

**Cardiac Surgery Mission Trips: Improving the Perception and
Preparation of Perfusionists**

by

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A Thesis Submitted to the Faculty of the
Milwaukee School of Engineering
in Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Perfusion

Milwaukee, Wisconsin

May, 2015

Abstract

The prevalence of cardiovascular diseases (CVDs) is increasing at an astonishing rate. It is the number one cause of death in the world and every facet of society is feeling its repercussions. Particularly affected are low- and middle-income (LIMI) countries that are struggling to develop. But most importantly is the effect it has on the poor in these developing countries, where families struggle to survive as is.

A number of initiatives have been introduced to address the prevalence of CVDs, but these initiatives are aimed solely at reducing risk factors and not increasing access to health care. Yet cardiac surgery is often the only option for individuals who have diagnosed CVD. It is the aim of non-profit organizations to address this demand and provide these individuals with the life saving surgery they need. To provide cardiac surgery in LIMI countries, these organizations establish relationships with local hospitals. When a relationship has been developed between the non-profit organization and the local hospital, the goal for organizations is to provide cardiac surgery to individuals that would have otherwise not been able to have such an operation. Perfusionists are critical members of the cardiac surgery team because they operate the heart-lung machine during such surgeries. But most perfusionists who volunteer to work on these teams are ill prepared for the trip, which can impact their ability to perform their job well. The goal of this project was to provide a description (based on personal experience) of cardiac surgery mission trips and to generate a series of protocols and guidelines for perfusionists planning on participating in such trips.

After attending the 2014 CardioStart International mission trip to India, the author recognized that guidelines and protocols unique to mission trips should be developed and utilized. Using information acquired from perfusionists with mission trip experience, guidelines were created guide a perfusionist through all aspects of a mission trip. In addition, checklists and protocols are provided that will aid the mission trip team in preparing for their trip and ensuring they are as productive as possible in their unique situation.

Acknowledgments

My sincerest thank you to my thesis committee members (Dr. Ron Gerrits, Johnathan Howard, and Kyle Schilling). This master's thesis would not have been possible without your help and guidance. I would also like to thank the American Society for Extracorporeal Technology for giving me the opportunity to attend a mission trip. The experience was invaluable and will be cherished forever. The entire perfusion community has been extremely helpful, but a special thank you to Kyler Hunter, Peter Allen, and Scott Snider for their diligent support. Lastly, I would also like to thank Gary Shimek for his review and formatting assistance. The generous advice, support, and hours put forth by the aforementioned are represented throughout the body of this work.

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1.0: Introduction

Non-communicable diseases (NCDs) are collectively responsible for the greatest number of deaths annually, outpacing deaths caused by communicable diseases, accidents, and violence [1]. As a category, NCDs include those chronic, non-transmittable diseases such as cardiovascular diseases (CVDs), cancer, diabetes, and lung diseases. Worldwide, they are responsible for killing 38 million people each year [1]. A disproportionate amount of the mortality associated with NCDs comes from low- and middle-income (LIMI) countries, where they cause 28 million deaths each year [1]. Much of this mortality is thought to be due to lack of appropriate medical access for the treatment of cardiovascular diseases (CVDs). Improving access to appropriate healthcare for LIMI individuals is critical to decreasing deaths caused by CVDs in this population.

Currently LIMI countries account for 80 percent of all CVD deaths [1]. In these countries, death also occurs at a younger age than in developed nations. Because the populations in LIMI countries are rapidly growing, their CVD associated mortality is expected to climb proportionally. This is expected to be associated with an economic loss of 3.76 trillion US dollars in LIMI countries [2]. The World Health Organization (WHO) has provided guidance in “best buy” interventions and practices costing 11 to 13 US billion annually [2]. These interventions and practices are aimed at curbing the escalating cost of CVDs that post crippling effects on LIMI countries.

A global call to action to combat the prevalence of CVDs has resulted in numerous government, religious, and non-government organizational efforts to prevent

CVDs' detrimental effects. One mechanism used to address CVD mortality in LIMC countries is through service organizations such as Doctors Without Borders. Such organizations rely on healthcare professionals from around the world to volunteer for these mission trips. One challenge with such organizations is recruitment of qualified individuals, many of whom are uncomfortable traveling and working in the countries that are in the most need of support. The goal of this document is to provide a description (based on personal experience) of cardiac surgery mission trips and to generate a series of protocols and guidelines for perfusionists planning on participating in such trips.

2.0: Background

2.1: Burden of Cardiovascular Disease on Low- and Middle-Income Nations

The industrial and technological revolutions that occurred in the past two centuries brought many advances in society. Accompanying these revolutions has been a transition of the leading cause of death worldwide. Before 1900, communicable diseases were the predominant cause of death. But deaths from communicable diseases fell from 650 to 50 per 100,000 between 1900 and 1996 (Figure 1) because of improvements in public health and nutrition [3, 4].

