A Digital Doorway to Global Surgery

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Guaranteeing Access to Safe Surgical Care: A Global Challenge

The concept of healthcare as a universal and inalienable human right dates back to the 1940s. It was, in fact, one of the founding principles of the World Health Organization (WHO), which in its original constitution declared its intention to promote ‘the highest attainable standard of health as a fundamental right of every human being’ [1].

Until very recently, however, surgery was conspicuous by its absence in definitions of specifically what kind of care people should be able to receive. It was due to the work of the Lancet Commission on Global Surgery, with its vision for ‘universal access to safe, affordable surgical and anaesthesia care when needed’, that surgery moved to centre stage, gaining a newfound interest in the global healthcare community [2].

In light of the commission’s work, the World Health Assembly amended its position in 2015, unanimously passing a resolution to recognize surgery within the concept of universal health care (UHC) [3].

The Lancet Commission’s work was based on two key premises: first, that global access to surgery is grossly unequal and, second, surgery’s role in driving better outcomes in healthcare has been drastically underappreciated. The implication is that, unless the structural inequalities in access and quality of surgical services are addressed, the UHC project would be fundamentally undermined. Moreover, populations will not receive the safe, quality surgical care they are entitled to receiving, without appropriate access to surgery.

The sobering conclusions from the Lancet Commission’s findings are now common currency – five billion people, almost three-quarters of the global population, ‘are excluded from what is often life-saving or disability-averting treatment offered by surgery’ [2]. The key reasons for this exclusion range from non-affordable care for services, to a dearth of local provisions with under-resourced and low-quality surgical care. Eyler et al. summarized the issue succinctly – one-third of the world’s burden of disease can be treated with surgery, and yet 70% of the global population lacks access to surgical care [4, 5].

The Lancet Commission also posed the argument that access to surgical services should be enshrined within the broader spectrum of universal rights to healthcare. It also sets ambitious global targets for progress towards universal provisions and what this should encompass by 2030. The commission outlined six key metrics for evaluating achievement (Table 26.1) [6, 7].

The implications of these targets are considerable. There are 143 million additional surgical procedures required each year to balance the deficit. This would require a doubling of the global surgical workforce, a potential cost of $420

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billion, which is separate from the estimated $371 billion required to achieve the UN’s health-related Sustainable Development Goals by 2030 [6, 8].

The Lancet Commission clearly emphasized that lower- to middle-income countries (LMICs) will face the brunt of the challenges in achieving these targets and openly framed the entire project of achieving universal surgical care in terms of redressing the imbalance between developed and undeveloped nations, between rich and poor. There are fundamental disparities which face the healthcare community if surgery is to be included as part of the UHC vision. This is underscored by the fact that three-quarters of the >300 million surgical procedures performed globally are undertaken in the richest 33% of nations. Meanwhile, 6% of surgeries are conducted in the poorest 33% [6].

Table 26.1 Core indicators for monitoring universal access to safe, affordable surgical and anaesthesia care when needed [6, 7]

| Indicator                                      | Definition                                                                 |
|------------------------------------------------|---------------------------------------------------------------------------|
| Access to timely essential surgery             | Two-hour access to the three Bellwether procedures (caesarean delivery, emergency laparotomy, and management of an open fracture) in 80% of countries. |
| Specialist surgical workforce density         | All countries with at least 20 surgical, anaesthesia, and obstetric physicians per 100,000 population. |
| Surgical volume                                | 5000 procedures per 100,000 population in all countries.                  |
| Perioperative mortality rate (POMR)           | Tracked and reported by 100% of countries.                                 |
| Protection against impoverishing expenditure  | No individual or family should be at risk from impoverishment from out-of-pocket payments for surgical care. |
| Protection against catastrophic expenditure   | No individual or family should be put at risk of financial ruin from out-of-pocket payments for surgical care. |

Even developed nations are not guaranteed a smooth path to delivering universal access to safe, high-quality surgical care. The Lancet Commission might have formulated its 2030 vision with the aim of challenging the global community to bring surgical services across LMICs up to a workable level of baseline targets, but for those nations that already satisfy these specific criteria, renewed focus is required to ensure that all surgical provisions satisfy the parameters set forth by the UHC:

- **Equity in access** – access to healthcare services should be universal, not dependent on ability to pay.
- **Guaranteed quality of service** – care should guarantee improvement in the health of those receiving them.
- **Avoidance of financial risk** – the cost of using services should not put persons at risk of financial harm [9].

