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Trends and Research Directions in Perioperative Antibiotic Use: A Bibliometric Study

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INDEXING

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Perioperative antibiotic use; Bibliometric analysis; Antimicrobial resistance; Surgical site infection; Evidence-based practice

ABSTRACT

The problem of antibiotic resistance has developed as a growing global health problem that substantially impacts the surgical site infections (SSIs). Perioperative antibiotics should be used in the prevention of surgical site infections; however, misuse of antibiotics can affect antibiotic resistance. This research paper aims to discuss the trends and the research directions of studying the use of perioperative antibiotics through bibliometric analysis with respect to detecting the trends in publishing, topic development, and future research directions. A systematic literature review (SLR) was conducted using 67 papers retrieved in the Web of Science database. R Studio and VOSviewer were used to analyze data to describe trends in the field of publications, collaboration of scholars, and the development of keywords. The information demonstrates that the research regarding the use of antibiotics during perioperative has increased significantly over time since 2015, which proves to be a primary focus of the prevention of surgical site infections (SSI). A double shift observed in bibliometric analysis was the focus of research towards prevention and more focused and evidence-based antibiotic treatment. The problem of antibiotic resistance emerged as one of the central themes that were based on such aspects as the time of treatment, the type of antibiotic, and adherence to clinical standards. The cartographic analysis demonstrated the development streams of research in the past two decades. This study emphasizes the increasing significance of perioperative antibiotic administration in the prevention of surgical site infections and illustrates the pressing necessity for evidence-based guidelines. It also delineates essential avenues for future research, encompassing the optimization of antibiotic prophylaxis, measures to mitigate resistance, adherence to therapeutic procedures, and socio-economic factors in perioperative antibiotic management.

Kata kunci:
Penggunaan antibiotik perioperatif; Analisis bibliometrik; Resistensi antimikroba; Infeksi situs bedah; Praktik berbasis bukti

Resistensi antibiotik telah menjadi masalah kesehatan global yang semakin meningkat, dengan dampak signifikan terhadap kejadian surgical site infections (SSI). Penggunaan antibiotik perioperatif memegang peranan penting dalam pencegahan SSI, namun praktik yang tidak tepat berpotensi memperburuk resistensi. Penelitian ini bertujuan untuk mengkaji tren dan arah penelitian terkait penggunaan antibiotik perioperatif melalui analisis bibliometrik, guna mengidentifikasi pola publikasi, perkembangan tema, serta peluang penelitian di masa depan. Tinjauan literatur sistematis (systematic literature review) dilakukan terhadap 67 artikel yang diperoleh dari basis data Web of Science. Data dianalisis menggunakan perangkat R Studio dan VOSviewer untuk memetakan tren publikasi, kolaborasi akademik, serta perkembangan kata kunci di bidang ini. Temuan menunjukkan bahwa penelitian mengenai penggunaan antibiotik perioperatif meningkat secara signifikan sejak tahun 2015 dan menjadi fokus utama dalam pencegahan SSI. Analisis bibliometrik mengungkap adanya pergeseran tren penelitian dari strategi pencegahan umum menuju manajemen antibiotik yang lebih selektif dan berbasis bukti. Isu resistensi antibiotik muncul sebagai tema utama, dipengaruhi oleh faktor waktu pemberian, jenis antibiotik, dan kepatuhan terhadap pedoman klinis. Analisis kartografis juga memperlihatkan evolusi aliran penelitian selama dua dekade terakhir. Studi ini menegaskan pentingnya penggunaan antibiotik perioperatif dalam pencegahan SSI serta kebutuhan mendesak akan pedoman berbasis bukti. Penelitian ini juga mengidentifikasi arah penelitian ke depan, termasuk optimasi profilaksis antibiotik, strategi menghadapi resistensi, peningkatan kepatuhan pada protokol klinis, serta pertimbangan sosial-ekonomi dalam manajemen antibiotik perioperatif.

