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Conditions requiring parenteral nutrition in high-risk newborns

Condições que demandam nutrição parenteral em recém-nascidos de risco

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ABSTRACT

Introduction: Some at-risk newborns (NBs) face complications that make enteral feeding unfeasible, especially those admitted to the neonatal intensive care unit (NICU). In these cases, parenteral nutrition (PN) is essential to provide adequate nutritional support for development until they can progress to exclusive oral feeding.

Objective: To evaluate the causes and conditions that require PN in at-risk newborns, describe their clinical characteristics, and analyze the complications resulting from this type of nutrition.

Method: A cross-sectional and retrospective study, carried out by collecting data from medical records of all newborns who used PN in the neonatal ICU during the year 2022.

Result: Of the 686 hospitalized at-risk newborns, 20% used PN for a median time of 8 days. The causes and indications for its use were classified into 4 categories: 1) prematurity; 2) malformations of the gastrointestinal tract; 3) major operations; 4) adynamia. Regarding complications, there were 18 cases of cholestasis and 18 cases of catheter infection. Eighteen newborns on PN died. The cost of the PN solution in the neonatal ICU was approximately 7 times higher than that of enteral feeding.

Conclusion: The conditions that require PN in high-risk newborns can be grouped into: prematurity, malformations of the gastrointestinal tract, major surgeries, and conditions of gastrointestinal adynamia. The 2 main complications observed were cholestasis and catheter infection.

KEYWORDS: Parenteral nutrition. Neonatal intensive care units. Prematurity.

Central message

Parenteral nutrition is essential to meet the nutritional needs of at-risk newborns in neonatal ICUs, particularly those with extreme prematurity or severe clinical conditions. Thus, parenteral nutrition provides the necessary nutrients when enteral feeding is not viable. Therefore, identifying the conditions that lead to this need is essential to improve neonatal care and reduce possible complications.

Perspective

It is essential that health professionals and hospital managers recognize the importance of adequate parenteral nutrition and its correct implementation. In addition, investing in training and protocols for its use can ensure that vulnerable newborns receive the necessary nutrition, promoting healthy development.

RESUMO

Introdução: Parte dos recém-nascidos (RN) de risco enfrentam complicações que inviabilizam a alimentação com dieta enteral, especialmente os internados em unidade de terapia intensiva (UTI) neonatal. Nesses casos, a nutrição parenteral (NP) é essencial para fornecer o aporte nutricional adequado ao desenvolvimento até que consigam evoluir para alimentação oral exclusiva.

Objetivo: Avaliar as causas e condições que demandam NP em RN de risco, descrever suas características clínicas e analisar as complicações decorrentes desse tipo de nutrição.

Método: Estudo com delineamento transversal e retrospectivo, realizado através da coleta de dados de prontuários de todos os RN que utilizaram NP em UTI neonatal durante o ano de 2022.

Resultado: Dos 686 RN de risco hospitalizados, 20% fizeram uso de NP por tempo mediano de 8 dias. As causas e indicações para o seu uso foram classificadas em 4 categorias: 1) prematuridade; 2) malformações do trato gastrointestinal; 3) grandes operações; 4) adinamia. Quanto às complicações, ocorreram 18 casos de colestase e 18 de infecção do cateter. Dezoito RN em NP evoluíram para óbito. O custo da solução de NP na UTI neonatal foi cerca de 7 vezes maior do que seria aquele da alimentação enteral.

Conclusão: As condições que demandam NP em RN de risco podem ser agrupadas em: prematuridade, malformações do trato gastrointestinal, grandes operações, condições de adinamia gastrointestinal. As 2 principais complicações observadas foram colestase e infecção do cateter.

PALAVRAS-CHAVE: Nutrição parenteral. Unidades de terapia intensiva neonatal. Prematuridade.

