

The *Lancet* Commission on diagnostics: What it means for Singapore

Benjamin Jyhan Kuo¹MD, Inny Busmanis²FAMS, Bien Peng Tan³FAMS, Puay Hoon Tan⁴FAMS,
Wey Chyi Teoh^{5,6}FAMS, Bien Soo Tan^{6,7}FAMS

Effective healthcare systems depend on a functioning healthcare value chain—defined as a care cascade comprising screening, diagnosis, treatment and follow-up. The tremendous heterogeneity and global disparity regarding this healthcare value chain has been one of the fundamental problems with prioritised urgency since the United Nation's Millennium Development Goals were established in 2000 and subsequently revised as the Sustainable Development Goals (SDGs) in 2015.^{1,2} Over the past decade, global health initiatives have developed a disease-centric focus and targeted downstream areas within the care cascade. Numerous commission reports have improved our understanding of the challenges within communicable diseases, child mortality, maternal health and global surgical areas.^{3,4} The reports have garnered financial backing and support from non-profit organisations, risen among government priorities and translated into international healthcare collaborations with improved health outcomes.^{5,6} While this is commendable and encouraging, there is an increasing need to address problems occurring upstream of the healthcare value chain, namely, screening and diagnostics.

Achieving SDG targets and universal health is crucially dependent on strengthening upstream screening and diagnostic areas, primarily along 2 fronts—pathology and laboratory medicine (PALM) and diagnostic imaging (DI). They remain a formidable challenge. For example, a three-part series on PALM in low-income and middle-income countries (LMICs) has highlighted how this crucial area has been largely neglected and severely inadequate.⁷⁻⁹ Access to reliable and prompt PALM services is key for therapy. In a similar vein, a crucial recurrent theme underpinning commission reports, such as the global surgery and oncology commissions, is the limited availability of DI resources in LMICs. The limitation precludes accurate and timely diagnosis of disease conditions, thereby curtailing surgical and

oncologic treatments.^{4,10} The three-part series on PALM concluded by offering a roadmap with tangible metrics and actionable solutions, and challenged the global health community for future concerted efforts to advance the diagnostics agenda.

The *Lancet* Commission on diagnostics (LCD) has recently published its landmark report on the state of global diagnostics (both PALM and DI).¹¹ Given the paucity of data on the availability of diagnostics within LMICs, the commission provides a comprehensive report on the subject and offers a tiered assessment of diagnostic disparity between primary care clinics and tertiary hospitals in LMICs. Diagnostic gaps, a crucial bottleneck in the care pathway in LMICs, were first identified. An estimated 47% of the global population has little to no access to proper diagnostics. The second objective of the report was to examine the complex barriers and factors that hindered the equitable advancement of PALM and DI services. Several factors were highlighted, which included workforce, infrastructure, financing, innovation and government policies. The third objective of the report was to justify the economic need for investing in diagnostics that would yield a net positive benefit-cost ratio in almost all scenarios. For example, a net yield return of USD179.19 can be achieved per USD1 invested in oncology imaging.¹⁰ Finally, the report puts forward a template of recommendations, targeted at both national and international levels, to coordinate and accelerate global efforts to improve equitable diagnostic access that has for far too long been largely left out of the global health conversation.

The COVID-19 pandemic has revealed, through the lens of diagnostics, 2 astonishing realities. One, in the face of intense health and economic pressures, the world was able to innovate, finance and manufacture highly accurate diagnostic tests and vaccines against COVID-19 in record time when it would have normally taken a

¹ Department of Diagnostic Radiology, Singapore General Hospital, Singapore

² Department of Anatomical Pathology, Singapore General Hospital, Singapore

³ Department of Diagnostic and Interventional Radiology, Tan Tock Seng Hospital, Singapore

⁴ Division of Pathology, Singapore General Hospital, Singapore

⁵ Department of Radiology, Changi General Hospital, Singapore

⁶ Duke-NUS Medical School, Singapore

⁷ Department of Vascular and Interventional Radiology, Singapore General Hospital, Singapore

Correspondence: Prof Bien Soo Tan, Department of Vascular and Interventional Radiology, 20 College Road, Academia Level 4, Singapore 169856.

