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Review Article

Cost of primary bloodstream infection and dimensions of impact: a scoping review*

Custo da infecção primária de corrente sanguínea e dimensões de impacto: revisão de escopo

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Janayna Thais Silva[1]
Daiana Kloh Khalaf[1]
Kariane Gomes Cezario Roscoche[1]
Márcia Helena de Souza Freire[1]
Shirley Boller[1]
Bruna da Costa Bueno[1]

ABSTRACT

Objective: to map the costs and dimensions associated with the treatment of bloodstream infection in adult and pediatric patients. **Methods:** a scoping review conducted across five national and international databases and three gray literature databases. **Results:** of the 258 studies identified, 12 were included in the final sample. Costs associated with the treatment of bloodstream infections ranged from US$122.91 to US$439,015.00, with increased hospital stays ranging from 10 to 135 days. Qualitative analysis revealed increased morbidity and complications related to prolonged hospitalization, the need to implement interventions to mitigate risks, and the substantial financial burden imposed on healthcare systems. **Conclusion:** bloodstream infection constitutes an adverse event with significant clinical, economic, and organizational impact, as it is associated with prolonged hospitalization, increased morbidity and mortality, and greater demand for resources, thereby imposing a considerable burden on healthcare systems. **Contributions to practice:** the findings reinforce the importance of institutional policies focused on patient safety, as well as the adoption of preventive practices aimed at strengthening care outcomes and optimizing available resources.

Descriptors: Patients; Catheter-Related Infections; Hospital Costs; Hospital Infection Control Program; Patient Safety.

RESUMO

Objetivo: mapear o custo e dimensões do tratamento da infecção primária de corrente sanguínea em pacientes adultos e pediátricos. **Métodos:** revisão de escopo conduzida em cinco bases de dados, nacionais e internacionais, e três bases de literatura cinzenta. **Resultados**: dos 258 estudos identificados, 12 foram incluídos na amostra final. Os custos associados ao tratamento de infecções primárias da corrente sanguínea variaram de US$122,91 a US$439.015,00, com incremento no tempo de internação entre 10 e 135 dias. Na análise qualitativa, evidenciaram-se aumento da morbidade e de complicações relacionadas ao prolongamento da hospitalização, a necessidade de implementação de intervenções para mitigação de riscos e o elevado impacto financeiro para os sistemas de saúde. **Conclusão:** a infecção primária da corrente sanguínea configura-se como um evento adverso de significativo impacto clínico, econômico e organizacional, por estar associada ao prolongamento das internações, ao aumento da morbimortalidade e à maior demanda por recursos, impondo importante ônus aos sistemas de saúde. **Contribuições para a prática:** os achados reforçam a importância de políticas institucionais voltadas à segurança do paciente, bem como da adoção de práticas preventivas, visando ao fortalecimento dos desfechos assistenciais e à otimização dos recursos disponíveis.

Descritores: Pacientes; Infecções Relacionadas a Cateter; Custos Hospitalares; Programa de Controle de Infecção Hospitalar; Segurança do Paciente.

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[1]Universidade Federal do Paraná.
Curitiba, PR, Brazil.

Corresponding author:
Janayna Thais Silva
Av. Prefeito Lothário Meissner, 623 - Jardim Botânico.
CEP: 80210-170. Curitiba, PR, Brazil.
E-mail: janathais.s@gmail.com

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Introduction

Bloodstream Infection (BSI) is classified as an adverse event, characterized by the absence of association with infections at other sites in the body[1]. This condition impacts patients' clinical outcomes, increases rates of healthcare-associated infections (HAIs), and results in substantial costs for healthcare services[2]. Catheter-associated bloodstream infections are among the most lethal, with attributable mortality rates ranging from 15% to 30%[3]. This scenario directly affects patient safety, requiring continuous attention from healthcare institutions regarding prevention, monitoring, and appropriate management.

From a clinical and epidemiological perspective, these infections are associated with increased morbidity and mortality. Catheter use is associated with a two- to threefold higher risk of mortality and an average increase of 16 days in the length of hospital stay[2]. In these scenarios, microbial resistance has been associated with higher mortality in bloodstream infections, with a 9.08-fold greater risk in cases caused by carbapenem-resistant Klebsiella spp. and a 2.23-fold greater risk in infections caused by methicillin-resistant Staphylococcus aureus (MRSA)[3]. Such repercussions affect both adult and pediatric patients, although these groups present particularities regarding vulnerability, treatment response, and clinical progression.

