Artigo Original

Healthcare-associated infections after pediatric cardiac surgery: a four-year survey

Infecções relacionadas à assistência à saúde após cirurgias cardíacas pediátricas: quatro anos de seguimento

André Ricardo Araujo da Silva[1,2], Leonardo Chaves Ferreira Coelho [1], Giovana Taia Nascimento [1]

[1]Federal Fluminense University, Rio de Janeiro, RJ, Brasil.
[2]-Centro Pediátrico da Lagoa, Rio de Janeiro, Brasil

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andrericardo@huap.uff.br

ABSTRACT

Background and objectives: Healthcare associated infections after pediatric cardiac surgery is a serious complication and the main types are surgical site infection and bloodstream infections. Our objective is to describe healthcare associated-infections types after pediatric cardiac surgery in a hospital from a middle-income country **Methods**: We did an observational prospective descriptive study in Pediatric Intensive Care Unit (PICU) of Centro Pediátrico da Lagoa, a tertiary private hospital in Rio de Janeiro, Brazil All children submitted to cardiac surgery were followed until 30 days after procedure. During this period, all HAI were described and compared with other patients admitted in the same period. **Results:** Between May 2012 and December 2015, we identified 27 (15.6%) HAI in 173 patients submitted to CS, totalizing 3063 patients-days. Density of incidence (per 1000 patients/days) of all HAI was 8.8 in the study group and 11.1 in patients not submitted to cardiac surgery. Of all HAI, we diagnosed 11 surgical site infections (SSI), 6 central-line bloodstream infections (CLABSI), 5 clinical sepsis, 2 ventilator-associated pneumonia (VAP), 1 catheter-associated urinary tract infection (CAUTI) and 1 vascular infection and cutaneous infection. SSI represented 40.7% of all cases of HAI. Media time to acquisition of SSI were 6.3 days and 15.2 days for CLABSI (p=0.0083). In 17 cases, HAIs were defined by clinical criteria, without etiological agent

identification. A Gram-negative bacteria was identified in 4 cases, a Gram-positive bacteria in other 4 cases, a yeast in one and, in the last case we found 2 bacteria (both Gram-positive) causing HAI. **Conclusion:** SSI was the most common type of HAI, but rates of infections after surgery were similar to other patients admitted in PICU during the same period.

KEYWORDS: Hospital infections. Thoracic surgery. Child. Critical care. Hospitalization.

RESUMO

Justificativa e objetivos: Infecções relacionadas à assistência à saúde após cirurgias cardíacas pediátricas são complicações sérias e os principais tipos são infecções de sítio cirúrgico e infecções de corrente sanguínea. Nosso objetivo foi descrever os tipos de infecções relacionadas à assistência à saúde após cirurgias cardíacas em crianças, em um hospital de um país em desenvolvimento. **Métodos:** Realizamos um estudo observacional prospectivo descritivo na unidade de tratamento intensivo pediátrica (UTI PED) do Centro Pediátrico da Lagoa, hospital privado terciário da cidade do Rio de Janeiro, Brasil. Todas as crianças submetidas a cirurgias cardíacas foram acompanhadas até 30 dias após o procedimento. Durante esse período, todos os casos de IRAS foram descritos e comparados com outros pacientes admitidos no mesmo período. **Resultados:** Entre maio de 2012 e dezembro de 2015, identificamos 27 (15,6%) casos de IRAS em 173 pacientes submetidos a CC, totalizando 3063 pacientes-dias. A densidade de incidência (por 1000 pacientes/dias) de todas as IRAS foi 8,8 no grupo do estudo e 11,1 nos pacientes não submetidos a cirurgias cardíacas. De todas as IRAS, diagnosticamos 11 infecções de sítio cirúrgico (ISC), 6 infecções primárias de corrente sanguínea confirmadas laboratorialmentel (IPCSL), 5 sepses clínicas, 2 pneumonias associadas a ventilação mecânica (PAV), 1 infecção urinária associada a cateter vesical (ITU AC), uma infecção vascular e uma cutânea. ISC representou 40,7% de todos os casos de IRAS. A média de tempo para aquisição de ISC foi de 6,3 dias e 15,2 dias para IPCSL (p=0,0083). Em 17 casos, as IRAS foram definidas por critérios clínicos, sem identificação de agentes etiológicos. Uma bactéria Gram-negativa foi identificada em 4 casos, uma Gram-positiva em outros 4 casos, uma levedura em um caso, e por último, encontramos 2 bactérias (ambas Gram-positivas) causando IRAS em um mesmo paciente. **Conclusão:** ISC foi o tipo mais comum de IRAS, porém as taxas de infecção após cirurgia foram similares a outros pacientes admitidos na UTI PED durante o mesmo período.