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INTRODUCTION

Of all newborns (NB), a high proportion has complications that justify hospitalization in the neonatal intensive care unit (ICU). They are called newborns at risk, with multiple morbidities. The vital processes demanded by the organism of the newborn at risk require an adequate amount of nutrients and energy for the development of their systems.[1,2] However, for multiple reasons, it is not possible to administer nutrients orally or enterally in a significant part of these children.[3,4] When such situations occur, the method of ensuring that the newborn receives adequate nutritional intake is parenteral nutrition (PN), alone or concomitantly with enteral nutrition.[5] It must contain carbohydrates, amino acids, lipids, vitamins and minerals, that is, it must be nutritionally complete. The early use of PN helps the NB to maintain adequate nutritional status, until the enteral route becomes viable for 100% of the nutritional needs. Inappropriate use, or non-use, of PN can promote short- or long-term growth or development deficits in childhood.[6-8]

It is likely that there is a long list of indications for the administration of PN in at-risk NB, and of the various organic conditions that make exclusive enteral nutrition unfeasible for some time. It seems important that neonatologists and intensivists who care for NB at risk have the opportunity to evaluate an epidemiological overview of the conditions that demand PN, whether malformations of the gastrointestinal tract, major surgeries, prematurity and other situations that promote enteral food intolerance.

The present study aimed to evaluate, in a reference hospital for high-risk pregnant women, the neonatal conditions that require PN in newborns at risk in neonatal ICU, to describe their clinical characteristics, the complications resulting from the use of PN and to estimate the costs of this method of neonatal nutrition.

METHOD

This was a cross-sectional and retrospective study, with analysis of the electronic medical records of NBs from the Obstetric and Neonatal Center of the Mackenzie Evangelical University Hospital (HUEM) in Curitiba, PR, Brazil, who required PN during some time of their hospitalization in the neonatal ICU between January 1 and December 31, 2022. The research project obtained a favorable opinion from the Human Research Ethics Committee of the Mackenzie Evangelical College of Paraná.

All at-risk NB of both sexes who started receiving PN solution infusion were included. The electronic medical record of each person who had received PN in 2022 was thoroughly reviewed in order to tabulate data from several categorical and continuous variables related to the patient's general characteristics, establish the probable reasons that led to the indication of PN, and the possible complications of its use.

Statistical analysis

The data compiled were tabulated in an Excel spreadsheet. Categorical variables were presented as numbers, percentages, and 95% confidence intervals (95%CI). Continuous variables were presented as mean and standard deviation, or median and interquartile range (IQR).

RESULT

In 2022, 686 newborns required admission to the neonatal ICU, of which 140 (20.4% - 95%CI 17.[4] to 23.4%) used PN for some time. The median time of PN use was 8 days, ranging from 1 to 93 days (IQR 5 - 16 days). Table 1 lists the quantitative variables of the 140 NB at risk who received PN. Table 2 lists the categorical variables analyzed.

TABLE 1 – Quantitative variables analyzed in the 140 newborns at risk submitted to PN

Quantitative variables	Mean (SD)	Median	IIQ I - III
Gestational age (weeks)	33,1 (4)	33	31 - 37
Birth weight (g)***	1.892 (837)	1.775	1298 - 2411
Height at birth (cm)	40,6 (6,1)	41	36,5 - 44
APGAR 1st min	5,8 (2,5)	7	4 - 8
APGAR 5th min	7,8 (1,9)	8	8 - 9
NP Usage Time (days)	13,7 (15)	8	5 - 16
Length of stay (days)	50 (41,1)	37	22 - 65

*IQR I – lower interquartile range, which is equivalent to the 25th percentile of the sample; **IQR III – upper interquartile range, which is equivalent to the 75th percentile of the sample; The birth weight range was from 505g to 4235g.

