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Epidemiological data on health care-associated infections (HAIs) reported in Brazil

Natiele da Silva Maciel
Hospital Regional Deputado Afonso Guizzo, Araranguá/SC, Brazil and Universidade Federal de Santa Catarina (UFSC)
Contato: natyellemaciel@gmail.com

Bruno Hech Dominski
Universidade Federal de Santa Catarina (UFSC)
Contato: brunodominski7@gmail.com

Ricardo Ruiz Mazzon
Universidade Federal de Santa Catarina (UFSC)
Contato: ricardo.mazzon@ufsc.br

Fabienne Antunes Ferreira
Universidade Federal de Santa Catarina (UFSC)
Contato: fabienne.ferreira@ufsc.br

Resumo: As Infecções Relacionadas à Assistência à Saúde (IRAS) constituem um grande problema à saúde pública mundial, já que estão relacionadas ao aumento de morbidade e mortalidade, aumentando custos hospitalares. Além disso, grande parte destas infecções estão relacionadas à microrganismos que apresentam resistência aos antimicrobianos (RM), dificultando o tratamento. Conhecer o perfil epidemiológico destas infecções contribui para o desenvolvimento de estratégias para o controle de IRAS/RM. Neste sentido, o presente trabalho realizou uma revisão bibliográfica de dados epidemiológicos das IRAS no Brasil publicados entre 2017-2022. Foram selecionadas 27 publicações científicas. 13 destas apresentaram prevalência/incidência geral de IRAS, com apenas um estudo multicêntrico, multisetorial e multietário. Os demais estudos reportaram taxas de IRAS a partir de dados epidemiológicos oriundos de infecções de corrente sanguínea, infecções de sítio cirúrgico e infecção urinária, entre outras. Quando disponíveis, os perfis microbiológicos/resistência a antimicrobianos foram incluídos, sendo compatíveis com o que reporta a literatura científica. A partir dos dados desta revisão, observou-se que, apesar dos avanços na área, os estudos que reportam taxas de IRAS ainda são escassos e limitados a um contexto específico no Brasil, evidenciando a necessidade de mais estudos multicêntricos e contínuos. Conhecer melhor a epidemiologia de IRAS a nível nacional e público possibilita um melhor planejamento, desenvolvimento de estudos científicos e implementação de estratégias de controle e mitigação destas infecções.
Palavras-chave: IRAS; Infecções Relacionadas à Assistência à Saúde; Epidemiologia, Brasil.

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Abstract: Health care-associated Infections (HAIs) are a major problem for global public health, as they are related to increased morbidity and mortality, increasing hospital costs. In addition, most of these infections are related to antimicrobial resistance (AMR), making treatment difficult. Knowing the epidemiological profile of these infections contributes to the development of strategies to control HAIs/AMR. The present study carried out a bibliographic review of epidemiological data on HAIs in Brazil published between 2017-2022. Twenty-seven scientific publications were selected. Thirteen of these showed an overall prevalence/incidence of HAIs, with only one multicenter, multisectoral and multi-age study. The remaining studies reported HAIs from epidemiological data from bloodstream infections, surgical site infections and urinary tract infections. When available, microbiological profiles/antimicrobial resistance

were included, which are consistent with what is reported in the scientific literature. Based on the data of this review, it was observed that despite advances in the area, studies reporting HAI rates are still scarce and limited to a specific context in Brazil, highlighting the need for more multicenter and continuous studies. Knowing the epidemiology of HAIs better at the national and public level allows for better planning, development of scientific studies and implementation of strategies to control and mitigate these infections.
Keywords: HAIs; Health care Infection; Epidemiology; Brazil.

