



# Review of Smart Hospital Services in Real Healthcare Environments

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**Objectives:** Smart hospitals involve the application of recent information and communications technology (ICT) innovations to medical services; however, the concept of a smart hospital has not been rigorously defined. In this study, we aimed to derive the definition and service types of smart hospitals and investigate cases of each type. **Methods:** A literature review was conducted regarding the background and technical characteristics of smart hospitals. On this basis, we conducted a focus group interview with experts in hospital information systems, and ultimately derived eight smart hospital service types. **Results:** Smart hospital services can be classified into the following types: services based on location recognition and tracking technology that measures and monitors the location information of an object based on short-range communication technology; high-speed communication network-based services based on new wireless communication technology; Internet of Things-based services that connect objects embedded with sensors and communication functions to the internet; mobile health services such as mobile phones, tablets, and wearables; artificial intelligence-based services for the diagnosis and prediction of diseases; robot services provided on behalf of humans in various medical fields; extended reality services that apply hyper-realistic immersive technology to medical practice; and telehealth using ICT. **Conclusions:** Smart hospitals can influence health and medical policies and create new medical value by defining and quantitatively measuring detailed indicators based on data collected from existing hospitals. Simultaneously, appropriate government incentives, consolidated interdisciplinary research, and active participation by industry are required to foster and facilitate smart hospitals.

**Keywords:** Hospital Design and Construction, Hospital Planning, Digital Technology, Meaningful Use, Health Services Administration

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## I. Introduction

In recent years, the focus in the medical field has shifted from disease treatment to prevention-oriented medicine, centering on medical consumers. In line with these changes, hospitals have introduced artificial intelligence (AI), robotics, and new technologies related to the Fourth Industrial Revolution, thereby raising expectations for improvements in the quality of disease diagnosis and treatment. There is an emerging need to reduce national medical costs by creating interconnections with other related medical facilities in the community, such as clinics, pharmacies, and rehabilitation

centers, integrating the latest information and communication technologies (ICT); and providing “patient-centered care” services where patients are given access to various health information so that they can choose their own treatment methods [1,2]. For these reasons, various support measures to foster smart hospital-related industrial developments are being promoted in major countries, and the smart hospital-related market is expanding worldwide [1].

Efforts to apply ICT in the medical field have been made in the past, and this perspective was initially applied through the concept of the “digital hospital.” The digital hospital is a concept that emerged in the early 2000s in Korea, with the goal of fostering a complete transformation from analog hospital workflows where charts, films, slips, papers, and pens were mostly used for all aspects of recording patients’ medical histories to a digital hospital workflow involving the “four ‘lesses” (filmless, chartless, slipless, paperless) method by establishing computerized physician order-entry, picture archiving and communication systems, Electronic Medical Record (EMR) systems, and hospital business systems [3,4]. Nonetheless, although the word “smart” in “smart hospitals” has been analogized to the SMART (Specific, Measurable, Action-oriented, Realistic, and Time-bound) framework used rhetorically in the field of management, the concept has not been rigorously defined from an academic standpoint [5,6].

Given the recent interest in smart hospitals, which are characterized by the application of recent innovative technology in the global information and communication field to medical services, this study sought to derive implications by exploring the definitions and service types of smart hospitals and reviewing cases of each type.

## II. Exploring the Concept of the Smart Hospital

As a concept similar to smart hospitals, the term “intelligent hospitals” started to be used in the context of radiofrequency identification (RFID), in the Healthcare Consortium sponsored by the RFID Educational Foundation in the United States in 2009. With this concept, the researchers proposed a service that applies real-time location tracking technology, communication technology, and interoperability technology to various spaces in hospitals such as operating rooms, hospital wards, and outpatient clinics [7]. An organization called the Intelligent Health Association, with a focus on intelligent hospital product and service companies was established in the United States, and has been producing high-quality technology education, thereby promoting the adoption and

implementation of new technology in the industry and expansion of the market. Medical institutions seek to improve patient management and safety, reduce medical costs, and revolutionize patient experiences through intelligent hospital services [8].

