Current State and Strategy for Establishing a Digitally Innovative Hospital
- Memorial Review Article for Opening of Yongin Severance Hospital -

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The emergence of new technologies, especially digital transformation, influences the entire society, including the medical aspects. Therefore, the concept of digital hospital has been emerging. Here we present the Yongin Severance Hospital, which has developed various novel solutions to serve as foundations for the establishment of a digitally innovative hospital. Further strategies have also been provided to implement consistent and long-term planning.

Key Words: Computer communication networks, data management, hospital administration

INTRODUCTION

The emergence of new technology affects all aspects of society, leads to changes in people's lifestyles and the operations of various industries, and has a great deal of influence on the management model of medical institutes. With digital transformation becoming more highlighted, the use of big data, artificial intelligence (AI), and the Internet of Things continues to thrive. Aside from higher-level technologies, digital transformation has also paved the way for greater cost reduction and work efficiency in diverse fields, including the public, in-

dustrial, and medical sectors, through which analog data is transformed into digital.[1,2] Following IBM's report in 2013,[3] wherein digital hospitals were found to save expenses and enhance process efficiency by providing faster and safer treatment processes, medical institutes have recently pursued a model for digital hospital as their management model.

The definition of a digital hospital can be diversified depending on the level of digitization of the medical institute's management and patient treatment efficiency, among other factors. The Healthcare Information and Management Systems Society (HIMSS) defines the digitization level as a scale system of 0–7 stages with the Electronic Medical Record Adoption Model of the medical institute, and Stage 7 is used as the standard for digital hospitals.[4] In terms of patient treatment efficiency, a digital hospital is defined to provide patient-oriented medical service that includes treatments and diagnoses, regardless of the limitations of time and space.[5] In addition, in terms of management efficiency of medical institutes, transformation into a digital hospital is a way to achieve cost reduction with digitization medical data, including the order communication systems, picture archiving and communication systems, and

electronic medical records (EMRs).

As described above, the definition of a digital hospital varies according to the standard followed. As the standard suggested by HIMSS only considers the digitization level without looking at management and patient treatment, it is crucial to design a standard model for digital hospitals that considers the digitization of medical data, the level of digitization, as well as the level of management and patient treatment efficiency. To this end, Yongin Severance Hospital has set the following as the opening goals of establishing an efficient and effective digital hospital: 1) digital implementation for patients' safety and convenience, 2) digital implementation for the utmost medical service, and 3) digital implementation for efficient management. Several digital solutions have been developed and applied to support these goals.

Digitally innovative hospital

Yongin Severance Hospital has established a digital data-based platform that can be used in digitally innovative hospitals (Fig. 1). In order to provide efficient patient-oriented quality treatment, the hospital focuses on three factors: a digital-centered environment, the improvement of patient experience, and the provision of cooperative treatment. A digital-centered environment, as the first factor, enables treatments that are integrated with data management, and establishes a digital platform through which management efficiency and interoperability should be improved. The establishment of such data-based optimal workflow promotes work efficiency by reducing repetitive tasks. Improvement of patient experience, as the second factor, enhances stability, confidence, and trust from patients and their caregivers on the medical staff by providing comprehensive, patient-oriented information from test/treatment to discharge. Furthermore, the patient-oriented environment of the hospital is also improved, resulting in greater patient convenience. Lastly, the provision of cooperative treatment, as the third factor, promotes the capability of the medical staff, executives, and employees, and reinforces the clinical decision-making power through digital solutions. Moreover, it provides customized and integrated services for patients under cooperative treatment.

Digital hospitals aim to build intelligent and innovative Information & Communication Technology (ICT) solutions that patients can directly enjoy. Such solutions include aids that allow medical staff to fully focus on patient treatment by reducing unnecessary workload and maximizing patient safety.

Digital solution

Key factors for a digitally innovative hospital are high-quality patient safety and convenience. To achieve these, Yongin Severance Hospital presents various digital solutions that go be-

Fig. 1. Digitally Innovative Yongin Severance Hospital.

Table 1. Current State of Digital Solutions of Yongin Severance Hospital

Target	Digital solution
Patient safety	- Integration and response space - Real-time location system - AI facial recognition solution for preventing patient swap - Analysis solution for infection epidemiology
Patient service	- Intelligent mobile application for patients - Bedside monitor - Prescription video in animations
Treatment efficiency	- Y-Talk (messenger application for cooperative treatment of doctors) - Automatic measuring kiosk for height/weight/blood pressure - Smart ID card for beds - 5G MEC infrastructure construction
Treatment accuracy	- AI voice recognition documenting system - AI decision-making solution

AI, artificial intelligence; MEC, mobile edge cloud

yond simple adoption of new equipment or systems. Such solutions are digital advancements designed to turn every area visited by the patient into the most optimal medical environment (Table 1).

Integration and response space

An integration and response space (IRS) is the first platform of its kind designed to collect and manage all data from hospitals to check the patient status in real time and detect patients' emergency in the early stage. Made in South Korea, IRS offers functionalities such as rapid response systems (RRSs), real-time location systems (RTLSs), real-time emergency room dashboards, infection tracking, and parking controls.[6,7]

To improve patient safety, RRSs, which are based on clinical observation records, rapidly delivers data to the medical staff by automatically analyzing the severity of patients' symptoms through monitoring of vital signs from all beds in the hospital in real time with expanded monitoring from previously ICU-centered monitoring system.

RTLSs can minimize the time gap between locating a patient in case of an emergency and sending a proper response with the ability of real-time positioning of the patients, hospital property, and medical staffs by using identification card or tag.[8,9] In the case of the recent COVID-19 pandemic, the main cause behind the spread of the infection is physical contact with the infected, both direct and indirect. In line with this, Yongin Severance Hospital has reinforced its safety system to contain the infection within the confines of the hospital during emergencies. Furthermore, the hospital filed a patent for an infection management system that identifies patients' recent contacts by tracing their location route and mathematically calculating such contacts' possible rate of infection.