DESCRITORES: Infecção hospitalar. Cirurgia torácica. Criança. Cuidados críticos. Hospitalização.

INTRODUCTION

Pediatric cardiac surgery can result in many different complications, which can be cardiac, such as cardiopulmonary resuscitation, extracorporeal membrane oxygenation,

reoperation, low cardiac output status and permanent pacemaker, or extracardiac (more frequent) such as neurologic, gastrointestinal, respiratory, renal, endocrine and hematologic and infectious.[1]

Healthcare-associated infections (HAI) are frequently one the most important complication in children and newborns after cardiac surgery that increases morbidity, mortality, length of stay and medical costs. Several risk factors to HAI acquisition, in children submitted to cardiac surgery are well described as: young age, surgical trauma, presence of invasive devices like central venous catheters, extensive lengths of stay pre and post-surgery, long extracorporeal circulation and mechanical ventilation utilization, higher ASA scores (measures the severity of illness preoperatively) and inotropic support.[2-7]

Among HAI, central line associated blood stream infection (CLABSI), catheter associated urinary tract infection (CAUTI), surgical site infections (SSI) and ventilator-associated pneumonia (VAP) are the most common while the most dangerous infections are represented by septicemia, endocarditis and mediastinitis.[8-10] Comparing the results, patients with HAI, had mortality rates notably higher than the other patients. For example, Grisaru-Soen reported a mortality of 23.7% in children submitted to cardiac surgery that developed HAI when compared with children without infection (2.2%).[10]

Rates of HAI after pediatric cardiac surgery could be different according the institution studied. In Finland, Sarkivi et al identified 80 HAI after 614 procedures (rates of 6.3/1000 patients-days or 13%).[8] For the other hand, Turcotte and cols found 38 HAI after 634 surgeries (rates of 6%) in two follow-up years.[9] Postoperative cardiovascular surgical site infections (SSIs) in children represents up to 1 in 4 of all healthcare-related infections and could affect until 10% of children submitted to cardiac surgeries. [3,4,6,8,10]

About rates of HAI in children submitted to cardiac surgery in low and middle-income countries, we found few data. For example, Elella and cols studying bloodstream infections (BSI) after PCS reported 27 cases after 311 surgeries (rates of 25.8/1000 CVC days).[11]

Considering this fact, it's important that hospitals know his casuistic about main types of HAI after pediatric cardiac surgery, specially from low and middle income countries, in order to define which strategies will be necessary to reduce infection rates.

The aim of this study is to describe the types of HAI after pediatric cardiac surgery in a single center of a middle-income country.

METHODS

We conducted an observational descriptive prospective study to identify all HAI in children submitted to pediatric cardiac surgery and all HAI in other patients during the same period. The study was developed in a pediatric intensive care unit (PICU) of Centro Pediátrico da Lagoa (CPL), Rio de Janeiro city, Brazil. The unit has 11 beds and all surgeries were performed in surgical rooms of the unit. After the surgery, all patients were followed-up in the PICU of the hospital until they discharged.

