

Karla Dal-Bó<sup>1</sup>, Rosemeri Maurici da Silva<sup>2</sup>, Thiago Mamôru Sakae<sup>1</sup>

## Nosocomial infections in a neonatal intensive care unit in South Brazil

*Infecção hospitalar em uma unidade de terapia intensiva neonatal do Sul do Brasil*

1. Master's Program in Health Sciences, Universidade do Sul de Santa Catarina - Unisul – Tubarão (SC), Brazil.  
2. Program in Health Sciences Coordinator, Universidade do Sul de Santa Catarina - Unisul – Tubarão (SC), Brazil.

### ABSTRACT

**Objective:** The aim of this study was to describe the incidence and epidemiology of nosocomial infection in newborns who were admitted to a neonatal intensive care unit in a hospital in south Santa Catarina, Brazil.

**Methods:** A prospective cohort study was conducted for 1 year among 239 neonates who remained as in-patients 48 hours after admission. The criteria that were used to diagnose infection were in accordance with the Centers for Disease Control and Prevention and the National Health Surveillance Agency.

**Results:** The incidence of nosocomial infection was 45.8%. The primary reasons for admission were primary bloodstream

infection (80.7%) and pneumonia (6.7%). Coagulase-negative *Staphylococcus* was the most commonly identified agent in the blood cultures and in the hospital unit. Prematurity was the most prevalent reason for admission. The general mortality rate was 12.1%, and mortality from nosocomial infection was 33.8%.

**Conclusions:** The incidence of nosocomial infection in the hospital unit was higher than rates that have been reported in other national studies. The major types of nosocomial infection were primary bloodstream infection and pneumonia.

**Keywords:** Nosocomial infection/epidemiology; Hospitalization; Neonatal intensive care; Brazil

### INTRODUCTION

A nosocomial infection is an infection in which the clinical, laboratorial and microbiological diagnostic evidence is found after the first 48 hours of admission in a hospital unit.<sup>(1)</sup>

Nosocomial infection is a common complication in hospitalized patients<sup>(2,3)</sup> and is an important cause of morbidity and mortality in neonatal intensive care units (NICUs).<sup>(4)</sup> Neonatal mortality, or death in the first 28 days of life, accounts for one-third of child mortality worldwide.<sup>(5)</sup>

The incidence of nosocomial infection varies between 18% and 34%<sup>(6-10)</sup> and accounts for as much as 40% of all neonatal deaths in developing countries.<sup>(5)</sup>

Studies suggest that approximately one-third of nosocomial infections would be preventable if hospitals had effective infection control protocols.<sup>(9)</sup> Despite epidemiological surveillance programs and preventative measures to control nosocomial infections, the risk of their development remains unacceptably high.<sup>(8)</sup>

Infections that are acquired in neonatal units are unique in many aspects. Newborns are extremely susceptible to infections for several reasons: their

This study was conducted at the Pediatric and Neonatal Intensive Care Unit, Hospital Nossa Senhora da Conceição - HNSC - Tubarão (SC), Brazil.

**Conflicts of interest:** None.

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#### Corresponding author:

Karla Dal-Bó  
Programa de Mestrado em Ciências da Saúde,  
Universidade do Sul de Santa Catarina  
Avenida José Acácio Moreira, sem número  
Zip Code: 88704-900 - Tubarão (SC), Brasil  
E-mail: karla@pod1.com.br

immune systems are still developing, so they have inefficient mucosal and cutaneous barriers, and they are exposed to variety of therapeutic interventions, such as the use of invasive devices and broad-spectrum antimicrobials.<sup>(7)</sup> These therapeutic interventions make newborns targets for infectious agents and the complications that follow. The defenses are even more fragile in premature neonates and in newborns with a low birth weight.<sup>(7,8,11)</sup>

Recent technological advances, particularly for premature or low birth weight neonates, have improved the neonatal survival rate. However, the improvements are associated with the use of invasive procedures and long-term admission in the NICU, which is associated with a higher risk of complications, including nosocomial infection.<sup>(9,12)</sup> Many factors contribute to poor hand hygiene, such as overcrowding, understaffing, work overload and an insufficient number or inconvenient location of washbasins. Inadequately trained staff and limited resources can also increase the risk of cross infection.<sup>(13,14)</sup>

The objective of this study was to estimate the incidence of nosocomial infection in a neonatal intensive care unit in south Brazil.