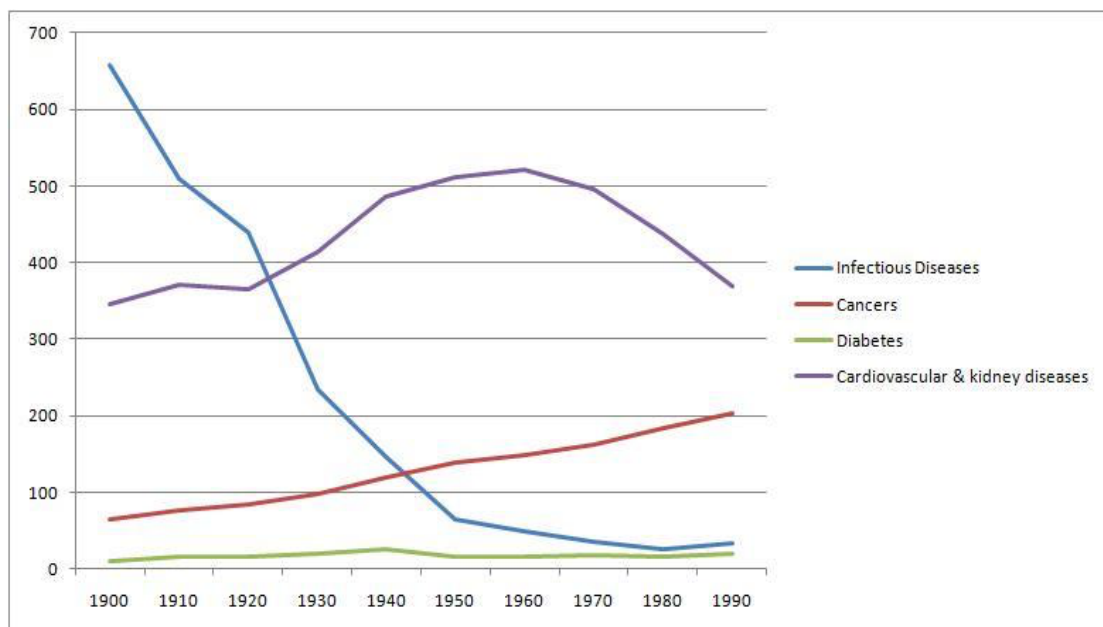


Figure 1: Leading Causes of Death Between 1900 and 1999 [4].

The leading cause of death worldwide is now non-communicable diseases (NCDs). Cardiovascular diseases (CVDs) represent the greatest percentage of mortality

caused by NCDs, making it the number one cause of mortality in the world (Figure 2) [2]. Overall, the mortality rate of CVD increased 20 percent from the 20th to 21st century [4]. Accounting for the increased rate are low- and middle-income (LIMI) nations where 80 percent of the global burden of CVD mortality occurs [5]. In 1996 the World Health Organization (WHO) predicted that by the year 2020, CVDs would be the leading cause of death, but that mark was actually reached in 2001 [6].

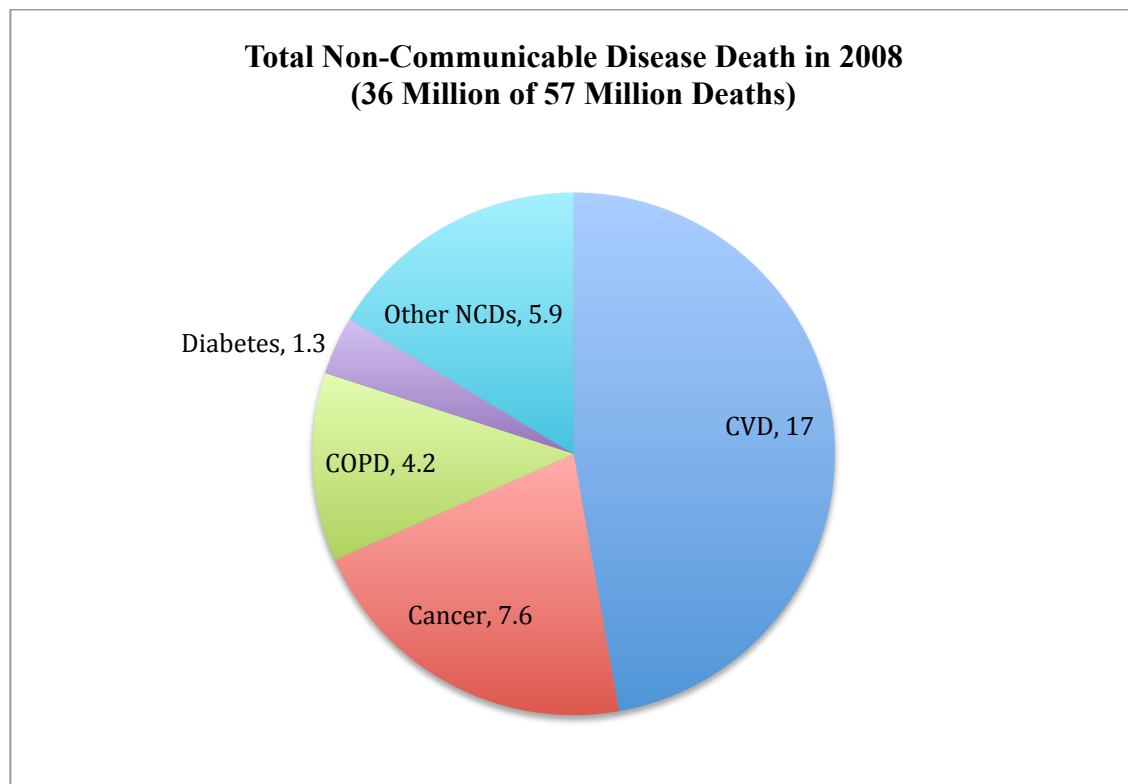


Figure 2: Etiologies Responsible for Non-Communicable Disease (NCD) Deaths in 2008 [2].

The predominant causes of CVD mortality are ischemic heart disease (IHD), stroke, and congestive heart failure (CHF). These diseases together account for 80

percent of CVD mortality in all income regions [5]. The risk factors contributing to the increased prevalence of CVDs can be classified as modifiable or non-modifiable. The non-modifiable risk factors include age, ethnicity, and gender. The modifiable risk factors are tobacco use, hypertension, high blood glucose, lipid abnormalities, obesity, and physical inactivity [5]. The occurrence rate of modifiable risk factors such as obesity, and tobacco use continue to climb. Tobacco use alone was reported to be at its highest level ever among 13-15 year age group in a 100 country survey conducted in 2004 [6]. It is certain that there will be a continual rise in the prevalence of CVDs if the risk factors continue to increase in the younger age groups.

Ischemic Heart Disease (IHD) most often manifests into acute myocardial infarction (AMI) and angina. It was responsible for 7.3 million deaths and 58 million disability-adjusted life years (DALYs) worldwide in 2001 [5]. IHD contributes the majority of CVD mortality in developed nations and is the largest contributor to the disease burden in low- and middle-income nations [5]. The overwhelming burden on low- and middle-income nations is staggering. These countries currently represent 75 percent of the mortality and 82 percent of DALYs associated with IHD [5].

