REPORT

Bridging the North-South Divide in Pediatric Heart Disease: A unique experience of the Stollery Children's Hospital mission to Sudan

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Background:

Pediatric heart surgery services in Sudan face tremendous difficulties: these include a shortage of trained staff (both physicians and nurses) due to emigration to the Arabian Gulf, Europe and North America, and limited facilities in operating rooms and intensive care units. Postoperative care is particularly deficient leading to the inability to perform open heart surgeries in small weight infants and neonates. Up to one third of patients must travel abroad to get definitive treatment(1).

Furthermore, due to limited access to primary care, children with heart disease usually present late, this increases the postoperative morbidity and mortality or precludes surgical intervention.

In 2003-2005, The Children's Heart Foundation, led by Professor William Novick, performed 52 operations mostly for infants less than 8 kg (2). Since that time, surgical missions from Qatar, Kingdom of Saudi Arabia (KSA), and the United Arab Emirates (UAE) conducted children heart surgery in Sudan. In most visits, many patients were operated on and training of local staff was conducted, however, the lack of sustainable training due to shortage of local staff particularly in surgery was a major limiting factor to the maximal utilization of these visits.

To overcome the shortage in trained staff, the Sudanese Medical Specialization Board (SMSB) initiated postgraduate training programs for pediatric cardiology and cardiac surgery in 2012 and collaborations developed with other countries for training in cardiology, cardiac surgery and cardiac intensive care.

In 2015, to help address some of these issues, Dr. Muhieldin, adult and pediatric cardiac surgeon in Stollery Children's Hospital in Edmonton, AB, Canada worked to forge links in training between Canadian and Sudanese entities. These efforts culminated in launching a training collaboration between the Stollery Children's Hospital and the University of Alberta with training centers in Sudan in pediatric cardiac surgery, pediatric intensive care, pediatric cardiology and neonatology. This report will focus on the surgical missions to Sudan Heart Center (SHC).

About Stollery Children's Hospital

Stollery Children's Hospital, in Edmonton, Alberta, Canada treats the second highest number of pediatric surgical cardiac cases in Canada. It is affiliated with the University of Alberta, and through the Western Canadian Children's Heart Network, patients from across western Canada receive surgical and other complex therapies at that hospital. These include highly complex procedures performed in very few centers, such as the "artificial" heart program and neonatal heart transplantations(3). The visiting team (Table1) to Sudan was composed of internationally renowned experts in pediatric heart surgery, pediatric cardiology and pediatric intensive care. It also included a team of operating room and intensive care nursing staff (Photo 1).



Photo1:
(Courtesy of www.littleknownplanet.com)

Objectives of the Sudan Mission:

- Perform congenital heart surgeries that are not routinely done in Sudan sparing the children and their parents the hardship of travelling abroad
- Build the capacity of intensive care services to provide good postoperative care for these cases through training of the Operating Room and Intensive Care staff (nurses, technicians and physicians).

Educate trainees in the early recognition of newborns with congenital heart disease and early referrals to Pediatric Cardiology.

Develop collaborative partnerships for Canadian trainers to train medical professionals in Sudan.

Surgical Results:

In 2016, the team performed heart surgeries in 16 patients in SHC. Several patients were neonates weighing 4-5 kilograms. Complex operations included: two cases of neonatal arterial switch operations, ventricular septal defects closure with Aortic Valve Repair, Glenn anastomosis, partial and complete atrioventricular septal defect repairs. There were two postoperative mortalities, one immediate and one 6 weeks after surgery due to severe infection.

In 2017, the team performed heart surgeries in 18 patients.
Complex operations included:

- Obstructed Total Anomalous Pulmonary Venous Drainage (TAPVD)
- Single Ventricular, Interrupted Inferior Vena Cava, left sided superior vena cava (SVC) with Azygous continuation (done as emergency for an oxygen saturation of 30%). This patient underwent "total cavopulmonary shunt operation" as described by Kawashima et al.(4)
- Four cases of rare atrioventricular septal defect (AVSD) with double orifice.

All patients were alive at discharge, with a single death on postoperative day 5 secondary to massive pulmonary embolus.
We consider these surgical results to be a remarkable achievement, given that all patients presented very late with advanced disease and complex anatomy.

Educational Activities Pediatric Cardiology

In 2016, a two-day workshop was held in SHC (accredited by the Sudan Medical Council for 6 credit points). This was attended by pediatricians, internists, pediatric and adult cardiology fellows. 3 lectures were delivered during the Sudan Heart Society Scientific Sessions by Professors Smallhorn, West and Adatia. Professor Smallhorn also held one to one echocardiography teaching sessions with the physicians and fellows in SHC (Photo 2).


Photo 2

In 2017, a two-day symposium was conducted, with the second day dedicated to congenital heart disease in adults and the suggested methods to establish adult congenital heart disease services in Sudan.