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INTRODUCTION

Nosocomial infections are currently described as Healthcare-Related Infections (HAIs), as these infections are not limited to the hospital environment. HAIs can be acquired in any healthcare setting, such as dentalcare clinics, hemodialysis service, long-stay institutions for the elderly, homecare systems, etc. In Brazil, HAIs are usually defined as infections acquired 72 hours after the patient's admission to a healthcare unit, when they can be related to hospitalization or clinical care procedures (BRASIL, 1998; ANVISA, 2013). Patients can manifest HAIs during the hospitalization/ clinical care period or after hospital/clinical care discharge (BRASIL, 1998). Over the years, the research done for knowing, preventing, and controlling HAIs has become increasingly relevant. In Brazil, the first reports on the occurrence of HAIs appeared in the 1950s. From 1968 on, the first reports of the creation of the Committees to Control Hospital Infection came out (CCIH; from Portuguese: *Comissão de Controle de Infecção Hospitalar*). However, it was only in 1985, after the death of the President of the Republic, Tancredo Neves, as a result of septicemia due to a post-surgical infection, that the Ministry of Health implemented actions in public policies that changed the scenario of infection control in the country. Several government actions triggered the enactment of Brazilian Federal Law 9,431/1997, which required the mandatory existence of Hospital Infection Control Programs in all hospitals nationwide; and later Ordinance 2,616/1999, which included the organization and competences of the CCIH. In 1999, the National Health Surveillance Agency (ANVISA; from Portuguese: *Agência Nacional de Vigilância Sanitária*) was created in Brazil, an autarchy associated to the Ministry of Health, and whose attributions also include the control of HAIs at the federal level, providing support to the State Departments (ANVISA, 2013).

Currently, ANVISA receives data collected and reported by CCIH through an electronic form from hospitals with Intensive Care Unit (ICU) beds or that perform surgical delivery. These data are analyzed and enable the evaluation of national indicators of HAI and Antimicrobial Resistance (AMR). The information recorded is subdivided into infections reported by ICU type (adult, neonatal and pediatric), indicating an Incidence Density (ID) of HAIs by clinical site [Laboratory Confirmed Bloodstream Infection (LCBI), Urinary Tract Infections (UTI), Ventilator-Associated Pneumonia (VAP) and Surgical Site Infection (SSI)] (ANVISA, 2020).

HAIs are related to negative impacts on both patients and professionals in healthcare units, which can increase morbidity and mortality, as well as the length of stay and costs to the health system (OPAS, 2020). It is estimated that, on average, 7% of patients in developed countries and 15% in developing countries will acquire at least one HAI during their healthcare. In neonatal or adult ICUs, infection rates are two to three times higher in low-income countries and three to twenty times higher in middle-income countries compared to high-income countries (WHO, 2021). Imunosuppression, submission to invasive procedures (including the use of implantable medical devices such as catheters, probes, prostheses and mechanical ventilation) and the ability of the microorganism to cause disease are factors that, in general, favor the occurrence of HAIs (SARTOR, 2021). Correct adherence to hand washing and correct hygiene/disinfection/sterilization of equipment/objects considerably minimize the risk of acquiring and disseminating HAIs (ANVISA, 2021).

Many HAIs are associated with antimicrobial-resistant microorganisms (O´NEILL, 2016). Patients affected by AMR strains require longer hospital stays and longer treatment periods, increasing the costs and risk of acquiring HAIs (OPAS, 2020). In 2017, WHO ranked antimicrobial-resistant microorganisms according to epidemiological relevance, where *Acinetobacter baumannii*, *Pseudomonas aeruginosa* and carbapenem-resistant (CPR) *Enterobacterales* members were considered a critical priority, while Vancomycin-resistant *Enterococcus* (VRE), methicillin-resistant *Staphylococcus aureus* (MRSA) and Vancomycin Intermediate-resistant *Staphylococcus aureus* (VISA) were considered high priority for surveillance, research and development of new antimicrobials (ANVISA, 2021). In Brazil, the Bulletin of Patient Safety and Quality in Health Services nº 23, prepared by ANVISA in 2020, reported that the main isolates with AMR associated with HAI in adult ICUs were: 3rd and 4th generation cephalosporin-resistant and CPR gram-negative bacilli; CPR *Acinetobacter baumanii-calcoaceticus*; vancomycin-resistant *Enterococcus faecium* (VRE) and oxacillin-resistant Coagulase-negative *Staphylococci* (CoNS) (ANVISA, 2020).

