Journal of Medical and Health Studies (JMHS)
ISSN: 2710-1452
DOI: 10.32996/jmhs
Journal Homepage: www.al-kindipublisher.com/index.php/jmhs

JMHS
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| RESEARCH ARTICLE

Epidemiological Trends of Healthcare-Associated Infections in Chile: A National Descriptive Study (2015–2022)

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| ABSTRACT
Healthcare-associated infections continue to represent a significant challenge for healthcare systems, particularly in resource-constrained settings. Evaluating national trends is essential to support infection prevention and control strategies, especially during periods of increased healthcare demand such as the COVID-19 pandemic. We conducted a retrospective ecological analysis using aggregated national surveillance data from medium- and high-complexity public hospitals in Chile between 2015 and 2022. Temporal trends in major HAIs, including ventilator-associated pneumonia (VAP), catheter-associated urinary tract infections (CAUTI), central line–associated bloodstream infections (CLABSI), and surgical site infections (SSI), were analyzed using descriptive statistics. A total of 43,478 HAIs were reported. Gram-negative microorganisms predominated overall, particularly in VAP and CAUTI, while Gram-positive organisms predominated in CLABSI and SSI. Although the total number of infections increased during the COVID-19 pandemic, the proportional distribution of major etiological groups remained relatively stable over time. Despite increased infection burden during the pandemic period, national surveillance data suggest stability in the overall distribution of major etiological groups. These findings highlight the importance of sustained surveillance systems to monitor infection trends and support infection control strategies in developing countries.

| KEYWORDS

Healthcare-associated infections; National surveillance; Epidemiological trends; Infection control; COVID-19.

| ARTICLE INFORMATION

ACCEPTED: 21 April 2026 **PUBLISHED:** 03 May 2026 **DOI:** 10.32996/jmhs.2027.7.2

1. Introduction

Healthcare-associated infections (HAIs) remain one of the most frequent and concerning adverse events affecting hospitalized patients worldwide (Raoofi et al., 2023). Prevalence estimates range from 5% to 15% in general hospital wards and may reach up to 37% in intensive care units (Haque et al., 2018). Beyond their clinical implications, HAIs contribute substantially to patient morbidity and mortality (Cassini et al., 2016), prolong hospital stays, and generate significant economic burden (World Health Organization, 2022). Importantly, many of these infections are preventable through sustained, evidence-based infection control practices (Sartelli et al., 2024).

A clear understanding of epidemiological patterns of HAIs, based on national surveillance data, is essential for guiding effective infection prevention measures and antimicrobial stewardship strategies (Sartelli et al., 2024). Device-associated infections—such as catheter-associated urinary tract infections (CAUTI), central line–associated bloodstream infections (CLABSI), and ventilator-associated pneumonia (VAP)—are of particular concern due to their severity and frequent association with antimicrobial resistance (Ayovi Obando & Castro Jalca, 2023). In these settings, Gram-negative pathogens often play a dominant role (European Centre for Disease Prevention and Control [ECDC], 2024; Weiner-Lastinger et al., 2022). Surgical site infections (SSI) likewise continue to represent a major challenge in hospital care, contributing to postoperative complications, extended hospitalization, and increased healthcare costs (World Health Organization, 2018).

The COVID-19 pandemic placed unprecedented pressure on healthcare delivery worldwide (Weiner-Lastinger et al., 2022). Chile experienced a high burden of COVID-19 during 2020–2021, followed by a relative decline in 2022, consistent with national and regional epidemiological reports (Pan American Health Organization, 2022). This period was characterized by substantial pressure on hospital capacity and intensive care services, which may have influenced healthcare-associated infection dynamics, potentially disrupting established infection prevention and control practices, altering antimicrobial prescribing patterns, and affecting infection epidemiology at the system level (Hirabayashi et al., 2021). International surveillance reports have described increases in certain multidrug-resistant organisms during pandemic periods, raising concerns about possible long-term consequences (Witt et al., 2022). However, comprehensive national analyses evaluating whether these disruptions resulted in sustained changes in infection patterns remain limited. This gap is particularly evident in Latin America, where surveillance systems are heterogeneous and long-term consolidated data remain scarce (Pan American Health Organization, 2023).

