White Paper

Digital Transformation
Health & Life Sciences

Digital Hospitals: Empowering the Transformation of the Healthcare Industry

Table of Contents

Introduction: From Informatization to Digital Hospitals

The journey to "digital hospitals" can be traced back to Rochester, Minnesota. In the late 1960s, the Mayo Clinic became one of the first major healthcare institutions to adopt electronic medical records (EHRs). At first, the use of these records was limited to large institutions that had the computational and financial resources to implement this new technology. But as time went on, adoption increased and a new era of "problem-oriented" medical care began. As clinicians became able to both store and access patient health data and share it with other doctors and nurses, they were able to improve patient care.

Digital hospitals are the next step in the journey to improving medical care through technology. Today, healthcare organizations can leverage artificial intelligence (AI), Internet of Things (IoT), 5G, cloud data storage, and other innovative digital technologies to further optimize hospital operations and management systems. This journey from informatization to digital hospitals will improve the quality and efficiency of medical care, optimize the allocation of healthcare resources, and improve the patient experience for generations to come.

What is a Digital Hospital?

The National Health Commission of the People's Republic of China (PRC) defines a digital hospital as being composed of three key elements:

- **Digital healthcare.** This refers to the integration and interconnection of internal hospital systems, unified management and application of medical data, and paperless diagnosis and treatment. This system integration facilitates the sharing of data between hospital EMRs and a patient's personal digital health records to improve the application of outpatient and emergency electronic medical systems to further the standardization of diagnosis and treatment.
- **Digital services.** This refers to the in-depth integration of information technologies and medical services to support delivery of personalized, intelligent, and convenient services before, during and after patient visits.
- **Digital management.** This refers to the establishment of hospital management platforms that leverage data from operations, performance evaluation, financial management, cost accounting, energy consumption, and other business functions to provide intelligent forecasting of hospital operation trends.

Designing a digital hospital is more than simply introducing new products and technologies. By intelligently integrating these elements in the construction and management of modern hospitals, healthcare organizations can better ensure that patients receive higher-quality care.

