

Technological Advances in The Management of Hospital-Acquired Infections: Impact of Hyperbaric Oxygen Therapy on Antibiotic Resistance

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Abstract

A bibliometric analysis of research papers related to Technology Infection Management and Hospital Care was conducted, focusing on Latin American institutions from 2018-2023, identifying 23 publications. The data were organized into graphs categorizing by Year of Publication, Country of Origin, Area of Knowledge, and Type of Publication. Brazil had the highest number of publications (15). Medicine was the leading area with 21 documents, and Journal Articles were the most common type (65%).

Keywords: Technology, Infection Management, Hospital Care.

INTRODUCTION

Healthcare-associated infections are a global challenge, increasing antimicrobial resistance and the presence of resistant microorganisms in health centers. Bacteria forming biofilms cause antibiotic-resistant infections. Hyperbaric oxygen therapy (HBOT) is a strategy to combat antibiotic resistance. HBOT promotes healing, enhances neutrophil bactericidal capacity, and reduces edema. It improves patient outcomes, reduces hospital stays, and is cost-effective (Cannellotto, 2018; Leung, 2022). HBOT enhances immune response, inhibits pathogen action, and potentiates antibiotics, reducing antibiotic resistance.

Based on this context, one of the strategies for antibiotic resistance is hyperbaric oxygen therapy. Hyperbaric oxygenation (HBOT) is a treatment modality that is performed in chambers that guarantee a pressurized environment, hyperoxygenation promotes healing, increases the bactericidal capacity of the neutrophil and reduces edema due to vasoconstriction of the arteriole.

Hyperoxia and reactive oxygen species generate a series of benefits in the body which are taken advantage of by several specialized companies with the aim of stabilizing or recovering the health of patients. The results obtained in wound healing, lung conditions and neurology have been achieved through the development of safe chambers and with trained professionals. Due to its benefits, HBOT is considered a therapeutic that improves the patient's quality of life, accelerates the recovery process after an infection and reduces the number of days spent in hospital. This method is economically sustainable due to the benefits obtained, which justifies the expenses they generate. (Cannellotto M R. F., 2018) (Leung JK, 2022)

In addition, hyperbaric oxygen reduces the growth of bacteria, which increases the activity of antibiotics, activates the body's defenses, and stimulates phagocytosis. Phagocytosis plays a fundamental role in the defense against infectious diseases; The amoeba and other protozoa carry out phagocytosis using pseudopods.

This process of hyperoxygenation can produce two scientifically proven factors: firstly, it potentiates the immune system and secondly, it blocks the action of pathogenic bacteria. Hyperbaric oxygen performs these functions, enhancing the ability of white blood cells to find and destroy invaders, and inhibiting the secretion

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of toxins by some bacteria, as well as enhancing the antibiotic and antiviral effects of medications. For this reason, this article seeks to describe the main characteristics of the compendium of publications indexed in the Scopus database related to the variables Technology, Infection Management, Hospital Care, as well. Such as the description of the position of certain authors affiliated with institutions, during the period between 2018-2023.

General Objective

To analyze the preparation and publication of research papers on Technology, Infection Management, and Hospital Care by Latin American institutions from 2018-2023 using a bibliometric and bibliographic approach.

Methodology

This mixed-methods research combines quantitative and qualitative analyses. Quantitatively, it uses a bibliometric approach to analyze scientific production. Qualitatively, it examines published works to describe author positions on the topic. The Scopus database was used, establishing the parameters in Figure 1.

On the one hand, a quantitative analysis of the information selected in Scopus is carried out under a bibliometric approach of the scientific production corresponding to the study of Technology, Infection Management, Hospital Care. On the other hand, examples of some research works published in the area of study mentioned above are analyzed from a qualitative perspective, based on a bibliographic approach that allows describing the position of different authors on the proposed topic. It is important to note that the entire search was carried out through Scopus, managing to establish the parameters referenced in *Figure 1*.