All children (from zero month to 18 years old) submitted to cardiac surgery with length of stay longer than 24 hours were included in the study, as well emergency surgeries or children transferred from other hospitals. The only exclusion criteria were parent's refusal to participate of the study. Demographics and clinical features for all eligible patients were collected in appropriated chart.

Types of HAI were defined, according to the National Healthcare Safety Network (NHSN) criteria and infections were diagnosed by physician of infection control (IC) team of the institution until 30 days after surgery.[12] We also used sepsis definition of Survival Sepsis Campaign.[13] Initial approach of patients according probable site of infection, antibiotic management and requisition of laboratorial exams were done by PICU staff, without infection control team interference. Pathogens' identification was done by the hospital's clinical microbiology laboratory, using Clinical Laboratory Standards Institute (CLSI) methodology, according clinical suspicion of assistant team.

Routine of infection control team includes since 2011 (before the beginning of the study) systematic measures to prevent and control HAI as: hand hygiene campaigns, technical reports to healthcare team about prevalent types and agents of HAI, politics of judicious use of ATB, discussion of HAI suspected cases with the PICU staff and write recommendations for prevention of HAI related to invasive devices and SSI.

Statistical analysis was conducted using SPSS v.24 (SPSSInc., Chicago, Illinois, USA). Continuous variables were presented as medians, and comparative analysis was conducted using Student's *t*-test. Chi-squared and Fisher's exact tests were used to

compare categorical variables, and odds ratios (OR) with 95% confidence intervals (95% CI) were calculated when it was necessary. A value of $p < 0.05$ was considered statistically significant. The project was submitted and approved by National Ethics Committee (Plataforma Brasil) under the number CAAE: 01119612.1.0000.5249, in 24th April of 2012.

RESULTS

Between May 2012 and December 2015, we diagnosed 27 (15%) HAI in 173 pediatric cardiac surgeries. Two patients were excluded due to death within the 24h after the surgery. The mean age of patients with HAI after pediatric cardiac surgery was 4.3 months (range 0-58 months) and 55.5% were male. At the time of the surgery, 8 out of 27 (29.6%) patients had presented one or more previous diseases. In 17 of 27 (63%) patients, it was not possible to identify an etiologic agent. In four patients (14.8%) Gram-positive bacteria was found. In other four patients (14.8%) a Gram-negative bacteria was identified and yeast was observed in one patient (3.7%). Lastly, we found two different bacteria in one patient. We present HAI types after pediatric cardiac surgery on table 1.

Table 1- Types of HAI infections in children submitted to cardiac surgery-Centro Pediátrico da Lagoa, May 2012- December 2015.

Types of HAI	N (%)	Agents isolated (Absolut Number)
Superficial incisional SSI	11 (40.7)	Not identified (10) *Pseudomonas* spp (1)
CLABSI	6 (22.2)	CoNS (3) *Candida albicans* (1) *E.cloacae* ESBL* (1) *Acinetobacter lowfii (*1)
Clinical sepsis	5 (18.5)	None (5)
VAP	2 (7.4)	CoNS (1) *S. sciuri* + *S. xylosus* (1)
CAUTI	1 (3.7)	*E.coli* (1)
Vascular infection	1 (3,7)	Not identified (1)

Cutaneous infection	1 (3,7)	Not identified (1)
Total	27 (100)	

ESBL- Extended spectrum beta-lactamase

We also compared the two main types of HAI about media of the days until acquisition of infection. Data are showed in table 2.

Table 2- Media in days until acquisition of HAI after pediatric cardiac surgery- Centro Pediátrico da Lagoa-May 2012- December 2015.

Types of HAI	Media in days until acquisition of HAI after surgery (range)	P value	IC
Superficial incisional SSI	6,4 (2-13)	0.0083	-14.9703 to -2.6297
CLABSI	15,2 (5-26)		

Rates of HAI in children submitted to pediatric cardiac surgery and in others patients admitted in PICU during the same period are showed in the table 3.

