

Cardiac catheterisation and surgery in Namibia

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INTRODUCTION

Namibia was under a South African (SA) protectorate until 1990, when it gained independence. It is a vast land with 2.5 million people. It is an upper-middle income economy with socio-economic inequalities. Tertiary services were poorly developed. Lately, economic instability has negatively impacted on health directorate operations.

Herein, we describe the evolution of cardiac services with particular attention to recent establishment of paediatric surgery and complex transcatheter interventions.

THE HEALTHCARE SYSTEM

The first medical school opened in 2009. The traditional 3-Tier; primary (40 health centres, 260 clinics), secondary (3 intermediate hospitals, 30 district hospitals) and tertiary (1 referral hospital), exist. Funding is government's sole responsibility via its subsidiary, the Ministry of Health (MOHSS). The budget is allocated centrally, without application of demand–supply algorithms. Private healthcare is for the insured (<10% of the

population). The state billing system, incomplete and flawed, does not contribute to hospitals' revenue. National Health Insurance (NHI) proposals have led to futile results.

Albeit with good future promise, healthcare is tainted by bureaucracy (policy and structural deficiencies) that warranted urgent addressing – before navigating new territories.

HISTORY OF CARDIAC CARE IN NAMIBIA

Fortunate patients were sent to South Africa for surgery. After independence, a SA cardiothoracic surgeon, Professor Johan Rossouw, started periodic visits. We pay special tribute to his work, as he was also instrumental in designing the unit we work in today.

With an increasing burden, Namibia agreed with the Kenyan government in the early 2000s, to operate on RHD patients referred by physicians. The caveat; no longitudinal follow-up or structured Warfarin programme.

The government opened its first unit at Windhoek Central Hospital in 2008 through an inter-governmental agreement mediated by the University of Cape Town (UCT). This coincided with 9 RHD operations by a team led by Professors Peter Zilla, Bongani Mayosi, John Hewitson, Johan Brink, Mpiko Ntsheke and their then cardiothoracic resident, Dr Jacques Scherman. This followed Professor Patrick Commerford's earlier visit. Namibian doctors and nurses were subsequently sent for training, with the aim of safeguarding future sustainability.

Paediatric cardiac care started when Dr Christopher Hugo-Hamman arrived in 2009, following Dr Henning Du Toit, a cardiothoracic surgeon, all from SA. Anaesthetist Dr Etienne Vermaak also joined, setting the ground for routine catheterisation and adult surgery in 2010. An adult cardiologist from Germany, Dr Andreas Wilberg, also arrived and has since left, with Dr Simon Beshir from the Czech Republic, taking over.

Without a paediatric surgeon and ICU conditioned staff, it was inconceivable that paediatric surgery could happen locally. A Private-Public-Partnership (PPP) outsourcing agreement with the Christiaan Barnard Memorial Hospital (CBMH) in Cape Town was signed, where >300 patients have been serviced between 2009 and 2018, with good published outcomes.

The first indigenous specialists returned after 2010; adult cardiac anaesthetist, Dr Nicolaas Feris, from his Canadian cardiac anaesthesia fellowship, and adult cardiothoracic surgeon, Dr Jones Nghamwa, from SA, in 2013. The first Namibian paediatric team (cardiologist, Dr Fenny Shidhika and cardiac surgeon, Dr Alfred Mureko) returned in July 2018 and January 2019, respectively. We have since introduced paediatric cardiac surgery.

INCIDENCE AND PREVALENCE OF CHD AND RHD

There are no concrete CHD data or antenatal service. Intra-uterine deaths are unaccounted. Anecdotally, we believe that our CHD prevalence is more than 1 in 100. Variable regional distribution aligns with population density (in Owamboland, Kavango, Ruacana).

The ARF and RHD registry has >700 patients. Occurrence is directly proportional to socio-economic deprivation. Recognition and delayed presentation remain challenging (Table I).

