The metaverse in the world of health: The present future. Challenges and opportunities

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ABSTRACT

The World Health Organization has defined "digital health" as the use of information and communication technologies to improve health. In recent years, there has been a strong acceleration in the adoption of these digital tools, which has had a major impact on traditional healthcare models.

We are currently witnessing the emergence of a large immersive virtual environment called the "metaverse." Its emergence creates new and challenging opportunities in health care. This article explores some metaverse-related concepts, provides specific examples of its use in pediatrics, describes experiences in the hospital setting, and finally delves into the resulting challenges and opportunities.

Keywords: metaverse; health; pediatrics; virtual reality; augmented reality.

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INTRODUCTION

A decade ago, although mobile cloud computing was just beginning and artificial intelligence seemed like science fiction, the pervasiveness of the Internet in everyday life was significant. However, having a medical consultation without leaving home was inconceivable.

The World Health Organization has established that "digital health" means the use of information and communication technologies to improve health.[1] In recent years, this process has been facilitated by a significant acceleration in the pace at which digital tools are adopted in medical practice, either in relation to telemedicine, prescriptions, or appointment scheduling. As a result of the pandemic, the digital transformation has had a major impact on traditional healthcare models.[2]

We are currently witnessing the emergence of a large immersive virtual environment called the "metaverse." Its emergence creates new and challenging opportunities in the healthcare field to move from a two-dimensional virtual care model to a three-dimensional experience. Interaction may therefore take place through body movements, language, gestures, and this improves the experience: it feels like really being there.[3]

In turn, innovation implies disruption, and any change leads to expectations and fears. In this article, therefore, we propose to review some concepts on Internet advances in the field of health care and the potential interactions in the near future.

WHAT IS THE METAVERSE?

The concept was first described in 1992, in Neal Stephenson's science fiction novel *Snow Crash*. The characters in *Snow Crash* became avatars (virtual representations of themselves) and worked in a three-dimensional virtual reality that was called the metaverse, a play on the words *meta* (what lies beyond) and *universe*.[4]

Specifically, nowadays the metaverse refers to any virtual space that emphasizes the creation of immersive environments as part of a developing ecosystem. While wearing special goggles, one interacts through an avatar to live the full experience, being a participant of the environment.

The complexity of the metaverse as a phenomenon enables its approach in multiple dimensions of analysis. From a functional perspective, the metaverse integrates access to information, social media, and game elements. From a technical perspective, it is a virtual reality technologies complex. Socially, it is a space where anyone who inhabits it leaves traces in their daily and financial life.[5,6]

Specific terms are used in the context of the metaverse. For the purposes of this article, below we describe some concepts that emerge from various studies on this matter.[7–10]

Virtual reality

It consists of the creation of an environment of real-looking technology-generated scenes and objects that makes the user feel immersed in it. This environment is viewed through a virtual reality device, glasses, or headset.

In pediatrics, virtual reality is being used, for example, for pain and stress management through distraction. Directing the attention to a virtual world decreases the processing of pain signals by the brain.[10]

Augmented reality

It is a type of real-world augmentation. The real world is visualized through a technological device that adds contextual graphical information related to the user's location or environment to augment existing information.

There are T-shirts that allow navigating the circulatory, respiratory, and digestive systems with fully immersive videos.[11]

Life tracking

It is a type of inner world augmentation that refers to the process of tracking and recording several aspects of daily life through the use of smart devices. For example, data on daily activities, exercise, diet, sleep, and even emotional states are stored.

Sensors that record exercise or location through wearable devices capture biometric information and use it in wellness and fitness apps. Some devices are designed especially for children with tailored features and functions.[12]

Mirror world

It is a type of digital replica of the real world, a virtual model enhanced with information from the real world.[13] The appearance, information, and structure of the real world are transferred to virtual reality as if reflected in a mirror.

During the pandemic, it was widely used in school settings to simulate educational

environments, the classroom, teachers, other students, contents, and academic material.

Robotics

Robotics can be defined as the discipline that encompasses several technological sciences (engineering, computing, biomechanics, physics) to develop robotic machines capable of performing automated tasks or simulating human behavior.

The use of robotics in the metaverse makes it possible to enter the patient's virtual body during surgery and perform high-precision procedures. The first pediatric metaverse surgery was performed in Brazil (see section "Current experiences").[14,15]

DATA FUSION: DIGITAL IDENTITY AND MEDICAL RECORDS

In recent years, we have observed that a patient's information may be integrated from various sources (wearables, mobile apps, etc.) to build a more robust, updated, and well-stocked medical profile. In this regard, the metaverse offers an unparalleled opportunity, as it would be a natural "integrator" of all the information generated, both from the medical point of view and from the data that is recorded as it passes through this virtual environment.

The new virtual environments would connect all users (healthcare providers, patients, and service providers) through information integration. This implies that data collection is no longer limited to history taking by the healthcare provider; instead, social media, search engines, and mobile apps would be a new permanent source of information to complete medical records.

