

Analysis Theories on Artificial Intelligence, ChatGPT, Data Science, and Metaverse: The Case of Digital Medicine

Yin Yang

<https://orcid.org/0000-0003-0162-5611>
West China Hospital, Sichuan University, China

Xingyun Liu

West China Hospital, Sichuan University, China

Jorge Luis Cuyubamba Dominguez

<https://orcid.org/0009-0000-0641-2717>
West China Hospital, Sichuan University, Peru

Yuan Fang

<https://orcid.org/0000-0003-2676-3957>
West China Hospital, Sichuan University, China

Wen Xie

<https://orcid.org/0009-0009-8448-0569>
West China Hospital, Sichuan University, China

Bairong Shen

<https://orcid.org/0000-0003-2899-1531>
West China Hospital, Sichuan University, China

Keng Leng Siau

<https://orcid.org/0000-0001-8139-4467>
Singapore Management University, Singapore

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ABSTRACT

Healthcare organizations are increasingly adopting digital technologies, with Artificial Intelligence (AI), Data Science, and the metaverse driving significant advancements in smart healthcare. AI facilitates personalized medicine and efficient drug development, while Data Science enables predictive analytics and big data management, enhancing patient outcomes and healthcare quality. The metaverse introduces immersive training and telemedicine platforms, revolutionizing patient engagement and healthcare research. This study conducts a scoping review of 6,171 articles, analyzing the transformational impact of AI, ChatGPT, Data Science, and the metaverse on healthcare. It highlights the benefits and risks of these technologies, identifies research gaps in their application within the healthcare field, and proposes new directions for advancing digital medicine. By exploring these developments, the research provides insights into the continuous evolution of healthcare through innovative digital solutions.

KEYWORDS

Digital Medicine, Digital Transformation, Smart Health, Artificial Intelligence, ChatGPT, Data Science, Metaverse

INTRODUCTION

Artificial intelligence (AI), data science, and the metaverse are transforming the digital medicine and digital healthcare industry. Digital medicine encompasses the use of advanced technologies such as AI, data science, metaverse, and machine learning to enhance healthcare delivery and improve healthcare quality. A more efficient and effective healthcare system benefits all stakeholders, from doctors and patients to healthcare organizations and governments. Many healthcare systems worldwide

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are undergoing rapid digital transformations (Kaplan, 2025). For example, the Obama administration announced in 2009 that the development of electronic health records (EHR) would be a strategic policy and allocated \$27 billion to formulate this strategy. On the one hand, advanced technologies are a crucial aspect of the future development of digital medicine and the core driving force of future medical advancements (Lund et al., 2025). On the other hand, the advancement of technologies poses challenges and threats. This study looks at three advanced technologies, AI, generative AI (GenAI), data science, and the metaverse, and develop analytic theories for these in the areas of digital medicine and digital healthcare.

AI

AI is a broad field that encompasses any technology enabling machines to mimic human behavior (Li et al., 2024; Ma et al., 2024; Raman et al., 2025). Within this vast field, GenAI, such as Chat Generative Pre-trained Transformer (ChatGPT), Sora/Sora 2, and DeepSeek, is currently one of the most significant AI technologies (Nehaa et al., 2025). GenAI is a branch of AI that creates new content by learning from data (Siau, 2025). It uses models like generative adversarial networks and variational autoencoders to generate original outputs, including text, images, and music. ChatGPT 4, developed by OpenAI, was officially released on March 14, 2023. Sora, a text-to-video GenAI, appeared in December 2024. DeepSeek-R1-0528, from a Chinese AI company, was made available on May 28, 2025.

With the rapid advancement of AI, it has also become prominent in healthcare, especially in disease diagnosis, personalized treatment, medical data analysis, image processing, and telemedicine. For example, Google DeepMind's eye disease diagnostic system uses deep learning technology. The AI system developed by DeepMind can analyze eye scan images and accurately detect eye diseases such as diabetic retinopathy and glaucoma (Ejaz et al., 2025). Another example is Insilico Medicine, which accelerates the drug discovery process using AI and deep learning technology, particularly making significant progress in developing drugs for age-related diseases and cancer (May, 2025).

Although the advancement of AI has many benefits in digital medicine and digital healthcare, it is not without concerns. In 2023, President Joe Biden issued an executive order on AI, focusing on risk management, transparency, and responsible innovation. The Bletchley Declaration, signed by 28 countries and the EU, emphasizes safe AI development, human rights, and long-term risks, with plans for an AI Safety Institute (Riedl, 2025). In early 2024, the U.S. Department of Health and Human Services announced a new strategic plan to promote the safe, effective, and equitable application of AI technology in the healthcare system.

Currently, key directions for AI in healthcare include revolutionizing diagnostics through advanced image analysis and pattern recognition to enable earlier and more accurate disease detection; leveraging genomics and real-world patient data to personalize treatment plans, optimize therapeutic strategies, and predict individual responses; and significantly accelerating drug discovery and development by reducing both time and costs (Matheny et al., 2025). Machine learning is another rapidly emerging area in digital healthcare. For example, a meta-explainable machine learning method employs a two-stage model with an explainable boosting machine and unsupervised learning to analyze maternal health data for identifying critical features. This approach optimizes medical resource allocation, enhances targeted interventions, and demonstrates global applicability for significantly improving public health outcomes and resource efficiency (Patel, 2025).

Data Science

Data science is an interdisciplinary field that employs scientific methods, algorithms, processes, and systems to extract, analyze, and interpret valuable information from large datasets (Ahmed & Hafeez, 2025). It integrates technologies such as statistics, computer science, data analysis, and machine learning to extract knowledge and insights from complex structured or unstructured data, thereby supporting improved decision making (Arora et al., 2025). For instance, prior studies have

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