

Challenges of Surgical Management of Childhood Cardiac Diseases in Sub-Saharan Africa, Experience of a Pediatric Cardiology Unit in Yaounde, Cameroon

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Abstract

Background: Unlike Western countries, Africa is marked by a very high infant-juvenile mortality rate. The main causes of these deaths were previously infectious diseases and malnutrition. The early 21st century is marked by an epidemiological transition, highlighting non-communicable diseases amongst which children's heart diseases. This raises another problem: the management of patients, including surgical treatment. We publish here the experience of our center showing the difficulties of surgical management.

Method: A retrospective and descriptive study was carried out on children younger than 16, diagnosed with cardiac condition between January 1st 2006 to June 30th 2015, at the Mother and Child Centre of the Chantal Biya Foundation in Yaounde. We collected data on socio-demographic background, the types of heart disease, clinical and therapeutical characteristics from registers, patient's files as well as the electronic database of echocardiographic records.

Results: Out of 17280 patients consulting in our cardiac unit during the study period, 1761 (%) were diagnosed of cardiopathies. Patients were generally from poor settings. Congenital cardiopathies (cardiac diseases) concerned 1315 (74.7%) patients with ventricular septal defect as the main type, 439 (24.9%) patients suffered from acquired cardiopathies, rheumatic valvulopathies been the main figure. Both congenital and acquired cardiopathies were associated in 7 (0.4%) children. An indication for surgery was given in 1019 patients. Only 72 (7.1%) could effectively benefit from surgery. The procedure took place abroad for 46 (63.9%) patients and locally for the 26 (36.1%) others. 2/3 (76%) of management fees were paid by occidental nongovernmental organisations, 21% by families, 3% by insurances and no case by the government.

Conclusion: The treatment, especially surgery in heart diseases of children is a challenge in Africa's poverty context. However, better organization of the health financing system could help to find a partial solution.

Keywords: Challenges; Surgical management; Cardiopathies; Children; Sub-Saharan Africa; Cameroon

Introduction

Sub-Saharan Africa hasn't been well armed in the past to face great scourges of child health. These were principally malnutrition, diverse infectious and parasitic diseases, and AIDS. In this region of the globe, the highest rate of under-five mortality has always been registered [1]. Right now, this region doesn't appear to be sufficiently prepared to face the challenges imposed by the epidemiological transition it is insidiously going through. Access to healthcare here is highly compromised by the almost absence of social security systems in most of the countries [2-4].

As infectious diseases (main causes of childhood morbidity and mortality in Africa) regress, we notice an epidemiological transition marked by the emergence of non-communicable diseases. Henceforth, health authorities will face sickle cell disease, cardiopathies, obesity and diabetes in children; illnesses which were neglected before [5,6]. It is worthwhile to acknowledge that the capacity of hospitals might risk not being sufficient to take on the new challenges [7,8]. If non-communicable diseases (NCD) continue to be ignored, we have reasons to fear that by the end, the Sustainable Development Goals (SDG) would not also have been achieved by 2030 [9,10].

Childhood cardiopathies now occupy a significant position in the spectrum of childhood diseases in Sub-Saharan Africa [11-13]. Congenital cardiopathies, the most frequent human major congenital abnormalities have an almost similar incidence in all regions of the world, which is about 8/1000 live births [14].

In addition to these ailments, the African child is confronted with post rheumatic heart diseases (RHD). Rheumatic fever (RF) and RHD in fact labeled as a disease of poverty stricken people, have become rare in rich nations. Meanwhile, it remains a major public health problem in developing countries [12,15,16]. Its cardiac sequelae which constitute its gravity weigh greatly on the health of children and adolescents in this region of the world. The economic consequences in terms of management cost and the non-availability of potential human resources are high [6,17].

Childhood heart surgery has revolutionized the prognosis of cardiac conditions which can be operated for more than a half century for which it has been practiced [18,19]. It is however a complex and onerous procedure, demanding highly qualified personnel and adequate infrastructure [6,20]. The northern countries for long now

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have been able to fulfill most of these requirements. On the contrary, in Africa, and particularly sub-Saharan Africa, the lack of resources often condemns these children to death.

There is a lack of adequate infrastructure for the effective management of pediatric cardiopathies and especially a system of financing of the healthcare of poor populations [21-23].