Although there is broad national and international recognition regarding the contribution of BSIs to preventable mortality, their impacts extend beyond the clinical dimension, reaching the economic sphere of healthcare services. It is estimated that a single episode may generate costs of up to R$100,000.00[4]. In pediatric and neonatal settings, immunological vulnerability and dependence on invasive devices increase the complexity of cost management, as HAIs in these groups result in financial repercussions up to 4.2 times greater than those associated with conventional care[5].

Given the relevance of BSIs to the promotion of patient safety and the need to systematize the available evidence, a gap in the literature is identified regarding the costs and dimensions associated with their treatment. Although studies addressing the economic aspects of BSIs exist, there is a lack of reviews that comprehensively integrate the direct financial impact and the qualitative dimensions of care in a broad perspective encompassing both adult and pediatric patients. In this context, the present study aimed to map the costs and dimensions associated with the treatment of BSI in adult and pediatric patients.

Methods

Study design

Scoping review conducted in accordance with the recommendations of the JBI(6), and structured according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist[7]. The study was developed following these stages: (1) definition and alignment of the review objective and question; (2) development and alignment of the inclusion criteria with the objective and question; (3) description of the planned approach for search, selection, data extraction, and presentation of evidence; (4) search for evidence; (5) selection of evidence; (6) extraction of evidence; (7) analysis of evidence; (8) presentation and interpretation of results; and (9) summary of evidence, conclusions, and implications of the findings[6]. The review protocol was registered in the Open Science Framework (OSF) under DOI: https://doi.org/10.17605/OSF.IO/QN82B.

Data sources and search strategy

The Participants, Concept, and Context (PCC) strategy was used to formulate the research question. The Population (P) included adult and pediatric patients, the Concept (C) addressed the cost of treating BSI and its dimensions of impact, and the Context (C) was the hospital setting. Thus, the central question of this review was: What are the costs and dimensions

associated with the treatment of BSI in adult and pediatric patients in the hospital setting?

Based on the guiding question, descriptors and keywords were defined for the identification of studies relevant to the topic. The search strategy began with the selection of terms in different languages from the controlled vocabularies Medical Subject Headings (MeSH) and Health Sciences Descriptors (DeCS), combined using the Boolean operators AND and OR. Based on the preliminary search, free terms extracted from the titles and abstracts of relevant articles, as well as subject descriptors used for indexing, were also incorporated in order to compose the complete search strategy.

This stage was supported by a librarian with expertise in health-related database searches. Thus, the following search strategy was adopted: (patient OR "patients") AND ("catheter infection" OR "catheter associated infection" OR "catheter associated infections" OR "catheter related infection" OR "catheter related infections" OR "catheter site infection" OR "catheter--related infections" OR "catheterization site infection" OR "infected catheter") AND ("hospital cost" OR "cost, hospital" OR "health facility cost" OR "hospital costs"). The search strategy was adapted to the specificities of each database while preserving the equivalent combination of descriptors.

The initial search was conducted in July 2024 and was established and completed in November 2024 across the following databases and data sources: Medical Literature Analysis and Retrieval System Online (MEDLINE), Latin American and Caribbean Health Sciences Literature (LILACS), Web of Science (WOS), Cumulative Index to Nursing and Allied Health Literature (CINAHL), and Excerpta Medica Database (EMBASE). For gray literature, searches were conducted in Google Scholar, OPENGREY, and the Journal Portal of the *Coordenação de Aperfeicoamento de Pessoal de Nível Superior* (CAPES).

Eligibility criteria

Analytical observational studies were considered, including prospective and retrospective cohort studies, case-control studies, and analytical cross-sectional studies, as well as descriptive observational studies, including case series, case reports, and descriptive cross-sectional studies. In addition, theses and dissertations were considered as part of the gray literature. Studies published in Portuguese, English, and Spanish, with a time limitation between January 2019 and November 2024, were included. This interval was chosen to reflect the current reality of the issue, avoiding distortions caused by monetary variations from earlier periods. Editorials, opinion articles, letters to the editor, and studies that did not present the costs of BSI either partially or in full were excluded.