TABLE 2 – Categorical variables analyzed in the 140 newborns at risk submitted to PN

Categorical variables	n (%)	95% CI
Cesarean delivery	103 (73,6%)	66.3 to 80.9%
Male	74 (52,8%)	44.6 to 61.1%
Respiratory failure	134 (95,7%)	92.4 to 99.1%
Mechanical ventilation	98 (70%)	62.4 to 77.6%
CPAP*	112 (80%)	73.4 to 86.6%
Antibiotics	139 (99,3%)	-
Blood transfusion	94 (67,1%)	59.4 to 74.9%
Sepsis	34 (24,2%)	17.2 to 31.4%
Other infections**	85 (60,7%)	52.6 to 68.8%
Central catheter	120 (85,7%)	79.9 to 91.5%
Death	18 (12,9%)	7.3 to 18.4%

* CPAP: Continuous positive airway pressure; ** Other infections: other infectious clinical conditions, other than sepsis, early or late.

Of the 140 patients who received PN, 103 (73.6%) were born preterm (gestational age <37 weeks). Considering that the PN indication protocol differs according to the range of prematurity, Table 3 presents the prematurity classification of the patients included in the study.

TABLE 3 – Classification of prematurity in 103 of the 140 NB submitted to PN

Gestational age	n (%)	95%CI
<32 weeks*	48 (34,3%)	26.4 to 42.1%
32-34 weeks**	41 (29,3%)	21.7 to 36.8%
35 and 36 weeks***	14 (10%)	5.0 to 15.0%

* PN was offered to newborns with gestational age <32 weeks before the first 24 h of life, until enteral feeding of 100 mL/kg/day was reached; ** NP was administered to individuals with a gestational age of 32 to 34 weeks on the first day of life, trying to insert enteral diet concomitantly, until good acceptance of enteral diet was established (around 80 ml/kg/day); PN was administered to newborns with gestational age >34 weeks until the 5th day of life when there was an aggravation that promoted food intolerance.

Table 4 presents the causes and conditions associated with the use of PN in the 140 patients. The major indications of PN in newborns at risk were grouped into 4 main conditions: 1) high prematurity; 2) malformations of the gastrointestinal tract that would prevent enteral nutrition; 3) large operations that make enteral nutrition unfeasible for some time; 4) conditions that induce adynamic ileus or enteritis, due to potential wall ischemia or hypoxia, dysbiosis, bacterial overgrowth, or intestinal infection (a condition often called food intolerance).

TABLE 4 — Causes and conditions associated with the use of PN in the 140 patients (includes patients who had 2 or more causes and conditions)

Causes	n=140	%
Birth weight <1500g*	49	35%
Prematurity <32 weeks*	48	34,3%
Severe respiratory failure**	91	65%
Sepsis**	34	24,2%
Food intolerance***	30	21,4%
Perinatal anoxia**	19	13,5%
Major surgery*****	18	12,8%
Severe congenital heart disease**	15	10,7%
GIT malformation****	13	9,3%
Necrotizing enterocolitis**	11	7,8%
GIT infection**	8	5,7%
Meconium ileus	1	0,7%
Short bowel syndrome	1	0,7%

* Prematurity <32 weeks and birth weight <1500 g are primary conditions that require the protocol use of PN, indicated until the newborn is able to reach enteral feeding of 100 ml/kg/day; **clinical conditions that can cause ischemia or oxygen deficiency in the intestinal wall, inducing adynamic ileus, making enteral feeding impossible, and promoting bacterial overgrowth in the small intestine (necrotizing enterocolitis is the most severe form of this pathophysiological condition); denomination when it is unfeasible to continue feeding the newborn enterally due to gastric stasis, vomiting, abdominal distension or difficulty in evacuation (this situation is often caused by the same conditions described above, in **); malformations of the gastrointestinal tract that prevented enteral nutrition, most of them requiring major operations: congenital megacolon (n=4); gastroschisis (n=4); esophageal atresia type C (n=3); laryngomalacia (n=1); diaphragmatic hernia (n=1); Major operation: situations in which, in the postoperative period, enteral feeding becomes unfeasible for some time, operation to correct digestive malformation (n=10); cardiovascular surgery (n=4); gastrointestinal surgery due to complications of necrotizing enterocolitis (n=3); extensive thoracic surgery due to pulmonary malformation and pneumonectomy (n=1).

