Barriers to Access to Cardiac Surgery: Canadian Situation and Global Context

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5.02 cardiac surgeons per million
32 cardiac centres, urban-rural divide
UHC model, Funding constraints
High-quality care, long wait times
Robust data, poor interoperability
HTA, regionalization of care

100+ countries without cardiac surgeon
Fragmented supply chains
Scarce funds, variable coverage
High rates of loss-to-follow-up
Limited data infrastructures
Minimal political prioritization

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Cardiovascular disease (CVD) remains the leading cause of morbidity and mortality worldwide. More than 18 million people die each year from CVD, whereas several hundred millions of people live with CVD.1 In Canada, 2.6 million people live with a CVD, and an average 14 adults die every hour as a result of CVD.5 Cardiovascular diseases have care needs across the health care system, ranging from primary and secondary prevention to primary, secondary, and tertiary care, each having different barriers and gaps. Tertiary care, in particular cardiac surgical and interventional cardiology care, presents unique challenges as a result of its cost and complexity. Globally, 6 billion people lack access to safe, timely, and affordable cardiac surgical care when needed, a majority of whom live in low- and middle-income countries (LMICs).3,4 Access to surgical care differentially affects populations living in different countries. In Canada, for example, access to health care services is largely favourable, and Canada’s health care system has been a leading model globally owing to high rates of population coverage under its universal health coverage (UHC) model.6 Despite this—or because of it—gaps in care persist and remain understudied in Canada, especially compared with the United States, where financial barriers to care are prevalent, and LMICs, where overall access to care is comparatively poorer.

In this narrative review, we discuss access to cardiovascular surgical care in Canada and globally in terms of distinct aspects of health care systems. In addition, we present persistent knowledge gaps requiring further study and highlight opportunities for improvement to leave no patient behind. Surgical care is often life-changing or life-saving for those requiring intervention, but we acknowledge that access to surgical care is only the tip of the iceberg for patients’ overall cardiovascular care needs.
Only around one-third of the world’s countries provide some form of UHC, leaving most of the world’s population burdened with financial and other barriers to care. Approximately one-half of the world’s population cannot access essential health services for a variety of reasons. In Canada, direct surgical costs are covered under the Medicare UHC model. However, other barriers prevail. Canada is the second-largest country worldwide but has the lowest population density. Institutional capacity in terms of both human and physical resources and the quality of care are favourable compared with most countries, but resources and outcomes vary by institution, and the health care workforce has been strained by the COVID-19 response, its own ageing with that of the population, and burnout. Finally, UHC is largely socially accepted, but long waiting times have resulted in growing dismay about the Canadian health care system, whereas the neglect of non-Western (eg, Indigenous) worldviews in health care results in the marginalisation of certain populations. As such, a comprehensive dissection of health care systems from a cardiac surgical perspective is necessary.

National Surgical, Obstetrical, and Anaesthesia Plans (NSOAPs), proposed by the Lancet Commission on Global Surgery, are strategic long-term policy plans embedded within national health plans with the aim of strengthening surgical systems. These plans are developed by countries to be context specific, meeting local needs and priorities, but, all NSOAPs have 6 key pillars: workforce, infrastructure, financing, service delivery, information management and technology, and governance. We discuss access to cardiac surgery in Canada through these 6 pillars. Furthermore, we present a comparison with other high-income countries as well as LMICs. However, an in-depth discussion of these 6 pillars for other countries falls outside the scope of this article and has been previously reported for LMICs.

**Access to Cardiac Surgery in Canada**

**Workforce**

High-income countries have, on average, 7.15 cardiac surgeons per million population compared with 0.04 per million population in low-income countries. Canada has nearly 2 fewer surgeons per million population compared with the high-income country average. Evaluating the Directory of the Royal College of Physicians and Surgeons of Canada, there are a total of 203 clinically active cardiac surgeons across Canada, averaging 5.02 per million population and ranging from 3.70 per million in Newfoundland and Labrador to 7.48 per million in Nova Scotia (Table 1). Within the workforce, there remains underrepresentation of women and Indigenous and other non-White communities. For example, only 11% of surgeons in Canada are women, with a minority of them in leadership positions (8% of program directors, 6% of division chiefs). Yet, sex discordance between surgeons and patients is associated with an increased risk of death, readmission, and complications following cardiac surgery, highlighting the importance of a representative and inclusive workforce.

