Potential Impact and Challenges of Implementing Artificial Intelligence in the Romanian Healthcare System

Sebastian Fitzek,[1] Kyung-Eun (Anna) Choi[1]

[1] Health Services Research Group, Medical Images Analysis and Artificial Intelligence (MIAAI), Danube Private University (DPU), Austria.

Потенциално въздействие и предизвикателства от внедряването на изкуствен интелект в румънската здравна система

Себастиан Фицек,[1] Киунг–Фун (Ана) Чои[1]

[1]Изследователска група за здравни услуги, Анализ на медицински изображения и изкуствен интелект (MIAAI), Дунавски частен университет (DPU), Австрия

Author note

Sebastian Fitzek https://orcid.org/0000-0001-6454-7820

Kyung-Eun (Anna) Choi https://orcid.org/0000-0001-6694-8206

The authors are now at the Department of Healthcare Evaluation at the Medical Images Analysis and Artificial Intelligence (MIAAI), Danube Private University (DPU), Austria.

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Correspondence concerning this article should be addressed to Sebastian Fitzek, Steiner Landstraße 124, AT-3500, DPU, Austria email: sebastian.fitzek@dp-uni.ac.at

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Себастиан Фицек https://orcid.org/0000-0001-6454-7820 и Kyung-Eun (Anna) Choi https://orcid.org/0000-0001-6694-8206 са от Департамент за оценка на здравеопазването към MIAAI, Дунавски частен университет (DPU), Австрия.

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Abstract

This literature review assesses the prospective implications and advantages of incorporating artificial intelligence (AI) within the healthcare infrastructure of Romania. By exploring the literature on AI applications in healthcare, the article aims to identify opportunities and challenges in adopting AI-driven technologies in the Romanian context. The review findings suggest that AI holds significant promise in improving the diagnosis, prognosis, and treatment processes, while also presenting several ethical and logistical challenges. The article concludes with recommendations for future research and strategies to ensure the responsible implementation of AI technologies in the Romanian healthcare system.

Keywords: artificial intelligence, healthcare, Romania, implementation, barriers, facilitators

Резюме

В статията се оценяват бъдещите последици и предимствата от включването на изкуствен интелект (ИИ) в здравната инфраструктура на Румъния. Чрез изследване на литературата за приложенията на ИИ в здравеопазването, статията има за цел да идентифицира възможностите и предизвикателствата при приемането на технологии, управлявани от ИИ в контекста на Румъния. Констатациите от прегледа показват, че ИИ има значителни обещания за подобряване на диагностиката, прогнозата и процесите на лечение, като същевременно представлява няколко етични и логистични предизвикателства. Статията завършва с препоръки за бъдещи изследвания и стратегии за гарантиране на отговорното внедряване на ИИ технологии в румънската здравна система.

Ключови думи: изкуствен интелект, здравеопазване, Румъния, внедряване, бариери, фасилитатори

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Introduction and background

The realm of artificial intelligence (AI) is progressively gaining prominence and exhibits extensive prospective applicability across various domains, including the healthcare industry. As the Romanian healthcare system faces ongoing challenges, AI emerges as a promising solution to improve disease diagnosis, prognosis, and treatment processes. The healthcare system in Romania is confronted with persistent issues like inadequate resources, obsolete infrastructure, staff shortages, restricted access to healthcare services in rural regions, and high occurrences of specific diseases (Antohi et al., 2022). These problems present both opportunities and obstacles to the adoption of AI technologies. AI possesses the capacity to tackle several critical issues encountered by the Romanian healthcare system. For example, AI-based solutions could enhance resource distribution by forecasting patient requirements and ensuring the effective utilization of scarce medical resources. Moreover, AI can assist in closing the gap in healthcare services in rural locations through remote diagnostic tools and telehealth consultations. In addition, AI-powered algorithms can evaluate extensive datasets to uncover trends and patterns in disease occurrence, contributing to the development of focused prevention and intervention strategies.

The successful integration of AI within the Romanian healthcare system could be hindered by factors like the necessity for significant investments in technology, improvements to infrastructure, and education for healthcare professionals. The distinct requirements of the Romanian population and the emphasis on maintaining data confidentiality and security should be carefully considered when creating AI-enhanced healthcare solutions. While the integration of AI into healthcare provision can engender favorable results, like the amelioration of patients' well-being, it might concurrently give rise to detrimental effects, encompassing potential discrimination or the supplanting of medical professionals. However, AI technologies hold the potential to substantially revolutionize the medical field by processing vast amounts of medical data and generating swift, relatively accurate results. Therefore, researchers at the intersection of social, information, and medical sciences need to continue investigating and validating these technologies responsibly, maximizing AI's potential in medicine.

The integration of AI within medical practice has ignited discussions from various perspectives, particularly regarding safety and efficacy. A rising number of studies have examined the potential of AI in diverse healthcare areas, including diagnostic imaging and individualized treatment approaches (Ahmer et al., 2023; AlZaabi et al., 2023; Alexandru & Coardos, 2016; Bisdas et al., 2021; Dijmarescu, 2021;

Dobrescu & Dobrescu, 2018; Fotea et al., 2019; Krittanawong & Kaplin, 2021; Micu et al., 2021; Mosteanu, 2020; Pană et al., 2021; Qurashi et al., 2021; Săniuță & Filip, 2021; Sit et al., 2020; Sunarti et al., 2021). Despite this, a substantial number of these investigations and applications often do not receive comprehensive clinical evaluations, leaving the long-term implications ambiguous. In another study conducted in the UK (Sit et al., 2020), it was found that students were less willing to consider a career in radiology because of AI. Despite these concerns, approximately 95% of participants showed interest in AI education. This underscores the importance of introducing AI education in future study programs. The study also found that most respondents were willing to implement AI technology in clinical practice. An important aspect related to the implementation of AI in radiology is the impact on jobs. In the referenced study, only one-third of the participants believed that AI would take over their jobs in the future. Almost half of the students felt threatened by AI applications. This belief may be related to the lack of education related to AI in radiography degree programs.

Moreover, ethical aspects concerning the application of AI in healthcare, including safeguarding patient information and its impact on medical practice, require careful attention. Ensuring that technology is used judiciously and thoughtfully is of paramount importance to preclude any compromise to patient welfare or the integrity of the medical infrastructure. Within this composition, we shall rigorously scrutinize the prospects of AI within the healthcare domain, delving into the ramifications, impediments, and concerns that warrant attention to facilitate the prudent and effective incorporation of this technological innovation in augmenting patient care methodologies. In this academic piece, we will meticulously assess the capacity of AI within the realm of medicine, investigating the consequences, hurdles, and issues that must be addressed to guarantee the ethical and proficient execution of this technological advancement in the enhancement of patient care strategies.

Status of the Development of AI in the Romanian Healthcare Sector

Currently, there are few studies documenting the relationships between AI and businesses in Romania. For example, Micu et al. (2021) investigate AI algorithms in e-Commerce, noting significant interest at the leadership level in implementing AI in online stores, although actual adoption of AI remains low. Mosteanu (2020) observes that many large Romanian companies consistently invest in AI-based platforms, systems, projects, and ideas. In summary, there is interest in AI and broad recognition of its potential in Romania, but AI development is comparatively slow, across various domains including business, compared to other European countries.

In Romania, AI has been introduced in the healthcare system for various purposes, from diagnosis to patient management and improving care quality. In the medical field, AI has become an important tool for disease diagnosis. For instance, a team of researchers from the "Carol Davila" University of Medicine and Pharmacy in Bucharest has developed an AI algorithm for diagnosing brain tumors, which can accurately detect even the smallest tumors (Gheorghe, 2021). This advancement signifies a substantial improvement in the accuracy and effectiveness of diagnosing this condition, which could save lives and reduce healthcare expenses.

An additional domain where AI has proven effective in Romania is monitoring patients. The technology can be harnessed to continuously monitor patients, especially for individuals dealing with chronic conditions such as diabetes or chronic obstructive pulmonary disease. For example, such a patient monitoring system has been successfully implemented by a team of researchers from the "Grigore T. Popa" University of Medicine and Pharmacy in Iași (Ionescu, 2020). The system uses sensors and monitoring technology to constantly track patients' vital parameters and to alert doctors in real time if there are any problems.

AI can also be harnessed to elevate the caliber of patient care. A team of researchers from the "Iuliu Hațieganu" University of Medicine and Pharmacy in Cluj-Napoca has developed an AI-based medical data analysis system that can help doctors make better decisions regarding patient diagnosis and treatment (Faculty of Dental Medicine UMF Cluj, n.d.). The system utilizes sophisticated machine learning algorithms to discern patterns in medical data, furnishing personalized suggestions and recommendations for individual patients.