CURRENT DEPARTMENTAL STAFFING

There is an absolute scarcity of a skilled workforce. Full-time staff servicing both populations are: 1 paediatric cardiologist, 1 paediatric/adult cardiac surgeon, 1 cardiac anaesthetist,

5 medical officers, 1 technologist, 1 technician, 1 perfusionist, 1 chief pharmacist and 25 registered/enrolled nurses, all adult trained (cath lab, clinic, ICU and theatre). Part-time staff are: 1 adult surgeon and cardiologist and 3 general anaesthetists, sharing sessions in cath lab and theatre, from private. Medipark Private Hospital (2 adult cardiologists, 1 paediatric cardiologist and technologist) offers pro-bono adult clinics and paediatric inpatient consultations, far north. Allied services (e.g. dieticians, physiotherapists, occupational therapists, social workers) warrant active promotion.

SCOPE OF PATHOLOGY

We have simple and complex CHD phenotypes and see unrepaired CHD natural history. Left to right shunts are the predominant lesions, with Tetralogy of Fallot spectrum, the predominant cyanotic condition. However, inter alia PA/IVS, DORV spectrum, Truncus, TGA and ccTGA, TAPVD, Ebstein and lesions with single ventricle physiology (including HLHS) are also observed.

Syndromes/associations (phenotypic correlation ± genotyping), e.g. Down syndrome (young mothers), 22q11.23 microdeletion, FAS, Noonan's, William's, Allagille, Shone complex, VACTERL, CHARGE, and Pierre Robin sequence are both observed. ARF/RHD ranges from sub-clinical to severe disease. Concurrent CHD and RHD is not unusual. Proven subacute bacterial endocarditis is frequently seen. Pericardial disease with TB constriction presenting in early childhood was strange. Sub-mitral/LV aneurysms were regularly observed, including a child under 4 years. We have a cohort of infantile/childhood cardiomyopathies (CMOs); e.g. non-compacted, familial, hypertrophic (including metabolic linked to consanguinity), and myocarditis. Adults typically present with RHD, coronary disease, arrhythmias and CMOs (including post-partum).

PERIPHERAL CARE

We get ad hoc national referrals (neonatal, local/peripheral hospitals) and perform 2 - 3 paediatric outreach clinics/annum to 2 hospitals, 600 - 700km away.

SERVICE INFRASTRUCTURE

Cardiac catheterisation laboratory

Housing biplane fluoroscopy, it is shared between adult-paediatric cardiology, hepato-biliary, vascular, and soon, neurosurgery. We simplified the consumables supply chain with direct consignment strategies, driving cost efficiency. We perform diagnostic studies for operability, complex anatomy delineation and before staged univentricular palliation. CT cardiac imaging is evolving. Paediatric transcatheter interventions have gained

TABLE I: Disease burden as indirectly reflected by outpatient visits in 2018 - 2019.

Clinic visits	2018	January - October 2019
CHD	806	619
RHD	353	371
Adult cardiology	977	401
INR	1 786	1 644
Outreach		290
Thoracic	676	336
Satellite adult cardiology	>700	>700
Cumulative surgery waiting list	-	>300

NB: November and December counts are not included.

momentum with support from Dr Oliver Stumper. We do not yet have electrophysiology equipment, when indicated, and this service needs to be outsourced. Adult interventions include coronary interventions and transvenous pacing.

Cardiac theatre

There is none shared theatre which was not optimally set-up for paediatric cardiac surgery. There is access to intraoperative imaging (transesophageal >10kg and epicardial). We only perform low-medium risk paediatric surgery in the interim; neonatal and complex patients are referred to Dr Andre Brooks and Susan Vosloo in Cape Town. We serve a "non-interventional paradigm" for HLHS and lethal Trisomies. Equally, we are conservative with univentricular palliation, for now.

Cardiac ICU

A PICU is planned, and in the interim we nurse paediatric patients in a shared adult ICU with a 5 ICU and 8 high-care bed capacity. We have access to conventional (and lately, non-invasive) and high frequency ventilation, a gas analyser with glucose and lactate reagents, critical drugs and inhaled nitric oxide. Our paediatric care bundles are based on Red Cross War Memorial and Birmingham Children's hospitals protocols.

Neonatal ICU

The well-equipped neonatal unit is remote from the cardiac ICU. On merits, duct-dependent newborns are nursed there while awaiting definitive plans.