Even in nations with well-funded healthcare systems, meeting these criteria becomes problematic in the context of surgical provision. In the United States, for example – which, as a percentage of GDP, spends more on healthcare provisions than any other country – the insurance-based, pay-at-the-point-of-delivery system has been linked to widespread inequality in access to healthcare in general. Dickman et al. highlighted that 27 million uninsured US citizens are effectively excluded from healthcare services, while a disproportionate amount of financial harm, extending to indebtedness and, in some cases, bankruptcy, is inflicted upon low-income patients who access healthcare services [10].

Dr. Adil Haidler (Harvard Medical School) has conducted extensive research into racial disparities in surgical access and patient outcomes in the United States, establishing links to socio-economic status, insurance status, and even the quality of care received by patients across differing demographics [11, 12]. By any objective standard, the US healthcare system faces substantial barriers to achieving a universal standard of surgical care.
The United Kingdom, with a free-at-point-of-delivery National Health Service (NHS), provides a contrasting service model to the United States – one that some perceive as an example of equitable, universal healthcare. However, the NHS also has shortcomings, including patient-access restrictions, variance in the quality of surgical care delivered, and, at times, patients placed at financial risk when surgical (and other) services are required.

Well-publicized complaints regarding so-called postal-code lotteries for surgical access across different regions within the UK are supported by academic studies into procedures including aesthetic surgery, cataract correction, gynecomastia reduction, and more [13–15]. Such studies have uncovered wide regional variations in operating criteria, with limitations in funding a frequently cited key factor. There has been ongoing criticism of the individual funding request approach which links provision of specialist treatments directly to cost-efficiencies [16, 17]. In extreme cases, patients are forced into difficult decisions about trying to fund their own treatments privately, raising the spectre of financial hardship often associated with access to surgery in less developed regions.

Limited resource is a key factor that affects access to surgery, even in advanced healthcare systems. For fiscal years 2017–2018, just under half (44%) of UK NHS trusts were in deficit, despite a £1.8 billion cash injection in 2015, aimed at curtailting the overspending gap [18].

A related concern is the shortage of available expertise. The Lancet Commission emphasized that much of the work required to meet the target of doubling the number of qualified surgical practitioners by 2030 would have to transpire in the developed world. According to the Association of American Medical Colleges (AAMC), the United States will need a minimum of 20,000 new surgeons by 2030 to meet the growing demand [19]. In the UK, one in four hospitals remains unable to offer minimally invasive procedures due to a shortage of interventionist radiologists [20].

The strain on surgical resources is, unfortunately, predicted to increase as a result of ageing populations. In the United States, it is forecast that there will be 30 million more individuals aged 65 and over by 2030 [21]. In the UK, the number of people aged 80 and over is expected to double in the same period to reach six million [22]. This shift in demographics will result in specific changes to the healthcare environment. For example, an increase in the prevalence of non-communicable disease is predicted, with greater complexity associated with the treatment of chronic conditions and comorbidity [23]. Surgery is a key part of the treatment pathway for many non-communicable diseases, yet increased age is also associated with greater risk of post-operative complications and longer hospital stays [24]. 

Ageing populations will therefore raise demands in terms of surgical volumes, quality of care, and hospital capacity.

Another important factor influencing ‘postal-code lottery’ variations in access to high-quality surgical care and upholding consistency of standards is due to a lack of consensus regarding the definition of ‘best practice’. Writing in The Lancet, Birkmeyer et al. argued that differences in illness burdens, diagnostic practices, and patient attitudes only have a modest impact on regional variations in the number of surgical procedures being performed, while ‘differences in physician beliefs about the indications for surgery’ demonstrated a much stronger correlation [25].

Appleby et al. cite the work of John Wennberg to suggest ‘that when there is strong evidence and a professional consensus that an intervention is effective, there tends to be little or no variation in clinical practice… admission rates for these conditions can be predicted’ [26]. When there is little evidence and only weak consensus about the efficacy of surgery, on the other hand, decision-making is dependent on the opinions of individual practitioners, leading to high levels of variation in admission rates and surgical outcomes. Even for standardized procedures (e.g., tonsillectomy, appendectomy), without robust professional consensus on the indicators for surgery, a patient’s likelihood of accessing treatment can vary considerably depending on where they happen to live (i.e., a postal-code lottery).
The Role of Technology in Achieving Universal Surgical Care

We can summarize that both the Lancet Commission’s 2030 targets and the WHO’s definition of UHC will require a durable change to the global healthcare framework, a change necessary to assure access to safe and effective surgical services. Key challenges include the following: (a) a shortage in numbers of trained surgeons, (b) an uneven distribution of expertise, (c) funding and resource deficits, and (d) a lack of consensus in best practice. Collectively, these factors can result in disparities in surgical quality of care.