## METHODS

This study was performed at the Pediatric and Neonatal Intensive Care Unit at Hospital Nossa Senhora da Conceição in Tubarão (SC), Brazil. The unit contains 12 hospital beds, including 9 neonatal and 3 pediatric beds. The hospital is a non-profit organization that treats patients who are born at the hospital and patients from the Associação de Municípios da Região de Laguna (AMUREL), which is a micro-region that includes 16 municipalities in south Santa Catarina.

A prospective cohort study was performed from January 1 until December 31, 2010. The study included all newborns (up to 28 days of age) who were admitted to the NICU and who remained as in-patients 48 hours after admission. To diagnose nosocomial infection, the unit followed criteria from the Centers for Disease Control and Prevention (CDC) and the National Health Surveillance Agency (Agência Nacional de Vigilância Sanitária - ANVISA).<sup>(1,15,16)</sup> After the legal guardian signed a free and informed consent form, each patient was followed from admission to discharge from the NICU or death. Refusal by the legal guardian to participate in the study was the only exclusion criterion. Data collection was performed by completing a pro-forma that was based on medical records, an interview with the mother, an analysis of the

“Pregnant Woman’s Card” (“*Carteira de Gestante*”) and an inspection of the prenatal and neonatal exam records. In addition to mortality data from the unit, the pro-forma contained clinical details of the patient, such as the birth weight, delivery method, sites of infection and results of lab cultures. Blood cultures were considered to be positive when they were collected using aseptic techniques and from three different samples from the patient.

As a form of surveillance to understand the colonizing flora in the unit, axillary, nasal and rectal swabs were collected weekly for all admitted neonates.

A database was created to analyze the information from the pro-forma. Excel and SPSS (Statistical Package for Social Sciences) 16.0 for Windows were used for statistical analyses. Incidences were calculated for the total infections and the site of infections. This project was approved by the Research Ethics Committee of Unisul on December 15, 2009 (reference 09.603.4.01.III).

## RESULTS

Out of 239 neonates who were followed, 71 (45.8%) developed 155 nosocomial infections. Data related to the site of nosocomial infections are shown in table 1.

**Table 1** - Site of nosocomial infections identified between January and December 2010

Sites of nosocomial infection	N (%)
Primary bloodstream infection	121 (78)
Pneumonia	10 (6.4)
Meningitis	8 (5.2)
Conjunctivitis	8 (5.2)
Enterocolitis	6 (3.9)
Urinary Tract	2 (1.3)
Total	155 (100)

The primary reasons for admission were prematurity (165/22.3%), early sepsis (112/15.2%), neonatal respiratory distress syndrome (103/13.9%), jaundice (77/10.4%) and transient tachypnea of the newborn (41/5.5%).

Neonatal weight varied from 700 to 4,385 g, and the average weight was 2,194 g (standard deviation - SD  $\pm 0.8$ ). A total of 176 neonates (73.6%) were delivered by cesarean.

The procedures that were performed in the unit included 177 cases of peripheral venipuncture (43.8%), 98 cases of umbilical catheterization (24.2%), 83 cases of endotracheal intubation (20.5%), 34 cases of urinary bladder catheterization (8.4%), 27 cases of surfactant administration (6.7%), 22 cases of parenteral nutrition

(5.4%), 21 cases of phlebotomy (5.2%), 16 cases of thoracic drainage (3.9%), 7 cases of exchange transfusion (1.7%), 2 cases of nitric oxide inhalation (0.4%) and 1 case of penrose drainage (0.2%).

Forty-eight blood cultures (67.6%) were collected from the neonates who were diagnosed with nosocomial infection, and 13 (27.1%) of the cultures were positive. The microorganisms that were identified from the blood cultures are shown in table 2.

**Table 2** - Microorganisms identified in the blood cultures of the neonates who were diagnosed with nosocomial infection between January and December 2010

Microorganism	N (%)
Coagulase-negative <i>Staphylococcus</i>	6 (33.3)
<i>Enterobacter</i> sp ESBL	4 (22.2)
Group D <i>Streptococcus</i>	2 (11.1)
<i>Acinetobacter</i> sp	2 (11.1)
<i>Staphylococcus aureus</i>	2 (11.1)
<i>Klebsiella pneumoniae</i>	1 (5.5)
Group B <i>Streptococcus</i>	1 (5.5)
Total	18 (100)

ESBL - extended-spectrum beta-lactamase.