Chile has maintained a structured national HAI surveillance system since 1988, providing more than three decades of continuous epidemiological monitoring (Ministerio de Salud de Chile, 2026). This long-standing framework offers a unique opportunity to examine longitudinal trends in healthcare-associated infections at the national level.

We hypothesized that the COVID-19 period could be associated with changes in the proportional distribution of major infection groups, particularly in the balance between Gram-negative and Gram-positive pathogens.

In this context, the present study aimed to analyze national trends in healthcare-associated infections in adult patients in Chile between 2015 and 2022, using aggregated surveillance data, and to assess the stability of these patterns over time.

2. Methodology

Materials and Methods

<u>Study Design and Setting</u>

We conducted a retrospective ecological longitudinal study based on aggregated national surveillance data of major healthcare-associated infections (HAIs) in adult patients in Chile between 2015 and 2022. The study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines (von Elm et al., 2007).

The study period was selected to evaluate long-term epidemiological trends and included three predefined phases: the pre-pandemic period (2015–2019), the COVID-19 pandemic period (2020–2021), and the initial post-pandemic year (2022). The pandemic period was defined in accordance with the official national declaration of COVID-19 emergency in Chile in March 2020.

Chile maintains a structured national HAI surveillance system coordinated by the Ministry of Health (MINSAL), which mandates reporting from all medium- and high-complexity public hospitals nationwide (Ministerio de Salud de Chile, n.d.).

<u>Data Sources</u>

Data were obtained from the official "Annual Reports of Healthcare-Associated Infection Surveillance" published by the Department of Quality and Patient Safety of the Chilean Ministry of Health (MINSAL) (Ministerio de Salud de Chile, n.d.). These reports provide standardized national data on infection rates and epidemiological characteristics.

The Chilean surveillance system is based on active, selective surveillance and covers 100% of medium- and high-complexity public hospitals. Data are collected at the institutional level and published in aggregated national format.

For each year (2015–2022), we extracted data corresponding to the following major HAIs in adult patients: catheter-associated urinary tract infections (CAUTI), central line–associated bloodstream infections (CLABSI), ventilator-associated pneumonia (VAP), and surgical site infections (SSI). These infection types were consistently included in national surveillance reports throughout the study period.

<u>Study Population</u>

The study population comprised adult patients hospitalized in Chilean public medium- and high-complexity hospitals who developed one of the selected healthcare-associated infections during the study period. Only aggregated national data were available; therefore, no patient-level demographic or clinical variables were analyzed.

Variables and Definitions

The analysis included aggregated data on etiological groups of microorganisms as reported in the national surveillance system, including Gram-positive, Gram-negative, and fungal pathogens.
The primary outcome was the distribution of major healthcare-associated infections according to broad etiological groups.
For each infection type and year, we extracted:

- Total number of reported infections
- Distribution of etiological groups
- Proportion of Gram-positive and Gram-negative microorganisms

Microorganisms were classified according to Gram staining characteristics based on standard microbiological taxonomy. Fungal pathogens were described separately when reported.
The category "other microorganisms" corresponds to etiological agents reported in the national surveillance system that were not individually specified within the main aggregated categories. According to official Ministry of Health reports, this group includes microorganisms reported without detailed taxonomic classification at the genus or species level.
To assess temporal patterns, we evaluated:

- Annual proportional distribution of major etiological groups
- Relative predominance of Gram-negative versus Gram-positive organisms
- Changes in the contribution of these groups over time

Statistical Analysis

Data were extracted from annual reports and consolidated into a structured database.