Modelled data has suggested future shortages in the cardiac surgical workforce in Canada by 2025, growing to as high as half the workforce, although a recent upward trend in the number of residency applications and filled spots may slow down or even prevent such shortages. Reviewing the Canadian Resident Matching Service (CaRMS) through 2022 suggests improvements in the interest in but not available number of residency spots for cardiac surgery. From 2008 (10 applicants) to 2022 (24 applicants), a gradual increase in the number of applicants through CaRMS was observed (Fig. 2), although the quota of positions remained static at 8 to 12 spots per year, with 45.5% (2009) to 100.0% (2016-2020 and 2022) filled during the first iteration. Applicants ranking cardiac surgery as first choice grew from 5 (50.0%) in 2008 to 16 (66.7%) in 2022.

Data on other members of the Heart Team are more scarce globally, limiting comparisons. Canada has 1596 active cardiologists based on Royal College Fellowship status, including an unspecified number of interventional cardiologists. Although no data on cardiac nursing staff are available, Canada has 10.1 nurses per 1000 population. This compares favourably against the OECD average of 9.4 nurses per 1000 population, but remains below that of the United States (12.0 nurses per 1000 population) and estimated needs. It is estimated that by 2030, Canada will have a shortage of over 100,000 nurses.

**Infrastructure**

There are 32 hospitals that perform cardiac surgery in Canada. As such, Canada has 1 cardiac centre per 1.26 million population or 0.79 cardiac centres per million population, which is slightly more than the global average of 0.73 centres per million population. In contrast, the United States has 1 centre per 120,000 population or 8.33 per million, which is a result of the lack of regionalisation models such as those observed in Canada. Rates in provinces with available centres range from 0.42 centres per million population in Alberta to 1.85 per million in Newfoundland and Labrador (Table 1). Provincial densities are slightly overestimated, because centres cover patients from regions without local capacity. For example, patients from Prince Edward Island are typically treated in New Brunswick and Nova Scotia. Similarly, patients from Yukon, Nunavut, and Northwest Territories seek care in bordering provinces. In addition to adult cardiac surgical centres, Canada has 9 hospitals performing paediatric and congenital heart surgery.

High-quality postoperative care is also crucial to favourable outcomes after cardiac surgery. A significant cause of perioperative morbidity and mortality is the inability to rescue patients from complications that are potentially reversible. Canada has 13.5 intensive care unit (ICU) beds per 100,000 population. Although in line with many other high-income and Organisation for Economic Cooperation and Development (OECD) countries, Canada’s critical care capacity still falls short compared with the United States, which has 34.7 ICU beds per 100,000. There also exists significant variation across provinces and territories in Canada, with western and central provinces having lower capacities than Atlantic provinces, and a North-South gradient with hospitals outside large cities having lower ICU capacity. These variations may reflect the inability to promptly increase critical care capacities to meet the increased demands of a fast-growing and ageing population.
Furthermore, there is a continuing undersupply of medical imaging equipment in Canada. Among OECD countries with information, Canada ranks 30th in the number of computed tomography (CT) units per million population and 26th in magnetic resonance imaging equipment. There is also marked variability in the availability of advanced imaging modalities among provinces in Canada: For example, Newfoundland and Labrador has the highest reported inventory of CT scanners, with 28.7 units per million population, and Ontario has the lowest, 11.5 per million. In addition, the imaging equipment is ageing in Canada: 32.4% of CT units are more than 10 years old, exceeding the proposed life expectancy as set in the guidelines by the Canadian Association of Radiologists. Geographic variability in the availability as well as ageing equipment is also seen for other imaging modalities.

Finally, postacute cardiac care provides support to patients who do not require further acute care hospitalisation. These services improve patient recovery and functioning after cardiac surgery and reduce hospital readmissions. Postacute cardiac care options include inpatient and outpatient cardiac rehabilitation facilities, long-term care hospitals, and nursing homes. Provision of postacute cardiac care services is excellent in Canada. There are around 220 cardiac rehabilitation programs that serve more than 50,000 new patients per year. However, because of the geographic diversity and varying population densities, considerable variability exists in access to cardiac rehabilitation across provinces. Nova Scotia has the greatest density, with 2.8 facilities per 100,000 population, and Newfoundland has the least, 0.2 facilities per 100,000. Notable geographic variability also exists in access to nursing homes or continuing care facilities across the provinces.