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INTRODUCTION

Surgical Site Infection (SSI) is a primary contributor to postoperative mortality, responsible for over one-third of all surgical fatalities globally (Portuondo et al., 2022). The prevalence of SSI differs throughout countries. In industrialized countries like the United States (1.9%), France (1.0%), and Italy (2.6%), prevalence rates are comparatively lower than in emerging nations such as Turkey (4.1%), China (4.5%), and India (5.0%). These disparities underscore the diversity in risk factors and the efficacy of infection prevention measures within each context. Various risk factors lead to the development of surgical site infection (SSI), which are associated with hospitalization duration before surgery, classification of wounds, and surgical duration. These circumstances can influence the likelihood of the pathogen developing and multiplying, which consequently leads to infection. Etiologically, studies have shown that Gram-negative bacteria cause 48 percent of the cases of surgical site infection, Gram-positive bacteria cause 40.8 percent of the cases, and fungi cause 11.2 percent of the infections (Wu et al., 2021). Escherichia coli (E. coli and S. aureus) are the most common bacteria associated with surgical site infections (SSIs) in China, with percentages of 25.9, 14.3, and 11.9, respectively. These results are consistent with the previous studies that confirm the distribution of the three pathogens in various types of illnesses (S. Li et al., 2020; Qiu et al., 2021; Du et al., 2022; L. Li et al., 2018; C. Ding et al., 2016). Growth of microorganisms in the surgical sites contributes significantly to the development of postoperative infections. It is of vital importance that the application of antimicrobial medicines be implemented carefully in decreasing the level of SSI occurrence (Yang et al., 2018). The knowledge of the risk factors and the most common pathogen variants will enable creating preventative actions more efficiently to decrease the infection load in postoperative patients.

Rasheed et al. (2018) reported that the level of antibiotic resistance to E. coli and K. pneumoniae in Indonesian hospitals was between 70% and 80%. A case study conducted in 2018 in Bagas Waras Klaten Regional Hospital and Dr. Moewardi Surakarta Regional Hospital in Indonesia on the use of antibiotics in patients with diabetic ulcers found that 75 percent of patients received antibiotics in their rational use, and 25 percent in their irrational use (Stiyanto & Suhesti, 2020). The concept of rational prescribing, as conceptualized by the World Health Organization (WHO), points to the practice of giving the correct patient the correct dosage and a particular number of times each day at the correct time of treatment; illogical prescribing points to the opposite, which is known as illogical prescribing (WHO, 2007). The WHO has emphasized the rational application of antibiotics and warned that antibiotic resistance due to improper use may lead to diseases. Even simple injuries, when they occur in the body, may lead to demise. Rational antibiotic use implies not too long, not excessive, symptomatic, and standardized antibiotic use. The rationality of antibiotic use is influenced by various factors, including the type of surgical incision, type of antibiotic, and antibiotic combination, and time of administration (Yang et al., 2018).

Several debates in previous literature studies examined various aspects related to the use of antibiotics in perioperative patients as an important strategy to prevent SSI. Yang et al. (2018) found that prophylactic antibiotic administration 30-60 minutes before surgery was effective in significantly reducing the risk of SSI. However, this finding raises a debate regarding the risk of antibiotic resistance due to uncontrolled use of prophylactic antibiotics. This resistance is a major concern for the WHO, which reports that antibiotic resistance has

increased morbidity, mortality, and health costs globally. WHO in 2022 also highlighted that the implementation of antibiotic restriction policies in developing countries, including Indonesia, is still constrained by limited access to safer alternative antibiotics.

Surgical site infection can also cause wounds to heal poorly, with the main cause of wound infection being wound contact with antimicrobial agents. The rational use of antibiotics is an important factor in preventing surgical site infections (Yang et al., 2018). SSI includes infections that occur in superficial incisional, deep incisional, and organ/tissue space infections, such as in encephalopiosis and peritonitis. Superficial incisions include skin and subcutaneous tissue incisions, deep incisions refer to deep soft tissue incisions (such as fascia and muscle layers), and organ/tissue spaces refer to anatomical structures that have been opened or treated surgically. The diagnostic criteria for SSI include infections that occur within 30 days after surgery. These infections can be identified by the presence of purulent exudate at the surgical site during this period. Symptoms such as fever, tenderness or localized pain, and swelling at the incision site should be promptly evaluated by a doctor to confirm the presence of an infection, especially if microbial growth is detected (Yang et al., 2018).

Although various studies have highlighted the importance of rational antibiotic use, there is little existing literature that discusses perioperative antibiotic use. The use of antibiotics is a primary therapy for treating bacterial infections. However, inappropriate use remains a serious issue in various healthcare facilities. According to Kuruvilla et al. (2023), irrational antibiotic use was found in 64% of tertiary care hospitals in South India, particularly in surgical units. Meanwhile, in Turkey, the rate of inappropriate antimicrobial use among hospitalized patients reached 67% (Şanal & Elmas, 2014). The increasing and uncontrolled use of antibiotics has become a global threat, contributing to the rise of bacterial resistance. Antibiotic resistance has significant social and economic impacts, including increased morbidity and mortality rates. Various resistant bacteria have now spread worldwide, including *Vancomycin-Resistant Enterococci* (VRE), *Methicillin-Resistant Staphylococcus aureus* (MRSA), *Penicillin-Resistant Pneumococci*, *Carbapenem-Resistant Acinetobacter baumannii*, and *Klebsiella pneumoniae* producing *Extended-Spectrum Beta-Lactamase* (ESBL). Additionally, *Multiresistant Mycobacterium tuberculosis* poses a serious threat to global infection control (Permenkes RI, 2011). In 2019, 25 countries reported to the Global Antimicrobial Resistance and Use Surveillance System (GLASS) on systemic infections caused by MRSA, while 49 countries reported data on systemic infections due to *E. coli*. Although the data is still not globally representative, the average rate observed for *S. aureus* with methicillin resistance reached 12.11% (IQR 6.4-26.4) and *E. coli* bacteria with resistance to 3rd generation cephalosporin antibiotics reached 36.0% (IQR 15.2-63.0) (WHO, 2021).