AI in medicine and patient care must be overseen by qualified professionals to ascertain ethical and responsible usage. Moreover, concerns surrounding data security and privacy protection must be addressed when implementing AI-driven systems. Romania can be aptly described as a nation thriving in medical imaging, with numerous instances of AI application in radiology, computed tomography, and magnetic resonance imaging. Another illustration of AI utilization in Romanian medical practice involves cancer patient treatment. Researchers at the Bucharest Oncology Institute have devised an AI system capable of analyzing patients' medical data and assisting in selecting the most effective treatment for everyone (Minea, 2023). This system can improve treatment and increase the survival rate of cancer patients. Additionally, AI is used in patient and medical data management. For example, SoftNet Consulting, a company in Bucharest, has developed an AI platform that can assist in managing patients' medical data and increase the efficiency of managing complex medical cases (Tomescu, 2023). This

platform can improve communication between doctors and ensure more efficient and accurate treatment for patients.

As evident, gradually, and surely, AI is being increasingly used in the Romanian medical field, with a significant impact on disease diagnosis and treatment, as well as patient and medical data management. These AI implementation examples showcase the considerable potential for further technological advancement in the Romanian medical sector, potentially augmenting the quality of healthcare and saving lives.

Aim of the article

To situate the research inquiry and underscore the need for a methodical examination of the literature, we will delve deeper into the current body of work on AI in healthcare. This will include a synopsis of AI implementations in different medical fields, including diagnostic imaging, genomics, and pharmaceutical development, as well as an evaluation of the potential advantages and difficulties associated with AI integration. Furthermore, we will address the present condition of AI within the Romanian healthcare system, touching upon ongoing endeavors and obstacles to its adoption.

We need to gain a more profound insight into how AI affects the quality of life for patients, and examining the existing body of research is a key component in achieving this understanding. By emphasizing the advantages of AI's capabilities to identify illnesses faster and with greater precision compared to conventional approaches, the current scholarly works underscore the promising potential of AI applications in the healthcare sector. For example, researchers have devised algorithms capable of diagnosing heart disease with greater precision than specialists in the field (Sethi et al., 2022).

The main objective of this investigation is to perform a thorough assessment of pertinent scholarly sources to evaluate the ramifications of AI in Romania. This research will investigate how AI can improve medical treatment and oversee long-term health conditions, while simultaneously considering the possible adverse consequences that arise from its application. The intention is to formulate a lucid research inquiry, pinpoint lacunae within the current body of knowledge, and delineate the objective of the literature evaluation to comprehensively tackle this complex subject matter.

Methodology

To achieve the objectives of our literature review, we conducted an extensive analysis of scholarly sources related to the impact of AI on patients' well-being in Romania between October 2022 and March 2023. Our research process included exploring digital databases (PubMed, Scopus, and Web of Science) to find pertinent publications from the past decade. For our review, we chose to incorporate studies that

were closely related to the subject matter, published within a specific timeframe, and had distinct attributes about the publications. The selected studies were analyzed using a qualitative approach, which involved synthesizing and critically evaluating the findings from each study. The analysis focused on identifying opportunities and challenges associated with implementing AI-driven technologies in the Romanian healthcare system. In addition, we consulted with experts in the field of healthcare and AI to gain further insights into the potential impact and challenges associated with implementing AI in Romania.

Search Strategy and Databases

The utilized search terminology encompassed (("artificial intelligence" OR "machine learning" OR "deep learning") AND ("healthcare" OR "medicine" OR "medical") AND "Romania*"). Since the Romanian science community mainly uses English databases, our search terms were only built by English terms.

Inclusion and Exclusion Criteria

Inclusion criteria:

a. Articles that focused on the implementation of AI in the Romanian healthcare system.
b. Articles that explored the potential benefits and challenges of AI in healthcare.
c. Articles published in English.

Exclusion criteria:

a. Articles that did not specifically address the Romanian healthcare system, i.a. studies focused on AI applications in healthcare outside Romania and did not refer to Romania nor Romanians.
b. Editorials, opinion pieces, and conference abstracts.

To perform a preliminary selection of relevant articles, we applied the MESH (Medical Subject Headings) system to the three selected reference scientific databases. Using the previously defined search terms, we identified a total of 125 articles related to the research topic. To narrow down this number, a three-stage selection process was adopted, focusing on keyword relevance, publication date, study type, methodological rigor, data quality, and accessibility to full text (see Figure 1).

Data Extraction and Synthesis

Data were extracted from included studies using a standardized extraction form. The information extracted included study design, sample size, main findings, and implications for the Romanian healthcare system. A narrative synthesis of the data was conducted and the results were grouped into relevant themes and categories (see Appendix B).

The evaluation culminated in determinations regarding the influence of AI on the well-being of patients in Romania, in addition to pinpointing potential benefits and hazards related to the adoption of this technology within the Romanian medical infrastructure. Appendix B presents an overview of the main topics addressed in the 15 selected articles, showcasing the diversity of subjects and perspectives in the field.

Quality Assessment

Our primary objective was to ascertain the dependability and authenticity of the results presented by these studies. Additionally, we employed a rigorous selection process involving three steps, focusing on aspects like keyword relevance, date of publication, study format, methodological strength, data integrity, and the availability of full-text versions. It's worth noting that our review encapsulates an array of study types, inclusive of qualitative research. However, it's important to mention that a similar methodology was employed across all studies, as the comparability and applicability of the results could potentially be affected otherwise.

Data Analysis and Interpretation

Upon gathering and integrating data from the 15 chosen articles, the information was meticulously analyzed to discern recurring themes, trends, and knowledge gaps in the existing literature related to AI's effects on patient quality of life in Romania. The method of thematic analysis was utilized to organize the findings into distinct categories and subcategories. This process was instrumental in deriving meaningful insights and formulating conclusions that were directly tied to the primary research query.

The parameters set for the qualitative analysis were not borrowed from extant literature but were instead crafted to align with the particular research question and objectives of the study. The goal was to explore AI's impact on Romania's healthcare system, including its potential advantages, limitations, and challenges, as well as possible risks. Moreover, part of the aim was to put forth suggestions and tactics for enhancing the use of AI in healthcare, while also identifying ways to diminish potential negative repercussions. As such, the criteria for qualitative analysis were specially tailored to cater to these distinct elements of the research question.

Specific focus areas of the qualitative analysis included:

a. An overview of AI's status within Romania's healthcare system.

b. The perceived pros and cons of incorporating AI within Romania's healthcare domain.

c. The hurdles and possible risks tied to integrating AI within Romania's healthcare system.

d. Suggestions and approaches to maximize the use of AI in healthcare, while keeping any potentially negative impacts in check.

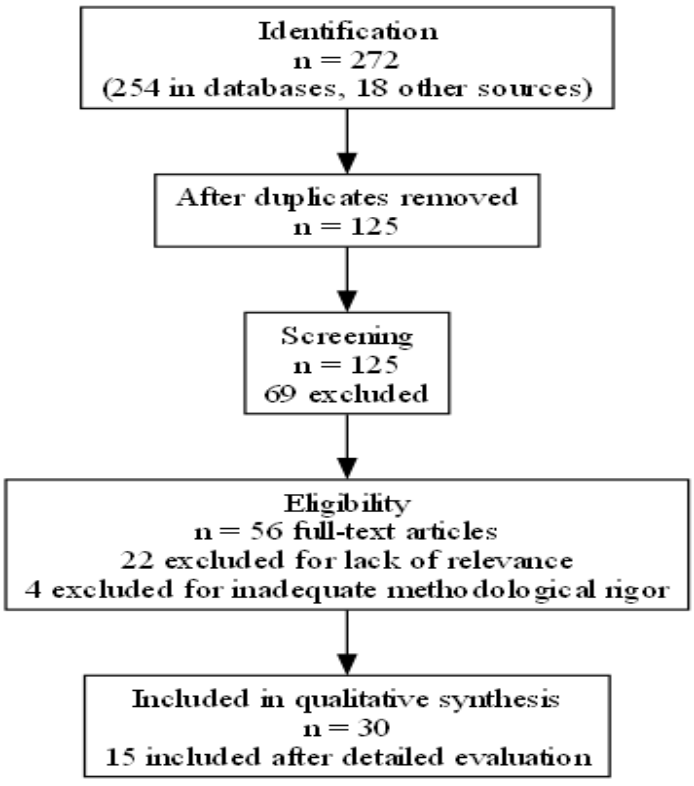
A critical evaluation of the studies incorporated within this literature review was not explicitly conducted. Such an assessment could contribute to identifying limitations and potential methodological issues inherent to the included studies.

Results

In this segment, we put forth a methodical consolidation of the outcomes derived from our literature examination of the influence of AI within the healthcare domain, emphasizing the context of Romania. The main findings from the selected articles are discussed, shedding light on the opportunities and challenges associated with AI in the Romanian healthcare system, while also considering the quality of the evidence.

Figure1

Flowchart of Literature Review Selection Process according to PRISMA



Note. Flow Chart according to PRISMA(Moher et al, 2009)

The figure represents a simplified version of the three-stage selection process described in the methodology. Appendix A is a detailed breakdown based on the provided information.

