



Editorial

Future Healthcare and Future Hospitals: The Control Tower of Communities

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In 2017, the Economist published an article to highlight how to re-build healthcare for the future, and hospitals should act like the control tower of airports to look after all community inhabitants like aircrafts in operation. The proposed future healthcare services and hospitals are an ongoing process and the speed of transition has been accelerated. The advancement in biomedical research and computer sciences would greatly change healthcare services in the near future. The success of precision medicine substantially modified the disease diagnosis and treatment courses, which also changed patient experiences in the treatment and recovery process. In addition to the progress of biomedical sciences, the application of modern information and computer sciences also changed the treatment and care pathway.¹ Moreover, the development of digital biomarkers may also modify the diagnostic algorithms of various diseases in the future. Mobile technology and wearable devices provided accurate and continuous measurements of vital signs and data of daily activities, which will substantially change the diagnosis, treatment and related lifestyle modifications.²⁻⁴ For example, clinicians used to monitor diabetes control of patients through the levels of hemoglobin A1c (HbA1c) that summarized the long-term glycemic status of a person, but studies have shown the status of glycemic variability provided further information beyond the average of cumulative glycemic.⁵⁻⁷ With more advanced development of wearable devices, healthcare service models would be changed as well.^{8,9}

The application of artificial intelligence-based facial recognition technology significantly differentiated older adults with and without dementia,¹⁰ but the application of facial recognition technology also triggered the controversies of privacy and consent of using various kinds of biomaterials. Similarly, voice and language ability have also become the new biomarker to identify Parkinson's disease and its severity, which can be implemented by smartphones.¹¹ All these new features of biomarkers captured and analyzed by artificial intelligence may therefore create a new scenario of clinical services. However, all the advanced development of biomedical and computer sciences aimed to improve the quality of healthcare services and the healthcare systems, so to improve the health and well-beings of all people. Inevitably, the implementation of new inventions through cross-disciplinary approach would generate various challenges from different perspectives. In particular, traditionally, biomedical sciences followed ethical

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principles of their own, but the implementation of inventions from the cross-disciplinary approach may confuse clinicians in the clinical practice.¹² Changed patient-doctor relationship and legal liability followed the introduction of digital technology are new challenges to care providers and all healthcare professionals. Nevertheless, all these efforts are dedicated to provide better health outcomes and person-centered care.¹³

As the control tower, future hospitals aim to conduct appropriate health management for all community inhabitants, which requires broader implementation of technology to connect hospitals and homes. To provide personal health promotion and management plans, future hospitals need to work on risk stratification for all community inhabitants, so to provide precision health care plans through integrated healthcare organizations. Traditionally, hospitals and primary care physicians worked closely for health of communities, but the traditional working model was more based on referrals and shared responsibilities between different healthcare providers. The success of the current working model relies on the care integration and cooperation between sectors, but it may be somewhat passive. Future hospitals may proactively respond the potential care needs based on risk stratification and prediction to prevent potentially avoidable hospitalizations and emergency department visits. Using machine learning or deep learning approach, prediction for adverse outcomes of people with high care needs becomes more accurate and feasible in the real world.^{14,15} A previous study compared the hypothesis-driven and data-driven approach in developing a multimorbidity index to predict adverse outcomes of older people,¹⁶ and showed that data-driven approach using machine learning identified older people with greater risk than the hypothesis-driven approach. The utilization of machine learning technology successfully captured the suicide risk at community levels that substantially improve understanding to suicide risk, a poorly understood challenge in the past decades, that may facilitate the development of suicide prevention programs.¹⁷

With the assistance of modern technology, professional healthcare services can be extended to communities and homes that is compatible with the conceptual proposal of airport control tower. Nevertheless, technology advancement alone may not change the mindset of healthcare professionals because conventional healthcare systems tended to be more provider-centric. It may be easier and more convenient for healthcare professionals to provide care in hospitals, but it may not be efficient for the whole population. Transitions between current health service models to technology-added ones take time, but the key determinant may be the attitudes and mindsets of healthcare professionals towards

these newly developed technology applications.^{18,19} Healthcare professionals are more used to new developments based on biomedical innovations, but are more reluctant to those based on computer sciences due to the relative lack of background knowledge. Until more scientific publications and the evidence-based recommendations are available, healthcare professionals may hesitate using these technology-valued applications as pioneers in the relatively more conservative and closed atmosphere of medical practice. Future healthcare professionals and future hospitals need not only adjustments of using digital biomarkers and digital healthcare solutions, but also changes of mindsets towards synchronized utilizations of biomedical and digital sciences for better person-centered care and patient outcomes.

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