Therefore, antibiotic treatment should be followed by efforts to determine the bacteria causing the infection and whether the bacteria are resistant to the antibiotics given. In order for the administration of antibiotics to be carried out properly, a policy is needed to regulate the restrictions on their administration. Antibiotics themselves are divided into groups of antibiotics that can be freely used by all clinicians (non-restricted) and antibiotics that must be strictly maintained with administration requiring expert approval (Kementrian Kesehatan, 2015). The objective of the paper, therefore, is to explain the trends and research directions related to perioperative antibiotic use through bibliometric analysis, aiming to understand the

development of literature, identify publication patterns, and provide insights for future research in evidence-based antibiotic management.

RESEARCH METHOD

This study used a bibliometric analysis approach. The data source in this study used the Web of Science (WOS) database with the keyword 'Perioperative Antibiotic Use' (see Table 1) from 1986 to 2024. Data analysis techniques employed Vosviewer and R Studio. VOSviewer tools were used to map keywords, overlays, and concept maps, while R Studio was used to see the trend of research over time and see the dominant theme (Wordcloud).

RESULTS AND DISCUSSION

The results showed that research on perioperative antibiotic use has gradually expanded in scope, with a total of 67 documents published between 1986 and 2024. Although the annual growth rate is relatively modest (1.79%), the average citation rate per document is fairly high (18.55), reflecting the significant academic impact of this field. The literature is distributed across 59 different sources, including journals, books, and conference proceedings, which indicates that the topic has attracted the attention of diverse scientific communities and has become increasingly relevant across disciplines. The bibliometric trends also show a steadily increasing trend of teamwork in the specified field, as 336 authors were involved in it, and the average number of authors per publication is 5.24. The multidisciplinary nature of the study of perioperative antibiotics is seen in this collaboration, as surgeons, microbiologists, pharmacologists, and public health specialists were involved. The 67 documents include both empirical studies and literature reviews, which means that the evolution of original data-driven research and critical reflections on the new patterns go both ways.

The review shows that the research on perioperative antibiotics has gone beyond descriptive research to a deeper analysis of the risk factors, patient-specific factors, and international challenges such as antimicrobial resistance. This progression underscores the importance of evidence-based antibiotic stewardship policies. It highlights future research directions, including optimizing prophylaxis timing, refining guidelines for high-risk surgical procedures, and assessing the socio-economic impact of antibiotic use in perioperative care.

In terms of collaboration, the total number of authors involved in the publications is 336, with an average of 5.24 authors per document, signaling that this research tends to be conducted in teams rather than by individuals. There are no documents written by a single author, which further strengthens the indication that academic collaboration plays a big role in the development of this field. Although the level of international collaboration is still relatively low (7.463%), cross-border involvement remains. In terms of publication type, the majority were journal articles (48), with an additional few proceedings articles (7) and literature reviews (12), indicating that, in addition to empirical research, there were also contributions in the form of literature reviews to analyze trends and developments in the field.

Table 1. Summarizes The Publication Characteristics

Description	Results	AUTHORS	Results
MAIN INFORMATION ABOUT DATA		Authors	336
Timespan	1986:2024	Authors of single-authored docs	0
Sources (Journals, Books, etc.)	59	AUTHORS COLLABORATION	
Documents	67	Single-authored docs	0
Annual Growth Rate %	1.79	Co-Authors per Doc	5.24
Document Average Age	9.28	International co-authorships %	7.463
Average citations per doc	18.55	DOCUMENT TYPES	
References	1836	Article	47
DOCUMENT CONTENTS		Article; early access	1
Keywords Plus (ID)	239	Article; proceedings paper	7
Author's Keywords (DE)	183	Review	12

Figure 1 illustrates the trend in the number of publications from 1986 to 2024. On the X-axis, the years of publication are displayed along with the number of documents below. At the same time, the Y-axis represents the number of documents published each year, ranging from 0 to 8. From the observed data patterns, it can be seen that the number of publications increased significantly after 2015. During this period, many researchers focused on strategies to prevent SSI and other infectious complications, including urinary tract infections, bacterial endocarditis, and septic arthritis. Many peaks represent periods of the highest number of publications, and these might be influenced by external factors like the development of technologies, the introduction of new regulations, or the growing interest of scientists in this field of research (Balakirski et al., 2023; Tolba et al., 2018).