Methodological design

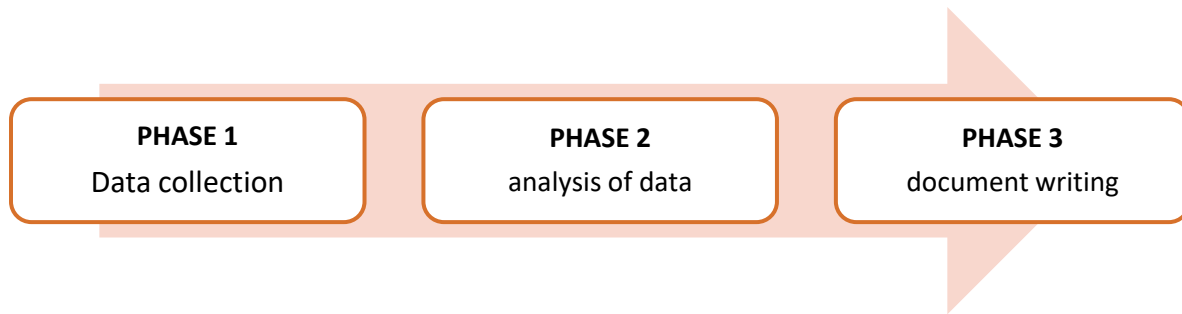


Figure 1. Methodological design

Source: Authors' own creation

Phase 1: Data collection

Data collection was carried out from the Search tool on the Scopus website, where 23 publications were obtained from the following filters:

TITLE-ABS-KEY (technology, AND infection AND management, AND hospital AND care) AND PUBYEAR > 2017 AND PUBYEAR < 2024 AND (LIMIT-TO (AFFILCOUNTRY , "Brazil") OR LIMIT-TO (AFFILCOUNTRY , "Peru") OR LIMIT-TO (AFFILCOUNTRY , "Mexico") OR LIMIT-TO (AFFILCOUNTRY , "Uruguay") OR LIMIT-TO (AFFILCOUNTRY , "Argentina") OR LIMIT-TO (AFFILCOUNTRY , "Costa Rica") OR LIMIT-TO (AFFILCOUNTRY , "Colombia") OR LIMIT-TO (AFFILCOUNTRY , "Chile") OR LIMIT-TO (AFFILCOUNTRY , "Paraguay") OR LIMIT-TO (AFFILCOUNTRY , "Bolivia")

Published documents whose study variables are related to the study of the variables Technology, Infection Management, Hospital Care

Limited to the period 2018-2023.

Limited to Latin American countries.

Without distinction of area of knowledge.

No distinction of type of publication.

Phase 2: Construction of Analytical Material

The information collected in Scopus during the previous phase is organized and then classified by graphs, figures and tables as follows:

Co-occurrence of words.

Country of origin of the publication.

Area of knowledge.

Type of publication.

Phase 3: Drafting of Conclusions and Outcome Document

In this phase, the results of the previous results are analysed, resulting in the determination of conclusions and, consequently, the obtaining of the final document.

RESULTS

Co-occurrence of Words

Figure 2 shows the co-occurrence of keywords in the identified publications. "Hospital-acquired infections" was the most frequent keyword. Medicine practice and variables like Treatments, Artificial Intelligence, Patients, Access to Health, Pandemic, Telemedicine, and Covid-19 were common.