Educational Activities – Neonatology:
The neonatal team was divided into 2 groups. The first group was composed of Dr. Dalal Abdelgadir and Amanda Pakutus to cover the dayshift with the day cardiac team. The second group was composed of Hannah Bazar, Andre Castilloux, Kelly Turner and Dr. Ernest Phillopos to cover the night shifts.
In addition to post-operative care, the neonatal team visited Soba University Hospital, Gaffer Ibnouf Children's hospital and Ahmed Gasim Hospital, where they gave lectures to staff and trainees. These sessions were well attended (150 total number of attendees) and were organized by Dr. Mohamed Khalil, neonatologist, Gaffer Ibnouf Children's Hospital.

Leadership Meetings:
In 2016, Prof. West met with the President of the Sudanese Medical Specialization Board (SMSB). This was preceded by a visit from the CEO of the Royal College of Physicians & Surgeons of Canada, who signed a memorandum of understanding with the SMSB. Prof. Smallhorn and Prof. Adatia held meetings to discuss the opportunities for training of pediatric residents in pediatric subspecialties.

In 2017, the Director of the international programs in the University of Alberta met with the President of the SMSB to discuss avenues of collaboration (Photo 3).


Photo 3

Funding & Sponsorship:
The Visiting team from Canada did not receive any remuneration for their time and conducted the missions on a completely voluntary basis.
In 2016, the visiting team's airline travel and hotel accommodation was sponsored by a group of Sudanese physicians and citizens abroad and some non-profit organizations while the patients' surgeries were partially sponsored by the Zakat Chamber.
In 2017, the visiting team's airline travel was sponsored by Sadagaat USA, a US non-profit organization established by Sudanese Americans, while the patients' surgeries were sponsored by the Zakat chamber, Bank of Khartoum and a group of Sudanese physicians and citizens abroad.

Conclusions and Future Collaboration:
The pediatric cardiac services in Sudan are in dire need for assistance. The ideal situation is the availability of well-trained local staff (anaesthesia, ICU, surgeons, perfusionist and nurses). The challenges outlined above are huge but not insurmountable. Collectively, we need to
Table 1: Visiting Team from Stollery Children's Hospital

Name	Specialty	Brief Bio
Jeffery Smallhorn Professor of Pediatrics, University of Alberta	Pediatric Cardiology Pediatric Echocardiography	Head of Echocardiography Lab, Toronto Hospital for Sick Children from 1983 to 2005. Head of Echocardiography Lab, Stollery Children's Hospital. Published 230 peer reviewed publications, many abstracts and and book chapters. Recipient of the Canadian Society of Echocardiography 2011 Achievement Award.
Lori Jeanne West* Professor of Pediatrics, University of Alberta	Pediatric Heart Transplant	Held leadership roles across the spectrum of clinical and academic organ transplantation, President of the International Society of Heart and Lung Transplantation, President of the Canadian Society of Transplantation, Board of Directors of the American Society of Transplantation and lead of several committees of The Transplantation Society. Dr. West was the clinical and research director of the Heart Transplant Program at the Hospital for Sick Children in Toronto from 1994 - 2005. She is currently the Director of the Alberta Transplant Institute.
Ian Adatia* Professor of Pediatrics, University of Alberta	Pediatric Intensive Care and Pulmonary Hypertension	Director of the Pediatric Pulmonary Hypertension Service and a Pediatric Cardiac Intensivist at the Stollery Children's Hospital and Mazankowski Alberta Heart Institute. He has published 25 book chapters, 100 abstracts and 108 peer reviewed papers.
Ernest Philipos	Neonatal Cardiology	Regional Medical Director, Neonatal Intensive Care, Alberta Health Services.
Mohammed Aklabi Clinical Assistant Professor Stollery Children's Hospital & Mazankowski Alberta Heart Institute.	Adult and Pediatric Cardiac Surgeon	Fellow of the Royal College of Physicians and Surgeons of Canada. Director of the fellowship program. He completed fellowships in pediatric cardiac surgery as well as heart and lung transplantation and ventricular assist devices. Visiting surgeon to Birmingham Children's hospital, UK and Boston Children's Hospital, USA.
Muhieldin M Muhieldin	Adult and Pediatric Cardiac Surgeon	Head of Cardiovascular Surgery Unit, Shaab Teaching Hospital, Khartoum, Sudan, 2005-2011. Consultant Cardiac Surgeon, Sudan Heart Center, Khartoum, Sudan, 2005-2011. Received training in Adult and Pediatric Cardiac Surgery in Zurich University Hospital, Switzerland, Cleveland Clinic, OH, USA, Royal Victoria Hospital, McGill University, Montreal, Canada, Minimally invasive surgery & Robotic Surgery and Valve Surgery Fellow at the University of Western Ontario, London, Canada, 2011-2012.

*visited in 2016, did not return in 2017

continue collaborating with teams coming from abroad to help advance pediatric cardiac services in Sudan and try to maximize utilization of the resources they offer. We believe that the Stollery Mission was a model for collaboration as it included not only surgical operations but also training and potential to develop strong academic relations. The team plans to return to Sudan in 2018.

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  - The Royal College of Physicians and Surgeons of Canada
  - Sudan Medical Specialization Board (SMSB)
  - Sudan Medical Council (SMC)
  - Sudan Embassy in Canada
  - Sudanese physician's and citizens abroad.

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