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Telesurgery: from Lindbergh to responsible clinical implementation

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Advancing evidence to accelerate universal health coverage

Global surgical inequity remains one of the most persistent and consequential challenges in modern healthcare. Despite significant advances in medical technology and clinical expertise, more than half of the world's population still lacks access to essential health services, and the majority of individuals living in low- and middle-income countries (LMICs) are unable to obtain safe, timely surgical care[1]. This disparity reflects not only limitations in infrastructure and workforce distribution but also structural barriers that prevent specialized knowledge from reaching the populations that need it most. In many regions, treatable surgical conditions continue to evolve into preventable disability and mortality simply because expertise and resources are geographically concentrated[2].

In this context, international collaboration between global health institutions and professional surgical societies may play a critical role in redefining how expertise is distributed worldwide. The partnership between the World Health Organization (WHO) and the Society of Robotic Surgery (SRS) represents an emerging model aimed at exploring how digital health technologies, including telesurgery, teleproctoring, and remote diagnostic services, can contribute to addressing global surgical inequities. By combining WHO's global public health normative guidance with the technical innovation and educational mission of SRS, this collaboration seeks to evaluate how modern surgical technologies can be integrated responsibly into broader health system strategies, particularly in underserved regions.

Importantly, there is a growing demand from countries for these types of digital and remote care solutions[2,3]. These efforts are not driven only by technological innovation, but by country-led priorities to expand access to primary and specialized care while maintaining safety and sustainability. By reducing geographical barriers, telesurgery can contribute directly to UHC objectives, emergency response capacity, and health system resilience. Building on extensive institutional capabilities, WHO addresses regional and system-level needs, while SRS identifies feasible technologies and provides experienced experts capable of supporting implementation in diverse clinical environments[4]. Ultimately, the collaboration further surfaces evidence to drive global policy formation, as well as contextualizing telesurgery innovation to the nuances and needs of communities[5].

The surgical access gap as a barrier to health equity

The global surgical access gap is frequently described as a problem of capacity. Indeed, it is estimated that approximately 143 million additional surgical procedures are required annually to meet existing needs[1]. However, framing the problem solely in terms of procedure volume risks obscuring the fundamental issue. In many settings, the true deficit is not simply the lack of operating rooms, but the absence of integrated systems capable of delivering expertise at the right time and place. Patients are excluded from care not because their conditions are untreatable, but because the surrounding ecosystem, such as trained personnel, diagnostic capability, referral networks, and perioperative infrastructure, does not exist or is geographically inaccessible.

Unfortunately, these consequences extend beyond clinical outcomes. Surgical conditions account for a substantial proportion of global mortality and disability, with an estimated 17 million deaths each year attributable to conditions that require surgical care. In consequence, the burden of disease captures only part of the societal implications[1,2]. Disability-adjusted life years (DALYs) associated with untreated surgical disease represent decades of lost productivity, disrupted lives and family structures, and diminished educational opportunities. In many LMICs, where household financial resilience is limited, the disability of a single family member may precipitate long-term economic instability for all family members.

Equally important is the economic paradox surrounding surgical care. Access is frequently limited not only by workforce shortages but by the financial risks associated with treatment. In low-resource settings, a significant proportion of surgical patients experience catastrophic health expenditures, highlighting that "access" without affordability can perpetuate inequity. Health systems that cannot distribute surgical services equitably risk reinforcing cycles of poverty, where untreated disease undermines both individual livelihoods and national development.

Workforce distribution remains a central determinant of this inequity. The Lancet Commission on Global Surgery proposed a benchmark of approximately 20 surgical providers per 100,000 population as a minimum threshold for adequate coverage[1,2]. Yet in some regions, provider density remains orders of magnitude lower. Such disparities reveal a critical reality: traditional approaches to workforce expansion alone are unlikely to close the gap in the near future. Training additional surgeons, anesthesiologists, and specialists remains essential, but it is a generational solution to an urgent problem that has generated millions of casualties.

Realizing the promise of digital health technologies; a case for telesurgery

Innovations are most effective when deployed with the supporting infrastructure, resource, and policy ecosystems. The structural inequity in global surgical access invites reconsideration of how expertise is distributed and delivered. Advances in digital health technologies, including telesurgery, teleproctoring, telepathology, and remote imaging interpretation, offer a potential mechanism for decoupling expertise from geography[6–8]. Rather than concentrating specialist knowledge within urban tertiary centers, these technologies enable extending expertise across distances in real time, with contributions from others located in remote cities, states, and even countries.