HAPTIC DEVICES

Moreover, the metaverse would open up the possibility of using devices that are responsible for highlighting tactile responses. These are called haptic devices and they would allow physical interaction with objects in the virtual space, that is, not only to show the avatar using an instrument, but also to awaken the physical sensations experienced in real life. These interactions would create a more compelling immersive experience with perceptions indistinguishable from the real thing.

CURRENT EXPERIENCES

In Hospital Infantil Sabará (Brazil), a brain tumor biopsy was performed recently, which was considered the first pediatric surgery performed in the metaverse. The model patient was a hyper-realistic 3D-printed phantom. The procedure was assisted by an avatar that guided providers during the surgery. For this, the entire healthcare team used a virtual reality device that allowed them to have a permanent interaction in the real environment using gestures and voice.[14]

Meanwhile, in the Department of Pediatrics of Severance Children's Hospital (Korea), a virtual reality environment was placed on a screen on the vaulted ceiling and a study was conducted to measure the impact on the pain scale during the insertion of intravenous lines in children. A significant reduction in overall pain scores was observed. This means that this method may be an effective distraction to reduce distress during the procedure.[16]

In addition, the Boston Children's Hospital implemented a virtual reality platform to explain complex medical conditions to children. This tool uses 3D images to illustrate, for example, the gastrointestinal tract in an immersive tour. Thus, it easily recreates the real endoscopic procedure of a patient and allows to explain conditions in an educational and entertaining manner.[17]

OPPORTUNITIES AND CHALLENGES OF THE METAVERSE

While the transfer of personal health data to social networking platforms is a very promising route of development, the healthcare industry is moving slowly towards the acceptance, promotion, and implementation of the emerging information technology. In this regard, there is a component of varying degrees of change aversion from the medical institutions themselves, but also a problem with the regulatory framework.

In addition, the implementation of a new technology requires a careful consideration of its impact. The opportunities and challenges of the metaverse development currently involve multiple intricate aspects to solve, such as the technology itself (interoperability, portability, stakeholder customization), laws and regulations, and human factors that already exist in other areas of digital health technology developments (skills, resistance, distrust, cyber attacks).[18–20]

MAIN OPPORTUNITIES[21,22]
• A new concept of access to health

The metaverse uses technology to enable patients and healthcare providers to take the lead in the development of the platform. Similar to what

happened in the online health communities, we believe that the metaverse in health care could gradually tend to the establishment of a secure, trusted, and patient-centered environment to effectively address patients' needs. Thus, it has been estimated that the app scenarios in medicine could be expanded and completely reshaped.

• An innovative experience of interaction with your own data

Data entry using speech and transformed to text is the obvious way to replace typing. This feature could also be used to trigger commands instead of using a menu in the virtual reality environment, which would turn the traditional data upload experience into a more dynamic and agile process.

• Medical practice transcends geographic boundaries

The limitations to access a specialist consultation anywhere in the world are becoming increasingly blurred, for both physician-patient encounters and for exchanges among healthcare providers. This offers a very encouraging outlook in terms of breaking down access barriers, especially when they involve costly travels.

In addition, this new space poses some challenges and unresolved issues to be taken into account:

• Technological barriers

Working together with colleagues around the world is a key feature of the metaverse concept and will require the communications infrastructure to reach high standards. A major barrier is that healthcare systems use different technologies that often do not communicate with one another, a problem that has also slowed the advances in the implementation of electronic medical records and patient portals.

• Safety and privacy

The metaverse, with massively connected devices and people, will inevitably generate significant gaps in terms of safety, raising questions about what surveillance measures could ensure proper navigation. Such risks threaten the personalized nature of the physician-patient relationship. For this reason, patient safety and privacy raise concerns involving personal, public, and societal aspects. The countless amount of data generated and shared by users around the world cannot be permanently verified.

NEXT STEPS AND CONCLUSIONS

The metaverse has been proclaimed as the next computing platform and the future of the Internet, aiming to achieve the integration of the digital and physical worlds. Once again, technology appears as the leading figure in this transition. In this regard, we are still taking the first steps to achieve its implementation in the medical and healthcare fields. As data sets grow in size, it will be necessary to generate experiences from local systems with very powerful storage and processing capabilities, or directly from the cloud. This will probably require a better infrastructure than the one we have today. Existing platforms are still far from providing the adequate and secure framework for an ideal healthcare metaverse.[18]

Just as social, cultural, and economic activities are moving toward this new platform, most likely the metaverse will bring about changes in our daily lives and economy, beyond the realm of games and entertainment.

However, further studies are still needed to explore the transition from 2D to 3D experience, so that it is user-friendly and adequately used. Once access to large multidimensional visualizations is achieved, it will be necessary to understand how human-computer interaction works to ensure that people remain at the center of the systems we develop.

We are living in a pivotal moment that offers a great opportunity. Healthcare providers must keep up to date and, in this way, we will be able to become the leading figures and designers of this new era in patient care. ∎

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