Smart hospitals and A&E departments in Hong Kong: Advantages, considerations and way forward

Overview
The concept of smart hospital is not new, but its development has unprecedentedly been accelerated by the COVID-19 pandemic. Hospitals are under stress to use a wide range of digital technology that facilitates the control of local epidemic in a ‘smarter’ way.1 In a recent survey conducted by Newsweek and Statista, Mayo Clinic and Johns Hopkin Hospital are considered the top two smart hospitals in the world.2 In general, smart hospitals usually involve digital transformation, enhanced connectivity, workflow automation, process optimization and the use of technological tools like Internet of Things (IoT) and robotics. In addition, through digital communication technologies such as video conferencing, texting and remote patient monitoring, smart hospitals can also offer telehealth3 to support optimization of patient care and wellness into the communities these hospitals serve.

Providing over 90% in-patient services in Hong Kong, Hospital Authority (HA) is also heading towards the development of smart hospitals. The New Territories West Cluster, Tseung Kwan O Hospital and Queen Elizabeth Hospital have been designated as pilot sites for deployment of smart hospital initiatives. Different from the conventional top down approach, the Smart Hospital project adopts a co-delivery concept that involves the input from HA Head Office (HAHO) to provide foundation components, individual hospitals to customize local IT systems for operational needs, universities to research into new technologies and external stakeholders to support the infrastructure. This co-delivery model does not only encourage innovation from cluster/local hospital but also facilitates the sharing of knowledge to other hospitals through the overall coordination of HAHO.

Numerous smart hospital applications are being tested out in the pilot sites. Technology-based clinical management applications such as Smart AED (Accident & Emergency Department), Smart Ward, eVital and telehealth are under exploration.

In each year, HA Hospitals serve approximately 1.84 million in-patient and 2.16 million Accident & Emergency (A&E) attendance, giving rise to more than 18 million transactions of clinical systems and 280 terabytes of health data per day. With the use of big data analytics, three command centres are set up. The command centre for capacity management aims at integrating different operation systems within the hospital, and aggregated data are presented to the management using business intelligence tools in a real-time manner. The command centre for resources management mainly applies in the coordination of supporting services, for example, porter services and supplies logistics with the use of robotics to improve the overall efficiency. The command centre for clinical services management focuses on improving hospital’s risk preparedness and management through the use of clinical data monitoring applications such as IoT and artificial intelligence (AI) to prompt clinical decision.

As data are regarded as the cornerstone for smart hospital, digital transformation has become a worldwide phenomenon that covers infinite possibilities of digital-based healthcare applications and services. There are many existing and increasing number of digital transformation technologies, in which some are particularly useful in A&E settings.

Telehealth is another core application under development in HA. Globally, telehealth has been rapidly adopted in many countries so as to maintain high quality of health services despite the need for social isolation to interrupt infectious transmission.4,5 One paper looked at facilitators of rapid uptake of telehealth in the United States around three key themes: (1) case descriptions of telehealth models that demonstrated feasibility, (2) rapid policy alterations to relax privacy and security protocols and (3) safeguarding standard of care through telehealth.6 These global examples and principles are important considerations in implementing telehealth in Hong Kong through smart hospitals in order to provide necessary and timely medical services to patient remotely, particularly during the COVID-19 pandemic and eventually as sustainable services.

Digital transformation as enabler of a smarter emergency department
The challenges of emergency department (ED) management in Hong Kong have unique characteristics of high
attendance volume with shared difficulties with foreign countries, including overcrowding and access block. In 2019–2020, the annual attendance to the 18 public EDs was over 2 million.\textsuperscript{7} The high ED throughput posed a specific challenge to maintain quality and workflow efficiency. Digital transformation had been developed in the past years in public EDs in Hong Kong with the eAED project of the HA and would be completely rolled out in all public EDs in Hong Kong by 2022–2023. The digital transformation process would not only convert written clinical documentations to digital format, clinical drawings or photos, but also transform the ED workflow to digital. There was a previous report that converting document to electronic alone may have negative impact on the operational efficiency of ED.\textsuperscript{8} Transforming to e-workflow does not only improve clinical communication and quality through closed-loop communication, it also has dramatic potential to improve the workflow efficiency and reform patient flow.\textsuperscript{9} Digitalized workflow in AED would improve the information continuity for patient care. A good example would be the clinical data access for admission and interhospital transfer cases where the destination point would be able to access the patient profile before the patient arrival. Real-time location tracking system (RTLS) and geofencing technologies had become mature in recent years, including Bluetooth, WiFi and ultra-wideband technologies. RTLS on assets and medical equipment would enable auto-stocktaking, while RTLS on patient and visitors would have positive impact on workflow efficiency, geofencing for high-risk patient (cognitively declined or disabled) and heatmap for crowd analysis.

More importantly, digital transformation would be the infrastructure of structural and text format health data for big data analytics and development of AI for decision support. Real-time digital health data, especially the vital monitoring data and in the setting of resuscitation room or critical care area, would be enabler of real-time data-driven decision support and protocol. This would have dramatic impact on care standardization and enhancement of patient safety. AI, when integrated with digitally transformed workflow and documentation, had great potential to include more predictors in the model, which is virtually impossible in conventional clinical predictive scores with manual calculation. Moreover, it may have better predictive accuracy and beauty of self-training. The ED health big data would also have potential impact on the development of geriatric and ambulatory emergency medicine to accurately identify high-acuity patients and stratify low-risk patients for ambulatory care.

In addition to supporting clinical care, the big data generated during digital transformation of ED would be of support to ED operation. Throughput and performance dashboard on ED operation running in real-time manner would facilitate ED managers to maintain smooth ED operation or even predict and anticipate the service surge. The real-time ED waiting time and overcrowding indicator had been shared to public through mobile apps and web portal which would improve the operational transparency. The operational data would also have great impact on managing mass-casualty incidents and disasters to allow centralized monitoring of resources to best match the available healthcare resources to handle the incident. Throughout the process of transformation, continuous impact evaluation and monitoring of service efficiency, throughput, quality indicators and staff evaluation are essential.\textsuperscript{10}

Telehealth is another innovative approach that ED can offer to patients to increase accessibility of services for the public and improve ED operations and flow.\textsuperscript{11} Various models of ED adoption of telehealth are appearing in the literature to shed light on feasibility of ED telehealth, including pre-hospital triage,\textsuperscript{12} prehospital transport,\textsuperscript{13} virtual telehealth services to patients that complement in-person ED visits\textsuperscript{14} and specialty consultations.\textsuperscript{15} Hong Kong is an ideal context to apply telehealth to support both urban and rural patient populations. Its deep and broad health professional expertise and experiences in Emergency Medicine, Hong Kong HA’s centralized electronic health records to support telehealth, its prehospital and emergency air medical services to treat patients where they are located, and its network of AEDs in different hospitals form a highly fertile ground to develop unique and innovative telehealth services for Hong Kong citizens and other countries to emulate.

Conclusion

While we see the increasing potentials of smart hospital, there are still a lot of emerging difficulties we need to overcome. To tackle the challenges, collaborative effort from stakeholder is essential. Investment in hardware development and human resources capacity will be of utmost significance in expanding the whole society’s capabilities towards a smart healthcare system. More importantly, local research on related subject should be highly supported as it plays a vital role in facilitating a common understanding within the society and building up new knowledge on the application of smart healthcare services in Hong Kong.

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