

Operation Open Heart 1995: lessons learned and thoughts for the future

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Introduction

A group of Australian volunteers was recently invited to Papua New Guinea by the PNG Health Department as part of an ongoing project code-named 'Operation Open Heart'. The 'Heart Team', as it is known in PNG, is coordinated by the Sydney Adventist Hospital in Australia in conjunction with the Adventist Development and Relief Agency (ADRA); additional financial support for this visit to PNG was provided by a wide range of groups including the Papua New Guinea Heart Foundation, Papua New Guinea Red Cross, local Rotary Clubs and businesses in PNG, local hospital boards and the PNG Department of Health.

Operation Open Heart aims to provide cardiac surgery to populations that are not served by indigenous programs and to provide education to local medical and nursing staff. It is intended that, over time, local teams will become conversant with the operative and intensive care techniques required to provide a service for their own populations. A more general discussion regarding the place of such a program within the overall provision of health care in Papua New Guinea is outside the scope of this article, but is clearly a matter for debate.

In 1995, the Heart Team spent two weeks in Goroka, in the Eastern Highlands Province, at

the invitation of the Board of Goroka Base Hospital. A senior cardiologist accompanied the team, under the auspices of IDP Education Australia, which manages the Visiting Medical Specialists Program on behalf of AusAID and the PNG government. As a result of this visit, it was suggested that the Heart Team compile some guidelines for local paediatricians, physicians and cardiologists in PNG indicating the sort of case that would be suitable for review by the Team on any future visit. This article is in two parts: the first describes the activities of the Team on the 1995 visit, which acts as a background for the second part of the article, which tackles the question of guidelines.

Part One: Operation Open Heart

The Heart Team numbered 35 in all and was drawn from all over Australia. It consisted of two theatre nurses, an anaesthetic nurse, 10 intensive care nurses, a medical technician and a medical registrar. Two teams of a cardiac surgeon, two anaesthetists and a perfusionist covered one week each, accompanied by the Team's public relations officer and the coordinator (RL).

During the visit, the Heart Team was ably supported by the medical, nursing and paramedical staff of Goroka Base Hospital, and by the radiography and pathology services, upon which the smooth running of the program is vitally dependent.

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Clinical organization and assessment

Local Papua New Guinean paediatricians and physicians from all areas had selected patients from their clinics for review by the visiting cardiologist for consideration of heart surgery on this, or another, occasion. Clinics were conducted in Port Moresby, Goroka, Mount Hagen, Madang and Rabaul, and up to 60 patients a day were seen. Small groups of patients from Tabubil, Mendi, Tari, Lae, Kavieng and Vunapope were accompanied by their medical officers. Each patient carried a health book detailing a cardiac history, or arrived at the centre with a referral letter. Most patients also carried a chest radiograph and a twelve-lead electrocardiogram. Presentation in children had been largely precipitated by the detection of a heart murmur during routine examination for an illness, whilst in adults presentation was determined by the appearance of cardiac symptoms, or by complications of rheumatic valvular lesions.

Each patient was assessed clinically, and two dimensional and m-mode echocardiography performed when indicated. Patients selected as possibly suitable for surgery were invited to undergo further echocardiographic assessment including Doppler studies at Goroka Base Hospital. Sedation with chloral hydrate 30-60 mg/kg was administered to children under 15 kg if necessary. Nearly 300 patients were screened in this way. Some patients referred themselves to Goroka and were seen and assessed as time permitted.

Screening

There were 295 assessments performed in 287 patients, most undergoing two-dimensional echocardiography. The vast majority of the adult population was under 40 years of age, and most of the children were under 6 years; 56% of all patients were male. The numbers assessed at each centre are shown in Table 1. As expected, congenital heart disease formed the bulk of the paediatric workload, whilst the cardiac complications of rheumatic fever predominated in the adult population. The numbers of patients in the main diagnostic categories are given in Table 2; there were 47 patients screened in whom no cardiac abnormality was found, their murmurs being innocent.