Complications associated with PN were cholestasis in 18 cases (12.9% - 95%CI 7.[3] to 18.4%) and catheter infection in 18 cases (12.9% - 95%CI 7.3 to 18.4%), all by the Gram-positive Staphylococcus epidermidis bacteria. Death occurred in 18 cases (12.9%), of which 16 had infections (9 of them with sepsis), 7 with birth weight less than 1,000 g, 1 with gastrointestinal malformation and several surgeries, 1 with a major corrective procedure for congenital heart disease, and 3 with malformations (renal, chromosomal disease, genetic syndrome).

Considering the value of R$ 0.10 per calorie and the administration of 100 kcal/kg/day, for the 140 patients with a mean weight of 1,892 g and a mean PN time of 13.7 days, it can be estimated that the costs of parenteral nutrition (without considering the catheter and other related equipment) were R$ 36,288.00. In comparison, if these patients had received enteral nutrition in that period, the expense would have been R$ 5,443.00.

DISCUSSION

In this study on the use of PN in 140 NB at risk in a large neonatal ICU, it was possible to group the causes and conditions that demanded PN into 4 major categories: 1) newborns with prematurity of 34 weeks or less (n=89); 2) GIT malformations that prevented enteral nutrition for some time (n=13); 3) major operations that prevented enteral nutrition for some time (n=18); 4) conditions that induced gastrointestinal adynamia and required the establishment of a period of enteral fasting, due to ischemia or hypoxia of the intestinal wall, dysbiosis, or intestinal bacterial overgrowth, caused by extreme prematurity, respiratory failure, severe infection, congenital heart disease (the vast majority of the 140 patients in PN had this condition, but the extreme form was necrotizing enterocolitis, which occurred in 11 cases, 3 of which required intestinal operation). One patient suffered the classic and severe form of prolonged PN requirement known as intestinal failure, due to short bowel syndrome, secondary to intestinal malrotation and massive necrosis. The 4 major categories of conditions that demand NP in the RN at risk, classified above, are not watertight. Certainly, in most cases, the NP indication fit into 2 or more categories.

Prematurity is associated with very peculiar anatomical and physiological characteristics. The younger the gestational age, the more difficult the neurological, respiratory, circulatory, and dietary functions, and the greater the risks of bacteremia and infection. The nutritional goal in premature newborns is to achieve postnatal growth at a rate that is comparable to the growth and intrauterine weight gain of a normal fetus of the same gestational age, avoiding nutritional deficiencies, metabolic complications or toxicity due to the exaggerated nutritional supply.[9,10] In the present study, 74% of the patients were born prematurely. Studies carried out in Ceará and Pernambuco, Brazil, documented a high proportion of prematurity among at-risk NB receiving PN. [11,12] In the present study, a large proportion of the NB using PN were born with GIT malformations, or required major surgeries. One patient was born with meconium ileus, 3 required laparotomy for severe necrotizing enterocolitis, and 1 suffered massive intestinal necrosis due to intestinal malrotation. The considerable demand for GIT operations in the NICU is also documented in other publications.[11,12]

Situations of food intolerance, in which the neonatologist establishes a period of fasting and administration of PN, are very common in critically ill patients in the neonatal ICU. It is quite common for such situations, caused by ischemia or anoxia of the intestinal wall, bacterial overgrowth, intestinal dysbiosis, to course with gastrointestinal adynamia, gastric stasis, vomiting, abdominal distension or bleeding in the stool as an immune response to intestinal dysbiosis.[13] It has often happened that such cases are treated with a specific food formula for cow's milk protein allergy, even though this type of allergy is very rarely present in newborns at risk. The comorbidities of the high-risk NB described in the present study are the real responsible for the symptoms of food intolerance.[14,15]

Almost all of the NB studied were affected by respiratory failure for some time, of which 73% required mechanical ventilation and 83% CPAP. A fifth were affected by sepsis, and 61% by other infections. The vast majority (99%) received prophylactic antibiotics or dressings.