Hospital unit colonization was identified using axillary, nasal and rectal swabs in 132 (55.2%), 101 (42.3%) and 110 (46%) patients, respectively. Coagulase-negative *Staphylococcus* was the most common microorganism that was identified (81 cases).

During the study, 210 patients (87.9%) were discharged from the NICU, and the mortality rate was 12.1%. Mortality associated with nosocomial infection was 33.8%.

## DISCUSSION

Nosocomial infections, particularly in NICUs, are recognized as one of the most important causes of morbidity and mortality in hospitalized neonates.<sup>(9)</sup> NICUs have unique characteristics that are reflected in the epidemiology of nosocomial infections. A constant and active surveillance system is necessary to control the factors that aggravate the risk of these infections. Despite an increased interest in the topic, there are relatively few studies that illustrate the epidemiological aspects and risk factors for nosocomial infections in Brazilian NICUs.

The incidence of nosocomial infection varies in the literature. It is important to note that methodological and conceptual differences occur between studies, and much care should be taken when comparing frequencies of infection in different studies. The diagnosis of neonatal infection is one of the most difficult tasks in

medicine and is initially made on the basis of clinical evaluation, pre-established guidelines and an adequate surveillance system.

The results of this study showed a 45.8% incidence of nosocomial infection in the hospital unit, which is similar to that found in other national studies. For example, Nagata et al.<sup>(11)</sup> reported an incidence of 50.7%, and Couto et al.<sup>(17)</sup> reported an incidence of 36.6%. However, other recent Brazilian studies have reported lower incidence rates, such as 14.5% in Brito et al.<sup>(18)</sup> and 18.3% in Lopes et al.<sup>(19)</sup>

In international studies, the incidence of nosocomial infection varies between 10% and 30%.<sup>(6,8,10,20-22)</sup> The differences among the studies can be attributed to different surveillance methods for calculating the incidence of nosocomial infection. However, international rates are much lower than what was found in the present study and what has been reported in other national studies. The elevated rates may be partially attributed to overcrowded units, differences in work situations, inadequate facilities within units (i.e., less space between beds than is recommended by ANVISA and the CDC), insufficient equipment and understaffing. These problems are chronic and persistent in NICUs in developing countries.<sup>(11)</sup>

The most prevalent nosocomial infection types in the present study were clinical sepsis and pneumonia, which is consistent with the literature.<sup>(7,23,24)</sup>

According to the World Health Organization (WHO),<sup>(25)</sup> caesarian delivery should correspond to a maximum of 15% of births. However, using data from the public and private sectors in Brazil, the Ministry of Health<sup>(26)</sup> reports that caesarians correspond to 43% of births. For private health care plans, the caesarian rates are as high as 80%. In the Unified Health System (Sistema Único de Saúde - SUS) of Brazil, caesarians account for 26% of all deliveries.

A normal delivery is the safest option for the mother and baby. Because they are a surgical procedure, caesarians should only be indicated in situations that are high risk for the mother or fetus. However, caesarians are often scheduled before labor commences, which increases the risk of newborns developing acute respiratory problems.<sup>(27,28)</sup> Consequently, caesarians can increase the need for NICU admission.

In the present study, caesarian rates reached 73.6%, which compares to national rates of 52.5% in Távora et al.<sup>(7)</sup> and 40.8% in Pinheiro et al.,<sup>(29)</sup> international rates of 48.8% in van der Zwet et al.<sup>(22)</sup> and 62.8% in Jeong et al.<sup>(6)</sup> are also lower. These rates are all above the rate that is recommended by the WHO. The service at the Hospital

Nossa Senhora da Conceição in Tubarão is the reference hospital for the southern region of the state, and many patients are at high risk, which could justify an increased percentage of caesarians. Furthermore, HNSC provides care to patients with both public and private health care, and private patients have a well-described preference for surgical delivery.<sup>(30)</sup>

Peripheral venipuncture was the most frequently conducted procedure in the present study, followed by umbilical catheterization, urinary bladder catheterization, surfactant administration, parenteral nutrition, venous dissection and thoracic drainage. In Cuba, Couto-Ramos et al.<sup>(31)</sup> reported similar procedures, and percutaneous catheterization and parenteral nutrition were the most common.