Descriptive statistics were used to summarize:

- Absolute frequencies of reported infections
- Annual proportions of Gram-positive and Gram-negative pathogens
- Distribution of etiological groups by infection type

Temporal trends were assessed through graphical analysis and comparison of annual proportional changes across the study period (2015–2022), with particular attention to variations during the COVID-19 pandemic years (2020–2021).

Absolute and relative changes in proportional distribution between 2015 and 2022 were calculated. Additionally, proportions were compared across three predefined periods (pre-pandemic, pandemic, and post-pandemic).

Given the aggregated ecological nature of the data, no patient-level multivariable analysis was performed. The study was designed to describe national-level epidemiological patterns rather than to establish causal associations.

Statistical analyses were performed using Stata version 17.0 (StataCorp LLC, College Station, TX, USA), and results were interpreted descriptively.

Ethics Statement

This study used aggregated, anonymized, and publicly available secondary data obtained from official reports published by the Chilean Ministry of Health.

The study did not involve direct contact with human participants, the use of identifiable personal data, or any intervention. According to national regulations and institutional policies, formal ethics committee approval and informed consent were not required.

3. Results

Between 2015 and 2022, a total of 43,478 healthcare-associated infections were reported nationwide. Across the study period, Gram-negative microorganisms consistently predominated, accounting for more than half of all infections, while Gram-positive organisms represented approximately one quarter. Fungal and other microorganisms contributed a smaller proportion throughout all years.
Although the total number of reported infections increased markedly during the pandemic period (2020–2021), the proportional distribution of major etiological groups remained relatively stable over time (Table 1).
When stratified by infection type, distinct patterns were observed.

Table 1. Overall distribution of healthcare-associated infections by etiological group, Chile (2015–2022)

Year	Gram-negative (GN), n	Gram-positive (GP), n	Fungi (F), n	Others, n	Total, n	GN, %	GP, %	F, %
2015	2,309	1,017	221	345	3,892	59.3	26.1	5.7
2016	2,485	1,066	208	352	4,111	60.4	25.9	5.1
2017	2,249	1,033	165	740	4,187	53.7	24.7	3.9
2018	2,254	1,046	139	739	4,178	53.9	25.0	3.3
2019	2,091	1,081	151	583	3,906	53.5	27.7	3.9
2020	3,184	1,708	303	616	5,811	54.8	29.4	5.2
2021	6,148	2,850	500	1,482	10,980	56.0	26.0	4.6
2022	3,442	1,809	277	885	6,413	53.7	28.2	4.3
Total	**24,162**	**11,610**	**1,964**	**5,742**	**43,478**	**55.6**	**26.7**	**4.5**

Note: Others: Microorganisms grouped as "other agents not previously specified" in the official national surveillance reports of the Chilean Ministry of Health.

Ventilator-Associated Pneumonia (VAP) (Table 2)

Ventilator-associated pneumonia showed a stable pattern over time, characterized by consistent predominance of Gram-negative microorganisms.

A total of 12,783 VAP cases were reported during the study period. Gram-negative microorganisms predominated throughout all years, accounting for 63.9% of cases overall. Annual proportions ranged from 61.4% to 69.8%. Gram-positive organisms represented 23.3% of cases overall, with annual values between 18.4% and 26.0%.

Fungal pathogens were absent in the pre-pandemic period and were first reported in 2020 (2.0%), remaining at low levels thereafter. The total number of VAP cases increased substantially in 2020 and peaked in 2021 (4,176 cases), before decreasing in 2022.

Central Line–Associated Bloodstream Infections (CLABSI) (Table 2)

CLABSI exhibited a distinct pattern, with overall predominance of Gram-positive organisms and a transient shift toward a more balanced distribution during the pandemic period.

A total of 12,085 CLABSI cases were reported. Overall, Gram-positive organisms predominated (45.6%), followed by Gram-negative organisms (35.7%), fungi (3.2%), and other microorganisms (15.5%).