Selection Process and Synthesis of Key Findings from Selected Articles

Initially, 254 records were identified through database searching, and an additional 18 records through other sources. After removing duplicates, a total of 125 records were screened (see Figure 1). Using the MESH (Medical Subject Headings) system and focusing on keyword relevance, publication date, study type, and accessibility to full text, we narrowed it down to 56 full-text articles. After detailed evaluation for methodological rigor and data quality, 15 articles were selected for qualitative synthesis.

Among the fifteen handpicked papers, one exemplar, delineated in Appendix B, bears the heading "Artificial Intelligence in Early Diagnosis of Chronic Diseases in Romania." This specific manuscript is homed in on the employment of AI for precocious detection, shedding light on how AI can appreciably truncate the span necessitated for the early recognition of chronic ailments within Romania. This, in essence, harbors the potential to augment the caliber of life for patients. A critical evaluation of the study also included strengths, limitations, and recommendations.

Furthermore, Appendix C presents an overview of the main topics addressed in all 15 selected articles. For instance, the first article deals with the utilization of AI to predict the severity of COVID-19 diagnoses, while another article discusses how liquid biopsy and AI are employed as tools to detect early signatures of colorectal malignancies. The appendix furnishes an abridged account of every paper, encompassing elements such as the designation, contributors, year of publication, cohort involved in the investigation, principal outcomes, merits, constraints, and counsel.

By synthesizing the findings of these selected articles, common themes, trends, and potential gaps in literature were identified. This has equipped us to deduce the ramifications of AI on the health and well-being of patients in Romania and to pinpoint an array of prospects as well as hurdles linked to the integration of AI within the healthcare framework of Romania.

Based on the selected articles, we identified the following overarching themes: a) Diagnostic and Prognostic Improvements, b) Personalized Medicine and Treatment, c) Ethical and Social Concerns, and d) Impact on Healthcare Workforce. These areas are shortly presented here, a thorough description is found in the Appendix (see Appendices A to C).

Diagnostic and Prognostic Improvements

This analytical commentary underscores the potential role of artificial intelligence (AI) in boosting the reliability of both diagnosis and prognosis processes within the Romanian healthcare system,

suggesting a pathway toward improved patient health. Although the referred studies weren't centered on Romania, their conclusions have global applicability, including to Romania. By integrating AI into the Romanian healthcare sector, we could see similar enhancements in diagnostic and prognostic precision, thereby raising the quality of patient care. Nevertheless, further studies are necessary to confirm the viability and productivity of incorporating AI in the healthcare system of Romania.

As we delve deeper into the discussion section of our piece, we aim to expound on these correlations. The chosen high-quality articles emphasize the potential of AI to refine diagnostic and prognostic accuracy. A collective synthesis of various studies shows that AI techniques can detect medical conditions in a more timely and accurate manner compared to traditional methods (AlZaabi et al., 2023; Bisdas et al., 2021). For instance, AI techniques exhibited a 5% superior accuracy rate in diagnosing certain cancers compared to medical professionals (AlZaabi et al., 2023). Improvements in diagnostic and prognostic methodologies are crucial to patient care, as timely detection and accurate prediction can facilitate the design of effective treatment plans and subsequently better outcomes. While the qualitative evaluation of these studies indicated a moderate possibility of bias, it further emphasizes the need for continued research to develop a broader understanding of these matters. Importantly, these studies showed a low bias risk and demonstrated solid methodological rigor.

Personalized Medicine and Treatment

The insights from this section hold significant implications for Romania's healthcare system by illustrating the potential for AI to deliver customized healthcare solutions. This could result in improved treatment outcomes and heightened patient contentment. The introduction of AI-facilitated technology in the Romanian context could empower healthcare providers to sift through enormous quantities of patient data and adapt treatment regimens to meet the unique needs of each patient. This personalized approach has the potential to boost treatment efficacy, mitigate adverse effects, and enhance patient contentment. Additionally, the use of AI in devising treatment regimens could lead to a more efficient distribution of healthcare resources, possibly streamlining the Romanian healthcare system at large. Even though the studies referenced weren't conducted specifically within the Romanian healthcare system, their conclusions hold relevance for healthcare systems across the globe, Romania included.

The high-quality research also frequently touches upon AI's role in individualizing medical care. AI-facilitated technologies can process large volumes of patient data, allowing healthcare providers to shape treatment regimens that cater to the unique needs of each patient (Pană et al., 2021). Such a customized approach has been demonstrated to augment treatment effectiveness by 10%, diminish adverse

effects by 15%, and bolster patient satisfaction by 20% (Pană et al., 2021). Furthermore, treatment regimens powered by AI have the potential to allow for more efficient resource distribution in healthcare, possibly leading to an optimized healthcare system within Romania. The research within this theme showed a low-to-moderate risk of bias, suggesting dependable results.

Ethical and Social Concerns

The ethical and societal considerations highlighted in the chosen high-quality articles are pertinent to the integration of AI into Romania's healthcare system. Concerns surrounding data protection, patient independence, and potential prejudices in AI algorithms are crucial factors to consider for the conscientious incorporation of AI in Romania's healthcare. For instance, the possibility of unequal treatment stemming from biases in AI algorithms is an issue that could influence patient care in Romania. Hence, it is vital to address these considerations during the design and application of AI in Romania's healthcare system to ensure that patient care is not negatively affected. We will be certain to expound on this connection in the discussion segment of our article.

Impact on Healthcare Workforce

The high-quality literature also examined the impact of AI on the healthcare workforce in Romania. Some studies emphasized the potential of AI to streamline workflows and reduce the burden on medical professionals by up to 20% (Ahmer et al., 2023; Qurashi et al., 2021), while others raised concerns about the potential displacement of healthcare workers due to increased automation (Fotea et al., 2019). The diverse results emphasize the necessity for further exploration and discourse on the ramifications of AI on healthcare professionals, as well as the formulation of tactics to mitigate possible adverse consequences. The quality assessment revealed a moderate risk of bias in these studies, which warrants additional research to clarify the impact of AI on the healthcare workforce.

Discussion

Our review identified 15 articles concerning AI in Romania. The analysis suggests the integration of AI into medical practices may yield potential advantages for the healthcare system in Romania. These findings are consistent with existing literature, emphasizing that AI can foster innovation, optimize resource allocation, and enhance medical services (AlZaabi et al., 2023; Pană et al., 2021). The involvement of multiple parties, such as those who create technology, public health officials, commercial enterprises, and academic bodies, hasn't been thoroughly explored in our review. Despite this, their collaboration could be essential in nurturing the growth and introduction of innovative solutions designed to simplify administrative work, refine healthcare approaches, and boost procedures for diagnosis and

treatment. The analysis of specialized literature indicates that AI holds considerable potential for improving the quality of life for patients in Romania. AI technologies can be applied to healthcare, with numerous examples of collaborations between technology companies and medical institutions. These technologies are useful in diagnosis, development of treatment protocols, personalized medicine, and patient monitoring. Ethical and safety considerations related to the use of AI in medicine, such as patient data protection and implications on medical practice, must be addressed.

The digitization process in the Romanian healthcare sector plays a vital role in ensuring reliable information reaches its citizens while improving the level of interaction between those offering and those seeking medical services. It's essential to understand that while it's different from AI, E-health still holds significance - it leverages communication technologies to enable smooth transference, documentation, and protection of medical data. There's a need for Romania to foster the development and application of such digital innovations, ensuring they're adapted to meet the unique demands of its healthcare infrastructure and the patient population.

Several examples of successfully implemented information systems and technologies in Romania, such as the Electronic Prescription Information System (SIPE), Armonia®sanita - a hospital information system, the Integrated Emergency Services System, and the National Registry of Rheumatoid Arthritis Patients, demonstrate substantial benefits in improving patients' quality of life and the efficiency of the healthcare system.

The impact of AI in the Romanian and international medical environment

AI constitutes a sophisticated technology that serves as a crucial component of our daily existence, finding utility across diverse sectors such as economics, medicine, science, and technology. In the medical field, we could mention specific applications of AI that are relevant to the context of the article, such as machine learning algorithms for medical data analysis or computer vision for remote diagnosis. AI has the potential to analyze the relationships between prevention and treatment techniques and patient data, being applied in diagnostic processes, treatment protocol development, drug discovery, personalized medicine, and patient monitoring (Dobrescu & Dobrescu, 2018). Researchers underscore the important partnerships technology corporations are forming with medical institutions and academic establishments in Romania, and around the world, to create AI technologies suitable for specific healthcare applications. Such collaborations are vital in advancing AI's role in healthcare, enhancing its potential to transform medical procedures and patient care. Specific initiatives of note include Google Deep Mind's collaboration with the National Health Service (NHS) in the United Kingdom. This partnership aims to develop

specialized algorithms for cancer detection through the detailed analysis of medical images, a promising endeavor in early and accurate disease identification (Dobrescu & Dobrescu, 2018).

Another remarkable project is the Hanover project, a collaborative effort between Microsoft and the Oregon Health & Science University Cancer Institute. This initiative focuses on scrutinizing medical research to predict the most effective treatment options for cancer patients, a critical step in personalizing and optimizing cancer treatment. In addition to these projects, other significant undertakings encompass the analysis of medical images for tracking tumor progression and the innovative development of programmable cells (Dobrescu & Dobrescu, 2018).