Congestive heart failure is the end stage of many heart diseases, and characterized by cardiac dysfunction resulting in patient fatigue, fluid retention, and decreased life expectancy [5]. The most common causes of CHF are hypertension-related heart disease, IHD, and pathological processes affecting the heart [5]. The risk of developing CHF for hypertensive men and women is two and three times greater, respectively, compared to

the normotensive population [5]. Patients suffering from an AMI have five times more likelihood of developing CHF [5]. The prognosis for patients with established CHF is poor with a 40 percent one-year mortality rate [6].

As mentioned previously, CVDs are the leading cause of death worldwide. The same is true for each geographical region, except Sub-Saharan Africa where HIV/AIDS has become the leading cause of mortality [6]. The rapidly evolving burden of CVDs is shifting from high-income nations to low- and middle-income nations. Twice as many deaths are now attributed to CVDs in developing nations compared to developed nations [5]. The economic impact of CVDs has particularly affected developing nations because working age adults account for a high proportion of the burden [7]. Estimates have predicted that each year, 21 million years of future productive life are lost due to the burden of CVDs [8].

2.2: Initiatives Aimed at Reducing Cardiovascular Diseases (CVDs)

Within the past decade, government, medical, and non-government organizations have been working together to fight the growing burden of CVD. In 2010, the World Heart Foundation released a “State of the Heart” report that outlined the progress made and challenges still faced for preventing CVD [9]. Table 1 lists the achievements made for limiting the prevalence of CVD [9].

Table 1: Progress Made to Limit the Prevalence of Cardiovascular Diseases (CVDs) [9].

1	Recognition of NCDs as an Urgent Public Health Priority by the United Nations	6	Improved Recognition of Symptoms and Treatment for Heart Attacks
2	The World Health Organization Framework Convention on Tobacco Control	7	Quality Improvements in Hospitals
3	Increased Awareness of the Importance of Diet and Physical Activity on Heart Health	8	Statin Therapy
4	Workplace-Wellness Initiatives to Promote Health Amongst Employees	9	The Development of Monitors to Assist in the Correction and Diagnosis of Atrial Fibrillation
5	Improved Public Awareness of, and Access to, CVD Healthcare in Developing Countries	10	Advances in Diagnosing and Treating Congenital Heart Defects

Recognizing the threat of NCDs, 193 Ministers of Health endorsed the Action Plan for the Global Strategy for the Prevention and Control of NCDs at the 61st World Health Assembly [10]. The World Health Organization (WHO), along with a multi-level coordinated response, helped to implement objective five of the Action Plan, which focused on improving awareness and access to CVD healthcare in more vulnerable nations [10]. The advocacy efforts of this coordinated response resulted in the unanimous vote by the general assembly of the United Nations (UN) to adopt resolution 64/265 [10]. This resolution addresses prevention and control of NCDs in low and middle-income countries. The resolution has substantially increased aid by bringing together governments from aid donor countries with the governments of vulnerable nations. The result is significant effort to educate the populations of risk factors such as tobacco use and obesity, and to add clinics and staffing that have the capability to address CVD itself.

Because of the threat tobacco use contributes to the rising prevalence of CVDs, the WHO established the Framework Convention on Tobacco Control. Although many previous attempts have been made to curb the use of tobacco, the WHO initiative has been recognized as being the most influential and significant effort to reduce the use of tobacco worldwide. The framework provides instruction for nations to reduce the demand and supply of tobacco [11]. Countries have been able to reduce the use of tobacco and save lives by banning tobacco advertising, preventing exposure to second hand smoke, and requiring picture warnings on cigarette packs [9].

To combat the rise of sedentary lifestyles, there has been a strong impetus directed at establishing the relationship between heart health with diet and exercise. This push of information can be attributed to government and non-government organizations alike. Building on this momentum is the WHO's Global Strategy on Diet, Physical Activity, and Health [9]. The strategy targets sustainable implementation of global, regional, and national policies that encourage increased physical activity and improved diets [9]. By increasing the public awareness of the correlation between a poor diet and lack of exercise with chronic debilitating diseases, the goal is to inspire communities and individuals to adopt healthier lifestyles.

Most of the workforce spends more than half of their lives at work, so it is reasonable to assume that businesses can play a significant role in the reduction of CVDs. It is estimated that chronic diseases account for US\$2 trillion in lost productivity each year, primarily the result of absenteeism [12]. A 2010 study found that workplace-

wellness programs could achieve a 25-30 percent reduction in medical and absenteeism costs in a period of 3.6 years [13]. To attain these reductions companies would need to limit risk factors such as smoking (and second hand smoke exposure), unhealthy diets, and inactiveness. In 2010, the World Economic Forum launched the “Working Towards Wellness Initiative”. This initiative works to help businesses realize the economic benefits of fostering a healthier work environment [9].

Based on current trends, it is predicted that CVDs will continue to increase in LIMC countries. The WHO has integrated NCD interventions in developing nations’ health care systems. This plan made it possible for developing nations to redesign their health systems in accordance with evolving local resources and demands [14]. Improving the recognition and symptoms of CVDs has enabled health care professionals the ability to treat high-risk individuals earlier. Aspirin, which is cheap, effective, and available in LIMC countries, has resulted in a 24% relative decrease in incidence and improved outcomes of heart attacks [15]. Another example of a cheap pharmaceutical that could be widely dispersed is a statin regimen. Statins were discovered in 1976 and have revolutionized the treatment of patients with increased low-density lipoproteins (LDLs) [16]. There is a well-established link between the accumulation of LDLs and CVDs. An increase in LDL puts patients at an increased mortality risk due to stroke or heart attack. The effect of starting patients on a statin therapy regimen has decreased the risk of ischemic heart disease events by 60% and stroke by 17% [16].

An original research article published in 2009 by the American Heart Association showed the association between socioeconomic status, race and ethnicity with access to healthcare [17, 18]. This report documented that among patients with acute coronary syndromes, ethnic minority groups are less likely to receive evidence-based care [17]. In response, the American Heart Association launched the *Get with the Guidelines* program to help hospitals improve upon their quality of care [19, 20]. This program provides hospitals with the most current scientific guidelines for treating patients with CVDs. A review of 443 hospitals that participated in the program showed that the differences in care improved [19]. The study has supported evidence indicating that participation in quality improvement programs leads to improved patient outcomes across all socioeconomic classes [9].