Following clinical assessment, a clinical diagnosis was recorded and medical treatment suggested, together with a recommendation for any necessary cardiac follow-up locally, or by the Heart Team.

Planning surgical intervention

Many factors were involved in making a decision about surgery, and these were necessarily pragmatic. More complex cardiac surgery (such as tetralogy repair or the Fontan operation) was not planned, as specialist postoperative care could necessarily only be provided for the duration of the Team's visit.

Valvular heart disease

A small number of prosthetic heart valves had been donated to the Heart Team, but there

TABLE 1

SCREENING AT EACH CLINIC CENTRE

Clinic Centre	Adults	Children	Total
Goroka*	28	56	84
Madang	1	51	52
Mount Hagen*	15	31	46
Port Moresby	8	56	64
Rabaul	1	48	49
Total	53	242	295

* Adult cases preselected by an adult cardiologist in PNG

were several concerns about their use. The management of mitral valve disease, in particular, was complicated by a lack of facility for anticoagulation control outside the major centres and for this reason, together with concerns about adequate rheumatic fever prophylaxis, elective valve replacement was not considered a practical management option on this occasion. Open mitral valvotomy was to be the surgical management of choice for symptomatic mitral stenosis (including those patients who had suffered embolic events); severe pulmonary hypertension and/or coexistent moderate mitral regurgitation were considered to be relative contraindications to this procedure. Elective aortic valve replacement was not excluded should clinical circumstance arise.

Congenital heart disease

Ligation of patent ductus arteriosus, closure of atrial septal defect and closure of ventricular septal defect were planned where possible. Surgical treatment of tetralogy of Fallot was

limited to palliation by systemic to pulmonary artery shunt (synthetic Blalock-Taussig shunt). Children were considered for surgical intervention if the cardiac lesion was 1) amenable to cure with a low operative risk and likelihood of short intensive care stay, 2) was of sufficient importance to warrant operative intervention within the next twelve months and/or 3) was causing cardiac decompensation and/or failure to thrive. Contraindications to surgery included 1) complex anatomy, 2) inadequate diagnostic information and 3) significant non-cardiac disease (particularly respiratory compromise).

Formulating the theatre list

The Team were to concentrate on adult patients during the first week of their visit, but had the potential to perform paediatric cardiac surgery if required. During the second week, it was intended to operate largely on children.

Few of the adult patients with rheumatic heart disease who had been referred for

TABLE 2

MAIN DIAGNOSTIC CATEGORIES BY CLINIC CENTRE

Centre	RHD Adult	CHD Adult	RHD Child	PDA	VSD	Tetralogy of Fallot	ASD	Complex CHD Child	Other cardiac
Goroka	18	3	2	9	15	4	2	2	9
Madang	1	0	3	1	24	4	1	8	8
Mount Hagen	6	1	1	7	9	2	1	1	7
Port Moresby	2	3	9	3	16	4	4	8	11
Rabaul	0	1	0	7	16	6	1	3	4
Total	27	8	15	27	80	20	9	22	39

RHD = rheumatic heart disease
 CHD = congenital heart disease
 PDA = patent ductus arteriosus
 VSD = ventricular septal defect
 ASD = atrial septal defect

evaluation were suitable for the limited surgical palliation that the Heart Team could offer; many were inoperable, and many more would face high-risk surgery with arguable limited benefits. Consequently, more children than expected underwent surgery in the first week, allowing time for the local surgeons and operative teams to expand techniques learned on previous Heart Team visits, particularly in non-bypass procedures such as ligation of patent ductus arteriosus. Overall, 32 procedures were performed in 31 patients (see Table 3), 25 of whom were children (less than 16 years of age).

As expected, there were more patients requiring procedures than operating time allowed. Precedence was given to patients in whom 1) timely surgery was required to prevent further deterioration and 2) totally corrective surgery could be performed. The Heart Team carried only a limited number of bypass circuits, effectively biasing the case selection toward non-bypass surgery.

