

Humanitarian cardiac care in Arequipa, Peru: experiences of a multidisciplinary Canadian cardiovascular team

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Background: The prevalence of cardiovascular disease and its associated mortality continue to increase in developing countries despite unparalleled improvements in cardiovascular medicine over the last century. Cardiovascular care in developing nations is often constrained by limited resources, poor access, lack of specialty training and inadequate financial support. Medical volunteerism by experienced health care teams can provide mentorship, medical expertise and health policy advice to local teams and improve cardiovascular patient outcomes.

Methods: We report our experience from annual successive humanitarian medical missions to Arequipa, Peru, and describe the challenges faced when performing cardiovascular interventions with limited resources.

Results: Over a 2-year period, we performed a total of 15 cardiac repairs in patients with rheumatic, congenital and ischemic heart disease. We assessed and managed 150 patients in an outpatient clinic, including 7 patients at 1-year postoperative follow-up.

Conclusion: Despite multiple challenges, we were able to help the local team deliver advanced cardiovascular care to many patients with few alternatives and achieve good early and 1-year outcomes. Interdisciplinary education at all levels of cardiac care, including preoperative assessment, intraoperative surgical and anesthetic details, and postoperative critical care management, were major goals for our medical missions.

Contexte : La prévalence de la maladie cardiovasculaire et de la mortalité connexe ne cessent d'augmenter dans les pays en développement, malgré l'essor sans précédent de la médecine cardiovasculaire au cours du siècle dernier. Les soins cardiovasculaires dans les pays en développement sont souvent limités par le manque de ressources, l'accessibilité limitée, la pénurie de formation spécialisée et l'insuffisance du soutien financier. Or, le bénévolat médical pratiqué par des équipes soignantes expérimentées peut faire profiter les équipes locales d'initiatives de mentorat, d'une expertise médicale et de conseils en santé publique et améliorer l'issue des patients atteints de maladie cardiovasculaire.

Méthodes : Nous relatons notre expérience au cours de missions médicales humanitaires successives menées annuellement à Arequipa, au Pérou, en insistant sur les difficultés de la pratique d'interventions cardiovasculaires dans un contexte de ressources limitées.

Résultats : Sur une période de 2 ans, nous avons effectué 15 interventions de réparation chirurgicale de cardiopathies ischémiques, congénitales et rhumatismales, et examiné et pris en charge 150 patients en consultation externe, dont 7 en suivi postopératoire à 1 an.

Conclusion : Malgré de multiples défis, nous avons pu aider l'équipe locale à prodiguer des soins cardiovasculaires avancés à de nombreux patients sans autre recours et nous avons obtenu des résultats favorables à court terme et à 1 an. La formation interdisciplinaire à toutes les étapes des soins cardiaques, y compris le bilan préopératoire, la conduite de l'intervention chirurgicale et de l'anesthésie durant l'opération et les soins de réanimation postopératoire, était centrale aux objectifs de nos missions.

Over the past several decades, considerable advancements have occurred in the field of cardiovascular medicine, resulting in overall improved morbidity and mortality. Whereas most of these advancements are widely available for patients in developed nations, access to such highly specialized cardiovascular care for those in underdeveloped or politically

and economically hampered countries has been slow.¹⁻³ Improving access and enhancing the quality of cardiovascular services in developing countries was highlighted as a goal by international cardiac societies more than a decade ago.⁴ However, despite these policy papers, improved educational opportunities and increased financial support for international health care, a substantial discrepancy in the level of cardiac care between developing and developed nations remains.⁵ Concurrently, it appears that the burden of cardiovascular disease in developing countries is forecast to further increase over the next several decades, as lifestyle-related cardiac risk factors continue to become more prevalent.⁶ Cardiovascular mortality has now surpassed infectious complications as the leading cause of death in many Latin American countries.⁷

Humanitarian missions consisting of highly specialized cardiovascular teams travelling from developed countries can provide valuable local assistance with patient care.^{1,5,8,9} Interventional and corrective surgical procedures can be performed and potentially save the lives of patients with no alternatives. For humanitarian mission groups to provide safe and high-quality cardiovascular care to these patients, it is critical to recognize local needs and inherent challenges and to triage appropriately while recognizing the local and visiting team's limitations.

We report the 2-year experience of a Canadian multidisciplinary cardiac surgery team volunteer mission to Arequipa, Peru. We describe the specific challenges we faced, how we addressed them and our attempt to develop sustainable cardiovascular care within this region.