We conducted a literature review to define the concept of a smart hospital and derive its service types. The review was based on keywords such as “smart hospital,” and we searched literature databases such as the Research Information Sharing Service (<http://www.riss.kr>), National Science & Technology Information Service (<http://www.ntis.go.kr>), Google (<http://scholar.google.co.kr>, <http://www.google.com>), and others. Among the search results, papers, books, and trend reports that could provide an academic interpretation of the medical field were selected as the final research target. The literature introduced the concepts of smart hospitals in various ways, as shown in Table 1 [2,9-13].

McKinsey Health presented the main characteristics of smart hospitals [12] as the establishment of interoperability of systems, mobile integrated solutions, digitalization of all information, establishment of unified communication systems, provision of stable core infrastructure, and system automation. The Korea Health Industry Development Institute defined smart hospitals as a holistic system that requires the participation of all parties who provide medical consumer-oriented services to improve their productivity and the accuracy of medical services by using ICT [1] (Table 2).

Following the literature review on smart hospitals, we conducted a focus group interview (FGI) to derive the concept of smart hospitals and the relevant service types. The FGI proceeded in the following order: selecting the interview subjects, sharing the literature review with the subjects, and an expert interview.

For the FGI, researchers who were faculty members in the department of hospital information system management and development at tertiary hospitals, as well as researchers with academic expertise in medical informatics or health information technology, were interviewed.

Upon providing the interviewees with the literature review results, we asked them to propose a smart hospital concept and the types of service it would provide. The discussion among the interviewees lasted until a consensus was reached.

Smart hospitals can be defined as medical institutions that create new value and insights on patient safety, quality of care, cost-effectiveness, and patient-centeredness using ICT, and provide them in a quantitative manner to patients and medical staff. The services of smart hospitals can be categorized into eight types of technology: location recogni-

Table 1. Various concepts of the "smart hospital"

Category	Content
Frost & Sullivan [9] (2017)	A medical institution that provides medical practices to minimize excessive expenditures of users and prevent medical accidents in advance by using an integrated solution based on information and communication.
Karen Taylor [10] (2017)	A medical institution that optimizes the ICT environment and establishes an automated process with the aim of improving treatment procedures for existing patients and introducing new functions.
European Union Agency for Network and Information Security [11] (2016)	A hospital that improves the patient treatment process based on IoT, optimizes asset management by establishing an ICT environment connected to the hospital's internal assets, and utilizes a business automation process.
Korea Embedded Software and System Industry Association [12] (2018)	A medical institution that has built an integrated management system for safe patient care and efficient hospital management by using ICT for various resources owned by the hospital, such as medical personnel, facilities, information, and equipment.
Seoul Asan Hospital Innovation Design Center [2] (2020)	A next-generation hospital that exceeds the limits of existing hospitals in terms of quality of care, patient safety, patient experience, and productivity by using technologies related to the fourth industrial revolution.
Ministry of Health and Welfare [13] (2020)	A hospital that provides medical services by applying ICT such as 5G and IoT to improve medical services such as enhancing patient safety, improving diagnosis and treatment quality, and reducing costs.

ICT: information and communication technology, IoT: Internet of Things.

Table 2. Key features of smart hospitals introduced by McKinsey Health [12]

Category	Content
A. Interoperability of systems	People, systems, and processes should be interconnected so that data can be efficiently shared and integrated to assist with diagnosis, treatment, management, and business decision-making.
B. Mobile integrated solutions	All resources, such as people, equipment, and technology, are integrated into mobile to narrow the point of treatment as much as possible.
C. Digitization of all information	All information generated in hospitals is stored in a separate and structured format for use in report and analysis whenever possible, aiming for an automated, paperless workflow.
D. Establishment of a unified communication system	Through the integration of audio, video, and data, smooth and safe communication between all stakeholders, including patients, caregivers, and medical staff, is made possible.
E. Provision of stable core infrastructure	Stable high-speed networking, perfect identification technology, and interconnection of sensor networks and embedded systems.
F. System automation	A to E should be able to contribute to an improved patient treatment experience by increasing the efficiency and productivity of hospital management.

tion and tracking technology, high-speed communication networks, the Internet of Things (IoT), mobile health, AI, robotics, extended reality, and telehealth.