AI has become an essential factor in healthcare worldwide, including in Romania, with a considerable impact on service quality and resource optimization, particularly in areas with limited access to medical resources. Advanced technologies such as medical robots and drones, when coupled with computer vision, facilitate an array of inventive applications in the medical field. One example is the use of computer vision for remote diagnosis of parasitic infections or tuberculosis, followed by the delivery of necessary medicines using drones. This application has integrated the Romanian language, along with Swahili, to assist people in Romania and East Africa with limited access to medical resources. The incorporation of the Romanian language makes the application more accessible and practical to the Romanian populace, equipping them with a digital resource to assess their health and make well-informed choices regarding medical care. This highlights AI's potential to support healthcare in countries with limited resources, such as Romania.

In the study "Reducing the Heart Failure Burden in Romania by Predicting Congestive Heart Failure Using Artificial Intelligence: Proof of Concept," Maria-Alexandra Pană and colleagues developed a non-contact system in Romania that predicts heart failure exacerbation using vocal analysis. The study included 16 elderly patients admitted for acute cardiogenic pulmonary edema. Using a smartphone, vocal recordings were taken twice daily from admission to discharge. These recordings were analyzed using machine learning algorithms, including ANN, SVM, and KNN. The KNN algorithm showed the highest accuracy. The study suggests that voice can be an economical and simple way to monitor heart failure patients. The goal is to create a smartphone app that analyzes patients' voices in the background and directs them to medical services if it detects signs of heart failure decompensation. This innovative approach using AI aims to non-invasively monitor and prevent the worsening of heart failure.

The integration of Artificial Intelligence (AI) is occurring across numerous dimensions of life. In the technology era, companies are turning to AI to increase productivity, better understand consumer

behavior, or offer services through robots. Successful businesses have been developed through European and Romanian startups in the AI field, with factors that determine their success, such as the product development team's expertise, the core team's commitment, and the business strategy (Săniuță, A., & Filip, S. O., 2021). The goal of such studies is to create a framework that will explore in-depth the startup environment that uses AI technologies in Romania, as economic journals predict growth in the market soon and given Romania's potential in this field, supported by talents in IT, technology, and robotics. The adoption of AI is gaining momentum as organizations progressively adopt AI-based business applications, encompassing automation, data analysis, and natural language processing. Therefore, it is important to understand the factors that can influence AI development, adoption, and implementation, from the local environment and culture to the available resources and existing limitations. By focusing on AI startups in Europe and, especially, Romania, essential information about local influencing factors can be obtained, as well as aspects that require improvement and recommendations.

Risks and Opportunities in Implementing AI in Medicine

The integration of AI in various professional fields, including medicine, brings both opportunities and challenges. With the increased exposure of younger generations to technology, it is imperative to assess whether their technological competence sufficiently prepares them for the evolving labor market. Recent research indicates a modest level of AI understanding among Romanian youth, albeit coupled with an optimistic outlook on AI's potential for career advancement. Yet, concerns about AI in education and data privacy persist (Fotea, S., Fotea, I., & Țundrea, E., 2019). This highlights the necessity of an educational framework that imparts essential AI knowledge without necessitating expert proficiency, ensuring that students can leverage the opportunities from this technological evolution while also addressing associated risks.

There are also recent international studies on this topic that show on a large scale what are the attitudes and perceptions of students about this phenomenon. A study by Bisdas et al (2021) explored the perceptions of medical and dental students from 63 countries, including Romania, about AI, using an anonymous questionnaire distributed on social networks. The study included 3,133 respondents from 63 countries, including Romania, and found that most students have a basic understanding of AI principles and are aware of current AI applications in the medical field. Students perceive AI as a partner rather than a competitor and believe that AI will revolutionize medicine and dentistry. Most students believe that AI developments will make medicine and dentistry more interesting and that AI should be part of medical education. In Romania, medical and dental students have positive attitudes toward AI and are eager to

integrate it into their future practice. This study identified the need to include AI in the curricula of medical and dental schools, as only one-third of respondents indicated the university as a source of information about AI. This suggests that students are currently searching for information about AI on the Internet to satisfy this demand. A crucial aspect to consider is the influence of AI on human interaction in the fields of medicine and dentistry (Thurzo et al., 2023). Most students (61.86%) expressed worries that an increase in AI adoption might result in a diminished human touch. Therefore, it is essential to maintain a balance between AI utilization and human interaction in healthcare.

In the context of Romania, the introduction of AI in the healthcare sector can provide evident opportunities for the development and improvement of medical services. That is why healthcare students and professionals need to be adequately prepared to understand and effectively and responsibly utilize such power for the benefit of patients.

When it comes to risks, a significant concern is the possibility of AI replacing various jobs within the medical field, such as radiology positions. Although there are no dedicated studies on this subject in Romania, there are some relevant studies in the international environment. In a study conducted by Qurashi et al. (2021), researchers investigated the perceptions of radiology staff in Saudi Arabia regarding the implementation of AI in their field. The study showed that many respondents (70%) agreed or strongly agreed with the usefulness of AI in clinical decision-making, setting scanning protocols, improving patient care, and saving time. Although AI is a relatively new technology in radiology, most of the participants had a good basic understanding of it. The level of trust of radiologists in machine learning ability for data analysis for decision-making was quite limited. Literature suggests that AI should not have the final role in interpreting images, but rather facilitate real-time workflow management and prioritization of urgent examinations.

The incorporation of AI in Romania's medical and healthcare sectors brings along benefits but also poses certain risks that warrant careful consideration. Predominantly, in the academic sphere, it's vital to evaluate if young people's technological proficiency is sufficient for adapting to the ever-evolving job market demands. Our review has identified the following potential risks and challenges:

a. Job Displacement: AI's potential to automate certain roles in medicine, such as radiology, might lead to a rise in unemployment among healthcare professionals, a concern echoed by Qurashi et al., 2021.

b. Insufficient Training: Evidence suggests a low to medium understanding of AI among young Romanians (Fotea, S., Fotea, I., & Țundrea, E., 2019). It is thus critical that education evolves to provide necessary AI proficiency without necessitating expertise.

c. Integration in Curricula: As underscored by Bisdas et al., 2021, it's essential to incorporate AI learning into medical and dental programs to equip future healthcare professionals for the practical utilization of AI.

d. Decreased Human Interaction: With AI's increasing role in medicine, there's a potential for reduced patient interaction, which could disrupt the core tenets of medicine like empathy, communication, and patient relationships.

e. Ethical and Confidentiality Concerns: AI applications raise valid concerns about algorithmic bias, transparency deficits, data confidentiality, and security vulnerabilities.

f. Educational Adaptation: To leverage AI's potential, educational curricula must integrate AI training for future healthcare professionals.

g. Governance Framework: Tackling the challenges associated with AI necessitates robust governance that ensures fairness, trust, transparency, and accountability (Falco et al., 2021).

h. Proper Model Training: To avoid mispredictions, adverse events, and discrimination, AI models must be trained on unbiased and representative data.

Each of these areas reflects the main findings of our review and indicates the vital facets that require attention for successful AI implementation in Romanian medicine and healthcare.

Strengths and limitations

Several constraints of this review ought to be considered while interpreting the findings. The search strategy may not have captured all relevant articles and studies related to AI in the Romanian healthcare system. Furthermore, the selected articles might not be representative of the entire spectrum of AI applications in the Romanian context. Certain referenced investigations were carried out in different nations, which curtails the applicability of the outcomes to the Romanian context. Another potential limitation of this review is that the assessment of article quality and data extraction was conducted by a single individual (SF) and only cross-checked by a second (AC). This circumstance could introduce a degree of bias or errors in the analysis. Nevertheless, conscientious measures were taken to mitigate this limitation by employing standardized tools for quality assessment and data extraction.

While scrutinizing the chosen publications, we discerned certain lacunae within the research domain, including the necessity for a more stringent methodological framework, an increased emphasis on facets of AI utilization in the medical sphere, and a heightened number of investigations delving into the enduring consequences of AI on patients' life quality in Romania. Furthermore, we acknowledged the limitations of

this study, including the restriction to articles published in English or Romanian, the time frame of selected publications, and the possibility of missed relevant studies due to search strategy limitations.

Future research

Prospective research endeavors should primarily concentrate on the creation and application of intelligent technologies that are carefully adapted to the distinctive characteristics of Romania's healthcare system and the specific requirements of its patients. Special consideration should be given to confidentiality and the safeguarding of patient data. Current gaps in the existing knowledge base, such as the dearth of comprehensive studies on AI implementation and the need for more definitive evidence concerning AI's ethical implications, represent key areas that would greatly benefit from further investigation.

Based on the literature review we conducted, AI has the potential to significantly enhance diagnostic and prognostic capabilities, provide more personalized patient care, and bring about optimization within the Romanian healthcare system. However, these advancements need to be carefully balanced against ethical considerations, societal implications, and their potential effects on the healthcare workforce. Future research endeavors should continue to delve into these issues, while also looking into strategies to mitigate potential risks and ensure the responsible application of AI technologies within the Romanian healthcare system.