With a population of close to 1.22 billion inhabitants, Africa is made up of some of the poorest countries of the globe [24]. The few cardiac surgery centers which exist in the continent are concentrated essentially in Egypt and South Africa. In sub-Saharan Africa, for an estimated population of 950 million inhabitants, there are only 8 functional cardiac surgery centers (Mozambique, Sudan, Kenya, Senegal, Ethiopia, Ghana, Nigeria, and Cameroon). In addition, their functioning depends essentially on collaboration programs with international nongovernmental organizations (NGOs). Those in Cameroon and Sudan are amongst the rare ones which practice pediatric cardiac surgery. There is great need because in sub-Saharan Africa, we expect close to 300000 newborns who are carriers of congenital cardiopathies. In addition, close to one million more children who are suffering from valvulopathies caused by RHD also require surgical intervention [15]. A great chunk of the world's population coming from impoverished zones is poorly served.

The main aim of our work was to bring to light, the difficulties encountered in the management of children who need cardiac surgery; based on our own experience in this popular pediatric hospital in the capital of Cameroon.

Background

Cameroon is a Central African country with a population of about 25 million people. About 45% of this total population is less than 15 years old (that is 10.75 million). The Gross Domestic Product (GDP)/habitant are about 2400 dollars (2013 estimation). For a country with a high poverty index (35.6%) and no universal health insurance system, it is quick to imagine that cardiac surgery is hardly bearable, especially as the majority of the cost is borne by the families who directly are required to incur the burden. Private health insurance is still at the embryonic level. Even when it exists, it is onerous, and only partially covers healthcare expenses. This concerns only a negligible proportion of salary earners, or people of a higher social class.

In addition, in Cameroon we count 1 doctor for 10000 inhabitants, 1 pediatrician for 100000 children, 1 cardiologist for 500000 inhabitants. Only one cardiac surgeon is permanent in the country [25]. The number of newborns expected per year is 1 million and the number of new congenital cardiopathies expected is 8000 every year.

One center for cardiac surgery exists since September 2009 in Cameroon [26]. It is so far the first and only in the country, presently at Shisong, located in the North West region, about 650 Km away from Yaounde, the capital city of Cameroon. The structure belongs to the catholic mission, in partnership with some Italian NGOs. The cost of surgical interventions is about 5600 US dollars for interventional catheterization, and 7000 US dollars for an open heart surgery. Surgical interventions are carried out here all through the year; however periodic interventions are also done with teams of western collaborators at a frequency of 3 to 4 times a year. This center receives patients coming from all regions of the country.

Except the cardiac surgery center mentioned above, our service is the only pediatric cardiology unit, located in the Center of Cameroon, with a single pediatric cardiologist. We receive the majority of pediatric

patients suffering from cardiopathies from all over the country. Thus, a significant proportion of patients referred to the cardiac surgery center initially pass through our unit. All these make the therapeutic route of the patients more cumbersome.

Materials and Method

Type of study

We did a retrospective and descriptive study from the consultation and hospitalization logbooks as well as records of patient from 0 to 16 years of age, suffering from a cardiac condition during the period spanning from January 1st 2006 to June 30th 2015.

Study site

The study was carried out at the Mother and Child center of the Chantal Biya Foundation (MCC/CBF). This is a pediatric hospital located in the heart of the town of Yaounde, the political capital of Cameroon, with a population of about 2.5 million inhabitants. It is one of the major pediatric hospitals in the country, which also participates in training medical doctors and pediatricians. This hospital has a capacity of 260 hospital beds, and receives about 30000 children annually and hospitalizes about 9000 of them.

In January 2006, a pediatric cardiology unit was put in place there, headed by a pediatrician who has received training in pediatric cardiology, assisted by a general practitioner and a resident in pediatrics. The unit handles external consultations and the medical management of the hospitalized patients. Non-invasive explorations especially echocardiography and electrocardiography are equally done there. A register of cardiopathies has been opened in this unit where all the confirmed cases of cardiopathies are systematically transcribed. The main information rubrics in the register are: Date of the examination, name the patient, gender, age at the time of diagnosis, the name of the physician who referred, indication of the echocardiography [27], the diagnosis upon echocardiography, the pulmonary arterial pressure, presence or absence of signs of rheumatic heart disease, socio-economic status of the parents determined from monthly family revenue, address of the family.

