



Systematic Review and Bibliometric Mapping on Image Processing in Electronic Health Records

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Abstract

The integration of medical image processing techniques into Electronic Health Records (EHRs) has become a vital element in transforming modern digital healthcare services. This study aims to conduct a Systematic Literature Review (SLR) and bibliometric analysis to evaluate current research trends, patterns, and gaps from 2021 to 2025. Using the PRISMA framework and data from the Scopus database, this study analyzes 23 selected articles visualized using VOSviewer software. The results reveal a significant surge in publications, driven by the adoption of Artificial Intelligence (AI) and Deep Learning, which have been proven to improve diagnostic accuracy and facilitate early detection of critical diseases. Although these technologies support better clinical decision-making, major challenges related to system interoperability, data standardization, and patient privacy security remain substantial obstacles that need to be overcome. The study also highlights the role of emerging technologies such as the Internet of Medical Things (IoMT) and blockchain as potential solutions for data security. In conclusion, this research provides strategic guidance for developers and policymakers to create a more interoperable, secure, and efficient EHR ecosystem.

Keywords: *Bibliometric Analysis, Data Security, Deep Learning, Electronic Health Records, Medical Image Processing.*

1. INTRODUCTION

Image processing has become a cornerstone technology in modern healthcare, fundamentally transforming how medical professionals diagnose, monitor, and treat various conditions. The application of image processing involves acquiring and transforming digital medical images such as X-rays, Magnetic Resonance Imaging (MRI), and Computed Tomography (CT) scans to enhance their quality and extract critical anatomical or pathological information [1]. As the volume and complexity of these medical images continue to grow exponentially, managing them efficiently has become a significant priority [2]. Consequently, these imaging technologies are increasingly intersecting with Electronic Health Records (EHR). EHRs serve as comprehensive digital repositories of a patient's medical history, encompassing not only text-based data like diagnoses and medications but also crucial multimedia data like radiology images [3]. Integrating advanced image processing directly into EHR systems holds immense potential to streamline data retrieval, enhance diagnostic accuracy, and ultimately improve patient care by providing a holistic view of patient health in a single platform.

Recent advancements in Artificial Intelligence (AI) and Machine Learning (ML) have further amplified the capabilities of image processing within clinical settings. AI algorithms can autonomously process massive imaging datasets to perform complex tasks such as image segmentation, registration, and three-dimensional reconstruction, which are vital for early disease detection and personalized treatment planning [4]. However, despite these technological leaps, embedding these sophisticated AI-driven image processing tools into EHR systems presents substantial logistical and technical challenges. Healthcare providers frequently face hurdles related to data interoperability, strict patient privacy regulations, and the sheer computational demand of managing high-resolution imaging data within standard EHR infrastructures [5]. Furthermore, variations in imaging hardware and a lack of standardized protocols across different healthcare settings create significant bottlenecks in achieving seamless integration.

To understand and mitigate these challenges, several Systematic Literature Reviews (SLRs) have been conducted in recent years. For instance, previous reviews have extensively explored the standalone application of deep learning in medical imaging, while others have focused purely on the adoption barriers and security challenges of EHR systems globally [6]. Furthermore, some recent studies have reviewed the

potential of emerging technologies like the Internet of Medical Things (IoMT) and blockchain in healthcare [7]. However, a critical research gap remains: there is a distinct lack of systematic reviews that specifically synthesize the literature at the direct intersection of image processing integration and Electronic Health Records. Existing reviews tend to treat medical imaging and EHRs as separate domains, failing to capture the comprehensive landscape, current trends, and structural bottlenecks of merging them.

This fragmentation in the current literature makes it difficult for researchers and healthcare policymakers to formulate targeted solutions for interoperability and data standardization. Without a synthesized overview of how image processing is currently being embedded into EHRs, future technological development risks being siloed and inefficient. Therefore, conducting a targeted SLR coupled with bibliometric mapping of this specific intersection is not only beneficial but also essential. Bibliometric mapping will provide a vital macroscopic view of publication trends, key authors, and evolving keywords, while the systematic review will delve into the qualitative challenges and proposed solutions scattered across fragmented studies.

Accordingly, the primary objective of this study is to systematically identify, analyze, synthesize, and map the existing research on integrating medical image processing into EHRs. By explicitly highlighting current research trends and mapping the intellectual structure of this field, this study aims to answer the formulated research problem: What is the current state of integration between image processing and EHRs, and what are the primary technological and methodological gaps hindering its widespread adoption. The findings of this SLR and bibliometric analysis are expected to provide clear, evidence-based guidance for future researchers to address specific data interoperability issues, standardize image-processing protocols, and successfully leverage advanced AI and IoMT technologies to enable more effective clinical decision-making.

2. LITERATURE REVIEW

[8] Developing a prospective research protocol that aims to investigate the relationship between neuroanatomical, genetic, and behavioral development in adolescents by repurposing clinical brain MRI data stored in EHR for cost efficiency and sample size increase. The study methodology involves recruiting 1,000 participants aged 12–20 years with limited imaging pathology (SLIP) criteria, followed by remote collection of psychopathological phenotype data and saliva-based DNA sampling from probands and biological parents. Data integration was performed through automated image processing and statistical harmonization to link quantitative brain features with genetic variants. Preliminary results validated the feasibility of this protocol by identifying 1,887 eligible candidates, although the article notes inherent limitations, including higher clinical MRI quality variability relative to research standards and a patient population that does not fully represent healthy controls.

