

Healthcare Failure Mode and Effect Analysis in Surgery Setting: A Bibliometrics Analysis and Literature Review

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doi: [10.5455/aim.2024.32.19-23](https://doi.org/10.5455/aim.2024.32.19-23)

ACTA INFORM MED. 2024, 32(1): 19-23

Received: JAN 05, 2024

Accepted: MAR 09, 2024

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ABSTRACT

Background: In the ever-evolving healthcare landscape, the imperative to ensure patient safety has driven the adoption of robust safety approaches. One of the most popular methods is Healthcare Failure Mode and Effect Analysis (HFMEA). **Objective:** This study aims to conduct a bibliometric analysis of HFMEA research in a surgery setting to identify relevant authors, topics, and journals, highlighting the scholarly collaboration trends in this area. This analysis can provide valuable insights into the current state of research, emerging trends, and future research directions. **Methods:** The data was acquired online from the PubMed database on December 16th, 2023. The downloaded data were analyzed using Google Sheets to predict trends. The publication output was then analyzed using VOSviewer. Subsequently, Biblioshiny was used to analyze the characteristics of the study, productive author, institution, and country; thematic map analysis; and topic timeline analysis. **Results:** This study analyzes 25 documents spanning 2005 to 2022, reflecting a collaborative effort involving 155 contributors. The upward trend in annual scientific publications, notably the surge from 2014 onwards and significant peaks in 2019 and 2022, underscores the growing recognition of HFMEA in enhancing patient safety within surgical environments. The prominent influence from prolific authors like Ahmed K, leading institutions such as King's College London, and the substantial contributions from Norway and the USA in shaping the HFMEA research landscape. **Conclusion:** This study contributes valuable insights that can shape the trajectory of HFMEA in the evolving landscape of surgical healthcare, ensuring enhanced patient safety and quality improvement.

Keywords: bibliometrics, healthcare failure mode and effect analysis, hospital management, review, surgery.

1. BACKGROUND

In the ever-evolving healthcare landscape, the imperative to ensure patient safety has driven the adoption of robust safety approaches. Over the past two decades, similar safety approaches have been adopted in healthcare to analyze high-risk processes (1).

One of the most popular methods is Healthcare Failure Mode and Effect Analysis (HFMEA). HFMEA was developed by the United States Department of Veterans Affairs National Center for Patient Safety (NCPS) in 2002 by combining concepts, components, and definitions from Failure Mode and Effect Analysis (FMEA), hazard analysis and critical control point (HACCP), and root cause anal-

ysis (2). HFMEA is a systematic risk assessment method derived from high-risk industries, which has been adapted to prospectively examine complex healthcare processes, including those in surgery (3). This method helps identify and mitigate potential failures and their effects, thus enhancing the quality of care and patient outcomes. Several studies have emphasized the importance of HFMEA in healthcare, including its application in surgery (4-10).

2. OBJECTIVE

This study aims to bibliometric analysis of HFMEA research in surgery to identify relevant authors, topics, and journals, highlighting the scholarly

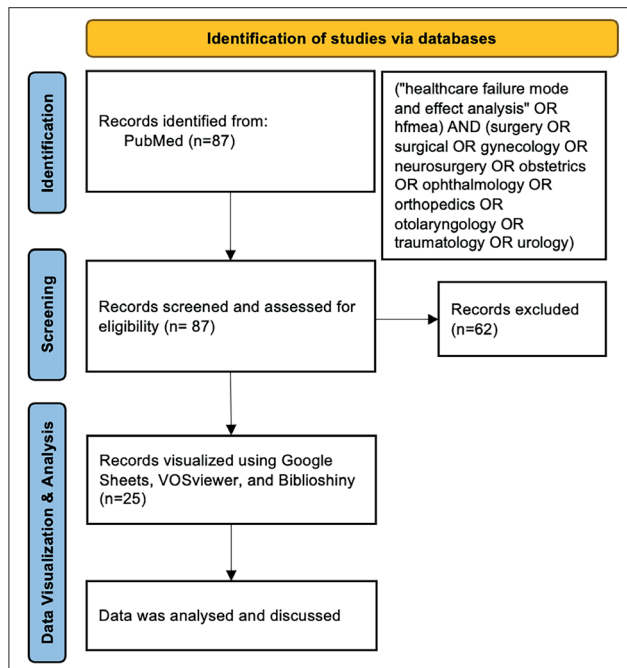


Figure 1. PRISMA 2020 flow diagram for bibliometrics analysis

collaboration trends in this area. This analysis can provide valuable insights into the current state of research, emerging trends, and future research directions.