Study population

Our study population was made of children below the age of 16 who have a confirmed cardiopathy (congenital or acquired). In our center, cardiac ultrasounds are done using cardiac ultrasound machine of the Accuson Cypress mark, having two multiple frequency probes : 3V2c(3.5/3.0/2.5/2.0 MHz) and 7V3c(7.0/6.0/5.0/3.5 MHz) and using the 2D, M, Pulse Doppler, continuous and color modes. The sub-costal, parasternal, apical 4 et 5 cavities as well as the sub-sternal incidences are systematically done. The technique employed is that of the American Heart Association (AHA). All cardiopathies are diagnosed following standard criteria [28-30]. The same pediatric cardiologist manipulates the cardiac ultrasound machine and interprets the results. At times the views of other cardiologists in town were requested.

Indications for surgical intervention are guided by clinical and echocardiographic data. These indications are a function of the type of cardiac lesion. The emergency depends on its gravity and also on the prognosis. Meanwhile, the medical management of patients accompanies the diagnosis, be it outpatient or patients in the course of hospitalization; and medical management could either precede or follow surgical intervention. Other paraclinical workup (Full blood counts, Blood urea, creatininemia, chest X-rays, viral hepatitis and HIV serologies) complete the clinical and echocardiographic findings and

condition the preparation of the clinical records in view of an eventual surgical intervention. All the examination fees are the responsibility of the families. Parents are systematically informed about the conditions of their children as well as the different therapeutic possibilities and the constraints and demands of each one of them. We intervene in the negotiation for centers for healthcare evacuation and in making the clinical records available to the families. According to the available means and wishes of families, the obvious choice could be the Shisong cardiac surgery center in Cameroon. There, surgeons are made of a local team of Cameroonians and other teams which come from European countries for the sake of cooperation. In some cases, especially when the parents are not able to pay anything we call on western NGOs for evacuation of patients. In very few cases the evacuation is done with the resources of the family itself. Financial aid from the state is regularly solicited for evacuation of patients to western countries or to the local surgery center. It could happen that the patient file for evacuation be accepted or rejected. In general, the financial input of the family remains appreciable whatever the mode of financing of the operation.

Ethical considerations

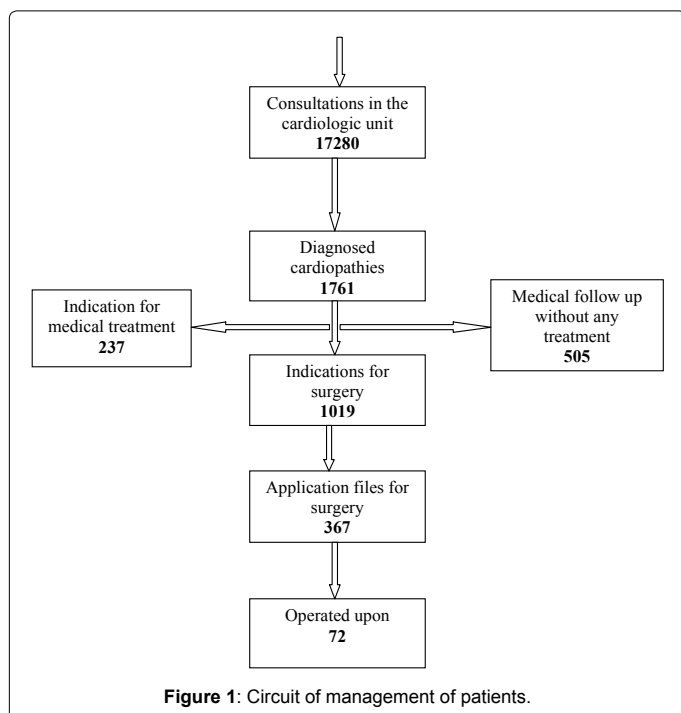
The same selection criteria were applied to all patients. The commitment of families and their capacity to mobilize financial contributions differ for each case. This study received the approbation of the ethical committee of the Faculty of Medicine and Biomedical Sciences of the University of Yaoundé I.

Statistical analyses

The data were entered into Excel and then transcribed in SPSS version 11.0 (SPSS, Inc. Chicago, Illinois, USA). Continuous variables were expressed as median with interquartile range (IQR) and categorical variables as percentages. Differences between the proportions were analyzed using χ^2 test. P values <0.05 were considered significant.

Results

Between January 2006 and June 2015, the MCC/CBF registered



Revenue of the families (FCFA)	Frequency (N=621)	Percentage (%)
<50000	206	33.2
50000–100000	131	21.1
101000–150000	129	20.7
151000–200000	90	14.5
>200000	65	10.5

Table 1: Monthly revenue of the families.