Fourteen patients required formal admission to Goroka Base Hospital for optimization of medical treatment and/or treatment of intercurrent infection before surgery could be considered. Seven patients were admitted for such therapy, but discharged without undergoing surgery. One four-year-old boy with a significant patent ductus arteriosus had a severe respiratory infection resistant to short-term therapy. Plans have been made to admit this child (who lives in the highlands) for intensive chest physiotherapy before the next visit of the Heart Team. A second child with a patent ductus had severe impetigo and scabies which precluded safe surgery. The remaining four adults and one child had mitral valve disease considered to be inoperable on this occasion despite the period of intensive medical therapy.

Requirement for surgery

As alluded to above, the clinical demand for surgery was far in excess of capacity. Table 4

TABLE 3

LIST OF OPERATIVE PROCEDURES

Procedure	No of cases
Ligation of patent ductus arteriosus	11
Open mitral valvotomy	5
Systemic to pulmonary artery shunt	5
Repair of ventricular septal defect	3
Repair of secundum atrial septal defect	3
Pulmonary artery banding	1
Pulmonary artery banding/coarctation repair	1
Primum ASD and cleft mitral valve repair	1
Mitral valve replacement	1
Total	31

ASD = atrial septal defect

details the number of patients deemed to require surgery for each diagnostic category. Decisions were based upon predetermined criteria as described above, with the exception of the rheumatic mitral valve disease category, which includes patients in whom valve replacement would be required were anticoagulation available.

A 31-year-old man with a ruptured sinus of Valsalva aneurysm and two children with tetralogy of Fallot were referred for surgery overseas. Overall, of the 287 patients screened, 95 (33%) were listed for possible surgery on this occasion, with many more (particularly those with ventricular septal defect) referred for review. In performing 31 operations the Heart Team was able to help one-third of the patients presenting who met the criteria for surgery in PNG.

Surgical results

All the operated patients survived to leave hospital and at one month reports continued to be good. The results following mitral valvotomy were disappointing, however, despite excellent technical results (minimal mitral incompetence at the end of the procedure). Almost without exception,

cardiomegaly developed within days of surgery with deteriorating left ventricular function and secondary increase in mitral incompetence. Treatment with diuretics, digoxin and angiotensin converting enzyme inhibitors was helpful, but the longer-term results are, of course, as yet unknown. One woman with tight mitral stenosis whose only symptom was shortness of breath on exertion did extremely well, and was discharged on no medication.

Complications

Preoperatively, one child with tetralogy of Fallot developed a hypercyanotic episode whilst awaiting premedication. He responded only partially to standard management (intravenous fluids, morphine, facial oxygen and intravenous propranolol) and required mechanical ventilation and urgent surgery. Perioperatively, a fifteen-year-old boy with severe mitral valve disease, tricuspid regurgitation and pulmonary hypertension was difficult to wean from cardiopulmonary bypass, necessitating unplanned mitral valve replacement. Reoperation was required in only one case - a thirteen-year-old boy who required ligation of a residual patent ductus arteriosus on the day following the initial procedure. Minor wound infection occurred in one patient.

TABLE 4

SURGERY RECOMMENDED WITHIN 12 MONTHS

Diagnostic category	Total screened	Operation required	Operation undertaken
Ventricular septal defect	80	31	5*
Patent ductus arteriosus	25	14	11
Tetralogy of Fallot	17	12	5**
Atrial septal defect	9	3	3
Rheumatic heart disease (child)	15	10	2
Rheumatic heart disease (adult)	25	11 [†]	4

* includes 2 children who underwent palliative pulmonary artery banding

** all palliated with systemic to pulmonary shunts

[†] includes those who might require valve replacement (see text)

Chest infections developed clinically in three cases, one with frank consolidation on X-ray. One patient with severe mitral valve disease and pulmonary hypertension developed pulmonary oedema and severe left ventricular failure, unmasking previously undetected aortic regurgitation. He required readmission to the intensive care area (but not reventilation) four days after successful open mitral valvotomy, and subsequently made a good recovery.