3. MATERIAL AND METHODS

Data Source and Search Strategy

The data was acquired online from the PubMed database. To avert the bias caused by daily database updates, the search process was conducted on December 16th, 2023. The keywords used were “(“healthcare failure mode and effect analysis” OR hfmea) AND (surgery OR surgical OR gynecology OR neurosurgery OR obstetrics OR ophthalmology OR orthopedics OR otolaryngology OR traumatology OR urology).” The ini-

tial search revealed 87 studies. We constrained the literature to those written in English, which had reached the final publication stage, and open-access literature. In this study, only articles, reviews, and conference papers published in journals were considered. Then, we screened all the studies that met our requirements based on the title and abstract and eliminated any irrelevant studies. Twenty five studies were downloaded and analyzed in total. The complete methodology process, including literature searching, screening process, and data analysis, is provided in Figure 1.

Data Analysis

The downloaded data were analyzed using Google Sheets to predict trends. The publication output was then analyzed using VOSviewer (version 1.6.18). VOSviewer is a visualization software with cluster analysis and excellent data visualization (11). Subsequently, Biblioshiny was used to analyze the characteristics of the study, productive author, institution, and country; thematic map analysis; and topic timeline analysis. Numerous tools provided by Biblioshiny enable researchers to conduct in-depth bibliometric studies (12).

4. RESULTS AND DISCUSSION

Characteristics of Study

A total of 25 documents from 2005 to 2022, drawn from a diverse array of 23 sources, were analyzed. There is an impressive annual growth rate of 8.5% and an average document age of 5.76 years. The comprehensive exploration of document contents includes 150 Keywords and 150 Author’s Keywords. Regarding authorship, the study involves 155 contributors, highlighting a collaborative research approach. Interestingly, no single-authored documents indicate a collective effort in addressing the complexities of healthcare failure analysis in the surgical context. The average number of co-authors per document stands at 6.48, emphasizing the collaborative nature of the research process. Moreover, an international co-authorship percentage of 8% suggests a global perspective,