Complications of PN are classically divided into 3 groups: mechanical or technical, metabolic, and infectious. Mechanical complications may be related to PN infusion, which may cause extravasation in the pericardium, peritoneum, and may also be linked to the catheter, causing pneumothorax, hemothorax, vascular lesions, air embolism, local and systemic infections, and superficial phlebitis.[16,17] Metabolic complications may be related to the type of nutrient administered, and there may be deficiency or elevation of the plasma level of certain substances, in addition to hepatic involvement and cholestasis.[16,17] In the present study, the review of medical records did not allow the reliable detection of possible mechanical or technical complications. However, 18 cases of PN-associated cholestasis and 18 cases of catheter-associated infections were confirmed. The longer the time of administration of PN, the greater the occurrence of infectious complications. As for infections, what differs from the literature is the type of bacteria found, since the predominance of S. aureus is documented, while in this study S. epidermidis was highlighted.[16] It was not possible to attribute the 18 deaths as a direct complication of PN, as they were patients with several very severe primary clinical conditions.

Regarding the cost of PN, it should be taken into account that it is used in a small proportion of hospital patients and for a limited time, when compared to enteral nutrition. Even so, studies show that total hospital expenditure on PN is 2.[2] times higher than that of enteral nutrition. In fact, the cost of PN solution in the patients evaluated in the present study was estimated to be about 7 times higher than the amount that would be spent on enteral formula in the period in which each patient received PN.[18]

As a limitation of this research, the obtaining of data from the neonatal ICU discharge records is highlighted, which makes reasonable heterogeneity inevitable in the way of describing and documenting the various clinical signs, symptoms or procedures. Despite this, it was surprising how much the reports in the medical records of at-risk NBs end up being filled out in a rich way in detail, compared to the medical records of patients from other hospital sectors. A striking peculiarity was the fact that, unlike most hospitals with a maternity sector, the hospital in this study is a referral center for high-risk pregnant women, with an expectation of a higher probability of morbidities that justify admission to the neonatal ICU, and neonatal mortality. The task of determining a single cause for the use of PN in each patient becomes complex, as several NB seem to present multiple factors that require the administration of parenteral nutrition.

The small number of scientific studies published on PN in at-risk NB reinforces the importance of the research presented here, which sought to improve knowledge about the main indications for parenteral nutrition, its complications and its cost.

CONCLUSION

In 2022, the administration of PN was performed in 20% of the total number of newborns hospitalized in the neonatal ICU of a hospital that receives high-risk pregnant women. The conditions analyzed that required the use of PN were: 1) newborns with prematurity of 34 weeks or less (n=89); 2) malformations of the gastrointestinal tract that prevented exclusive enteral nutrition (n=13); 3) major operations that prevented exclusive enteral nutrition (n=18); 4) conditions, commonly called food intolerance, which induced gastrointestinal adynamia and forced the establishment of a period of enteral fasting, due to ischemia or hypoxia of the intestinal wall, dysbiosis, or intestinal bacterial overgrowth (they course with gastric stasis, abdominal distension, vomiting, streaks of blood in the feces, and in its extreme form necrotizing enterocolitis). The most common complications associated with PN were catheter infection and cholestatic syndrome.

Author´s contributions

Gabriella Mara Arcie: Conceptualization, Writing (original draft)
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João Arthur Sachser Rocha: Conceptualization, Writing (original draft)
Aristides Schier da Cruz: Project administration, Writing (original draft), Writing (review and editing)
Thaís Ariela Machado Brites: Investigation, Writing (original draft)

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