Comments

Rheumatic heart disease continues to make up a large proportion of heart disease in adults presenting to the Heart Team. Most of the patients in this group had established pulmonary hypertension and/or tricuspid regurgitation, and many were severely incapacitated by poor exercise tolerance and cardiac cachexia. Associated mitral regurgitation was deemed a relative contraindication to surgery on this visit. Interestingly, in contrast to other reports, pure rheumatic mitral regurgitation was quite rare in the referral group; this is associated with ongoing disease activity, so *may* represent a better than average use of penicillin prophylaxis, although this is unlikely (1). Optimum management of the disease at any stage continues to provoke discussion, particularly in the developing world. Closed mitral valvotomy would seem to have given way to percutaneous balloon valvuloplasty in selected patients (2-3). Comparison with open valvotomy is ongoing (4). However, a successful percutaneous balloon valvuloplasty program is characterized by very careful case selection using sophisticated echocardiographic and interventional investigational techniques not at present available in PNG. There is an increasing move toward mitral valve repair in rheumatic valve disease; however, experience suggests that the younger population does less well at five-year follow-up with a particularly high requirement for reoperation; neither is the risk of atrial fibrillation and its concomitant morbidity reduced significantly (5-6). Mitral valve replacement is fraught with difficulty, as the poor durability of tissue valves is a major consideration in younger patients. Mechanical valves require careful, formal anticoagulation, particularly in the mitral position, and are not

appropriate in PNG in the majority of cases. Our experience on this visit would suggest that those who were selected for surgery (open mitral valvotomy) did not do well early on, mainly due to early left ventricular dysfunction and concomitant pulmonary hypertension. Reevaluation after a longer period of postoperative medication will be important. Perhaps it is the patients with *moderate* mitral valve disease that should be referred - ie, those with minimal symptoms - so that valvotomy and/or repair may be performed to limit the development of pulmonary hypertension, preserve left ventricular function and possibly delay the onset of atrial fibrillation.

Whilst the majority of patients with valvular heart disease were receiving prophylactic penicillin in one form or another, there were a number that were not - sometimes due to problems in supply of medication at a local level. A discussion about the prevention of rheumatic fever is outside the scope of this article, but we would comment that penicillin remains the mainstay of primary and secondary prevention worldwide (7).

Long-term anticoagulation, a valuable asset in reducing morbidity from embolic events in mitral valve disease both before and after surgery, is almost unobtainable outside major centres. Problems with standardizing and performing the necessary assays, together with specimen collection and reduced patient compliance, are cited as reasons for failed anticoagulation. Studies looking at the possible role of aspirin rather than coumadin have been disappointing (8). Ticlopidine and other newer agents have yet to be evaluated, but cost may preclude their use in the longer term.

Referral patterns

To try to get a feel for the relative prevalence of congenital heart lesions in the referral population, this year's group of patients was compared with a similar group referred to the Boston Children's Hospital in the USA (9). The relative referral rates were surprisingly similar - ventricular septal defect 49% (Boston 30%), patent ductus arteriosus 15% (Boston 12%), tetralogy of Fallot 10% (Boston 26%), secundum atrial septal defect 6% (Boston 6%) and 'other' 19% (Boston 26%). The figures for tetralogy probably reflect the early fatality in

untreated patients in PNG. Other common congenital heart lesions (transposition of the great arteries, aortic coarctation and hypoplastic left heart) are not often seen in PNG. While this may simply be because these babies die early in the neonatal period, it is nevertheless worth noting that few children with congenital aortic stenosis were seen either. Only one older patient with aortic stenosis and one infant with coarctation of the aorta were seen, raising the possibility of a genetic variation in the nature of congenital heart disease in PNG, as in other Asia-Pacific regions.