Financing

Canada spends approximately 11.7% of its gross domestic product (GDP), or US$6,086 per capita, on health care. In comparison, the OECD average is 13.9% of GDP and US$5,293 per capita. When adjusting for population pyramids (ie, percentage of the population aged 65 years and older), Canada spends the highest proportion of GDP on health care.

Table 1. Cardiac surgical workforce and infrastructure in Canada by province and territory

<table>
<thead>
<tr>
<th>Province or territory</th>
<th>Population</th>
<th>No. (density) of cardiac surgeons</th>
<th>No. (density) of cardiac surgery centers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provinces</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alberta</td>
<td>4,744,283</td>
<td>22 (4.64)</td>
<td>2 (0.42)</td>
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<tr>
<td>British Columbia</td>
<td>5,568,971</td>
<td>27 (4.85)</td>
<td>5 (0.90)</td>
</tr>
<tr>
<td>Manitoba</td>
<td>1,466,891</td>
<td>9 (6.14)</td>
<td>1 (0.68)</td>
</tr>
<tr>
<td>New Brunswick</td>
<td>843,318</td>
<td>5 (5.93)</td>
<td>1 (1.19)</td>
</tr>
<tr>
<td>Newfoundland and Labrador</td>
<td>540,569</td>
<td>2 (3.70)</td>
<td>1 (1.85)</td>
</tr>
<tr>
<td>Nova Scotia</td>
<td>1,069,008</td>
<td>8 (7.48)</td>
<td>1 (0.94)</td>
</tr>
<tr>
<td>Ontario</td>
<td>15,746,134</td>
<td>74 (4.70)</td>
<td>11 (0.70)</td>
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<tr>
<td>Prince Edward Island</td>
<td>175,985</td>
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<td>0 (0.00)</td>
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<tr>
<td>Québec</td>
<td>8,934,770</td>
<td>48 (5.37)</td>
<td>8 (0.90)</td>
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<tr>
<td>Saskatchewan</td>
<td>1,219,182</td>
<td>7 (5.74)</td>
<td>2 (1.64)</td>
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<td>Territories</td>
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<tr>
<td>Northwest Territories</td>
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<td>0 (0.00)</td>
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<tr>
<td>Nunavut</td>
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<td>0 (0.00)</td>
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<tr>
<td>Yukon</td>
<td>45,219</td>
<td>0 (0.00)</td>
<td>0 (0.00)</td>
</tr>
<tr>
<td>Canada (total)</td>
<td>40,440,422</td>
<td>203 (5.02)</td>
<td>32 (0.79)</td>
</tr>
</tbody>
</table>

Densities are presented as numbers per million population. Population data obtained from Statistics Canada as of October 25, 2023.

Figure 1. Clinically active adult cardiac surgeons per million population across Canada based on the Directory of the Royal College of Physicians and Surgeons of Canada. Map created with mapchart.net.
among countries with UHC models. In 2022, this resulted in cumulative spending of CAD$331 billion across Canada. Health care in Canada is most commonly funded through global budgets, but health care is decentralised to the provincial level and variations exist across provinces. For example, in Ontario, cardiac surgical care is funded through volume-based funding based on episodes of care. The majority (70%) of payments to physicians happen through fee-for-service models, whereas approximately one-third happen through alternative payment plans, with variations by province. For example, in Nova Scotia, two-thirds of physicians payments happen through alternative payments plans, whereas Alberta has the highest rate of fee-for-service payments in the country, nearly 90%. Treatment of cardiovascular diseases are very resource intensive, with surgery often being the most expensive intervention. For example, in Ontario, the total health care utilisation associated with thoracic aortic aneurysms and dissections from 2003 to 2016 (n=17,113) accounted for CAD$587.3 million, with surgery accounting for CAD$312.1 million. The total yearly expenditures for these conditions in Ontario have been consistently increasing over the years, likely owing to both increased incidence and better diagnosis of disease. In Ontario, the median cost of surgery was CAD$22,949 for aneurysm repairs and CAD$30,372 for dissection repairs (in 2017 Canadian dollars). Furthermore, costs of cardiac surgery vary significantly by province. For example, the average hospital cost for on-pump coronary artery bypass grafting (CABG) with coronary angiography is highest in Alberta, at CAD$45,532, and lowest in Ontario, at CAD$28,260. Although costs of care do not affect patients directly owing to the presence of universal health coverage, Canada’s relatively fixed health budget requires costs to be minimised as much as possible to ensure sustainability of the health care system and further adoption of other health services and technologies.