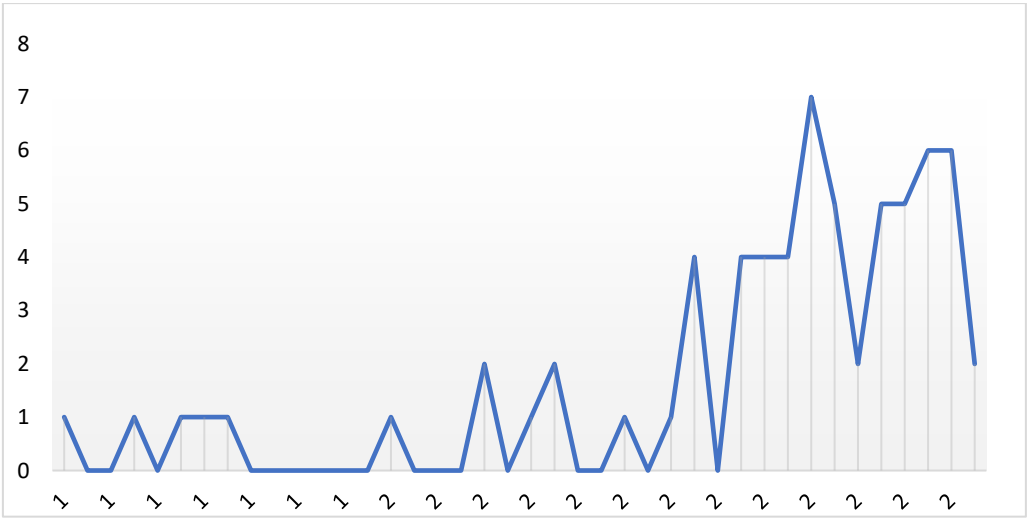

Figure 1. Total Number of Publications Trends by Year and Research Streams Over Time
Source: *ISI Web of Science*

Five chosen articles summarized in Table 2 focus on the use of perioperative antibiotics and their association with several surgical operations and diseases. These articles were highlighted because they provide exhaustive and generalized results that will be related to the research objective, such as infection prevention measures and antibiotic usage trends. Even though other articles in the overall research covered similar areas, these five studies were chosen

to be discussed in-depth to represent the range of approaches and the significant implications of the use of perioperative antibiotics in different surgical facilities. The top-ranked paper is a research by J. Ding et al. (2024), which evaluated the effectiveness of prophylaxis antibiotics in preventing infection of the lower genital tract after induced abortion. The research demonstrated the inability to provide successful infection prevention even with prevention strategies, which points to the idea that practical clinical results do not always reflect the theoretical benefits. It substantiates even more sharply the necessity to change the current practice of prophylaxis, especially in gynecological surgery, and focus on other or alternative methods or strategies, such as the timely organization of dosage schedules or preventive methods of prophylaxis.

Niu et al. (2023) also developed this problem by analyzing the correlation between the penicillin allergy and the number of achievements of the orthopedic surgery in the surgical site infections. They discovered that patients who have penicillin allergies are more at risk of catching a post-operative infection due to reduced access to antibiotics, with the impact usually being through the consumption of weaker ones. It is here that the significance of the accuracy of the procedures of allergy testing and desensitization procedures is reflected, in that the patients are not deprived of the first-line antibiotics unjustly.

Simultaneously, K. L. Li, Fang, Hawn, Agarwal, Kshettry, et al. (2022) and K. L. Li, Fang, Hawn, Agarwal, Kshretty, et al. (2022) cast some light on the complications of skull base surgery, which is a high-risk location, and infection prevention is a significant issue. They showed in their surveys the variety of practices relating to prevention and the necessity to standardize and evidence-based guidelines to implement them in a complicated surgical case. These observations raise the general question of assuring the uniformity in handling of the antibiotics in the diverse circles of surgery.

Plager et al. (2020) furthered this debate by proving the benefit of preoperative testing of penicillin allergy in patients who undergo heart surgery. Through the identification of incorrect cases of allergy, physicians may be able to administer more effective first-line antibiotics, which would reduce the chances of infection and surgical sequelae. This paper explains the possibility of direct patient outcomes improvement through individualized antibiotic choice approaches.