Conclusions

It could be argued that a specialized team with limited resources should do small amounts of good for lots of people, whilst educating local teams to perform the same tasks. Ligation of patent ductus arteriosus is such a procedure in point. The procedure is curative for a potentially fatal condition, patients rarely have other cardiac problems, and there is usually no urgency. Diagnosis can be made clinically (with chest radiography) but echocardiography is useful in excluding other causes of a continuous murmur and in estimating the degree of pulmonary hypertension. The procedure does not require cardiopulmonary bypass and is performed through a lateral thoracotomy. Postoperative intensive care facilities are not required, with the proviso that significant contusion of the ipsilateral lung can occur, necessitating meticulous attention to pre- and post-operative chest physiotherapy, particularly in these children who often have less than optimal respiratory function.

Lessons learned from this and other trips may improve efficiency during subsequent visits, and help to raise awareness of cardiac disease among local paediatricians and physicians in PNG. The second part of this article will address some of these points. It is hoped that the experience gained from this visit will be of benefit in future visits and in the aim of helping to improve provision of health care in PNG.

Part Two: Guidelines for referral to the Heart Team

The following suggestions are based on the

experience of the Heart Team during visits to Papua New Guinea and other developing countries. The Heart Team would welcome any comments and suggestions.

1. General role of the Heart Team

- i Diagnosis and management
- ii Surgical selection
- iii Follow-up - preferably in conjunction with a local paediatrician or physician
- iv Education

It is helpful if the referring doctor and the patient have a clear idea of what is expected of the planned consultation, and that the visiting cardiologist has an understanding of what is feasible, practical and appropriate before making a recommendation. The decisions made during the consultation should be made known to the referring physician and a clear plan of further management outlined. Logistics do not allow written communication other than via the patient's health book. The services of an interpreter are invaluable - particularly a nurse or doctor who may be involved in ongoing care, providing additional educational opportunity for all concerned.

i) Diagnosis and management

This category is self-explanatory and would include those patients in whom the diagnosis was not in question but for whom management issues were a problem. Where significant lesions are detected, adequate follow-up is required, so each patient (regardless of the diagnosis) should return to the referring physician with the result of the consultation. The patient may not have understood the import of their consultation visit, for reasons of language, time and culture.

ii) Surgical selection

As discussed in the first part of this article, decisions regarding surgery are based on three principles: 1) surgery is required within 12 months; 2) surgery would be curative or offer substantial palliation, eg, systemic to pulmonary shunts in tetralogy of Fallot, mitral

valvotomy; 3) surgery is technically feasible in PNG. Table 5 outlines the characteristics of suitable patients in the common diagnostic categories which are discussed further below.

iii) Follow-up

Logistically, it is not possible for the Heart Team to follow up every patient, and one would suspect that neither would local physicians wish that to be the case. It may be helpful for the Heart Team to indicate which patients require more specialist follow-up - with echocardiography etc. These would, on the whole, be patients in whom operative intervention may be necessary at some time.

For those patients with more chronic conditions, a change in symptom status may be a useful index by which to judge the need for more specialist follow-up and/or consideration for surgery.

In either case, it would be very important that local follow-up continues, to reinforce advice about endocarditis and rheumatic fever prophylaxis etc. It may be that some patients would not report symptoms spontaneously, but may need direction - this would be particularly relevant in slowly progressive lesions such as mitral stenosis (see below).

iv) Education

Ideally, referring paediatricians and physicians should be present during the consultations - not necessarily confined to their own patients. Each referring specialist may wish to bring up one particular patient for more in-depth discussion. There is always pressure of time during the Heart Team visit, but education is one of the aims of the Team and time must be set aside for teaching, even at the expense of one or two consultations or even operations. Whilst it is difficult to appreciate in the middle of a clinic with fifty patients waiting, such an approach is bound to be more productive in the longer term and should be a very important part of the Team's

activities. To achieve this will require a slight shift of emphasis on behalf of the Team and the referring specialists. Members of the Team are changing all the time, and on first arriving in PNG the wider issues involved can be obscured by the immediate problems faced.