The study [9] aimed to digitize paper-based anesthesia medical records in low- and middle-income countries using computer vision on smartphone images to improve clinical data accessibility. The research methodology involved image pre-processing for perspective correction and the use of deep learning models (YOLOv8 and RegNetY) to extract handwritten data. The results show high accuracy in digitizing blood pressure (MAE ~ 1.0 mmHg) and checkboxes ($>99\%$), but limited accuracy for physiological indicators (85.2%) due to poor handwriting quality variability. The main limitation of this study is the model's specificity to a single hospital form.

[10] The aim is to develop an Android-based interoperable EHR system integrated with a Decision Support System (DSS) using a Convolutional Neural Network (CNN) for early detection of lung cancer. Through model training on 316 CT scan images with an 80:20 validation split, this study successfully confirmed the interoperability of clinical data across health facilities and achieved a general disease detection accuracy of 93%. However, this article has significant limitations related to the limited dataset, which caused class imbalance and low specific prediction accuracy in large cell carcinoma (49.03%) compared to other subtypes, as well as the need for further investigation into data privacy and security on cloud platforms.

[7] Proposing a digital health data security framework that aims to ensure confidentiality and integrity through multimodal image fusion and double watermarking. This methodology integrates MRI and SPECT/PET image fusion via Laplacian decomposition, followed by the insertion of patient identities and hash values using a hybrid transformation (LWT-HD-SVD) and PSDCLS encryption. The results show excellent performance, with high imperceptibility (PSNR 37.79 dB; SSIM 0.9993) and robustness against various image processing attacks. However, this article notes limitations related to high computational complexity that could potentially hinder real-time applications, as well as the lack of evaluation of high-resolution images and advanced cyber attacks, such as adversarial attacks.

[11] Aims to overcome the challenges of recording immunization history in resource-poor areas through the development of microneedle-based on-patient medical record (OPMR) technology that is biocompatible and capable of simultaneously delivering therapeutic mRNA. The research methodology integrates near-infrared (NIR) quantum dot microparticles with an Error Correcting Code (ECC) scheme and deep learning algorithms to ensure data resilience against spatial distortion in pig and mouse skin models.

The results of the study show signal retention of >98% for 12 weeks, 100% pattern-decoding success, and SARS-CoV-2 vaccine immunogenicity comparable to that of conventional injections. However, the main limitations lie in the scanning duration, which is not yet real-time (>2 minutes), and image quality variability due to environmental factors such as lighting and physical skin conditions that affect reading accuracy. Defnction of image processing in electronic health records from various sources can be seen in Table 1.

Table 1. Definition of Image Processing in Electronic Health Records

No	Definition of Image Processing in Electronic Health Records	Reference
1	Image processing is used to curate and analyze existing clinical brain MRI scans, extract quantitative neuroanatomical phenotypes (brain volumes), and harmonize cross-scanner data to investigate the relationships among brain development, genetics, and behavior.	[8]
2	Image processing uses convolutional autoencoders as a defense mechanism to eliminate noise in chest X-ray images, detect adversarial attacks, and restore image quality, ensuring accurate and safe classification of pneumonia.	[13]
3	Image processing applies computer vision to digitize paper anesthesia medical records from smartphone photos. This technique includes perspective correction, shadow removal, and deep learning (YOLOv8) to extract handwritten data such as blood pressure.	[9]
4	Image processing is used in EHR applications for early detection of lung cancer through CT scan pre-processing (grayscale conversion, segmentation), feature extraction, and classification using a Convolutional Neural Network (CNN) as a clinical decision support system.	[10]
5	Image processing focuses on securing medical data through biometric watermarking. This technique extracts palm features using Gabor filters and embeds them into medical images through the Discrete Cosine Transform (DCT) for copyright and privacy protection.	[14]
6	Image processing involves segmenting medical images into Regions of Interest (RoI) and Non-Regions of Interest (RoNI). Watermarks are embedded in RoNI using a hybrid DWT-SVD transformation to ensure security and integrity, while maintaining the visual quality of RoI for diagnosis.	[7]
7	Image processing using Federated Generative Adversarial Networks (FedGAN) to generate high-quality synthetic retinal images. This enables collaborative cross-institutional training for diabetic retinopathy diagnosis while maintaining patient data privacy through decentralized learning.	[15]
8	Image processing utilizes radiomics to extract stable features from Coronary CT Angiography (CCTA). These features are used in interpretable machine learning models to measure coronary calcification and stenosis, with emphasis on feature stability across various imaging settings.	[16]
9	Image processing using lightweight deep learning (EfficientNet-B0) on edge devices to analyze fundus images. This technique includes CLAHE pre-processing and the use of heatmaps for interpretability, enabling real-time diagnosis of various eye diseases in resource-limited environments.	[17]
10	Image processing using deep learning to decode invisible near-infrared (NIR) patterns on the skin. This involves image rectification, binarization, and error correction to accurately retrieve stored medical records from the patient's skin.	[11]

3. MATERIALS AND METHOD

This study adopts a SLR approach with bibliometric methods to conduct a quantitative evaluation of the literature in order to identify trends, patterns, and key entities within a discipline. Referring to the PRISMA framework, this study ensures that the literature review process is comprehensive, transparent, and replicable. The inclusion criteria set include English-language articles published until December 20, 2025, with a specific focus on the topic of image processing in EHR.