The challenge of making surgery a universal patient right mandates a new paradigm. Such a paradigm should increase resource availability, redistribute surgeon expertise, reduce costs, and, as a result, improve outcomes for patients. It requires an overhaul in capacity, efficiency, collaboration, and capability that industries and service providers are seeking from a digital transformation.

The UK’s Royal College of Surgeons (RCS) launched its own commission on the Future of Surgery to look specifically at the potential impact of technology on surgical services over the next 20 years. The final report defines four key categories of technology which its authors argue will transform surgical provision:

- Robotics and minimally invasive techniques
- Imaging technologies, including the use of virtual and augmented reality
- Intelligence technology utilizing big data, artificial intelligence, and genomics
- ‘Specialist interventions’, under which the commission includes innovations like stem-cell therapies and 3D bioprinting [27]

Overall, the RCS envisions a future where automation, data-driven intelligence, sophisticated imaging, and patient-specific interventions, such as tissue and organ generation for implants, drive better outcomes for the majority of surgical procedures. However, it is not entirely clear that the application of digital technology in this manner will naturally lead to resolution of surgeon shortages, rising healthcare and surgical care costs, and limits to global access. In fact, the RCS foresees that highly specialized interventions will probably remain centralized, with skills and resources concentrated in a small number of locations, requiring patients to travel to receive high-quality surgical care. However, the RCS also concluded that technology, like robotics, ‘could enable more types of routine surgery to be delivered locally if resources are available’ [emphasis added].

It is important to recognize that advanced hardware-based solutions – such as master-slave robotics for minimally invasive surgery – may represent a cost which, for many healthcare environments, is prohibitive. While automation does present one solution to the shortage of surgical expertise, it would take a considerable reduction in costs for such technology to become universally accessible. The report also accepts that, in order for such solutions to be delivered effectively, surgical teams must be made up of ‘multilingualists’ who combine knowledge and skills in medicine, genetics, surgery, radiotherapy, and bioengineering. This imposes an additional burden on the need to develop and distribute expertise effectively. Birkmeyer et al. suggests that new technologies and innovations in techniques can themselves contribute to variation in care because adoption tends to progress in a piecemeal fashion and often without adequate discussion about efficacy and best practice [25].

The key to driving equal distribution of (and access to) surgical care is how to radically scale such services to meet demand while reducing costs. Increasing surgical capacity to the levels set forth by the Lancet Commission and other sources will be contingent upon integration of services [4, 6]. Fortunately, there is a family of affordable technologies readily available worldwide which lend themselves to solving this problem. They are the combination of digital communication solutions and cloud-based software applications that are collectively referred to as telemedicine.

The concept of telemedicine specifically refers to the use of ICT and telecommunication technologies to overcome geographical barriers
to service delivery – such as for the medical/surgeon expert who might be geographically divided from the patient who requires treatment [28]. Bashshur’s definition of telemedicine talks about the use of technology ‘as a substitute for face-to-face contact between provider and client’, with specific benefits listed including improving access, addressing variations in quality standards, and controlling cost inflation [29].

Interest in telemedicine and proliferation of its solutions has accelerated in tandem with the rapid advances in digital communications over the past two decades. Faster Internet speeds, mobile technology, smartphones, livestream video, cloud data networks, and more have opened the door to significant new possibilities in how patients can be effectively connected to healthcare services over distance, as well as to how medical professionals can connect to, and collaborate with, one another. Typical patient-focused applications for telemedicine include self-diagnosis and health management routes which empower people to make better informed decisions about their own care through online information pathways, remote monitoring through wearable health-tech devices, and remote consultations via video, online messaging, or even social media networks. For healthcare professionals, tele-medical applications extend from the now commonplace use of online reference materials in making day-to-day decisions about care, to using digital collaboration platforms to connect colleagues across different clinical settings, to the use of digital resources in education and training [30].