The papers, all these, are the ideal examples of how the various focal points of the research on antibiotics take place. Still, of the same color, the focus is to ensure accuracy, targeting, and contextual fit when using antibiotics. The results support the need to include patient-specific factors, the complexity of the surgery, and real-life data in an infection prevention approach, instead of using the same approach. This fact supports the argument to develop more advanced and evidence-based guidelines to increase patient safety and reduce the problem of antibiotic resistance.

Table 2. Ranking of Trending Articles

Rank	Author/Year/Title	Publisher
1	Failure to reduce the risk of postoperative lower genital tract infection with perioperative antibiotic prophylaxis during induced abortion: a real-world study (J. Ding et al., 2024).	Frontiers in Medicine
2	The association between penicillin allergy and surgical site infection after orthopedic surgeries: a retrospective cohort study (Niu et al., 2023).	Frontiers in Cellular and Infection Microbiology

Table 2. Ranking of Trending Articles (cont')

Rank	Author/Year/Title	Publisher
3	Antibiotic Use in Lateral Skull Base Surgery: A Survey of the North American Skull Base Society (K. L. Li, Fang, Hawn, Agarwal, Kshettry, et al., 2022).	Journal of Neurological Surgery Part B-Skull Base
4	Preoperative penicillin allergy testing in patients undergoing cardiac surgery (Plager et al., 2020).	Annals of Allergy Asthma & Immunology
5	Antibiotic prophylaxis in anterior skull-base surgery: a survey of the North American Skull Base Society (K. L. Li, Fang, Hawn, Agarwal, Kshretty, et al., 2022).	International Forum of Allergy & Rhinology

Source: *ISI Web of Science*

Figure 2 comprises a cluster of words that illustrate the major themes in studies regarding the use of prophylactic antibiotics during operations. Terms such as prophylaxis, prophylactic antibiotics, prevention, and infection are characterized by a high rate of repetition in the literature. It justifies the necessity of infection control programs through the systematic administration of prescribed antibiotics.

The attention paid to the topics, including the SSI, the risk factors, and the complications, tests the significance of the study aimed at investigating the risks and clinical implications of the postoperative infections. It correlates with the observation that prevention of a surgical site infection (SSI) is among the most debatable issues of perioperative care since it has a gigantic impact on patient safety and expenditures in health care institutions (Sartelli et al., 2023). The high frequency of the introduction of such names as guidelines and antimicrobial prophylaxis attests to the paramount importance of the evidence-based practice guidelines in enhancing the application of antibiotics in perioperative settings. According to Friedrichs et al. (2021), strong antibiotic stewardship frameworks are essential for compliance with these guidelines.

The other repetitive word is the keyword of resistance, which demands increased interest in the international issue of antimicrobial resistance. As mentioned by Y. Wang et al. (2022), bacteria have developed mechanisms to reduce the efficacy of antibiotics, and they thus need to be used more judiciously. Purba et al. (2018) depicted that in economic terms. However, preventative antibiotics are often economically viable in infection prevention; the financial cost of resistance as a result of misuse cannot be disregarded.

The term cloud demonstrates the complexity and vastness of the research on the issue of infection prevention in the surgical environment, with the interconnection of risk assessment, clinical guidance, stewardship programs, and the problem of global resistance. Altogether, these facts demonstrate the importance of effective and careful use of antibiotics as one of the keys to safe perioperative practice.

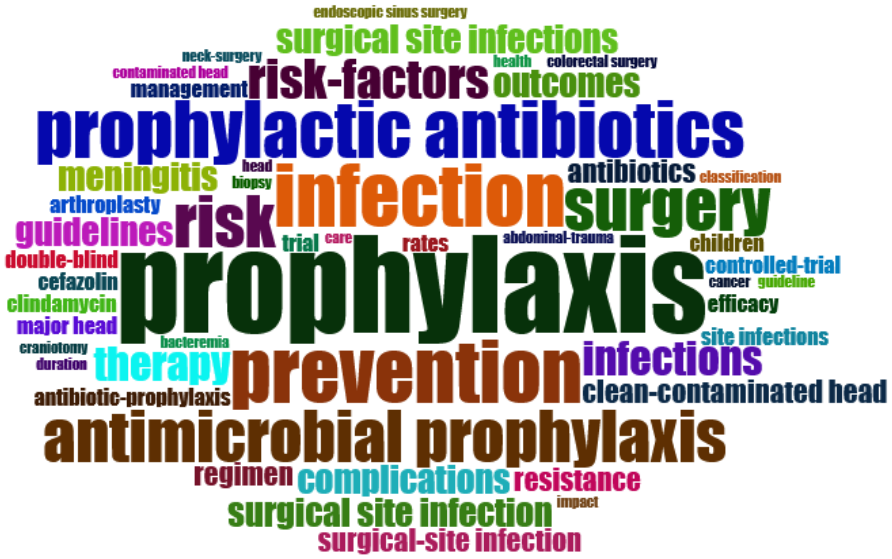

Figure 2. Perioperative Antibiotic Use: Prevention and Risk Management (WordCloud)
Source: *Processed by Author Using VOSviewer*