In this study, bibliometric analysis is used to explore trends, patterns, and dynamics that are developing in the literature on the integration of medical image processing with Electronic Health Records. The bibliometric analysis process was carried out using VOSviewer software, which allows for the visualization of bibliographic data and maps the relationships between articles, collaborations between authors, and the distribution of frequently appearing keywords. The first stage of this analysis involved collecting data from leading academic databases, such as Scopus, using customized keywords. The collected data was then analyzed to identify citation networks, where frequently cited articles indicate significant influence in this field. Next, collaboration between authors and institutional affiliations was mapped to reveal major research partnerships and the contributions of countries or regions in this field. The analysis process also includes examining the frequency of keywords appearing in the literature, providing insight into the most researched topics and the latest technological trends. The results of this bibliometric analysis are expected to provide a deeper understanding of the direction of future research and identify areas that require further exploration in medical image processing and health data management.

The scientific examination process began with the selection of keywords using a macro (top-down) methodological approach, gradually narrowing the search focus from a broad scope to more specific topics. This approach was chosen to overcome the limitations of previous studies and considering the rarity of studies that specifically discuss image processing in Electronic Medical Records. Therefore, this investigation focuses on these keywords when scanning the titles, abstracts, and keyword sections of relevant articles. In addition, researchers use the Scopus database as the primary tool for conducting literature reviews, identifying experts in related fields, and monitoring the latest research trends.

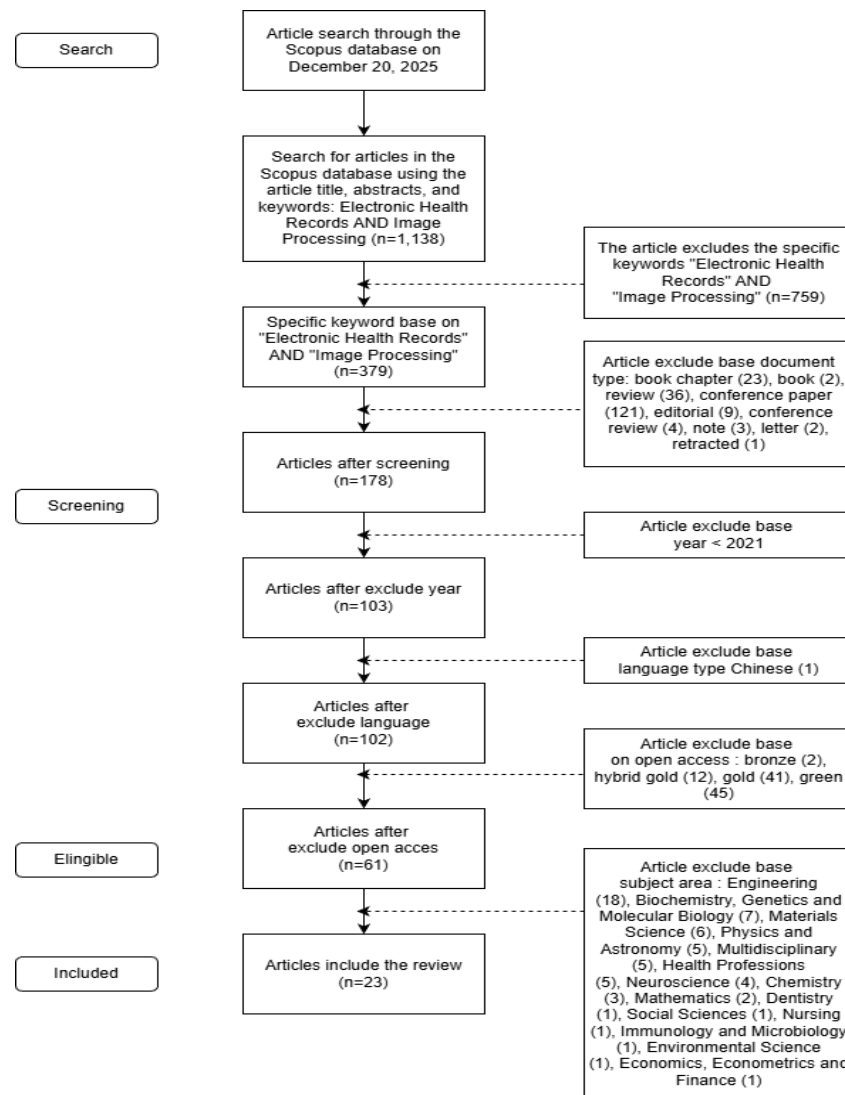


Figure 1. Systematic Literature Review Information Flow Using Prisma

Based on the PRISMA Flow Diagram in Figure 1, the article search process began on December 20, 2025, through Scopus using the keywords Electronic Health Records AND Image Processing, which yielded 1,138 articles. After that, the search was refined using more specific keywords, namely “Electronic Health Records” AND “Image Processing,” which reduced the number of articles to 379. In addition, articles were also filtered based on document type, excluding books, reviews, and conference papers, leaving 178 articles. The next screening excluded articles published before 2021 and articles in Chinese, as well as articles with bronze, hybrid gold, and green open access, which ultimately resulted in 61 articles that met the criteria.

