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Review

Generative AI in Improving Personalized Patient Care Plans: Opportunities and Barriers Towards Its Wider Adoption

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Abstract: The main aim of this study is to investigate the opportunities, challenges, and barriers in implementing generative artificial intelligence (Gen AI) in personalized patient care plans (PPCPs). This systematic review paper provides a comprehensive analysis of the current state, potential applications, and opportunities of Gen AI in patient care settings. This review aims to serve as a key resource for various stakeholders such as researchers, medical professionals, and data governance. We adopted the PRISMA review methodology and screened a total of 247 articles. After considering the eligibility and selection criteria, we selected 13 articles published between 2021 and 2024 (inclusive). The selection criteria were based on the inclusion of studies that report on the opportunities and challenges in improving PPCPs using Gen AI. We found that a holistic approach is required involving strategy, communications, integrations, and collaboration between AI developers, healthcare professionals, regulatory bodies, and patients. Developing frameworks that prioritize ethical considerations, patient privacy, and model transparency is crucial for the responsible deployment of Gen AI in healthcare. Balancing these opportunities and challenges requires collaboration between wider stakeholders to create a robust framework that maximizes the benefits of Gen AI in healthcare while addressing the key challenges and barriers such as explainability of the models, validation, regulation, and privacy integration with the existing clinical workflows.

Keywords: generative artificial intelligence; Gen AI; patient care; personalized patient care; large language models (LLMs); opportunities and challenges of using generative AI; clinical decision support

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1. Introduction

In recent years, the healthcare industry has witnessed a paradigm shift towards personalized patient care, driven by advancements in artificial intelligence (AI) technologies. Among these, generative artificial intelligence (Gen AI) stands out as a pioneering approach poised to revolutionize how healthcare is delivered and experienced. While AI is a broad field incorporating various techniques for simulating human intelligence, Gen AI specifically focuses on creating new content or data using machine learning (ML) algorithms and models [1–4]. By leveraging sophisticated AI/ML algorithms such as deep learning techniques, Gen AI enables the simulation of personalized solutions tailored to the unique needs and characteristics of individual patients. This introduction delves into the transformative potential of Gen AI in shaping the future of personalized patient care plans (PPCPs), exploring its applications, benefits, and implications for healthcare practitioners and patients alike. Gen AI is poised to revolutionize personalized treatment care plans by

leveraging advanced algorithms to create tailored solutions for individual patient needs. This innovative approach enables healthcare providers to analyze vast datasets, including patient health records, genetic information, and treatment histories, to generate highly customized care plans. By synthesizing this data, Gen AI can identify optimal treatment options, dosage regimens, and therapeutic interventions tailored to each patient's unique characteristics and medical history [5–7].

The rapid evolution of AI has fundamentally reshaped numerous industries, with healthcare being one of the most significant beneficiaries. AI-driven innovations are revolutionizing how patient data is processed, analyzed, and applied, enabling unprecedented capabilities in disease diagnosis, prognosis, and personalized care planning. A particular focus has emerged on personalized patient care, which involves tailoring medical interventions to individual patient profiles based on a comprehensive analysis of genetic, phenotypic, environmental, and lifestyle data. This patient-centric approach is at the forefront of precision medicine and has been enhanced by recent advances in AI technologies [8].

Generative AI, a subset of AI, has shown extraordinary promise in transforming healthcare through its ability to create new, meaningful data representations. Unlike traditional AI models, which primarily focus on classification or prediction tasks, generative AI is designed to generate new content or simulate realistic data. The two primary architectures underpinning Gen AI in healthcare are generative adversarial networks (GANs) and transformer-based models, such as GPTs (generative pre-trained transformers). These models have unique characteristics and applications that make them suitable for enhancing personalized patient care [9].

Generative AI offers a significant advantage in creating personalized treatment care plans by simultaneously analyzing a wide range of factors, including patient demographics, existing comorbidities, treatment preferences, and responses to previous therapies. This comprehensive approach allows healthcare professionals to design tailored care plans that meet the unique needs and preferences of individual patients [8–10].

Moreover, Gen AI has the potential to improve treatment outcomes by predicting patient responses to various interventions and fine-tuning treatment strategies accordingly. By examining patterns within patient data and clinical outcomes, Gen AI can uncover trends and correlations that may not be easily detected by clinicians, facilitating more informed and personalized clinical decision-making [11].