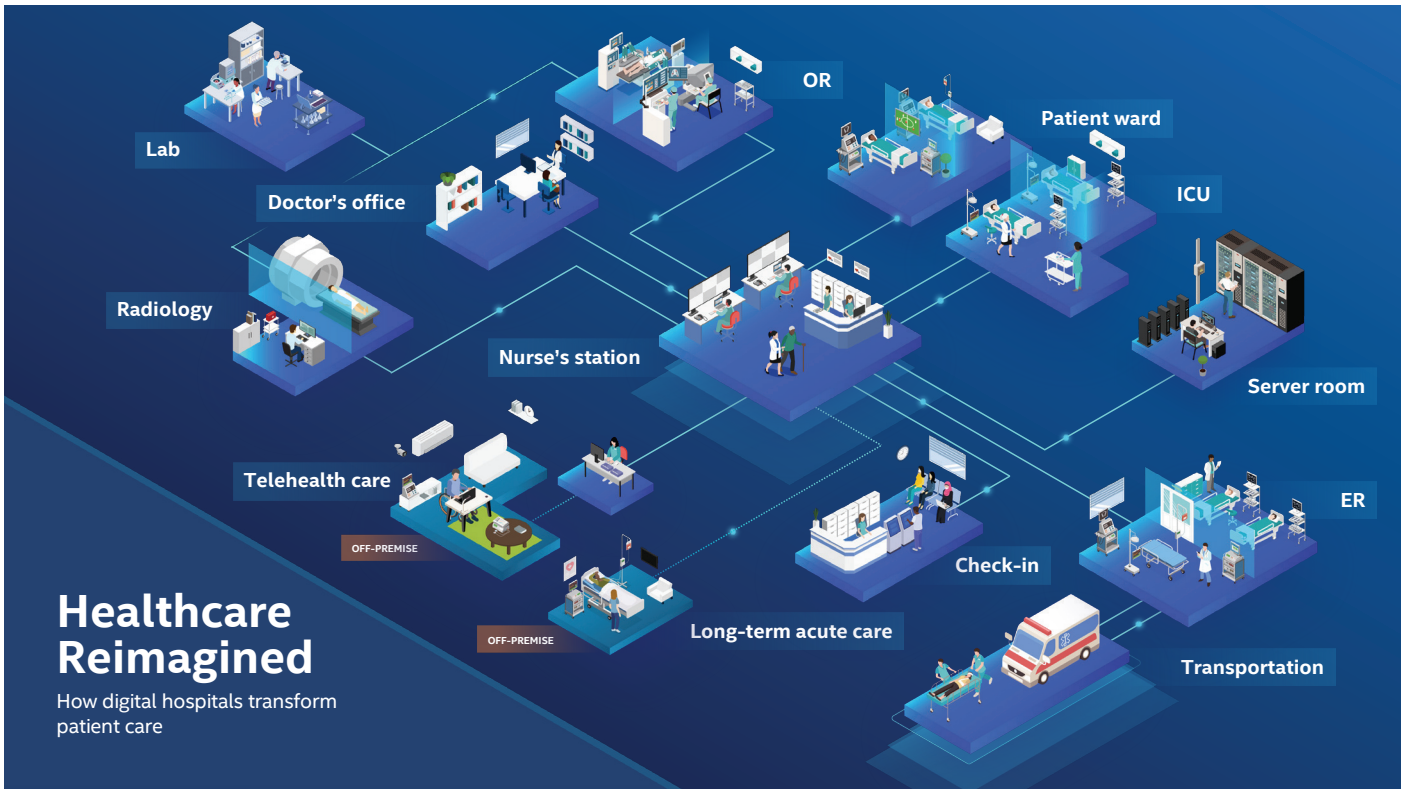

Figure 1. Overview of a digital hospital ecosystem

Driving Factors of Digital Hospital Development

In recent years, digital hospital transformation has become a key development strategy for hospitals across the globe due to the impact of several factors.

Market Demands

To keep up with patient demands for high-quality healthcare, more organizations are looking at adopting digital hospital technologies. Digital hospitals make it possible to efficiently collect, integrate, store, and analyze medical data while providing patients with higher-quality and more human-oriented services through a variety of smart applications.

There is also an imbalance in the supply and demand of healthcare resources for patients, especially for those that live in rural areas and lack access to high-quality care.

Other impacts on demand include the continued aging of the population, increasing public awareness of health issues, rapid demand for the diagnosis and treatment of chronic communicable diseases, and the uptick of complex diseases such as cancer. These factors have placed greater pressure on hospitals to innovate and provide more targeted methods of diagnosis and treatment. Digital hospital construction can help increase operational agility, enable genomics and precision medicine for personalized treatment plans and monitoring services for patients, and meet the public demand for healthcare services.

Technical Resources

Innovation in digital technologies serves as a direct driving force behind the increased demand for digital hospitals. The development of AI, big data, cloud computing, 5G, 3D printing, IoT, virtual reality/augmented reality (VR/AR), cognitive computing, blockchain, and other technologies is playing an increasingly significant role in fields such as diagnosis and treatment, patient services, and hospital management.

Cloud platforms can be used to collect massive amounts of dynamic hospital data, centrally manage and dispatch healthcare data and resources, flexibly configure such data, and help hospitals construct new digital infrastructure.

AI plays a key role in the construction of digital hospitals, particularly in aspects such as medical imaging, computer-aided diagnosis, disease forecasting, health management, and drug development. In the field of smart healthcare, AI can be integrated with medical imaging, computer-aided diagnosis, disease forecasting, and other applications to provide smart diagnosis and treatment and support for treatment decision-making, ensure the safe and effective application of medical data, and realize the closed-loop coverage of all diagnosis and treatment services. AI also has a strong role to play in smart services, with applications like service robots, smart medical guidance and triage, and surgical robotics. With IoT integration, AI will guide intelligent transformation of medical equipment and applications to create rich hospital application scenarios that include the intelligent collection of patient data, mobile ward rounds, and remote diagnosis and treatment. AI-empowered decision-making applications can efficiently analyze operations and management data, assist decision-making, and enhance work efficiency through virtual personal assistants and robotic process automation (RPA).