The screening process also included selection based on subject areas relevant to the main focus of the research. The subjects “Medicine” and “Computer Science” were chosen as the main focus points in this study, given that both are closely related to electronic medical records and medical image processing, which are the main topics of this SLR. By selecting “Medicine” and “Computer Science” as the core subjects, this process ensured that the articles included were more focused on the practical application of medical image processing in health information systems, which is highly relevant to the objectives of this study. This document serves as an in-depth analysis aimed at answering various questions in this study. *RQ1: Does the exploration of electronic medical records using medical image processing continue to hold relevance and*

significance for future scientific research? RQ 2: How does the current allocation of research relate to electronic medical records and medical image processing in the existing literature? RQ:3 What are the theoretical and practical implications from the perspective of research development in the field of electronic medical records and medical image processing in the future?

4. RESULTS AND DISCUSSION

The results of this study focus on findings from 23 articles identified in the Scopus database on “Electronic Health Records” and “Image Processing,” which aim to explore the integration of medical image processing in electronic medical record systems. This analysis includes identifying the number of articles published, the distribution of publications in recent years, and the sources of journals that contain articles related to this topic. The findings show a significant upward trend in the number of publications related to the integration of image processing with EHRs in the last 5 years, reflecting the development of technology and medical applications. In addition, this study also reveals the contributions of various authors, institutional affiliations, and countries that are active in this research, with certain countries such as the United States and India becoming major research centers in this field. The authors and affiliations involved show the dominance of academic and research institutions with a strong focus on the development of medical technology and health information systems. These results also provide insight into the increasingly important international collaboration in accelerating innovation in the field of electronic medical records and medical image processing.

RQ1: Does the exploration of electronic medical records using medical image processing continue to hold relevance and significance for scientific research in the future?

Based on data obtained from the Scopus database in Figure 2, it can be seen that the number of documents published on “HER” and “Image Processing” has increased significantly from 2021 to 2025. In 2021, there were only two documents listed in Scopus, indicating that research in this field was still very limited at that time. However, starting in 2022, the number of articles began to increase gradually, with the largest surge seen in 2023 to 2025, where the number of documents reached more than six articles in 2024 and nearly ten articles in 2025. This indicates that the integration between EHR and medical image processing is gaining attention from the scientific community, with a rapid increase in recent years. This trend may be influenced by new technological developments, such as improvements in image processing algorithms, as well as an increasing need for more efficient and accurate health information system integration. Several previous studies have noted the relevance and importance of this topic, as expressed by [18] in Systematic Mapping Study of AI/Machine Learning in Healthcare and Future Directions, which highlights the enormous potential of AI and machine learning in improving medical data processing. In addition, [19] in Artificial Intelligence in Cancer Care: Legal and Regulatory Dimensions also underlined the significant impact of this technology in the field of healthcare, including the application of image processing in cancer management. In the specific field of EHR and medical imaging, [16] in Interpretable and Reproducible Machine Learning Model for Coronary Calcification and Segment-level Stenoses Stratification on Computed Tomography Angiography, emphasizes the application of machine learning models in medical imaging for early detection of heart disease. Research by [20] in Towards Intelligent Virtual Clerks: AI-Driven Automation for Clinical Data Entry in Dialysis Care also shows how AI-based technology can improve the efficiency of clinical data management, including in medical image processing. With the number of publications continuing to increase and practical applications becoming more widespread, it is clear that the exploration of medical image processing in electronic medical records remains relevant and will continue to be an important area of scientific research in the future, with great potential to improve the quality of healthcare services and clinical decision-making.

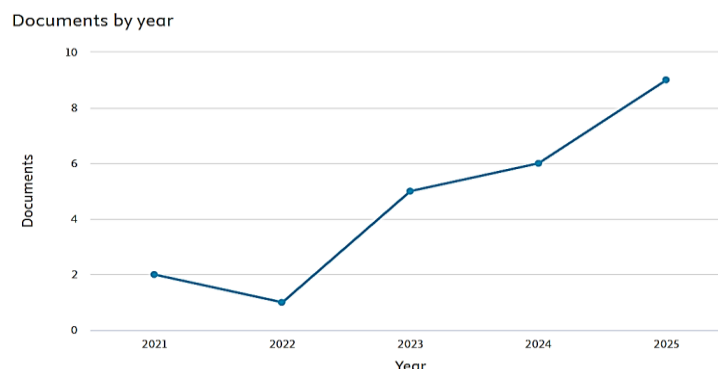


Figure 2. Document by Year

Since 2021, literature on the integration of EHR with medical image processing has been limited, with relatively few studies published in reputable journals initially. However, with technological developments and increasing attention to AI and machine learning applications in the health sector, the number of publications on this topic has increased significantly from 2023 to 2025. This opens up opportunities for future researchers to fill this gap and continue to explore the potential and challenges of applying medical image processing to EHRs. This research is important for advancing insights into the integration of technology in health information systems, which can improve the efficiency of patient data management and support better clinical decision-making. In the future, further development in this field can facilitate a deeper understanding of the practical and sustainable application of EHRs supported by medical images in various healthcare facilities.

RQ 2: How does current research allocation relate to electronic medical records and medical image processing in the existing literature?

Analysis of the distribution of research on the integration of EHR with medical image processing in articles published in Scopus shows a rapidly growing trend in recent years. This study categorizes articles based on country, region, affiliation, source, and author classifications, with a limit of only the top 10 articles in each classification. A deep understanding of the allocation of scientific works related to EHR and medical image processing will be very useful for academics and practitioners in planning future research agendas, particularly in accelerating innovation in the health sector.