Email: tan.bien.soo@singhealth.com.sg

decade.¹² This highlights the global competency in mobilising international collaborative efforts to swiftly address a pandemic. The second reality, or the unintended consequence of the COVID-19 era response, was the stark differences among economies and demographics with regards to diagnostic access and provision of medical treatment.¹³ The LCD report was timely in revealing the disparity magnified by COVID-19 in diagnostic access among global economies. Many high-income countries (HICs) have existing medical infrastructure, commercial companies with vested financial interest, public health and political interest, robust manufacturing and efficient distribution systems. In many LMICs however, such resources and networks do not exist. As such, a further implication for many LMICs with disproportionately limited COVID-19 diagnostic access and vaccine availability compared to HICs, is that existing global efforts to improve diagnostic equitability will inevitably face significant setbacks.

The wide disparities in diagnostic access and health outcomes that are evident and magnified during the COVID-19 pandemic exist also within HICs. In recognising this issue and in anticipation of future disease outbreaks, Singapore's future transformative healthcare agenda should examine the critical role of diagnostics and include a focus on 3 crucial themes, based on takeaways from the LCD report.

Healthcare workforce expansion and upskilling for contemporary diagnostic skills. Shortages in the diagnostic workforce are contributed by an increased demand in technological capacity for advanced imaging, as well as a stagnating pool of trained radiologists and radiological technicians. Across HICs, the ratio of radiologists per 100,000 population ranges from 4.7 (UK) to nearly 12.0 (Sweden), with 8.7 reported for the US in 2014. A ratio of 8.0 per 100,000 population represents the bare minimum needed to meet the rise in imaging demand by 2022 in the UK.¹⁴ Singapore's ratio of radiologist per 100,000 population in 2014 was 5.2 (total 286 radiologists), which increased to 6.4 in 2017 (total 357 radiologists), and to 7.2 in 2020 (total 409 radiologists).¹⁵ The growth in radiological technicians over the same period was a ratio of 23.8 per 100,000 in 2014 (total 1,300 technicians) to 28.1 in 2017 (total 1,579 technicians), representing a 21% increase.¹⁶ While these growth rates are encouraging, continued efforts to ensure a steady pipeline of next-generation radiologists and radiological technicians will be important.

In the PALM arena, similar shortages are encountered for both pathologists and trained laboratory allied health professionals. Singapore's ratio of pathologist per

100,000 population in 2014 was 2.6 (total 146 pathologists), which increased to 3.1 in 2017 (total 176 pathologists) and has remained at 3.1 in 2020 (total 180 pathologists).¹⁷ For comparison, the ratio of pathologists for the US in 2017 was nearly 4.0 per 100,000.¹⁸ Even in the US, a first-world country, pathologists remain in strong demand.¹⁹ The relative lack of pathologists in Singapore has existed for decades, and while active attempts to train staff internally have partially stemmed the shortage, we remain in a state where pathologist vacancies await to be filled. Therefore, the status quo approaches to training and educating diagnostic specialists, technicians and pathologists are inadequate, and long-term national strategic plans to address this gap should be among the top focus areas for Singapore's future healthcare goals.

Governance and regulatory frameworks to support and oversee diagnostic quality and safety. While Singapore has established government authorities and professional bodies to evaluate the safety and efficacy of diagnostic medical devices, adaptation to the changing diagnostic landscape without being excessively restrictive is needed. Among the changes in public perception and clinical practice of diagnostics is the push for more upstream screening and preventive measures. There should be new regulatory policies and standards that expand the focus on quality, safety and cost containment, and to incorporate rigorous cost-effectiveness analyses that take into account future health benefit and savings.