In view of the problem of HAIs and AMR associated with these infections, a better understanding of the Brazilian epidemiological situation on the subject is needed. Although the performance of the Brazilian PCIH/CCIH is fundamental for the control and prevention of HAIs, national epidemiological data are not, in general, published in the form of scientific publications. Agencies such as CDC (*Centers for disease control and prevention*) and ECDC (*European CDC*) present periodic reports with national indicators on the prevalence/incidence of HAIs, commonly associated microorganisms; as well as AMR rates and potential risk factors, among other indicators (ECDC, 2019; CDC, 2020). Additionally, several foreign researchers also publish studies from their respective countries on the national epidemiological situation in scientific journals (O'NEILL, 2016; GOZEL et al., 2021; SUN et al., 2021; WEINER-LASTINGER et al., 2021). In Brazil, epidemiological and publicly available data on the subject are still scarce. ANVISA makes a partial disclosure of the data and there are also some important scientific publications (PADOVEZE; FORTALEZA 2014; FORTALEZA et al., 2017). However, there are few HAI/AMR indicators, at the national level, compiled and published in a single document. A better understanding of the epidemiology of HAIs/AMR at the national and public level allows for better planning, development of scientific studies and implementation of strategies to control and mitigate these infections, which culminate in the reduction of HAI/AMR rates. Thus, the aim of the present study was to compile, disseminate and discuss recent epidemiological data related to HAIs in Brazil through a bibliographic review of publications from 2017 to 2022.

DEVELOPMENT

This is a study carried out through a bibliographic survey. Publications that explicitly present the prevalence/incidence of HAIs in Brazil were obtained from a search in the indexed databases of Pubmed (https://pubmed.ncbi.nlm.nih.gov/) and Scielo (https://scielo.org/pt/). The search for publications was carried out in the search field of the aforementioned databases using the following keywords: "*healthcare-acquired infections and Brazil*", "*hospital infections and Brazil*", "*hospital-associated infections and Brazil*". Only publications from January 1st, 2017, to August 1st, 2022 were included, corresponding to five years and seven months. The selected publications were exported to a bibliographic reference management folder. From the selection of scientific publications according to the search criteria, the following data were analyzed in each study: a) HAI rate (percentage, incidence, prevalence); b) Study period (days, months and/or years); c) Study location (hospital/hospital sector/care unit/city/Brazilian state); d) Types of infectious sites, such as Surgical Site Infections (SSI), Bloodstream Infections (BSI), ventilator-associated pneumonia (VAP), Urinary Tract Infections (UTI), among others; e) Diagnosed microbial species and antimicrobial susceptibility profile of the identified microorganisms; f) Profile of patients recruited in each study, such as demographic data and associated hospital and/or healthcare sector, as well as pre-existing comorbidities, when available; g) Potential risk factors associated with patient morbidity and/or mortality, when available. In this study, the "Patient Safety and Quality Bulletin in Health Services No. 23 - National Assessment of HAI and MR indicators - 2020" was also found, reported by ANVISA in 2020 on the subject, which encompasses notifications at the national level (ANVISA, 2020). Although there are important data on the incidence of HAIs, data in this bulletin is not presented in the form of a report and does not contain a detailed discussion of referred data. Therefore, data from this bulletin were not included in this review. However, the ANVISA report was the most complete in terms of epidemiological data on the subject. The Agency has made progress in recent years with epidemiological information obtained from an increasing number of recruited hospitals.

In the search in databases, 5,503 results were analyzed. After following the search criteria, a total of 27 publications were selected. Most of the studies found were excluded because they did not present a prevalence/incidence rate of HAIs. Data were subdivided by type of infectious sites, as shown in Table 1.

Although advances have been made in recent decades and despite efforts to understand, prevent and control the incidence of HAIs, the present work highlights the lack of epidemiological studies published nationally in Brazil. During the search carried out in this review, a considerable number (5,503) of articles related to HAIs was found. However, most do not explicitly report an HAI prevalence/incidence rate. Thus, a relatively low number (27) of publications were selected; in many of them the information comes from local studies, reported in short periods of analysis and focusing on specific occurrences (site of infection, microbial species, patient group, sector hospital).