The distribution of research categorized by country or geographical region shows the dominance of large countries in health research, such as the United States with 9 articles, India with 6 articles, and China with 4 articles, indicating a high level of interest in this topic in countries with advanced healthcare systems and strong research resources. They are followed by Australia, Canada, and Saudi Arabia, each of which has made a significant contribution in terms of the number of publications. Countries such as the United Kingdom, France, Hungary, and Iran have also contributed articles related to EHR integration and image processing, albeit in smaller numbers, as shown in Figure 3.

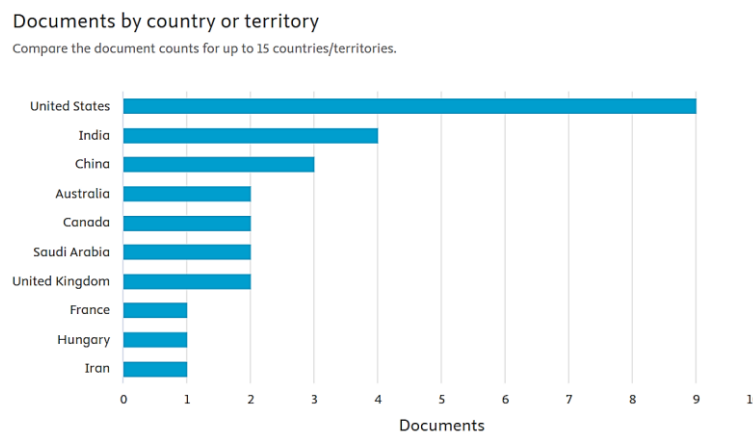


Figure 3. Number of articles by country or teortiry



Figure 4. Country visualization

Based on Figure 4, we can see patterns of international collaboration in publications related to EHR and “Image Processing.” Countries such as India, China, and the United Kingdom show close ties in research in this field, with India and China collaborating more frequently in joint research. The United Kingdom, although more isolated, still makes important contributions to the development of this topic. Meanwhile, Canada also appears to contribute, albeit with fewer publications. This figure illustrates the importance of global collaboration in advancing research on the integration of EHR with medical image processing, which supports technological advances in health information systems.

Second, based on Figure 5, the allocation of research related to medical image processing in EHR based on institutional affiliation is dominated by the University of Pennsylvania with the largest contribution,

namely more than 2 articles. In addition, several other institutions have contributed significant publications, including Linyi Central Hospital, Perth Clinic, and Heim Pál National Pediatric Institute, each with more than one article. Other institutions, such as the Hungarian University of Sports Science, The Skin Hospital, and the Australasian College of Dermatologists, also play an important role with almost comparable contributions. Mayo Clinic Health System and Hodgson Associates also contributed several articles related to this topic. This image shows that renowned medical and health institutions, both based in the United States and in other countries, play a major role in the development of research on EHR and medical image processing, demonstrating the global focus on this evolving topic.

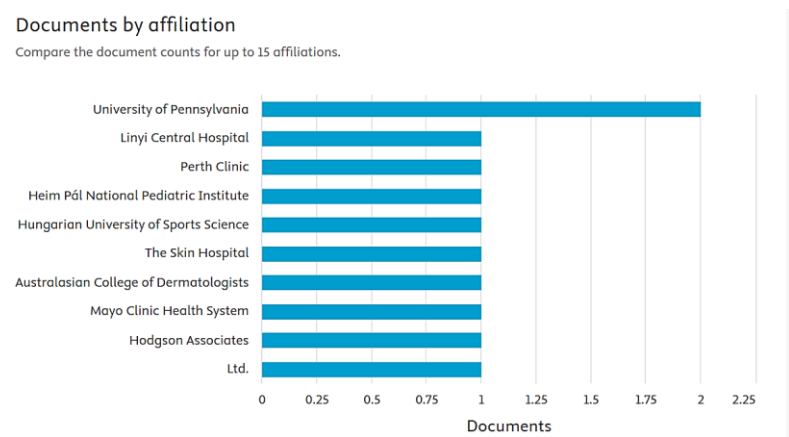


Figure 5. Affiliation visualization

Based on an analysis of the distribution of research related to electronic health record (EHR) integration and medical image processing, publications are dominated by countries such as the United States, India, and China. Leading universities such as the University of Pennsylvania contribute significantly, reflecting strong global collaboration in advancing this research in the health sector.

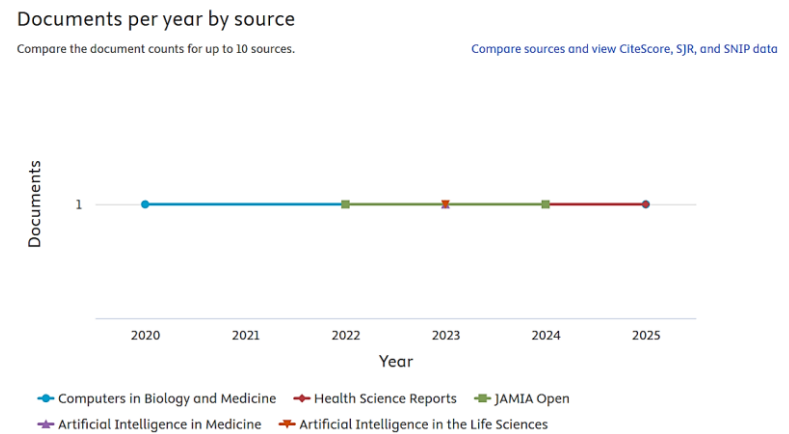


Figure 6. Number of articles by source

Figure 6. Shows that the allocation of research related to EHR and medical image processing based on its source indicates that publications in this field are evenly distributed across various journals. The journal Computers in Biology and Medicine dominates publications with consistent contributions from 2020 to 2025. Additionally, the journals Health Science Reports, Artificial Intelligence in Medicine, and Artificial Intelligence in the Life Sciences also play an important role, albeit with a lower number of publications. JAMIA Open appears to make a significant contribution in 2024, reflecting growing interest in this topic in open-access journals. Overall, this trend indicates that medical image processing in EHRs is becoming widely accepted in various scientific journals, with increasing attention each year.