### III. Examples of the Representative Service Types of Smart Hospitals

#### 1. Location Recognition and Tracking Services

Various services can be provided by measuring and moni-

toring the location information of objects in a specific space using location recognition and tracking technology based on short-range communication technology [14]. The associated technologies include beacons, Bluetooth, Wi-Fi, Zigbee, RFID, GPS, A-GPS, barcodes, QR codes, and ultra-wideband communication (e.g., 5G technology standard). In particular, by introducing a tracking system for real-time assets (e.g., medical devices, medical supplies, and pharmaceutical products) based on beacon sensors and tags, medical institutions

can improve the efficiency of logistics management related to hospital work and the workflow of medical staff [15,16] (Figure 1).

The University Health System, a medical institution in the United States, introduced a smart infusion pump with an attached RFID, which has been reported to increase productivity and efficiency by reducing the time required for the medical staff to use the device in the hospital from the previous maximum of 2 hours to 8–12 minutes through real-time location monitoring [17].

**2. High-Speed Communication Network-based Services**

High-speed communication network-based services, such as 5G high-speed communication and Wi-Fi 6, provide medical services that overcome the previous limitations of data collection, utilization, and communication based on new wireless communication technology. Wi-Fi 6, as a high-speed communication network, is particularly suitable for use in hospital systems where there is a large volume of traffic and frequent environmental changes and updates. By using orthogonal frequency-division multiple access (OFDMA; Wi-Fi 6 technology that allows multiple clients with different requirements to access a single access point at the same time), the transmission waiting time can be reduced, and the target wake time function allows power-saving for devices and improved battery life. Using Wi-Fi 6, it is possible to accurately analyze patient records and real-time data and improve treatment outcomes by accurately administering medication following an objective decision-making process based on accurate, up-to-date patient data [18].

Wi-Fi 6-enabled medical devices, such as infusion pumps

with adjustable data transfer times, can reduce usage overlap and improve the efficiency of device operation and maintenance through OFDMA by allowing up to 30 different devices to share the same infusion pump and channel without changing orders [19].

Researchers from Huazhong College of Science and Technology have proposed an integrated system termed “5G-Smart Diabetes” that manages patients with diabetes using machine learning, medical big data, social networks, and smart clothing based on 5G wireless technology. Using 5G technology, this system continuously monitors physiological indicators in patients with diabetes, shares the relevant data, and applies a personalized data analysis model to provide tailored treatment services without any restrictions on the patient’s daily life [20].

In addition, the reduction in data transmission time has upgraded the use of smart hospitals in terms of health monitoring. Through fast communication network services, health monitoring has become reliable anytime, anywhere. Even in emerging countries and hard-to-reach areas, a lack of data access is no longer a serious problem. To improve the situation further, research is being conducted on the use of a low peak-to-average power ratio, an efficient spectrum, low latency, and faster data compression and delivery [21].

**3. IoT-based Services**

IoT-based services are technologies that connect various objects embedded with sensors and communication functions to the Internet, including object identification, network construction, sensor attachment (sensation), and action instruction (control) [22,23]. With IoT, smart hospitals can

