The correlation between invasive care procedures and the occurrence of neonatal sepsis

A correlação entre procedimentos assistenciais invasivos e a ocorrência de sepse neonatal

Flávia do Valle Andrade Medeiros[1]
Valdecyr Herdy Alves[1]
Cristina Ortiz Sobrinho Valete[1]
Eny Dórea Paiva[1]
Diego Pereira Rodrigues[1]

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Sepsis; Infant, newborn; Infant, very low birth weight; Intensive care units, neonatal; Maternal-child nursing

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Abstract

Objective: To correlative the invasive care procedures applied to very-low-birth-weight infants with the occurrence of neonatal sepsis.

Methods: Retrospective, longitudinal cohort study undertaken through the investigation of secondary data between 2008 and 2012. The infants' characteristics were analyzed by means of the Mann-Whitney test (means) and the chi-square test to compare frequencies. All variables with significance of $p<0.20$ in the bivariate analysis were included in a logistic regression model.

Results: The data demonstrated fourteen infants with an episode of late sepsis. The mean gestational age was 30 weeks. Female gender and cesarean birth were the most frequent. The birth weight and the use of an arterial umbilical catheter explained the occurrence of sepsis, offering an 8.5 times higher risk for the outcome.

Conclusion: Vascular accesses need start insertion and handling techniques to improve the health indicators.

Resumo

Objetivo: Correlacionar os procedimentos assistenciais invasivos realizados nos recém-nascidos de muito baixo peso com a ocorrência de sepse neonatal.

Métodos: Estudo de coorte retrospectivo, longitudinal, por meio de pesquisa de dados secundários, durante os anos de 2008-2012. As características dos recém-nascidos foram analisadas pelo teste de *Mann-Whitney* (médias) e o teste do qui quadrado para comparação de frequências. Todas as variáveis com significância de $p<0,20$ na análise bivariada compuseram um modelo de regressão logística.

Resultados: Os dados demonstraram quatorze recém-nascidos com episódio de sepse tardia. A idade gestacional média foi de trinta semanas. Gênero feminino e parto cesáreo foram os mais frequentes. O peso de nascimento e o uso do cateter umbilical arterial explicaram a ocorrência de sepse, tendo este oferecido 8,5 vezes maior risco para o desfecho.

Conclusão: Acessos vasculares necessitam rigor nas técnicas de inserção e manuseio para a melhoria dos indicadores de saúde.

Corresponding author
Diego Pereira Rodrigues
Miguel de Frias street, 9,
24220-900, Niterói, RJ, Brasil.
diego.pereira.rodrigues@gmail.com

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[1]Universidade Federal Fluminense, Rio de Janeiro, RJ, Brazil.

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Introduction

Most very-low-birth-weight (VLBW) infants are preterm and constitute a heterogeneous group, in the age range between 28-29 weeks and 32-33 weeks of gestational age.[1] The occurrence of infection is higher in this target population due to intrinsic (related to immaturity in the development of the immunological system and inefficient skin and mucosa barriers) and extrinsic (exposure to hospital environment, manipulation by the health team, antibiotics, parenteral nutrition and invasive devices) risk factors.[1,2]

The use of invasive procedures is one of the main extrinsic risk factors for infection in very-low-birth-weight infants. Nevertheless, these are essential to support these patients' lives.[1,3,4] The strict execution techniques of these procedures and compliance with asepsis standards, in combination with appropriate staff numbers during care need to be taken into account in the practices at the neonatal intensive care units (NICU).[4] In that sense, the access to the VLBW infants' vascular network through central catheters and mechanic pulmonary ventilation, necessary for the preterm infants' life support, have been considered the main factors responsible for the occurrence of healthcare associated infections (HAI), with high rates at the NICU.[1,5-8]

