PUBLICAÇÃO OFICIAL DO NÚCLEO HOSPITALAR DE EPIDEMIOLOGIA DO HOSPITAL SANTA CRUZ E PROGRAMA DE PÓS GRADUAÇÃO EM PROMOÇÃO DA SAÚDE - DEPARTAMENTO DE BIOLOGIA E FARMÁCIA DA UNISC

Revista de Epidemiologia e Controle de Infecção

Hospital Santa Cruz

ORIGINAL ARTICLE

# Epidemiological profile of isolated bacteria in a public pediatric hospital

## *Perfil epidemiológico de bactérias isoladas em um hospital pediátrico público*

## *Perfil epidemiológico de bacterias aisladas en un hospital pediátrico público*

***https://doi.org/10.17058/reci.v10i4.14708***

***Received:*** *21/01/2020*
***Accepted:*** *29/10/2020*
***Available online:*** *04/10/2020*

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## ABSTRACT

**Background and objectives:** in recent years, the incidence of resistant bacteria has increased significantly, and in Brazil there is little research on the subject regarding pediatric hospitals. Therefore, this study aimed to analyze the epidemiological profile of the main bacteria recovered from biological samples of a Brazilian pediatric hospital. **Methods:** this is a descriptive and retrospective study. The study was conducted over 24 months based on reports of microbiological tests issued by the infection control service of a pediatric hospital located in the Center-West of the Brazilian state of Minas Gerais. Results: a total of 4286 bacteria were recovered from biological samples, of which 1107 (25.82 %) were responsible for healthcare-associated infection (HAI) at the institution of origin. The main microorganisms identified were *Pseudomonas aeruginosa* (10.4%), *Acinetobacter baumannii* (7.8%), *Staphylococcus aureus* (4.3%), *Escherichia coli* (4.3%), and *Klebsiella pneumoniae* (3.5%). Isolates with minimal inhibitory concentration (MIC) ≥ 4mg/L were considered resistant. **Conclusion:** knowledge of the local epidemiological profile has been shown to be effective in the strategies established by the institutions to reduce infections related to health care. The prevalence profile of bacteria recovered from biological samples was similar to other studies conducted at national and international levels.

***Keywords:*** *Hospital's pediatric. Bacteria. Child.*

## RESUMO

**Justificativa e Objetivos:** Nos últimos anos, a incidência de bactérias resistentes tem aumentado significativamente e, no Brasil, existem poucas pesquisas sobre o tema, em hospitais pediátricos. Portanto, este estudo teve como objetivo analisar o perfil epidemiológico das principais bactérias recuperadas de amostras biológicas de um hospital pediátrico brasileiro. **Métodos:** trata-se de um estudo descritivo documental e retrospectivo. O estudo foi conduzido em 24 meses a partir de laudos de exames microbiológicos emitidos pelo serviço de controle de infecção hospitalar



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de um hospital pediátrico localizado no Centro-Oeste de Minas Gerais. **Resultados:** foram recuperadas de amostras biológicas, neste período, 4.286 bactérias, sendo 1.107 (25,82%) responsáveis por infecções relacionadas à assistência à saúde (IRAS) na instituição de origem. Os principais microrganismos identificados foram *Pseudomonas aeruginosa* (10.4%), *Acinetobacter baumannii* (7.8%), *Staphylococcus aureus* (4.3%), *Escherichia coli* (4.3%) e *Klebsiella pneumoniae* (3.5%). Os isolados que apresentaram concentração inibitória mínima (CIM) ≥ 4mg/L foram considerados resistentes. **Conclusão:** o conhecimento do perfil epidemiológico local tem se mostrado efetivo nas estratégias estabelecidas pelas instituições para redução das infecções relacionadas à assistência à saúde. O perfil de prevalência das bactérias recuperadas das amostras biológicas foi similar a outros estudos conduzidos em âmbito nacional e internacional.