Service delivery

Despite high investments in health care, Canada experiences far greater waiting times to see one’s family medicine doctor, visit a specialist, or receive scheduled surgery. Moreover, 22% of Canadian adults (6.5 million people) report not having a family physician, ranging from 13% in Ontario to 31% in Québec. This implies a mismatch between the money spent on health care and the value received by the population in Canada. For scheduled CABG, Canada’s waiting times in 2018 appeared to be lower than those in most OECD countries (median waiting time of 6 days vs OECD average of 24 days), although definitions and measurements vary between countries, and overall waiting times for scheduled cardiac surgery in 2022 have been reported as high as 16.4 weeks in Canada. Differences further exist based on province and location of residence within provinces in Canada. For example, in Nova Scotia, there is only 1 cardiac surgical centre, and where one lives in the province determines the time to treatment and survival after surgery. Moreover, Indigenous Peoples in Canada report lower utilisation of and poorer outcomes after cardiac surgery. Similarly, sex, ethnicity, and socioeconomic status are associated with differential referrals, utilisation rates, and outcomes of interventional cardiology and cardiac surgery procedures in Canada.

Across Canada, more than 30,000 cardiac surgical procedures are performed each year, with a median of 1012 (range 400-1900) procedures by centre and mean of 175 (range 125-300) cardiac procedures by surgeon. Variations by province are observed in procedural choice, such as in the rates of CABG vs percutaneous coronary intervention for coronary artery disease, as well as in decisions to operate in ethically challenging circumstances (eg, endocarditis reoperations in people who inject drugs).

Information management and technology

The regulation of health care at the provincial level in Canada results in health administrative data collected and managed by provincial health care systems. Although this limits detailed interprovincial comparisons of health care utilisation and long-term health outcomes, the available administrative data per province are comprehensive owing to enrolling all individuals covered by the provincial health plans,
thus capturing nearly the entire population. Most provincial health administrative data include information on health care utilisation across the health care system, including information on inpatient and outpatient care, diagnoses, procedures, drugs, imaging use, and common risk factors and sociodemographic factors. As such, the long-term outcomes of individual conditions (eg, natural histories) and interventions (eg, comparative effectiveness research) may be assessed through these robust health administrative datasets, which have been the source of a range of important population-based studies in cardiology. Preliminary efforts are in place to facilitate interprovincial linkages and comparisons through the Data Access Support Hub (DASH) by the Health Data Research Network Canada.50

Robust information management practices have an important role in facilitating appropriate postoperative care and safe and early discharge from hospitals by optimising workflows and reducing process failures.51 In Saskatchewan, online platforms have been leveraged to scale educational and knowledge translation efforts surrounding enhanced recovery after cardiology among health care professionals, patients, and families. Although the impact on clinical care has yet to be determined, the intervention has proved to be both feasible and well received.52 Digital health technologies further provide a unique opportunity to expand access to care and provide efficient and convenient care to patients with CVDs. They empower patients and allow evaluation and close monitoring of patients and delivery of rehabilitation programs.53-55 However, many barriers exist that prevent equitable delivery of virtual care to everyone living in Canada. Historically, Canada has lagged behind its peers in adoption of digital communication technologies.56,57 In recent years, especially since the onset of COVID-19, Canada has seen increased growth and uptake of information technologies and virtual care offerings. In 2022, 93% of primary care physicians in Canada were using electronic medical records, which is on par with other Commonwealth Fund (CMWF) countries.58 The provision of excellent virtual care requires smooth sharing of data to facilitate communication and continuity of care. Although Canada experienced considerable improvements in the domains of electronic exchange of information in 2022, it still failed to meet the CMWF averages.59,60 Only 12% of practices provided patients the ability to view their patient visit summaries online (CMWF: 42%), and 50% allowed electronic communication regarding any medical concerns with their physicians (CMWF: 75%).61 There were fewer Canadian primary care practices that could electronically exchange information with other doctors outside their own practice, including patient clinical summaries (38%), medication lists (51%), and results from laboratory and diagnostic tests (55%). The CMWF average ranged from 67% to 72% for these options.62 There are many barriers in place hindering the scaling up of virtual care. There are no national standards in place for quality and safety of virtual care and electronic access of patients to their information.63-65 Fragmented, locally, or regionally designed electronic medical records and lack of digital interoperability across systems impede delivery of integrated care.66 Different licensing requirements for physicians across jurisdictions act as an obstacle to providing care across provincial boundaries.67 Varying compensation for services and limited fee code frameworks may also act as a barrier to adoption of virtual care.55,59 Canada has much ground to cover before it can provide the level of virtual care available in other countries.