Moreover, Gen AI can streamline the care planning process by automating repetitive tasks, such as data analysis and treatment plan generation, allowing healthcare providers to focus more time and attention on patient care and interaction. This increased efficiency can lead to faster decision-making, reduced administrative burden, and improved patient satisfaction [12–14].

However, it is essential to recognize the challenges and considerations associated with implementing Gen AI in personalized treatment care plans. These may include concerns about data privacy and security, the need for robust validation and testing of AI algorithms, and the importance of maintaining transparency and accountability in decision-making processes [15].

Overall, Gen AI holds tremendous promise in revolutionizing personalized treatment care plans, offering the potential to improve treatment outcomes, enhance patient satisfaction, and advance the practice of precision medicine [10,16]. By leveraging the power of AI to analyze complex patient data and generate tailored care plans, healthcare providers can deliver more effective and personalized care to patients, ultimately leading to better health outcomes and quality of life [17–19].

Key Considerations of Generative Artificial Intelligence on Personalized Patient Care Plans

Key Considerations of Gen AI on PPCPs [20–23]:

(a) Ethical use of data: Ensuring that patient data used by Gen AI algorithms are collected and utilized ethically, with proper consent, and in compliance with data privacy regulations;
(b) Transparency and explainability: Promoting transparency in AI algorithms to enhance trust among healthcare professionals and patients, ensuring that the decision-making process is understandable and explainable;
(c) Bias and fairness: Mitigating biases inherent in AI algorithms to prevent disparities in personalized patient care, particularly concerning underrepresented populations;
(d) Interoperability: Enhancing interoperability between different healthcare systems and data sources to facilitate seamless data exchange and integration of Gen AI solutions;
(e) Clinical validation: Conducting rigorous validation studies to assess the clinical efficacy, safety, and reliability of Gen AI algorithms before widespread adoption in PPCPs;
(f) Health equity: Addressing disparities in access to personalized patient care by ensuring that AI technologies benefit all patient populations, regardless of socioeconomic status or geographic location.
(g) Human oversight: Maintaining human oversight in AI-driven decision-making processes to validate results, interpret outputs, and ensure alignment with patient preferences and ethical standards;
(h) Continual improvement: Embracing a culture of continual improvement and learning, iteratively refining Gen AI algorithms based on feedback from healthcare professionals, patients, and real-world use cases.

By considering these key considerations, healthcare organizations can harness the transformative potential of Gen AI to advance PPCPs while mitigating risks and ensuring ethical, transparent, and equitable use of AI technologies. As we delve into the intricate landscape of Gen AI in healthcare, it is crucial to strike a balance between innovation and responsibility. This introduction marks the beginning of a journey into a future where AI augments human capabilities, fostering a healthcare ecosystem that is not only technologically advanced but also ethical, secure, and centered around patient well-being [2,24,25].

2. Methodology

2.1. Articles Search and Selection Criteria

To review the literature on the adoption and effectiveness of Gen AI in patient care, a comprehensive search was conducted using relevant keywords across major scientific databases, including IEEE Xplore, Springer Link, Scopus, and PubMed. The systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [1]. Initially, duplicate records were removed, and a detailed screening of titles and abstracts was performed to refine the selection. Keywords used in the search included "generative AI in patient care", "generative artificial intelligence in personalized care plans", "Gen AI in personalized patient care plans", and "generative AI and patient care plans". Subsequently, a thorough review of the full-text articles was conducted to assess their eligibility. The inclusion criteria for this review were as follows:

- Original research articles, primarily journal publications;
- Studies published between 2021 and 2024 (inclusive);
- Research focused on the application of generative AI in patient care;
- Targeted inpatient and community care settings;
- Articles written and published in English.

Exclusion criteria included non-original research (e.g., editorials, commentaries, or reviews). Additionally, studies exclusively focused on patient monitoring, remote monitoring, intensive/emergency care, or other general monitoring tools were not considered, as the review specifically targeted the use of generative AI in direct patient care planning.

2.2. Article Search Results

Initially, 247 studies were identified through database searching. A total of 171 records did not meet our inclusion criteria based on the initial screening, and therefore, 76 studies were included by checking against eligibility from the high-rank journals. Full-text records were retrieved and reviewed. After excluding unrelated studies and duplicate records, a total of 13 articles were selected for the final review. Figure 1 summarizes the article selection process. Categorization of the year of publication, their area of application, and the ratio of the related articles vs. the total number of selected articles (n = 13) are given in Table 1.