From 2015 to 2019, Gram-positive organisms consistently accounted for approximately 45–53% of cases. In 2020 and 2021, an increase in Gram-negative proportions was observed (43.3% and 40.9%, respectively). In 2022, the distribution returned to a pattern similar to pre-pandemic years.

Total CLABSI cases increased markedly in 2021 (2,980 cases) compared to previous years.

Table 2. Distribution of VAP and CLABSI by etiological group, Chile (2015–2022)

Panel A. Ventilator-Associated Pneumonia (VAP)

Year	GN n (%)	GP n (%)	F n (%)	Others n (%)	Total
2015	731 (61.8)	292 (24.7)	0 (0.0)	160 (13.5)	1,183
2016	766 (66.3)	231 (20.0)	0 (0.0)	158 (13.7)	1,155
2017	654 (65.5)	208 (20.8)	0 (0.0)	136 (13.6)	998
2018	517 (61.4)	181 (21.5)	0 (0.0)	145 (17.2)	843
2019	545 (69.8)	144 (18.4)	0 (0.0)	92 (11.8)	781
2020	1,271 (63.4)	478 (23.9)	41 (2.0)	213 (10.6)	2,003
2021	2,604 (62.3)	1,087 (26.0)	66 (1.6)	419 (10.0)	4,176
2022	1,088 (66.2)	361 (22.0)	20 (1.2)	175 (10.6)	1,644
Total	**8,176 (63.9)**	**2,982 (23.3)**	**127 (1.0)**	**1,498 (11.7)**	**12,783**

Panel B. Central Line–Associated Bloodstream Infections (CLABSI)

Year	GN n (%)	GP n (%)	F n (%)	Others n (%)	Total
2015	279 (30.5)	428 (46.7)	42 (4.6)	167 (18.2)	916
2016	333 (33.2)	456 (45.5)	41 (4.1)	173 (17.3)	1,003
2017	350 (31.4)	503 (45.1)	45 (4.0)	217 (19.5)	1,115
2018	411 (33.5)	554 (45.2)	31 (2.5)	230 (18.8)	1,226
2019	339 (28.7)	625 (52.8)	42 (3.6)	177 (15.0)	1,183
2020	664 (43.3)	758 (49.4)	50 (3.3)	61 (4.0)	1,533
2021	1,218 (40.9)	1,221 (41.0)	65 (2.2)	476 (16.0)	2,980
2022	724 (34.0)	961 (45.1)	70 (3.3)	374 (17.6)	2,129
Total	**4,318 (35.7)**	**5,506 (45.6)**	**386 (3.2)**	**1,875 (15.5)**	**12,085**

Note: Others: Microorganisms grouped as "other agents not previously specified" in the official national surveillance reports of the Chilean Ministry of Health.

Catheter-Associated Urinary Tract Infections (CAUTI) (Table 3)

CAUTI maintained a stable predominance of Gram-negative microorganisms throughout the study period, with moderate variability in the contribution of other categories.

A total of 16,947 CAUTI cases were reported. Gram-negative microorganisms predominated across all years, representing 64.7% of cases overall. Annual proportions ranged from 56.3% in 2020 to 76.4% in 2015 and 2016.

Gram-positive organisms accounted for 12.8% of cases overall, while fungal pathogens represented 8.5%. The proportion of "other" microorganisms varied across years, reaching its highest value in 2017 (20.9%).

The total number of CAUTI cases increased notably in 2020 and 2021, with a peak of 3,677 cases in 2021, followed by a decrease in 2022.

Surgical Site Infections (SSI) (Table 3)

SSI demonstrated a consistently Gram-positive predominant pattern, with minimal variation over time.

A total of 1,564 SSI cases were reported. Gram-positive microorganisms predominated throughout the study period, accounting for 60.7% of cases overall, while Gram-negative organisms represented 39.3%. No fungal pathogens were reported in SSI during the study period.