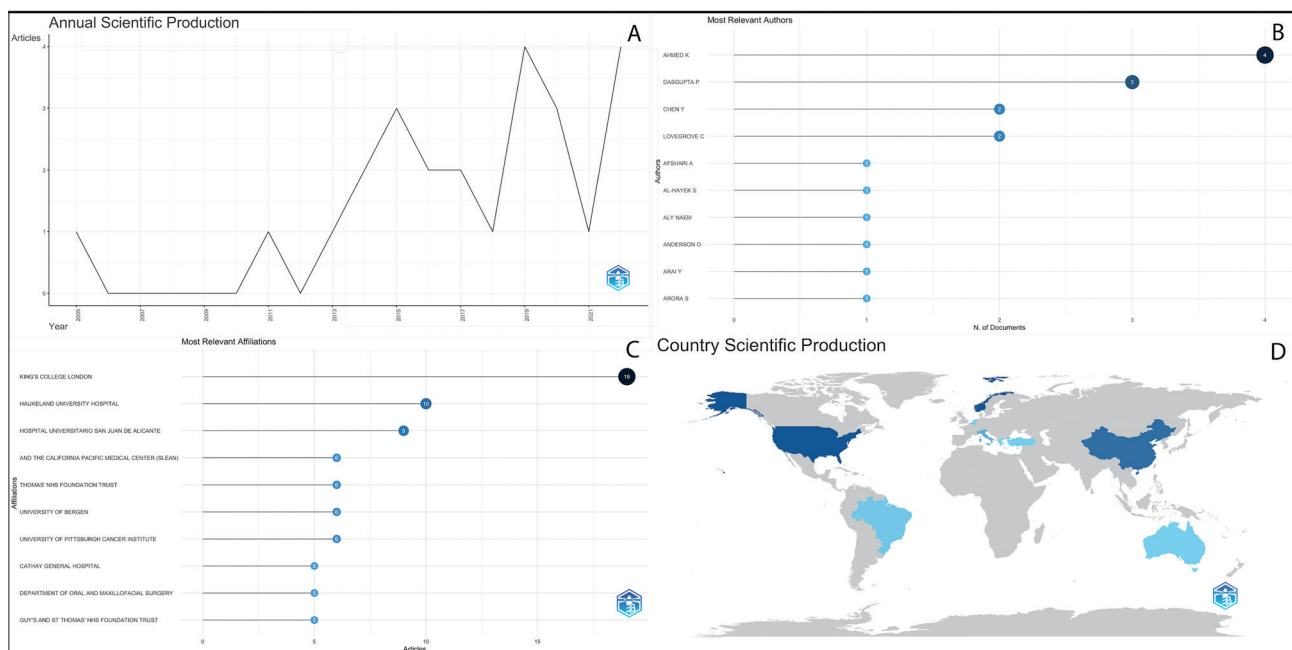


Figure 2. Number of publications and most productive authors, institutions, and countries. (A) Annual scientific publications throughout the entire publication period, (B) Top ten of most productive authors based on the number of publications, (C) Top ten of most productive institutions based on the number of publications, and (D) Map of country scientific productions.