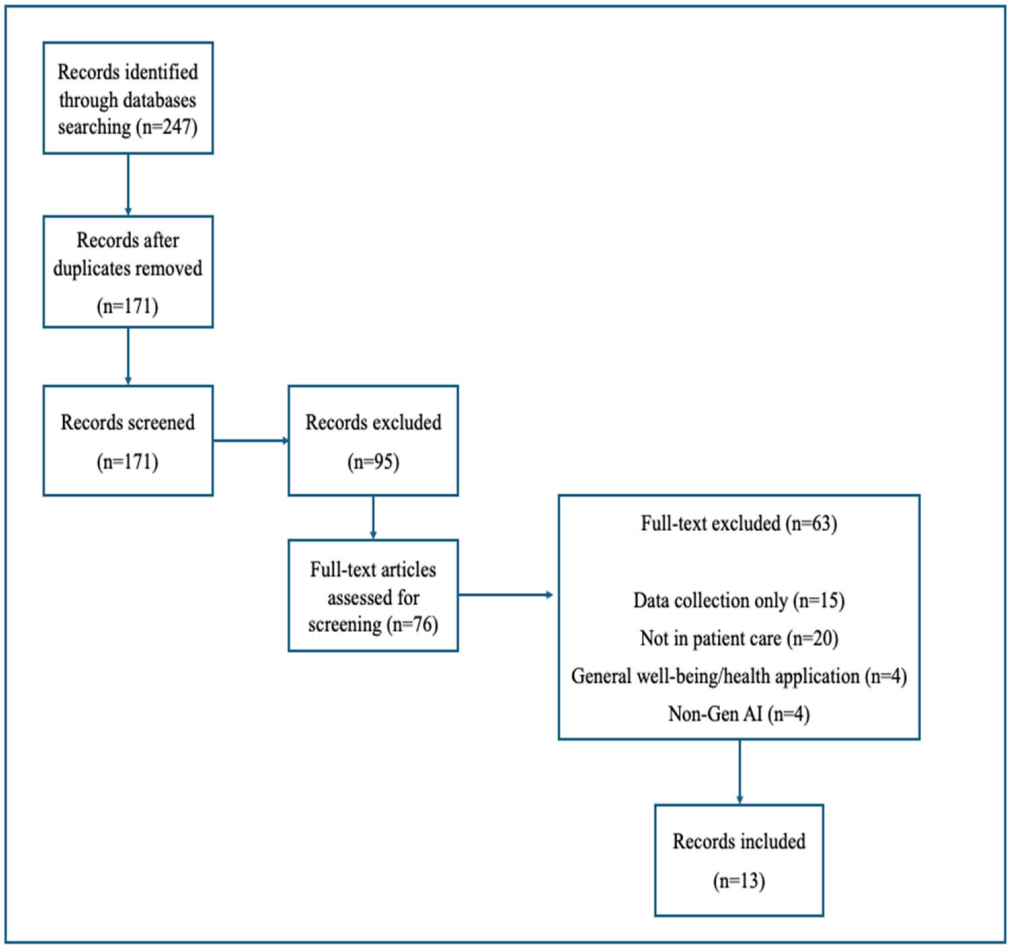

Figure 1. The article selection process.

Table 1. Categorization of the selected articles.

Year of Publication (2021–2024)	Reference(s)	Area of Application	The Ratio (%)
2024	[18]	Clinical decision support	1 (7.7%)
2023	[2–4,7,8,17,19–23]	Personalized treatment plans, digital pathology, natural language processing, clinical decision support	11 (84.6%)
2021	[16]	Clinical decision support	1 (7.7%)

3. Review of Generative Artificial Intelligence in Patient Care Applications

3.1. Recent Advancements in Generative AI in Patient Care

Gen AI, as a specific subset or application of AI, focuses on generating new information or data that are similar to its training examples. Gen AI techniques often involve training

deep neurula network models on large datasets and then generating new content, such as medical notes, images, or sound, based on the patterns and structures learned from the training data. While AI models cover a broader field of applications by incorporating various ML techniques for simulating human intelligence, the Gen AI models can create new, original content by extrapolating from the patterns they have learned, sometimes producing outputs that are novel and different from human perception. Therefore, Gen AI holds considerable potential to transform patient care across various healthcare domains. Studies [8,26–31] included in this review underscore several healthcare domains where the role of Gen AI in enhancing patient care has garnered significant interest and demonstrated promising results, as outlined below:

(a) Personalized treatment plans or precision medicine: Gen AI can analyze a patient's medical history, genetic information, and other relevant data to generate personalized treatment plans. This ensures treatments are tailored to individual patient characteristics, improving efficacy and minimizing side effects. A study by Zhang et al. [2] examined how Gen AI produces factually precise and contextually significant structured-discussion feedback, showing that Gen AI algorithms can be deployed to support laboratory diagnostics, public health outbreak management, and clinical decision support tools [2–4];

(b) Automated tasks and documentation: Natural language processing capabilities of the Gen AI models can help analyze unstructured clinical notes and medical literature to extract valuable insights. This helps healthcare professionals stay informed about the latest research and make evidence-based decisions, thus releasing clinician time from these trivial tasks and letting the clinicians focus on higher-level tasks such as decision-making or direct patient interactions [5–9];

(c) Early disease detection using wearable and IoT devices: Generative AI can analyze diverse data sources, including electronic health records, wearable device data, and patient-reported symptoms, in order to identify patterns indicative of early disease onset. This enables early intervention and improved outcomes. The Internet of Things (or Internet-connected things) has attracted many applications and sectors for producing results efficiently, and these devices are generating a lot of data (vast data) which can be used for further prediction/forecast by Gen AI models [10–12]. Moreover, safeguarding the 'false positives' through the robust validation process is also key for enabling PPCPs;

(d) Clinical decision support (CDS): Generative AI can assist healthcare professionals by analyzing complex patient data and recommending optimal treatment options based on the latest medical research and patient-specific factors. This supports more informed decision-making, using NLP, contextual understanding, and free-text analysis [5,10–12]. On the other side, the Gen AI models require rigorous evaluation, training data, and adherence to healthcare regulations to simplify complex medical language into summaries that patients can understand [6,10,13–15]. Also, other types of AI assistance available are Shadow AI (with partial AI automation and/ or full AI automation) as this embeds into an organization's clinical decision support (CDS) framework to mitigate against the validation challenges.

Other areas are predictive analytics, chatbots for symptom triage, genomic data analysis, health and wellness education, and support services [6,10,13–20].

These are a few areas of high impact and versatility of Gen AI in improving patient care, ranging from personalized treatments to advanced diagnostic support and remote healthcare solutions. As the technology continues to evolve, more innovative applications are likely to emerge, further enhancing the impact of Gen AI in healthcare [5]. Table 2 summarizes the reviewed articles, highlighting the main aim/area of each study, tools/techniques used, and study outcomes.

Table 2. Summary of the reviewed studies.

Reference	Area of Study	Objectives	Outcomes
Grupac et al. [15]	"Generative AI-based Treatment Planning in Clinical Decision-Making, in Precision Medicine, and in Personalized Healthcare"	Examine how Gen AI can assist physicians and patients by inspecting complex datasets and producing personalized treatment recommendations	The study found that the deployed models produced significant structured discussion feedback to key clinical questions
Zhang et al. [2]	"Generative AI in Medicine and Healthcare: Promises, Opportunities and Challenges"	Presented a selection of representative examples of Gen AI applications in medicine and healthcare	As Gen AI evolves and gets better tailored to the unique settings and requirements of the medical domain and as the laws, policies, and regulatory frameworks surrounding its use start taking shape
Duffourc et al. [18]	"Generative AI in Health Care and Liability Risks for Physicians and Safety Concerns for Patients"	Generative AI is being heralded in the medical field for its potential to ease the long-lamented burden of medical documentation by generating visit notes, treatment codes, and medical summaries	Physicians and patients might also turn to Gen AI to answer medical questions about symptoms, treatment recommendations, or potential diagnoses; while these tools may improve patient care, the liability implications of using AI to generate health information are still in flux
Wachter et al. [1]	"Will Generative Artificial Intelligence Deliver on Its Promise in Health Care?"	Gen AI has unique properties that may shorten the usual lag between implementation and productivity and/or quality gains in health care.	The ability of Gen AI to rapidly improve and the capacity of organizations to implement complementary innovations that allow IT tools to reach their potential are more advanced than in the past
Zaballa et al. [3]	"Learning the progression patterns of treatments using a probabilistic generative model"	To identify distinct subtypes of treatments for a given disease and discover their development and progression	The proposed model can be seen as a tool for classification, simulation, data augmentation, and missing data imputation
Paladugu et al. [6]	"Generative Adversarial Networks in Medicine: Important Considerations for this Emerging Innovation in Artificial Intelligence"	There is a necessity for framework regulations to ensure equitable and safe deployment of technology. Generative adversarial networks (GANs) are emerging ML techniques that have immense applications in medical imaging	As observed with its other AI predecessors, considerations must be taken into place to help regulate its development for clinical use; in this paper, we discuss the legal, ethical, and technical challenges for future safe integration of this technology in the healthcare sector
Kannan Nova [8]	"Generative AI in Healthcare: Advancements in Electronic Health Records, facilitating Medical Languages, and Personalized Patient Care"	The authors propose a technical framework for utilizing Gen AI to listen to conversations during healthcare appointments and generate concise summaries for inclusion in EHRs	The study explores the utilization of Gen AI for personalized care recommendations using data from smartwatches and wearables; its technical sequence flow encompasses data collection, data transfer to the cloud, data preprocessing, data analysis with Gen AI, personalized care recommendations, delivery of recommendations, user interaction, and feedback