To date, much of the academic interest in how these principles can be applied specifically to surgery – a field often referred to as telesurgery – have narrowed around the use of robotics to enable surgery to be managed remotely [31]. While robotic telesurgery may contribute to tackling the geographical barriers which prevent high-quality surgical access, and while robotics may solve, to some degree, the problem of surgeon shortage, focusing on this technology alone will not adequately address the core challenges of access, shortages of expertise, and variations in standards and cost, which collectively pose impediment to universal patient access to top-level surgical care. Thus, robotic surgery alone does not address the critical issue of needing to train more surgeons so as to increase the global pool of available surgical expertise [32, 33].

This is why, in order to unlock the digital doorway to global access to quality surgical care, the definition of telesurgery should be redefined to include other technologies, namely, digital technology that centres upon communication, collaboration, and information exchange. It is these technologies which are crucial in meeting the challenges outlined by the Lancet Commission and by the definitions of UHC.

A Cloud-Based Communications Platform (Proximie)

Proximie (London, UK) is a cloud-based audio-visual (AV) communications platform which supplements livestream video with augmented reality (AR). It takes the form of an app that can be downloaded on any suitable internet-ready device with a camera and a screen – such as a laptop, tablet, or smartphone. It can be used equally for real-time communication, collaboration, and video recording – with AR providing a rich digital overlay in either case. The Proximie app, therefore, comprises six core component technologies. They are as follows: (1) real-time remote communication (RTRC), (2) AV, (3) AR, (4) cloud computing, (5) ML, and (6) AI. These core components are familiar across a range of telemedicine solutions. Each can be seen to make a distinct contribution to solving the challenge of universal surgical provision. ML and AI can also further enhance the telemedicine experience by providing real-time guidance to surgeons. For instance, Fig. 26.1 demonstrates the capabilities of ML and AI as applied to polyp recognition.

Proximie was developed to help improve access to surgery. Its founding objective was to give surgical practitioners (residing in different locales) a platform that provides an interactive experience, reliable enough to allow them to collaborate on live procedures in real time, overcoming the common problem of not having a
particular specialist available. Rather than waiting for a specialist to become available, or forcing a patient to travel for care, expertise can be ‘beamed in’ from varying geographical locations. In this manner, surgeons are able to effectively consult, directly guide, mentor, and demonstrate operations in such a way that they can be safely performed in local (underserved) healthcare environments (please refer to Fig. 26.2).

AR plays an important role in replicating the ‘live’ experience, substituting a colleague’s actual physical presence in the operating room with sophisticated telepresence. This can be accomplished with tools such as digital markup of a live video image, gesture-activated demonstration, and the ability to post digital content directly to the feed. Via their cameras and screens, remote colleagues are able to interact on a more meaningful level than just watching a plain video feed and simple voice telecommunication.

RTRC technologies help to overcome geographical barriers to surgery by eliminating the inefficiency associated with waiting times and travel. This applies to all stages of the patient journey. Audiovisual communications allow for the possibility of consultants carrying out patient assessments remotely, drastically reducing the time it takes to make decisions about surgical pathways when an appropriately qualified specialist is not available at a particular hospital [34].

Many of the elements of high-quality surgical care are related to planning, preparation, and sharing of expertise. Hence, the use of technology to enable effective collaboration (wherever practitioners happen to practice) will shorten delivery cycles and increasingly ensure complex procedures can be delivered in more locations. Better communication thus answers the Lancet Commission’s call for surgical services to be more tightly integrated across all levels of care –
from community referral networks to specialist surgical teams [6].

There is an important role for RTRC technologies in enabling ‘tele-live’ procedures, by connecting practitioners to remote experts as they operate: the virtual equivalent of the consultant ‘looking over the shoulder’ in the operating room. But this, alone, will not resolve all challenges of providing universal surgical care. Geographical barriers to access are, in part, caused by shortages and uneven distribution of surgical expertise. The only sustainable remedy to this dilemma is to increase the global surgical skills base, by training more surgeons, and by expanding the range of procedures they are able to perform. Communications technologies, and AV platforms in particular, have a well-established role in surgical training and skillset development, providing a means of sharing knowledge more broadly.

In general terms, the use of video technology in surgical education is widely associated across academic studies with improved resident knowledge and greater participant satisfaction [35]. Recorded video is widely used in peer-to-peer coaching across all levels of expertise [36]. Studies into the use of video review of procedures in training and development indicates better learning outcomes, with coaches and mentors able to make more teaching points per unit of time, compared to conventional feedback and guidance given during a procedure. Video reviews result in improved technical, cognitive, and decision-making skills [37, 38].