Based on Figure 7, the distribution of research related to EHR and medical image processing by author shows no clear dominance. Among the top 10 authors, each author [1], [8], [10], [19], [21], [22], [23], [24]. Each has contributed an almost equal number of articles, with no single author standing out significantly more than the others. This reflects the balanced collaboration among researchers in developing this research, indicating that the topics of EHR and medical image processing are the collective focus of many experts across various disciplines.

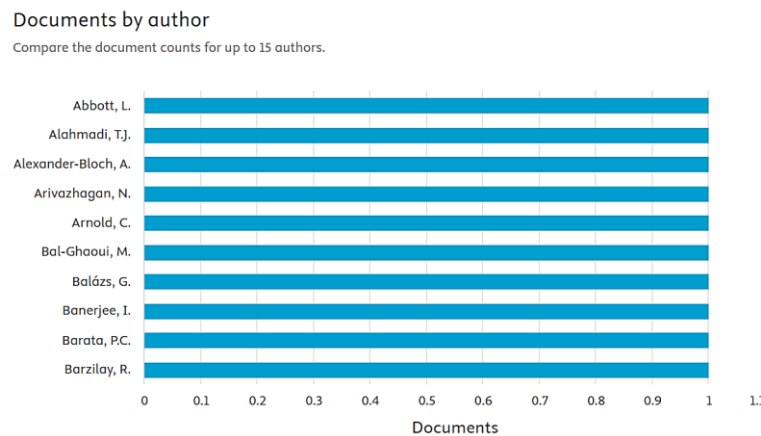


Figure 7. Count of publication by author

RQ:3 What are the theoretical and practical implications of the research development perspective in the field of electronic medical records and medical image processing in the future?

An analysis was conducted on 23 articles obtained from the Scopus repository related to the integration of EHR and medical image processing. Using a bibliometric approach with the help of VOSviewer, the results of this study reveal significant developments in this topic from a theoretical and practical perspective. Theoretically, the analysis shows that although medical image processing in EHR has attracted widespread attention, some areas of research are still relatively unexplored, particularly those related to interoperability and the application of cutting-edge technologies such as deep learning in image-based diagnosis. The theoretical implications of these findings emphasize the need for further exploration of the integration of the latest technologies into EHR systems, as well as the challenges that must be overcome in terms of the accuracy and efficiency of medical data processing. From a practical perspective, these findings provide insight into the importance of improving the quality of medical image-based EHR implementation in healthcare facilities, as well as the challenges faced by practitioners in effectively adopting this technology. Other practical implications include the need for specialized training for medical personnel and system developers to ensure successful implementation. This study also provides direction for further research in the development of more efficient and accurate EHRs, as well as supporting technology-based clinical decision-making in the future.

Based on Figure 8, the frequency of keyword appearances is: image processing (31), electronic health record (30), electronic health records (17), deep learning (13), artificial intelligence (13), retrospective study (10), machine learning (11), image segmentation (9), natural language processing (9), electronic medical record (9), computer-assisted tomography (4), healthcare (5), medical image processing (5), medical record (3), information processing (5), algorithm (7), major clinical study (8), medical informatics (4), cohort analysis (6), comparative study (3), clinical evolution (3), medical computing (5), classifier (3), prediction (5), automation (3), validation process (3), health care system (4).

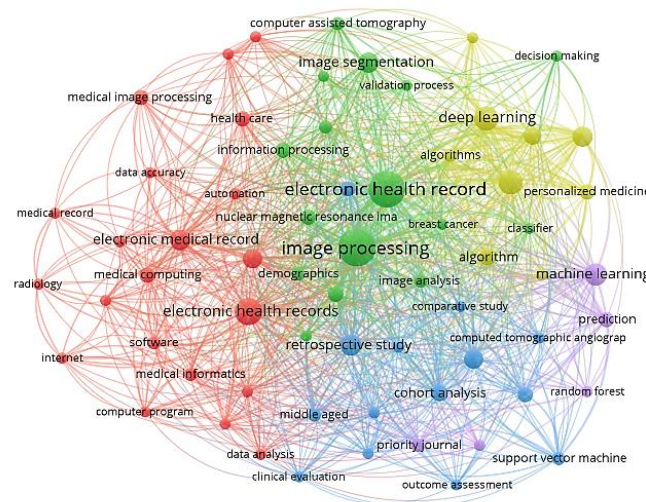


Figure 8. Co-occurrence framework and representation of key items

Based on the analysis of the keywords found in Table 2, “Image processing” dominates with a total strength of 461, indicating that medical image processing is a key component in the development of EHR to improve diagnostic accuracy and medical data management. “Electronic health record” also ranks second with a total strength of 399, confirming the central role of EHR in patient information management. In addition, variations in terminology such as “electronic health records” (243) and “electronic medical record” (124) indicate the use of different but closely related terms in studies on health information systems. More advanced technologies, such as “Deep learning” (184) and “Artificial intelligence” (168), are increasingly used in medical image processing, which is increasingly applied to support clinical decision-making. “Machine learning” (153) and “Natural language processing” (127) also play an important role in medical data analysis and in the processing of unstructured information.