Type of Cardiopathy	Number	Percentage (%)
Congenital Heart Defects (N=1315)		
VSD	484	36.8
PS	198	15.0
PDA	193	14.7
ASD	140	10.6
ToF	108	8.2
AVCD	71	5.4
Other associations of congenital heart diseases	59	4.5
TA	26	1.9
TGV+ASD	8	0.6
PAVSD	6	0.5
TrA	7	0.5
APVR	5	0.4
Hypoplastic Left Heart	4	0.3
Coarctation of the Aorta	2	0.2
Ebstein's Anomaly	2	0.2
Cardiac ectopy	2	0.2
Acquired cardiopathies (N=439)		
Rheumatic valvulopathy	212	48.3
Cardiomyopathy	175	39.8
Isolated Pericarditis	50	11.4
Right atrium tumor	2	0.5
Mixed Cardiopathies		
	7	100

PAVSD: Pulmonary Atresia with Ventricular Septal Defect; AVCD: Atrioventricular Canal Defect; ASD: Atrial Septal Defect; VSD: Ventricular Septal Defect; EMF: Endomyocardial Fibrosis; MR: Mitral Regurgitation; PDA: Patent Ductus Arteriosus; APVR: Anomalous Pulmonary Venous Return; PS: Pulmonary Stenosis; TA: Truncus Arteriosus; TrA: Tricuspid Atresia; TGV: Transposition of Great Vessels; ToF: Tetralogy of Fallot

Table 2: Different types of diagnosed heart diseases (N=1761).

285469 consultations of patients below the age of 16 years suffering from diverse ailments. 1761 of them were diagnosed of cardiopathies (0.62%). An indication for surgery was found in 1019 patients. The surgical intervention was effective in 72 of them, giving a success rate of 7.1% (Figure 1).

General characteristics of the population

Age of patients at the time of diagnosis and their gender: The age of the patients at the time of diagnosis varied from one day to 15 years. The median age was 9 months (Interquartile interval: 4 to 30 months) for patients suffering from congenital cardiopathies; and 131 months (Interquartile interval: 96 to 151 months) for those with acquired cardiopathies. There were almost equal numbers of boys (867) and girls (894).

Socio-economic level of the parents: Socio-economic data were available for only 621 families of children who had to undergo a surgical procedure (Table 1). More than half of the families (54.5%) had a monthly revenue less than 100000FCFA (200 US Dollars).

Types of cardiopathies encountered: There were 1315 patients with congenital cardiopathies (74.7%) as against 439 acquired cardiopathies (24.9%). In 7 patients (0.4%) we found an association of both types (Table 2).

Congenital cardiopathies were particularly non-cyanotic with the first of them being ventricular septal defect (38.9%). The most encountered cyanotic cardiopathy was Fallot's tetralogy. It occupied the 5th position in the list of congenital cardiopathies that is 8.2%.

Acquired cardiopathies were dominated by post rheumatic valvulopathies (48.3%). The mitral valve had lesions in all the patients (100%) who had post rheumatic cardiopathies. Mitral lesions were isolated in 129 patients (60.8%) while in other cases; they were associated to other valvular lesions (Figure 2).

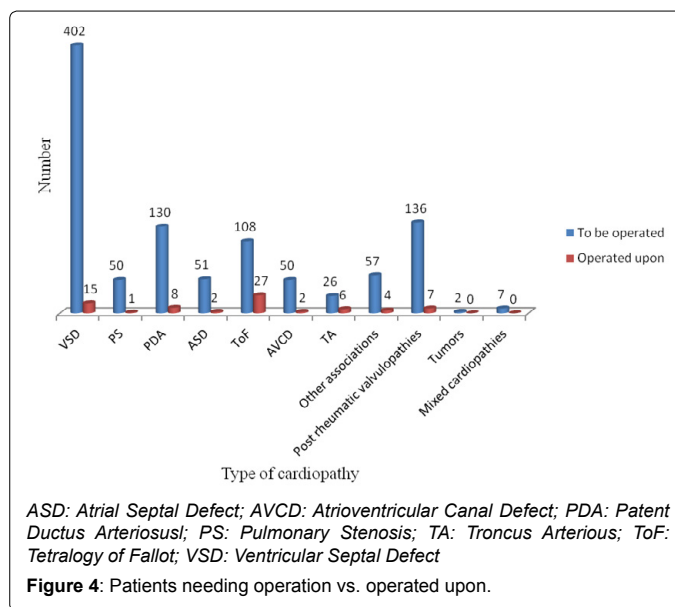
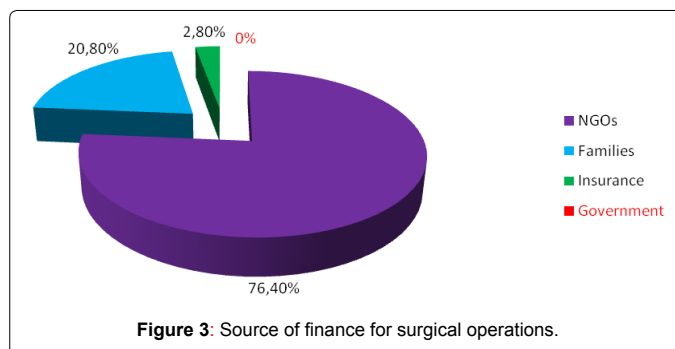
Therapeutic indications