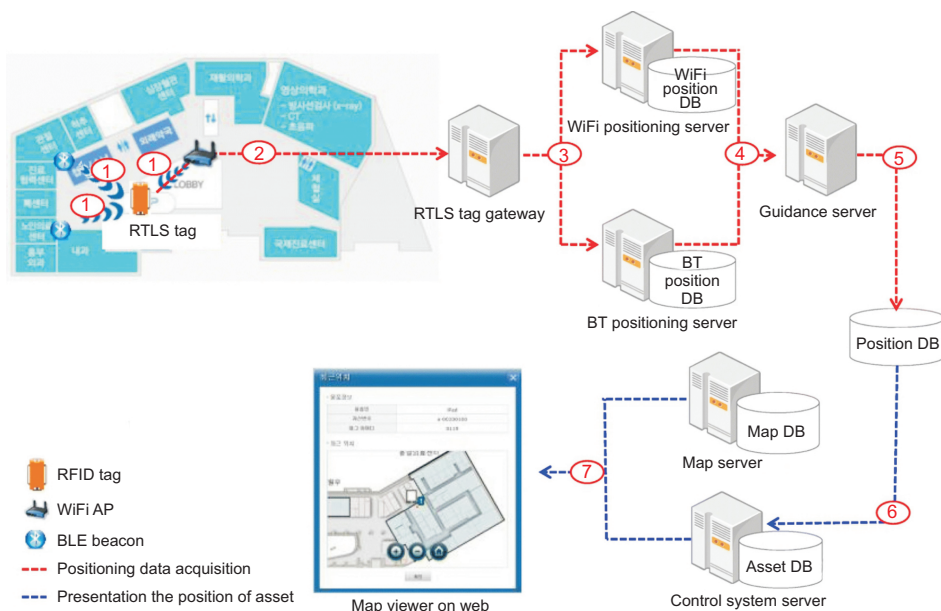


Figure 1. Example of an asset management service in hospitals. Adapted from Yoo et al. [15].



be developed by leveraging sensors, connection methods, internet protocols, databases, cloud computing, and analytics as infrastructure, and using multiple systems together in a composite [24]. IoT and intelligent building technologies can be used for a wide range of purposes, such as decreasing operating costs, increasing treatment effects, reducing diagnostic delays, detecting deterioration early, maximizing equipment utilization, improving patient safety, increasing energy efficiency in hospital buildings, increasing profitability, improving user experience, increasing operational efficiency, and protecting resources [25].

In the nursing field, IoT is used to automate the measurement of patients' vital signs and various indicators. IoT-based vital sign measurement sensors have been gradually miniaturized, as shown in Figure 2, to be attached or inserted into the body, and new indicators are being added, such as to measure patient posture and the number of steps [26]. Barcodes, RFID, fingerprint/iris/face recognition, and ultrasound-based recognition systems are used in smart hospital buildings [27].

The most actively used IoT-based technology is RFID systems, which are used for people, buildings, and medical devices, and research on the use of mobile near-field communication (NFC) systems has also been carried out [28-32].

A study at an academic medical center in the United States investigated the use of a system in which a patch is attached to patients in the intensive care unit that sends an alarm to nurses through the dashboard. It reported that this system reduced the incidence of bedsores in patients to approximately one-third of the original rate, thereby improving patient safety and cost efficiency [33]. An analysis of the effectiveness of a mobile EMR system based on short-range communication technology in hospital emergency rooms, as depicted in Figure 2, showed that it increased patient consul-

tation time by optimizing the travel distance of the medical staff and reducing the time required for operating IT equipment [31,33].

Recent research has also explored the use of machine learning and IoT to diagnose coronavirus disease 2019 (COVID-19) patients. The proposed model, which is based on machine learning and IoT, can serve as a clinical decision support system. In addition, the results are expected to contribute to reducing the excessive workload of doctors and solving the problem of patient overcrowding caused by COVID-19 [34].

#### 4. Mobile Health Services

Mobile health services are services provided through mobile devices such as cell phones, tablets, and wearable devices. Personal health records (PHRs), as a mobile health record system, are built to allow self-monitoring and management by collecting treatment and examination information from various medical institutions, as well as activity level, weight, and blood glucose data collected by smartphones [35,36]. Previous PHR-related research addressed the usability of these systems and their ability to increase patient participation [37-39].

Researchers at the Icahn School of Medicine at Mount Sinai in the United States analyzed heart rate variability (HRV) data from medical staff asked to wear a smartwatch equipped with an app that measured HRV. The analysis revealed that COVID-19 infection could be detected through changes in HRV, even among those without symptoms. In an experiment performed at Stanford University, 81% of test participants wearing smart watches or fitness trackers were reported to have HRV up to 9 days before the onset of COVID-19 symptoms [40].