2. **Particular diagnostic categories**

- i Murmurs in asymptomatic children
- ii Patent ductus arteriosus
- iii Ventricular septal defect
- iv Cyanotic congenital heart disease
- v Isolated pulmonary hypertension
- vi Mitral valve disease

A synopsis of cases suitable for surgery in PNG is given in Table 5.

i) Childhood murmurs

A diagnostic service would always be provided. However, whilst having some children with minor valve lesions, small ventricular septal defects and innocent murmurs in the clinic benefits the teaching exercise, there is a limit to the number that can be accommodated.

A significant pathological basis for a cardiac murmur in childhood should be suspected if:

- a. there are associated cardiac symptoms or signs (breathlessness, fatigue, cyanosis, heart failure);
- b. there is significant failure to thrive;
- c. there is cardiac overactivity (active praecordium);
- d. there are both systolic and diastolic murmurs.

Endocarditis prophylaxis is probably advisable if the diagnosis is uncertain.

ii) Patent ductus arteriosus

These should be ligated if at all possible. It is a low-risk operation, carries a low morbidity and is generally curative. Local surgeons now have the expertise to perform this operation in PNG.

iii) Ventricular septal defect (VSD)

Infants with large VSDs are likely to die of heart failure in early life or survive by virtue of developing early pulmonary vascular disease (Eisenmenger syndrome). Overall, however, many of these defects become haemodynamically less significant with age. The Heart Team may usefully identify which of these patients no longer require active follow-

up. Endocarditis prophylaxis remains an issue whenever a structural lesion is present. Children may be reviewed by the Heart Team two or three years following diagnosis with the proviso that it is better to see them sooner should there be failure to thrive, development of heart failure or reduced exercise tolerance.

Should a child with a moderate or large VSD develop a chest infection and

TABLE 5

SYNOPSIS OF CASES SUITABLE FOR SURGERY IN PNG

Diagnosis (Operation)	Clinical signs	Indications for surgery
Patent ductus arteriosus (Ligation)	Continuous murmur (diastolic component may be short if significant pulmonary hypertension). Wide pulse pressure. Cardiomegaly on chest X-ray.	All cases - particularly if associated with heart failure or frequent respiratory infection.
Atrial septal defect (Repair)	Wide split second heart sound with loud P2. Pulmonary ejection murmur and apical mid-diastolic murmur.	All cases - unless ASD very small.
Ventricular septal defect (Repair)	Pansystolic murmur loudest at left sternal edge. Mid-diastolic murmur at apex. Cardiomegaly on chest X-ray.	Heart failure. Failure to thrive. Associated with aortic regurgitation (subaortic VSD).
Pulmonary valve stenosis (Open valvotomy)	Ejection systolic murmur in pulmonary area with ejection click. Right ventricular hypertrophy on electrocardiogram.	Doppler echo gradient in excess of 60 mmHg - often asymptomatic.
Tetralogy of Fallot (Palliation with systemic to pulmonary shunt)	Cyanosis and clubbing (sometimes acyanotic at rest). Pulmonary ejection murmur. 'Boot-shaped' cardiac silhouette on X-ray.	Cyanosis or poor exercise tolerance. Hypercyanotic episodes. Failure to thrive.
Mitral valve disease (Open valvotomy or repair)	Single lesion - stenosis or regurgitation. Normal aortic valve and left ventricle. Little evidence of pulmonary hypertension.	'Pure' mitral stenosis. Moderate to severe mitral regurgitation with good left ventricular function.

require hospitalization, it is probably best to avoid administering oxygen unless absolutely necessary. Oxygen in this circumstance will cause a fall in pulmonary vascular resistance, increasing the left to right shunt and precipitating heart failure in a significant minority of individuals.

iv) Cyanotic congenital heart disease

With few exceptions, palliation is all that can be offered in PNG at present. Palliative systemic to pulmonary artery shunts in children will eventually need repair or further palliation, so operation at this stage will leave the ethical dilemma of what to do next. Cases are being considered on an individual basis for repair in Australia at the rate of perhaps two a year. This year in PNG saw 16 children referred with tetralogy of Fallot or variants.