Table 3- NI after pediatric cardiac surgery and in other patients admitted at PICU of Centro Pediátrico da Lagoa- May 2012- December 2015.

Variables	Children submitted to cardiac surgery	Children not submitted to cardiac surgery
Patient days	3063	7893
NI rates (in density of incidence)	8,81	11,1
CLABSI rate (absolute number/ CVC-days)	3,01 (6/1993)	3,69 (11/2981)
VAP rate (absolute number/ ventilator-days)	1,55 (2/1291)	4,61 (9/1952)
CAUTI rate (absolute number/ vesical catheter days)	0,97 (1/1033)	3,98 (4/1004)

DISCUSSION

Success of paediatric cardiac surgeries depends on several factors, including prevention and control of healthcare-associated infections (HAI) that is one of the most important complication after surgery.[3-5,8] Types of HAI are different according to the paediatrics institutions, but usually BSI, SSI and sepsis are the main types reported in high-income countries.[1,3,8,10,14] Few reports described the importance of HAI after paediatric cardiac surgery in low and middle-income countries.

In our study, we found a global rate of HAI after pediatric cardiac surgery of 15% that is similar to reported by Levy in Israel (16.4%) but lower than reported by Valera in Italy (48.1%) and Soen in Israel (38.3%).[3,4,10] But small rates of HAI were described by Turcotte et al, in a three-year follow-up study (6%) and by Agarwal and cols (8.3%) with both studies conducted in USA.[1,9]

The two main types of HAI presented in our report were SSI and CLABSI, which is compatible with previous studies' results, but SSI alone represented almost half of all HAI. This finding motivated infection prevention team to review all procedures to avoid this specific type of infection and adopted a bundle of measures according to CDC recommendation.[15] Our media time to SSI acquisition after surgery (6.4 days) were statistical significant lower when compared with the second most common HAI (CLABSI). Some reports related successful interventions to reduce SSI in until 82% of the cases, with adoption of basic procedures as: antibiotic prophylaxis until 1 hour before incision, maintenance of normothermia during the perioperative period, control of bool glucose during the immediate post-operative period, use alcohol-containing preoperative skin preparatory agents if no contraindication exists and use of a checklist based on the World Health Organization (WHO) guidance to ensure compliance with best practices to improve surgical patient safety. [15-17]

Other interesting point is that in the most of HAI cases no etiological agents was found. In cases of which was possible to identify an etiological agent Gram-positive and Gram-negative bacteria had the same percentage. Predominant agents of HAI are also different according to each institution. For example, Levy and Metha reported Gram-negative bacteria as the causing leading of HAI in children after cardiac surgery while Turcotte and Soen reported Gram-positive bacteria as the most common.[3,9,10,14] After the results, in collaboration with PICU and laboratory team, we reviewed our laboratory

routine to improve rate of infectious agent detection.

An important point finding of our job was to identify that children submitted to cardiac surgery had similar rates of HAI and not higher than other patients admitted in PICU, in the same period. When we compared CLABSI in both groups of patients the rates were also similar.

Therefore, it's crucial that healthcare institutions implement surveillance systems to identify HAI in children who submitted to cardiac surgery in order to create specific actions to reduce all infection rates. Recently WHO published new recommendations about core components of infection prevention and control programmes at the National and Acute Health Care Facility Level with aim to effectively prevent health care-associated infections (HAIs) and combat antimicrobial resistance (AMR). This document contains eight guideline recommendations and good practice statements, including multimodal strategies, monitoring, audit and feedback, built environmental, materials and equipment, workload, staffing and bed occupancy (WHO).[18]

Specifically, in the present study the results help us to review our protocol to SSI prevention and define better approach to all healthcare team, but future studies are necessary to verify which strategies are effective in reducing SSI rates in paediatric population because most of the interventions to reduce SSI rates are derived from adults' studies.[19]

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