As can be shown in Figure 3, the problems of preventive, prophylactic antibiotics, and antibiotic prophylaxis have a center stage in the network, as demonstrated by the bibliometric map. This stand implies that these themes have a high level of interconnection with many other concepts in the scientific literature. Prevention involves the implementation of measures that can improve the process of antibiotic prescribing and treatment, and it requires staff and infrastructure resources (Friedrichs et al., 2021).

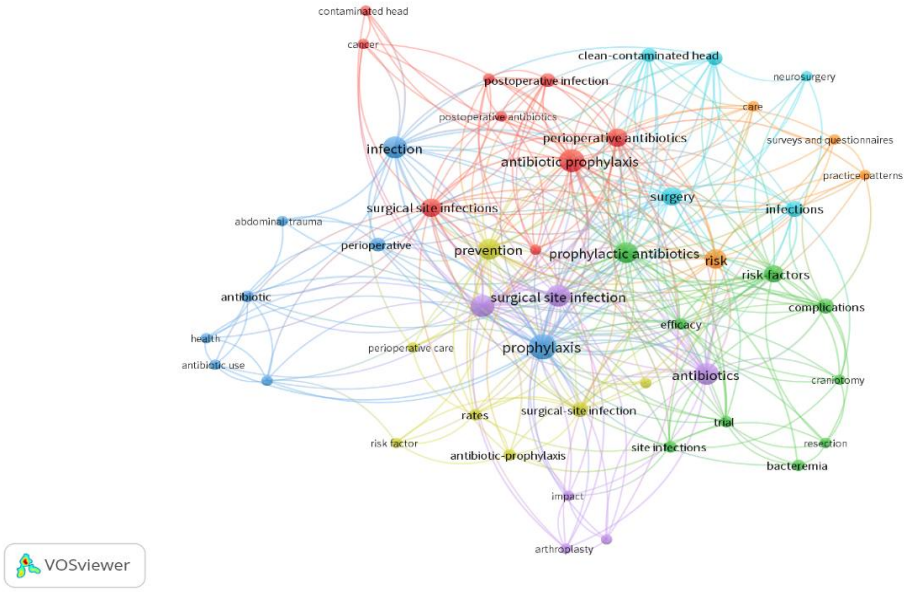

Figure 3. Bibliometric Network of Perioperative Antibiotic Use
Source: *Processed by Author Using VOSviewer*

The vast and strong cross-linking with other topics implies that the area of antibiotic-related research and preventive use of antibiotics as a means to prevent infection is the issue that receives considerable attention in the health and biomedical domains.

Medical practice requires antibiotics to treat many dangerous bacterial diseases, including pneumonia, urinary tract infection, and post-operative wound infection (Upmanyu & Malviya, 2020). There is a huge challenge related to antibiotic resistance in the massive use of antibiotics. It occurs when bacteria develop mechanisms that will help them to mitigate the effects of antibiotics, making them less effective or completely useless (Y. Wang et al., 2022; Mahizhchi et al., 2024). Such situations promote the mass-scale investigation of the action mechanism and the development of the next generation of antibiotics as a solution to the allergy issue.

Additionally, there are some diseases, such as surgery or chronic illnesses, along with exposure to some specific bacteria, in which prophylactic antibiotics are prescribed to prevent their spread. Such situations would warrant the use of prophylactic antibiotics for rheumatic fever, infective endocarditis, and frequent urinary tract infection, among others (Sloane et al., 2020). The economic viability of prophylactic antibiotics is not the same. In the majority of cases, prophylactic antibiotics can be proven to be cost-effective with regard to the prevention of catheter-associated urinary tract infections (R. Wang et al., 2020) however, the economic consequences of antibiotic resistance and misuse should be considered (Purba et al., 2018). Meanwhile, antibiotic prophylaxis refers to a systematic strategy of using antibiotics to prevent infection in patients who have certain health conditions or before undergoing certain medical procedures (Karapetyan et al., 2023; Freitas et al., 2023).