***Descritores:*** *Hospitais pediátricos. Bactéria. Crianças*

## RESUMEN

**Justificación y objetivos:** en los últimos años, la incidencia de bacterias resistentes ha aumentados significativamente y en Brasil hay poca investigación sobre el tema con respecto a los hospitales pediátricos. Por lo tanto, este estudio tuvo como objetivo analizar el perfil epidemiológico de las principales bacterias recuperadas de muestras biológicas de un hospital pediátrico brasileño. **Métodos:** este es un estudio descriptivo y retrospectivo. El estudio se realizó durante 24 meses en base a informes de pruebas microbiológicas emitidas por el servicio de control de infecciones de un hospital pediátrico ubicado en el centro oeste del estado brasileño de Minas Gerais. **Resultados:** se recuperaron un total de 4286 bacterias de muestras biológicas, de las cuales 1107 (25.82%) fueron responsables de infecciones relacionadas con la atención médica (IRAS) en la institución de origen. Los principales microorganismos identificados fueron *Pseudomonas aeruginosa* (10.4%), *Acinetobacter baumannii* (7.8%), *Staphylococcus aureus* (4.3%), *Escherichia coli* (4.3%) y *Klebsiella pneumoniae* (3.5%). Los aislamientos con concentración mínima inhibitoria (MIC) ≥ 4 mg/L se consideraron resistentes. **Conclusiones:** el conocimiento del perfil epidemiológico local se ha mostrado efectivo en las estrategias establecidas por las instituciones para reducir las infecciones relacionadas con la atención de la salud.

***Palabras clave:*** *Hospitales pediátricos. Bacterias. Niño.*

## INTRODUCTION

Bacterial infections are a worldwide public health problem, since they increase the number of hospital admissions and mortality rates, with a high financial impact on health institutions.[1]

Moreover, complications from bacterial infections, mainly from healthcare-associated infection (HAI), also represent a social, legal, and ethical concern with regard to the implications for patient safety and quality of health services in the world.[2]

In recent years, the incidence of HAI associated with resistant microorganisms has increased worldwide, being of particular concern in pediatric hospitals. Thus, children admitted to health care facilities are exposed to a wide variety of bacteria with a diverse antimicrobial susceptibility profile, and to the increasing use of broad-spectrum antibiotics, and that are associated with higher rates of adverse events.[3] It is noteworthy that in children, bacterial infections can aggravate rapidly due to a relatively immature cellular and humoral immune system, skin and mucosa immature, and medical invasive procedures.[2,4]

Knowing the bacterial epidemiological profile of a health care institution is of extreme importance for decision-making regarding infection prevention, in order to formulate appropriate antibiotic policy for effective treatment within first few hours to decrease the mortality and on complication prevention.[4-6]

In Brazil, generally speaking, there are few studies on the bacterial epidemiological profile and infections in health institutions.[7] Therefore, this study aimed to describe the epidemiological profile of the main bacteria of a Brazilian pediatric hospital over two years of observation.

## METHODS

This is a retrospective and descriptive documentary study conducted to assess the epidemiological profile of bacteria isolated from cultures of biological samples of a large public pediatric hospital, a reference in pediatrics in the southeast of the Brazilian state of Minas Gerais. The study was approved under CAE (*Certificado de Apresentação para Apreciação Ética* - Certificate of Presentation for Ethical Consideration) 44803815.700005545.

The data used in the research were obtained through analysis of the results of microbiological exams and annual report of HAI of the said hospital, over a period of 24 months (01 November, 2014 to 31 October, 2016), made available by the infection control service (ICS) of the hospital. Results of cultures of positive biological samples for fungi and all culture of epidemiological surveillance were excluded from the study.

The variables of interest assessed were: community infections and HAI, isolated bacteria, type of biological sample (blood, urine, catheter tip, and secretions: skin, ear, eye and lung), minimum inhibitory concentration (MIC), determined by Clinical & Laboratory Standards



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Institute (CLSI),[8] and major sites of infection related to health care. In descriptive statistics, data were expressed in absolute and relative frequency.

## RESULTS

Institutional context of infections in the pediatric population served over the two-year period.

The hospital performs about 30 thousand visits/year. Analysis of reports from the pediatric hospital under study showed that in 2014 and 2016 respiratory tract infections (58%), diarrhea and gastroenteritis (14%), dengue, complications of chronic diseases, food poisoning, and traumas (28%) were the main causes of hospitalizations.

In this same two-year period, a total of 4286 bacteria were recovered from biological samples. It was observed that the majority of infections were characterized as acquired in the community (74.2 %). However, a significant percentage of bacteria were recovered from HAI (25.8 %). Moreover, a 12.5 % increase of these infections in 2016 in all three sectors was observed in the hospitalization unit II (UII), in hospitalization unit III (UIII), and Unit Intensive Care Unit (ICU).