Furthermore, a digital divide based on place of residence exists in Canada. Approximately 95% of Canadian households in a census metropolitan area or census agglomeration had a home internet connection, with three-fourths having internet speed of 50 Mbps or more.60 In comparison, 88% living outside these areas had an internet connection, with fewer than half having internet speed of 50 Mbps or more.60 Vulnerable populations, such as First Nations peoples, are especially affected by the inequality in access to technology, with only 24% of households among Indigenous Peoples having high-speed internet.55 Non-English language, lower income levels, and ages over 65 years were also associated with decreased internet access,61-63 thus affecting the populations most likely to have poorer access to or outcomes after cardiac surgery and further impeding opportunities for virtual care services. Among those with reliable access to the internet, the use of digital health technologies may vary depending on the level of technologic literacy. Older patients have lower confidence and comfort in using electronic devices, are less likely to find the internet to be user friendly, display increased frustration with using technology, and find it difficult to navigate new technologies and troubleshoot technical problems.54,61,62,64

Governance

At the systems level, a balance needs to be sought between population health, patient outcomes, access to care, medical advances, and distributive justice vs cost minimisation, resource utilisation, appropriate use, UHC sustainability, and scarcity of resources. In Canada, the Canadian Agency for Drugs and Technologies in Health (CADTH) leads health technology assessment discussions concerning new health technologies, treatments, and programs, and provincial bodies extend this at the provincial level. These agencies consider the available evidence, contextual economic evaluations (eg, cost-effectiveness or cost-utility analyses), and government budget impact analyses to determine whether or not new health interventions should be reimbursed. In addition, by engaging patient voices and ethicists, health technology assessment processes in Canada consider ethical, legal, social, and patient issues to optimise equity and minimise opportunity costs related to the adoption of such new interventions within health care systems with constrained budgets. For example, in Ontario, the Ontario Health Technology Advisory Committee recently sequentially considered transcatheter aortic valve implantation for patients with decreasing risk profiles to determine the outcomes, costs per patient, and impact on the Ontario health budget compared with surgical aortic valve replacement, concluding that transcatheter aortic valve implantation is cost-effective across the full spectrum of risk but recognising the variable uptake and access to care across and within Canadian provinces.65 Such comprehensive assessments of procedures ensure timely uptake of novel interventions whilst safeguarding the sustainability of publicly funded health care systems.

At the provincial level, variations in health administration exist. Alberta, Nova Scotia, and Prince Edward Island each has
a single centralised health care authority. In other provinces, regional health authorities operate with administrative decentralisation, which may empower community engagement and more patient-oriented processes.

At the institutional level, efforts may be taken to reduce waiting times and optimise health care delivery processes. For example, in New Brunswick, the New Brunswick Heart Centre, in partnership with Integrated Health Solutions, engaged stakeholders and identified opportunities for improvement with the use of Lean principles. After 2 years, they saw a 10.8% increase in the annual number of cardiac surgical interventions, from 788 to 873, and a 35% decrease in the best median wait time, from 52 to 35 days, without adding any additional beds or operating rooms.

Finally, the density and distribution of centres in Canada highlight the regionalisation of cardiac surgical services in Canada compared with the decentralisation in the United States. Although regionalisation may affect geographic access, it promotes economies of scale and thus improves cost-effectiveness, institutional surgical volume, and outcomes.