Given the fragmentation in the locations and subjects of

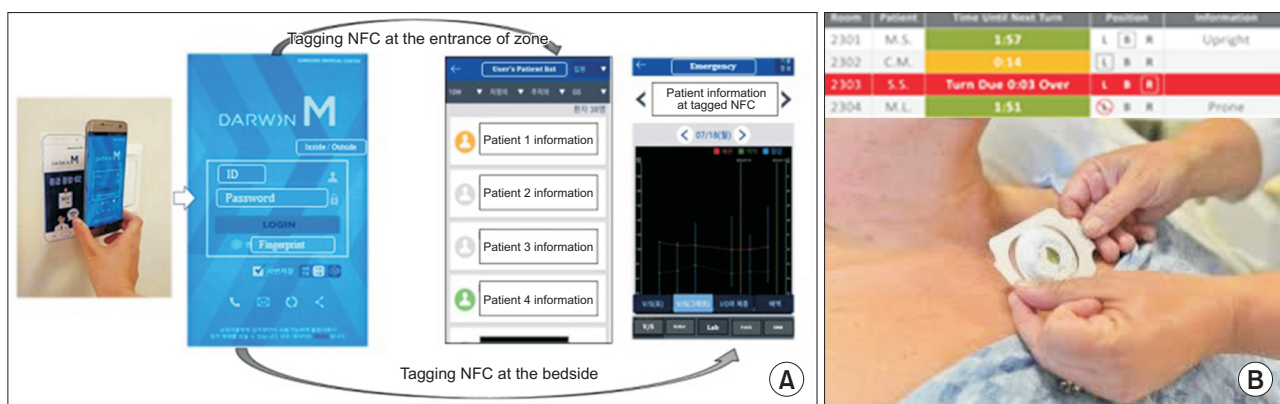


Figure 2. Examples of applications of Internet of Things technology in hospitals. (A) A mobile Electronic Medical Record (EMR) communicates with a near-field communication (NFC) system, and the mobile EMR displays progress after NFC tagging. (B) Combination of a wearable patient sensor and a dashboard.

existing medical services, the demand for services such as mobile EMRs that medical staff use to contact patients in various places is also increasing. An NHS-based app in the United Kingdom provides access to hospital EMRs, prescription refills, appointments, and treatment plan reviews [41].

The use of mobile EMRs was confirmed to have partially increased actual work efficiency, but the results were often limited to Korea, and the research mostly focused on the targets and content [42] (Figure 3).

**5. AI-based Services**

AI-based services use intelligence (learning, reasoning, perception, and understanding abilities) as the main technological element for the diagnosis and prediction of diseases [43,44]. AI serves as the engine of clinical decision support systems, which help physicians make clinical decisions for diagnosis and prescription, thereby enhancing the effectiveness, efficiency, and safety of treatment. In particular, image data-based AI services are being developed rapidly.

Johns Hopkins Hospital in the United States maximized the efficiency of the hospital system by introducing GE's capacity command center (CCC) [45]. Furthermore, systems for making decisions using clinical data, not just by reading medical image data, are in progress [46].

Several hospitals have made efforts to introduce smart

speakers. Many research results are expected to emerge owing to improvements in smart speakers' performance and increasing awareness among the public over the last 2 to 3 years. Patients can easily use the system, mainly for routine functions such as TV control, but the protection of personal information is a major issue [47,48].

Several studies have reported on dashboard designs such as CCC, but reports on system improvements are rare. CCC was first applied in 2016, but only usability case reports have been published [49]. Although few studies have investigated the effects of AI dashboards, the effects of using data on system improvements have been demonstrated from various perspectives, and this framework has been applied to optimize human resource utilization, workflow improvement, and facilities [50].

**6. Robot Services**

Robot services involve robots performing medical actions on behalf of humans. The scope of these services in various fields includes surgery, rehabilitation, nursing care, and logistics.

As a remote collaborative care robot, "Rudy" by INF Robotics has nursing and telemedicine capabilities [43]. Seoul National University Hospital developed a robotic system using telepresence technology, which promotes direct commu-