METHODS

We conducted 2 consecutive humanitarian medical missions to Arequipa, Peru, in March 2009 and March 2010, with anticipated ongoing annual trips. Arequipa is the second largest city in Peru, with a population of about 1 mil-

lion and a much larger peripheral referral base. The city is located in the southern Peruvian Andes at an elevation of 2325 m above sea level. A recent population-based study evaluated the prevalence of smoking, alcohol consumption, physical activity and high dietary fat consumption in 1878 individuals from Arequipa and found a startling change in the population's general health.⁶ The study identified a significant increase in lifestyle-related coronary risk factors, reaching parity with rates in developed countries. The prevalence of current smoking was 31.1% in men and 12.1% in women. The incidence of sedentary lifestyle and high-fat diet were 57.6% and 42.0%, respectively.⁶ Whereas both private and public health care is available in Arequipa, local resources only allow for limited cardiovascular care, with substantial constraints on diagnostic and therapeutic abilities. In addition, cardiovascular surgery and interventional procedures are very limited. Most cardiac operations are available only in Lima, the capital city. However, extensive wait times and the prohibitive cost of cardiac surgery prevent most patients in Arequipa from receiving advanced-level care. As a consequence, the cumulative result of increasing cardiovascular disease and inadequate local resources is a large unmet need for the population in Arequipa and surrounding areas.

Our humanitarian team consisted of specialists in cardiac surgery, cardiology, anesthesiology and critical care; cardiopulmonary bypass perfusionists; operating room nurses; respiratory therapists; and intensive care nurses. Table 1 shows the total number of participants over 2 trips. All members of the team had a strong interest in improving medical care in developing countries and were committed to performing repeat medical missions (Fig. 1).

Prior to the mission, we worked with CardioSalud, a local nonprofit volunteer agency, to assess the local resources and patient needs in Arequipa. This organization was started in 2005 and, to date, has organized 6 international campaigns: 4 with cardiac teams from the United

Table 1. Number of participants over the 2 years of The London Heart Team's humanitarian mission to Arequipa, Peru (n = 54)

Personnel	No.
Cardiac surgeon	1
Cardiac surgery residents	2
Anesthesiologists	2
Anesthesiology resident	1
Cardiologist	1
Intensive care specialist	1
Operating room nurses	4
Catheterization laboratory nurses	2
Intensive care nurses	35
Perfusionists	2
Advanced nurse practitioner	1
Respiratory therapists	2



Fig. 1. Our cardiovascular team from our first mission in 2009.

States and our 2 missions from Canada. CardioSalud arranged for support services, such as translators, prepared our travel and hotel accommodations, and provided information about the types of medical supplies and procedures that would most benefit the patients in Arequipa. All members of our team donated their time and were self-funded.

On arrival, we organized our group into 3 teams, a cardiovascular assessment team, a surgical team and a postoperative intensive care team. The cardiovascular assessment team consisted of members from cardiology and cardiac surgery and an advanced nurse practitioner. This group met daily with the local cardiology team and assessed patients in the clinic. Valvular heart disease, congestive heart failure, ischemic heart disease and arrhythmias were the most common problems seen. These daily clinics allowed for increased efforts into primary care initiatives, such as screening for and controlling cardiovascular risk factors.

The surgical team consisted of members from cardiac surgery, interventional cardiology, anesthesiology and critical care. Patients identified for surgical intervention were reviewed in a group setting with members from the local cardiology group where relevant imaging and investigations were discussed. Special attention was focused on operative risk and complexity of surgical repair. All patients were considered for surgery; however, patients with limited life expectancy, irreversible comorbidities or known cancer were deferred in favour of other younger patients whom we thought would benefit most. Many of these decisions were based on clinical acumen, since extensive laboratory and radiological testing was often limited. Patients selected were generally felt to have a high likelihood of achieving fast-track goals for perioperative cardiac surgical care, quick recovery and maximal survival benefit. Prolonged mechanical ventilation and support in intensive care would have limited our ability to continue surgery and may have placed undue strain on local resources. Consent for all operations and interventions was obtained with the help of a translator under the guidance of the host cardiology service. Risks and benefits for all procedures were clearly explained to patients and their families.

The postoperative team consisted of members from cardiac surgery, critical care, anesthesiology and intensive care nursing. The team provided 24-hour "one-to-one" bedside nursing for each cardiac surgery patient in the intensive care unit. During day shifts, we organized learning opportunities for the local nursing staff about unique postoperative issues for cardiac surgery patients. Postoperative analgesia was usually in the form of intraoperative parenteral opioids and ketamine (when this option was not felt to be contraindicated), and postoperative parenteral opioids and nonsteroidal anti-inflammatory medication (after 12 h of postoperative hemostasis). In one instance, we administered a preoperative thoracic epidural for a left posterolateral thoracotomy to repair an aortic coarctation.