Figure 4 shows the evolution of research topics related to perioperative antibiotic use over time in several periods. In the early phase (2010-2013), keywords such as SSI dominated, reflecting the initial focus of research on the effectiveness of antibiotics in preventing infections in the surgical area (Sartelli et al., 2023). Over time, there has been a diversification of research themes, demonstrated by the increasing number of linked terms in the periods 2015-2017 and 2018-2019. In this period, many researchers studied perioperative care, including the medical care provided to patients from the time surgery is planned until full recovery (Grocott & Levett, 2022; Yam, 2024). It demonstrates the growing concerns with protocols of antibiotic use and a multidisciplinary approach to perioperative care.

The research witnessed a concrete expansion of the field during the period 2020-2022, which brought fresh topics and subjects of interest, posing clinical challenges and altered medical practice, namely, the issue of antibiotic resistance and the dominance of prescription antibiotics (Krolak-Ulińska et al., 2024). These studies demonstrate that the realization of the growing acceptance that antibiotic resistance is not an imaginary concept but a practical point of contention that is of paramount significance and directly influences the post-operative exposure. These priorities with the concern of prophylaxis imply the additional consideration of the concept of prevention of surgery site infections and managing inhibiting hazards.

Their research themes at the latest stage (2022-2025) will shift to more rational use of antibiotics and introduction of evidence-based policies, and once again with the priority to cost-efficiency and precision medicine (Banji et al., 2024; Sarwar, 2023). The change can demonstrate the fact that the scope of study has begun to encompass not only clinical efficacy but also the financial and moral costs of antibiotic management. The cost-efficiency debate is

centered on whether there is a need to compromise the scarcity of medical services with suitable infection control, and precision medicine talks about the use of changing the use of antibiotics that should rely on patient risk factors, genetic factors, or microbiological characteristics.

This shift in pattern constitutes a healthy change of direction in research whereby they started to shift from the old way of infection prevention to a more detailed system that comprises clinical efficacy, economically viable, and personalized therapy. The evolutions indicate that the future of perioperative management, as per the usage of antibiotics, is starting to take another dimension, whereby judicious use is guided by the objectives of patient safety and long-term audits, thus ensuring the sustainability of antibiotics in the incoming generation.

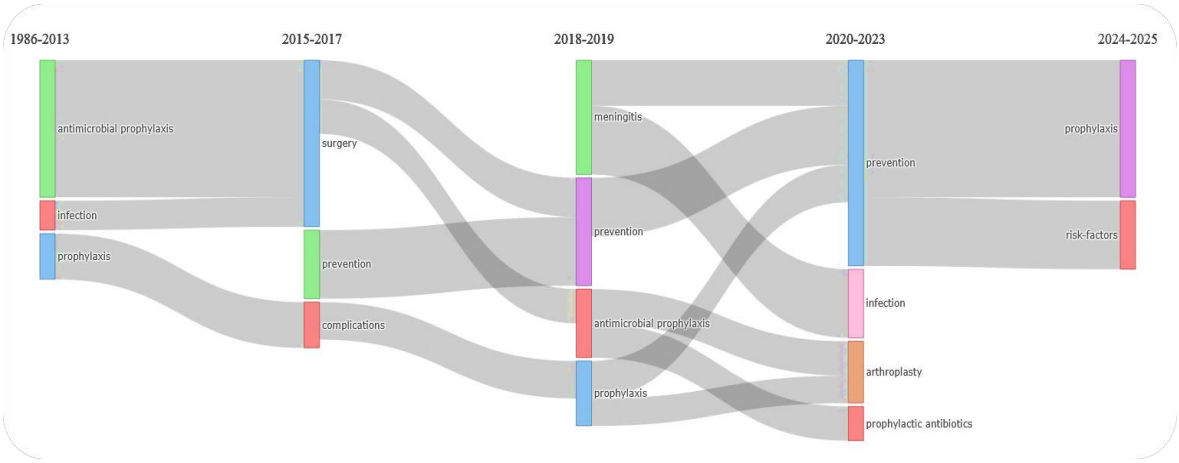

Figure 4. Evolution of Research Keywords in Perioperative Antibiotic Use

Source: *Processed by Author Using R Studio*

Based on the data represented in Figure 5, antibiotic prophylaxis in medical and surgical situations shows that light colors (yellow) imply a greater concentration of keywords, which represent the subjects where the focus is on the research. The dominant theme of the literature is research on prophylaxis, antibiotic prophylaxis, and prevention, which points to the use of antibiotics as the focus of infection prevention.