Table 2. *Cont.*

Reference	Area of Study	Objectives	Outcomes
Ooi et al. [7]	"The Potential of Generative Artificial Intelligence Across Disciplines: Perspectives and Future Directions"	Gen AI utilizes machine learning, neural networks, and other techniques to generate new content (e.g., text, images, music) by analyzing patterns and information from the training data	The current article brings together experts in a variety of fields to expound and provide multidisciplinary insights on the opportunities, challenges, and research agendas of Gen AI in specific industries (i.e., marketing, healthcare, human resources, education, banking, retailing, the workplace, manufacturing, and sustainable IT management)
Arora et al. [22]	"Generative Adversarial Networks and Synthetic Patient Data: current challenges and future perspectives"	Gen AI, including generative adversarial networks, is a newer type of machine learning that functions to create fake data after learning the properties of real data	This study investigated three key uses of synthetic data: clinical research, data privacy, and medical education; we also highlight ethical and practical concerns that require consideration
Kanbach et al. [11]	"The Gen AI is out of the Bottle: Generative Artificial Intelligence from a business model innovation perspective"	This study provides a BMI perspective on Gen AI with two primary contributions: (1) the development of six comprehensive propositions outlining the impact of Gen AI on businesses, and (2) the discussion of three industry examples, specifically software engineering, healthcare, and financial services	This study employs a qualitative content analysis using a scoping review methodology, drawing from a wide-ranging sample of 513 data points
Blease and Torous et al. [19]	"ChatGPT and Mental Healthcare: balancing benefits with risks of harms"	Although Gen AI itself is not new, technical advances and the increased accessibility of large language models (LLMs) (e.g., OpenAI's GPT-4 and Google's Bard) suggest use of these tools could be clinically significant	The study examines the potential promise and the risks of using LLMs in mental healthcare today, focusing on their scope to impact mental healthcare, including global equity in the delivery of care
Gu et al. [32]	"Deep Learning in Automating Breast Cancer Diagnosis from Microscopy Images"	Using 12 combinations of deep learning model architectures (i.e., including five non-specialized and seven digital pathology-specialized model architectures), image data preprocessing, and hyperparameter configurations, the validation accuracy of tumor versus normal classification were calculated using the BreAst Cancer Histology (BACH) dataset	The DenseNet201, a non-specialized model architecture, with a transfer learning approach, achieved 98.61% validation accuracy compared to only 64.00% for the digital pathology-specialized model architecture
Javaid et al. [33]	"ChatGPT for Healthcare Services: An emerging stage for an innovative perspective"	This study briefs about ChatGPT and its need for healthcare, its significant workflow dimensions, and typical features of ChatGPT for the healthcare domain	ChatGPT can comprehend the conversational context and provide contextually appropriate replies; its effectiveness as a conversational AI tool makes it useful for chatbots, virtual assistants, and other applications

3.2. Literature Review of Gen AI-Based Patient Care Applications

This section provides an overview of key studies related to the use of generative artificial intelligence (Gen AI) in healthcare, covering various areas such as clinical decision-making, treatment planning, diagnostics, personalized care, and the challenges surrounding the implementation of AI-driven systems.

