# Chapter 3
# Digital Twins in Healthcare:
## Addressing Concerns and Meeting Professional Needs

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## ABSTRACT

*Digital twin is the virtual representation of a physical system that processes information from its physical counterpart's environment, used to predict, simulate, and validate the physical system's future behaviour. Digital twin system, being an emergent technology, has seen implementations in a wide array of industries such as smart cities, engineering, etc. In healthcare, the digital twin technology shows great promise to improve various areas such as patient care, virtualization of hospital spaces, etc. There are concerns regarding patient data confidentiality, patient safety, accuracy and reliability, avoidance of bias, etc. These concerns can be combated only through thorough feedback from system experts, i.e., healthcare professionals. This chapter aims to provide valuable insights into the different needs of healthcare professionals while implementing digital twin systems in aiding diagnosis, treatment planning, patient monitoring, and collaboration among different specialty teams all while dealing with concerns regarding patient data security and sampling bias.*

## 1. INTRODUCTION

In 2019, B.R. Barricelli et al. compiled the a set of definitions of Digital Twins, A physical machine or virtual model that replicates, mimics, mirrors, or "twins" the life of a physical thing is called a digital twin. Out of the starting set of 75 papers that the literature survey included, the four main application domains were: Manufacturing (38), Aviation (22), Hospital Management (2) and Precision Medicine

(15), where two papers come under both aviation and manufacturing domains. There were 29 unique definitions of Digital Twins in the 75 papers, whose main ideas were: (1) Digital twins are integrated systems,(2) The physical twins and the digital twins are counterparts of each other,(3) Data and information are the ties that link the twins together,(4) The digital twin is an information construct of the physical twin and lastly (5) The digital twin is a safe area to experiment and test the potential change on the performance of the system. Figure 1 depicts the abstract concept of digital twins where the physical and digital counterparts exchange information.

*Figure 1. High Level Diagram of Digital Twins*
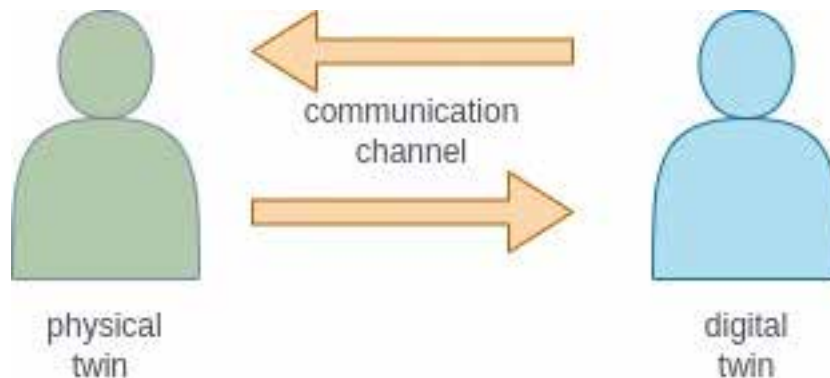


The two main categories of Digital Twins with respect to healthcare are Digital Twins catered to Individuals and Digital Twins catered to some demographic.

## 1.1 Digital Twins for Individuals

Targeting the disease before it arises and, if prevention is not possible, treating it individually or tailored is a key objective of precision medicine (Ying Liu et al., 2019). Smart medical equipment can be used to continuously gather several types of data, including service, medical, and patient data. This results in the shift to continuous and individualized healthcare.

A patient's digital twin can be produced on several levels, Several different treatments and interventions can be simulated using a full-body DT, which enables the prediction and avoidance of any issues or unfavorable reactions (Wang Erdan et al., 2023). DT allows for a thorough examination of how bodily systems, including as the neurological, urinary, and digestive systems, function and interact with one another. The study of many use cases related to these systems, such as neurological problems using a digital twin of the nervous system, may benefit from an understanding of how these systems function. When it comes to organ-specific therapies like transplants, surgeries, drug regimes, etc., digital twins at the organ level include modeling of different organs like the heart, lungs, etc. At the most basic level, deep learning (DT) can be used to mimic bodily molecules and cells. This can be especially useful for assessing the body's reaction to drugs and searching for genetic differences that may contribute to the development of disease.

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