Out of the 1761 patients with cardiopathies, 1019 (57.8%) had a surgical indication. An exclusive medical treatment was instituted in 237 patients (13.5%) amongst which the 42 initially indicated for surgery were declared inoperable because of the complexity of the anomalies or by virtue of the complications which occurred during the waiting period. A simple medical follow up without any particular medical or surgical intervention was indicated in 505 (28.7%) patients.

Outcome of patients who had an indication for surgery: Of the 1019 patients who had an indication for surgery, 367 application files for surgical interventions were successfully prepared. Only 72 (7.1%) patients were operated upon (Table 3). There were 65 (90.3%) patients with congenital cardiopathies and 7(9,7%) with acquired cardiopathies (Figure 3).

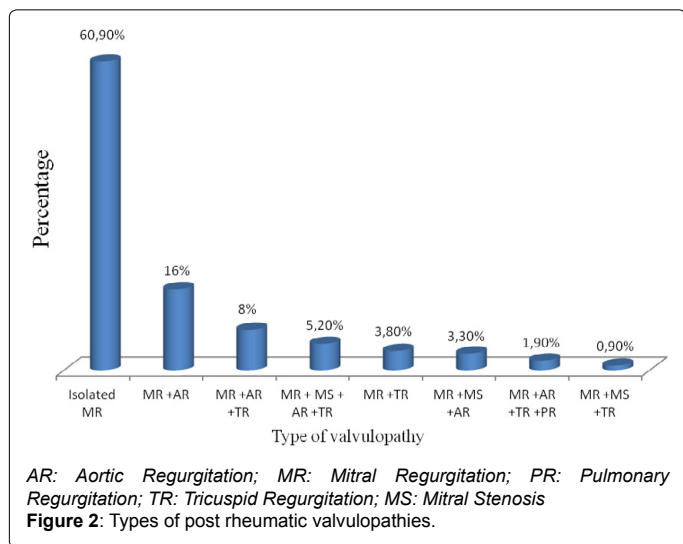
Falot's tetralogy and ventricular septal defect were the congenital cardiopathies which were most often operated upon, that are 27(37.5%) and 15(20.8%) respectively. All the 7 patients operated from acquired cardiopathies suffered from mitral regurgitation (Figure 4).

Mode of financing the surgical interventions: Five NGOs entirely financed the entire procedure which led to the cardiac surgery of 55



ASD: Atrial Septal Defect; AVCD: Atrioventricular Canal Defect; PDA: Patent Ductus Arteriosus; PS: Pulmonary Stenosis; TA: Truncus Arteriosus; ToF: Tetralogy of Fallot; VSD: Ventricular Septal Defect

Figure 4: Patients needing operation vs. operated upon.



AR: Aortic Regurgitation; MR: Mitral Regurgitation; PR: Pulmonary Regurgitation; TR: Tricuspid Regurgitation; MS: Mitral Stenosis
Figure 2: Types of post rheumatic valvulopathies.

Status	Frequency	Percentage (%)
Operated	72	7.1
Waiting for surgery	248	24.3
Refused surgery	7	0.7
Deceased	282	27.7
Lost from the study	410	40.2
Total	1019	100

Table 3: Global outcome of patients with an indication for surgery.