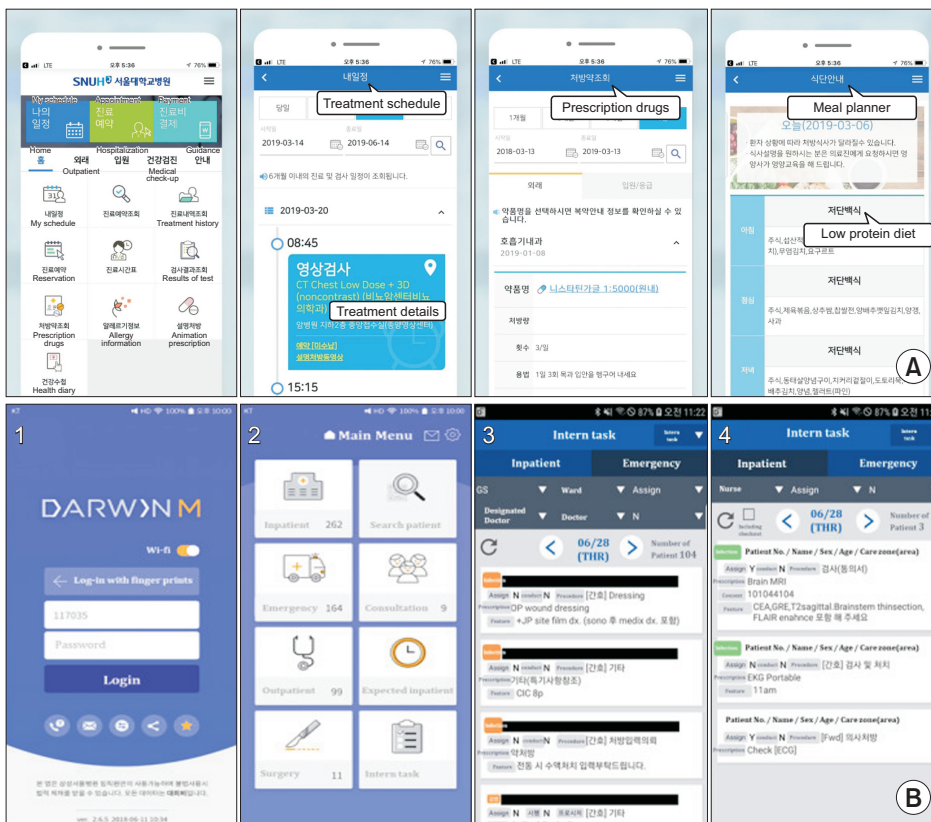


Figure 3. Examples of hospital mobile terminal-based services. (A) Seoul National University Hospital's PHR service. Using the application, the patient can check information such as the treatment schedule, treatment details, results of test, and prescription drugs. (B) Samsung Seoul Hospital's mobile EMR service (DARWIN). PHR: personal health record, EMR: Electronic Medical Record.

nication between patients and medical staff to enable remote collaborative care. An economic evaluation showed that people made 4.01 times fewer doctor visits per year since the robot was deployed [51,52].

The Baylor Scott and White Health Care System evaluated the effect of the pet robot PARO, an FDA-approved biofeedback device, on the treatment of symptoms related to dementia and found that PARO reduced the pulse rate and the use of analgesics and psychoactive drugs [53]. Boston Children's Hospital reported that a conversational social robot provided to children aged 3–10 years had a positive emotional impact [54].

Other caring service robots [43] include the excretion support robot by Cyberdyne, a rehabilitation robot company; TUG, an autonomous transport robot developed by Aethon in the United States that transfers and transports blood, medicines, meals, and garbage [55]; Cuboid, developed by Wireless City Planning; HOSPI, developed by Panasonic; quarantine robots such as GermFalcon, an aircraft sterilization robot sold by Dimer UVC Innovations; and UVD, produced by UVD Robots, a Danish robot company [56]. Examples of the use of medical services provided by robots are shown in Figure 4.

## 7. Extended Reality Services

Extended reality refers to ultra-realistic technologies and services, including virtual reality (VR), augmented reality (AR), and mixed reality (MR). VR enables a virtual experience by providing a virtual signal to the user's senses, whereas AR augments reality by providing digital information. MR combines AR with VR in the real world [57].

VR in healthcare applications can potentially be used for clinical skills, training, and education of practitioners to address cognitive, psychological, motor, and functional im-

pairments. Clinicians are showing more interest in clinical trials and applied research with VR simulations because of the encouraging comments published in the medical literature [58]. Furthermore, certain surgical skills acquired *via* a VR simulator can be transferred to the operating room, and actual surgical performance can be predicted from its results [59].

The Imperial College Healthcare NHS Trust developed AR technology for extremity reconstruction surgery using a three-dimensional (3D) vascular model with perforating vessels. This system enables the preoperative identification of anatomical structures without an incision by providing CT angiography information. It reduces anesthesia time and adverse outcomes related to surgery, shortens surgical training time, and provides remote support for surgery. In addition, through drug information provision technology using AR, patients can see the mechanism of action of drugs in a 3D graphic format [60,61].

