



Editorial

The metaverse in cancer care: Applications and challenges



Cancer is a global pandemic affecting nearly 30 million people worldwide and imposing a considerable human and economic burden.¹ A new paradigm of cancer care is required to reduce heavy care burden; one possible solution may be embracing artificial intelligence technologies to drive fundamental change in cancer care. The metaverse incorporates cutting-edge artificial intelligence technologies via an emergent amalgamation of augmented reality, virtual reality, and mixed reality, cloud computing techniques, blockchain, and 5G/6G wireless communication networks.^{2,3} Hence, the metaverse may be the “new paradigm” and the “next frontier” of cancer care.⁴

What is the metaverse?

The concept of the metaverse has been widely discussed since 2021, particularly after the announcement of “Facebook” changing its company name to “Meta”. Currently, there is a lack of a comprehensive definition of the metaverse. It is loosely defined as a broad term for a shared virtual environment accessed by individuals via augmented reality, virtual reality (VR), mixed reality, and extended reality, running on the Internet, and using blockchain.⁴ Others believe that the metaverse is a ternary digital world established on the basis of digital technology integrating the virtual and real worlds, which people enter with digital identities.⁵ The metaverse has numerous potential applications in cancer care, ranging from immersive VR therapy for cognitive assessment and rehabilitation⁶ to digital evaluation of drug interactions.⁷ Overall, the metaverse is considered to be the next-generation mobile computing platform.⁸

Potential applications of the metaverse

An expert panel listed the potential applications of the metaverse in medicine, including eighteen potential scenarios. The following clinical applications are worthy of attention in cancer care: clinical research, healthcare, physical examination, self-care, diagnosis and treatment of disease, drug and device therapy, surgical treatment, hospital management, pharmacy, quality control in medicine, and disease prevention.⁵ To be more specific, applications of the metaverse to cancer care could be in the areas of surgical treatment and cancer rehabilitation. For example, Johns Hopkins neurosurgeons using Augmedics headsets removed a cancerous tumor from a patient's spine.⁸ This review also stated that the application of VR to rehabilitation practice improved patient outcomes.⁸ For instance, Zeng *et al.* applied immersive VR to cognitive rehabilitation for patients with cancer and reported promising results in a pilot clinical study.⁶ The metaverse could also give rise to new dimensions of telemedicine services in cancer care by enabling avatar-based patient–doctor

consultations inside virtual rooms, regardless of the location of the participants.⁹ By leveraging the strong visualization and navigation capabilities of augmented reality/VR technologies, it can introduce new approaches to delivering health education in cancer care for clinicians and patients via accessible 3D anatomical images.⁸ Certainly, more application scenarios of the metaverse in cancer care need to be explored and carried out.

Ethical and legal challenges of the metaverse

While oncologists would work better with the help of the metaverse, especially surgeons, many ethical and legal challenges draw attention to data security and regulatory concerns regarding the use of AI technologies.³ Murtha³ pointed out that the metaverse relies on the capability of sharing data across systematic, institutional, and national lines, which will increase the risk of cyber-attack. Using blockchain technology, however, can partially solve the issue of data privacy and security in cancer care.¹⁰ The blockchain is the digital key to the metaverse, as it is a distributed, decentralized ledger of information held across multiple users to maintain immutable records for users.¹¹ The key characteristic of blockchain for data security is its utilization of non-fungible tokens as a security asset and an immutable and unique unit for recording patient data.⁹ Certainly, the application of non-fungible tokens to electronic health records is still in its infancy. In addition, traditional aspects of healthcare require person-to-person relationships between healthcare professionals and patients, especially in cancer care, as “oncology is an area of medicine where human contact and empathy are essential.”¹² In consequence, the metaverse in cancer care could possibly disrupt the traditional clinician–patient relationship.³ One of the keystones of the successful use of the metaverse in cancer care may therefore be the utilization of haptic technology to partially compensate for the lack of human contact, as haptics can apply vibrations to users' skin to mimic real physical touch.¹¹

Implications for nursing

In the past two decades, nurses have adapted their workload and practice to the influx of data resulting from the introduction of clinical information systems, electronic medical records, and integrated medical equipment and support systems.¹³ With fast technological advancement, the evolutionary shift is moving beyond implementing new systems to capture clinical data, building a whole new type of relationship between nurses and technologies. In the near future, nurses will need to have a partnership with the metaverse, which will open unlimited innovative solutions to problems regarding efficiency, capacity, and quality of

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cancer care.¹³

In conclusion, by utilizing cutting-edge AI technologies, there is huge potential for the metaverse to transform cancer care and to offer new frontiers over the spectrum of cancer prevention, treatment, and rehabilitation.

Declaration of competing interest

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