Among the 13 studies that showed an overall prevalence/incidence of HAIs, only one study was multicenter, multisectoral and multiage (FORTALEZA et al., 2017). Even though this study is the most comprehensive among the publications selected in this review, the authors cite some limitations in their study, including those inherent to the cross-sectional design, such as the lack of follow-up of the subjects and the impossibility of detecting HAIs after discharge, as well as the continental dimensions of Brazil, which prevented them from including hospitals in all 26 states. However, the inclusion of multiple hospitals in the five macro-regions allowed a perception of the burden of HAIs in Brazil (Table 1). A study by Huerta-Gutierrez et al. (2019), included the three age groups (adult, pediatric and neonatal), was regionalized (in only one state) and presented a prevalence of one day (7.23%). In addition to these two, we found six more studies conducted with an adult, four pediatric and one neonatal population that showed an overall prevalence/incidence of HAIs (Table 1). Pediatric and/or neonatal studies were performed in only one hospital each (TEIXEIRA et al, 2017; ALVARES et al, 2019; AMANCIO et al., 2020; SILVA et al., 2021). Among the studies composed only of adult patients, only one (BRAGA et al., 2018) was regionalized, in ICUs of 28 hospitals in the same state (Minas Gerais; MG). The other six (LOPES et al., 2018; VESCO et al., 2018; LIMAYLLA et al., 2019; FERREIRA et al., 2020; SABINO et al., 2020; D´OLIVEIRA et al., 2022) were performed in a single hospital each. The populations that composed the studies had numbers ranging from 3,201 patients (LIMAYLLA et al., 2019) to 53 patients (VESCO et al., 2018). Three studies (LOPES et al., 2018; SABINO et al., 2020; D´OLIVEIRA et al., 2022) were carried out in the ICU sectors. HAI rates ranged from 55.1% (SABINO et al., 2020) to 5.3% (LOPES et al., 2018), excluding the 78.3% rate found in the study by D`Oliveira et al. (2022) because it involved critically ill patients with cirrhosis and in the ICU. Due to the distinctions listed in all the studies evaluated at this stage, it is not correct to compare the rates presented in studies with such different approaches. That is why the ANVISA bulletin (ANVISA, 2020) presents the data separately by infectious site, so that they are comparable. Listing the peculiarities of the publications allows us to demonstrate the heterogeneity of the studies included in this review. Thus, it is observed that the information is restricted to specific contexts and times, and at a local or regional level in the studies published and available to the community. This makes it difficult to compare and overview HAI rates in Brazil.

Table 1. Description of selected publications and main results reported. The table includes the basic data of the publications (authors, year of publication and location), type of HAIs and the main results, considering HAI rates, main microorganisms and antimicrobial resistance reported and main population characteristics/risk factors, when available.

Author(s)/ Year of publication	Type of HAIs	City/State	Incidence/Prevalence of HAIs	Most frequent microorganisms and antimicrobial resistance	Population characteristics/ risk factors for HAIs
Alvares et al., 2019	Overall prevalence of HAI in pediatric ICU	São Paulo/SP	448 patients: Incidence density (ID) of HAI in the P-ICU was 14.32 cases per 1,000 patients-day.	GNB 63%, GPB 19%, and fungi 13%. AMR: 35% CPR among GNB; 33% VRE among GPB.	Mean age:13.4 months (P-ICU). BSI- device associated was the most common HAI.
Amancio et al., 2020	Overall prevalence of HAI in a pediatric transplant unit	Curitiba/PR	86 episodes of HAI in 66 patients: ID 16.5 infections/1,000 patients days.	GPB 11.8%, GNB 7.8%, virus 13.1% and fungi 5.2%. AMR: ESBL-positive *Klebsiella* spp. and *E. coli*; CPR *K. pneumoniae*.	Mean age: 8.1y; 71 (65.1%) were male; 55 (50.5%) with an oncologic diagnosis.
Armede et al., 2017	SSI incidence	State of São Paulo	Among 185 patients included, the overall incidence of SSI was 8.1%.	NA	Mean age: 34y, 73.3% female. Risk factors: contaminated or dirty wound, perioperative hair removal, and placement of drains.
Braga et al., 2018	Overall prevalence of HAIs in adult ICUs	16 cities/MG	Among the 303 patients from all ICUs, prevalence of infection was 51.2%.	GNB 52.9%, GPB 38.7%, *Candida* spp. 8.4%. AMR: MRSA, 3rd and 4th generation cephalosporin resistant *E. coli* and CPR *P. aeruginosa*.	Mean age: 58.4y, male (58.5%). Diabetes mellitus (34.1%) was the most reported comorbidity.
Canela et al., 2017	Incidence of SSI by *Candida spp.*	Ribeirão Preto/SP	Among 79 patients enrolled, the candidemia incidence was 1.52 per 1,000 admissions.	*C. albicans* 44%, *C. glabrata* 19%, *C. tropicalis* 19%, *C. parapsilosis* 14% and *C. orthopsilosis* 4%. One *C. albicans* isolate resistant to azoles.	Mean age: 42.7y, 57% male. Main risk factors: Previous antibiotic therapy, urinary and central venous catheters, among others.
Chueiri Neto et al., 2019	Incidence of SSI	Campinas/SP	From 401 patients, 103 (25.7%) patients had 139 microbiologically proven BSI.	GNB 63.31%, GPB 28.78%, fungi 7.91%. Fifty-six infections (43.75%) were MDR bacteria.	72.1% male. Strong relationship between MDR, BSI and lower serum albumin.