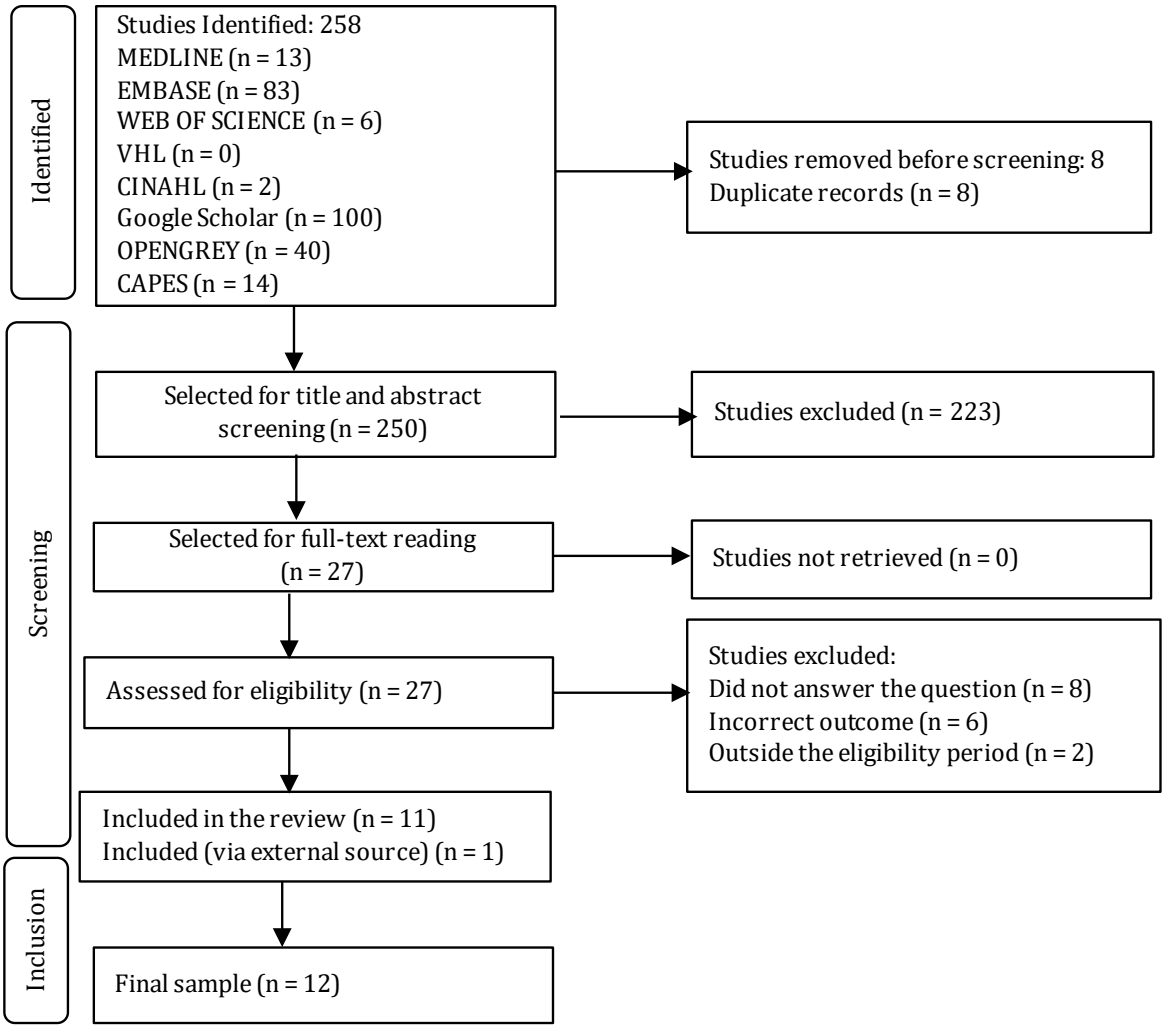
Selection, extraction, and data analysis

After the database search, the selected studies were imported into the Rayyan® reference manager. Title and abstract screening was performed independently by two reviewers in a double-blind process, with disagreements resolved by consensus involving a third reviewer. Data extraction from the included documents was conducted independently and organized in a Microsoft Excel® spreadsheet. The extraction instrument was developed according to the recommendations of the JBI®, based on the characterization of the publications, and included the following variables: author(s) and year of publication; objective; methodological design; participants/sample; currency; partial or total costs related to BSI; additional length of hospital stay (mean in days); and outcomes.