RESULTS

Over the 2 consecutive years, the cardiovascular clinic team evaluated and treated about 150 patients. The surgical team performed 4 diagnostic angiograms, 2 percutaneous coronary interventions and 15 cardiac surgery operations (7 in the first year and 8 in the second), 13 of which included cardiopulmonary bypass. In the first year, there were no early or late deaths, and all 7 surgical patients had follow-up assessments when we returned the next year. In the second year, we performed operations on patients who were older and had more comorbidities and greater subsequent risk. Of the 8 patients who had surgery in the second year, 7 were doing well at the last assessment. There were no deaths while our team was present; however, 1 (6.7%) high-risk patient with preoperative liver failure died after our departure. Two patients had to be taken back to the operating room for postoperative bleeding, with no obvious source identified. There were no perioperative myocardial infarctions, arrhythmias or cardiac arrests. One patient who previously had a stroke experienced postoperative transient neurologic decline but made a full recovery to baseline level of activity and was discharged on postoperative day 20. All remaining patients made a full, uneventful recovery, returning to normal activities within 4 weeks of surgery. The median length of stay in hospital was 5 (range 5–20) days. One patient was readmitted for a late wound infection. Of the 15 patients who had cardiac surgery procedures, there were 10 men and 5 women with a mean age of 53 (range 19–77) years. The surgeries performed were isolated coronary artery bypass procedures ($n = 4$; 3 with cardiopulmonary bypass and 1 off-pump coronary artery bypass), coronary artery bypass with mechanical aortic valve replacement ($n = 2$), isolated adult aortic coarctation repair ($n = 1$), aortic valve replacement with ascending to descending aortic bypass graft for concomitant aortic stenosis and coarctation ($n = 1$), isolated mechanical aortic valve replacement ($n = 1$), isolated mechanical mitral valve replacements ($n = 3$; 2 were reoperations), repair of atrial septal defect ($n = 1$), aortic and mitral valve mechanical valve replacement with ventricular septal myectomy ($n = 1$) and mitral valve with tricuspid valve repair ($n = 1$). Of the 6 patients who had valvular procedures, 3 had critical mitral valve stenosis as a consequence of rheumatic fever. Table 2 summarizes patient demographic characteristics, pathology and cardiac surgery procedures performed.

At the 1-year follow-up assessment of the 7 patients who had surgery in the first year, all 7 were doing well and had returned to their previous level of activity. All patients had New York Heart Association class I or Canadian Cardiovascular Society class 0 symptoms. All patients who had undergone coronary artery bypass underwent exercise stress testing and showed no signs of ischemia. All valvular

patients underwent transthoracic echocardiography, which demonstrated good prosthetic valve function, normal gradients and no evidence of paravalvular leaks.

DISCUSSION

Humanitarian medical missions can be personally rewarding, provide immediate high-quality surgical care and create an important educational opportunity for all involved. The patients benefit substantially in their quality of life and in short- and long-term survival.^{5,8,10,11} Most of these patients are often accompanied by their entire extended families, which reinforces important lifestyle modifying behaviours to promote good cardiovascular health not only in the individual patients, but also in their entire families. These medical missions can foster the development of bilateral linkages that allow the host team to develop a large resource base with the visiting medical team. Historically, these humanitarian missions have been criticized for their short duration, involving a select number of patients, raising concerns about sustainability and long-term benefit.⁴ We feel that volunteer missions can help to achieve

both short- and long-term goals by providing comprehensive care to the individuals assessed on each mission. Barriers, such as communication challenges, limited organizational support, lack of coordination and personal unpreparedness, can be overcome. Most importantly, we feel that volunteer missions can help provide the local medical team with the education and tools needed to deliver much-needed care to the population at large.