Virtual Iraq is a program that is part of BraveMind and was developed by the US Department of Defense and the University of Southern California [62]. They created a VR program based on clinical data to treat soldiers with PTSD [63]. VIPAAR (<http://helplightning.com>) has been providing telemedicine technology using MR in North America. In addition, the Surgical Navigation Advanced Platform (<https://www.surgicaltheater.com/>) is an AR/VR solution that helps doctors establish precise and stable surgical plans by identifying the three-dimensional structures of blood vessels and nerves in the brain during head and neck surgery.

Shionogi Pharmaceutical in Japan developed a digital therapeutic app, AKL-T01, which led to significant improvements in children with attention deficit hyperactivity disorder who regularly played games with individually optimized difficulty levels using the app [64]. A clinical trial of reSET, a

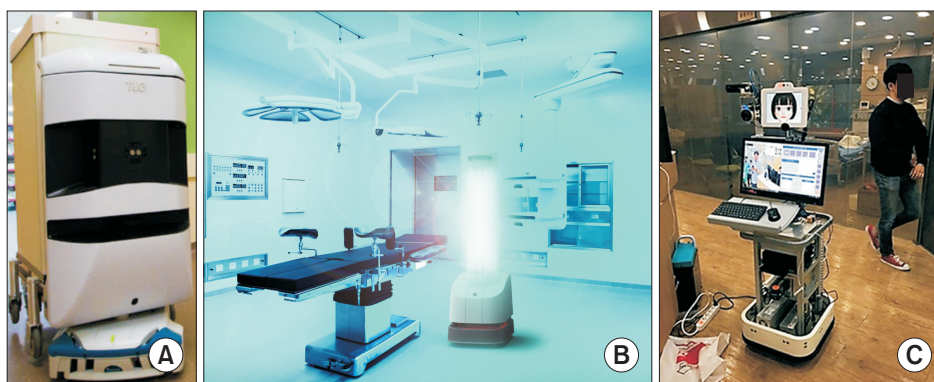


Figure 4. Examples of the use of medical services by robots. (A) Autonomous transport robot, TUG. Adapted from Siao et al. [55]. (B) Quarantine robot, UVD. Adapted from Holland et al. [56]. (C) Remote collaborative care robot at Seoul National University Hospital. Adapted from Lee and Kim [52].

Table 3. Telehealth-related research trends

Study	Hospital	ICU mortality change	Average LOS change	Study type (design)	Outcome variable
Rosenfeld et al. [68] (2000)	A 10-bed surgical ICU in at Johns Hopkins Medical Institution	Severity-adjusted mortality rate in the ICU decreased by 46% - Hospital by 30%	ICU length of stay decreased by 30%	Observational time series triple cohort study	Surgical ICU in a 450-bed, academic-affiliated hospital
Zawada et al. [69] (2009)	Conducted in Avera Health System (one large tertiary hospital, three rural hospitals, two community hospitals and 9 critical care centers)	Adjusted mortality rate ranged between unchanged and 29% reduction	LOS reduction ranged from 22.5% to 45% (9 sites)	Observational time series cohort study	506-bed tertiary referral hospital for the Avera Health System, 3 rural regional hospitals with 10, 6, and 10 ICU beds, respectively, 2 community hospitals (100 total beds), and 9 critical access hospitals (25 beds)
Morrison et al. [70] (2010)	Two community hospitals in the metropolitan Chicago area	No significant effect on ICU or non-ICU/total mortality	No effect on LOS	Before-and-after trial	Two adult ICUs in a 650-bed tertiary care teaching hospital
Lilly et al. [71] (2011)	University of Massachusetts	2.1% decrease	1.9 days decrease	Prospective stepped-wedge clinical practice study	7 ICUs (3 medical, 3 surgical, and 1 mixed cardiovascular) on 2 campuses of an 834-bed academic medical center
Young et al. [72] (2011)	Review	Odds ratio for pooled data was 0.80, showing a reduction	1.26 days decrease		

ICU: intensive care unit, LOS: length of stay.

drug addiction treatment app developed by Pear Therapeutics, showed that the proportion of patients who remained abstinent while using the app was 40.3%, which was higher than that of patients who did not use the app (17.6%) [65].