The findings were synthesized narratively and structured into figures and tables, relating costs converted into a single currency (US$) to enable comparability between international and national studies. The extracted data underwent a thematic coding process using the WebQDA software, allowing the identification of patterns and the qualitative categorization of outcomes into clinical, management, and economic dimensions. As this was a scoping review, approval by a Research Ethics Committee was not required.

Results

A total of 258 studies were identified across the databases and gray literature sources. After the removal of duplicates, title and abstract screening, and full-text reading according to the established eligibility criteria, 12 studies were included in this review. Figure 1 presents the flowchart of the process of identification, selection, and inclusion of the sources of evidence.



CAPES: *Coordenação de Aperfeicoamento de Pessoal de Nível Superior*

Figure 1 – Flowchart according to PRISMA criteria. Curitiba, PR, Brazil, 2026

Based on the analysis of the 12 included studies, publications between 2019 and 2024 were identified, with the highest percentage occurring between 2019 and 2020 (n=6; 50%), followed by 2023 and 2024 (n=4; 33.3%), and 2021 and 2022 (n=2; 16.6%). Of these, 5 studies (41.6%) were conducted in the United States of America, 3 (25%) in Brazil, and 1 study (8.3%) in each of the following countries: the United Kingdom, Greece, Pakistan, and Germany.

Regarding methodological approach, the sample consisted predominantly of retrospective cohort studies (n=7; 58.3%), followed by case-control studies (n=2; 16.6%), economic analysis (n=1; 8.3%), prospective cohort studies (n=1; 8.3%), and observa-

tional cohort studies (n=1; 8.3%). Concerning sample characterization, a high number of studies involving adult participants (13,035) was observed, followed by pediatric and neonatal participants (4,937), and mixed samples including both adult and pediatric participants (166).

With regard to the additional length of hospital stay resulting from BSI, the duration varied according to different variables, with the shortest additional period being approximately 10 days (9.71 days) and the longest additional hospitalization period reaching 135 days. The descriptive characteristics of the studies are summarized in Figure 2.

Author/Year/Country	Study design	Population	Partial or total costs US$*	Mean additional length of hospital stay (days)
Haughey et al (2019)[8] United States	Retrospective cohort	Pediatric and neonatal patients/4,749	439,015.00	135
Karagiannidou et al (2019)[9] Greece	Retrospective cohort	Pediatric and neonatal patients/188	16,053.72	21
Len et al (2019)[10] United States	Retrospective cohort	Adults/2,562	49,201.00 (ICU† cost per 1,000/patient-day)	–
Baier et al (2020)[11] Germany	Retrospective cohort	Adults/610	10,303.29	25
Brown; Burke (2020)[12] United Kingdom	Retrospective cohort	Adults/80	Limitation: only the value for the total sample	18
Osme et al (2020)[13] Brazil	Case-control	Adult and pediatric patients/166	10,149.00	16
Osme et al (2021)[14] Brazil	Economic analysis/ Monte Carlo simulation	Adults/949	17,630.00	21
Khan et al (2022)[15] Pakistan	Observational cohort	Adults/250	122.91	11.3
Hou et al (2023)[16] United States	Retrospective cohort	Adults/7,423	42,307.00	9.71
Yu et al (2023)[17] United States	Retrospective cohort	Adults/403	55,001.00	17.4
Bezerra et al (2024)[18] Brazil	Prospective cohort	Adults/574	20,277.00	20
Yengudhati et al (2024)[19] United States	Quasi-experimental case-control	Adults/184	83,446.00	25.1

*Partial or total costs of bloodstream infection in dollars = currencies converted to U.S. dollars through the website https://www.bcb.gov.br/conversao, exchange rate dated 09/12/2025; †ICU: Intensive Care Unit

Figure 2 – Description of the selected studies (n=12). Curitiba, PR, Brazil, 2025

Regarding the costs associated with BSI treatment per patient, heterogeneity was observed in the presentation of the data, with the use of different currencies and distinctions between total and partial costs. The U.S. dollar (US$) was the predominant currency (n=8; 66.6%)[8,10,13-14,16-18], followed by the Euro (€)[9,11] (n=2; 16.6%), the British Pound Sterling (£)[12] (n=1; 8.3%), and the Pakistani Rupee (PKR)[15] (n=1; 8.3%).