Voice recognition

Various solutions using voice recognition, including automatic input of EMRs, as well as the management and documentation of medical activities through data linking between medical devices, are applied to enhance the safety of patients and reduce the medical staff's workload.

Facial recognition

Digital solutions using facial recognition are applied to enhance the patients' convenience and safety.[10] The protection of medical staff from infection is reinforced through the establishment of a contactless facial recognition system for access control in the hospital's main facilities, instead of the previous vein recognition system that requires physical contact. An AI-based facial recognition patient swap prevention system is applied to support patient identification in front of a general filming room and outpatient clinic. Facial recognition enables patients to be checked in without using a separate card, and the data are automatically linked to EMRs, adding convenience for both patients and medical staff.

Bedside monitor

A bedside monitor is installed per bed in the "sympathetic digital" ward, and offers diversified services for inpatients to provide an innovative patient experience. Patients can use various services from customized services, including hospital stay guidance, disease education, medical record requests, and convenience services. It also provides Hi-Chart, which explains test and surgery procedures in customized animation videos.

Mobile app for patients

A mobile application that implements a workflow customized to the patient's behavioral patterns allows the provision of sympathetic digital services for patients to enjoy. Here, patients can make an appointment with a doctor by checking information about the medical department and the treating doctor on the mobile application. Patients can also experience swift and convenient hospital treatment services with the use of tags, which are automatically issued when checking in, as well as the payment-free pass system with prior card registration, by checking the treatment process displayed on the application.

Collaborator app for medical staff

As a first in South Korea, a 5G network has been established in the hospital to promote the efficiency of cooperation between medical staff through faster communication. This application can be actively used for multidisciplinary treatments and diagnoses with its communication functions, such as checking the patient list for cooperative treatment using the inpatient medicine collaborator application, a real-time messenger to discuss the patient's condition, and video conferencing.

Digital medical industry center

Yongin Severance Hospital, which represents a new medical model created through industry-university-institute-hospital collaboration, has newly founded the Digital Medical Industry Center as a governing institute for establishing digital solutions and managing research and projects to enhance the medical industry. The center plays a pivotal role in conducting pan-clinical department-level hospital research and development (R&D), in addition to awarding, supporting, and conducting large-scale national assignments related to digital medical ICT. At the same time, the center actively carries forward the digitally substantial projects of the hospital, including the development of contents converging medical knowledge with various digital technologies, such as information and communications technology, augmented/virtual reality, mobile, and AI. Using the Digital Medical Industry Center as a foothold of industry-university-institute-hospital collaboration, Yongin Severance Hospital suggests new profit-creating models for the medical industry by conducting relevant academic studies and creating an expansive medical industry ecosystem in partnership with promising bio healthcare enterprises. In addition, the hospital is equipped with the system infrastructure for collecting big data for research by investing personnel dedicated to R&D, even before the opening of the hospital. By utilizing the collected extensive data, the hospital plans to provide customized treatment services for patients and improve the working environment of medical staff.

CONCLUSION

Yongin Severance Hospital has developed various digital solutions that can serve as foundations for the establishment of a digitally innovative hospital. Furthermore, the hospital has defined its competitiveness with its status as "a digital hospital," and established the following strategies to implement consistent and long-term planning.

First, the hospital prioritizes patient safety and service, as well as treatment efficiency and accuracy, to become a digitally innovative hospital. As a result, diverse digital solutions, including IRSs, mobile apps for patients, and Y-Talk, a messenger application for cooperative treatment of doctors, have been developed. In particular, it has become the first hospital in South Korea to use the IRS for design and operation for patient safety. It also serves as a foundation of the digital data-based platform that plays a role in controlling and managing significant data collected through the solutions.

Second, the hospital creates a "future-oriented medical ecosystem," which exceeds the current medical system with its establishment of a "Digital Medical Industry Center." The hospital plans to build an innovative medical system with the following measures: creating profit and securing intellectual property rights through collaborative development with other companies; promoting a rapid decision-making process by organizing pan-clinical department R&D group, escaping from the previous hospital system that involved clinical departments separately; and flexible communication and decision-making through active participation of medical staff from both inside and outside of the hospital under an open-type organization policy.

Third, the hospital aims to set the standard for a "data-centered" platform. By establishing a standardized data registry, Yongin Severance Hospital can analyze AI deep learning and machine learning, leading to greater precision in the medicine sector. It also serves the purpose of improving hospital management as well as patient treatment using collected data. For instance, Yongin Severance Hospital signed an MOU with Genius February in 2019 to establish and utilize a quality clinical genetic integrated database. Moreover, the hospital has set a final goal of standardizing a digitally innovative hospital, which builds the standard platform using data from digital solutions and data registry, and collects various data by sharing them externally.

The abovementioned three strategies form a mutually virtuous cycle. The utilization of digital solutions attracts cooperation, exchange, and investment from companies and produces a vast amount of data. The data production, made possible with the solid R&D resources at the Digital Medical Industry Center, results in the recruitment of qualified staff. The level of requirement for digital solutions can be identified through the demand of recruitment. Consequently, the hospital can leap forward to become a digitally centered hospital and a leader in the digital medical industry market through positive ripple effects.

Above all, active cooperation from industry-university-institute-hospital, as well as medical staff, are required for the hospital to be successfully transformed into a substantially effective digital hospital. To be considered a pioneer in the standardization of digitally innovative hospitals in the medical ecosystem, Yongin Severance Hospital aims to share the value of digitization and data with the community, the country, and the world.

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