ESTABLISHING PAEDIATRIC HEART SURGERY IN 2018

Politics play a critical role and we had to engage MOHSS and importantly the staff, to endorse the concept. We cannot over-emphasise "Twinning" with experienced/successful institutions. We motivated for critical drugs (e.g. Milrinone, Noradrenaline, Esmolol, Nitroprusside, Dexmedetomidine) that were not listed or only available on compassionate clearance. Oral Prostin supply issues remain.

We recognise the obligation to adhere to ethical principles; beneficence (do good), non-maleficence (do not harm), autonomy and social justice, reporting with integrity, as we promote accessibility, affordability, safety and sustainability.

Pilot work

The first operations were performed in September 2018 when we invited Dr Mureko (then in training), Professor Brink and Mr Johnathan Stuurman-Muller (PICU nurse), to test the ground. We operated successfully on 10 children (e.g. VSD, ASD, PDA, pericardiectomy, PA Band (ccTGA/VSD, re-do high

risk RHD)). The second campaign was performed in January 2019, upon Dr Mureko's return to Namibia. Currently, we have had 4 CHD campaigns with Professor Brink and one charitable, with the Mending Kids team, led by Dr Salvatore Agati and interval operations.

We have performed modified RACHS-I categories 1 - 3 operations (e.g. left to right shunts (including Trisomy 21-AVSDs), coarctation/interruption, pulmonary valvotomy ± supralvalvar relief, subaortic membrane/supra-mitral ring resection, sub-mitral and LV aneurysms, mitral arcade, the Bentall procedure, Fontan completion, and pericardiectomies) on patients aged 3 months - 50 years old. Concomitant RHD and CABG, with some valve-sparing procedures were performed successfully on selected patients. We also perform thoracic surgery in both populations.

Quality control

There is obligatory full-time cover. Simple infection control measures were instituted. "High risk" aversion is the norm, unless under clear duress. We have weekly surgical discussions and monthly morbidity and mortality audits. We obtained our International Quality Improvement Collaborative for CHD (IQIC) membership in May 2019. A comprehensive electronic database is imminent.

Postoperative morbidity and mortality

We do postoperative care ourselves, in the absence of paediatric intensivists in the country. The MOs and nurses have displayed remarkable growth in this area. Children made up >63% of cardiac operations. Postoperative infection (wound and invasive) caused morbidity. We serially audit our infection control measures and modify them. In total, 11 patients out of 363 patients died (CHD, RHD, CABG, thoracic) in 2019 (refer to Table II: Surgery).

Mortality in the CHD group was secondary to proven bacteraemia in all 5 patients (though we screen all patients preoperatively using blood counts, CRP and PCT), except for one pulmonary hypertensive crisis in a Trisomy 21-AVSD and one Fenestrated extracardiac Fontan completion + LPA patching + total occlusion of forward flow (Non-syndromic unbalanced AVSD/Malposed great arteries/PS). She died during the re-exploration of the Glenn anastomosis, LPA and residual forward flow, as we could not address them percutaneously. In hindsight, though, there were favourable baseline haemodynamics; she was perhaps not a good anatomical substrate.

TABLE II: Surgery 2019.

Month	Total cases	Morbidity	Mortality	Cardiac	Thoracic
January	11		0	9	2
February	41		1	14	27
March	33		2	14	19
April	37		1	14	23
May	44		2	16	28
June	36		4	9	25
July	50		1	10	25
August	24		1	7	14
September	29		1	10	16
October	25		2	15	10
November	33		2	8	18
Total	363		11	126	207

NB: The referrals to Cape Town in 2019 were 8 in total, 1 Angolan and 7 Namibian (neonates - 2 years). The lesions were TGA, Severe sub- and valvar AS for Ross consideration, TAPVD/inlet VSD/Arch hypoplasia, obstructed TAPVD, Critical short segment Aortic coarctation/ASD with LV dysfunction, Big muscular-outlet VSD with functional arch hypoplasia from streaming effects, and a late Truncus at 12 months. No mortality was recorded.