Table 1. continuation

Comerlato et al., 2017	Other HAIs (related to catheter)	Porto Alegre/RS	311 patients: catheter-related infection was detected in 11.1%.	NA	Mean age: 51.5y and 42.9% male.
Correa and Fortaleza, 2019	Other HAIs (CPR-*Enterobacterales*)	Bauru/SP	384 patients: 51 (13.2%) had HAI (ID, 7.3 per 1,000 hospitalization-days).	*K. pneumoniae* 85.7%, *Enterobacter spp.* 13.3% e *pneumonia. coli* 1.0%.	Mean age: 61y; 37.8% female. Risk factor: urinary catheter.
Damasco et al., 2019	Other HAIs (infectious endocarditis)	Rio de Janeiro/RJ	73 cases of infective endocartidis (IE): 67.1% prevalence of HAI-IE.	*S. aureus* 38.7%, *Enterococcus* spp., 20.4% e CoNS 10.2%. AMR: MRSA and VRE.	NA
D´Oliveira et al., 2022	Overall prevalence of HAIs in critically ill patients with cirrhosis	Salvador/BA	784 patients; 374 bacterial infections identified. 293 (78.3%) were HAIs.	GNP 73%; GPB 27%. AMR: ESBL and CPR-*Enterobacteriaceae*.	Factors associated to mortality: hospital length of stay, infections by ESBL, among others.
Ferreira et al., 2018	BSI incidence (transplant unit)	São Paulo/SP	Among 232 patients, the cumulative incidence of BSI was 25.4%.	GNB 55.2%, mainly *P. aeruginosa*; GPB 44.8%, mainly CoNS. 40.3% were MDR.	Mean age: 49y; 60% were male. Risk factors: age (>62y), parental Nutrition and previous colonization.
Ferreira et al., 2020	General prevalence of HAIs (heart surgery)	Curitiba/PR	Among the 195 patients available, the HAI rate was 22.6%.	NA	Female gender and age were risk factors for infections.
Fortaleza et al., 2017	General prevalence of HAIs	Multicenter: 10 Brazilian states (152 hospitals)	6,520 patients: the overall HCAI prevalence was 10.8%	NA	NA
Fortaleza et al., 2019	Incidence of SSI	Botucatu/SP	36,429 patients from 13 surgical specialties. The overall incidence of SSIs was 8.4%.	NA	Association between temperature and the individual risk of SSI in clean wound procedures.
Freitas et al., 2019	BSI incidence in neonatal ICU	Brasília/DF	1,560 neonates: 22% of incidence of BSI (18.6 per 1,000 CVC-days).	GPB 66%, GNB 25% and fungi 9%. AMR: GNB resistant to 3rd and 4th generation cephalosporins (34%) and MRSA (14%)	Risk Factor: birth weight. Mean gestational age: 33 weeks and Mean birth weight:1820 g.