Medical palliation with oral propranolol may be helpful in children with hypercyanotic episodes associated with tetralogy of Fallot.

v) Isolated pulmonary hypertension

This visit produced a spate of young children with evidence of heart failure and high estimated pulmonary artery pressure with no obvious cause. Many of them live at a high altitude and have had recurrent chest infections. Whether we are seeing cause or effect is not yet clear. A longitudinal study of this unusual condition could be undertaken by PNG physicians, with Doppler echocardiography. Other conditions such as patent ductus arteriosus and anomalous pulmonary venous return should not be overlooked.

vi) Mitral valve disease

As discussed in Part One, the management of this condition is particularly difficult. Prevention is the key to this disease, by improving the general health of the population, improving living conditions and providing accessible health care at the

local level. Palliation is possible, but is limited to the few with anatomical lesions suitable for surgery. Symptomatic pure mitral stenosis is an indication for valvotomy. Reduced exercise tolerance will remain the prime symptom in these patients and such symptoms should be actively sought at each visit. Associated mild mitral regurgitation or mild aortic regurgitation may not preclude surgery, but cardiomegaly and severe mitral regurgitation may prove a problem, although repair may be possible. Echocardiographic assessment would be required. Pure mitral regurgitation is amenable to repair in the absence of severe left ventricular dysfunction. However, it remains that surgery for this condition in PNG is generally only palliative and is applicable to a small minority of patients.

Long-term penicillin is mandatory, as the incidence and epidemiological characteristics of recurrent rheumatic fever in PNG have not been established.

Where possible, formal anticoagulation should be offered to patients in atrial fibrillation, and for those with tight mitral stenosis regardless of rhythm.

3. Referral for surgery overseas

The financial and logistic capability to organize an operation overseas is only part of the story. More complex surgical palliation for congenital heart disease (eg, Fontan procedure for one-ventricle hearts) requires prolonged specialist postoperative care, which may need to continue for some months after discharge from hospital. Many procedures for complex congenital heart disease are staged, and several operations may be required. In adults, if valve replacement is performed, will anticoagulation be available on return to PNG? What happens should the valve acutely (or chronically) malfunction? Complete heart block is a recognized complication of aortic valve surgery in adults and occurs occasionally in children following repair of complex septal defects. Pacemakers in children and adults require regular follow-up, with multiple operations for lead and battery problems, particularly in children.

4. Future directions

The incidence of congenital heart disease appears to be stable but the needs of the population grow as new cases present to health services. Because of the large costs involved and specialist training required, provision of open heart surgery in PNG seems several years away at present. It might be conceivable that percutaneous balloon mitral valvuloplasty be developed in PNG in line with the experience in India. Setting up such a service would be a significant commitment both in financial and professional terms, but might provide palliation for a large number of individuals at relatively low cost in the long term. In the meantime, strenuous efforts directed toward prevention are ever important, as discussed earlier.

Final remarks

The Heart Team visited PNG for a very short time to provide a very specialized service. There would be many critics of this approach, particularly when the provision of basic health care in PNG is often fraught with difficulty. However, one could argue that one has to start somewhere and, in conjunction with local specialists and services, a small fraction of the problem has been addressed. We hope that as a result of this study of the 1995 visit the next visit will address a slightly larger proportion of the case load with more efficient use of time and energy, coupled with better educational opportunities for local physicians and other health care workers.

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