## 8. Telehealth

Telehealth refers to a form of medical services provided from a distant site using ICT and includes concepts such as a tele-intensive care unit (tele-ICU), tele-consulting, and tele-collaboration. Telehealth can be performed synchronously (telephone and video), asynchronously (patient portal messages, e-consults), and through virtual agents (chatbots) and wearable devices, without physical contact [66].

In the United States, American Well and Doctor on Demand provide primary care to people living in remote locations. Twine Health, acquired by Fitbit, allows patients to work with doctors to create action plans and use the device and apps to track progress and induce behavioral changes. Through tablets, patients have discussions with their health

coaches and participate in the treatment process. TytoCare is a portable device that allows parents to consult with clinicians by sharing images and records through video chats to monitor their children's diseases and analyze the results.

A tele-ICU [67] is connected through an external command center to patients and medical staff via real-time audio-visual and electronic means in the ICU to exchange medical information [68-72]. According to a study by Rosenfeld et al. [68] at Johns Hopkins Hospital, an analysis of the financial impacts of the tele-ICU program showed that the length of stay in the ICU was shortened and the clinical results were improved, resulting in a 24.6% reduction in cost per case (Table 3).

## IV. Discussion

From the viewpoint of patient safety, quality of care, cost-effectiveness, and patient-centered services, we have shown through practical examples that smart hospital services can



create new value and insights that are not provided by existing medical services and provide them to patients and medical staff.

The eight services provided by smart hospitals are expected to contribute to solving the following issues in medical institutions related to the COVID-19 response. By applying location recognition and tracking, IoT, and AI technologies to asset management and patient monitoring in the ward, it will be possible to improve the efficiency of integrated nursing care services. Using robots, high-speed communication, XR, and telehealth technologies for patient-to-doctor telemedicine and professional-to-professional telementoring, treatment, education, and training in medical institutions will be operated more safely and efficiently.

The following policy efforts are needed to motivate useful smart-hospital services within medical institutions. First, the government should encourage the spread of smart hospitals through various policies. The market size should be expanded through various policies to revitalize the smart-hospital-related industrial ecosystem. Appropriate incentive policies to motivate existing hospitals to transform into smart hospitals are needed. It is necessary to promote the spread of smart hospitals through direct and indirect incentives such as medical institution certification and related fee settings.

Second, it is necessary for medical institutions to revise and supplement the existing hospital work process so that the technological units of smart hospital services can be actively reflected in the design of new building spaces, as well as in spaces and facilities in existing hospitals.

With the introduction of smart hospitals, preventive health management is provided in various living spaces of local communities, such as homes and workplaces, using the latest ICTs, such as mobile and wearable sensors, which is expected to achieve customer-centered medical services that can be accessed from the comfort of people's residences through the virtual expansion of hospitals without physical space restrictions. In addition, based on the data collected through smart hospitals, specific detailed indicators related to the core aspects of medical value can be defined, quantitatively measured, and fed back to inform healthcare policy.

Third, industry needs to maintain a close cooperative relationship with medical institutions, which are the consumers of the services, and pursue the commercialization of related technologies based on demonstrations in the practical medical field.

Finally, stakeholders from industry, academia, research, and the medical field should form a standardization-related consultative body to maintain close communication, lead

standardization in domestic and foreign industries, and contribute to improving competitiveness in the relevant market [73].

Data collected through smart hospital services within medical institutions will contribute to the establishment of national healthcare policies by defining and quantitatively measuring detailed indicators related to core aspects of medical value. The active introduction of the smart hospital concept will enable preventive health management in the various living spaces of local communities, such as homes and work, beyond the physical space constraints of existing hospitals. This "virtual expansion of hospitals" will contribute to the realization of customer-oriented medical services that individuals encounter in their daily lives.

## Conflict of Interest

Hyoun-Joong Kong is an editorial member of Healthcare Informatics Research; however, he did not involve in the peer reviewer selection, evaluation, and decision process of this article. Otherwise, no potential conflict of interest relevant to this article was reported.

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