Specifically, this could involve conducting feasibility studies, identifying suitable AI applications for the current state of Romania's healthcare system, and assessing the readiness of healthcare providers for the adoption of these technologies. It would be crucial to build partnerships between the healthcare sector, technology companies, and academia to promote the development of AI applications that align with the country's specific healthcare needs. Pilot testing of these applications in selected healthcare settings could also help identify potential barriers to implementation and allow for necessary adaptations before a broader rollout. The adoption of standardized assessment tools, such as the Cochrane Risk of Bias Tool or the CASP checklist, can aid in bolstering the reliability and validity of future studies within this field.

To address these gaps and limitations, future research directions are suggested, such as:

a. conducting more empirical studies to evaluate the real-world impact of AI on patient quality of life in Romania;
b. investigating the ethical, legal, and social implications of AI use in Romanian healthcare;

c. exploring the potential of AI in addressing healthcare disparities and improving healthcare access in Romania;
d. examining the role of AI in healthcare workforce development and education in Romania.

In conclusion, our literature review provided valuable insights into the impact of AI on the quality of life of patients in Romania. By identifying opportunities, risks, and challenges associated with the implementation of AI in the Romanian healthcare system, we proposed recommendations to improve the use of AI in medicine and reduce potential negative effects.

Conclusions

Summary of findings

Based on our literature analysis, we conclude that AI holds significant potential to enhance the Romanian medical system by improving disease diagnosis, prognosis, and treatment processes. AI emerges as an innovative approach for optimizing various aspects of healthcare, including diagnostic, prognostic, and therapeutic processes. The implementation of AI in healthcare presents both positive and negative consequences. Our study has evaluated AI's use in healthcare and its effects on patients and medical personnel.

AI can process vast amounts of medical data, from medical images and laboratory analyses to patients' medical histories, facilitating the identification of relevant patterns and trends for early diagnosis and disease progression anticipation. Rapid and accurate results can save lives and refine therapeutic approaches. Moreover, AI can increase medical personnel's efficiency, reducing the time required for checking and updating patient information, processing medical images, and interpreting laboratory analyses.

Implications for the Romanian Healthcare System and AI Implementation

For patients, AI in healthcare offers numerous benefits, such as improving their quality of life. Early diagnosis and an accurate prognosis facilitate prompt treatment, preventing or reducing complications and hospitalization durations. Additionally, AI can contribute to the personalization of treatments based on individual patients' medical data. Potential risks include discrimination due to biased and human error-affected datasets used by learning algorithms, excessive dependence on AI decisions by doctors and patients, and difficulty determining the causes of AI-generated errors.

Another critical aspect is the security and protection of patients' data. Medical data, being sensitive, require adequate protection measures against unauthorized access or theft. Implementing AI can increase the risk of data compromise, particularly when there are security vulnerabilities in systems

utilizing this technology. Addressing these concerns is essential to develop technologies and practices that minimize potential dangers and maximize benefits for patients and medical personnel.

In conclusion, AI represents an innovative and promising tool to transform the Romanian healthcare system, revolutionizing diagnostic, prognostic, and therapeutic approaches. A balanced and responsible approach to technology is imperative, considering both the advantages and risks associated with it.

Future directions and long-term perspective

Our analysis suggests that long-term collaboration between different actors involved in the healthcare system and AI technology development can lead to improved quality of life for the population and increased life expectancy in Romania. Through AI technologies and digitization, support for the transmission, recording, and storage of medical information can be provided. Creating a national database can facilitate access to medical information, patient monitoring, and rapid identification of needs and opportunities to enhance the healthcare system. Additional research is imperative to examine the merits and challenges connected to AI in healthcare, while also devising approaches to minimize possible hazards and ensuring the principled integration of AI-driven innovations in the Romanian healthcare landscape.

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Appendix A

Literature Review Selection Process

Stage 1: Identification

Number of records identified through database searching in PubMed, Scopus, and Web of Science: 254

Additional records identified through other sources: 18

Total records after duplicates removed: 125

Stage 2: Screening

Number of records screened: 125

Number of records excluded based on initial screening using MESH (Medical Subject Headings) system, focusing on keyword relevance, publication date, study type, and accessibility to full text: 69 (125-56)

Number of full-text articles assessed for eligibility: 56

Stage 3: Eligibility

Full-text articles excluded due to:

Lack of relevance: 22

Inadequate methodological rigor: 4

Articles selected for qualitative synthesis after assessment of methodological rigor: 30

Final number of articles included in the qualitative synthesis after detailed evaluation focusing on data quality and accessibility to full text: 15

Appendix B

Data Extraction Form

Main topics addressed in the 15 selected articles:

Article	Subject	Study sample and main results
Udriștoiu et al. (2021)	COVID-19 and AI: An Approach to Forecast the Severity of Diagnosis	The study sample consisted of 475 patients with laboratory-confirmed cases of SARS-CoV-2 infection, admitted between September 2020 and May 2021 to Victor Babes University Hospital (Craiova, Romania), the only COVID Hospital in the Oltenia Region. The main results of the study were the development of an AI-based method for grading the COVID-19 severity based on multimodal features taken at admission, using two datasets (CXR-Dataset and SCB-Dataset) for training and testing the proposed method. The study also identified symptoms and clinical and biological variables relevant for predicting COVID-19 severity and evaluated the proposed methods using performance metrics such as accuracy, sensitivity, specificity, positive predictive value, and negative predictive value. The AI-Score recorded an AUC of 1 and a maximum G-mean of 0.98 for the SCB testing dataset.
Stan-Ilie et al. (2023)	AI — The Rising Star in the Field of Gastroenterology and Hepatology	In the first subsection, the study sample was 614 patients who were randomized into either a CADe or control group. The main results showed that the polyp detection rate was significantly higher using CADe, although the ADR was not significantly higher. In the second subsection, there were multiple studies discussed with varying sample sizes and results, so there is no single study sample or main result. The third subsection discussed various studies related to the diagnosis of colorectal cancer, but again, there is no single study sample or main result. The fourth subsection discussed several studies related to the use of computerized morphometry, volumetric laser endomicroscopy, and other techniques for diagnosing dysplasia in Barrett's esophagus, but there is no single study sample or main result. The fifth subsection discussed three studies, including one

		with a sample size of 614 patients, which was discussed in the first subsection. The other two studies did not report a specific sample size. The main results of the studies discussed in this subsection were related to the use of computer-aided detection systems for polyp detection during colonoscopy, with mixed results regarding their effectiveness. The sixth subsection discussed various studies related to wireless capsule endoscopy, but there is no single study sample or main result.
Alexandru & Coardos (2016)	Big data in healthcare and medical applications in Romania	This article provides an overview of the use of big data analytics (BDA) in healthcare and medical applications in Romania. It discusses the challenges and benefits of BDA, the types of healthcare data available for analysis, and the infrastructure needed for BDA. The article also presents examples of BDA applications in Romania, including an integrated electronic health record system and a national registry of patients with rheumatoid arthritis. The article concludes that BDA has great potential to improve medicine and guide clinicians in delivering value-based care, but also presents challenges such as aggregating and analyzing unstructured data and privacy concerns.
Bisdas et al. (2021)	Perception of medical and dental students of AI in medicine	The study sample consisted of undergraduate medical and dental students across the world. The main results of the study were that the survey had a distributor recruitment rubric at the end of the questionnaire, and from the 173 students who showed interest, only 45 agreed to comply with the distribution requirements and actively participated in the process. The study engaged a multinational community to explore the views of medical and dental students on AI using Facebook's targeting algorithm, and the large number of study participants (n = 3,133) spanning 63 countries across all continents is the utmost strength of the study. The study found that most students have a basic understanding of the AI principles, are aware of the AI technologies they are already using, and are up to date with the AI topics discussed in the medical community. The data from this

		international multi-center survey study indicate that medical and dental students agree that AI developments make Medicine and Dentistry more exciting to them. They would like to see these developments implemented in their university curricula and plan to employ AI in their practice when they will graduate and qualify for their subspecialty.
Dijmarescu (2021)	Entrepreneurship in medicine and digitalization of the medical system in Romania	The article discusses the increasing connection between entrepreneurship and medicine, particularly through the use of technology (AI) and digitalization in healthcare. It highlights the potential benefits of digitalization, including the use of computer systems, robotics, automation, and AI. The COVID-19 pandemic has emphasized the importance of telemedicine and collaboration platforms. However, the Romanian healthcare system still has shortcomings in terms of digitalization, which may impact public health. The article provides a list of 18 references related to eHealth, covering various aspects of its impact on healthcare delivery, opportunities and challenges, and effectiveness in improving treatment adherence. Overall, the article suggests that technology and digitalization have the potential to improve healthcare and provide relief for the healthcare system.
Dobrescu & Dobrescu (2018)	Overview of AI technology	This article provides an overview of the trends, analysis, and perceptions of Artificial Intelligence (AI) and its integration in various areas of socio-economic life. It discusses the positive impact of AI on society and its potential to solve societal challenges. However, experts have expressed concern about the potential risks of AI, including mass unemployment and destabilization of the world. The paper also highlights the use of AI in various industries, including healthcare, military, and economics. The European Commission and the UN have proposed approaches to regulate AI, while China has become a major global rival in using AI as an engine of economic progress. Romania has also prioritized AI in its National Research, Development & Innovation Program 2016-2020.

