

Chapter 6

The Virtual Revolution of Digital Twins in Chronic Healthcare Management

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ABSTRACT

The introduction of digital twin technology is transforming chronic disease management and ushering in a new era of precision medicine and proactive care. The concept of the digital twin is a virtual representation of a physical entity that uses real-time data to provide a comprehensive and up-to-date health status of the patient. In the context of chronic disease management, these digital counterparts allow healthcare providers to monitor the patient in real-time, predict disease progression and develop personalized treatment strategies. This paradigm shift enables patients and physicians to move from reactive to predictive and preventive care. The integration of the digital twin into chronic disease management is not without its challenges. Issues such as data privacy, interoperability and the need for a robust computing infrastructure need to be addressed to realize its full potential. By fostering collaboration between healthcare providers, this innovation can redefine the future of

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healthcare and deliver more effective solutions for chronic disease management.

1 INTRODUCTION TO DIGITAL TWINS IN HEALTHCARE

The Digital Twin, an insight from engineering and manufacturing, has extended its reach to healthcare, where it is extremely valuable. In other words, a Digital Twin is an accurate simulation of an actual object or system. It can be updated with real-time data at any time. In healthcare, this technology enables the accurate creation of models of patients, organs, medical devices or even hospital systems, where knowledge can be augmented by dynamic data inputs. Digital Twins expand the possibilities for using data-driven solutions by combining new computational models, sensor data and patient histories in one system to enable new approaches such as personalized and predictive medicine as well as surgery optimization (Croatti et al., 2020).

A more compelling use of Digital Twins in healthcare is the understanding of personalization in the medical field. This allows clinicians to use virtual patient models to assess the outcomes of different approaches – disease progression, drug efficacy, or surgical interventions – without actually putting the patient’s life at risk. The case of the heart, for example, a Digital Twin helps cardiologists to assess how certain treatments for a particular condition will work in the real world. This also makes treatment more accurate and safer from the patient’s perspective because trial and error is radically reduced (Awasthi et al., 2025). They can also help in the management of chronic diseases as they are constantly informed about the patient’s current status. Apart from the patient level, the concept of Digital Twins is also transformative at the system level of healthcare applications. They can use Digital Twins to understand the distribution of resources, predict problems at large scale and improve the operational performance of acute care facilities. As with medical devices, the Digital Twin allows both the manufacturer and the healthcare provider to monitor device performance, identify potential or emerging issues, proactively schedule maintenance, etc. Using these capabilities and new developments such as Artificial Intelligence (AI), Internet of Things (IoT) and blockchain, the Digital Twin creates a stable environment for real-time decision-making and new developments in healthcare.

One of the strongest sides of the Digital Twin is the ability to examine vast amounts of individual patient data collected by smart wearable devices, and IoT instruments. All of this information is then exposed to drive scientific methodologies that lead to recommendations that are as practical as they are personalized to the patient’s profile. For diseases such as diabetes, cardiovascular disease, and cancer, different forms of treatment can be modeled to perform clinical assessments regarding their

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