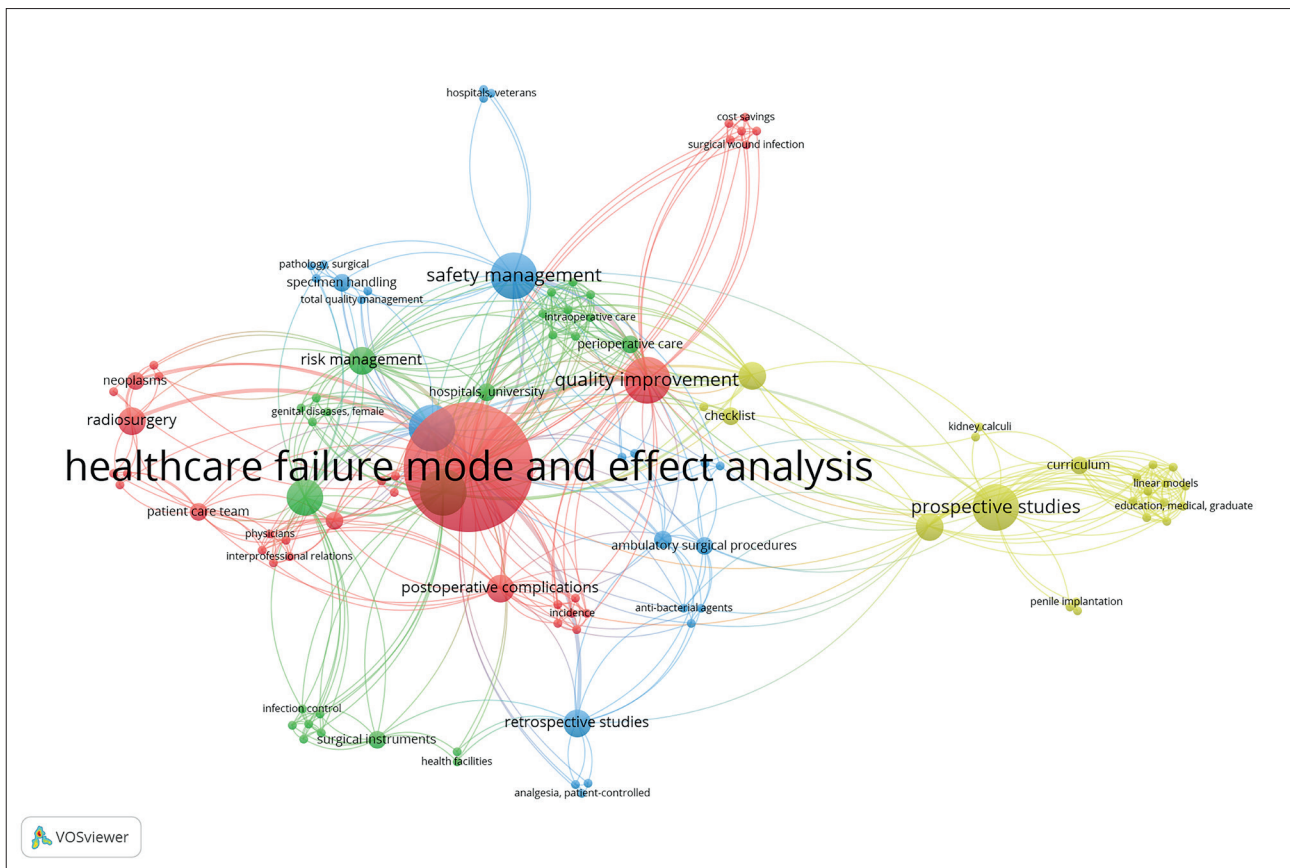


Figure 3. Main theme cluster analysis. Co-occurrence clusters of the author's keyword are represented by different colors. The size of the circle is proportional to the occurrence of the keyword, while the thickness is proportional to the strength of co-occurrence.

reflecting the diverse and inclusive nature of the study's authorship.

Annual Scientific Publications

The analysis of annual scientific publications reveals a discernible trend over the years. In 2005, one article was published, signaling an initial foray into the application of HFMEA in surgical contexts. Subsequent years witnessed limited or no publications until 2011, when another article emerged. From 2014 onwards, there was a noticeable surge in interest, with two to three publications each year. The most significant peak occurred in 2019 and 2022, with four articles published yearly. This uptick in publications suggests a growing recognition of the importance of HFMEA in enhancing patient safety within surgical environments. The trend underscores an increasing emphasis on systematic error prevention and risk reduction in surgical practices, reflecting the evolving research landscape in this critical domain. The entire annual scientific publications over time were visualized in Figure 2A.

Productive Author, Institution, and Country

Topping the list is Ahmed K, who has contributed significantly with 4 articles, showcasing a notable dedication to research in this domain. Following closely is Dasgupta P, with 3 articles demonstrating a substantial contribution to the HFMEA literature. Chen Y and Lovegrove C each have 2 articles, solidifying their positions as productive authors in this field. The top ten most productive authors based on the number of publications were visualized in Figure 2B. These authors play a crucial role in advancing the understanding of HFMEA, and their contributions underscore the diversity of

expertise and perspectives shaping the literature in this critical area of healthcare research.

In the scope of the institution, King's College London, having contributed a substantial 19 articles, followed by Haukeland University Hospital with 10 articles, and Hospital Universitario San Juan de Alicante with 9 articles. The California Pacific Medical Center (SLEAN), St. Thomas' NHS Foundation Trust, the University of Bergen, and the University of Pittsburgh Cancer Institute boast 6 articles demonstrating a noteworthy commitment to HFMEA research. Cathay General Hospital, the Department of Oral and Maxillofacial Surgery, and Guy's and St Thomas' NHS Foundation Trust, each with 5 articles, round out the top ten institutions. These institutions exemplify a diverse and highly productive landscape, contributing significantly to the evolving understanding of HFMEA applications in healthcare and surgery settings. The top ten most productive institutions based on the number of publications were visualized in Figure 2C.

Subsequently, based on country productivity, Norway and the USA lead the list, each contributing 22 articles, indicating a shared prominence in the research landscape of HFMEA. China follows with 17 articles, underscoring its significant and growing role in scientific contributions to the field. Italy follows suit with 6 articles, showcasing a substantial presence in HFMEA research. Belgium and Brazil are also noteworthy contributors, each with 2 articles. Australia, Greece, the Netherlands, and Turkey each have a single article demonstrating a global distribution of scientific output in the context of HFMEA. This international distribution emphasizes the collaborative and diverse nature of research

efforts to enhance healthcare practices by applying HFMEA methodologies. A map of the country's scientific productions was visualized in Figure 2D.