Knowledge Gaps and Way Forward in Canada

Several questions remain surrounding access to high-quality cardiovascular care in Canada. First, Indigenous Peoples represent approximately 5% of the population in Canada and are known to have worse outcomes after cardiovascular care as a result of poorer access to care, intergenerational trauma, and systemic racism. However, recent procedure- and location-specific evidence on these gaps is limited, as consistent with respecting the First Nations principles of Ownership, Control, Access, and Possession, which state that First Nations have control over collection and use of data pertaining to individuals in their communities, resulting in an absence of indigenous variables in health administrative data. Second, low levels of English literacy are associated with poorer access to health care across all levels of the health care system. Similar associations may exist in Canada’s French provinces and bilingual regions for French literacy. Independently from literacy, immigration status may (lack of health card or refugee status) or may not (healthy immigrant effect) be associated with differential access to care. These factors have been poorly studied in the context of cardiac surgery in Canada and require further evaluation. Third, other socioeconomic factors, including homelessness and marginalisation, have been associated with CVD and poorer health outcomes. Finally, patient preference, patient-centred outcomes, and patient-reported outcome measures remain insufficiently elicited and used in cardiac surgical research and planning, including in Canada. Understanding patients’ wishes and needs may guide improved clinical decision making and resource allocation, ultimately benefitting both patients and the health care system.

Moving forward, various action points arise for the Canadian cardiovascular community and policymakers to anticipate growing challenges in access to cardiac care for the Canadian population. An increase in per capita cardiac surgical workforce is needed to redistribute case volumes by centre and catchment area and reduce waiting and travel times. Lessons may be learned from Saskatchewan, which has the lowest median waiting times for CABG across Canadian provinces. The Saskatchewan Surgical Initiative fostered clear government commitment, collaborative and inclusive decision making by front-line health workers, a patient-centred focus, and transparent and effective communication with the public, which altogether resulted in streamlining care delivery and reduced waiting times. In addition, it is critical to continue to engage trainees early and foster an inclusive future cardiovascular surgery workforce. Although the drop in interest in cardiac surgery at the medical student level has been overcome, this must be maintained and built on in the future to continue to attract committed, bright, and diverse future surgeons to our specialty. This must be met by an active commitment to diversity in the cardiac surgical workforce, cultivating a collaborative and inclusive culture that places patients first. From an infrastructure perspective, increased imaging modalities and postacute cardiac care facilities per population unit are required to bridge gaps between provinces as well as relative to other high-income countries in order to reduce waiting times and associated, potentially preventable, complications. Concerning service delivery, further efforts are needed to promote integrated care and facilitate follow-up after cardiac surgery. Rates of loss-to-follow-up vary but remain unnecessarily high, including for critical conditions such as transition from paediatric to adult care for congenital heart disease and after thoracic aortic surgery. Integrated care efforts shift the perspective to patients and families to empower them in their care processes across the health care system (eg, between home-based primary care and cardiology and cardiac surgery services).

Simultaneously, concerted efforts are required to monitor and evaluate clinical and patient-centred outcomes across population groups in order to detect and address disparities in care. Investments need to match increases in health needs of the population and ongoing inflation. For example, in 2022-2023, Ontario underspent their health budget by CAD$1.7 billion despite pressing staffing shortages and emergency room closures in rural areas. Investments should promote value-based care, moving away from fee-for-service models that may encourage health care utilisation and toward payment models that reward quality of care (eg, risk-adjusted bundled payments). Furthermore, more streamlined adoption of electronic health records across institutions is necessary, particularly with a focus on future interoperability of health records to reduce preventable medical errors and improve patient care flows throughout the health care system. Machine learning algorithms may support care delivery (eg, risk prediction), health care management (eg, operating room and supply chain planning), and health promotion (eg, health chatbots and medication reminders).

Finally, governance efforts at the level of the health care system and hospitals may reduce waiting times for cardiac surgical care. Leadership should actively consult members of the heart team, health professionals, patients, and other relevant parties to determine existing challenges with increasing volumes or facilitating bed turnover. Particular attention should be given to burdens on health professionals, considering existing pressures and understaffing, as well as on the quality and equity of care delivered. Canada has been a world leader in UHC, and meeting the cardiovascular needs of the
Canadian population will be critical to continue to lead by example.