ESTABLISHING COMPLEX PAEDIATRIC TRANSCATHETER INTERVENTIONS

Paediatric data

We performed 37 interventions successfully in 2 campaigns (March and October 2019) with Dr Oliver Stumper, with no mortality. The procedures were:

ASD device	1
ASD patch fenestration (Late ASD full patch repair, significant PHT)	1
Attempt PV perforation (18 years, Tetralogy of Fallot (TOF) with pulmonary atresia (confluent PAs), no MAPCAS (bronchial arteries only) - very cyanosed. Diagnostic information with retrograde PV wedge angiography)	1
Bilateral PA balloon angioplasty (22q phenotype, TOF (transannular patch) repair 2015 with branch PS)	1
Coarctation of Aorta stent angioplasty (covered CP) (37 years, Coarctation syndrome; bicuspid AV with mild-moderate incompetence, LV dysfunction - to recover function before a future Bentall procedure)	1
Decompressing vein occlusion (AVP II) (Mesocardia, ccTGA/VSD/PS undergoing univentricular palliation; Glenn shunt 2016 - high circuit pressures, very cyanosed) + PV valvuloplasty; in view of unlikelihood to achieve stage III palliation, to review serially; post-procedure saturation 82%)	1
LPA recruitment (stent angioplasty) (Trisomy 21, AVSD- Fallot (no critical infundibular narrowing but disconnecting hypoplastic LPA: for future RVOT stenting as final palliation when very cyanosed)	1
PDA device (COOK Flipper coils, ADO I, ADO II, ADO II AS, AVP II)	11
Anomalous systemic collateral to the lung RUL occlusion (coil) (Non-specific dysmorphism + haemodynamically significant PDA)	1
PDA stent (Functionally single ventricle; Tricuspid-pulmonary atresia, for a Cavo-pulmonary shunt in 6 months)	1
Pulmonary valvuloplasty	3
RVOT stents (Trisomy 21, AVSD- Fallot as final palliation, rehabilitate native hypoplastic PAs and to relieve debilitating cyanosis (long surgery waiting list)	8
RMBTS stent (22q phenotype, TOF with pulmonary atresia (borderline PA structures, out-grown shunt with severe cyanosis)	1

The TOEs were performed to assess ASDs feasibility for device closure and Mustard exploration (late TGA – Mustard 1995).

Adult data 2019

Two hundred and three coronary stents were implanted (average of 1.3 stents/procedure). Thirty patients had transvenous pacemaker implantations.

FUTURE GOALS, OPPORTUNITIES AND POTENTIAL THREATS

- Continuous capacity development, with updated “FILE-MAKER PRO” database enrolment (UCT collaboration).
- PICU project execution 2020.
- Expand infection control bundles.
- A paediatric intensivist, cardiac technologist and hopefully, an anaesthetist to join in 2020. A paediatrician is due to start PICU specialisation.
- Dr Tangeni Auala (adult cardiologist), Dr Ismail Awala (adult cardiothoracic surgeon) and Dr Jones Nghaamwa (adult cardiothoracic surgeon on fellowship) are returning in 2020. Dr Wim De Mey is pursuing paediatric cardiology.
- A paediatric cardiology chapter was added to the NEMLIST.
- Empowering peripheries include expanding outreach clinics to Kavango.
- Develop a GUCH protocol/clinic.
- Broaden funding and charities (Children HeartLink, continue with Mending Kids). The budget is declining.
- Trust (Namibia Children Health Organisation) to start active work.

RESEARCH

We got ethics approval for AFROSTREP, PROTEA and Pulse Oximetry Screening in 2019. Mr Shimanda is pursuing a PhD in epidemiology and health economics (RHD) in collaboration with a Swedish university. Sister Charmaine Njembo is completing a MSc in GUCH. We teach final year medical students and have hosted 3 elective students from Germany, Poland and South Africa.

CONCLUSION

This is a hard assignment in the face of budget and skills limitations, but there is definite political will. We defeated the odds by establishing paediatric cardiac surgery. Including percutaneous interventions, we have served >120 children in 2019. The learning curve was remarkably steep, but we are willing to learn and grow.

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ETHICS AND DISCLOSURES

The main author declares no conflict of interest. MoHSS approved dissemination.