Annual total SSI cases ranged from 143 in 2015 to 240 in 2019, with lower numbers observed in 2020 and 2021.

Table 3. Distribution of CAUTI and SSI by etiological group, Chile (2015–2022)

Panel A. Catheter-Associated Urinary Tract Infections (CAUTI)

Year	GN n (%)	GP n (%)	F n (%)	Others n (%)	Total
2015	1,246 (76.4)	207 (12.7)	179 (11.0)	0 (0.0)	1,632
2016	1,302 (76.4)	235 (13.8)	167 (9.8)	0 (0.0)	1,704
2017	1,152 (62.3)	191 (10.3)	120 (6.5)	387 (20.9)	1,850
2018	1,172 (64.6)	169 (9.3)	108 (6.0)	364 (20.1)	1,813
2019	1,106 (65.0)	173 (10.2)	109 (6.4)	314 (18.4)	1,702
2020	1,191 (56.3)	371 (17.5)	212 (10.0)	342 (16.2)	2,116
2021	2,256 (61.4)	465 (12.6)	369 (10.0)	587 (16.0)	3,677
2022	1,568 (63.9)	362 (14.8)	187 (7.6)	336 (13.7)	2,453
Total	**10,993 (64.7)**	**2,173 (12.8)**	**1,451 (8.5)**	**2,330 (13.7)**	**16,947**

Panel B. Surgical Site Infections (SSI)

Year	GN n (%)	GP n (%)	F n (%)	Others n (%)	Total
2015	53 (37.1)	90 (62.9)	0	0	143
2016	84 (36.8)	144 (63.2)	0	0	228
2017	93 (41.5)	131 (58.5)	0	0	224
2018	94 (39.8)	142 (60.2)	0	0	236
2019	101 (42.1)	139 (57.9)	0	0	240
2020	58 (36.5)	101 (63.5)	0	0	159
2021	70 (47.6)	77 (52.4)	0	0	147
2022	62 (33.2)	125 (66.8)	0	0	187
Total	**615 (39.3)**	**949 (60.7)**	**0**	**0**	**1,564**

Note: Others: Microorganisms grouped as "other agents not previously specified" in the official national surveillance reports of the Chilean Ministry of Health.

4. Discussion

Discussion

This national longitudinal analysis of major healthcare-associated infections in Chile between 2015 and 2022 demonstrated a sustained predominance of Gram-negative microorganisms across the study period. Despite a marked increase in the total number of reported infections during the COVID-19 pandemic years (2020–2021), the overall distribution of infections according to broad etiological groups remained relatively stable.

Device-associated infections showed consistent patterns, with Gram-negative predominance in ventilator-associated pneumonia (VAP) and catheter-associated urinary tract infections (CAUTI), and Gram-positive predominance in central line–associated bloodstream infections (CLABSI) and surgical site infections (SSI). Although a temporary proportional fluctuation was observed in CLABSI during the pandemic period, no sustained structural shift was identified. These findings highlight the relative stability of national infection patterns over time within a long-standing surveillance framework (Weiner-Lastinger et al., 2022).

The persistent predominance of Gram-negative microorganisms in VAP and CAUTI observed in this study aligns with the well-established epidemiology of device-associated infections in hospitalized adult populations (Weiner-Lastinger et al., 2020). Gram-negative pathogens, particularly in intensive care settings, have been consistently reported as leading etiological agents in ventilator-associated pneumonia (Erfani et al., 2016) and catheter-associated urinary tract infections (Peng et al., 2018).

This stability across both pre-pandemic and pandemic periods suggests that the underlying epidemiological patterns of these device-associated infections remained consistent at the national level. Given the recognized association between Gram-negative organisms and antimicrobial resistance (Antimicrobial Resistance Collaborators, 2022), sustained surveillance of these pathogens remains essential for infection prevention and antimicrobial stewardship strategies (Weiner-Lastinger et al., 2020).