To facilitate understanding and standardization of cost data, the values presented in their original currencies in Figure 2 were converted to U.S. dollars (US$). This approach enabled the establishment of a comparative overview across countries and studies. The cost of BSI treatment ranged from US$122.91[15] to US$439,015.00[8]. This significant variation results from the substantial appreciation of the U.S. dollar within the economic context of Pakistan. It was not possible to convert the cost reported in the study whose

original currency was the British Pound Sterling[12], as the value referred to the total sample rather than the cost per patient.

In the included studies, three dimensions were analyzed based on the qualitative analysis of the outcomes presented, as shown in Figure 3. The Clinical Outcome dimension included the following subcategories: morbidity and associated complications (n=6; 50%), increased length of hospital stay (n=10; 83.3%), increased risk for patients with pre-existing conditions (n=4; 33.3%), and increased mortality associated with HAI/BSI (n=9; 75%).

The second category, Hospital Management Outcome, included the following subcategories: need for interventions to reduce risk (n=7; 58.3%), association between hospitalization setting and incidence of HAI/BSI (n=2; 16.6%), and effects of implementing technologies for risk mitigation (n=2; 16.6%). The Economic Outcome, the third category, comprised: high costs in patients with HAI/BSI (n=12; 100%), substantial financial waste within the healthcare system (n=9; 75%), and significant economic impact across different countries (n=6; 50%).