Creating sustainable benefits from volunteer missions and placing a strong emphasis on education for all members of the cardiovascular team was a critical element of our experience. The local team was eager to learn, so we provided daily interactive educational sessions on many aspects of patient care, including preoperative assessment, intraoperative surgical and anesthetic procedures, and postoperative critical care. We did extensive teaching with the local surgical team about operative conduct, procedural details and avoiding complications. As the local surgical program had been on hold because of poor outcomes, we mentored the local surgeons during each case. One of the major goals of the outpatient clinic was to raise awareness about cardiovascular risk factor control, including

Table 2. Demographic and clinical characteristics of the 15 patients who underwent surgery during the 2009 and 2010 missions

Year	Age, yr	Sex	NYHA	Pathology	Operation	LOS, d	30-d outcome	1-year outcome*
2009	32	M	2	Aortic stenosis and aortic coarctation	Aortic valve replacement (mechanical) and ascending to descending aortic bypass	5	Doing well	Full recovery
2009	19	M	1	Post ductal aortic coarctation	Interposition graft repair	5	Doing well	Full recovery
2009	60	M	1	Coronary artery disease	Coronary artery bypass × 5	10	Doing well	Full recovery, CCS 0
2009	54	M	3	Left atrial myxoma	Excision of left atrial tumour (myxoma)	5	Doing well	Full recovery
2009	66	F	4	Rheumatic mitral stenosis	Redo mitral valve replacement (mechanical)	7	Doing well	Full recovery, NYHA I
2009	54	M	2	Coronary artery disease, critical degenerative aortic stenosis	Coronary artery bypass × 3 and aortic valve replacement (mechanical)	5	Doing well	Full recovery, CCS 0
2009	57	M	3	Rheumatic mitral stenosis	Mitral valve replacement (mechanical)	7	Doing well	Full recovery, NYHA I
2010	54	M	2	Coronary artery disease	Coronary artery bypass × 3	5	Doing well	—
2010	60	M	2	Coronary artery disease	Coronary artery bypass × 5	5	Doing well	—
2010	58	F	3	Coronary artery disease; critical aortic stenosis	Coronary artery bypass × 3 and aortic valve replacement (mechanical)	20	Doing well	—
2010	25	F	2	Atrial septal defect closed 1 year previously with percutaneous AMPLATZER Septal Occluder	Removal of percutaneous device, atrial septic defect patch closure	5	Doing well	—
2010	59	F	3	Aortic and mitral valve stenosis (rheumatic etiology)	Aortic valve replacement, mitral valve repair (anterior leaflet patch plasty) and septal myectomy.	5	Doing well	—
2010	77	M	2	Coronary artery disease	Coronary artery bypass × 3	5	Doing well	—
2010	57	M	3	Rheumatic disease, failed mitral prosthesis, functional tricuspid regurgitation. Severe comorbidities: liver failure, CVD, PVD, COPD	Redo mitral valve replacement and tricuspid valve repair (annuloplasty)	7	Death on postoperative day 7	—
2010	65	F	2	Rheumatic aortic and mitral stenosis	Aortic and mitral valve replacement (mechanical)	6	Doing well	—

CCS = Canadian Cardiovascular Society; COPD = chronic obstructive pulmonary disease; CVD = cardiovascular disease; F = female; LOS = length of stay; M = male; NYHA = New York Heart Association; PVD = peripheral vascular disease.

*1-year follow-up data were available only for the 7 patients who underwent surgery during the first mission.

smoking cessation, obesity and dietary modification.

Another important element in our successful humanitarian missions was establishing a commitment to follow-up care. We returned to the same centre to foster a communicative and interactive relationship and assess all operative and nonoperative patients annually. This continuity of care established familiarity for both teams and patients, and allowed for open discussion regarding individual patient management. Through electronic and telephone correspondence, we continue to provide year-round mentoring and consultation to the cardiologist and cardiac surgeon in Arequipa. We invited cardiologists and cardiac surgery teams in Arequipa to visit our centre in Canada, which could provide further educational opportunities for the local team; however, it must be tempered within the context of a much wealthier and more advanced Canadian health care system that may not be reproducible within the social and economic restraints in Peru.

A commitment to continuity of care created the ability to increase autonomy between both the host and mission teams. On the second mission, the host cardiovascular team demonstrated more independence. The three areas in which members from the host team demonstrated the most improvement were cardiopulmonary bypass, assisting with surgical procedures and administering general anesthesia. Frequent communication with CardioSalud was beneficial to providing optimal patient care in an organized and timely fashion. This group assisted with bridging important language and cultural barriers and provided accurate needs assessments specific to the local population, orienting the visiting team's goals appropriately.