The Main Theme of Research Focuses

The primary topics within the HFMEA framework applied to surgery encompass medical errors, patient safety, quality improvement, safety management, risk assessment, and postoperative complications. Each of these aspects represents critical dimensions in understanding and addressing the challenges associated with surgical procedures. Medical errors, for instance, delve into the identification and prevention of mistakes, while patient safety emphasizes the paramount importance of ensuring the well-being of patients throughout the surgical process. Quality improvement strategies aim to enhance the overall surgical procedures, safety management protocols, risk assessment practices, and the mitigation of postoperative complications, contributing significantly to enhancing surgical outcomes. The main theme cluster analysis is visualized in Figure 3.

Cluster analysis also identifies clusters of related topics that merit attention in future research endeavors. The identification and implementation of cost-saving measures in surgical procedures stand out as a critical theme, urging researchers to explore strategies that optimize resource utilization without compromising patient safety. Educational measurement, a cluster that emerges from the analysis, invites a deeper examination of how educational interventions impact the understanding and application of HFMEA principles among surgical teams. Proportional hazard models offer a statistical lens through which the temporal aspects of risks in surgery can be further elucidated, providing insights into the dynamic nature of complications over time.

Subsequently, based on the application in each specialization, it is essential to note that the studies are primarily concentrated only on a few specializations, including urology (13, 14), maxillofacial surgery (15), radiosurgery (16-18), neurosurgery (19), thyroid surgery (20), eye surgery (21, 22), orthopedic surgery (23), ENT surgery (24), obstetrics surgery (25). In contrast, specific specializations such as vascular, plastic, pediatric, and gastrointestinal surgery have not yet been explored.

Topic Timeline and Thematic Map Analysis

The topic timeline analysis (Figure 4A) reveals evolving trends, highlighting key topics that have gained prominence over the years. Notably, a growing focus on patient safety is underscored by increased publications related to HFMEA and patient safety standards. The integration of risk assessment and safety management methods has gradually risen, indicating a heightened awareness of preventive measures in healthcare settings. Quality improvement and prospec-

