

## Case report: Study of neonatal hospital infections caused by cross-transmission

Relato de caso: Estudo de infecções hospitalares neonatais causadas por transmissão cruzada

Reporte de caso: Estudio de infecciones hospitalarias neonatales por transmisión cruzada

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### **Abstract**

Cross-infection refers to the transmission of infectious agents within a hospital environment that can occur through person-to-person contact. This study aims to show the importance of hand hygiene and disinfection in hospital work environments, as well as the proper use of PPE, in controlling the cross-transmission of microorganisms. We present a root cause study evaluating the evolution and clinical complications experienced by two neonates infected with *Citrobacter freundii*, a bacterium transmitted through cross-infection. The presence of pediatric infectious disease specialists at the forefront of infection control efforts is essential for the effectiveness of prevention strategies and for ensuring the health and well-being of hospitalized children and newborns. It is essential that future research explore the importance of these professionals in the control of hospital-acquired infections, as well as the impact of appropriate medical device management on neonates.

**Keywords:** Disease transmission; Newborn; Hand disinfection.

### **Resumo**

A infecção cruzada é uma transmissão de agentes infecciosos dentro de um ambiente hospitalar que pode ser realizada através do contato de pessoa para pessoa. O presente trabalho tem o objetivo mostrar a importância da higienização das mãos, desinfecção no ambiente de trabalho hospitalar, bem como o uso adequado de EPI's e assim controlar a via de transmissão cruzada de microrganismos. Relatamos um estudo de causa raiz avaliando a evolução e as complicações clínicas de dois neonatos infectados pela bactéria *Citrobacter freundii*, através de um processo de infecção cruzada. A presença de especialistas em doenças infecciosas pediátricas na vanguarda dos esforços de controle de infecções é essencial para a eficácia das estratégias de prevenção e para garantir a saúde e o bem-estar de crianças e recém-nascidos hospitalizados. É essencial que pesquisas futuras explorem a importância desses profissionais no controle de infecções adquiridas em hospitais, bem como o impacto do gerenciamento apropriado de dispositivos médicos em neonatos.

**Palavras-chave:** Transmissão de doença infecciosa; Recém-nascido; Higienização das mãos.

## Resumen

La infección cruzada se refiere a la transmisión de agentes infecciosos dentro de un ambiente hospitalario que puede ocurrir a través del contacto de persona a persona. Este estudio pretende mostrar la importancia de la higiene y desinfección de manos en los entornos laborales hospitalarios, así como del uso adecuado de los EPI, en el control de la transmisión cruzada de microorganismos. Presentamos un estudio de causa raíz que evalúa la evolución y las complicaciones clínicas experimentadas por dos recién nacidos infectados con *Citrobacter freundii*, una bacteria transmitida por infección cruzada. La presencia de especialistas en enfermedades infecciosas pediátricas en la vanguardia de las iniciativas de control de infecciones es esencial para la eficacia de las estrategias de prevención y para garantizar la salud y el bienestar de los niños y los recién nacidos hospitalizados. Es esencial que las futuras investigaciones exploren la importancia de estos profesionales en el control de las infecciones adquiridas en el hospital, así como el impacto de la gestión adecuada de los dispositivos médicos en los neonatos.

**Palabras clave:** Transmisión de enfermedad infecciosa; Recién nacido; Desinfección de las manos.

## 1. Introduction

Healthcare-Associated Infections (HAIs) are adverse events that occur when a patient is receiving care in a hospital or healthcare facility (Haque et al., 2018).

One of the main mechanisms of transmission for the risk of acquiring HAIs is cross-infection. The frequency with which cross-infection occurs in a hospital environment ranges from 13.0% to 34.6% (Montenegro et al., 2013).

Cross-infection, a leading cause of hospital-acquired infections, occurs through the transmission of a microorganism from one patient to another. This occurs mainly via the hands of healthcare professionals, companions and visitors (Freiberger et al., 2011).

Hand hygiene is globally recognized as a fundamental measure in controlling HAIs. For this reason, it is considered one of the pillars of infection prevention and control in healthcare services, including those against the cross-transmission of multidrug-resistant microorganisms (Mouajou et al., 2021).

This study aims to show the importance of hand hygiene and disinfection in hospital work environments, as well as the proper use of PPE, in controlling the cross-transmission of microorganisms.