Table 1. continuation

Huerta-Gutiérrez et al., 2019	General prevalence of HAIs	3 hospitals in Brazil (Porto Alegre/RS)	From 721 patients in Brazil, Prevalence of at least one HAI was 7.1%	40.9% *Enterobacterales, K. pneumoniae* (40.9%) being the most frequent. 34.1% GPB (25% *S. aureus*).	Patients with ≥70y of age, 46.1% had undergone surgery and 48% used invasive devices.
Limaylla et al., 2019	General prevalence of HAIs	Botucatu/SP	3,201 patients: The aggregate value of HAI prevalence for all surveys was 4.1%.	NA	Temperature was positively associated with SSIs and inversely associated with UTI.
Lopes et al., 2018	Overall prevalence of HAIs in adult ICU	Natal/RN	From 749 patients admitted in the ICU, the prevalence rate of infection was 5.3%	GNB 71.05%, GPB 21.05% and 7.9% of fungi. AMR: ampicillin and/or amoxicillin-resistant: CPR and cephalosporin-resistant.	The patients were female (63.6%), elderly (54.6%;62-92y) and came from other inpatient units of the institution.
Mota and Oliveira, 2019	Urinary infection incidence associated with urinary catheter	City not specified/ MG	402 patients enrolled. The ID of UTI related to urinary catheter use was 4.8 per 1,000 catheters/day	*K. pneumoniae* 46.7%, *E. coli* 20%, *P. aeruginosa* 13.3%, *A. baumannii* 13.3% and *Enterococcus* sp. 6.7%. MDR: associated with catheter-related UTI.	Mean age: 50.6y; 56.7% male. The mean hospitalization and ICU was 30 and 8.6 days, respectively. 70.9% had previously used antibiotics.
Oliveira et al., 2019	SSI incidence (transplanted unit)	São José dos Campos/SP	The incidence of SSIs in the 176 recipients was 26.9%.	Culture from 11 patients: *Staphylococcus*, Enterobacteriaceae and one *C. albicans*. AMR: MRSA, CPR ESBL-producing.	Risk Factors: High glycemic level in postoperative, longer surgical procedure, and differences between donor and recipient body mass index.
Sabino et al., 2020	Overall prevalence of HAI in adult ICU	Uberlândia/ MG	Among 2,168 patients, the incidence rate of HAI was 55.1%.	56.1% Non-fermenting GNB; 14.5% *Klebsiella* spp.; 33.7%, GPB, 58.6% SCoN; 10.1% Yeasts: AMR: MRSA (19.7%), CPR *P. aeruginosa* (15.4%), CPR *A. baumannii* (11.4%), oxacillin resistant SCoN (9.8%).	Mean age: 55y; 37.2% female. The most common HAI site were the lungs (pneumonia) and the BSIs were associated with an invasive device.

Table 1. continuation

Silva et al., 2021	General Prevalence of HAIs (Pediatrics/ Neonatology)	Belo Horizonte/ MG	2,751 neonates were included. HAI ID was 23 per 1,000 patient-day.	36 MDR were identified, mainly *K. pneumoniae*, *A. baumannii* and *S. aureus*.	The incidence density of HAIs per weight range was higher in the group under 750 g.
Teixeira et al., 2017	General prevalence of HAIs (pediatrics transplant unit)	Belo Horizonte/ MG	86 HSCTs in 81 patients: 140 HAIs; ID of 28.2 infections/1,000 patient-days.	BSI: higher prevalence of GNB (58.5%). GPB 30.2%. *Candida* sp. was the isolated pathogen in all fungal BSIs (11.3%).	Mean age 10y; 85% males. BSI was the main infection site; 93.48% of CVC-BSI.
Torres et al., 2018	SSI incidence	São Paulo/SP	Of the 173 patients undergoing craniotomy, 20 developed an SSI (Overall incidence of SSI of 11.56%).	*S. aureus* was the main pathogen found (15% of cases).	Mean age 51.9y; 50.9% male. Risk factors: surgical time greater than four hours, drainage time and having undergone reoperation.
Vesco et al., 2018	General prevalence of HAIs (transplant unit)	Fortaleza/ CE	Of the 53 liver receptors, 15 (28.3%) presented infection, with the most prevalent being clinical sepsis (37.4%)	Among the 10 microorganisms isolated, the majority (9; 90.0%) were GNB, mainly *E. coli*. Only 1 GPB (*S. aureus*) was isolated (10%).	Mean age 45.7y; 60% male. Risk factors: days of postoperative hospitalization, the use of immunosuppressant and use of invasive devices.
Westphal et al., 2019	BSI incidence – Sepsis	Southern Region of Brazil - City and State not specified	543 patients with a diagnosis of sepsis 319 (58%) cases were classified as hospital-acquired sepsis.	NA	Mean age: 62y; 47.3% male. Hospital-acquired sepsis associated with higher mortality and longer ICU and hospital stays.
Yoshida et al., 2019	BSI incidence associated with the use of central intravenous catheter in ICU	Central Brazil– City and State not specified	Adult ICU: 11.446 patients; 3.40 the ID of CVC-BSI. Pediatric ICU: 3.791 patients, 3.36 the ID of HAIs.	61.8% GNB (28.2% *P. aeruginosa*); 30.8% GPB (15.4% *S. aureus*); 10.3% Fungi, (7.7% *C.* non-*albicans*).	78.1% male in ICU. The main diagnosis in patients with CVC-BSIs was AIDS (48.7%), followed by tuberculosis (12.8%)