**Access to Cardiac Surgery in the Global Context**

**High-income countries**

High-income countries, home to 1.24 billion people (15.7% of world’s population), largely meet the cardiac surgical needs of their populations, which are ageing (19% of overall population, compared with 10% globally and 8% in LMICs). However, some variations exist. For example, high-income country ministates and island states commonly have population sizes that are too small to justify a local cardiac centre, requiring patients to seek care abroad or overseas. Meanwhile, the United States is the only large high-income country without UHC, and as a result, up to one in two households report an inability to pay all of their medical bills. Because cardiac surgical care is a high-resource intervention and longitudinal care and follow-up is often needed, financial barriers may be particularly prevalent and even prohibit care-seeking behaviours. Simultaneously, waiting lists for scheduled procedures are not uncommon across high-income countries with UHC models. For example, in England, nearly 400,000 people are waiting for some form of cardiovascular care. This may be aggravated by predicted surgical workforce shortages in the future, which have been noted in multiple countries, including the United States, South Korea, and Japan. As a result of increases in disease burdens, ageing populations, and unfilled training positions. Nevertheless, other high-income countries, such as France, note a balanced inflow and outflow of cardiac surgeons commensurate with projected population needs.

Barriers in access to care present in ways similar to the Canadian context. Notably, colonial practices and systemic racism have resulted in poorer access to care for Indigenous Peoples across multiple high-income countries. In Australia, Indigenous Peoples experience an increased burden of CVD, present earlier, and are almost 2 times more likely to die from cardiac conditions. Access to cardiac specialist services and rehabilitation are also limited in regions where large populations of Indigenous communities reside. Once admitted, they are 40% less likely to receive percutaneous coronary intervention and 20% less likely to receive CABG. Similarly, surgical revascularisation rates are lower among Maori in New Zealand despite higher disease burdens and greater clinical priority scores. Recently, New Zealand introduced an equity adjuster tool to provide fairer access to treatments within reasonable time frames, in large part in response to the disparities observed for Indigenous Peoples. Furthermore, immigrant and refugee populations generally experience poorer care owing to language and cultural barriers, different patient journeys, and conscious and unconscious biases from local health workers. Although research specific to cardiac surgery has been limited in this patient population, evidence exists for other surgical conditions for which the costs of care are lower and access greater compared with cardiac surgical care.

Finally, other population demographics, such as sex, gender, and socioeconomic status have been found to be associated with access to cardiac surgical care and differential outcomes after cardiac surgery in various high-income countries.

**Low- and middle-income countries**

Most of the world’s population (84.3% or 6.71 billion people) reside in LMICs, where more than 80% of all cardiovascular deaths occur worldwide. More than 90% of the population in LMICs, however, do not have access to necessary cardiac surgical care. More than 100 countries and territories lack a single cardiac surgeon or centre, whereas LMICs with local capacity have largely inadequate human resources or infrastructure. For example, high-income countries have 7.15 cardiac surgeons per million population, whereas low-income countries have only 0.04. Similarly, high-income countries possess half (49.4%) of the world’s cardiac centres for 16.6% of the world population, compared with low-income countries having only 26 centres (0.5% of total) for more than 600 million people (9.1% of the world population). As a result, many LMICs continue to rely on nongovernmental organisations or academic visiting teams to both support health care delivery and capacity building. Such teams contribute meaningfully, with more than 12,000 cardiac surgical operations each year worldwide, but they are only a fraction of what is needed to meet the needs of the populations in LMICs and do not happen continuously or in an equally distributed manner. Further barriers to scaling the global capacity include fragmented supply chains, insufficient diagnostic capacities, a lack of training programs or clear training pathways abroad, and variable political and economic climates. There is a particular need to recognise the scarcity of cardiac surgical supplies as a barrier to initiating and sustaining cardiac surgery services in LMICs. The development of cardiac surgical centres, purchasing of necessary equipment, and training of local surgeons abroad may be initiated by their governments, but without continued surgical supplies and efficient and affordable supply chains, sustainable cardiac surgical services, growing surgical volumes, and effective capacity building are difficult to maintain. Finally, low work satisfaction is common and can contribute to surgeons leaving or not returning to LMICs (ie, brain drain). To address this, political commitment (eg, appropriate remuneration and academic opportunities), improved supply chains, and structured training programs are necessary.