Pandemic Factors

The onset of the COVID-19 pandemic during the start of 2020 had a profound impact on the healthcare industry, impacting the direction and progress of digital hospital construction and related matters. In response, the demand for remote applications like telehealth, medical self-service terminals, and self-service triage and guidance has increased rapidly. Furthermore, as hospitals placed restrictions on physical diagnosis and treatment, the demand for remote consultation, surgical education, surgery, and diagnosis has also accelerated.

Common Digital Hospital Solutions

Smart healthcare, services, and management all have different requirements for digital capacity. Through the integration of AI, IoT, 5G, and other technologies, medical service providers can help hospitals solve the pain points in smart transformation and accelerate the overall construction of digital hospital systems.

Below is a snapshot of the digital hospital solution and technologies, including stakeholder pain points and model solutions, that early adopters are implementing today.

Case Study: Emergency Treatment

Emergency treatment primarily relies on resources such as alert terminals, emergency centers, ambulances, doctors, volunteers, and the hospital itself to provide patients with consultation, local treatment, transfer, and other medical services.

Stakeholder Pain Points

- **Medical Personnel:** The primary challenge for medical personnel is the ability to obtain patient information in a timely manner and use it to prepare treatment plans relevant to the patient's condition. It is also critical that medical personnel in the ER can make full use of hospital resources to effectively treat patients. As ambulances do not carry a large amount of medical equipment, it is difficult to achieve timely emergency treatment by only relying on existing ambulance equipment and personnel. As well, conventional ambulances rely on 4G networks that have limited bandwidth and may lack the ability to transmit enough data to hospitals for them to prepare for the patient's arrival.
- **Hospital Management Personnel:** Hospital management must be able to record emergency treatment information in a timely and complete manner, conduct refined management of emergency resource allocation, and assist decision-making through the processing and analysis of relevant emergency information. As conventional emergency treatment solutions are limited by network transmission speeds and delays, the realization of real-time recording has been difficult.

Figure 2. Emergency room

Solution: 5G Ambulances

With added network capacity and solution capabilities, ambulances can deliver a comprehensive, mobile emergency treatment system.

By using a remote consultation system, panoramic technology, and ultra-low latency VR glasses and 5G networks, emergency departments can prepare for the patient's arrival earlier and gain the visibility required to prioritize the patients with the most urgent needs, greatly improve the transmission speed and efficiency of emergency medical information and provide the best possible chance for patient recovery.

Case Study: Hospital Registration and Triage

As a key pre-diagnostic process, the primary goal of hospital registration and triage is to match the needs of the patient with the relevant department, doctor, and other resources. The severity of the patient's condition must be ascertained, along with the relevant specialty based on the patient's primarily symptoms and signs.

Figure 3. Hospital registration and triage

Stakeholder Pain Points

- **Patients:** During peak hours at a busy emergency room, the wait time for hospital registration and triage can take hours. The issue is largely caused by delays in communication between appointment, diagnosis, and treatment mechanisms, along with the lack of self-service hospital registration and triage equipment. However, self-service registration may be a challenge for patients who are elderly or unfamiliar with technology.
- **Hospital Management Personnel:** Information from different appointment platforms such as registration windows, self-service kiosks, web terminals, and mobile terminals must be collated into a unified platform for processing. Decentralization and poor communication between departments may make it difficult for hospitals to provide patients with accurate information and guidance during the hospital registration and triage process.

Solution: Smart Healthcare Self-Service System

A smart healthcare self-service system enables rapid registration of patients through handheld devices, self-service kiosks, and other hospital models to provide remote consultation, dual referral, health check-up, chronic disease management, precise appointment, and other healthcare services. This type of digital front door model for digital hospitals provides a smooth, frictionless patient experience overall.