Research such as that conducted by [2] In a deep learning-based NLP data pipeline for EHR-scanned document information extraction, [5] in Analysis of Swin-UNet vision transformer for Inferior Vena Cava filter segmentation from CT scans, and research by [25] In the requirements specification, design, and evaluation of dental image exchange, these technologies have been applied to improve diagnostic accuracy and EHR system efficiency. In addition, research by [1] on Fusion Modeling: Combining Clinical and Imaging Data to Advance Cardiac Care and by [3] in Open-set recognition of breast cancer treatments shows how this technology is used to improve the quality of data-based medical care and more integrative medical imaging. Research by [26] The volumetric differences of thalamic nuclei in children with trisomy 21 also demonstrate the importance of image processing in the diagnosis of specific diseases. These findings emphasize that the use of image processing and artificial intelligence techniques in EHR systems has great potential to accelerate innovation in healthcare.

Table 2. Keywords by author

Rank	Keyword	Total link strength
1	Image processing	461
2	Electronic health record	399
3	Electronic health records	243
4	Deep learning	184
5	Artificial intelligence	168
6	Retrospective study	163
7	Machine learning	153
8	Major clinical study	150
9	Natural language processing	127
10	Electronic medical record	124

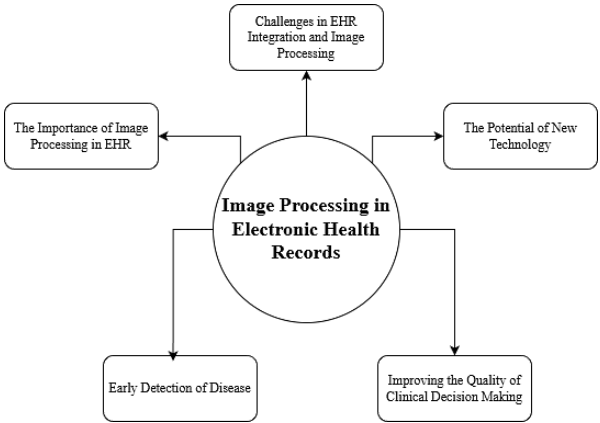


Figure 9. Attribut

Reference : [1], [5], [27], [28], [28], [29], [29], [30], [31], [32], [33], [34], [35], [36], [37], [38]

In Figure 9 Image Processing in EHR refers to the integration of advanced computational methods used to enhance and analyze medical images, which are essential for modern healthcare practices. Electronic Health Record (EHR) systems are essential tools for managing patient data, and when combined with image processing techniques, they significantly improve the accuracy and speed of diagnosis. This integration enables the storage, retrieval, and analysis of medical images, such as X-rays, MRIs, and CT scans, in patients' digital medical records. Rapid advances in AI and ML have further enhanced image processing capabilities, enabling real-time analysis and supporting better clinical decision-making [5]. This technology not only helps improve the accuracy of diagnostic procedures, but also supports more personalized treatment plans, which are better tailored to the individual conditions of patients [1].

3.1. The Importance of Image Processing in EHR

Image processing in EHRs is essential for providing a more comprehensive picture of a patient's health condition. In modern medical practice, medical image processing, such as X-rays, MRIs, and CT scans, plays a huge role in improving the accuracy of diagnosis and treatment planning. This is supported by the ability of image processing to improve image quality, separate specific parts of an image (segmentation), and identify medical conditions more accurately. Van Assen et al. (2023) emphasize that without proper image processing, EHR systems cannot fully provide reliable information for clinical decision-making. On the other hand, Hsu et al. (2022) note that applying image processing techniques to EHRs enables the storage of medical images in a more organized format, thereby facilitating access and collaboration among medical personnel.

Image processing in EHRs is important not only for storing medical images but also for improving the quality of information available to medical personnel. With more advanced image processing, diagnosis and treatment can be performed more accurately, thereby improving patients' quality of life. In the long term, this can reduce treatment costs and improve the efficiency of the healthcare system.

3.2. Early Detection of Disease

One of the main benefits of image processing in EHR is its ability to detect diseases early. With technologies such as deep learning, systems can scan medical images and detect patterns indicative of disease, even before physical symptoms appear. This is particularly useful in the treatment of cancer, heart disease, and other disorders, where early diagnosis can significantly improve a patient's chances of recovery. [39] state that the use of deep learning techniques in medical image processing can identify suspicious areas faster than traditional methods. In addition, image processing can help doctors more quickly decide on the appropriate course of treatment by providing more accurate image analysis results.

Early detection is key to saving patients' lives and reducing long-term treatment costs. Therefore, integrating more advanced image processing technology into EHR systems is essential. The use of AI and machine learning for early detection can also improve doctors' ability to identify potential diseases, thereby reducing the risk of further complications.