HAI distribution among ICUs, the lower complexity hospitalization unit, and the institution's chronic hospitalization unit are shown in Table 1. In UII and UIII, the overall rates were 5 infections/1000 patient-days and 14 infections/1000 patient-days; 7 % HAI increase in 2016, with an overall incidence o(f 31.4% in the ICU sector and a global rate of 36 infections/1000 patient-days.

**Table 1.** Healthcare-associated infection distribution and frequency by sector and year (2014/2016).

| Hospitalization unit | 12 Months (2014/2015)* n (%) | 12 Months (2015/2016)** n (%) |
|---|---|---|
| ICU | 172 (33%) | 184 (31.4%) |
| UII | 58 (11%) | 39 (6.6%) |
| UIII | 291(56%) | 363 (62%) |

*ICU: Intensive Care Unit. UII: Hospitalization unit II. UIII: Hospitalization unit III. HAI: Healthcare-associated infection. * Nov 01, 2014/ Oct 31, 2015 and **Nov 01, 2015/Oct 31, 2016.*

In this work, the main infection sites were skin and soft tissues, respiratory tract, urinary tract, and gastrointestinal tract (Table 2). The number of bacteria isolated from respiratory tract samples, including confirmed cases of pneumonia, was 38.4 %, followed by skin and soft tissue (36%) and bloodstream infections (11%).

**Table 2.** Number of bacteria recovered at several sites of healthcare-associated infection.

| Principal site | Absolute frequency (n) | Relative frequency (%) |
|---|---|---|
| Skin and soft tissue | 399 | 36.0 % |
| Eyes/ears/nose/oropharynx/mouth | 147 | 13.3 % |
| Lower respiratory tract (except pneumonia) * | 145 | 13.0 % |
| Pneumonia | 137 | 12.4 % |
| Bloodstream infections | 121 | 11.0 % |
| Urinary tract | 71 | 6.4 % |
| Cardiovascular system | 63 | 5.7 % |
| Gastrointestinal | 20 | 1.8 % |
| Reproductive system | 4 | 0.4 % |

** Lower respiratory tract (except pneumonia): Bronchiolitis; Bronchitis; Cystic fibrosis.*

### Microbiological profile of infections in the studied pediatric population

Analysis of culture results from biological samples showed that Gram-negative bacteria were more recovered than Gram-positive in catheter tips, blood, diverse secretions, and urine samples (Table 3 and 4).

**Table 3.** Distribution of bacteria in different biological samples.

| Biological Samples | Gram-negative bacteria frequency | Gram-positive Cocci frequency |
|---|---|---|
| Catheter tip | 27 (0.6 %) | 16 (0.3 %) |
| Blood | 176 (4.1 %) | 416 (9.8 %) |
| Diverse secretions | 1295 (30.2 %) | 857 (20 %) |
| Urine | 1320 (30.8 %) | 179 (4.2 %) |

Among Gram-positive bacteria, *Staphylococcus aureus* was the most recovered microorganism, followed by *Streptococcus pneumoniae* (Table 4).

**Table 4.** Frequency of Gram-positive and Gram-negative bacteria recovered in a pediatric hospital over a 2-year period.

| Bacteria | n | Relative Frequency (%) |
|---|---|---|
| **Gram-positive** | | |
| *Staphylococcus aureus* | 768 | 20% |
| *Streptococcus pneumoniae* | 159 | 4.2% |
| *Staphylococcus epidermidis* | 143 | 3.8% |
| *Enterococcus faecalis* | 94 | 2.4% |
| *Staphylococcus hominis* | 76 | 2 % |
| *Corynebacterium* sp. | 52 | 1.3% |
| *Bacillus* sp. | 12 | 0.3% |
| **Gram-negative** | | |
| *Escherichia coli* | 627 | 16.3% |
| *Proteus mirabilis* | 470 | 12.3% |
| *Klebsiella pneumoniae* | 192 | 5% |
| *Enterobacter cloacae* | 97 | 2.5% |
| *Pseudomonas aeruginosa* | 701 | 18.3% |
| *Acinetobacter baumannii* | 270 | 7% |
| *Stenotrophomonas maltophilia* | 55 | 1.4% |
| *Burkholderia cepacia* | 47 | 1.2% |



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In this study, the five most prevalent HAI bacteria (n = 1107) were *Pseudomonas aeruginosa* (10.4%, n=116), *Acinetobacter baumannii* (7.8%, n=87), *S. aureus* (4.3%, n=48), *Escherichia coli* (4.3%, n=48), and *Klebsiella pneumoniae* (3.5%, n=39).