Despite all these advances in the diagnosis and treatment of CVDs, there is still a gross inadequacy of access to cardiovascular healthcare in developing nations. Recognizing the urgent need for help, non-government organization groups have stepped up. These groups are able to come into a local hospital and work with the local team. This has enhanced the education of the local staff, which has had the greatest effect in reaching the most patients. In addition to empowering the local staff, certain groups sponsor cardiac surgery mission trips.

There are three primary types of mission trips, and the role of a perfusionist may vary significantly depending on which type of mission trip. The first are on/off missions where the team arrives in a location completely absent of cardiac surgeries, and offers

surgery for a brief period of time. These types of missions are typically the most demanding and involve bringing everything needed to conduct surgery. The second type is satellite mission trips, which involve establishing a relationship with a hospital where the local care team does the initial evaluation, preparation, and postoperative care while the mission trip team arrives and performs the procedures. Satellite mission trips are typical for pediatric institutions because the complexity of the surgical correction and amount of cases. The last type of mission trip is an improvement mission, where the mission team arrives and assesses where improvements can be made. On improvement mission trips, the local hospital has an established cardiac surgery program and is seeking support in improving their process.

The experience amongst the different types may range between the different type mission trips. But in general, a typical mission trip consists of a large team of volunteers that work with the local team to provide life-saving surgery to individuals who would have otherwise not received such care. One of the critical team members is the perfusionist, who is responsible for the setup and operation of the heart lung machine. These responsibilities can be intimidating to perfusionists who have been practicing in a modern, stable environment. The setup and operation can drastically change when considering the obstacles the perfusionist must overcome on a mission trip. One of the challenges for all team members is preparation for the conditions under which they will be working when serving in one of these clinics. A feeling of unpreparedness may be preventing perfusionists from applying for such positions. Better documentation could be beneficial in this area.

2.3: Project Goal

In order to improve outcomes for patients with CVDs in LIMC countries, volunteer surgical teams must be efficient in all aspects of the trip, including travel and clinical work. There seems to be a lack of resources for preparing individuals for these trips. With greater support, more perfusionists might participate. The goal of this project was to use personal mission trip experience to identify those areas where the perfusionist could have been better prepared, and then generate documents that would be beneficial to perfusionists that are considering, or have committed to, a future mission trip.

3.0: Methods

The generation of resources for mission trips was based on the personal experiences of the author (a student), and input from perfusionists with mission trip experience. Much of what is presented in this section is the thought process involved. This process was not all introspective, as many conversations, and ultimately the trip itself, had significant impact on the experience. Very few students apply to, and participate in, mission trips. In 2014, the author may have been the only perfusion student from the U.S. to participate as a student in such a trip. This limits the student experiences from which to draw from. This is why the current project does not involve input from other students participating in such trips. This section describes both the mission experience and then those areas that the author feels would have improved either the experience or the ability to deliver important health care on the trip.

3.1: Mission Experience

In the beginning of the perfusion education at the Milwaukee School of Engineering, the faculty mentioned several unique opportunities a perfusionist could participate in. One such opportunity was to attend a cardiac surgery mission trip to a foreign country. Being able to visit a foreign country and experience a new culture is something that appealed to many, but the thought of practicing medicine in underdeveloped countries was also a scary proposition to some. It is likely the latter reason that limits the number of applicants to such mission trips.

The American Society for Extra Corporeal Technology (AmSECT) sub-committee Perfusion Without Borders (PWOB) Student Mission Trip Scholarship provides reimbursement for a perfusion student to attend a cardiac surgery mission trip of their choosing. In 2014, there were no applicants at the time of the original deadline. This may have been because of a lack of awareness of the scholarship, but much of it was likely due to students feeling uncomfortably prepared for such a trip. When the deadline was extended and an effort was made to promote the scholarship, the author further investigated the opportunity, applied and was selected for the scholarship. The scholarship was not tied to any particular mission trip, but could be used to support any suitable trip.

After selection of the scholarship, mission trips were investigated. Research started on the AmSECT PWOB website [21]. At the time, there were two upcoming perfusion trips available. One of the trips was sponsored by the organization BabyHeart that focuses primarily on pediatric cardiac surgery. The second organization was CardioStart International, which focuses on the areas in most need for cardiac surgery. There are other organizations that sponsor mission trips (Table 2), but they were not further investigated.

Table 2: Cardiac Surgery Mission Trip Organizations.

Cardiac Surgery Mission Trip Organizations
• CardioStart International (cardiostart.org)
• BabyHeart (babyheart.org)
• HeartCare International (heartcareintl.org)
• Heart to Heart (hearttoheart.org)
• Solidarity Bridge (solidaritybridge.org)
• Surgeons of Hope (surgeonsofhope.org)
• Cardiac Alliance (cardiac-alliance.org)
• Hospital Sponsored

The 2014 CardioStart International mission trip to Bangalore, India from December 14th through 23rd was the first choice of the author and he was accepted for participation in the trip. After being accepted, CardioStart sent out a selection letter that included a list of items that needed to be submitted prior to the trip. Table 3 lists some of the items that CardioStart and the host nation required for the mission trip. The most difficult documentation to acquire was the Visa, which required making an appointment at an India Embassy to interview with an agent. Some members of the mission trip team had tremendous difficulty obtaining a Visa.

Table 3: A List of the Requirements for Attending the Mission Trip to India.

1. Most Recent Resume/CV	2. Signed Volunteer Disclaimer
3. Signed Media Release	4. Copy of Current Medical Licenses
5. Copy of Board Certifications	6. Digital Photo
7. Passport (Valid for 6 months)	8. Visa
9. Emergency Contact Information	10. Medical Clearance
11. Health Insurance	12. Travel Vaccines

When the mission trip team was confirmed, CardioStart held a teleconference to give each individual insight into the plan. The team consisted of two cardiac surgeons (one of whom was certified in adult and pediatrics), one perfusionist, one cardiologist, seven nurses, one medical student, and one photographer. During the discussion, the team was made aware that the institute was already offering cardiac surgery with their own staff. The mission team was able to exchange emails with the local team and found out they had a need for pediatric tubing packs, connectors, cannulas, and tissue/mechanical valves. From that point, the focus was mainly on collecting items and supplies necessary for the trip.