AMR: antimicrobial-resistance; BA: Bahia; BSI: Blood Stream Infection; CE: Ceará; CPR: carbapenem-resistant; CVC-BSI: central venous catheter-associated bloodstream infections; DF: Distrito Federal; ESBL: Extended-Spectrum Betalactamases; GNB: Gram-negative bacteria GPB: Gram-positive bacteria; HAIs: Health care-related infections; ICU: Adult Intensive Care Unit; ID: incidence density; IE: Infectious Endocarditis; MDR: multidrug-resistant; MG: Minas Gerais; MRSA: Methicillin-resistant *Staphylococcus aureus*; NA: not available (Data were not presented in the study); P-ICU: Pedriatric Intensive Care Unit (P-ICU); PR: Paraná; RJ: Rio de Janeiro; RN: Rio Grande do Norte; RS: Rio Grande do Sul; SP: São Paulo; CoNS: Coagulase-negative *Staphylococcus*; SSI: Surgical Site Infection; UTI: Urinary Tract Infection; UTI-BC: UTI Associated with Bladder Catheter; VRE: Vancomycin-resistant Enterococci.

Additionally, six published studies involving BSI were included in this review. All were performed in only one establishment providing health services. In one of the studies (YOSHIDA et al., 2019), the research focus was BSI associated with the central venous catheter, where the ID was 3.4 per 1,000 CVC-day in an adult ICU, lower than that presented by the ECDC regarding Italy, where the BSI rate associated with the central venous catheter was 4.8 per 1,000 CVC-day, and significantly higher than the rates of 1.7 per 1,000 CVC-day reported in the same ECDC report (2019) for countries such as Portugal and Luxembourg (ECDC, 2019). The other publications included in this review pointed to the occurrence of BSIs in specific contexts such as BSIs caused by *Candida* spp. (CANELA et al., 2017), ICS in adult transplant patients (FERREIRA et al., 2018; CHUEIRI NETO et al., 2019); Hospital sepsis in adult patients (WESTPHAL et al., 2019), late-onset BSI in neonates (FREITAS et al. 2019), making the correlation with multicentric publications unfeasible. The populations that composed the studies had numbers ranging from 11,465 CVC-days (YOSHIDA et al., 2019) to 79 patients (CANELA et al., 2017).

Three publications referring to SSI rates were also included (Table 1). Among the selected articles, only one (ARMEDE et al., 2017) was carried out in more than one hospital. However, the study is characterized as regionalized, as it covered three hospitals in the same state. The other studies (TORRES et al., 2018; FORTALEZA et al., 2019; OLIVEIRA et al., 2019) were carried out in a single health facility. Two studies (ARMEDE et al., 2017; FORTALEZA et al., 2019) showed a general incidence of SSIs, the others were developed with a focus on SSIs in specific surgical types, such as liver transplantation (OLIVEIRA et al., 2019) and craniotomy (TORRES et al., 2018). The number of patients who composed the studies ranged from 36,429 patients (FORTALEZA et al. 2019) to 173 patients (TORRES et al., 2018).

Only one study was found reporting the incidence of urinary tract infection (UTI), related to the use of a bladder catheter (MOTA; OLIVEIRA, 2019). In this study with 402 patients, the incidence of ICU related infection to urinary catheter use was 4.8 per 1,000 catheters/day. In the search performed in this review, no publication specifically presented the prevalence/incidence of respiratory tract infection.