The main agents of bloodstream infection, *S. epidermidis*, *S. hominis*, *A. baumannii*, *S. aureus*, *K. pneumoniae*, and *E. coli* (Figure 1a), were found in order of prevalence. Among the other isolated species *E. faecalis*, *P. aeruginosa* and *E. cloacae* stand out.

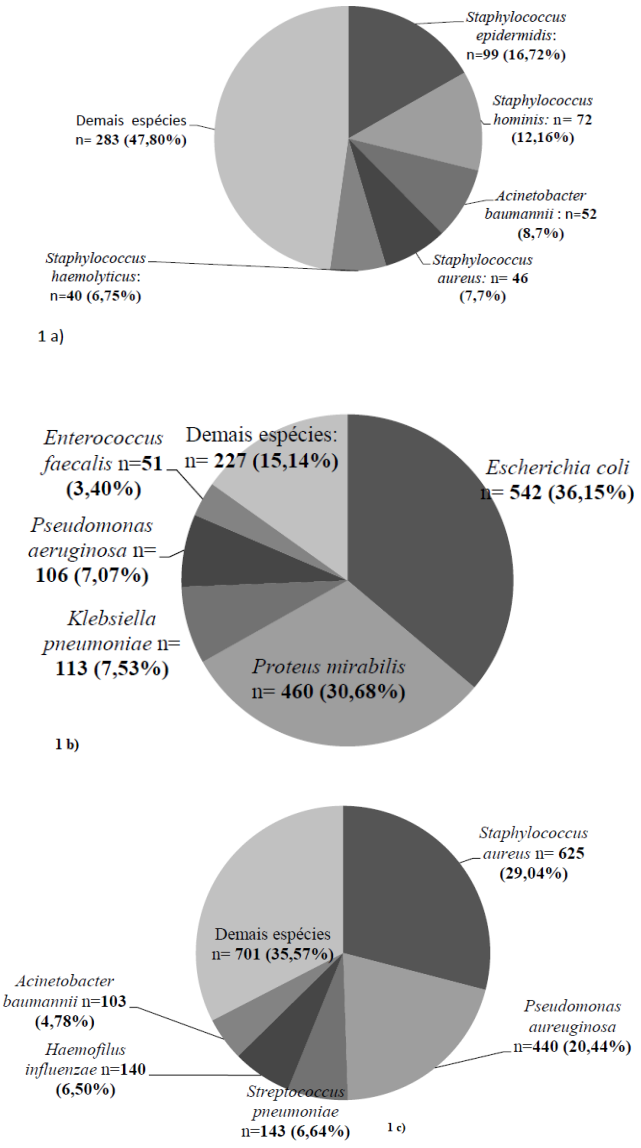


**Figure 1.** Main bacteria isolated from samples of the pediatric population treated at a public hospital for children over a 24-month period (2014/2016). a) bloodstream; b) urinary tract; c) diverse secretions.

In urinary tract infections, *E. coli* was more prevalent followed by *Proteus mirabilis* (Figure 1b). Furthermore, *K. pneumoniae, P. aeruginosa*, and *E. faecalis* were also recovered. Microbiological findings of various secretions including skin, ear and lower respiratory tract were also analyzed, and a similarity of prevalence between Gram-positive and Gram-negative bacteria as agents of infection was observed. *S. aureus* followed by *P. aeruginosa, S. pneumoniae*, *Haemophilus influenzae* and *A. baumanni* were the most recovered microorganisms (Figure 1c).

Regarding Gram-positive bacteria, absolute sensitivity to vancomycin was observed between *Staphylococcus* spp.; 33% of *Enterococcus* spp. and 25 (2.25 %) of the HAI were caused by carbapenem-resistant Gram-negative bacteria, such as *A. baumannii* and *P. aeruginosa*. Regarding the reports that contained data related to the minimum inhibitory concentration (MIC), of the isolates assessed, the findings ranged from 0.5 to 8mg/L. Those with MIC ≥ 4mg/L were considered resistant according to CLSI data.