In South America, where population health coverage is high, health care systems and geographies vary widely. For example, Brazil is the fifth largest country in the world by area and possesses several state-of-the-art cardiac surgical centres in its large cities. However, it also faces great inequality in the availability of cardiac services and surgeons across the country, with the north and northwest of Brazil being disproportionately affected. The southeast of Brazil, home to its most well-off states and cities, have more than 50% of all cardiac surgeons, who perform the largest volume of CABG and other cardiac surgical procedures. Similar observations exist in other countries in the region, where services outside national and state capital cities are poor and unevenly distributed.
Outside South America, most LMICs do not have UHC or possess only primary care packages not incorporating surgical services.125 Nevertheless, several LMICs are making progress in making cardiac surgical care affordable, whether by reducing the costs of care (eg, India and Vietnam perform cardiac surgery at as little as US$2,000-3,000 per procedure) or by introducing microinsurance schemes to make cardiac surgery free for the elderly, children, and poor (eg, in Nepal).126 Conversely, political prioritisation and buy-in across countries and intergovernmental organisations, such as the World Health Organisation and the United Nations, remain limited.127 At the national level, Zambia has the only NSOAP developed to date to incorporate cardiac surgical care in its long-term surgical planning.11 At the international level, the WHO and the UN fail to appropriately recognise cardiac surgical care or even nonsurgical cardiovascular care commensurate with global disease burdens.128 This is consistent with limited attention to broader emergency and essential surgical care.129 Funding agencies, whether as foreign aid bodies or large philanthropic organisations, most commonly allocate funds based on predefined agendas or priorities, not allowing governments to use funds for other needs. As a result of both such earmarking of funds and limited political interest in noncommunicable diseases, one-half of all global health financing is allocated to HIV/AIDS, tuberculosis, and malaria, whereas surgical care (less than 1% of funding but 28%-32% of the global burden of disease) and noncommunicable diseases (less than 2% of funding but three-fourths of global mortality) receive only a small fraction of global health spending despite accounting for more than 5 to 10 times as many deaths each year as HIV/AIDS, tuberculosis, and malaria combined.10,130-132 Ultimately, horizontal health care system efforts, rather than vertical disease silos, are necessary to benefit both communicable and noncommunicable disease prevention and care across populations.133,134

**Shared Learning**

Ultimately, no country is immune from disparities in access to care, requiring concerted and collaborative efforts to challenge the status quo. Clinical innovations in high-income countries should recognise the financial burdens they may introduce to health care systems and their accessibility outside centres of excellence or well resourced health care systems. Similarly, frugal innovations may support not only access to care in LMICs, but also reduced health care spending in high-income countries, where health care systems are observing considerable financial pressures.135 Efforts may also be expanded to facilitate clinical training across borders. This includes reducing the barriers to surgical training for LMIC medical graduates from countries with no local training programs or surgeons.112 In addition, this may entail more opportunities for short-term training in LMICs during residency, fellowship, or as a surgeon to learn from the expertise of clinicians managing different disease burdens and more progressive disease amidst growing resource pressures and increasing globalisation.136,137 Societies play a particularly important role in this context, both by providing a platform for discourse surrounding disparities in global cardiac surgical care and by supporting trainees and surgeons in studying disparities or seeking further training.138

**Conclusion**

Challenges in access to cardiac surgical care prevail around the globe. Although Canada has been exemplary in advancing cardiac surgical care delivery, areas for improvement remain. Geographic challenges are impossible to overcome, whereas the ageing population and accompanying disease burden have become a growing reality. However, systemic barriers, structural racism, workforce shortages and protection, health care system financing, and health information technology can be addressed. Canada’s pride in UHC can be justified only if truly no patient is left behind. In addition, Canada’s lessons and leadership may extend globally by supporting other countries in innovation, training, research, and cardiac surgical care delivery.

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**Ethics Statement**

This article has adhered to the relevant ethical guidelines. No ethics approval was required for this literature review, as no human subjects research was performed and only publicly available data were used.

**Patient Consent**

The authors confirm that patient consent is not applicable to this article, as the article is a review article and did not involve human subjects research.

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