## 2. Methodology

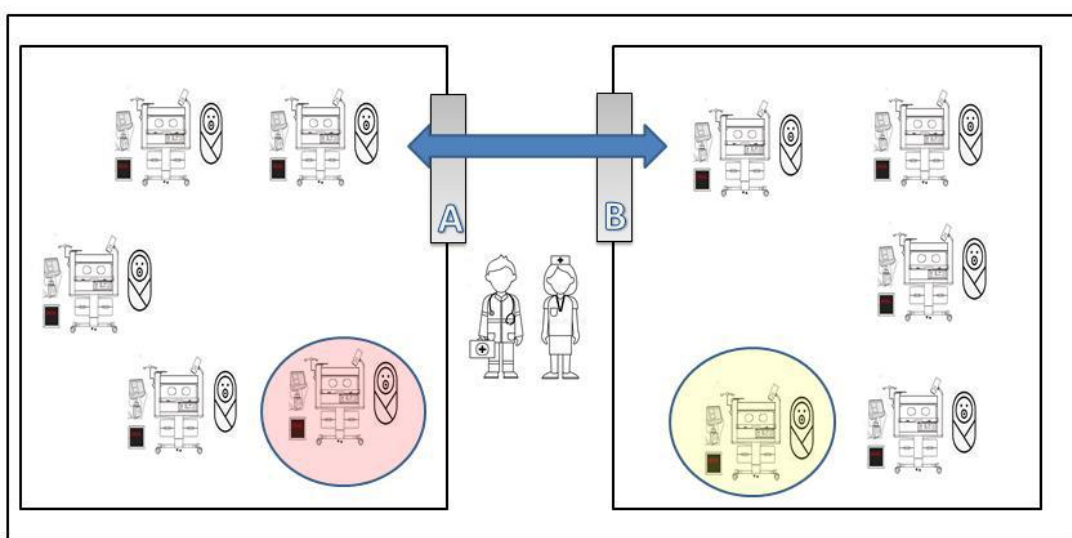
This is a descriptive study evaluating the clinical progression and complications of 2 newborns infected by the bacterium *Citrobacter freundii* through a cross-infection process. Updated articles on the topic of “cross-infection” were used, using the descriptors: “Cross-infection”, “Biosafety” and “infection control” to seek scientific support on the topic. The evaluation of the cases was structured based on the analysis of the clinical history provided by the medical records, microbiological reports and follow-up reports from the Infection Control Service related to Healthcare of the Hospital, with prior informed consent and approval from those responsible. The search for information for the discussion was carried out in databases such as Pubmed, Scopus, among others, using the descriptors: “Cross-infection”, “Biosafety” and “infection control” to seek scientific support on the topic. The objective of the bibliographic search is to acquire knowledge and assist in decision-making, integrating essential information in a unitary and global perspective. The approach of this study is based on solid principles of scientific investigation, according to the guidelines established by different experts in the area. Below are some authors and their relevant methodological contributions: Pereira et al. (2018). The content of this text establishes the necessary foundations for conducting scientific research, from the generation and testing of hypotheses to the processing and study of the information collected. Its focus is on the essential principles of research methodology, which can be applied to different scientific disciplines (Estrela, 2018).

The Free and Informed Consent Form (FICF) was signed and authorized by the patient's guardian, in accordance with resolution 466/2012, as well as the principles of the Research Ethics Committee and, specifically, for case studies involving people, through official letter CONEP/2018.

### 3. Results

This study describes two cases of HAI in neonates who were admitted to the intensive care unit (ICU) of a pediatric hospital in the northeast of Brazil. The hospital's ICU is made up of a multi-professional team that cares for children and neonates. The ICU is physically divided into two rooms, separated by walls (intensive care rooms "A" and "B"), but the patients in both rooms receive health care from the same team of health professionals. Each bed has its own medical equipment and devices, and these items are not shared between patients, as shown in Figure 1.

**Figure 1** - Layout of the intensive care rooms A and B.



Source: Authorship.

In this image, we illustrate that the first neonate, highlighted in red, was in room A of the ICU, succumbing to bacterial sepsis caused by *Citrobacter freundii*. The second neonate, highlighted in yellow, was in ward B of the ICU, also suffering from an infection caused by the same bacteria. Both were hospitalized during the same period and were receiving care from the same team of health professionals.