## DISCUSSION

Currently, data from literature on the bacterial profile in pediatric hospitals assessing both community infections and HAI are not found. The focus of hospital institutions are only HAI, patient safety measures, and risk associated with bacterial resistance. In general, the prevalence profile of the bacteria found in the pediatric hospital studied over a two-year period is similar to studies conducted internationally in children, and the increase in HAI is also highlighted, despite efforts to propose safe practices and protocols to contain cases. Understanding the regional epidemiological and microbiological data is of great importance when handling potentially life-threatening infections and are crucial for successful therapy.[9]

In a systematic review that assessed the main causes of hospitalizations of children in Brazil, with 11 articles included from 2008 to 2015, reported respiratory tract infections and gastroenteritis as the main causes of hospital admission.[10] In the present study, the same circumstances or events observed were reported as causes of hospitalizations. Of particular concern is an increase in HAI cases, which may be related to failure to observe protocols for safety measures and precautions for infections, and the lack of a local antimicrobial prescription protocol. HAIs are important adverse events that affect not only the permanence of admissions and costs, but also morbidity and mortality.[10-11]

In UII and UIII, the overall rates of HAIs were 5 infections/1,000 patient-days and 14 infections/1,000 patient-days, respectively. The higher frequency of HAIs in the hospitalization units when compared to ICUs may be associated with a higher number of beds, professional turnover, people from different locations, and presence of relatives. In a study in five years of observation, the overall rate in hospitalization and ICU units was 14.32 infections/1,000 patient-days, showing that the distribution and expected incidence of infection may vary according to the institutional profile and that vigilance must be constant in to implement good practices in the health service.[11]



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In general, studies describe that HAIs tend to be more incident in ICUs due to the severity of clinical picture, immune compromise, and invasive procedures.[10-11] In the present study, from the annual reports provided by the ICS there was an increase of 12.5% between 2014 and 2015 and 2015 and 2016. A 7% HAI increase in 2016, with an overall incidence of 31.4% in the ICU sector. According to data from the Brazilian National Agency of Sanitary Surveillance (*Agência Nacional de Vigilância Sanitária* - ANVISA), in Brazil the rates of HAI in pediatric ICUs vary from 3% to 27%. The overall rate of infection has not been frequently observed; however, data from ANVISA show the overall rate of infection varies between 19.2 and 49 infections/1,000 patient-days.[1] Regarding the major HAI sites, contrary to what was observed here, in another study, bloodstream infections were the most frequent (31%), followed by respiratory tract infections (20%).[11] Regarding the major HAI sites, the CDC/National Health Security Network (*Rede Nacional de Segurança em Saúde* – NHSN) describes the importance of relating infection sites in hospital settings.[12] Differences in the prevalence of certain bacteria can occur at each site of infection, with *S. aureus* being more frequent in bloodstream, respiratory tract and skin infections. [1]The implementation of preventive strategies for HAI control in health institutions, aiming at a better quality of care, has contribute greatly to the possible reduction of infection rates, although they may still be considered significant. [10-11]

According to Infectious Diseases Society of America, among the most important clinical and epidemiological bacteria are *E. faecium, S. aureus, K. pneumoniae, A. baumannii*, *P. aeruginosa*, and *Enterobacter* spp, denominated pathogens *ESKAPE*.[13] The *ESKAPE* pathogens are responsible for a substantial percentage of nosocomial infections and represent the vast majority of isolates.[14] In this context, it is worth noting that Latin American countries, including Brazil, have high levels of bacterial resistance to antimicrobials among bacteria of clinical importance (*ESKAPE*).[15,16] In the present study, the frequency of *P. aeruginosa* (10.4%) and *A. baumannii* (7.8%) was also significant, similar to that found in another analysis that describe that *P. aeruginosa* these are the main bacteria isolated from biological samples, besides including *K. pneumoniae*.[17] In this study, the assessing community based and health care related infections, *S. aureus* has been reported as more frequent. However, prevalence patterns may vary by region, and the differences are probably attributable to variations in populations studied, denoting again the necessity to know the local bacterial profile.[18]