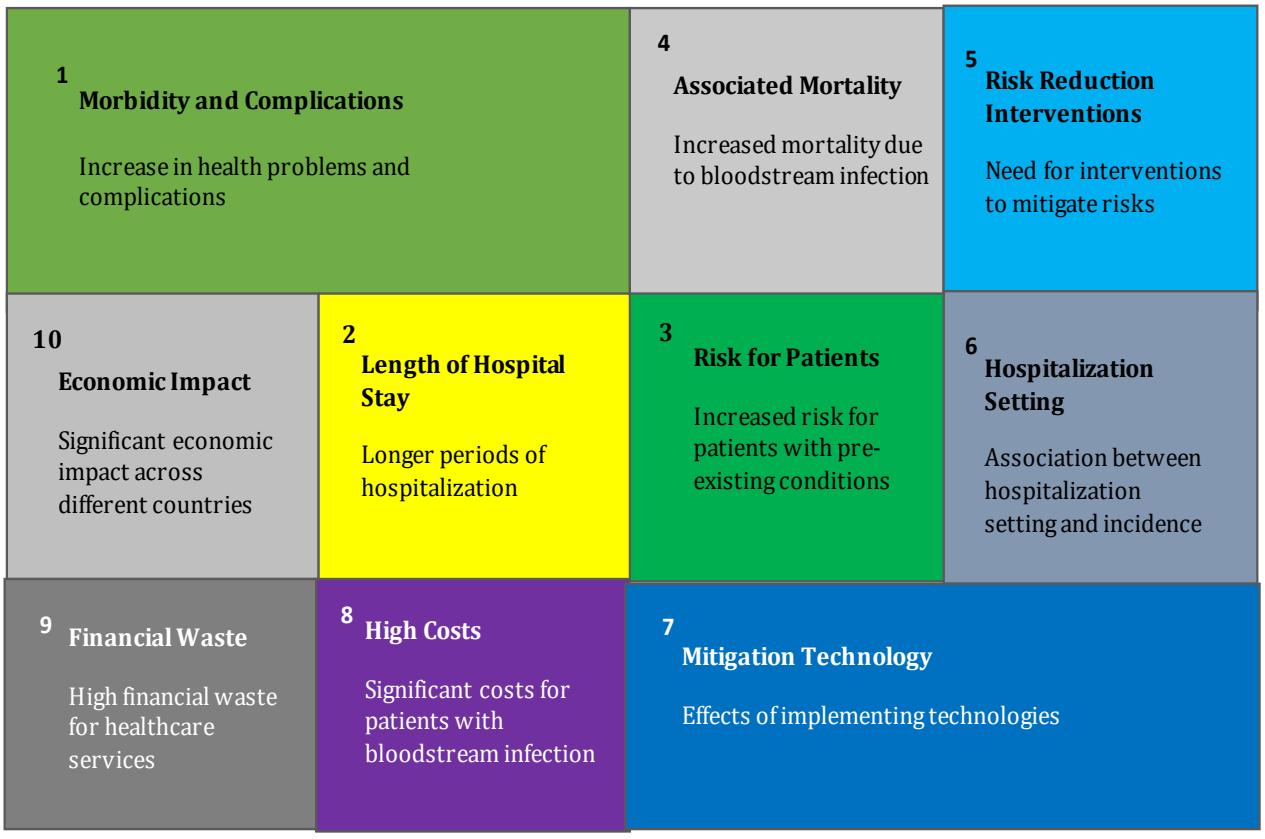


Figure 3 – Mapping of qualitative categories. Curitiba, PR, Brazil, 2025

Discussion

This review enabled the mapping of scientific evidence regarding the costs and dimensions associated with the treatment of BSI in adult and pediatric patients. Given the scarcity of studies specifically focused on evaluating the costs associated with BSI, a convergence of investigations conducted in different international contexts was observed, which may be attributed, among other factors, to the central role of patient safety as a strategy for reducing adverse events and mitigating costs in healthcare services.

In the United States, since 2008, a non-reimbursement policy has been in effect for healthcare institutions regarding complications considered preventable, a measure aimed at increasing institutional accountability and strengthening safe practices related to the prevention of BSI[20]. In the Brazilian context, the National Health Surveillance Agency (ANVISA in Portuguese) plays a strategic role in the surveillance and control of HAIs. In 2024, 1,899 healthcare services reported laboratory-confirmed cases of BSI in adult Intensive Care Units (ICUs), highlighting the scope of surveillance and the relevance of continuous monitoring of these events[21].

The results indicate the impact of BSI on patients' length of stay in healthcare services[8-10,12-15,17,19]. Such prolongation, especially when associated with unfavorable clinical outcomes, directly affects the organizational dynamics of healthcare services, intensifying workload demands and contributing to the development of psychological distress among healthcare professionals, including anxiety, depression, and burnout syndrome[22].

BSI directly impacts the length of hospital stay, with variations ranging from approximately 10 to 135 days. The upper limit of this range (135 days) was observed specifically in neonatal and pediatric patients with congenital heart disease, highlighting the clinical vulnerability of this group. This prolongation increases the complexity of care and hospital costs, requiring greater mobilization of resources and healthcare teams[8].

Corroborating these findings, a Brazilian investigation that analyzed medical records of newborns admitted to a neonatal ICU identified that, among 751 patients with a central venous catheter, 123 (16.4%) developed BSI. Although the implementation of the prevention bundle did not significantly reduce the incidence of infection, a direct impact on the length of hospitalization was observed, reinforcing that the systematic adoption of evidence-based practices may contribute to mitigating adverse outcomes, even in highly complex care settings[23-24].

The analyzed studies highlight the substantial avoidable economic burden and the significant financial impact on healthcare systems resulting from the morbidity and complications associated with BSI[8-9,11-12,17-18]. This scenario is further aggravated in patients with pre-existing conditions, who are at increased risk for the development of infections[8,11-12,16], as well as a greater likelihood of progression to unfavorable clinical outcomes, including increased mortality rates associated with HAI/BSI[8-12,15-18].

Additionally, the Society for Infectious Diseases highlighted a set of clinical and organizational elements that act as aggravating factors in cases of BSI. These include neutropenia, body mass index greater than 40, prematurity, prolonged hospital stay prior to catheterization, high microbial colonization at the insertion site and catheter hub, concomitant use of multiple venous devices, inadequate catheter care, transfusion of blood products, insertion into the internal jugular vein associated with the presence of tracheostomy, and inadequate nurse-to-patient ratios[25-26].

Antimicrobial susceptibility trends of etiological agents, as well as coexisting comorbidities and other mortality-related risk factors in hospitalized patients with bloodstream infections, were analyzed. The results revealed an overall 30-day mortality rate of 33.6%, with rates of 38.3% among adults, 25.0% among children, and 15.0% among neonates, demonstrating patterns consistent with the findings of the present study[27].

In onco-hematological patients, costs reached US$10,303.29 per episode[12], while in parenteral nutrition, secondary complications generated annual costs exceeding £800,000. Such evidence confirms that, beyond direct expenditures, BSI generates significant secondary financial impacts. These amounts include direct costs related to treatment, diagnostic tests, procedures, and prolonged hospital stay. In intensive care units, HAIs may triple healthcare costs[11], evidence that converges with findings from a Brazilian investigation[13], which evaluated the direct costs

of HAIs in public university hospitals and demonstrated that the mean cost per patient exceeded hospital reimbursement by 111.5%.