The first newborn, a 32-week-old preterm male with a birth weight of 1,840g, was born via vaginal delivery. His Apgar score was unrecorded, he required no resuscitation after birth, and had no early risk factors for HAI. Following his birth at a maternity hospital, he was admitted to ICU "A" of the same hospital due to respiratory failure, and required orotracheal intubation and umbilical catheterization. He developed early acute respiratory failure (ARF) and was treated with ampicillin and gentamicin antibiotics, targeting maternal microbiota, as well as intensive support measures, such as mechanical ventilation and hemodynamic support. After three days, his clinical and laboratory conditions improved and he no longer needed vasoactive drugs. He was successfully extubated and started on an enteral diet. However, a week later, the patient's respiratory pattern worsened, marked by moaning, apnea, dysthymia, and laboratory changes, requiring ventilatory and hemodynamic support once again. Blood cultures were drawn and an antimicrobial regimen targeting hospital microbiota was started with Piperacillin-tazobactam, leading to a diagnosis of late HAI. Laboratory tests showed leukocytosis of  $26,750/\text{mm}^3$  with a left shift, anemia and thrombocytopenia of  $6,300/\text{mm}^3$ , elevated C-Reactive Protein of 6.09 mg/dL (RV:  $< 0.5$  mg/dL)

and metabolic acidosis. Even with the new antimicrobial regimen, the neonate's clinical condition and laboratory parameters progressively worsened, requiring increased ventilatory and hemodynamic support, as well as the transfusion of various blood components. Five days into this decline, blood culture results revealed growth of *Citrobacter freundii*, with a multidrug-resistant profile, showing sensitivity to meropenem and polymyxin B only. Consequently, and due to the severity of the case, his antimicrobials were switched to meropenem and polymyxin B. However, the patient did not respond to treatment and passed away after receiving all possible intensive support measures.

The second newborn was a 33-week-old preterm male, with a birth weight of 1,830g, and born via vaginal delivery. His Apgar score was 8/9, he did not require resuscitation after birth and had no early risk factors for HAI. Born in a maternity hospital in the interior of Maranhão state, he developed respiratory failure after birth, being admitted to the ICU the same week that the first described neonate had passed away. However, the second neonate was placed in room B of the ICU. On admission, clinical and laboratory signs of early ARF were identified, and so ampicillin and gentamicin were started. Non-invasive mechanical ventilation was also initiated. The newborn initially evolved well, but on the 5th day, he presented with nasal bleeding, mild respiratory discomfort and hypoactivity. Laboratory tests showed thrombocytopenia and an increase in C-reactive protein levels (6.44 mg/dL). A blood culture was taken and treatment with amikacin and oxacillin for late ARF was started. On the seventh day, we received preliminary critical results from the blood culture, which indicated the growth of *Citrobacter freundii*. The previous antibiotic was replaced with meropenem and the neonate showed clinical improvement. The microbiology laboratory later confirmed that the *Citrobacter freundii* isolated from the second newborn's blood culture had the same sensitivity profile as that of the first newborn, despite them being in physically separate rooms. No other patients were affected. It should be noted that both neonates admitted to this ICU had a bloodstream infection caused by *Citrobacter freundii*. The first neonate (room A) died, a catastrophic event likely resulting from cross-infection.

#### 4. Discussion

ICU patients are more likely to develop HAI, especially neonates. In the neonatal period, HAI can be acquired intrapartum, during hospitalization or up to 48 hours after discharge. This excludes transplacental infections (syphilis, toxoplasmosis, rubella, cytomegalovirus, hepatitis B, herpes simplex, human immunodeficiency virus infection, etc.), with maternal infections occurring within the first 48 hours of life, and environmental infections arising after this period (Saleem et al., 2013; Shane et al., 2014; Pessoa et al., 2021).