In addition, the topics of surgical site infection (SSI), infection, and risk factors are important in highlighting the high level of correlation between the prophylaxis of the use of antibiotics and the reduction of the risk of post-operative infection. Sartelli et al. (2023) highlighted that surgical site infections (SSIs) are still a major issue in perioperative practice that requires extreme adherence to prophylactic measures to decrease morbidity and healthcare costs. Just off the map, the temporal issues like clean-contaminated head surgery and perioperative infections represent indicators of sub-areas that are getting minimal scholarly consideration but clinical significance due to their complexity and severity of the impact.

The subtopics align with Freitas et al. (2023), who observed that particular surgical contexts, such as abdominal or cranial surgeries, necessitate customized prophylactic methods to mitigate their distinct infection risks. Sloane et al. (2020) emphasized that incorrect or excessive prophylactic antibiotic usage in specific environments, such as long-term care institutions, can result in unnecessary antibiotic exposure and hasten resistance development.

This tendency demonstrates that the research in this sphere is not only focused on the general issue of the prevention of the infection, but also gaining momentum in its reference to

the technical and clinical complexity. The results indicate the necessity and formulation of context-specific guidance, as well as demonstrate the necessity of further research on unexplored fields of surgery, where the use of antibiotic agents should be holistic and receptive to different clinical environments.

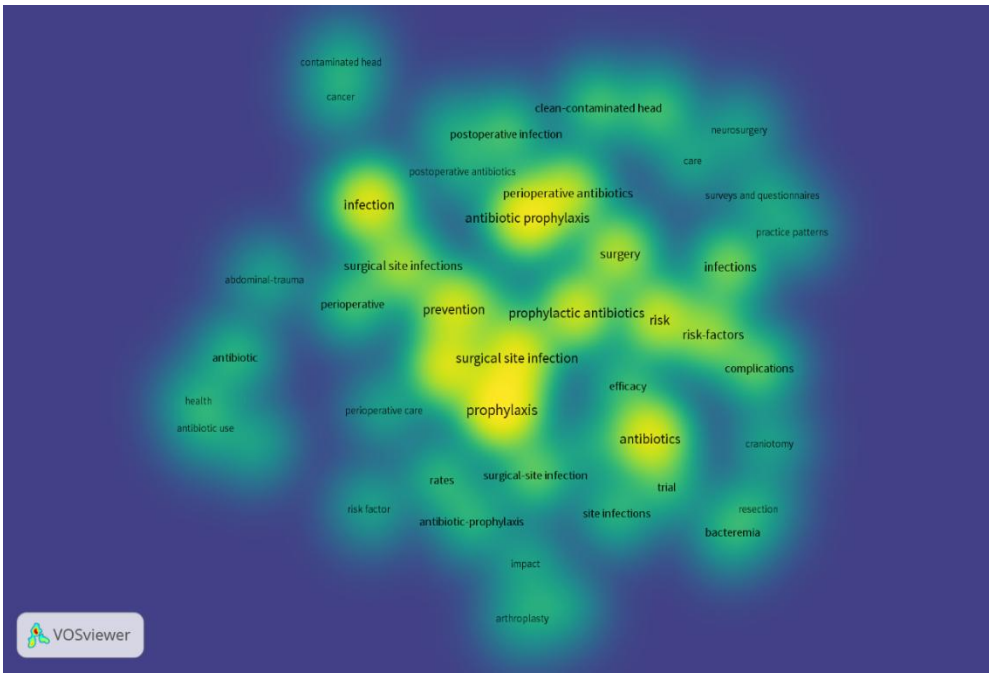

Figure 5. Bibliometric Density of Perioperative Antibiotic Use

Source: *Processed by Author Using VOSviewer*

CONCLUSION

This paper confirms that the use of perioperative antibiotics is an important intervention in minimizing surgical site infections, and research trends have changed through a broad use of perioperative antibiotics to more targeted, evidence-based, and patient-centered care. The analysis of 67 articles published between 1986 and 2024 shows that the number of publications, especially since 2015, has risen significantly due to the concern of antimicrobial resistance, the importance of timing, antibiotic choice, and adherence to clinical practice. The findings highlight that different surgical settings, which include orthopedic, gynecological, and skull base surgery, require unique approaches as opposed to a generalized one. Therefore, the following are the recommendations: improvement of evidence-based clinical policies and guidelines, better allocation of time in terms of allergy screening and prophylaxis, and reasonable choice of antibiotics and further research on precision medicine, cost-effectiveness, and socio-economic implications of the consequences to balance patient safety with the distribution of healthcare resources. Moreover, the increased collaboration across the globe and the development of multifaceted antibiotic stewardship initiatives are essential to reduce the problem of antimicrobial resistance and to ensure that future generations can use the effectiveness of antibiotics.

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