In contrast to VAP and CAUTI, CLABSI exhibited a distinct baseline pattern characterized by Gram-positive predominance during the pre-pandemic period, consistent with the recognized role of skin commensals in catheter-related bloodstream infections (Raoofi et al., 2023). The relative increase in Gram-negative organisms observed in 2020 and 2021 resulted in a more balanced distribution between Gram-positive and Gram-negative groups (Alshamrani et al., 2024; Porto et al., 2023).

A plausible explanation for this proportional fluctuation may relate to differences in the pathogenesis of CLABSI. Gram-positive organisms are commonly associated with contamination from the patient's skin microbiota during catheter insertion or manipulation (Gonçalves et al., 2015). In contrast, Gram-negative organisms are more commonly associated with environmental reservoirs in healthcare settings and cross-transmission through contaminated surfaces and equipment (Lastinger et al., 2023). The increased clinical complexity, greater device utilization, and heightened workload reported during the pandemic period may have influenced these dynamics (Lastinger et al., 2023).

However, the return to a Gram-positive predominant pattern in 2022 suggests that the observed fluctuation was transient rather than indicative of a sustained transformation. Similar proportional fluctuations in bloodstream infections during the COVID-19 pandemic have been reported in other healthcare systems, where increased intensive care utilization and changes in clinical practices were documented (Jafarpour et al., 2025). Nevertheless, in the present study, the distribution in 2022 resembled that observed before the pandemic period, suggesting the absence of a sustained shift.

Together, these findings suggest that the distinction between increased case volume and proportional stability provides important insight into infection dynamics during periods of systemic healthcare stress, consistent with reports from similar settings (Alp & Damani, 2015).

Surgical site infections exhibited a stable pattern throughout the study period, with consistent predominance of Gram-positive organisms. This distribution remained relatively unchanged across pre-pandemic, pandemic, and post-pandemic years, and no fungal pathogens were reported. However, the reduction in SSI case volume observed during the pandemic period may be partly explained by the substantial decrease in elective surgical procedures and the reorganization of hospital services during COVID-19. Therefore, this reduction should not be interpreted as an improvement in underlying infection risk, but rather as a reflection of changes in surgical activity and healthcare delivery. These findings are consistent with the established global epidemiology of surgical site infections, where Gram-positive organisms—particularly skin commensals—represent the most frequent etiological agents (Kirby & Mazuski, 2009).

An increase in the total number of reported healthcare-associated infections was observed during 2020 and particularly in 2021, coinciding with the COVID-19 pandemic period. This pattern is consistent with the high national burden of COVID-19 observed in Chile during 2020–2021 (Pan American Health Organization, 2022). However, despite this quantitative rise, the proportional distribution across infection types remained largely consistent.

Although international reports have described pandemic-related shifts in pathogen distribution—including increases in non-fermenting Gram-negative organisms—our national data did not demonstrate a sustained change in the distribution of broad etiological groups. In other settings, significant rises in Pseudomonas aeruginosa and Acinetobacter baumannii have been observed (De La Motte et al., 2025). Similar trends were reported in Türkiye, where A. baumannii and Klebsiella pneumoniae became predominant and showed increasing resistance to carbapenems and colistin (Sargın-Altunok et al., 2025), alongside broader increases in multidrug-resistant organisms (Sulayyim et al., 2022; Alshammari & Alruwaili, 2025).

This study has several strengths. It is based on nationwide surveillance data collected over an eight-year period within a standardized reporting framework, allowing for longitudinal assessment across pre-pandemic, pandemic, and post-pandemic phases. The use of aggregated national data enhances the representativeness of findings within the public hospital system and provides a comprehensive overview of infection trends at the country level.

However, certain limitations should be acknowledged. The analysis relied on aggregated data, precluding patient-level adjustment for demographic or clinical variables. Information on antimicrobial resistance phenotypes was not available within the extracted reports, limiting the ability to explore resistance dynamics. Additionally, the level of aggregation precluded analysis at the genus or species level.