3.3. Improving the Quality of Clinical Decision Making

The integration of image processing into EHRs provides significant advantages for clinical decision-making. With medical image data well integrated into the EHR system, doctors can obtain a more complete and detailed picture of the patient's condition. This allows doctors to make more accurate decisions regarding diagnosis, treatment plans, and appropriate therapies. According to Gomes et al. (2023), proper image processing allows medical personnel to better understand the patient's condition, which is crucial in evidence-based medicine. In addition, this technology also facilitates collaboration between specialists in planning patient care. Image processing in EHRs allows doctors not only to rely on text data and medical records but also to see a visual representation of the medical condition. This enables more accurate and timely decision-making, which has the potential to increase patient recovery rates and reduce medical errors.

3.4. Challenges in EHR Integration and Image Processing

Integrating image processing into EHRs offers many benefits, but it is not without challenges. One of the main challenges is interoperability between the various systems and devices used in image processing and EHR storage. This can make it difficult to access and share data across different hospitals or healthcare institutions. In addition, other challenges include issues related to patient data security and privacy protection. This is very important, as medical images contain sensitive data that must be strictly protected. Van Assen et al. (2023) emphasize the importance of standards and protocols to ensure that medical image data can be exchanged securely and in compliance with regulations.

These challenges need to be addressed by developing clear standards and protocols for the interoperability of EHR systems that integrate medical images. In addition, strengthening regulations governing patient data protection is essential to maintaining the security and privacy of highly sensitive information.

3.5. The Potential of New Technology

New technologies such as blockchain and IoMT have great potential to improve image processing in EHRs. Blockchain can enhance data security and integrity, while IoMT enables medical devices to connect and share data in real time. These technologies can enable more efficient and secure image processing and support more responsive, integrated EHR systems. According to Hsu et al. (2022), blockchain can provide a higher level of security for the storage and exchange of medical image data, while IoMT can improve real-time patient monitoring capabilities and optimize data-driven decision-making.

The potential of these new technologies brings opportunities to make EHR systems more effective and efficient. By integrating blockchain and IoMT, EHR systems that rely on image processing can be more

secure, interactive, and responsive to the needs of patients and medical personnel. These technologies will reduce delays in medical data processing and facilitate more direct and real-time patient monitoring.

Based on the variable model described in Figure 10, image processing in Electronic Health Records (EHR) can significantly improve the quality of diagnosis, clinical decision-making, and patient data security and privacy. Independent variables such as image processing, integration with EHR systems, and the application of the latest technologies such as AI, ML, and IoMT play an important role in improving the efficiency and accuracy of medical analysis. In this study, the use of technologies such as AI and ML not only speeds up the data processing process, but also helps in detecting more accurate patterns in medical images, which ultimately improves the quality of diagnosis and supports more accurate clinical decision-making. Implementing this technology can also minimize human error in analyzing medical images, thereby helping doctors provide more appropriate and effective treatment recommendations.

However, while the integration of technology and image processing in EHRs offers numerous benefits, the main challenges faced are system interoperability and patient data protection. Healthcare systems need to ensure that the data generated can be accessed and exchanged securely between different platforms without compromising patient privacy and information security. In addition, data protection and legal compliance are also major concerns in the application of this technology. Healthcare systems must meet strict data protection standards to prevent privacy violations and ensure that sensitive data remains protected, both in the image processing process and in the EHR storage system as a whole. Therefore, although advanced technology offers great potential, appropriate policies and regulations must be developed to optimize the application of image processing in EHR, for the well-being of patients and the sustainability of healthcare systems in the future.

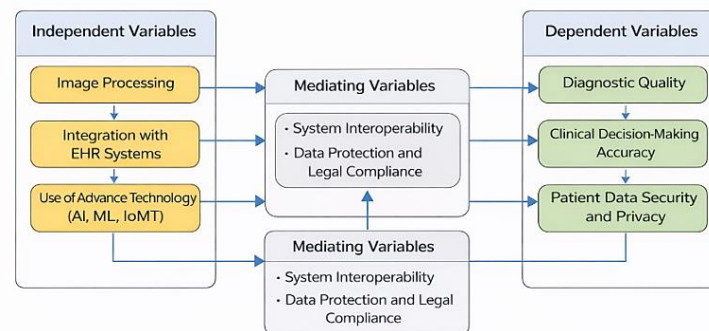


Figure 10. Variable

5. CONCLUSION

Based on an SLR and a bibliometric analysis of articles published between 2021 and 2025, this study concludes that the integration of medical image processing into EHRs has led to a significant increase in publications. This increase is driven by rapid advances in AI and Deep Learning. The findings of this study confirm that this technology plays a key role in modernizing healthcare services, particularly by improving diagnostic accuracy, facilitating early detection of critical diseases such as cancer and cardiovascular disorders, and supporting evidence-based clinical decision-making.

However, this research also identifies major challenges that remain, including interoperability issues between systems, variability in image quality, and the enormous challenge of maintaining the privacy and security of sensitive patient data. Although the adoption of new technologies such as the IoMT and blockchain offers great potential, these obstacles remain significant barriers to wider implementation.

A key contribution of this study is its systematic mapping of the current research landscape, which identifies several crucial research gaps, particularly in the standardization of image processing techniques and the need for stricter data security protocols, especially in the context of data storage and processing on cloud platforms. Theoretically, this study enriches the existing literature by elucidating the synergistic relationship between textual and visual clinical data in EHRs. Practically, these findings provide valuable strategic guidance for technology developers and policymakers to focus future efforts on creating interoperable and secure EHR systems. Thus, this research not only confirms the relevance of integrating medical images into EHRs but also lays a strong foundation for the development of a more efficient, secure, and responsive digital health framework for the future needs of patients.

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