The team arrived in Bangalore, India, on separate flights, were greeted at the airport by a CardioStart team member and transported to a hotel while awaiting all team members. From there, the team was taken from the hotel to the Sri Sai Sathya Institute of Higher Medical Sciences (SSSIHMS). The hospital staff greeted the team and provided

an orientation of the hospital before introducing each team member to the area that they would be working.

The following day, the mission trip team began working. The SSSIHMS had three operating theaters, five surgeons, four anesthesiologists, and three perfusionists. The goal was to perform five procedures each day, typically three adult and two pediatric operations. The mission trip team began by just observing and assisting where possible, and over the course of the week, slowly worked into the scenario more and more. Being able to watch the local teamwork was an invaluable experience for the author. In a hospital that offers free healthcare to its patients, it is necessary for them to operate on minimal costs. To be able to do this, they reuse much of their equipment. The hospital had comprehensive sterilization techniques, and most importantly, hasn't had any adverse patient outcomes associated with their practice. Overall, the mission trip went very well. The local and mission trip teams learned equally from one another. Together, the teams performed sixteen successful procedures, which are listed in Table 4.

Table 4: Procedures and Results of Mission Trip to India.

Id No: (HIPAA applies)	Age	Procedure	Outcome
INDR001	38	Mitral Valve Replacement	Satisfactory
INDR002	2	Closure of PDA & VSD	Satisfactory
INDR003	46	Mitral Valve Replacement	Satisfactory
INDR004	12	Sub-aortic membrane resection	Satisfactory
INDR005	53	Aortic & Mitral valve replacement& repair of Tricuspid valve	Satisfactory
INDR007	42	Mitral Valve replacement	Satisfactory
INDR008	50	CABG x 3	Satisfactory
INDR009	35	Aortic Valve replacement CABG x 1	Satisfactory
INDR010	4	Supra-cardiac TAPVC correction	Satisfactory
INDR011	9	Fontan full correction	Satisfactory
INDR012	39	Sinus Venosus ASD repair	Satisfactory
INDR013	13	TOF correction with PV replacement	Satisfactory
INDR015	39	Mitral Valve repair	Satisfactory
INDR016	4	VSD closure	Satisfactory

As a perfusion student attending the mission trip, the author was required to work under the direction of a certified clinical perfusionist (CCP). But prior to the trip, the CCP contacted CardioStart and indicated that they were unable to attend the mission trip. The Perfusion Without Borders Committee determined that the author would still be able to attend the trip, but would operate alongside the perfusion team in India. When confronted with this task, the author felt overwhelmed and underprepared, and suspects many perfusionists in this situation would feel similarly.

The author began by seeking advice from perfusionists that have been on previous mission trips with CardioStart. Peter Allen (London Health Sciences Centre, London, England), Kyler Hunter (Kaiser Permanente, Los Angeles, California), and Scott Snider (Duke University Hospital, Durham, North Carolina) provided much guidance and support to the author for the mission trip. They suggested the creation of a checklist that covered all aspects needed for a safe surgical procedure with emphasis on not taking anything for granted. This checklist was designed to be completed prior to initiation of cardiopulmonary bypass and was used to ensure the facility had adequate resources. For example, the first category required access to the patient chart, which required the author to determine how he could obtain access. This particular item required minimal effort and time, but was critical for patient safety. Information necessary to verify and/or understand some of the other items on the checklist took much more effort to obtain (Table 5 lists such items).

Table 5: Parameters Needing Thorough Verification on a Mission Trip.

Electrical System and Backup Sources
Medical Gases Supply and Backup Sources
CPB Circuit Component Availability
Cardioplegia Delivery / Solution
Safety Devices Available
Verification of Anticoagulation
Drugs Available
Blood Products Available
Patient Monitoring Devices Available

The electrical distribution system needs to be considered when attending a mission trip. One potential complication is that the American outlets deliver 110 volts, whereas it is 220 volts in many other countries. Other common complications are the physical layout of the outlets. Upon arrival to the hospital, this was the first thing verified. Most of the equipment used in the hospital ran on the same three-prong outlet that the author was accustomed to. After verifying these sources, the battery backup was checked on the heart-lung machines. Each machine had a backup battery supply lasting at least 60 minutes, which was determined to be adequate for operations. The final check of the electrical system was to verify the hospital's backup generator in the event that all power was lost. This was verified in the initial walk-around with the local perfusion team.

The medical gas supply was verified much the same way as the electrical components. During the initial walk around, the perfusion team was able to show the mission trip team the medical gas supply tanks of oxygen, carbon dioxide, and medical air. The backup sources of oxygen and carbon dioxide tanks were stored in the operating room in the event the medical gas supply failed. The local perfusion team then went over their protocols in the event of a gas supply failure, in which 100 percent oxygen would be connected directly to the oxygenator to provide gas exchange.

The hospital had three heart-lung machines, two of which were Sarns 9000, and one was the Terumo System One. All three were roller pumps, and each had two additional roller heads that were used for pump suction and vent. Myocardial protection

was achieved using the Kole cardioplegia system, which was a second reservoir with separate heater-cooler lines. The hospital used St. Thomas cardioplegia system with a four to one ratio of blood to crystalloid. The author wasn't familiar with either the Kole cardioplegia system, or the St. Thomas cardioplegia solution. Access to the Internet proved to be an invaluable resource on this mission trip, as aspects that the author wasn't familiar with could be accessed rather easily. The hospital utilized the Medtronic Affinity oxygenator and pack for adults and the Medtronic Minimax oxygenator and packs for pediatrics. The author didn't have any difficulties with the oxygenators and packs the hospital utilized. However, the cardioplegia solution and delivery methods were completely foreign to the author. To overcome this obstacle, the author would arrive at the hospital before the other mission trip team members to ensure familiarity with the new system.