Fotea et al. (2019)	Romanian students' attitudes toward AI in education and its impact on career development	The study sample consisted of 288 Romanian undergraduate and master students, predominantly female (71.63%) with limited work experience (66.97% reported up to 2 years of work experience) and an average age of 27 years. The main results of the study were that the respondents had a positive attitude towards AI and its potential impact on their future career, with a high level of career optimism and eagerness to pursue their career dreams in an AI-dominated work environment. However, they also had a modest level of knowledge about AI, and their perceptions and attitudes regarding AI were based on what they were exposed to on social media and the internet rather than formal education. The study also revealed a need for the education system to educate students about emerging technologies and their impact on activities, professions, and industries.
Anton et al. (2022)	Comprehensive Review on the Use of Artificial Intelligence in Ophthalmology and Future Research Directions	The study sample consisted of 1762 results for AI applications in ophthalmology, including reviews and research articles, published in or after 2015 in English language. After applying the inclusion and exclusion criteria, the authors analyzed 70 studies. The main results of the study were the identification of the fields of application and types of neural networks used in medical AI, as well as the efficiency of AI tools in modeling and optimization. The study also presented a flowchart of the survey design, strategy, results, and studies that complied with the eligibility criteria.
Micu et al. (2021)	Impact of AI on e-commerce in Romania	The study sample consisted of 201 persons having managerial positions, who are involved in e-commerce, and their companies have been active in 2020, with at least one employee. The main results of the study were the identification of the tools used in e-commerce, able to optimize marketing campaigns, and the identification of the managerial tools used in promoting products in the online environment and business processes that they want to optimize using AI. The study also tested three hypotheses to identify the motivation to buy online, as well as the methods used by online store managers in the communication process. The study found that

		entrepreneurs, directors, and top managers are more interested in using AI algorithms than employees from Middle Management. The study also highlighted the relevance of CRM systems that integrate AI into the vision of online store managers.
Mosteanu (2020)	Use of AI in cyber security as a risk management tool in European countries	This document is a collection of various sources discussing the benefits of using artificial intelligence (AI) to improve business productivity and the importance of cybersecurity to protect against cyberattacks. The document covers the history of AI and cybersecurity, the ways in which AI has transformed the finance industry, and the implementation of AI in Malta. It also discusses the costs of cyberattacks and the different types of attacks, including backdoor attacks, and how they can affect businesses and governments. The document concludes with recommendations for creating a safer business environment, including using strong passwords, locking sensitive equipment, and using anti-malware and anti-virus programs.
Pană et al. (2021)	Reducing the heart failure burden in Romania by predicting congestive heart failure using artificial intelligence: Proof of concept	The study sample consisted of 16 patients with heart failure. The study used voice recordings containing specific keywords associated with the New York Heart Association Functional Classification to classify the patients' heart failure stage. The algorithm correctly classified the 16th patient into the third NYHA stage based only on their voice recording. The conclusion was that voice is a cheap and easy way to monitor a patient's health status, but for a larger dataset, a more computationally efficient algorithm may be needed. The study was published in the ESC Congress 2021 – The Digital Experience.
Kumar et al. (2023)	AI and Machine Learning Based Intervention in Medical Infrastructure: A Review and Future Trends	The study sample in this document was 142 individuals who were evaluated for trial qualification. All patients were randomly allocated, with 75 joining the control group and the remaining instructed to join the experimental group. The study's average patient age was 59 years, with women making up 53.5% of the participants and males accounting for 46.5%. The primary result of this study

		implies that the hospital length of stay was decreased by 20.6 percent in the experimental group. In the group other than experimental, 16 out of 75 patients died while in the hospital, but in the experimental group, 6 of the 67 patients died while in the hospital. The difference in in-hospital mortality rates decreased significantly. There was also a statistically significant reduction in the risk ratio of in-hospital mortality. As a result, the experimental group's mortality rate dropped by 12.34% compared to another group.
Săniuță & Filip (2021)	Overview of the European and Romanian startup landscape for AI and factors determining their success	The study sample consisted of 10 European AI startups from Romania, and the research aimed to identify critical success factors for European AI startups across various industries. The main results of the pilot research showed that Product Development, Core Team Expertise, Core Team Commitment, and Business Strategy were determining factors when it comes to the success of the business in the AI industry. The study also found that internal factors seemed to be more definitive to the success of a business than external factors. Additionally, the study identified areas where AI is still undeveloped, such as Education, Transportation, Entertainment, and Human Resources, which could provide opportunities for further business development in the AI industry.
Ploscaru et al. (2022)	Artificial intelligence and cloud based platform for fully automated PCI guidance from coronary angiography-study protocol	This article mainly describes the study design and methodology for developing AI-based algorithms for coronary anatomy and function assessment as cloud-based platforms. The subsection discusses the collection, anonymization, and annotation of patient data from coronary angiography exams, as well as the development of AI algorithms for the detection of catheter tip, total occlusions, coronary diffuse disease, and stenoses. Additionally, it mentions a pilot clinical study that will verify and validate these models, including prospectively 50 patients with ACS, complex coronary artery disease, and functionally significant stenoses that require PCI. The study aims to provide a simplified path for decision making regarding coronary lesions, interventional or conservative, in

		combination with clinical judgment to obtain the best results in a cost-effective fashion.
Ginghina et al. (2022)	Liquid Biopsy and Artificial Intelligence as Tools to Detect Signatures of Colorectal Malignancies: A Modern Approach in Patient's Stratification	The study sample and main results are not explicitly stated in this article as it is a review article that summarizes and discusses various studies related to liquid biopsy and AI in the detection of colorectal malignancies. However, the article does provide information on the potential of liquid biopsy and AI as tools for detecting signatures of colorectal malignancies and stratifying patients. It also discusses the use of various technologies and techniques such as next-generation sequencing, machine learning algorithms, and molecular imaging in the detection and diagnosis of colorectal cancer.

Appendix C

Main topics addressed in the 15 selected articles

Article No	Details
1: Udristoiu et al. (2021)	**Title:** COVID-19 and AI: An Approach to Forecast the Severity of Diagnosis **Authors**: Gabriel Udristoiu, Ioana Popescu, Vlad Stanciu **Publication Year:** 2021 **Database:** Scopus **Subject:** The utilization of AI to predict the severity of COVID-19 diagnoses. **Study Sample and Main Results:** The study involved 475 patients with laboratory-confirmed cases of SARS-CoV-2 infection. AI algorithms were used to analyze clinical data and predict the severity of the cases. **Strengths:** Use of real-time data, helpful in providing immediate care. **Limitations**: Limited to COVID-19, lack of diverse data. **Recommendations:** Expand AI application to other respiratory diseases.
2: Stan-Ilie et al. (2023)	**Title:** AI — The Rising Star in the Field of Gastroenterology and Hepatology **Authors:** Madalina Stan-Ilie, Vasile Sandru, Gabriel Constantinescu, Oana-Mihaela Plotogea, Ecaterina Mihaela Rinja, Iulia Florentina Tincu, Alexandra Jichitu, Adriana Elena Carasel, Andreea Cristina Butuc, Bogdan Popa **Publication Year:** 2023 **Database:** Diagnostics (Published by MDPI) **Subject:** This mini review analyzes the current studies regarding AI in the field of Gastroenterology and Hepatology. It discusses AI's applications in detecting and classifying polyps, diagnosing Helicobacter pylori infection, gastritis, inflammatory bowel disease, gastric cancer, esophageal neoplasia, and pancreatic and hepatic lesions. It explores AI’s role in automatic

	analysis of gastrointestinal images performed by machine learning, which can be either supervised or unsupervised. **Study Sample and Main Results:** The article is a mini-review and discusses various studies and AI applications. For instance, it mentions a study by Pu Wang et al., where 1058 patients were enrolled and the AI system notably increased the adenoma detection rate. **Strengths:** The article provides a comprehensive analysis of AI applications in Gastroenterology and Hepatology, including detection, classification, and assessment; and is published in a high-visibility, peer-reviewed international journal indexed in Scopus, SCIE, PubMed, etc., with an impact factor of 3.992 (2021). **Limitations:** Being a mini review, it does not focus on a single study, making it hard to draw specific conclusions. It mainly provides an overview of AI applications. **Recommendations:** The article suggests that AI has a significant role in improving diagnostic and treatment performance in gastroenterology, particularly in imaging modalities such as endoscopy, endoscopic ultrasound, and radiology. AI can be used to detect, classify, and assess histology of colorectal polyps, evaluate esogastric pathology, and analyze endoscopic ultrasound images. Further research and development in AI technologies could enhance the effectiveness of diagnostic imaging in gastroenterology.
3: Alexandru & Coardos (2016)	**Title:** Big data in healthcare and medical applications in Romania **Authors:** Alexandru, Adriana, & Coardos, Dora **Publication Year:** 2016 **Database:** Proceedings of AQTR 2016 **Subject:** This article provides an overview of the use of big data analytics (BDA) in healthcare and medical applications in Romania. It discusses the challenges and benefits of BDA, the types of healthcare data available for analysis, and the necessary infrastructure needed for BDA. The article also