A third element for creating a successful humanitarian mission was recognizing the resource limitations and unique challenges of our selected location. We encountered various challenges from a resource allocation, infrastructure and financial perspective. Some of these limitations are mentioned in Box 1. Recognizing them prior to our medical missions was crucial to avoiding complications. The patients' pathology included a higher prevalence of adult congenital disease and manifestations of rheumatic fever, which were more common than the typical ischemic heart disease seen in North America.¹² We performed 2 procedures for adult coarctation, which is uncommon in Canada, as this type of repair is usually performed in childhood or early adolescence. There also seems to be an increase in the number of cardiac manifestations from infectious diseases, as 3 of the 6 valvular procedures we performed appeared to be directly related to the effects of rheumatic fever. Chagas disease, caused by *Trypanosoma cruzi* infection, is an urban problem specific to Arequipa.⁹ Although not considered in the differential diagnosis in Canada, we had to maintain a high index of suspicion for Chagas disease when assessing patients with heart failure in the outpatient clinic. Standard diagnostic blood work and cardiac imaging equipment and techniques that are readily available in Canada, such as pul-

monary artery catheters, intraoperative transesophageal echocardiography, computed tomography and intra-aortic balloon pumps, were not available in Peru. Results of available laboratory work had to be interpreted considering altered normal values that may be related to elevated altitude. Equipment at our host country's hospital was often unfamiliar. Donated medical supplies were often expired, were missing critical parts or were incompatible with one another. On each mission, we brought as many supplies as possible from Canada, including valve prostheses, operative and cardiopulmonary bypass equipment and anesthetics. Since we had to carry most of the medical supplies ourselves, we were limited by airplane passenger weight limits and international customs regulations. The availability of drugs to facilitate the goal of fast-track surgery was limited, and the current climate at international borders makes the transport of controlled drugs or drug precursors difficult. Clinical decision-making often relied more heavily on accurate history and physical examinations. Another challenge we faced was increased perioperative blood loss, leading us to consider undetected coagulopathy, such as a qualitative platelet disorder or mild nutritional deficiency. On our 2010 mission, we prophylactically treated all patients with preoperative vitamin K and experienced a subjective improvement in postcardiopulmonary bypass bleeding time. No patients in our 2010 cohort required reoperative exploration for bleeding.

Careful patient selection for surgical and interventional procedures was a critical element in our mission. Constraints, such as mission length, resource availability (including medications), risk of reoperation and consideration of maximal future benefit, were taken into account. We recommend a collaborative decision-making process involving all members from cardiac surgery, cardiology,

Box 1. Summary of specific challenges encountered

Limited resources

- Basic diagnostic equipment
- Basic surgical instruments
- Limited surgical supplies (suture material, prosthetic heart valves)
- Poor temperature control in hospital
- Cardiopulmonary bypass machine pump head failure
- Poor central suction
- Patient poverty (inability to afford basic medications)
- Unreliable blood bank
- Severely limited pharmacy (especially vasoactive medications)
- Outdated technology

Infrastructure and support staff

- Only 1–2 intensive care unit beds available
- No ancillary staff (e.g., respiratory therapy, physiotherapy, social work)
- Inexperience with postoperative recovery in complex patients
- Need for 24-hour bedside mentorship
- Visiting team member illness (gastroenteritis, fatigue)

Cultural barriers

- Language

anesthesiology and critical care from both the host and volunteer teams. A strong dedication and commitment by all members of the team was needed to achieve low mortality and morbidity. The only death occurred in a very high-risk patient with pulmonary disease and liver failure who required reoperative mitral and tricuspid valve replacement. He survived the immediate perioperative period, but experienced severe vasodilatory shock. Unfortunately, epinephrine and dopamine were the only available vasopressors. Despite repeated echocardiograms that demonstrated good valvular and ventricular function, he succumbed to multisystem organ failure on postoperative day 7.

Such mission trips are generally quite rewarding for the volunteering and local teams and can be an unparalleled learning experience for trainees. Learners are exposed to a broader scope of disease and work in an environment where a greater emphasis is placed on reliable history-taking and physical examination skills. Specific to our mission was the exposure to less common pathology than that seen in developed countries, including adult congenital heart disease, end-stage rheumatic disease and Chagas disease.

CONCLUSION

We feel that cardiovascular health care professionals from developed centres must continue to increase efforts to assist with international health initiatives in centres in the developing world. The burden of cardiovascular disease is increasing, and without such assistance this will become an important health issue in the decades to come. Whereas humanitarian missions have limitations, they can provide substantial health care benefits to those treated and can provide the educational framework to help many local physicians care for their future patients. These missions must be structured properly to create sustainable improvements in cardiovascular outcomes. We feel that a commitment of several separate missions to a single centre with strong educational efforts, increasing autonomy, recognition of unique challenges and collaborative patient care are critical elements for humanitarian mission groups. In describing our experience, we hope to instill in others the same passion for international surgery initiatives and raise further awareness of the increasing incidence of cardiovascular disease in developing countries.

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