In general, the Gram-negative bacteria mentioned herein exhibited a high antimicrobial susceptibility profile, 25 (2.25%) of the HAI were caused by carbapenem-resistant Gram-negative bacteria such as *A. baumannii* and *P. aeruginosa*. Regarding Gram-positive bacteria, absolute sensitivity to vancomycin was observed between *Staphylococcus spp*. and 33% of *Enterococcus spp*. Another study reported a high rate of resistance to carbapenems (18 to 35%) between *K. pneumoniae, A. baumannii,* and *P. aeruginosa*, over a five-year period in an institution similar to this study.[11] According to literature, vancomycin resistant *Enterococcus* (VRE) account for for 4% of all HAI in the United States.[19] In Brazil, VRE is considered the eighth cause of HAI, mainly *E. faecalis*, in contrast to other countries where *E. faecium* is more frequent.[15] As an alert to control the spread of bacterial resistance, it is worth noting that VRE rates in Latin America increased from 5.0% in 2003 to 15.5% in 2008, and the most significant increase occurred among isolates from Brazilian centers.[15,20] In the pediatric population, antimicrobial resistance among Gram-negative bacteria is of concern due to the implications in clinical practice. The rate of resistance to carbapenems and other drugs, especially in *A. baumannii* and *P. aeruginosa*, is among the highest described in the world literature.[21-23]

In relation to bloodstream infections, we observed that *S. epidermidis* was the most frequently found in the analyzes. In other study performed in a neonatal ICU, *S. epidermidis* was the most frequent agent of bloodstream infections, possibly due to the use of invasive procedures in ICUs. Additionally, the authors caution against an increase in cases of infections of the bloodstream by *Staphylococcus* spp. and also by Gram-negative resistant bacteria such as *Acinetobacter* spp.[23] In children hospitalized in the United States, coagulase negative *Staphylococcus* are the main agents of infections in the bloodstream, which consolidates this genus as the most frequent in this site. [24]

Analysis of the data provided by the ICS of the pediatric hospital allowed a more detailed assessment of the incidence of bacteria associated with systemic infection, of the urinary tract, and isolated from diverse secretions of the pediatric population attended in the public hospital studied. In urinary tract infections, *E. coli* was more prevalent followed by *P. mirabilis*. Data from the literature show that *E. coli* accounted for 69 % of infections, either HAI or those acquired in the community, followed by *P. aeruginosa* as main agents.[25] However, in contrast to our data, *P. mirabilis* was not isolated, and this is possibly due to the study approach only in HAI, which differs from the proposal of this work which includes community infections. The finding of *P. aeruginosa* is possibly associated with medical intervention with devices such as catheters and probes, where it easily adheres and forms biofilms that are difficult to treat.[23]

Data from literature referring specifically to the epidemiological profile of bacteria recovered from various secretions are not found. Generally, specific HAI studies address the prevalence of bacteria isolated from the bloodstream, surgical sites, respiratory tract, and skin separately, with reports of these same bacteria being frequent.[7,10-11]

This study presented as a limitation the use of retrospective data. Brazil is marked by socioeconomic inequalities, and hospital institutions are heterogeneous in terms of organization, structure, and resources, with HAI data rarely disclosed and often not consolidated. Nevertheless, the epidemiological data presented here



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may contribute to expand knowledge of the context of infections in the pediatric population, still scarce in Brazil, and provide better treatment and control measures of HAI in hospital institutions. Finally, the knowledge of prevalent bacterial isolates is crucial when choosing a therapy to decrease morbidity and mortality in hospitals.

## ACKNOWLEDGMENTS

We would like to thank the João Paulo II Children's Hospital, together with a hospital infection control team. Itaúna University, MG for the partnership. And the Graduate Program at UFSJ/MG. We also appreciate the support of the Coordination for the Improvement of Higher Education Personnel - Brazil (*Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil* - CAPES) - Financing Code 001.

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**Geisa Cristina da Silva Alves** contribuiu para a concepção, delineamento, análise e redação do artigo.

**Magna Cristina Paiva e André de Oliveira Baldoni** contribuíram para o planejamento, análise e revisão final do artigo.

**Cristina Sanches** contribuiu para o planejamento e delineamento do artigo, revisão e aprovação final do artigo.

Todos os autores aprovaram a versão final a ser publicada e são responsáveis por todos os aspectos do trabalho, incluindo a garantia de sua precisão e integridade.



***Please cite this article as:*** *ALVES, Geisa Cristina Silva et al. Epidemiological profile of isolated bacteria in a public pediatric hospital. Revista de Epidemiologia e Controle de Infecção, [S.l.], v. 10, n. 4, out. 2020. ISSN 2238-3360. Available at: <https://online.unisc.br/seer/index.php/epidemiologia/article/view/14708>. Date accessed: 21 jul. 2021. doi:https://doi.org/10.17058/reci.v10i4.14708.*