In the Brazilian context, an estimated analysis of the direct costs of HAIs conducted in 50 university hospitals considered the existence of 211,427 annual bed-days in intensive care units. Based on the duration of hospitalization, the annual number of hospitalized patients with and without HAIs was estimated. The study showed that the mean direct cost for BSI treatment was US$17,630.00 per patient. The authors emphasized that, if the rate of patients with HAIs reached 61.6%, the additional annual costs could amount to as much as US$147 million. Furthermore, maintaining fixed parameters related to the number of patients, each 1% increase in HAI prevalence was associated with an approximate annual increase of US$2.8 million in hospital costs. These findings highlight the financial burden of infections within the Brazilian public healthcare system, while also reinforcing patients' increased exposure and vulnerability to healthcare-associated adverse events[14].

In a pediatric onco-hematology unit, a comparative evaluation was conducted between the pre- and post-implementation periods of a standardized bundle incorporating technologies aimed at preventing BSI. The results demonstrated that the cost of infection treatment was lower in the intervention group, even when considering the investment in technologies, which totaled US$116,579.00, compared with US$130,661.00 in the control group. Furthermore, implementation of the bundle[28] prevented 71 episodes of BSI, resulting in estimated savings of approximately US$208,977.00 for the institution.

It is noteworthy that approximately 20% of HAIs are acquired in ICUs, settings characterized by a higher incidence density of BSI due to the insertion of multiple vascular catheters, the use of high-risk devices, and recurrent manipulations in urgent care contexts, resulting in increased morbidity and mortality, negative healthcare indicators, and substantial hospital costs[10,14,18,26].

From the perspective of hospital management, investment in research and the development of new technologies, as well as the continuous training of healthcare professionals, is necessary. It should be emphasized that the formulation of institutional policies encouraging the adoption of evidence-based practices and the standardization of technology use may significantly transform the scenario of BSI prevention[16]. In this way, hospital management assumes a central role in promoting a safer, more efficient care environment aligned with best clinical practices[29-30]. The implementation of advanced measures, combined with heightened attention to vulnerable patients, enables treatment effectiveness, clear identification of causality, and the development of preventive action plans[9,11-13,16-17,19].

In summary, BSI imposes clinical and economic implications on healthcare services. The adoption of protocols, preventive technologies, and continuous professional training is essential to reduce the incidence of infections and optimize resources. Thus, the integration of evidence-based measures and effective management contributes to a safer and more efficient hospital environment.

Study limitations

Among the main limitations of this study are the adopted time frame, the language restriction, which may have influenced the composition of the final sample, and the difficulties in accessing paid articles, factors that may compromise the robustness of the available evidence regarding the costs and dimensions of BSI in the current literature. Furthermore, there is a scarcity of studies conducted in the Brazilian context, as well as the possibility that relevant studies indexed in databases not included in this review may exist.

Contributions to practice

The presented data may support the planning of care strategies aimed at the prevention and mana-

gement of BSI, with emphasis on the central role of nursing. Furthermore, they contribute to the development and improvement of institutional protocols and care bundles, promoting the standardization of evidence-based practices, the systematic monitoring of indicators, and strengthened adherence to preventive measures. In this context, the findings contribute to the improvement of healthcare quality, especially regarding patient safety, efficient resource management, and the reduction of adverse events.

Conclusion

The dimensions of impact are consolidated into unfavorable clinical outcomes (morbidity and mortality), management challenges (need for technologies and protocols), and economic losses that exceed institutional reimbursement. The findings confirm BSI as an event associated with a high financial and organizational burden, whose prevention represents the primary mechanism for the sustainability of healthcare services. Therefore, the implementation of public policies, protocols, and care bundles that optimize resources, reduce complications, and promote safe practices is essential.

Authors' contributions

Conception and design or analysis and interpretation of data: **Silva JT, Khalaf DK, Bueno BC**. Manuscript writing, critical review of relevant intellectual content, final approval of the version to be published, and agreement to be accountable for all aspects of the manuscript related to the accuracy or integrity of any part of the work, ensuring that questions related to these aspects are appropriately investigated and resolved: **Silva JT, Khalaf DK, Roscoche KGC, Freire MHS, Boller S, Bueno BC**.

Data availability

The data and content supporting this study are contained within the manuscript itself.

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