Furthermore, surveillance data were restricted to medium- and high-complexity public hospitals, and findings may not be generalizable to private healthcare settings. Potential variations in surveillance sensitivity and reporting completeness during the pandemic period may also have influenced observed trends.

5. Conclusions

This national longitudinal study described temporal trends in healthcare-associated infections in adult patients in Chile between 2015 and 2022 using aggregated national surveillance data. Across the study period, Gram-negative microorganisms predominated overall, particularly in device-associated infections such as VAP and CAUTI, while Gram-positive organisms remained predominant in CLABSI and surgical site infections.

Despite a substantial increase in the total number of reported infections during the COVID-19 pandemic years, no sustained shift in the proportional distribution of broad etiological groups (Gram-positive and Gram-negative) was observed. Patterns during the pandemic period were broadly comparable to those observed in pre-pandemic years at the aggregate level.

However, because the available surveillance data were limited to aggregated categories and did not include genus-, species-, or antimicrobial resistance–level information, these findings should not be interpreted as evidence of stability within specific pathogens.

Continuous national surveillance with greater microbiological resolution remains essential to monitor potential changes in pathogen distribution and antimicrobial resistance patterns over time.

Funding: This research received no external funding.
Conflicts of Interest: The authors declare no conflict of interest.
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References

[1]. Alp, E., & Damani, N. (2015). Healthcare-associated infections in intensive care units: Epidemiology and infection control in low-to-middle income countries. Journal of Infection in Developing Countries, 9(10), 1040–1045. https://doi.org/10.3855/jidc.6832

[2]. Alshammari, I. T., & Alruwaili, Y. (2025). Prevalence, microbiological profile, and risk factors of healthcare-associated infections in intensive care units: A retrospective study. Microorganisms, 13, 1916. https://doi.org/10.3390/microorganisms13081916

[3]. Alshamrani, M. M., El-Saed, A., Aldayhani, O., et al. (2024). Risk of central line-associated bloodstream infections during COVID-19 pandemic in intensive care patients. Epidemiology and Infection, 152, e95. https://doi.org/10.1017/S0950268824000736

[4]. Antimicrobial Resistance Collaborators. (2022). Global burden of bacterial antimicrobial resistance in 2019: A systematic analysis. The Lancet, 399(10325), 629–655. https://doi.org/10.1016/S0140-6736(21)02724-0

[5]. Ayovi Obando, N., & Castro Jalca, J. G. (2023). Infecciones asociadas a la atención en salud: agente etiológico, factores de riesgo y diagnóstico microbiológico. Polo del Conocimiento, 8(4), 142–172.

[6]. Cassini, A., Plachouras, D., Eckmanns, T., et al. (2016). Burden of six healthcare-associated infections on European population health. PLoS Medicine, 13(10), e1002150. https://doi.org/10.1371/journal.pmed.1002150

[7]. De La Motte, L. R., Deflorio, L., Stefano, E., et al. (2025). Evolution of respiratory pathogens and antimicrobial resistance over the COVID-19 timeline. Antibiotics, 14(8), 796. https://doi.org/10.3390/antibiotics14080796

[8]. Erfani, Y., Rasti, A., & Janani, L. (2016). Prevalence of Gram-negative bacteria in ventilator-associated pneumonia. BMJ Open, 6(10), e012298. https://doi.org/10.1136/bmjopen-2016-012298

[9]. European Centre for Disease Prevention and Control. (2024). Healthcare-associated infections in European hospitals (PPS survey 2022–2023). https://www.ecdc.europa.eu

[10]. Gonçalves, P., Menezes, F. G., Toniolo, A. R., et al. (2015). Secular trends in central line-associated bloodstream infection. Infection Control & Hospital Epidemiology, 36(9), 1106–1107. https://doi.org/10.1017/ice.2015.128