Grupac et al. [15] examined the application of Gen AI in treatment planning, clinical decision-making, and precision medicine. The study emphasized the role of Gen AI in assisting physicians and patients by analyzing complex datasets and offering personalized treatment recommendations. The deployed models were found to generate structured feedback to key clinical questions, contributing to improved decision-making processes. Wachter et al. [1] explored the potential of Gen AI to deliver on its promise in healthcare. The authors suggested that the rapid improvements in Gen AI, combined with organizations' ability to implement complementary innovations, could lead to productivity and quality gains in healthcare. Zhang et al. [2] reviewed the promises, opportunities, and challenges of Gen AI in medicine and healthcare. The paper highlighted that, as Gen AI evolves, it is becoming better suited to the unique demands of the medical domain. It also noted that the development of regulatory frameworks would be critical to ensuring the safe and effective use of these technologies in clinical settings.

Gu et al. [32] investigated breast cancer diagnosis using deep learning on the microscopy images. The study used the DenseNet201 model and compared 12 combinations (models, image data, and hyperparameter configurations) on the BreAst Cancer Histology (BACH) dataset. Duffourc et al. [18] explored the potential of Gen AI to alleviate the workload associated with medical documentation, including the generation of visit notes, treatment codes, and medical summaries. The study also highlighted concerns about liability risks for both physicians and patients when relying on Gen AI for medical advice and information, emphasizing the importance of addressing legal and safety considerations.

Paladugu et al. [6] discussed generative adversarial networks (GANs) in medicine, highlighting the importance of regulatory frameworks to ensure the safe deployment of this technology. The study emphasized the need for legal, ethical, and technical considerations for integrating GANs into clinical use. Kannan Nova [8] suggested a technical framework for integrating Gen AI into electronic health records (EHRs) and personalized patient care. The study emphasized leveraging Gen AI to capture healthcare conversations and produce summaries for EHR documentation, as well as utilizing data from wearable devices to provide tailored care recommendations. Zaballa et al. [3] investigated treatment progression patterns using a probabilistic generative model. The study aimed to identify distinct treatment subtypes for a specific disease and to analyze their development and progression. The results indicate that the proposed model has wide-ranging applications in classification, simulation, data augmentation, and the imputation of missing data, highlighting its potential to support diverse clinical use cases.

Ooi et al. [7] reviewed the potential of Gen AI across various disciplines, including healthcare. The paper presented a multidisciplinary perspective on the opportunities and challenges of Gen AI, with particular attention to its applications in industries such as healthcare, education, and finance. Arora et al. [22] investigated the use of generative adversarial networks (GANs) and synthetic patient data in clinical research, data privacy, and medical education. The study also highlighted the ethical and practical challenges that arise when using synthetic data in these fields. Kanbach et al. [11] provided a business model innovation (BMI) perspective on Gen AI. The study outlined six propositions regarding the impact of Gen AI on businesses and discussed its implications in industries such as healthcare, software engineering, and financial services. Javaid et al. [33] focused on the use of ChatGPT in healthcare, discussing its capabilities as a conversational AI tool. The study noted that ChatGPT 3.5 can comprehend conversational context and provide appropriate replies, making it valuable for applications such as virtual assistants and chatbots in healthcare services.

Finally, Blease and Torous et al. [19] focused on the use of large language models (LLMs) like ChatGPT in mental healthcare. The study explored the benefits and risks associated with LLMs, particularly their potential to influence global equity in the delivery of mental healthcare. Together, these studies highlight the diverse applications of Gen AI in healthcare and the ongoing challenges of ensuring safe, effective, and equitable deployment of these technologies in clinical practice [2,10,16,24,25].

4. Discussion

4.1. Opportunities and Challenges Related to the Use of Generative AI in Personalized Patient Care

Generative AI in healthcare offers substantial potential for enhancing personalized patient care, yet it also comes with its own set of challenges [7,8,29–31]. Here is the summary of the opportunities and challenges associated with the use of Gen AI in healthcare:

4.1.1. Opportunities

(a) Medical imaging: Gen AI models can improve the quality of medical imaging by generating high-resolution images, aiding in more accurate diagnoses and treatment planning;
(b) Natural language processing: Gen AI models excel in natural language processing tasks, enabling the analysis of unstructured data such as clinical notes, research papers, and patient narratives for better understanding of patient conditions, reducing medical errors, and enhancing treatment outcomes;
(c) Patient engagement and education: Gen AI models can generate personalized educational content for patients, providing them with relevant information about their conditions, treatment options, and preventive measures;
(d) Remote monitoring and telemedicine: Gen AI can enhance remote monitoring solutions, enabling healthcare providers to remotely track and analyze patient data, leading to more proactive and personalized care;
(e) Predictive analytics: Gen AI models can predict patient outcomes, helping healthcare providers identify high-risk patients and intervene early to prevent complications;
(f) Reducing healthcare costs: By improving the efficiency and accuracy of diagnoses and treatment plans, Gen AI has the potential to reduce healthcare costs associated with unnecessary tests, treatments, and hospitalizations.

4.1.2. Challenges

(a) Data privacy and security: Generative AI models often require access to sensitive patient data. Strong privacy and security measures are needed to protect patient information and meet regulations like HIPAA;
(b) Ethical considerations: The ethical use of Gen AI in healthcare, including issues related to bias, transparency, and accountability, must be carefully addressed to maintain trust and fairness;
(c) Interoperability of data: Healthcare data are often stored in disparate systems that may not easily communicate with each other. Achieving interoperability and seamless integration of data from different sources is a challenge;
(d) Validation and regulation: Gen AI models need rigorous validation and regulatory approval to ensure their safety, efficacy, and reliability before widespread clinical adoption;
(e) Explainability of models: Understanding the decisions made by Gen AI models is crucial for healthcare professionals. Ensuring the explainability of these models is a challenge, especially when dealing with complex neural network architectures;
(f) Integration with clinical workflows: Integrating Gen AI seamlessly into clinical workflows is challenging. The technology should complement existing practices without causing disruptions;

(g) Bias in data and models: If the training data used to develop Gen AI models are biased, the models can perpetuate or amplify these biases. Ensuring fairness in AI applications is an ongoing concern;
(h) User acceptance and adoption: Healthcare professionals and patients may be skeptical or resistant to adopting Gen AI technologies. Ensuring user acceptance and addressing concerns is crucial for successful implementation;
(i) Ongoing model maintenance: Gen AI models need continuous monitoring, updating, and refinement to adapt to evolving medical knowledge, changing patient demographics, and emerging healthcare trends.

Balancing these opportunities and challenges requires collaboration between AI developers, healthcare practitioners, regulatory bodies, and patients to create a framework that maximizes the benefits of Gen AI in healthcare while addressing ethical, privacy, and operational concerns.

4.2. Key Action Points for a Successful Generative AI in Personalized Patient Care Framework

Figure 2 states the key action points for a Gen AI in a personalized patient care framework. By prioritizing these key action points, healthcare organizations can establish a successful Gen AI framework for personalized patient care, leveraging AI technologies to improve clinical outcomes, enhance patient experiences, and advance healthcare delivery.

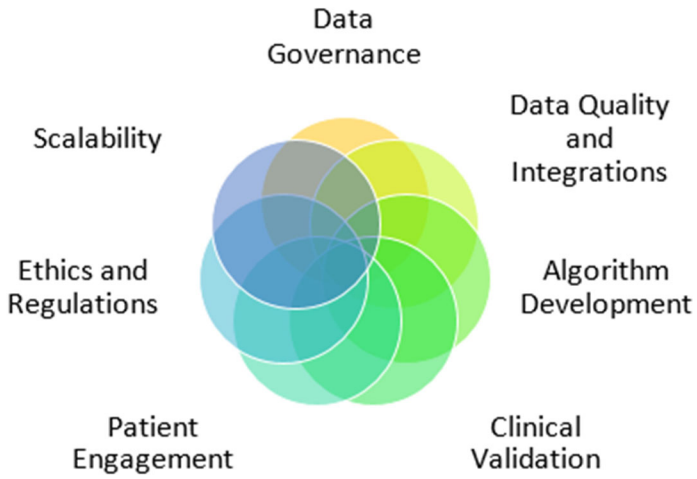

Figure 2. Key action points for a Gen AI in personalized patient care framework.

5. Conclusions, Key Issues, and Concerns

In conclusion, Gen AI holds significant potential for addressing challenges and barriers in healthcare, offering innovative solutions in various areas. From the review, we found some studies addressing how AI can help solve these issues:

Data accessibility and integration is addressed by aggregating and harmonizing disparate data sources, creating structured datasets from unstructured medical records and images. AI systems can create frameworks that integrate data from various electronic health record (EHR) systems, medical devices, and other health platforms, improving interoperability between systems [2,24,25].

