Commentary

Artificial Intelligence: a Singapore Response

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The world is in the midst of a new industrial transformation with the rise of artificial intelligence (AI)\(^1\), physicians and health systems will increasingly need to adapt amidst skyrocketing demand for healthcare services due to multiple converging socioeconomic trends. Ageing populations in many countries demand more healthcare services, a trend exacerbated by heightened expectations due to improved healthcare quality and life expectancy and reduced proportion of young healthcare workers. AI exhibits great potential to disrupt healthcare delivery and revolutionise patient treatment to meet this need.

**The Application of AI Augmented Healthcare**

AI in healthcare had been around since 1970s and has gone through several hype-and-bust cycles. Nonetheless the convergence of several trends today heralds exciting new potential. Exponentially increasing computing power, investment capital, explosive data creation and capture, and development of deep learning (DL) techniques utilising multi-layered neural networks create conditions that improve AI detection accuracy. In 2014, GoogLeNet, a convolutional neural network, classified fifteen million internet images into more than twenty thousand categories at near-human accuracy to much worldwide sensation\(^2\).

DL neural networks, not limited by human fatigue and able to process large amounts of information round the clock, can be trained to take over a large variety of repetitive cognitive tasks across the entire healthcare setting. The future of healthcare augmented by AI systems holds immense potential, and Singapore researchers are well-placed to participate in its creation.\(^1\)

The radiologists are early adopters of AI in medicine, with the use of DL for detection and classification of pneumonia\(^3\), tuberculosis\(^4,5\) and fractures\(^6\) on radiographs to
tumour auto-segmentation and even to imaging workflow optimisations. DL algorithms are now trained to upsample data from low dose computed tomography (CT) studies to give high quality images comparable to conventional CT scans, thereby reducing radiation exposure to the patients.

AI-based image analysis solutions also have been adopted in the pathology lab to predict which tumours result in poorer outcomes. The team from National Neuroscience Institute (NNI) used DL to classify brain glioma specimens into histological grades. They also adapted their work to classify breast histology images thereby showing the use of transfer learning across tissue types.

Moreover, researchers at Singapore National Eye Centre (SNEC) also trained DL systems to detect diabetic retinopathy in digital retinal photography with excellent accuracy. Such efforts have now extended to other conditions (eg. glaucoma and age-related macular degeneration), and also adopted in under-resourced African countries to revolutionise eye screening and reduce incidence of preventable blindness. Similar technologies can also predict cardiovascular risk factors from retinal images, something not previously thought possible with human readers. Researchers at National Heart Centre Singapore (NHCS) assimilated demographic, clinical, electrocardiographic and imaging data to diagnose coronary artery disease with AI. Predictive analytics aggregating data from diverse sources, including medical history and environmental parameters also have the potential to revolutionise public health and preventive medicine.

**Making AI Augment Human Healthcare Professionals**

Despite immense potential, a few limitations inherent in AI need to be addressed before widespread implementation. The value proposition of deep learning lies in its
ability to derive its own conclusion and method of interpretation. However, its
decision-making logic is often not clear – a well-known “Black Box” effect. The
opacity of AI decision-making thus presents potentially serious accountability
problems. To further complicate matters, it is now possible to develop adversarial
systems which corrupt raw imaging data to confuse AI into making erroneous
diagnoses\textsuperscript{15}: thus, clinically-trained human oversight and validation are still
indispensable in order to prevent poor patient outcomes.

Another limitation of DL is the dependence on a large amount of good quality, well-
annotated data for effective neural network training. Experienced clinicians are
needed to select, validate and label data precisely and accurately, as well as to
ensure that DL systems trained on external data is applicable to the local patient
population. Singapore doctors need to continually audit, retrain and revalidate AI
applications even after adoption.

Finally, currently available clinical AI solutions are designed for niche implementation
and focus on specific tasks; a general AI solution does not appear to be on the
horizon anytime soon. Therefore, a wide gamut of different specific AI tools may be
needed for different clinical scenarios. Healthcare professionals will soon need to
also help patients navigate these complexities and make sense of AI outputs. We will
also need to customize medical systems for judicious implementation of AI systems
in controlled clinical environments to ensure safe and effective care for patients in
Singapore\textsuperscript{7}. This holds true for every stage of AI development from identifying real
clinical needs at the inception of a DL system, to clinical data labelling, to system
validation, to implementation in the clinical setting, to helping individual patients
make sense of their data and finally to auditing pooled outcome measures.
A Bright, Not Dystopian, Future

Healthcare professionals who once had unfounded fears of being replaced by AI now look forward to embracing the potential that an AI-augmented healthcare system brings. In a recent survey of attitudes towards AI among radiology residents and faculty in Singapore, the majority of respondents were confident that human radiologists will not be replaced and they were also motivated to advance their knowledge of AI, and be involved in related research. 16

In the brave new world of AI-augmented healthcare, we need to adapt to our evolving role in patient care. Traditional healthcare roles will move from mere technical expertise in diagnosis and therapy to a greater emphasis on patient-centric care, focusing on the emotive and less tangible needs of our patients and their families. AI will also empower patients to be active participants in care provision, as real-time data collected from patients’ wearable or implantable sensors can alert doctors to actionable knowledge and contribute to a growing pool of training data for AI systems. AI systems can even be used to operate robotics and smart machinery to automate routine healthcare procedures, thereby freeing up limited healthcare manpower to provide more holistic patient care. As more repetitive clerical work is handled by intelligent computer systems, we will have more time to address patients’ ideas, concerns and expectations and be more humanistic in our practice.

On the flip side, a dystopian future can be imagined: unbridled, error-prone AI systems that are unchecked by ethics, operating in a workspace cohabited with a burnt-out, demoralized and disempowered workforce. Such a scenario does not benefit our patients or health systems. As the provision of healthcare become more intricately woven into the flow of data and information, healthcare providers will need
Doctors need to raise our own data literacy and competency in managing healthcare information, as well as combine bedside knowledge with bench-side capabilities to create AI-augmented healthcare solutions. Singapore can be at the forefront of designing and implementing ethical and robust data strategies across healthcare systems to ensure patients – their data and their interests – are protected. Ethics, professionalism, citizenship and advocacy may become even more vital to good clinical practice.

In conclusion, healthcare is on the cusp of a new exciting age. Healthcare professionals need to strengthen our mindsets, our practice and our capabilities. Singapore can lead the way in implementing real AI solutions to bring benefit to our patients, to be their voice and champion their interests in this brave new age.

Patients may not need a sophisticated AI who knows, but they definitely need an AI-augmented doctor who cares.

References

1. Tan E. Editorial.


