



Editorial

No Patient Left Behind: Addressing the Global Shortage of Cardiac Surgical Teams

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Academic Editor: Giuseppe Santarpino

Submitted: 21 November 2025 Revised: 11 December 2025 Accepted: 18 December 2025 Published: 16 March 2026

1. Introduction

Cardiac surgery provides life-saving treatment for newborns with complex congenital heart defects (CHDs) and for adolescents and young adults with rheumatic heart disease (RHD). CHD accounts for nearly one-third of all congenital abnormalities [1], whereas RHD is the leading cause of youth cardiovascular morbidity in low- and middle-income countries (LMICs), associated with an estimated 319,400 deaths in 2015 alone [2]. Acquired cardiovascular disease has been declared a public health crisis globally, with 19.2 million cases annually, a sharp increase from 13.1 million in 1990 [3]. Yet, a severe global shortage of cardiac surgical teams leaves billions of people without access to life-saving interventions [4]. This shortage is not limited to surgeons but also encompasses the entire multidisciplinary heart team, including anaesthetists, cardiologists, intensive care unit (ICU) personnel, perfusionists, technicians, and nurses.

In this editorial, we discuss the extent of the worldwide workforce gaps in adult and pediatric cardiac surgery, deficiencies in training programs, issues of underrepresentation and lack of diversity within the field, economic constraints, and disparities in career development. We conclude with recommendations to bridge these capacity gaps to help ensure no patient is left behind.

2. The Heart Team

Worldwide, the cardiac surgery workforce remains far short of what is necessary to deliver adequate care. Recent estimates indicate that around six billion people lack timely access to cardiac surgical care when it is needed — a figure that reflects the mismatch between the burden of cardiac disease and available services [4]. In 2017, roughly 12,000 adult cardiac surgeons and 4000 pediatric cardiac surgeons were practicing worldwide, yet the availability of a cardiac surgeon per million population was 140–180 times higher in high-income countries (HICs) compared to low-income countries (LICs). A recent appraisal of the pediatric car-

diac surgery workforce found that some LMICs reported just 0.13 congenital cardiac surgeons per million population, compared to 8.68 per million in HICs [5]. South Asia alone accounts for roughly 28–30% of the world's congenital heart disease population, yet the region carries only about 15% of the global pediatric cardiac surgical capacity [5]. More than half of the countries and territories in the world have no cardiac surgeons at all, forcing patients to rely on visiting teams or to go without care [4]. The situation represents a profound deficit in global health capacity, contributing to preventable deaths in both children and adults with heart disease.

Historically, global health efforts in cardiac care focused more on children through international visiting teams. Of the 86 international NGOs providing cardiac surgical care in LMICs, 81 deliver pediatric cardiac surgery [6]. However, the burden of adult cardiac disease, including coronary artery disease, degenerative and rheumatic valvular heart disease, and heart failure, is significant and growing in LMICs. By 2030, over 80% of cardiovascular disease will occur in LMICs [7]. There are, however, successful examples demonstrating how partnerships can improve local capacity. Programs such as the Narayana Health model in India have shown that high-volume, high-quality cardiac surgery can be delivered sustainably in low-resource settings with stable funding, mixed private-public subsidization, and national government investments.

The workforce shortage extends beyond surgeons. Although data on anaesthetists, perfusionists, and other allied personnel are limited, the evidence indicates that they are also critically lacking in regions with the greatest needs [8]. For example, many LMICs have few or no cardiac anaesthetists or perfusionists in-country. A recent workforce assessment noted that while HICs train and employ substantial numbers of cardiac anaesthetists and perfusionists, most LMICs lack even a single specialist [8]. It is reported that one in five cardiac anaesthetists practice in hospitals where fewer than one hundred cases are performed each year. Of those, less than a third perform pediatric cardiac surgery,



and another third perform fewer than one hundred cases a year [8].

Even with appropriate infrastructure, human resources remain the critical component: without trained staff to run heart-lung machines or post-operative ICU care, cardiac surgery cannot be delivered. The loss of skilled professionals to HICs exacerbates the disparity in the ability to deliver care. Current workforce figures highlight a significant disparity between population demand and the capacity of cardiac surgical teams — a divide strongly rooted in a country's economic development and global geographic inequities. While the shortage of personnel is often framed as a workforce problem, it is fundamentally a health systems issue. Practical solutions must include structured international accreditation pathways that allow temporary deployment of allied cardiac professionals to underserved regions. Ministries of health must incorporate cardiac surgery into national non-communicable disease strategies, allocate ring-fenced budgets for ICU infrastructure, and establish long-term workforce planning models.