This system is capable of fully meeting the demands of hospitals in areas such as self-service card issuance, registration, recharge, payment, query, invoice printing, and receipt printing while enabling services such as self-service medical record printing, lab report printing, hospitalization fee prepayment, settlement, and schedule printing in a manner that effectively avoids problems such as duplicate collection of medical information, long waiting periods, and financial security.

Case Study: Diagnosis and Treatment

Diagnosis and treatment can be divided into scenarios such as computer-aided diagnosis, computer-aided clinical decision-making, and patient communication. Computer-aided diagnosis refers to the use of a system capable of helping doctors improve the efficiency of case processing while enhancing image analysis accuracy, shortening diagnosis result report times, and improving the diagnostic capability of medical systems. Computer-aided clinical decision-making refers to the utilization of knowledge bases and machine learning to provide basic support for clinical decision-making.

Stakeholder Pain Points

- **Patients:** During diagnosis or treatment, patients may transfer to another hospital as the result of referrals, relocation, or other factors. Different hospitals may provide different diagnoses to the same patient.
- **Medical Personnel:** Conventional diagnosis methods rely on the judgment of medical personnel, which can be inefficient and prone to errors. Gaps in patient records mean that medical personnel must spend a lot of time acquiring basic details during diagnosis and treatment, reducing the time for effective face-to-face communication with patients. The lack of computer-aided diagnosis and treatment technologies also makes it difficult for medical personnel to improve their professional expertise.
- **Hospital Management Personnel:** The primary issues faced by hospital management are the lack of standardization and closed-off institutional data in conventional diagnosis solutions, leading to inconsistent diagnosis across different medical institutions.

Figure 4. Doctor's office

Solution: Computer-Aided Diagnosis System

Smart computer-aided diagnosis systems can perform semantic segmentation of suspected legion areas through AI modeling. Through the input of ultrasound, CT, NMRI, and other medical AI models, the area and structure of the (color-coded) suspected lesions are generated. This allows for the intelligent transformation of a process that originally required manual identification and labeling, thereby accelerating image interpretation.

Smart computer-aided diagnosis systems can help radiologists screen out normal images, focus on marking suspected lesion areas, avoid repetitive tasks, improve accuracy, and reduce inefficiencies in the analysis of images to empower doctors to focus their skills and efforts on the higher-value service needs of patients. These systems are of even greater significance to remote areas and rural doctors by ensuring the timely diagnosis and treatment of patients.

Case Study: Surgery

A key hospital service, surgery primary revolves around the operating room and supporting patient services. Surgical scenarios include anesthetic management, surgical care, surgical education and consultation, doctor-patient collaboration, central monitoring and management, narcotics management, high-value consumables management, surgical and medical equipment management, and computer-aided surgical decision-making.

Stakeholder Pain Points

- **Patients:** When receiving patient-oriented surgical services, patients often experience a gap in expectations with regards to surgery and service experience quality. This is primarily reflected in the lack of communication time before surgery, lack of follow-up and postoperative rehabilitation guidance, and the difficulty in making appointments with relevant experts.

- **Medical Personnel:** In conventional surgery programs, tasks such as surgical operations, anesthetic management, and surgical education and consultation are typically completed manually. The lack of access to computer-aided surgery also reduces the efficiency of medical staff.

Figure 5. Operating room

Solution: Precision Surgical Planning and Evaluation System

Based on AI-assisted imaging and diagnosis, biomechanics, 3D simulation, and other methods, these systems can be trained to analyze medical images while providing a variety of interventional treatment modes along with precise pre-operative planning and post-operative evaluation of surgical operations for stringent quality controls.

The system provides surgeons with three-dimensional, dynamic, and concrete information before and after surgery, along with post-operative effect simulation to improve decision-making. By incorporating AI algorithms, the system can facilitate the rapid segmentation of internal organs, tumors, blood vessels, and areas of interest; individualized pre-operative planning; precise post-ablation evaluation; and other applications with high levels of clinical value.

Case Study: Drug Consumption Management

The smart management of medicines, consumables, and reagents involves automated dispensation, strengthening of drug consumption management, and assurance of drug safety.