The results of the blood cultures were consistent with previous literature.<sup>(32)</sup> Some authors have suggested that *Klebsiella sp* account for most of the infections in underdeveloped countries. In technologically advanced countries, Gram-positive cocci, such as coagulase-negative *Staphylococcus*, account for most of the infections.<sup>(5,17,33,34)</sup> Despite a relatively low rate of positive blood cultures in the present study, the microbial agents were consistent with national and international studies; coagulase-negative *Staphylococcus* was the most commonly identified agent.<sup>(11,18,35)</sup> Previous studies have identified significant risk factors for coagulase-negative *Staphylococcus* infection, including admission to NICU, the use of a venous catheter, mechanical ventilation and parenteral nutrition.<sup>(36,37)</sup>

Previous literature describes the use of swabs to investigate colonizing flora in hospital units,<sup>(19)</sup> and, as in this study, coagulase-negative *Staphylococcus* was the microbial agent that was most commonly involved in colonization.

In recent years, an increase in the survival rate of neonates can be attributed to improvements in the quality of and access to health care services.<sup>(11,19)</sup> Nevertheless, the mortality rates in NICUs in developing countries, which vary from 11.9% to 14.7%,<sup>(11,18)</sup> are higher than the rates in developed countries, which vary from 6.1% to 7.1%.<sup>(8,21)</sup> The mortality rate in the present study (12.1%) is in accordance with the national average. It is important to highlight that the severity of illness and type of patient in the hospital unit can influence the morbidity and mortality in critically ill neonates.<sup>(11)</sup> Morbidity and mortality can be reduced with better infrastructure, more advanced technologies, improved access to knowledge and training in infection control processes, better health care systems and additional financial resources.<sup>(5)</sup>

In an epidemiological study on neonatal infections at the Hospital Universitário de Londrina (PR), Lopes et al.<sup>(19)</sup> found nosocomial infection a mortality rate of 15.8%, which is similar to the rate that was reported by Auriti et al.<sup>(8)</sup> in an Italian cohort study (12.7%). In a cohort study performed in Londrina, Nagata et al.<sup>(11)</sup> found a nosocomial infection mortality rate of 24.1%, which is closer to the rate in the present study (33.8%). It is extremely difficult to establish the role that nosocomial infection has on the death of a neonate who is admitted to a NICU. Infants are vulnerable to many complications from their initial condition, and several coexisting factors can contribute to undesirable outcomes.

## CONCLUSIONS

The incidence of nosocomial infection in the studied hospital unit was higher than rates that have been reported in other national studies. Primary bloodstream infection and pneumonia were the primary types of infection. Coagulase-negative *Staphylococcus* was the most commonly identified microbial agent.

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## RESUMO

**Objetivo:** Descrever a incidência e a epidemiologia da infecção hospitalar em recém-nascidos internados em unidade de terapia intensiva neonatal de um hospital no sul de Santa Catarina.

**Métodos:** Foi realizado um estudo de coorte prospectivo durante 1 ano, com 239 neonatos que permaneceram internados após 48 horas da admissão. Os critérios utilizados para diagnóstico de infecção estiveram de acordo com os preconizados pelo *Center for Disease Control and Prevention* e pela Agência Nacional de Vigilância Sanitária.

**Resultados:** A incidência de infecção hospitalar foi de 45,8%, sendo a infecção primária na corrente sanguínea o principal motivo de internação (80,7%), seguida da pneumonia (6,7%). O *Staphylococcus coagulase* negativo foi o agente mais encontrado nas hemoculturas e como colonizante na unidade estudada. A prematuridade foi o motivo de internação prevalente. A taxa de mortalidade geral foi de 12,1%, e a mortalidade por infecção nosocomial foi de 33,8%.

**Conclusões:** A incidência de infecção nosocomial na unidade estudada está acima da reportada por outros estudos nacionais, sendo a infecção primária na corrente sanguínea e a pneumonia os principais sítios de infecção hospitalar.

**Descritores:** Infecção hospitalar/epidemiologia; Hospitalização; Terapia intensiva neonatal; Brasil

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