Everything about the hospital in India was different than the author was familiar with. Safety devices such as level alarms, and bubble detectors are standard in hospitals in America, but there were no standards to follow for India perfusionists. For safety devices, the India perfusionists utilized a level alarm. Patient monitoring was limited to one monitor within the operating room. The monitor displayed the patient hemodynamics from the radial and central venous lines. To reduce costs the hospital didn't utilize the Swan-Ganz catheter, which limited patient monitoring to mean arterial pressure, and central venous pressure. Regional oxygen saturation monitors were not available.

Prior to cannulation and initiating cardiopulmonary bypass, systemic heparinization was achieved with a loading dose of 400 units of heparin per kilogram of patient weight. A Hemochron Junior activated clotting time machine was used to ensure that hemostasis was a minimum of 480 seconds. This activated clotting time (ACT) machine is common in the United States, but the author primarily used a HMS Plus heparin concentration and ACT machine. The HMS plus calculates a heparin dose response curve based on the heparin concentration, and in turn provides the amount of heparin needed to achieve the necessary concentration. But the Hemochron Junior only provides an ACT, and the user must be able to determine the amount of heparin needed to achieve the amount of anticoagulation desired. To accomplish this, the user must be able to create a heparin dose response curve. Being a student and just learning how to create a heparin dose response curve was very beneficial on this trip. The Indian perfusion team practice was to give the full loading dose of heparin and check the ACT. If the ACT extended beyond 480 seconds, then another sample ACT wouldn't be drawn for an hour, but if it was lower, another sample would be taken in 30 minutes. This practice was much different than the protocols the author was familiar with.

In America, each hospital differs from the next. Each facility has different equipment, drug brands, methods, and practices. When any perfusionist, either a new graduate or experienced, starts at a new hospital, there is a period of time dedicated for them to become familiar with their new setting. On mission trips where each volunteer uses their paid time off (PTO) days to attend, a break-in period isn't available. This part

cannot be emphasized enough. Working in a new setting with new team members requires everyone to be alert and to look out for one another.

Based on this experience, the author has determined that pre-trip planning is critical for feeling as comfortable as possible on mission trips. This is especially true for students, who don't have the clinical experience of those that have been practicing for some time. Yet, even the most experienced perfusionists are unlikely to have practiced under the conditions found at most mission hospitals. Therefore, the goal was to use the personal experience of the author to create checklists for future perfusionists considering mission trips that can be used as an aid in trip preparation.

4.0: Results

Three different forms were generated. The first form (Appendix A) was designed to aid a perfusionist who is attending a mission trip for the first time. The form is able to guide the perfusionist through the mission planning process, and will help in determining the needs of hospital. It is suggested that mission trip preparation start three months prior to the trip by reviewing background information about the hospital and reports from previous mission trips, if available. CardioStart and other cardiac surgery mission trip organizations establish relationships with local hospitals and schedule mission trips annually. If this is the case for the selected mission trip, then previous reports are very beneficial. The reports can be obtained from the mission trip organization as well as the contact information for the perfusionist who attended that mission. If the hospital has a pre-existing cardiac surgery department, the local perfusion team can answer specific questions about their capabilities. A representative from the mission trip organization can aid in providing contact information with the local hospital staff. Appendix A will assist the perfusionist while considering what the capabilities of the local hospital are.

The second form created (Appendix B) is a checklist to be utilized during the initial inspection of the hospital resources. The checklist will guide the perfusionist through ensuring the hospital has the appropriate resources to conduct cardiac surgery. The checklist's aim is to ensure patient safety by verifying the primary and backup sources are operational.

The third form (Appendix C) contains eight sections (Table 6) that act as a checklist prior to the initiation of cardiopulmonary bypass. The first section covers patient-specific information such as age, recent lab results, and diagnosis. Section two is specific to the circuit required for the patient, including oxygenator, arterial-venous loop size, cardioplegia delivery system/solution, and other bypass considerations. The third section requires the inspection of the electrical components of the heart-lung machine, which includes backup sources and safety devices. The fourth section is for disposable equipment and solutions. The fifth section is for accessories needed, such as blood filters, tubing clamps, and gun ties. The sixth section is for ancillary devices, such as heater-cooler settings and laboratory equipment quality checks. The seventh section details the circuit setup and priming, and the eighth section is a quick checklist to consider when initiating cardiopulmonary bypass emergently.

Table 6: Cardiopulmonary Bypass Checklist Sections.

Cardiopulmonary Bypass Checklist
1. Review Patient History / Information
2. Circuit/Bypass
3. Electrical Equipment Inspection
4. Disposable Equipment / Solutions
5. Accessories
6. Ancillary
7. Circuit Setup and Prime
8. Immediate Pre-CPB Initiation

5.0: Discussion

As a perfusion student attending a mission trip for the first time, the author had a great experience and looks forward to attending mission trips in the future. Yet there were aspects of the trip that were overwhelming and the goal of this document is to help future perfusionists who are planning for a mission trip for the first time. Therefore, three forms were created that should be beneficial in such cases.

The generated forms could likely be improved with input from other perfusionists who have attended mission trips, but unfortunately, there doesn't seem to be any master list of such perfusionists. In order to obtain such feedback, the author is going to make a request to the AmSECT PWOB committee to post the documents in their section of the website, and to seek further input on them.

One of the author's goals is to join the PWOB committee after gaining his perfusion certification. He would specifically like to work with all of the mission trip organizations to coordinate their need for perfusionists. Currently, it seems that mission trips needs for volunteers are difficult to locate. If the mission trip organizations were to post their requests to AmSECT, any perfusionist seeking to attend a mission trip could see the request. In addition to seeing the request, there will be documents such as this one to aid in their preparation.

One of the challenges that is common for perfusionists on mission trips is myocardial protection. The author has heard multiple accounts of perfusionists on

mission trips where, in order to adequately cool the cardioplegia solution, they would place the tubing in ice water. This would be a source of significant stress on a mission trip. The author has contacted Quest MPS who is willing to provide and ship a Quest MPS 2 system for any perfusionist attending a mission trip. Contacts such as these are beneficial and an index of such contacts could be an invaluable resource for a perfusionist attending a mission trip.