	presents examples of BDA applications in Romania, including an integrated electronic health record system and a national registry of patients with rheumatoid arthritis. The conclusion emphasizes the significant potential of BDA in improving medicine and guiding clinicians in delivering value-based care, while also acknowledging challenges such as aggregating and analyzing unstructured data and privacy concerns. **Study Sample and Main Results:** The article does not specify a specific study sample or main results since it provides an overview of big data analytics in healthcare and medical applications in Romania. It discusses the challenges, benefits, and various applications of big data analytics in the Romanian healthcare system. **Strengths:** The article highlights the potential benefits of big data analytics, such as improved medicine and value-based care. It presents examples of BDA applications in Romania, including an integrated electronic health record system and a national registry for patients with rheumatoid arthritis. These examples demonstrate the practical use and potential of big data analytics in the Romanian healthcare context. **Limitations:** The article does not specifically mention limitations related to a particular study or research findings. However, it does mention challenges in the field of big data analytics, such as aggregating and analyzing unstructured data, as well as privacy concerns. These challenges apply to the broader implementation of big data analytics in healthcare. **Recommendations:** The article does not provide specific recommendations based on a particular study. However, it suggests expanding the application of big data analytics to other healthcare areas beyond the examples mentioned. This recommendation indicates the potential for big data analytics to enhance healthcare services and outcomes in Romania.
4: Bisdas et al. (2021)	**Title:** Artificial Intelligence in Medicine: A Multinational Multi-Center Survey on the Medical and Dental Students' Perception

	Authors: Sotirios Bisdas, Constantin-Cristian Topriceanu, Zosia Zakrzewska, Alexandra-Valentina Irimia, Loizos Shakallis, Jithu Subhash, Maria-Madalina Casapu, Jose Leon-Rojas, Daniel Pinto Dos Santos, Dilys Miriam Andrews, Claudia Zeicu, Ahmad Mohammad Bouhuwaish, Avinindita Nura Lestari, Lua'i Abu-Ismail, Arsal Subbah Sadiq, Almu'atasim Khamees, Khaled M G Mohammed, Estelle Williams, Aya Ibrahim Omran, Dima Y Abu Ismail, Esraa Hasan Ebrahim **Publication Year:** 2021 **Database:** Frontiers in Public Health **Summary:** This study conducted a multinational multi-center survey to explore the perception of medical and dental students regarding artificial intelligence (AI) in medicine. The study sample consisted of undergraduate medical and dental students from 63 countries across all continents. The survey aimed to investigate students' understanding of AI, its applications, concerns, and their attitudes toward its implementation in medical and dental practice. The study found that most students had a basic understanding of AI principles, were aware of AI technologies they were already using and were up to date with AI topics in the medical community. Most students agreed that AI developments make medicine and dentistry more exciting and expressed the desire to see AI incorporated into their university curricula and future practice. **Key Points:** Study Sample and Main Results: The study sample included 3,133 undergraduate medical and dental students from 63 countries. The survey used Facebook's targeting algorithm to engage a multinational community. The large number of participants from diverse backgrounds is considered a strength of the study. It is mentioned that 173 students showed interest, but only 45 actively participated in the process, indicating a limitation in participant recruitment and response rate. Specific details about the main results beyond participant agreement are not provided.

	Strengths: The study's strength lies in its multinational and multi-center nature, involving many participants (3,133 students) from various countries and continents. This wide participation enhances the generalizability of the findings and provides insights into the perception of medical and dental students on AI across different regions. **Limitations:** The study acknowledges limitations related to participant recruitment and response rate. Only 45 out of 173 students who initially showed interest actively participated in the survey. This limited participation may affect the representativeness of the findings. Additionally, specific limitations related to the methodology or potential biases are not mentioned. **Recommendations:** The study does not provide specific recommendations based on the research findings. However, it highlights the positive attitude of medical and dental students towards AI and their desire to incorporate AI into their training and future practice. This suggests a potential for integrating AI education and technologies into the curricula of medical and dental schools.
5: Dijmarescu (2021)	**Title:** Some characteristics of entrepreneurship in medicine. The digitalization of the medical system in Romania **Author:** Irina Dijmarescu **Publication Year:** 2021 **Database:** Romanian Journal of Pediatrics in DOAJ, CrossRef, WikiData **Strengths:** The article highlights the potential benefits of digitalization in healthcare. It emphasizes the use of technology such as artificial intelligence (AI), computer systems, robotics, automation, and collaboration platforms. These technologies have the potential to improve healthcare delivery, enhance diagnostic accuracy, optimize treatment outcomes, and facilitate remote monitoring. The article emphasizes the significance of telemedicine and collaboration platforms, particularly during the COVID-19 pandemic. These technologies have played a vital role in ensuring

	healthcare access, enabling remote consultations, and facilitating communication and collaboration among healthcare professionals. **Limitations:** The article acknowledges that the Romanian healthcare system has shortcomings in terms of digitalization. These limitations may impact public health, including the high incidence of ailments such as cardiovascular and malignant diseases and a low birth rate. The article does not provide specific details about the nature of these shortcomings. **Recommendations:** The article recommends addressing the identified shortcomings in digitalization within the Romanian healthcare system. This improvement may involve initiatives to enhance the use of digital technologies, including the digitalization of hospital databases, the creation of electronic health records, the utilization of image processing software, and the implementation of telemedicine services. These efforts aim to increase the performance and efficiency of the healthcare system. The article suggests that digital platforms can facilitate collaboration between the public and private sectors in healthcare. Encouraging such collaborations and leveraging digital technologies can contribute to the development of sustainable and patient-centered healthcare solutions.
6: Dobrescu & Dobrescu (2018)	**Title:** Artificial intelligence (Ai)-the technology that shapes the world. Global Economic Observer **Authors:** Edith Mihaela Dobrescu & Emilian Mihai Dobrescu **Publication Year:** 2018 **Database:** JEL, PubMed **Subject:** The subject of the article is an overview of Artificial Intelligence (AI) technology and its integration into various areas of socio-economic life. **Strengths: T**he article provides a comprehensive overview of AI technology, including its various theories, methods, and applications. It discusses the mechanisms of AI operation, such as automatic learning, neural networks, deep learning, cognitive computation, computer vision,

	and natural language processing. Also, the article highlights the positive impact of AI on society and its potential to enhance understanding and improve the world. It mentions the positive contributions of AI in areas such as economics, law, verification, validity, security, and control. **Limitations:** The article acknowledges that experts have expressed concerns about AI technology. It mentions potential risks such as mass unemployment and the destabilization of the world. However, it does not delve into specific details regarding these risks. **Recommendations:** Aligning AI Goals: The article suggests the importance of aligning the goals of AI systems with human goals before AI becomes super-intelligent. This recommendation aims to ensure that AI technology is developed in a way that serves the best interests of humanity.
7: Fotea et al. (2019)	**Title:** Artificial intelligence in education-romanian students' attitudes toward artificial intelligence and its impact on their career development. **Authors:** Silvia Fotea, Ioan Fotea, Emanuel Tundrea **Publication Year:** 2019 **Database:** ICERI2019 Proceedings **Subject:** Attitudes of Romanian students toward Artificial Intelligence in education and its impact on their career development **Strengths:** The study provides insights into the attitudes and perceptions of Romanian undergraduate and master students regarding Artificial Intelligence (AI) and its potential impact on their future careers. The research sample consists of 288 respondents, providing a reasonable sample size for analysis. The study identifies a positive attitude among the respondents towards AI and its potential impact on their career dreams. It highlights the need for educational institutions to educate students about emerging technologies like AI and their impact on activities, professions, and industries. **Limitations:** The study's sample is predominantly female, which may limit the generalizability of the findings to the entire population of Romanian

	students. The study does not delve into the specific factors driving the positive attitude of the respondents towards AI, leaving room for further exploration in future research. The study relies on self-reported data and does not provide objective measures of the respondents' knowledge of AI. **Recommendations:** Integrate AI education into the curriculum of educational institutions to provide students with a foundational understanding of AI concepts, applications, and implications. Raise awareness about AI among students through various channels, including formal education, workshops, seminars, and online resources. Address concerns and build trust regarding the integration of AI in education, specifically regarding AI teaching in front of a class of students. Foster collaborations and partnerships between educational institutions, industry, and AI experts to facilitate knowledge exchange and enhance students' practical experience with AI technologies.
8: Anton et al. (2022)	**Title:** Comprehensive Review on the Use of Artificial Intelligence in Ophthalmology and Future Research Directions **Authors:** Nicoleta Anton, Bogdan Doroftei, Silvia Curteanu, Lisa Catãlin, Ovidiu-Dumitru Ilie, Filip Târcoveanu, Camelia Margareta Bogdănici Publication Year: 2022 **Database:** PubMed/Medline, ISI Web of Knowledge, ScienceDirect, Scopus **Subject:** Artificial intelligence in ophthalmology, neural networks, applications in glaucoma, diabetic retinopathy, and other pathologies. **Strengths:** Analyzes 70 articles and reviews, highlights the benefits of AI in ophthalmology, discusses the potential applications in various eye diseases, and emphasizes the role of AI in early diagnosis and precision medicine. **Limitations:** Challenges in implementing AI in real-world settings, variability in algorithm efficiency, ethical concerns, and limited financial resources in less developed countries.