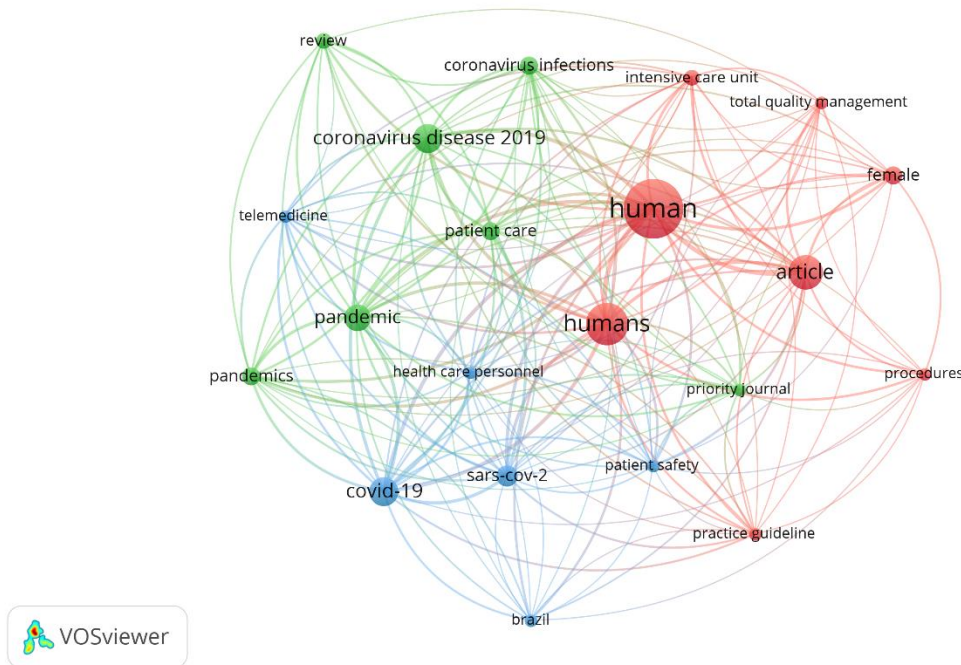


Figure 2. Co-occurrence of words

Source: Authors' own elaboration (2024); based on data exported from Scopus.

"Hospital-acquired infections" was the most frequently used keyword in the studies identified during Phase 1 of the Methodological Design. "Medicine practice" was also frequently associated with variables such as Treatments, Artificial Intelligence, Patients, Access to Health, Pandemic, Telemedicine, and Covid-19. Notably, hyperbaric therapy enhances oxygen delivery to organs and tissues. Benefits include better oxygen distribution,

reduced edema, and lower infection risk. Hyperbaric therapy helps infected wounds heal faster and reduces antibiotic resistance.

Distribution of scientific production by year of publication

Figure 3 shows the distribution by year. There was an increase in 2021, with 9 publications. This article discusses future directions for infection prevention and control, emphasizing clinical and cost-effective evaluations (Gray, 2015).

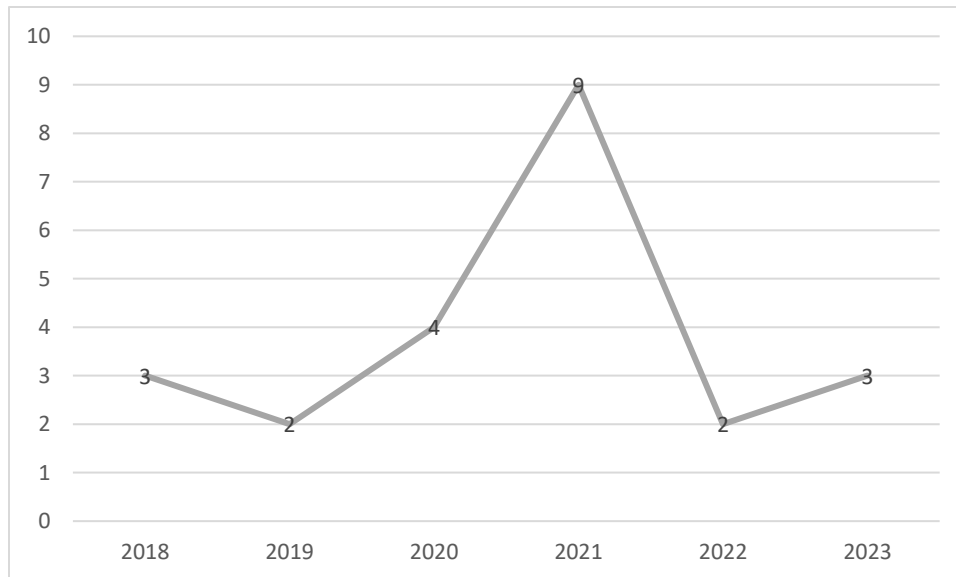


Figure 3. Distribution of scientific production by year of publication.