3. Training Programs: Variation, Scarcity, and Barriers

A major contributor to the workforce shortage is the limited and uneven training opportunities in cardiac surgery globally. Training pathways vary drastically by country and region. In some HICs, cardiac surgery training is highly structured (lengthy residency and fellowship programs with a well-defined curriculum), whereas in many LMICs, formal cardiothoracic training programs are few or non-existent [9]. For example, some regions have no dedicated cardiac surgery residency, instead offering a more research-oriented “Master’s in Surgery” degree with minimal cardiac exposure [10]. As a result, young surgeons in these countries are often unable to complete their entire cardiac surgery training locally and must seek opportunities abroad — a path accessible to only a limited number of trainees.

Where training programs do exist in LMICs, they are often concentrated in a few urban centers and may lack resources or case volumes [11]. Trainees in these settings may not obtain adequate hands-on experience with complex cases or newer technologies. This contrasts with training in higher-volume centers in HICs, where exposure is broad. A global survey [12] found wide variations in training program length, trainee autonomy, and supervision. Many trainees from LMICs reported traveling to multiple centers, sometimes in different countries, to acquire comprehensive skills.

Significant administrative and logistical barriers impede access to quality training for those from underserved regions. Visa regulations often pose a major hurdle. Licensing and examination requirements are another barrier; foreign medical graduates frequently must pass challenging exams and language proficiency tests to be eligible for

training posts in HICs. Even when they succeed, host country regulations might limit them to observer status due to medico-legal concerns regarding licensing. Another major constraint is cost; not all training programs provide a salary, and some require trainees, particularly international applicants, to pay substantial tuition or placement fees. In addition to relocation, licensing, and visa expenses, these financial demands can amount to significant personal debt. For many candidates from LMICs, the economic burden alone is enough to prevent them from pursuing cardiac surgery training, further narrowing the global pipeline of future surgeons.

Language and cultural barriers also play a role. Training in a foreign language or adapting to a different clinical culture can be daunting. There may be subtle biases or a lack of inclusive support in some training environments for international trainees. Collectively, these factors contribute to significant attrition: even among the few individuals from LMICs who manage to secure training abroad, many are unable to complete it or return home to practice.

Current training programs are insufficient in number and accessibility to produce the volume of cardiac surgical providers needed globally. LMICs have extremely scarce local training slots — this requires active governmental involvement in national policies that standardize the surgical curriculum, guarantee sufficient case exposure, and secure reliable funding for trainers and trainees.

4. Persistent Gender Disparities Inhibiting Female Surgeons

The existing cardiac surgery workforce is marked by a striking under-representation of females. Cardiac surgery has historically been one of the most male-dominated surgical specialties, and despite some progress, the sex gap remains wide. A recent global analysis revealed that females constitute only about 8% of the worldwide cardiac surgical workforce [13]. In some regions, the disparity is even more acute — for example, less than 5% of cardiac surgeons in much of Africa are females, reflecting both cultural barriers and lack of mentorship for females in these countries [5]. A global census of pediatric cardiac surgeons found that 93.4% of surgeons were males [5].

Even in HICs, although females make up over 50% of medical students in the United States and Canada, only a small minority pursue cardiac surgery [14]. Even in these nations, where efforts toward gender inclusion are more developed, females represent approximately 8% of adult and 6% of practicing pediatric cardiac surgeons [5,13]. This highlights a pipeline deficiency in cardiac surgery training — for example, over half of medical students are females, but females make up only 21% of cardiothoracic surgery residency applicants, and 5% of practicing cardiothoracic surgeons in the United States [15]. In Canada, the number of female applicants to cardiac surgery programs has been steadily increasing to near-parity [14]. Moreover, match-

ing rates between male and female applicants are comparable, suggesting that selection committee bias may not be a primary barrier. Primary barriers for females pursuing cardiac surgery relate largely to social factors, and this gender gap is perpetuated by outdated views on family dynamics, the lack of opportunity for career advancements, and the scarcity of female cardiac surgeons in leadership and mentorship roles [16]. Addressing these systemic barriers and disheartening statistics is crucial to ensuring that the potential of female surgeons is fully realized and that patient care benefits from a more diverse and more qualified surgical workforce are provided. Targeted interventions, including funding early-career research fellowships for females, and structured mentorship programs pairing female trainees with senior surgeons, could substantially strengthen recruitment and retention.