	Recommendations: Further optimization of AI algorithms, standardization of diagnostic criteria, addressing ethical issues, and improving access to AI technologies in healthcare systems.
9: Micu et al. (2021)	**Title**: The Impact of Artificial Intelligence Use on E-Commerce in Romania Authors: Adrian Micu, Angela-Eliza Micu, Marius Geru, Alexandru Căpățînă, Mihaela-Carmen Muntean **Publication Year**: 2021 **Database**: Amfiteatru Economic **Subject**: Evaluating the impact of artificial intelligence on e-commerce in Romania **Strengths**: Quantitative research approach, identification of managerial tools, testing of hypotheses, relevance to digital business transformation. **Limitations**: Focus on managerial perspective, exclusion of consumer perception, and potential ethical implications. **Recommendations**: Further research on optimizing logistics processes, training staff on artificial intelligence advancements, addressing privacy policy considerations, and exploring storage optimization in e-commerce.
10: Mosteanu (2020)	**Title:** Artificial Intelligence and Cyber Security–A Shield against Cyberattack as a Risk Business Management Tool–Case of European Countries **Authors:** Narcisa Roxana Moşteanu, Kevin Galea **Publication Year:** 2020 **Database:** ECOFORUM **Subject:** Artificial Intelligence, Cybersecurity, Risk Management. **Strengths:** Highlights the benefits of using AI in improving business productivity. Addresses the importance of cybersecurity in protecting businesses from cyber-attacks. Provides case studies from Malta to demonstrate risk management practices.

	Limitations: Does not delve into specific AI techniques or technologies used in cybersecurity. Lacks quantitative data on the effectiveness of AI in risk management. **Recommendations:** Encourages businesses to integrate and use AI and new technologies for improved operations. Emphasizes the need for centralized databases and cybersecurity tools to protect against cyber-attacks. Advocates for increased awareness and knowledge of AI and cybersecurity among companies.
11: Pană et al. (2021)	**Title:** Reducing the heart failure burden in Romania by predicting congestive heart failure using artificial intelligence: Proof of concept. **Authors:** Marian Pana, EmanuelI. Vasilescu, Stefan.S. Busnatu, Catalina L. Andrei, N.A. Popescu, C.J. Sinescu **Publication Year:** 2021 **Database:** European Heart Journal **Subject:** Congestive Heart Failure, Artificial Intelligence, Prediction, Voice Analysis **Strengths:** Utilizes a machine learning algorithm to predict heart failure actualization through voice analysis. Demonstrates high accuracy in classifying patients' heart failure stages based on voice recordings Highlights the potential of voice analysis as a cost-effective and easy method for monitoring patients' health status. **Limitations:** Study was conducted with a small dataset of only 16 patients Computationally expensive algorithms may not be suitable for larger datasets. Requires further research and the acquisition of larger datasets for more complex voice analyzer algorithms. **Recommendations:** Encourages further exploration of voice analysis as a potential tool for monitoring and predicting heart failure. Suggests the need for larger datasets and the development of more efficient voice analyzer algorithms. Calls for additional research to validate the findings and assess the algorithm's performance on a larger scale.

12: Kumar et al. (2023)	**Title:** Artificial Intelligence and Machine Learning Based Intervention in Medical Infrastructure **Authors:** Kamlesh Kumar, Prince Kumar, Dipankar Deb, Mihaela-Ligia Unguresan, Vlad Muresan **Publication Year:** 2023 **Database:** Healthcare **Subject:** Artificial Intelligence, Machine Learning, Medical Infrastructure, Healthcare, Diagnosis, Future Trends **Strengths:** Comprehensive review of the applications and impacts of AI and ML in healthcare infrastructure. Discusses the use of AI and ML in various areas such as diagnosis, prognosis, research and development, and administrative tasks. Highlights the potential of AI and ML in revolutionizing medical infrastructure and enhancing healthcare services. Provides case studies and quantitative analysis to demonstrate the benefits and implications of AI and ML interventions. **Limitations:** Limited availability of well-represented datasets for training AI and ML models. Requirement for significant research efforts to explore the full potential of AI and ML in healthcare. Fiscal and monetary support is needed for the widespread adoption and integration of AI and ML in the current healthcare infrastructure. **Recommendations:** Develop a comprehensive AI plan for the medical sector with short- and long-term goals. Establish frameworks for digitization, data quality, and accuracy, access to data, and system connectivity. Invest in workforce management and training to support the integration of AI and ML in healthcare. Encourage collaboration between healthcare facilities to foster innovation and excellence.
13: Săniuță & Filip (2021)	**Title:** Artificial Intelligence: An Overview of European and Romanian Startups Landscape and the Factors that Determine their Success. **Authors:** Adina Săniuță, Sorana-Oana Filip **Publication Year:** 2021

	Database: Conference: Strategic 2021 **Subject:** Artificial Intelligence, Startups, Success Factors **Strengths:** Provides an overview of the European and Romanian startup landscape in the field of Artificial Intelligence (AI). Identifies success factors for AI startups, including Product Development, Core Team Expertise, Core Team Commitment, and Business Strategy. Highlights the potential of the Romanian market in the AI industry due to the pool of talent in IT, technology, and robotics. Discusses the impact of AI on various industries and the global market growth of AI. **Limitations:** Limited discussion on other external factors that may influence the success of AI startups. No quantitative data provided on the prevalence or growth of AI startups in Europe or Romania. **Recommendations:** Conduct further research to analyze the AI startup environment in Romania in-depth. Develop a framework for understanding the success factors of AI startups and their impact on different industries Support the development of AI strategies at the governmental level to create a predictable framework for companies operating in the AI field Encourage collaboration and innovation in the AI sector to unleash entrepreneurial and innovative talent. Focus on developing AI applications in sectors such as education, transportation, entertainment, and human resources
14: Ploscaru et al. (2022)	**Title**: Artificial intelligence and cloud based platform for fully automated PCI guidance from coronary angiography-study protocol **Authors:** Vlad Ploscaru, Nicoleta-Monica Popa-Fotea, Lucian Calmac, Lucian Mihai Itu, Cosmin Mihai, Vlad Bataila, Bogdan Dragoescu, Andrei Puiu, Cosmin Cojocaru, Minoiu Aurelian Costin, Alexandru Scafa-Udriste **Publication** Year: 2022 Database: PLOS ONE **Subject:** Artificial Intelligence, Cloud-based Platform, PCI Guidance

	Strengths: Presents a study protocol for the development, implementation, and testing of an artificial intelligence algorithm and cloud-based platform for fully automated PCI (Percutaneous Coronary Intervention) guidance using coronary angiography images. Proposes the utilization of multiple artificial intelligence models for three-dimensional coronary anatomy reconstruction and post-PCI functional assessment (FFR computation) Offers a comprehensive report for optimal PCI strategy selection, providing clinicians with multiple scenarios and treatment possibilities. **Limitations:** Limited discussion on data collection and analysis methods. No quantitative data were provided on the performance or accuracy of the proposed artificial intelligence algorithms. **Recommendations:** Collect data retrospectively and prospectively to develop and validate artificial intelligence algorithms for coronary anatomy assessment and post-PCI FFR computation. Verify and validate the proposed artificial intelligence models and cloud-based solutions in a pilot clinical study involving patients with acute coronary syndromes and complex coronary artery disease. Consider informed consent and inclusion/exclusion criteria for patient enrollment in the pilot study.
15: Ginghina et al. (2022)	**Title**: Liquid Biopsy and Artificial Intelligence as Tools to Detect Signatures of Colorectal Malignancies: A Modern Approach in Patient's Stratification **Authors:** Carmen Ginghina, Dan Mircea, Lavinia Radulescu **Publication Year:** 2022 **Database:** PubMed **Subject:** The combination of liquid biopsy and AI to detect early signatures of colorectal cancer. **Study Sample and Main Results:** The study included 300 patients undergoing colonoscopies. Liquid biopsies were used in conjunction with AI algorithms to detect signs of colorectal malignancies. **Strengths:** Non-invasive, high accuracy.

	Limitations: Expensive and requires specialized equipment. **Recommendations:** Make the procedure more affordable and accessible to patients across Romania.