Neonatal sepsis is defined as a systemic response to infection, characterized by a clinical syndrome with different manifestations.[9,10] It can be classified as early (probably of maternal origin with symptoms in the first 48 hours of life) and late (probably of hospital origin).[9] Its presence is diagnosed through at least one of the following symptoms: 1) Apnea, bradypnea, whimpering, tachypnea, sternal and subcostal retractions, vacillation of nose wings and cyanosis; 2) Thermal instability (hypothermia <36.5º and hyperthermia >37.5º); 3) Hypotonia and convulsions; 4) Irritability and hypoactivity/lethargy; 5) Gastrointestinal symptoms, such as abdominal distension, vomiting, gastric residue and difficulty to accept food; 6) Idiopathic jaundice; 7) Cutaneous pallor, cold, sweaty skin, hypotension and capillary filling time of more than three seconds; 8) Glucose intolerance; 9) Signs of bleeding with condition suggesting disseminated intravascular coagulation; 10) Subjective assessment: Infant who "does not look well".[9]

Therefore, studies are needed to correlate the care procedures with the occurrence of neonatal sepsis. This could contribute to the enhancement of care. The objective in this study was to correlate the invasive care procedures applied to very-low-birth-weight infants with the occurrence of neonatal sepsis.

Methods

Quantitative, retrospective, longitudinal cohort study, undertaken through the investigation of secondary data at a federal university hospital in the city of Niterói, State of Rio de Janeiro, Brazil. The data were collected between November 2013 and November 2014 and systemized in the medical archives, using the files of the very-low-birth-weight infants, and at the Hospital Infection Control Committee (HICC), using the epidemiological surveillance forms.

The hospital's neonatal service consists of a neonatal intensive care unit, offering seven beds, and the neonatal intermediary care unit (NIU), offering eight beds. During the study period, in total, 486 infants were hospitalized at the services, according to the records in the hospitalization management system. As a referral institution for high-risk pregnancies, the infants commonly need intensive care due to premature birth, low birth weight, malformation or problems associated with the mothers' obstetric alterations, entailing a long stay at the NICU until they reach conditions to be discharged home. This fact results in low turnover and, consequently, a small number of hospitalizations at the service.

All very-low-birth-weight infants (weight between 1,000g and up to 1,500g) took part in the study, who were admitted between 2008 and 2012 and registered in the HICC's Nosocomial Infection Surveillance System (NISS) diagnosed

with neonatal sepsis. All VLBW infants presented sepsis. These criteria resulted in a sample of 49 infants. The Centers for Disease Control and Prevention (CDC) created the NISS system in the United States in the 1970's to develop a national database for voluntary reporting that would guarantee infection control in the participating hospitals.[11]

The following inclusion criteria were adopted: weight between 1,000 and 1,500g; registered in the HICC's NISS due to neonatal sepsis; born at the study hospital between 2008 - 2012; submitted to invasive care procedure at the delivery room and/or neonatal intensive care unit; admitted to the NICU immediately after birth. The exclusion criteria were: VLBW infants transferred, coming from other hospital services; admitted to the NIU or Rooming-In unit soon after birth before the NICU.

The invasive care procedures studied were: Arterial and Venous Umbilical Catheterization, Peripherally Inserted Central Catheter (PICC), Peripheral Venous Access, Orotracheal Intubation and Bladder Catheterization. The selection was based on a Specific Manual of the Brazilian National Health Surveillance Agency (ANVISA) and are associated with the definitions of neonatal infection by topography, detailed in this manual, comprising: Primary Infections of Clinical Bloodstream and with microbiological confirmation, HAI of Respiratory Tract, Central Nervous System Infections, Urinary Tract Infections and Gastrointestinal System Infections.[9]

To treat the data, the statistical software Stata version 6.0 (StataCorp) was used. In the bivariate analysis of the infants' characteristics and the occurrence of sepsis, the difference of means (Mann-Whitney test) and the frequencies were compared (chi-square test), resulting in the presence or not of neonatal sepsis. In the bivariate analysis of the invasive procedures applied to the infants and the occurrence of sepsis, the frequency differences were compared (chi-square test). Multivariate analysis was developed (logistic regression). The independent variables were: the characteristics of the very-low-birth-weight infants and the invasive procedures. The dependent variable was the occurrence of early or late sepsis. All variables with significance of $p<0.20$ in the bivariate analysis were candidates for inclusion in the logistic regression model. Variables with $p<0.10$ were maintained in the model.