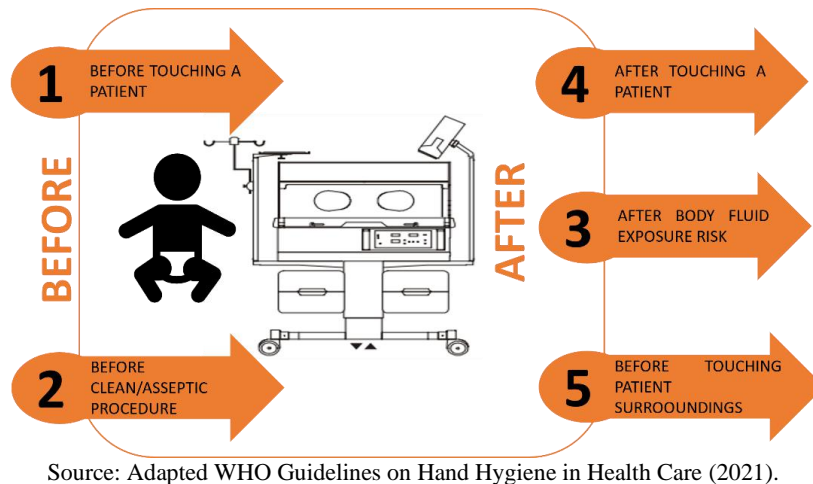
The literature highlights that one of the main causes of HAI is cross-infection. Further, the transmission of a microorganism from one patient to another can be attributed to incorrect hand hygiene (Ragusa et al., 2018).

In this case, the transmission dynamics of the agent may have occurred at a certain moment between the admission of the second neonate and the death of the first neonate, suggesting a probable failure in hand hygiene during the care of both neonates. The most important risk factor for acquiring HAIs is hand hygiene (Squeri et al., 2016).

Studies show high rates of HAIs caused by multidrug-resistant bacteria in ICUs, with high morbidity and mortality in developing countries (Alp et al., 2015). In our study, we observed that both neonates were in an ICU and were infected by a multidrug-resistant gram-negative bacterium. Unfortunately, one of the cases resulted in death, while the other experienced severe complications but later showed improvement.

It is of fundamental importance that every member of the hospital team is committed to ensuring good hand hygiene and that they are frequently trained in the five stages of hand hygiene as recommended by the World Health Organization (WHO), 2021. These steps have been adapted for the care of neonates in heated incubators, as shown in Figure 2.

**Figure 2** – Adaptation of the 5 Stages of Hand Hygiene for newborns according to WHO guidelines.



In this way, we can assume that there was a failure or absence of hand hygiene at the recommended times in both patients, suggesting that cross-transmission may have occurred at the first, second or fourth stages. Among the procedures for controlling cross-infection, hand hygiene has been proven to be effective in the epidemiology of hospital-acquired infections (Creedon, 2005).

Hand hygiene is the basis for preventing the transmission of pathogens between patients, healthcare professionals and the care environment. The use of gloves in patient care does not negate the need for hand hygiene through correct techniques before and after glove use. Although gloves are essential in certain circumstances, they should only be used when appropriate and not as a substitute for proper hand hygiene. Excessive use of gloves should be seen as a "red flag" for potential non-compliance with hand hygiene (Allegranzi & Pittet, 2009).

The microbiological analysis of the two children infected at the hospital in question identified *Citrobacter freundii*, a rare opportunistic pathogen in our environment. Members of the *Citrobacter* genus are found in the feces of humans and animals (Allegranzi et al., 2009). *Citrobacter* spp. is an opportunistic microorganism involved in infections of immunocompromised patients, such as preterm neonates. *Citrobacter diversus* is associated with approximately 40% of cases in the literature, while *Citrobacter freundii* accounts for approximately 29%. *Citrobacter* spp. cause neonatal meningitis and have an unusual propensity to cause brain abscesses. *Citrobacter freundii* can invade and replicate in microvascular endothelial cells of the human brain. The outer membrane protein in *Citrobacter* spp. can also act as a neurovirulence factor, causing ventriculitis and brain abscesses in children (Plakkal et al., 2013).

## 5. Conclusion

This report draws attention to the probable spread of a multidrug-resistant microorganism in a neonatal ICU, emphasizing that practices such as hand hygiene carried out at the times recommended by the WHO, the use of standard or contact precautions, cleaning of the work environment, rational antibiotic use and continuous training of healthcare teams are fundamental. The presence of pediatric infectious disease specialists at the forefront of infection control efforts is essential for the effectiveness of prevention strategies and for ensuring the health and well-being of hospitalized children and newborns. These professionals are experts in the management of infectious diseases in pediatric populations, offering crucial expertise in the implementation of prevention protocols and the appropriate use of antibiotics. It is essential that future research explore the importance of these professionals in the control of hospital-acquired infections, as well as the impact of appropriate medical

device management on neonates. Investigating these areas will contribute significantly to improving pediatric health care, minimizing risks and improving clinical outcomes for the youngest and most vulnerable patients.

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