Furthermore, the pandemic era has accelerated the diagnostic frontier, particularly along the point-of-care (POC) testing front, with innovative self-administered testing. This has addressed previous traditional access barriers. As access to more innovative, decentralised diagnostics become more prevalent, evaluation of their quality, safety and reliability are of paramount importance in future. New channels are needed to streamline and fast-track innovative diagnostic kits, devices and methods for targeting unmet diagnostic needs and patients with barriers to healthcare access, without comprising accuracy and reliability.²⁰

Fostering development and appropriate use of technology to benefit everyone. The shift towards upstream diagnostics is in accordance with the "3 Beyonds" mandate of the Ministry of Health, Singapore: (1) beyond healthcare to health; (2) beyond hospital to community; and (3) beyond quality to value.²¹ A part of bringing patients more value and shifting towards a community-oriented mindset is to first identify those patients most "at risk" of health complications and those who face heightened barriers to diagnostic

access—one of the salient themes in the LCD report. Targeted timely upstream diagnostic access, accompanied by appropriate medical interventions for this patient group, has achieved both better clinical outcomes and economic savings. In Singapore, citizens from lower socio-economic backgrounds may face hurdles to diagnostic access, exhibit health-seeking reluctance and incur significant healthcare costs down the road.²² The future diagnostic agenda initiatives should not neglect this demographic, and should entail proactive education and provision of low-cost health screening of common diseases in a national effort. Similar to POC diagnostics, health technology advances in cutting-edge artificial intelligence and robotics have been exponential during the pandemic, prompted by the need for virtual teleconsultation, social distancing guidelines, workforce shortages and Smart Nation initiatives.²³ While innovation is key to drive diagnostic progress, it is important to consider a tiered network in which technologies are integrated within the existing healthcare infrastructure to maintain cost and ensure the appropriate prioritisation of diagnostic needs and resource allocation.²⁴

Singapore's healthcare has many challenges and its future diagnostic agenda should incorporate elements from the 3 themes outlined above—namely, healthcare workforce, government and regulatory frameworks, and fostering development and appropriate use of technology to benefit everyone. Beyond its own challenges, Singapore is a regional leader in healthcare and as such, there is a moral imperative to leverage its economics and healthcare expertise to collaborate with neighbouring countries to advance diagnostic access in a pursuit of equitable health for all. While the COVID-19 pandemic has exemplified the attainability of global cooperation with regards to streamlining diagnostic and therapeutic advances, it has also magnified the blatant disparities in diagnostic access between LMICs and certain demographic groups within HICs. Without timely intervention, the interdependent nature of both global economy and global health will likely result in further diagnostic disparities. With the LCD report, a framework to transform access to diagnostics has been laid, and a call for Singapore and countries in the region to act and lead for the future of diagnostics is clear.

This article was first presented at “A regional outlook on the global crisis in diagnostics—The Lancet Commission on diagnostics” that was co-organised by the Academy of Medicine, Singapore on 16 February 2022.