Source: Authors' own elaboration (2024); based on data exported from Scopus

The distribution of scientific production by year of publication showed an increase in 2021, with 9 documents published in Scopus-indexed journals. This article will explore future directions for innovation and research in infection prevention and control, emphasizing the importance of clinical and cost-effective evaluations. It will consider opportunities for studies in various areas, including prevention and control of existing and emerging infection risks, challenges from changes in healthcare delivery, technological advances for infection control, benefits of new laboratory diagnostic technologies, cleaning and decontamination, and infection control aspects of hospital design. The need for robust economic data to support the broad and timely implementation of evidence-based practices is emphasized (Gray, 2015).

Distribution of Scientific Production by Country Of Origin

Figure 4 shows the distribution by country. Brazil had the highest number of publications (15), followed by Mexico (3) and Colombia (2). An example is "Hyperbaric oxygen therapy: descriptive review of the technology and current application in chronic wounds" (Hajhosseini, 2020).

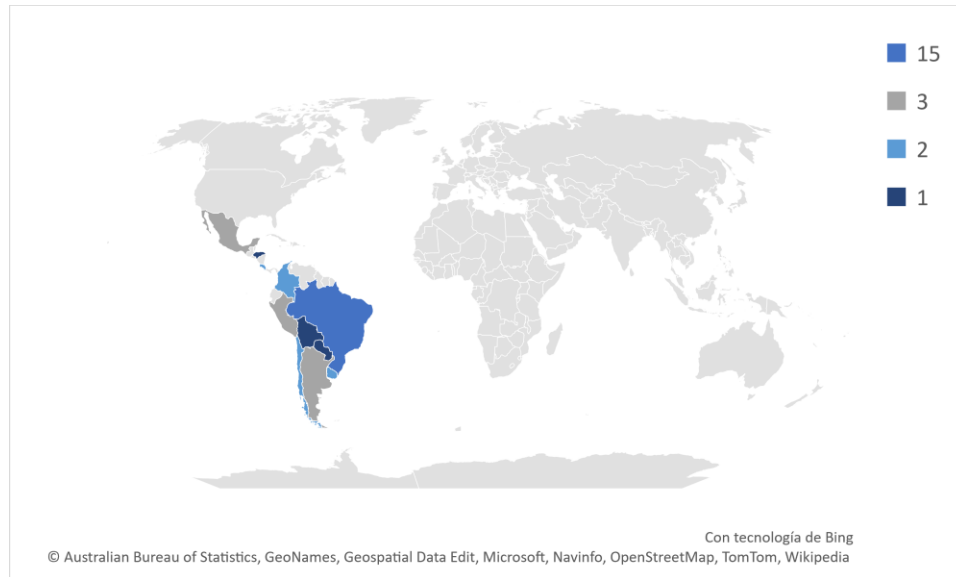


Figure 4. Distribution of scientific production by country of origin.

Source: Authors' own elaboration (2023); based on data provided by Scopus.

Within the distribution of scientific production by country of origin, Brazil had the highest number of publications indexed in Scopus during 2018-2023, with a total of 15 publications. Mexico ranked second with 3 scientific papers, and Colombia third with 2 documents, including "Hyperbaric oxygen therapy: descriptive review of the technology and current application in chronic wounds." Hyperbaric oxygen therapy (HBOT) serves as a primary or complementary therapy for various pathologies, including life-threatening conditions like carbon monoxide poisoning, decompression sickness, and gaseous embolisms. HBOT has been used for decades as an adjunctive therapy in medical disciplines, including chronic wounds, affecting approximately 6.5 million Americans annually. Chronic wounds are characterized by hypoxia, impaired angiogenesis, and prolonged inflammation, which HBOT can theoretically improve. However, the cellular, biochemical, and physiological mechanisms of HBOT's benefits in chronic wounds are not fully understood, and skepticism remains regarding its efficacy. This review article provides an overview of HBOT, discussing its history, mechanisms of action, and implications in treating chronic wounds, particularly diabetic foot ulcers. It highlights the controversy surrounding HBOT's efficacy and the scarcity of high-quality research, offering future guidance to address existing challenges (Hajhosseini, 2020).