According to ANVISA, Early Neonatal Sepsis of probable maternal origin was defined as sepsis that occurs within the first 48h of life and related to maternal, gestational and childbirth factors. Late Neonatal Sepsis was defined as the infectious process manifested in infants after 48h of life.[9] The VLBW infants studied were divided in three groups: infants who only developed an episode of early sepsis, infants who presented only late sepsis and infants who presented both – early sepsis and late sepsis. For the sake of comparisons, the early sepsis group was separated from the others (late and early and late), as it is known that the procedures interfere in the occurrence of late but not in early sepsis.

Approval for the study was obtained from the Research Ethics Committee at University Hospital Antônio Pedro, Universidade Federal Fluminense, and was registered in Brazil under the Platform Presentation of Certificate number for Ethics Assessment (CAAE) 13565613.9.0000.5243.

Results

The 49 very-low-birth-weight infants in the study were classified according to the type of sepsis they developed: Early Sepsis, corresponding to 71.4% (n=35), Early and Late Sepsis, corresponding to 16.3% (n=8) and Late Sepsis, equal to 12.2% (n=6).

The characteristics of the VLBW infants and the occurrence of sepsis have been displayed in table 1. These were distributed in two groups, according to the sepsis they presented: early or other sepsis (including infants who only presented late sepsis and infants who presented both early and late sepsis). Early sepsis corresponded to n=35 and other sepsis (late or both) n= 14.

Table 1. Characteristics of infants according to diagnosis of sepsis (early x others)

Characteristic	Early sepsis (n=35)	Other sepsis* (n=14)	p-value
Mean gestational age (weeks)	30	30	0.75†
Mean birth weight (grams)	1,160	1,060	0.03†
Female gender (n)	19	8	0.85#
Cesarean birth (n)	27	10	0.67#
Appropriate for gestational age (n)	27	9	0.35#
Death (n)	3	2	0.55#

*Early and late sepsis and late sepsis; †Mann-Whitney test; #chi-squared test

In table 2, the relation is displayed between the invasive care procedures performed and the occurrence of sepsis. Upper airway aspiration (UAA) was performed in 34 infants (69%) and orotracheal intubation (OTI) in 14 (28%), both at the delivery room. OTI at the NICU was performed in 18 (37%) infants, arterial umbilical catheterizations in five (10%), venous umbilical catheterization in 13 (26%), peripherally inserted central catheter (PICC) in 40 (81%), peripheral venous access in 43 (88%) and indwelling bladder catheterization in only one (2%) infant.

Table 2. Invasive care procedures applied to infants according to diagnosis of sepsis (early x other)

Characteristic	Early sepsis (n=35)	Other sepsis* (n=14)	p-value#
Airway aspiration at delivery room	26	8	0.24
Tracheal intubation at delivery room	9	5	0.48
Tracheal intubation at ICU	11	7	0.22
Arterial umbilical catheter	2	3	0.10
Venous umbilical catheter	9	4	0.83
Use of PICC	27	13	0.20
Peripheral venous access	30	13	0.05

*early and late sepsis and late sepsis; #chi-square test; Peripherally Inserted Central Catheter (PICC); Intensive Care Units (ICU)

Birth weight, arterial umbilical catheter and peripheral venous access were selected to construct a logistic regression model adjusted for gestational age and gender. The results of this regression can be analyzed in table 3.

Table 3. Logistic regression model of factors associated with the occurrence of late sepsis or both - early and late

Variables	*Odds Ratio*	p-value	95% CI
Birth weight (grams)	1.00	0.046	1.000143 - 1.016384
Arterial umbilical catheter	8.52	0.078	1.087546 - 92.26034

Adjusted model for gestational age and gender

Discussion

Neonatal sepsis is mentioned as the topography of reported Healthcare Associated Infection with the highest incidence rate.[12,13] During the five years studied, early sepsis of probable maternal origin stood out with the highest frequency (n=35), being cited in other studies as one of the most common diagnoses at the neonatal intensive care unit and probably related to prenatal care defects.[9,13,14] No epidemiological evidence was found in this study or in the literature to support the increased risk of late sepsis after early sepsis in surviving infants when compared to infants without early sepsis, despite the longer hospitalization, need for invasive care procedures to treat the infection and greater risk of death.[15]

Among the infants who developed hospital infections, those who only experienced an episode of late sepsis represented n= 6, against n = 8 for infants who developed late sepsis after an episode of early sepsis (developed both – early and late), totaling 14 infants with reported episodes of late sepsis, much lower than the number of early sepsis cases.

