: Suitability of administration route in patients based on osmolarity

Location	Administration route	n = 71	%	Mean (Min–Max)		Conformity with baseline
				Initial osmolarity (mOsm/l)	Final osmolarity (mOsm/l)	
NICU - Perinatology	Peripheral	61	85.91	528.77 (212-965.9)	579.54 (212-885)	**Yes**
NICU	Central	5	7.04	536.7 (501.4-663.7)	949.51 (805-1251)	**Yes**
	Central to peripheral	2	2.81	885 (854.6-915.67)	659.9 (639.2-680.6)	**Yes**
	Peripheral to central	2	2.81	655 (505-805)	756.76 (599-914.53)	**Yes**
	Peripheral to central to peripheral	1	1.40	212	212	**No**

Table IV: Complications in neonate patients

Complications*	N	Percentage (%)
Cholestatic jaundice	15	22.53
Phlebitis	25	35.22
Abdominal distention	2	2.81
Infection	2	2.81
Hypoglycemia	1	1.40
Sepsis	2	2.8

*Patients could have more than one

The most prevalent complication was phlebitis, which occurred in 25 neonates (35.22%) who received PN peripherally. Phlebitis manifestations included redness, inflammation (swelling), discolouration of the hands or feet, and increased body temperature. Cholestatic jaundice occurred in 15 patients (22.53%), evidenced by a yellow colouration of the skin or eyes (jaundice) and increased laboratory values (Table IV).

Discussion

In this study, PN was administered to patients around 1-7 days after birth, with most patients receiving breast

milk simultaneously with PN. Low birth weight was the predominant indication for PN, highlighting the increased nutritional needs in neonates with this condition. Respiratory disorders, such as respiratory disease syndrome (RDS) and asphyxia, were the second most common indication among neonates receiving PN. These conditions could stem from factors like prematurity, maternal comorbidities, and experiencing organ failure during adaptation (Herman & Tri Joewono, 2020).

Caloric balance was achieved when the calories provided met or exceeded the caloric needs of the neonates. However, seven premature and six full-term patients experienced caloric imbalance in the present study. The calculation of caloric intake involved breast milk, formula, and direct breastfeeding with the same volume for patients. Neonates' caloric balances are influenced by the components they receive, including lipids. Several studies have highlighted the importance of administering lipids carefully due to the increased risk of phlebitis (Angelina, 2016).

In this study, all the patients gained weight during the administration of PN, but changes in body weight at birth weight only occurred in 14 patients. In contrast, 51 patients did not return to their birth weight. Return to birth weight in 4-7 days has been previously described (Wright & Parkinson, 2014). Diarrhea and spitting up/vomiting could have affected changes in body weight.

The appropriateness of administration routes for PN was based on PN osmolarity. PN solutions with an osmolarity exceeding 900 mOsm/l had a higher concentration level, making them more suitable for the central route, where blood vessels are more prominent (Worthington *et al.,* 2017).

Some patients had their administration routes changed to reduce their risk of phlebitis and infection (Indrati *et al*., 2021). Reasons for changing the administration route include complications, such as inflammation or infection, or preventing side effects. The administration was monitored daily for both peripheral and axillary routes. The treatment was carried out once every three days.

The two most encountered complications in patients were phlebitis and cholestatic jaundice. In neonates, complications can occur more than once. Phlebitis was the most frequent complication, occurring in 25 patients. It was manifested by skin colour changes and swelling accompanied by an increased temperature and redness. Factors influencing the risk of phlebitis included the type of fluid, administration route, and duration of PN administration (Yuningsih *et al.,* 2020).

Cholestatic jaundice is characterised by a change in skin colour and increased BUN, SGPT, and SGOT values, as evidenced by laboratory test results. An increase in the amount of dextrose in PN is suspected to cause cholestatic jaundice in patients (Götze *et al.,* 2015).

Conclusion

Parenteral nutrition effectively increased the patients' weight when suitable calculations were made between calories needed, calories provided, and the osmolarity of the preparation. Phlebitis is a suspected complication that may arise in patients receiving PN. Further research is necessary to determine the factors that can help achieve the return to birth weight and the incidence of phlebitis.

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