This review also found three studies that pointed to context-specific HAIs: unspecified central intravenous catheter-related infections (COMERLATO et al., 2017), healthcare-acquired infective endocarditis (DAMASCO et al., 2019) and HAIs caused by ERC (CORREA et al., 2019). In the case of the latter study, Correa et al. (2019) reported an incidence of 13.2% HAIs caused by ERC. In this sense, Kotb et al. (2020) aimed to describe the epidemiology of HAIs caused by ERC in Egyptian hospitals, showing that 47.9% of the isolated *Enterobacterales* were ERC, reporting that the overall incidence of HAIs caused by ERC was 3.7 per 10,000 patient-days. When observing the microbial species presented in the two studies, the same species are the most frequent: *K. pneumoniae* (Brazil: 85.7%/Egypt: 53.7%), *Enterobacter spp.* (Brazil: 13.3% / Egypt: 43.5%) and *E. coli* (Brazil: 1% / Egypt: 27.1%) (KOTB et al., 2020).

Among the studies that presented a microbiological profile, a higher frequency of gram-negative bacteria was observed, followed by gram-positive bacteria and fungi. Among the microbial species with the highest incidence reported in the studies, we can mention: *S. aureus*, species belonging to the SCoN group; *K. pneumoniae*, *P. aeruginosa*, *Enterobacter* spp., *A. baumannii*, *E. coli* and *Candida* spp. These microorganisms were similar to those that were most frequent in the ECDC report (ECDC, 2019). When observing the profile of Antimicrobial Resistance (AMR), we found that SCoN resistant to oxacillin; MRSA; *Klebsiella* producing ESBL; 3rd and/or 4th generation cephalosporin-resistant *K. pneumoniae*; *P. aeruginosa* resistant to carbapenems; *E. coli* resistant to 3rd and 4th generation cephalosporins; Carbapenem-resistant *A. baumannii* and VRE were the most reported AMRs among the studies presented in this review. These results are consistent with the antimicrobial resistant isolates presented in the ECDC report (ECDC, 2019). It is noteworthy that carbapenem-resistant *A. baumannii* and ERC are among the group of urgent antimicrobial resistance threats described in the CDC report (CDC, 2020). ESBL-producing *Enterobacteriaceae*, multidrug-resistant *P. aeruginosa*, and MRSA are listed as serious threats in this same report.

Among the risk factors for the acquisition and development of HAIs highlighted in the selected studies, it was reported that the use of invasive devices (central venous catheter, bladder catheter, orotracheal tube), prolonged hospitalization time (longer than nine days), surgery and age extremes were the most commonly reported risk factors. These factors are consistent with the risk factors reported by Sinésio et al. (2018) in a cross-sectional study carried out with 155 patients hospitalized between 2012 and 2014 in two intensive care units of two public hospitals in the Federal District, which aimed to identify risk factors associated with the occurrence of HAIs in intensive care units. Souza et al. (2015), in an epidemiological study, aimed to determine the mortality and risks associated with HAIs in patients admitted to a hospital in Londrina in the state of Paraná.

One of the limitations found in this review is the inclusion and exclusion criteria (including only studies published in scientific journals, with specific keywords and excluding theses and dissertations), which possibly resulted in studies relevant to the topic not being included. In addition, the following can be mentioned as limiting factors: the heterogeneity of the studies, which makes comparisons between them difficult; the relatively low number of publications that showed prevalence/incidence of HAIs; and finally, studies carried out in specific contexts limited the presentation of a compilation of general data on HAIs and AMRs at the national level.

FINAL CONSIDERATIONS

As expected, it was possible to observe that, despite the understanding of the importance of the topic, epidemiological data on HAIs are scarce in the Brazilian literature. Through the analyzed studies, it can be observed that the data are mostly from local/regional studies and focused on specific infectious sites and hospital sectors, highlighting the urgent need for more multicenter and continuous epidemiological studies. However, ANVISA has made progress in recent years, providing more public epidemiological data on the subject, recruiting a greater number of participating health care facilities and acting in the surveillance of antimicrobial resistance. It is suggested that the more these data are known, studied and disseminated, the better the control of HAIs and of the spread of potentially pathogenic microorganisms will be, including those resistant to antimicrobials. Therefore, in order to help ensure the success of high-quality health care, this review was carried out, facilitating access to information and contributing to providing data for future scientific research on the subject. In view of the above, we can conclude that continuous epidemiological monitoring of HAIs and AMRs is essential to recognize infection rates, types of infections and their most common causative agents, making it possible to estimate the impacts on patients and health professionals, as well as improve prevention and surveillance.

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