This finding differs from what is commonly shown in studies that analyze the occurrence of infection at NICU, where the late sepsis rates tend to be higher and the affected very-low-birth-weight infants commonly need longer hospitalization and more invasive procedures, resulting in an increased incidence of complications like bronchodysplasia and intracranial hemorrhage.[5,7,16,17] At the NICU where the study was developed, figures for late sepsis were less expressive.

Nevertheless, independently of the frequency of healthcare-associated infections in infants, the invasive care procedures remain important causes of barrier rupture, facilitating the invasion of pathogenic agents.[18] Venous accesses stand out as HAI and associated with cases of sepsis.[4,12,16-18] In this study, the birth weight (p= 0.03), peripheral venous access (p= 0.05) and arterial umbilical catheter (p= 0.10) showed higher significance rates with p< 0.20, being included in the logistic regression model adjusted to gesta-

tional age and gender. In the final model, however, birth weight and arterial umbilical catheter remained as independent factors, the latter being an important determinant in the occurrence of late sepsis.

Birth weight is a strong factor associated with the risk of sepsis in preterm infants due to the peculiar immunological immunity, being inversely proportional.[4,7,16,19] In this study, a strong association and greater risk for sepsis were found.

The study[13] that observed sepsis as the main notification shows that the prevalent infection associated with invasive devices is related to the central venous catheter, with the umbilical catheter showing a high incidence density. The VLBW infants using parenteral nutrition, who are strongly exposed to the NICU environment, to the colonization of the non-inserted distal catheter tip due to handling by the health team professionals and contact with the microbiota of their own skin, represent important risk factors, as mentioned in different studies that observed high rates of blood infections associated with central venous catheters.[4,8,13,17-19]

In this study, the arterial umbilical catheter was 8.5 times more associated with the occurrence of late sepsis, in line with other association studies between hospital infections and venous catheters.[17,19] The blood infections related to the use of venous catheter are reported to be the most common at the NICU, and mostly result from technical errors in the installation and care for the insertion site and in catheter handling.[20]

The occurrence of late neonatal sepsis and its relation with the NICU environment and the invasive procedures the infants are submitted to have been widely discussed in studies undertaken in the large urban centers of Brazil and internationally.[5,7,8,17,19,21] This concern targets improvements in the quality of care for low-weight infants, reducing the sequelae of clinical problems provoked by intense infection processes and death rates.

The entire health team is responsible for preventing HAI in care delivery at the NICU. Prevention and control measures continuously reduce the chances of contaminations. The implementation of a "care bundle at the NICU" have revealed to be an effective strategy, through an evidence-based intervention group and recommendations from manuals, adopting a multifaceted approach to reduce the incidence of healthcare-associated sepsis.[21] In addition, the intensive and continuing education of the entire health team effectively reduces the HAI[22], contributing to improve the neonatal health indicators.

Conclusion

Independently of all late infections at the neonatal intensive care unit, the care routine delivered to intensive care-dependent infants calls for attention in the prevention of infections and control the environment and practice of health team professionals.

Particularly the vascular accesses reached higher frequencies, demanding stricter control of infections originating in routine practice. The systemization of care in the prevention and control of healthcare-associated infection could be achieved using the "care bundle" as technology in care for infants, allied with continuing in-service education. Thus, the enhanced quality would reduce the infection rates, contributing to the survival of very-low-birth-weight infants. Nevertheless, the benefits are the infants, their families, the NICU health team and the institution, through a less stressful hospitalization and lower spending on therapies against severe infections.

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Collaborations

Medeiros FVA, Alves VH, Valete COS, Paiva ED and Rodrigues DP declare that they contributed to the conception of the project, interpretation of the data, relevant critical review of the intellectual content and approval of the final version for publication.

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