Cardiac surgery mission trips are an invaluable experience for any perfusionist. As the author was presenting the mission trip to India at the 2015 AmSECT International Conference, there were multiple perfusionists who wanted to share their experiences as well. The perfusion community is very supportive, and there are multiple resources for perfusionists to troubleshoot issues they face. A forum created specifically for perfusionists to subscribe to, which provides input and support for perfusionists attending a mission trip, could be very helpful.

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Appendix A

Prior to the Mission Trip Preparation

Version 1 Updated May 2015

Overall

- ☐ Start preparation 3 months prior to the trip
- ☐ Make travel arrangements
 - ☐ Determine closest airport, lodging availability, and mode of transportation
 - ☐ Purchase travel insurance
 - ☐ Provide the mission trip organization the travel arrangements.
- ☐ Visit the CDC website (<http://wwwnc.cdc.gov/travel/destinations/list>) to determine if any vaccines are required or recommended
- ☐ Study the mission invitation and previous mission reports (if available)
- ☐ Obtain (from the local perfusion team):
 - ☐ The make and model of equipment that you will be working with, as well as any repair issues or missing accessories (ie. cables, monitors, alarm devices, handcranks, Hansen connectors for the water pump, emergency lighting, tubing guides, etc.). Utilize the local perfusion staff and mission trip organization biomed services to coordinate the immediate evaluation and/or repair of any disabled equipment on arrival at the mission location. Utilize perfusion resources to request and locate, if possible, any missing accessories using online resources (Perflist, Perfmail, AmSECT PWOB, mass email request) and/or vendor support
 - ☐ The electrical distribution system
 - ☐ The availability of a back-up generator or battery supply
 - ☐ The location of gas supplies (central supply, or tanks)
 - ☐ The availability of ice / an ice-machine
 - ☐ The availability of internet
- ☐ Request an inventory of supplies left from previous visits, if one is available. Ensure that the following supplies are available at least one month in advance of the arrival date. These supplies must be verified before a mission can proceed:
 - ☐ Heart-Lung machine, which must have the following:
 - ☐ Either a working bubble detector alarm module and cable and a working alarm monitor (need not be servo-regulated), or a working level detector module and cable and a working alarm monitor (need not be servo-regulated)

- Either a pressure manometer and a pressure cable and a working display monitor (need not be servo-regulated), or a DLP pressure monitor and a supply of disposables, or a sphygmomanometer and a supply of pressure bulbs and a luered accessed point on the arterial line.
 - Hand crank, clamps, and emergency lighting or flashlight.
 - FiO₂ gas mixer for pediatric cases
- ❑ An ACT machine and disposables, and a gas/electrolyte analyzer and disposables
- ❑ An adequate number of perfusion packs for the anticipated caseload (either complete packs, or individual components), which must have the following:
 - Either an oxygenator with an incorporated reservoir, or an oxygenator and a reservoir with an incorporated over-pressurization relief valve or luer access.
 - 1/2", 3/8" and 1/4" tubing. 1/4" one-way valves for vent line
- ❑ An adequate number of arterial and venous cannula.
- ❑ An adequate supply of connectors: adult - 1/2" x 3/8", 3/8" x 3/8" x 1/2", 3/8" x 3/8" x 3/8", pediatric - 1/4" x 3/8", 1/4" x 1/4", 3/8" x 1/4" x 1/4", 1/4" x 1/4" x 1/4"
- ❑ An adequate supply of donated or local heparin, protamine, crystalloids, potassium, magnesium, anti-arrhythmics, colloids, buffers, vasoconstrictors, vasodilators, insulin.
- ❑ The following supplies are highly recommended, although not necessary:
 - ❑ Arterial line filter
 - ❑ Cardioplegia units (can be substituted by an IV bolus and a pressure bag)
 - ❑ Retrograde and/or ostial cannula for open-heart procedures (can be substituted by a single, antegrade loading dose at the surgeon's discretion)
 - ❑ A water pump (can be substituted with a pump head and tubing)
 - ❑ Hemoconcentrators

Safety:

- ❑ On arrival, all perfusion equipment should be visually checked. Any known repair issues should be immediately coordinated with the mission trip organization biomed team.
- ❑ Please check the pump rollers on each pump head that is being used. Loose rollers can be tested/prevented by either: slowly turning the pump head by hand and feeling for loose rollers, or by checking occlusion with a fluid column.
- ❑ Before surgery begins, a primed pump circuit must be tested for the following (because of the uncertainty of local utilities, hospital security and donated supplies, these tests must be performed before every case):

- ☐ Test the dry oxygenator, and cardioplegia unit if used, for any water coil leaks prior to priming by attaching and running a water pump to each component
 - Once primed, test the oxygenator for any membrane leaks under gas pressure
 - Simulate circuit pressure by circulating with a partial clamp on the arterial line to test for any weakness in connections and oxygenator housing
 - Test any available alarms including pressure alarms, bubble detector, and temperature alarms. There must be a working method of monitoring arterial line pressures, and either a working bubble detector or working level detector, before initiating bypass
 - Test heater-cooler, if available, for maximum temperature settings (over-temp prevention)
 - If possible, check for availability of spare O2 tanks and, if possible, check oxygen lines for O2 content. Confirm the source of O2 in the room (ie. is it central gas supply for the hospital, or does it come from a refillable tank that should be checked)
 - Confirm a backup battery source, handcranks, backup tubing kit and components, availability of ice, backup water source, backup arterial head, flashlight.
 - If you are using local heparin, please confirm that it is not Baxter.
- ☐ Cardioplegia:
 - ☐ Quest MPS: use KCL as an arrest agent with a minimum concentration of 20mEq/L arrest, and 10mEq/L concentration for subsequent doses. For the additive use a mixture of lidocaine, magnesium sulfate, and sodium bicarbonate with a concentration no greater than 10mEq/L.
 - Arrest dose should be a minimum of 800 mL, and subsequent doses should be given every 20 minutes (or sooner if needed) with a minimum of 400 mL
 - ☐ 4:1, or IV bolus: Unless using a pre-mixed solution, please use a cardioplegia formula of crystalloid, KCL, lidocaine, magnesium sulfate and sodium bicarbonate. If the crystalloid is D5, please add 30 units of insulin per liter.