[11]. Haque, M., Sartelli, M., McKimm, J., et al. (2018). Health care-associated infections—An overview. Infection and Drug Resistance, 11, 2321–2333. https://doi.org/10.2147/IDR.S177247

[12]. Hirabayashi, A., Kajihara, T., Yahara, K., et al. (2021). Impact of COVID-19 on antimicrobial resistance surveillance. Journal of Hospital Infection, 117, 147–156. https://doi.org/10.1016/j.jhin.2021.09.011

[13]. Jafarpour, Z., Karimi, M., Pouladfar, G., et al. (2025). Changes in microbiological characteristics of bloodstream infections. BMC Infectious Diseases, 25, 1300. https://doi.org/10.1186/s12879-025-11564-4

[14]. Kirby, J. P., & Mazuski, J. E. (2009). Prevention of surgical site infection. Surgical Clinics of North America, 89(2), 365–389. https://doi.org/10.1016/j.suc.2009.01.001

[15]. Lastinger, L. M., Alvarez, C. R., Kofman, A., et al. (2023). Continued increases in healthcare-associated infections during COVID-19. Infection Control & Hospital Epidemiology, 44(6), 997–1001. https://doi.org/10.1017/ice.2022.116

[16]. Ministerio de Salud de Chile. (n.d.). Infecciones asociadas a la atención en salud (IAAS). https://www.minsal.cl/infecciones-asociadas-a-la-atencion-en-salud-iaas/

[17]. Pan American Health Organization. (2022). COVID-19 response report. https://www.paho.org

[18]. Pan American Health Organization. (2023). Surveillance of antimicrobial resistance in Latin America and the Caribbean. https://www.paho.org

[19]. Peng, D., Li, X., Liu, P., et al. (2018). Epidemiology of catheter-associated urinary tract infections. American Journal of Infection Control, 46(12), e81–e90. https://doi.org/10.1016/j.ajic.2018.07.012

[20]. Porto, A. P. M., Borges, I. C., Buss, L., et al. (2023). Healthcare-associated infections during COVID-19 in Brazil. Infection Control & Hospital Epidemiology, 44(2), 284–290. https://doi.org/10.1017/ice.2022.65

[21]. Raoofi, S., Pashazadeh Kan, F., Rafiei, S., et al. (2023). Global prevalence of nosocomial infection. PLoS One, 18(1), e0274248. https://doi.org/10.1371/journal.pone.0274248

[22]. Sargın-Altunok, E., Keske, Ş., Batırel, A., et al. (2025). Impact of COVID-19 on CLABSI rates and resistance. Infectious Diseases and Clinical Microbiology, 7(3), 273–282. https://doi.org/10.36519/idcm.2025.513

[23]. Sartelli, M., Marini, C. P., McNelis, J., et al. (2024). Preventing healthcare-associated infections. Antibiotics, 13(9), 896. https://doi.org/10.3390/antibiotics13090896

[24]. Sulayyim, H. J. A., Ismail, R., Hamid, A. A., et al. (2022). Antibiotic resistance during COVID-19. International Journal of Environmental Research and Public Health, 19(19), 11931. https://doi.org/10.3390/ijerph191911931

[25]. Weiner-Lastinger, L. M., Pattabiraman, V., Konnor, R. Y., et al. (2022). Impact of COVID-19 on healthcare-associated infections. Infection Control & Hospital Epidemiology, 43(1), 12–25. https://doi.org/10.1017/ice.2021.362

[26]. Weiner-Lastinger, L. M., Abner, S., Edwards, J. R., et al. (2020). Antimicrobial-resistant pathogens in healthcare-associated infections. Infection Control & Hospital Epidemiology, 41(1), 1–18. https://doi.org/10.1017/ice.2019.296

[27]. World Health Organization. (2018). Global guidelines for the prevention of surgical site infection. https://www.who.int/publications

[28]. World Health Organization. (2022). Global report on infection prevention and control. https://cdn.who.int