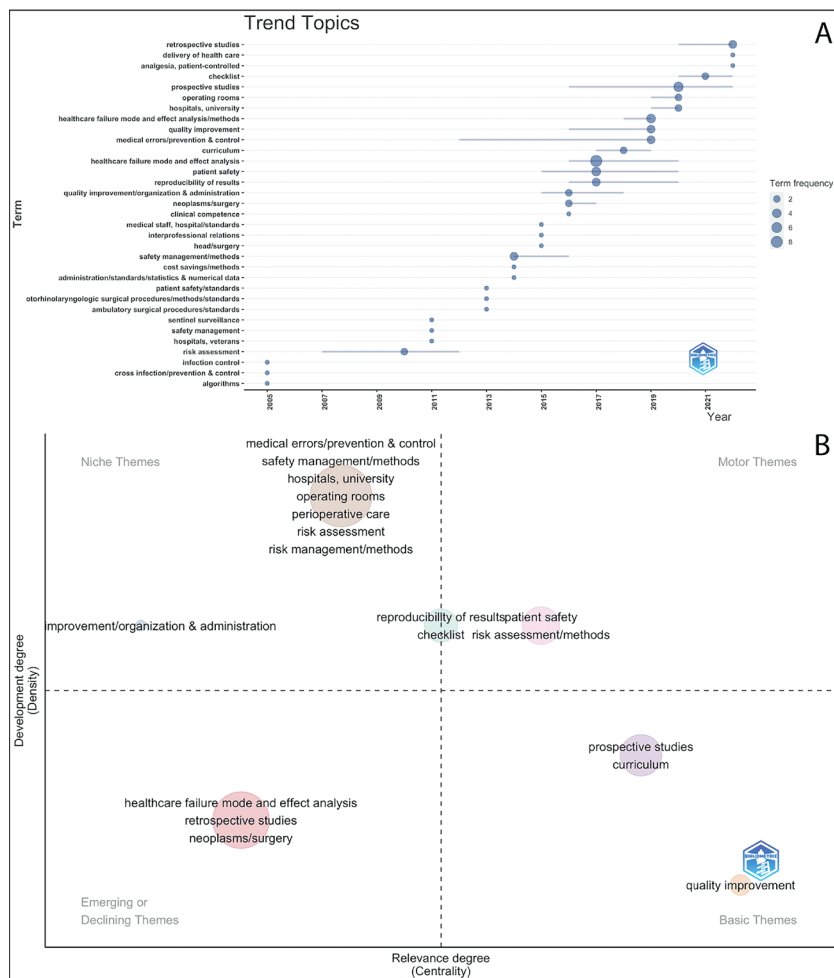


Figure 4. Trend topic and thematic map. (A) Trend topics throughout the publication period and (B) Thematic map analysis

tive studies have emerged as persistent and evolving themes, emphasizing a commitment to enhancing healthcare practices and methodologies. Moreover, the data suggests a shift towards proactive measures, as evidenced by the increasing emphasis on curriculum development, medical error prevention and control, and interprofessional relations. On the other hand, the decline in retrospective studies suggests a changing research landscape, possibly indicative of a shift towards prospective and forward-looking methodologies in healthcare research. Including topics such as checklist implementation in recent years reflects a growing interest in practical tools and frameworks for ensuring systematic and standardized procedures in healthcare delivery.

Furthermore, a comprehensive exploration of potential future studies within the HFMEA framework in surgery reveals intriguing avenues for research that are also provided by thematic maps analysis. Thematic maps suggest that the evolution of surgical education, particularly in curriculum development, holds promise for further investigation. The dynamic nature of neoplasm surgery, a field marked by continuous advancements, presents a suitable area for future studies to contribute to refining protocols and enhancing patient outcomes. Moreover, the intersection of HFMEA with curriculum development may unveil innovative approaches to integrate safety protocols into surgical training programs, fostering a culture of continuous improvement. Thematic map analysis is provided in Figure 4B.

5. CONCLUSION

This comprehensive analysis sheds light on the multifaceted landscape of HFMEA within surgical settings. The study encompassed a total of 25 documents spanning the years 2005 to 2022, drawing from 23 diverse sources. The impressive annual growth rate of 8.5%, the collaborative approach involving 155 contributors, and the absence of single-authored documents underscore the research's dynamic and collective nature in addressing healthcare failure analysis in surgery. The thematic analysis reveals a compelling evolution of research topics over the years, emphasizing the critical dimensions of medical errors, patient safety, quality improvement, safety management, risk assessment, and postoperative complications within the HFMEA framework.

Looking forward, the identified gaps and opportunities for future investigations underscore the potential for further advancements in surgical research. The exploration of themes such as the evolution of surgical education, neoplasm surgery, cost-saving measures, and educational measurement provides clear pathways for future studies to contribute to refining protocols, enhancing patient outcomes, and integrating HFMEA principles into educational frameworks. The identified clusters further guide researchers toward critical areas such as optimizing resource utilization, understanding the impact of educational interventions, and elucidating the temporal aspects of risks in surgery. This collective body of knowledge enriches the existing literature. It paves the way for a more nuanced and impactful application of HFMEA methodologies in the ever-evolving landscape of surgical healthcare.

- **Authors contribution:** TS, MFI, and AD were involved in the study conception and design. TS and MFI reviewed search results and completed data extraction. TS and MFI performed data analysis and interpretation. TS and MFI drafted the manuscript, then AD critically revised it. All authors provided their final approval for the to-be-published version and agreed to be held accountable for all aspects of the work. **unding:** This research received no external funding.
- **Conflicts of Interest:** The authors declare no conflict of interest.
- **Financial support and sponsorship:** None.

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