Medical Staff Interaction:

- ☐ If a local perfusion team is present, then the mission trip perfusionist should not operate all of the cases. The local perfusion team should be given a step-wise opportunity to do more during each case as the mission progresses.

Appendix B

Initial Hospital Inspection Checklist

Version 1 Updated May 2015

Electrical Equipment

- ☐ Electrical distribution system operational
- ☐ Backup electrical supply available and operational
- ☐ Heart/lung machine backup battery source operational
- ☐ Hand cranks available

Medical Gases

- ☐ Air/CO2 available and source confirmed with backup
- ☐ Suction/vacuum devices available
- ☐ Gas flowmeter, blender, and vaporizer operational

Equipment

- ☐ Heart-Lung machines available and operational
- ☐ Cardioplegia delivery method
- ☐ Heater/cooler available
- ☐ Ice machine available
- ☐ Hemodynamic monitors available
- ☐ ACT machines available

Cardiopulmonary Bypass Circuit

- ☐ Cannulas available
- ☐ Oxygenator sizes available
- ☐ A/V loop sizes, venous return line available
- ☐ Suction/Vacuum available
- ☐ Backup disposable and equipment available
- ☐ Hemoconcentration devices available

Supplies

- ☐ Backup disposable and equipment available
- ☐ Crystalloid and colloid solutions
- ☐ Anticoagulant available
- ☐ Cardioplegia solutions available
- ☐ Drugs syringes and labels available

Accessories

- ☐ Personal protection equipment available
- ☐ Tubing clamps, gun ties (with gun), scissors available
- ☐ Blood transfer bags with patient labels available
- ☐ Blood (micro-aggregates) filters available

Patient Information

- ☐ Access to patient history and labs available

Pharmaceutical / Blood Products

- ☐ Anticoagulants/ Reverse anticoagulants available
- ☐ Vasoconstrictors/dilators available
- ☐ Myocardial protection drugs available
 - ☐ Potassium chloride, magnesium sulfate, adenosine, substrates, etc.
- ☐ Crystalloid and colloid solutions available
- ☐ Diuretics available
- ☐ Blood available
- ☐ Anesthetic gases available

Safety Devices

- ☐ Level alarms operational and available
- ☐ Bubble detectors operational and available
- ☐ Flow probes operational and available
- ☐ Anticoagulation verification sources operational and available

Appendix C

Cardiopulmonary Bypass Checklist

Version 1. Updated May 2015

Review Patient History / Information

- ☐ Patient name/age/DOB/MR #
- ☐ Patient Ht, Wt, BSA, allergy, recent labs
- ☐ Diagnosis – anomaly – Planned surgical procedure
- ☐ Blood Available. Check type and Rh factor
- ☐ Pre-bypass calculations complete

Circuit / Bypass

- ☐ Oxygenator size needed
- ☐ A/V loop size, venous return line
- ☐ Level of hypothermia for selected procedure
- ☐ Cardioplegia delivery system and solution
- ☐ Hemoconcentration available
- ☐ Other bypass considerations, MUF, Pre-BUF, Z-BUF

Electrical Equipment

- ☐ Electrical and operational inspection of all equipment
- ☐ Heart/lung machine and heater/cooler
- ☐ Air/CO2 available and source confirmed with backup
- ☐ Suction/vacuum devices available
- ☐ Roller head occlusions checked
- ☐ Battery power checked/ backup
- ☐ Hand cranks available
- ☐ Level alarm checked
- ☐ Bubble detector checked
- ☐ Gas flowmeter, blender, and vaporizer operating correctly

Disposable Equipment / Solutions

- ☐ Sterile package integrity maintained
- ☐ Oxygenator heat/water flow tested
- ☐ Sterile technique employed for assembly
- ☐ In-line O2 sensor calibrated and operating correctly

- ☐ Backup disposable and equipment available
- ☐ Crystalloid and colloid solutions
- ☐ Anticoagulant available
- ☐ Cardioplegia solutions available
- ☐ Drugs syringes and labels available
- ☐ Flashlight available

Accessories

- ☐ Backup lighting source operational
- ☐ Tubing clamps, gun ties (with gun), scissors available
- ☐ Blood transfer bags with patient labels available
- ☐ Blood (micro-aggregates) filters available

Ancillary

- ☐ Laboratory equipment calibrated and QC's complete
- ☐ Desired temperature and water level confirmed
- ☐ Personal protection equipment available

Circuit Setup and Prime

- ☐ Disposables checked for defects
- ☐ Lot numbers recorded
- ☐ Expiration dates checked (solutions, drugs, disposables, etc.)
- ☐ H2O Lines to heat exchanger / leak test done
- ☐ Cardiotomy open to atmosphere and oxygenator gas exhaust port open
- ☐ Tubing loaded in pump heads correctly
- ☐ Tubing kink free and connections secure (Use gun ties if possible)
- ☐ Arterial filter and purge line direction checked
- ☐ Arterial and venous sample ports available
- ☐ LV vacuum relief / One-way valve checked
- ☐ Line pressure monitoring installed
- ☐ Temperature probes in place
- ☐ CO2 flush complete (if using arterial line filter)
- ☐ Oxygenator primed and de-aired/ tested for gas leaks
- ☐ Arterial filter primed and de-aired
- ☐ Cardioplegia system primed and de-aired
- ☐ Centrifugal pump flow probe calibrated
- ☐ Simulated circuit pressure- partial clamp on arterial line
- ☐ Line pressure monitoring installed

Immediate Pre-CPB Initiation

- ☐ Heparin dose given and ACT extended beyond 480 sec.
- ☐ Arterial (if centrifugal) and venous line clamped
- ☐ Purge lines off

Name: _____

Date/Time: _____