Telesurgery, in particular, represents a conceptual shift in surgical care and the delivery of surgical training. Traditionally, surgical expertise has been inseparable from physical presence, but robotic and telecommunication technologies challenge this assumption by enabling experienced surgeons to guide or perform procedures from remote locations. While still emerging, early experiences suggest that telesurgical systems may function as force multipliers for the global

surgical workforce, allowing experts worldwide to support multiple sites simultaneously[9,10]. A practical example of this approach is the recent FDA IDE-approved telesurgery study connecting the United States and Angola, in which a robot-assisted radical prostatectomy was performed with the primary surgeon operating remotely from the U.S.[11]. This model demonstrates how patients in resource-limited settings with reduced numbers of healthcare providers can access high-level oncologic care that would otherwise not be available locally. This experience serves as a technical and clinical demonstration of feasibility rather than a generalized model for immediate large-scale adoption.

Equally important are the diagnostic dimensions of remote care. Telepathology and remote radiologic interpretation can significantly shorten the diagnostic interval in settings where pathology and imaging specialists are absent. For oncologic patients, whose outcomes often depend on timely diagnosis and treatment, such capabilities may be transformative. Current delays that span weeks or months could be reduced to hours, enabling earlier intervention and more optimized care pathways.

However, technological optimism must be balanced with system-level realism. WHO guidance emphasizes that successful innovation scaling in public systems is contingent upon a multifaceted institutional approach—one that combines governmental leadership, robust and adaptable regulatory frameworks, effective partnerships, and capacity-building. In the case of telesurgery, reliable power infrastructure, secure network connectivity, standardized regulatory frameworks, cybersecurity protections, and sustainable financing models constitute additional prerequisites for the responsible deployment of these services. Without these elements, advanced technologies risk becoming isolated projects rather than scalable solutions. Achieving meaningful adoption will thus require coordinated, multi-stakeholder systems involving policymakers, clinicians, innovators, investors, and researchers. In this context, mechanisms such as the WHO Digital Innovation Investment Platform, connecting policymakers, innovators, the private sector, and investor community to build the foundations for life-saving digital innovations for all may help support the broader ecosystem needed to address fragmented financing, infrastructure limitations, and decentralized implementation efforts[12].

Moreover, the ethical dimension of innovation cannot be ignored[13,14]. New technologies should not merely introduce advanced tools into already privileged environments. Instead, they must be evaluated by their capacity to reduce inequity, particularly for rural and underserved populations. If implemented without deliberate attention to equity, digital health innovations could paradoxically increase disparities by concentrating resources in well-funded centers. When thoughtfully integrated into health systems, however, remote surgical and diagnostic technologies may represent a meaningful step toward redistributing global medical expertise[13]. By enabling real-time collaboration between specialists and local surgical teams, telesurgery can support capacity building, mentorship, and knowledge transfer alongside direct patient care. In this scenario, the technology is not only a clinical tool but also an educational platform that can strengthen local health systems.

Importantly, such innovations should be viewed not as substitutes for local workforce development but as complementary strategies. The ultimate goal remains the expansion of sustainable surgical systems within LMICs. However, while workforce training and infrastructure development proceed, remote technologies offer a pragmatic pathway to reduce the immediate consequences of expertise scarcity.

Addressing global surgical disparity through holistic multi-sectoral collaboration

Reducing global disparities in surgical care requires more than increasing procedure volume or expanding physical infrastructure; it demands innovative strategies that enable expertise to reach patients regardless of geographic location. However, barriers such as limited digital infrastructure, regulatory differences, and workforce training challenges can inhibit adoption. Emerging digital health technologies, including telesurgery, telementoring, and remote diagnostic platforms, offer a potential pathway to extend specialized knowledge beyond traditional institutional boundaries. When integrated within robust health systems and guided by appropriate ethical, regulatory, and technical frameworks, these tools may help redistribute surgical expertise more equitably across regions.

In summary, the collaboration between the WHO and the SRS represents an important step toward exploring how such innovations can be responsibly implemented at a global scale. By aligning technological advancement with public health priorities, this partnership has the potential to promote safer, more accessible, and more sustainable models of surgical care. Moving forward, the field must evolve beyond proof-of-concept experiences toward sustainable and scalable implementation. Frameworks such as WHO guidance on scaling innovations in public health systems may provide a useful structure to support country-led integration of these technologies in a safe, realistic, and equitable way[14]. The success of these initiatives will depend not only on technological capability but on the collective commitment of global health institutions, professional societies, and local healthcare systems to ensure that innovation serves the broader goal of health equity.

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