REFERENCES

1. Waage J, Banerji R, Campbell O, et al. The Millennium Development Goals: a cross-sectoral analysis and principles for goal setting after 2015. Lancet and London International Development Centre Commission. Lancet 2010;376:991-1023.
2. World Health Organization. Health in the 2030 Agenda for Sustainable Development, 2016. Available at: <https://apps.who.int/iris/handle/10665/252791>. Accessed on 24 January 2022.
3. Black RE, Taylor CE, Arole S, et al. Comprehensive review of the evidence regarding the effectiveness of community-based primary health care in improving maternal, neonatal and child health: 8. summary and recommendations of the Expert Panel. J Glob Health 2017;7:010908.
4. Meara JG, Leather AJ, Hagander L, et al. Global Surgery 2030: Evidence and solutions for achieving health, welfare, and economic development. Surgery 2015;158:3-6.
5. Jumbam DT, Durnwald L, Ayala R, Kanmounye US. The role of non-governmental organizations in advancing the global surgery and anesthesia goals. J Public Health Emerg 2020;4:18.
6. The Global Surgery Foundation. Annual report 2020. Available at: https://static1.squarespace.com/static/5c838b3aab1a621eed7c5c41/t/6113cc8bf3c3bd6de88f039a/1628687503560/GSF_annual+report+2020_compressed_ext.pdf. Accessed on 17 January 2022.
7. Wilson ML, Fleming KA, Kuti MA, et al. Access to pathology and laboratory medicine services: a crucial gap. Lancet 2018;391:1927-38.
8. Sayed S, Cherniak W, Lawler M, et al. Improving pathology and laboratory medicine in low-income and middle-income countries: roadmap to solutions. Lancet 2018;391:1939-52.
9. Horton S, Sullivan R, Flanagan J, et al. Delivering modern, high-quality, affordable pathology and laboratory medicine to low-income and middle-income countries: a call to action. Lancet 2018;391:1953-64.
10. Hricak H, Abdel-Wahab M, Atun R, et al. Medical imaging and nuclear medicine: a Lancet Oncology Commission. Lancet Oncol 2021;22:e136-72.
11. Fleming KA, Horton S, Wilson ML, et al. The Lancet Commission on diagnostics: transforming access to diagnostics [published correction appears in Lancet 2021 Nov 27;398(10315):1964]. Lancet 2021;398:1997-2050.
12. Bok K, Sitar S, Graham BS, et al. Accelerated COVID-19 vaccine development: milestones, lessons, and prospects. Immunity 2021;54:1636-51.
13. Mishra V, Seyedzenouzi G, Almohtadi A, et al. Health inequalities during COVID-19 and their effects on morbidity and mortality. J Health Leadersh 2021;13:19-26.
14. Silvestrin C. Europe's looming radiology capacity challenge: a comparative study, 9 November 2016. Available at: https://www.telemedicineclinic.com/wp-content/uploads/2016/11/Europes_looming_radiology_capacity_challenge-A_comparative_study.pdf. Accessed on 24 January 2022.
15. Cheng LT, Sng LH, Lim TC, et al. Imaging in the Lion City: Singapore radiology country report. J Glob Radiol 2016;2:1029.
16. Allied Health Professions Council. Supplement to the annual report: The registration of diagnostic radiographers & radiation therapists 2016/2017. Available at: <https://www.healthprofessionals.com>.

- gov.sg/docs/librariesprovider5/forms-and-downloads/drrt-registration-report_final-(published)v25174507760eb4e16b1224a68ed5eb9a0.pdf. Accessed on 12 January 2022.
17. Singapore Medical Council. Singapore Medical Council Annual Report 2020. Available at: <https://www.healthprofessionals.gov.sg/docs/librariesprovider2/publications-newsroom/smc-annual-reports/smc-annual-report-2020.pdf>. Accessed on 24 January 2022.
 18. Märkl B, Füzesi L, Huss R, et al. Number of pathologists in Germany: comparison with European countries, USA, and Canada. *Virchows Arch* 2021;478:335-41.
 19. Allen TC. Pathologists will prevail. *Arch Pathol Lab Med* 2020; 144:416-9.
 20. The Academy of Medical Sciences. Improving the Development and Deployment of Diagnostics in Southeast Asia, 23–24 October 2018. Available at: <https://acmedsci.ac.uk/file-download/94242103>. Accessed on 10 January 2022.
 21. Ministry of Health, Singapore. Speech by Minister of State for Health, Dr Lam Pin Min, at the MOH Committee Of Supply Debate 2017: Foundations for a healthier future, 9 March 2017. Available at: <https://www.moh.gov.sg/news-highlights/details/speech-by-minister-of-state-for-health-dr-lam-pin-min-at-the-moh-committee-of-supply-debate-2017>. Accessed on 24 January 2022.
 22. Chan CQH, Lee KH, Low LL. A systematic review of health status, health seeking behaviour and healthcare utilisation of low socioeconomic status populations in urban Singapore. *Int J Equity Health* 2018;17:39.
 23. Gunasekaran DV, Tseng RMWW, Tham YC, et al. Applications of digital health for public health responses to COVID-19: a systematic scoping review of artificial intelligence, telehealth and related technologies. *NPJ Digit Med* 2021;4:40.
 24. Lim BP, Heng BH, Tai HY, et al. Health technology disinvestment in Singapore. *Ann Acad Med Singap* 2018;47:338-44.