Distribution of Scientific Production by Area Of Knowledge

Figure 5 shows the distribution by area. Medicine led with 21 documents, followed by Pharmacy, Toxicology, and Pharmaceuticals (2), and Microbiology and Immunology (1). The impactful article was "Hyperbaric oxygen: applications in infectious diseases" (Kaide, 2008).

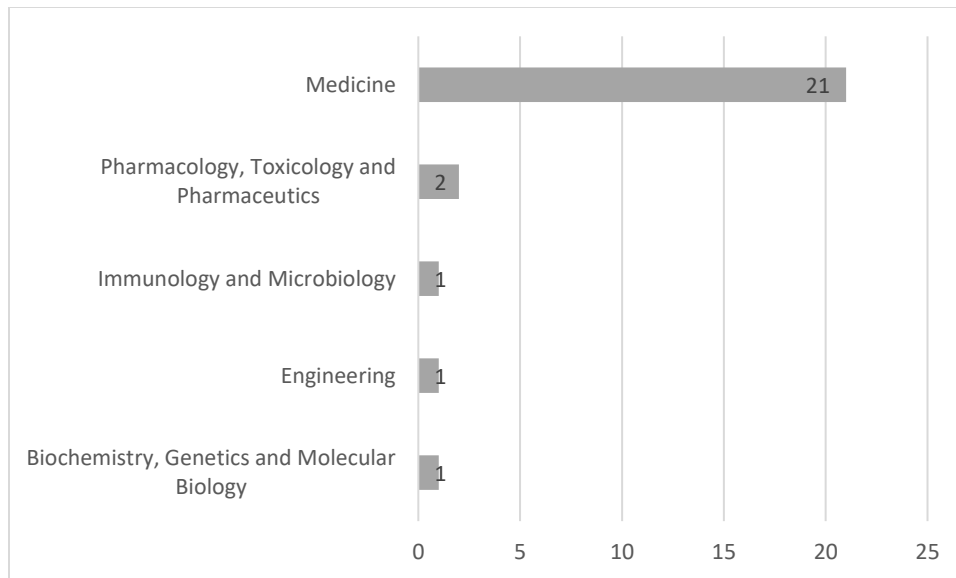


Figure 5. Distribution of scientific production by area of knowledge.

Source: Authors' own elaboration (2023); based on data provided by Scopus.

Medicine was the area with the highest number of publications registered in Scopus, totaling 21 documents. Pharmacy, Toxicology, and Pharmaceutics ranked second with 2 articles, followed by Microbiology and Immunology with 1. The significant impact of these fields is exemplified by the Medicine article titled "Hyperbaric oxygen: applications in infectious diseases." This article reviews the use of hyperbaric oxygen (HBO) as an adjuvant treatment for specific infections. The Society of Hyperbaric and Underwater Medicine recommends HBO for conditions such as necrotizing fasciitis, gas gangrene, chronic refractory osteomyelitis (including malignant otitis externa), mucormycosis, intracranial abscesses, and diabetic foot ulcers with infections. HBO is used alongside antimicrobial agents and aggressive surgical debridement in these cases. The article details each infection and the supporting research for HBO use (Colin G. Kaide MD, 2008).

Type of Publication

Figure 6 shows the distribution by type. Journal Articles were the most common (65%), followed by Journal (22%) and Session Paper (9%). The notable article was "Hyperbaric oxygen therapy for the treatment of chronic wounds: patient selection and perspectives" (Huang, 2019).