Stakeholder Pain Points

- **Patients:** During the diagnosis and treatment process, patients may experience issues with drug safety and precision if they are responsible for their own medication delivery.
- **Medical Personnel:** Conventional drug consumption management programs have been challenged by limited participation of pharmacists and clinicians. In addition to increasing the workload of hospital staff, this can also lead to errors due to omissions in manual inventory, review, and other processes.
- **Hospital Management Personnel:** Many hospitals experience problems such as personnel shortages, imperfect quality control systems, opaque resource management, and lack of refined management of drugs and consumables.

Figure 6. Hospital pharmacy

Solution: Closed-Loop Smart Drug & Consumables Management

A comprehensive closed-loop smart drug and consumables supervision center enables the interconnection of management systems to eliminate data silos and provide real-time and multi-dimensional monitoring of drug consumption. When combined with the drug consumption supply chain management platform, the system provides insights into the standardized marking of orders while supporting functions such as supply chain views, supplier qualification evaluation, and early warning for certificate expirations, thereby improving supplier management and reducing costs while reducing staffing burdens.

The solution can be equipped with smart hardware terminals such as drug and consumable cabinets, vehicle transfer, and mobile workstations. Through integration of 5G, AI, image recognition, gravity sensing, and infrared/laser technologies, the solution supports the upgrade and transformation of controlled and general drug management models, collection of real-time data, and the deployment of smart systems to regulate the use of drugs and consumables.

Case Study: Hospital Management

Management plays a key role in the delivery of high-quality hospital care. Improving hospital management is a key method to optimize the allocation of hospital resources like personnel, finances, and materials; enhance operational efficiency; and reduce operating costs, thereby providing a solid foundation for digital hospital development.

Ransomware, customized attacks, and credential-based attacks pose serious problems to hospital data and application security. Hospitals must further ensure the security of their digital systems through enhanced features such as application isolation, virtual machines and container isolation, full memory encryption, and platform firmware resiliency. Hospitals must also improve the management of medical images, electronic medical records, and other data stored in the cloud in addition to strengthening the management of desktop terminals to meet safety, compliance, and other requirements while improving informatization efficiency.

Stakeholder Pain Points

- **Hospital Management Personnel:** Management often faces problems in areas such as difficulty of cost control, lack of comprehensive management tools, and lack of full-process management. There is also a widespread problem that data cannot be interconnected between management and operational departments.

Figure 7. Patient rooms

Solution: Refined Hospital Management

Digital hospitals must rely on a comprehensive system of personnel, financial, and material management that includes healthcare operations, internal team development, and data optimization. The system is equipped with personal portal, personnel, salary, accounting, payable, receivable, expense, consumable, material, drug, fixed asset, and other functional modules along with performance, budget, project funding, contract, SRM, BI, and other management modules.

The solution realizes the closed-loop management of the financial chain in a manner that integrates budgeting, settlement, and accounting; closed-loop management of the entire asset and equipment value chain; closed-loop management of the entire lifecycle of the material chain; and closed-loop management of the comprehensive internal budget control strategy chain. Through this, the solution supports a full-coverage smart operations management system capable of enabling the hospital's strategic goals.

Conclusion

Innovation in digital technologies is enabling the construction of digital hospitals across the healthcare industry. By constructing smart healthcare, service, and management systems, healthcare organizations can transform diagnosis, treatment, and service models to better benefit people's lives.

Intel Corporation and its partner ecosystem is working to develop transformative edge-to-cloud technology solutions that reduce costs and improve patient outcomes. These solutions can help improve the efficiency of medical personnel through interconnected and integrated systems and realize cutting-edge growth in the clinical treatment and life science industry segments.

When implemented at the cloud, edge, or through other methods, digital technologies have the potential to simplify work processes, enhance clinician expertise, and eliminate problems such as limited access to care in rural areas, medical personnel shortages, and the rapid growth of medical insurance costs. This furthers the potential of new technological innovations to create a better future for all.

0522/EOH/MESH/PDF 351547-001US