4.1 Representation and Diversity in the Cardiac Surgery Workforce

Sex and gender are not the only deficiencies in which representation is lacking. Racial, ethnic, geographic, and socio-economic diversity also remains limited within cardiothoracic surgery. This lack of diversity is significant, as evidence suggests that alignment between clinician and patient backgrounds can enhance trust and improve health outcomes, and that diverse teams are associated with greater innovation [17].

Representation also varies widely within a country, with rural populations often lacking access to the specialist workforce. In many cases, this is due not to a lack of willingness or training, but to the structural and logistical challenges of establishing and sustaining advanced surgical services in remote settings. Geographic disparities within countries also contribute to the migration of talent, as promising trainees from under-resourced areas are often required to relocate to wealthier urban centers or even abroad for training, with many ultimately unable or unwilling to return to serve their home regions. This urban concentration of the workforce further exacerbates inequitable access to care for rural populations.

Furthermore, some countries rely on expatriate or foreign surgeons to run programs. While visiting specialists play an important role, the optimal approach is to train local surgeons who are familiar with local needs and realities. Ultimately, the cardiac surgery workforce suffers from a representation deficit that mirrors and reinforces broader inequities. Addressing these imbalances is not only a matter of fairness and professional inclusion but also crucial for improving patient outcomes and workforce sustainability. Prioritizing diversity allows systems to attract and retain the best talent in cardiac surgical teams [16]. Efforts such as mentorship programs for female medical students, outreach to underrepresented minorities, and policies encouraging distribution of trainees across regions are steps in the right direction, but much more remains to be done to

create a workforce truly representative of the populations being served.

4.2 Economic Barriers to Training and Practice

Compounding these challenges is the harsh reality that economic barriers continue to dictate who is able to enter and sustain a career in cardiac surgery. Training in cardiothoracic surgery is long and costly, and this is particularly prohibitive for those from low-income backgrounds. Many surgical trainees from LMICs receive only modest (or no) stipends during training, and they must often cover exam fees, travel, and sometimes even basic equipment out-of-pocket. Unlike in HICs, where residents are salaried, a trainee in some LMICs may have to work without pay or pay tuition to the training institution — essentially “pay-to-train” [18]. Such unpaid or fee-based training programs naturally exclude those who cannot afford to support themselves and their families for years with no income. This economic filter means many promising doctors never specialize in cardiac surgery because they simply cannot manage the costs.

Even after qualification, economic factors influence career trajectories. In LMICs, cardiac surgeons and their team members may earn relatively low salaries, leading some to seek opportunities abroad for better pay, further depleting the local workforce. Additionally, a lack of funding for cardiac surgery programs means new graduates may not have a job to step into, as governments may fund only a few cardiac surgery positions nationally. Those who do practice often work in the private sector or in urban hospitals serving wealthier patients, as public sector salaries are not competitive. This dynamic can leave the public health system without specialists or push surgeons to split time between public and private practice, limiting productivity. Retention can be strengthened by tiered salary structures and performance-linked incentives for surgeons practicing in underserved, high-demand regions. Remote and virtual surgical training programs have also successfully expanded capacity in LMICs by enabling trainees to acquire technical skills irrespective of geographic limitations [19].

5. Conclusion

The global shortage of adult and pediatric cardiac surgical teams represents an urgent global public health crisis that necessitates immediate intervention. To effectively reduce this shortage, work over the next decade must focus on coordinated efforts to expand local training capacities, enhance access to international educational opportunities, and address barriers faced by under-represented groups within cardiac surgery. International societies and governments should coordinate the development of accreditation pathways enabling temporary deployment of allied cardiac professionals to underserved regions, while expanding remote and virtual surgical training programs that have already demonstrated success in building capacity. Central

to this effort is the establishment of fully funded regional training hubs in LMICs, ensuring that trainees can complete comprehensive, high-volume training without leaving their home regions. Sustainable progress will require a holistic response to the interdisciplinary forces undermining these shortages, acknowledging that building capacity must extend beyond surgeons and to all members of the heart team. Only then can we truly ensure life-saving care for patients around the world, leaving no community and, indeed, ensuring that no patient is left behind.

Author Contributions

JF, VJ, VM and DV participated in the conception and writing of the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

Not applicable.

Acknowledgment

Not applicable.

Funding

This research received no external funding.

Conflict of Interest

The authors declare no conflict of interest. Dominique Vervoort is serving as one of the Editorial Board members of this journal. We declare that Dominique Vervoort had no involvement in the peer review of this article and has no access to information regarding its peer review. Full responsibility for the editorial process for this article was delegated to Giuseppe Santarpino.

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