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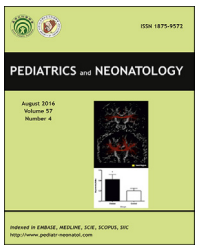

Original Article

Risk factors for nosocomial infections after cardiac surgery in newborns with congenital heart disease

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Key Words
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Background: Congenital heart diseases are among the most common congenital malformations. Approximately 50% of the patients with congenital heart disease undergo cardiac surgery. Nosocomial infections (NIs) are the main complications and an important cause of increased morbidity and mortality associated with congenital heart diseases. This study's objective was to identify the risk factors associated with the development of NIs after cardiac surgery in newborns with congenital heart disease.
Methods: This was a nested case–control study that included 112 newborns, including 56 cases (with NI) and 56 controls (without NI). Variables analyzed included perinatal history, associated congenital malformations, Risk-Adjusted Congenital Heart Surgery (RACHS-1) score, perioperative and postoperative factors, transfusions, length of central venous catheter, nutritional support, and mechanical ventilation. Statistical analysis: Differences were calculated with the Mann–Whitney-*U* test, Pearson X^2, or Fisher's exact test. A multivariate logistic regression was used to determine the independent risk factors.
Results: Sepsis was the most common NI (37.5%), and the main causative microorganisms were gram-positive *cocci*. The independent risk factors associated with NI were non-cardiac congenital malformations (OR 6.1, CI 95% 1.3–29.4), central venous catheter indwelling time > 14 days (OR 3.7, CI 95% 1.3–11.0), duration of mechanical ventilation > 7 days (OR 6.6, CI 95% 2.1–20.1), and ≥5 transfusions of blood products (OR 3.1, CI 95% 1.3–8.5). Mortality attributed to NI was 17.8%.
Conclusion: Newborns with non-cardiac congenital malformations and with >7 days of mechanical ventilation were at higher risk for a postoperative NI. Efforts must focus on

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preventable infections, especially in bloodstream catheter-related infections, which account for 20.5% of all NIs.

1. Introduction

In Mexico, congenital heart disease (CHD) is a significant cause of mortality in children under one year of age. According to a recent data analysis, mortality increased from 114.4 to 146.4/100,000 live births from 2008 to 2013. Almost one-third of the deaths occurred during the first week of life.[1] The prevalence of CHD in Mexico is still unknown, but it is assumed to be similar to worldwide prevalence (6–8 per 1000 live births).[2] In 2008, a Mexican Association of Specialists in Congenital Heart Disease (abbreviation in Spanish AMECC) was created to implement a national plan for regionalization of care for patients with CHD.[3,4]

Early diagnoses of CHD in fetuses and newborns, along with specialized cardiovascular surgeons and national referral centers, have improved the prognosis for neonates due to corrective surgery. In Mexico, approximately 50% of patients with cardiac defects undergo surgical repair, and 30% of them require open heart surgery with cardiopulmonary bypass.[5,6] In the postoperative period, a systemic uncontrolled inflammatory response has been documented due to complex humoral and cellular interactions, contributing to organ dysfunction and derived complications.[7,8] Infectious complications vary from center to center, but in Latin America, the prevalence is high (40–50%).[9–13]

Common infections in these patients are central line-associated bloodstream infections, ventilator-associated pneumonia, nosocomial pneumonia, and surgical site infections.[14–21] In a systematic analysis by Dresbach et al.,[13] 20 of 23 papers published in English reported risk factors for nosocomial infections (NIs). One of the general risk factors for NIs was the group of neonates (OR 5.89, CI 95% 2.96–11.58). Because of the heterogeneity of the studies, it was not possible to compare the results for specific risk factors and provide definite data. Some of the risk factors mentioned in several studies are prematurity, malnutrition, cyanotic lesion, duration of surgical procedure, more than one surgical intervention, complexity score (RACHS-1), delayed sternal closure, number of blood transfusions, preoperative length of hospital stay, central venous catheter (CVC) indwelling time, and length of total parenteral nutrition.[10–24]

The present study's objective was to identify the risk factors for NI after cardiac surgery in newborns with CHD, in a neonatal intensive care unit (NICU).

2. Material and methods

A nested case–control study was carried out with newborns who underwent cardiac surgery from January 2012 to June 2014 in a pediatric tertiary care level hospital, in Mexico City, Mexico. The Ethics Institutional Review Board approved the study. A case was defined as a patient who acquired an NI during postoperative care after cardiac surgery. A control was a patient randomly selected, who did not develop an NI. The ratio of case:control was 1:1. Both a case and a control must fulfill the selection criteria. Inclusion criteria: newborns admitted to the NICU with clinical and two-dimensional echocardiogram-based diagnosis of CHD, which was established by pediatric cardiologist, and who underwent cardiac surgery during hospitalization. Exclusion criteria: patients who died within 48 h postoperatively, those with infection within the first 48 h after hospitalization, and premature patients with patent ductus arteriosus as the only lesion.

NIs were defined according to the Centers for Disease Control and Prevention criteria and the National Health Care Safety Network.[25,26] The following infections were included: central line-associated bloodstream infection, clinical sepsis, pneumonia, ventilator-associated pneumonia (VAP), surgical-site infection, clinical sepsis, intra-abdominal infection, and endocarditis. Sepsis was defined according to the proposed definition in the International Sepsis Forum definition of infection in the intensive care unit.[27]

Data collected included demographic and perinatal characteristics, type of CHD, antimicrobial prophylaxis, length of hospital stay before surgery, CVC indwelling time, type of surgery and complexity score (RACHS-1),[22] duration of surgical procedure, duration of cardio-pulmonary bypass, duration of aortic cross-clamp, delayed sternal closure, respiratory support, chest drain, multiple surgeries, transfusions and total parenteral nutrition. Data of the isolated pathogens were collected from the bacteriology laboratory.

NI diagnosis was corroborated by two investigators.

2.1. Statistical analysis

The mortality rate associated with NI was calculated as the ratio between the number of deaths among all children with an NI. Analysis for categorical variables was performed using chi-square or Fisher's exact tests, and for quantitative variables, Mann–Whitney *U* tests were used. Odds ratio and 95% confidence interval were calculated. A multivariate logistic regression was used to identify independent risk factors for NI. Variables with a p value ≤ 0.10 were introduced in the model. Statistical significance was set at $p \leq 0.05$. Analyses were performed with the Software SPSS v.17.

3. Results

From January 2012 to June 2014, 155 patients with CHD underwent cardiac surgery, 56 patients developed a NI and 56 controls were selected.

General characteristics were similar for both cases and controls, with some differences; newborns with NIs had lower Apgar scores, a higher frequency of other congenital

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