Customized treatment plans are generated based on the genetic information, patient history, and lifestyle data to recommend personalized treatment options and custom therapies for diseases like cancer, diabetes, or rare genetic disorders. Healthcare data privacy and security are addressed by Gen AI models through data synthetization using synthetic datasets that mirror real patient data without exposing actual patient information, enabling research and AI training without compromising privacy. Moreover, applying AI-driven encryption techniques and federated learning models ensures that sensitive data are processed in a decentralized manner, without transferring patient data outside secure environments [17,19,23,26,31].

Key issues and concerns related to the use of Gen AI in healthcare are summarized in Table 3. Addressing these issues requires a holistic approach involving collaboration between AI developers, healthcare professionals, regulatory bodies, and patients. Developing frameworks that prioritize ethical considerations, patient privacy, and model transparency is crucial for the responsible deployment of Gen AI in healthcare [2,5,22,26,29].

Table 3. Summarizing key issues and concerns related to the use of Gen AI in personalized patient care.

Area	Studies in This Area	Issue	Concern
Data privacy and security	[10,21,34–36]	Generative AI often requires access to sensitive patient data. Ensuring the privacy and security of this data is challenging, especially given the stringent regulations in healthcare (e.g., HIPAA).	Unauthorized access, data breaches, and the potential for re-identification of anonymized data pose serious privacy risks.
Ethical regulations	[2,22,26,29]	The ethical implications of Gen AI, including biases in training data and decision-making processes, raise concerns about fairness and equitable treatment of diverse patient populations.	Ethical considerations regarding informed consent, algorithmic transparency, and the potential for unintended consequences in patient care.
Model interpretability	[2,9,23,29]	Many Gen AI models, especially complex deep learning architectures, lack interpretability. Understanding how the model arrives at a decision is challenging, impacting the trust healthcare professionals and patients place in the technology.	Lack of interpretability may hinder acceptance and hinder the integration of Gen AI into clinical workflows.
Bias and fairness	[37–42]	Generative AI models can inherit biases present in training data, leading to biased outcomes in healthcare decision-making.	Biases may disproportionately affect certain demographic groups, potentially exacerbating existing healthcare disparities.
End-user (patient) trust and confidence	[41]	Patients may be skeptical or hesitant to trust AI-driven technologies with their healthcare data and decisions, particularly if they perceive a lack of transparency or understanding of how the technology works.	Low patient trust may impede the adoption and effectiveness of Gen AI applications in healthcare.
Clinical workflow integration	[1,16,27,29,30,32,42]	Integrating Gen AI models into existing clinical workflows is challenging. Healthcare professionals may face disruptions in their routines, and the technology may not seamlessly align with established practices.	Resistance to change, workflow interruptions, and the need for additional training can hinder successful integration.
Resources and tools	[26,29,41]	Developing and maintaining Gen AI models, especially those that require large datasets and computational resources, can be resource-intensive.	Limited access to resources may hinder the implementation of Gen AI in healthcare, particularly in smaller or resource-constrained healthcare settings.

Table 3. *Cont.*

Area	Studies in This Area	Issue	Concern
Explainability and interpretation	[2,9,23,29]	Communicating AI-generated decisions to patients in a comprehensible manner can be challenging. Patients may find it difficult to trust or accept recommendations they do not understand.	Lack of transparency and communication may lead to patient dissatisfaction and reluctance to follow AI-generated recommendations.
Validation	[3,10,17,21]	There is a lack of standardized validation methods for Gen AI models in healthcare. Regulatory frameworks may struggle to keep pace with the rapid advancements in AI technology.	Inadequate validation may result in the deployment of models that have not been rigorously tested, potentially leading to errors in diagnoses and treatment recommendations.

Bias and fairness in Gen AI models are of key interest and applicable to the wider and broader application beyond health and well-being. Gen AI tools can audit datasets and models to detect and correct biases related to gender, race, socioeconomic status, or other demographic factors. These AI tools can also be used to continuously improve fairness in healthcare decisions. Interpretability of the model is critical, ensuring that healthcare professionals understand how AI-driven decisions are made, fostering trust and accountability [3,17,18,31].

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Conflicts of Interest: Authors Mirza Mansoor Baig and Chris Hobson were employed by the company Orion Health. The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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