Recorded video thus provides an invaluable resource which is helping to strengthen surgical skills globally. But by combining video with RTRC technologies and also making livestreaming a core part of training and education, a radical overhaul of how surgical skills, standards, and how best practice are disseminated can be achieved. Ultimately, this will overcome barriers (imposed by geography) to facilitate a truly global flow of expertise.

As an example of real-world application, Proximie has been used in training programs at major academic centres (e.g. University College London and Yale University) to allow trainee surgeons to observe procedures carried out by specialists based in distant hospitals. Through the lens of AR enhancement, an immersive, interactive learning experience helps bridge the divide between theory and practical application. Tantamount to ‘tele-observation’, dozens of students can watch and learn at once – rather than the otherwise 1–2 who might be present in the operating room. Knowledge therefore spreads further and faster.

Proximie applications have been used in transnational mentoring projects to help connect globally recognized experts with local surgical teams. In Peru and Vietnam, for example, the Proximie app was used to connect local surgical teams with academic centres in the United States and UK. The remote development program at the EsSalud Hospital in Trujillo, Peru, led to the team achieving a significant increase in the number of cleft lip and cleft palate corrections it was able to perform, as a direct result of long-distance professional dialogues around best practice and via remote coaching.

Similarly, the International Society for Hip Arthroscopy (ISHA) has adopted Proximie as a means of connecting members across four continents, with the aim of establishing best practice principles and enabling effective collaboration. The organization uses both livestream and recorded video to conduct live and ‘as live’ training and development conferences, creating a platform for global specialists to demonstrate and discuss surgical techniques and procedural nuances in the OR. This directly aided ISHA in promoting global standards in patient care, reducing variations from region to region (by connecting practitioners in real time), and extending the professional community beyond the boundaries of a particular hospital or department.

Finally, in the context of making access to surgery a universal right that people in all parts of the world can benefit from in practice, it is important to emphasize that the digital technologies highlighted herein come with an additional cost burden (albeit minimal) and indeed may even help to improve cost-efficiency overall. The assumption is often that technological solutions are expensive, require large amounts of complex
equipment, and may require years of implementation before value is achieved. But in this paradigm of telesurgery, that may no longer be a valid assessment.

Solutions which are built on readily available, affordable technologies that have become part of the fabric of everyday life – the Internet, laptops, smartphones, digital cameras – may not impose a significant new cost. Cloud-based software is not only highly cost-effective, it is also easily accessible to anyone with an Internet connection and enormously scalable – exactly what is required when we are aiming to extend surgical services to tens of millions of people worldwide and improve access and quality for those who already have it. Moreover, because these existing technologies are already familiar to surgeons and healthcare providers, they are immediately ready for rapid adoption.

**Conclusion**

Achieving global standards in surgical care, allowing for safe, universal access is a daunting challenge. What is clear from the scale of the task to 2030 and beyond is that old models of surgical provision must be updated and replaced by approaches that suit a truly global vision. The solution will require the use of digital technology integration across disciplines, across departments, between hospitals, regions, and nations. The paradigms described herein, increased availability of surgical expertise, standardized practice, and improved resource efficiency will all allow surgery to become more widely accessible.

In order to achieve the aims of better integration, improved collaboration, expanded knowledge sharing, and open surgeon dialogue, digital communication technology is essential. Ultimately, digital-based communication and apps represent the key which unlocks the global doorway to surgical care. It is integral to resolving the problem of surgical access. By providing remote access, timely support, open knowledge exchange, and a networked infrastructure, technology can increase the availability of surgery and quality of care without the need for an unsustainable increase in human or capital resources.

At the time of writing, telemedicine is actively being employed to respond to one of the greatest challenges ever faced by modern healthcare systems: the COVID-19 global pandemic. As the relentless spread of the virus threatens humanity as a whole, the need for clinicians and surgeons to connect remotely has never been more vital. Telemedicine is enabling healthcare providers to access expert advice and best practice solutions in real time while also containing viral spread by reducing the number of individuals required to be physically present in a clinical space. In March 2020, during the midst of the pandemic, Proximie was employed by a cardiothoracic surgeon in Beirut to connect with a medical device expert in order to perform a life-saving novel mitral clip surgery, a procedure that would have otherwise been impossible in light of the current travel restrictions. It is during these critical times, when healthcare communities must stand shoulder to shoulder, that we can recognize the true value of augmented technology solutions and appreciate their role in providing access to surgical care for all patients, regardless of location.

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