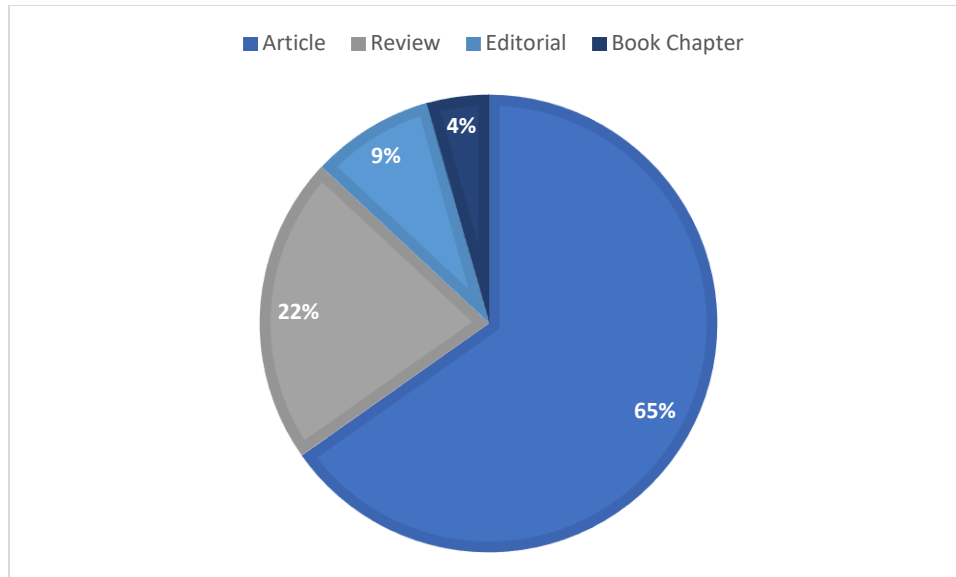


Figure 6. Type of publication.

Fontain: Authors' own elaboration (2023); based on data provided by Scopus.

The most frequently used publication type by researchers referenced in this document was the Journal Article, comprising 65% of the total production analyzed, followed by Journals at 22%. Session Papers represented 9% of the research papers published during 2018-2023 in Scopus-indexed journals. Notably, the article "Hyperbaric oxygen therapy for the treatment of chronic wounds: patient selection and perspectives" stands out. This article analyzes the use of hyperbaric oxygen (HBO2) for treating "selected problematic wounds." The treatment of diabetic foot ulcers (DUs) has dominated discussions due to their prevalence and reimbursement availability. Other problematic wounds like calciphylaxis ulcers, sickle ulcers, and pyoderma gangrenosum have been infrequently treated with HBO2. Despite strong fundamental reasons for HBO2's benefits, high-quality evidence supporting its routine use is still needed (Enoch Huang, 2019).

CONCLUSION

Brazil had the highest number of publications on Technology, Infection Management, and Hospital Care. The application of hyperbaric oxygen in Medicine is crucial for treating wounds and controlling chronic infections. HBOT enhances oxygen delivery, promotes healing, and strengthens the immune response, reducing antibiotic resistance. Despite high costs, the benefits make HBOT economically sustainable. It accelerates recovery, reduces inflammation, and prevents infection, proving essential for healthcare.

Hyperbaric oxygenation therapy activates microbial, fungal, and viral defenses, favoring the phagocytosis of polymorphonuclear leukocytes, chemotaxis, and oxidative destruction of bacteria. This effect is achieved through reactive oxygen species, primarily produced in phagocytes during HBOT. These mechanisms not only enable infection control but also minimize antibiotic dependence, reducing antibiotic resistance problems.

While HBOT for infection control requires significant resources and can be inaccessible to some health institutions due to high costs, its medium and long-term benefits make it economically viable.

In conclusion, despite the challenges health centers face when implementing HBOT, it undoubtedly stimulates and accelerates recovery from injuries and reduces inflammation. Injured tissues are more susceptible to infection than healthy tissues, and hyperbaric oxygen prevents infection before it starts.

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