(76.4%) patients. The operation fees of all patients operated upon in Europe was handled by European NGOs. While 3 of these NGOs systematically evacuated children to Europe, 2 of them financed the surgical operations which took place at the Shisong cardiac center in Cameroon with the help of surgical teams which came from Europe. No financing was obtained from the state (Figure 3). Except for 2 patients whose fees were paid by their parent's insurance, the rest of the patients' expenses were paid by their families, notwithstanding their socio-economic levels. In fact, 11/25 families had a monthly revenue barely close to half of the minimum salary.

Site of the surgical Operations: Surgical operations were carried out on 46 (63.9%) patients abroad and 26 (36.1%) others in Cameroon (Table 4). Close to half (47.2%) were done in France. Patients suffering from transposition of great vessels and truncus arteriosus were all operated upon in France. The other types of cardiopathies were operated upon either in Cameroon or abroad.

Site of the surgical operation	Frequency	Percentage (%)
Abroad N=46	France	34
	Italy	8
	Switzerland	2
	Belgium	1
	South Africa	1
Cameroon (Shisong)	26	36.1
Total	72	100

Table 4: Site of the surgical operations.

Discussion

Magnitude of cardiopathies in Cameroon

This pilot study done over a period of 9 years shows that many different cardiac diseases are frequently diagnosed in children in Cameroon and that those in our study site (Yaounde) are a numerous. There exists a clear predominance of congenital cardiopathies, especially the non-cyanotic cardiopathies, confirming previous studies carried out in Africa [12,28,29]. Acquired cardiopathies, particularly post rheumatic cardiopathies represent an additional heavy burden specific to our context as compared to western epidemiology where they have almost disappeared [30,31]. In this economically disfavored context, patients only go to the hospital when they have the very glaring symptoms or signs [32]. In reality, the number of children who suffer from cardiopathies is underestimated. Because of the cultural pressure and multiple barriers of access to healthcare facilities, many children tend to die in the community [33,34], children suffering from cardiopathies are not excluded.

Age at the moment of diagnosis

Generally, patients were diagnosed at a late age. The median age of discovery of post rheumatic valvulopathies in our series was about 11 years. This could be explained partly by the mean age of occurrence of rheumatic fever which is about 10 years [35]. On the contrary the diagnosis of congenital cardiopathies which was posed in half of patients at 9 months seems pretty late to us. This lateness connotes the insufficiency of capacities of healthcare personnel and facilities necessary for the early diagnosis of childhood cardiopathies in our context. Qualified personnel and adequate structures are not sufficient enough to organize screening programs [25]. Unlike what is happening in the western world [36-38], no policy for screening of these ailments is envisaged yet in our country. All these lapses are at the origin of late discoveries [39]. The lateness in diagnosis inevitably affects the prognosis in the majority of cardiopathies, notably cardiopathies with a left to right shunt. They are complicated by changes in the pulmonary vascular bed bringing about pulmonary artery hypertension which can constitute a contraindication to every surgical procedure, or be responsible for high rate of pre and post operative morbidity and mortality [40].

It is important to increase qualified human resources in pediatrics and particularly in pediatric cardiology so as to facilitate the screening and early management of childhood cardiac diseases. This would be done best in the framework of a well-defined program of management of childhood cardiopathies.

Outcome of patients who have received an indication for surgery and mode of financing of operated cases

The rate of surgical interventions was low in our series (Figures 1 and 4). Almost all the patients who required surgery would have been operated upon had it been they were in an economically favorable environment. This rate is even lower than that of the team of Diop in Senegal 20 years earlier [41]. In a series of 103 patients suffering from operable congenital cardiopathies published by Diop and his collaborators in 1995 surgery was possible in 17.3%. In our case, there is a considerable lack of teams of local specialists to carry out cardiac surgical operations at lower cost. On the other hand adequate structures are insufficient to envisage such interventions. The insufficiency of funds made available by the state to the healthcare sector and the inadequacy of a social security system have as corollary the fact that families have to auto finance their patients treatment. Moreover, the

solidarity system developed locally by the population is insufficient to foot the bills of expensive medical procedures. Given the poverty stricken conditions of the families and the state, healthcare evacuations for better management abroad are difficult in our countries [42].

The support of NGOs for an evacuation of patients is encouraged; meanwhile, emphasis should be laid on the reinforcement of existing local structures and on the multiplication of other local centers for heart surgery. This would minimize costs and would enable opportunities to be given to more patients to have access to healthcare. Local experiences of heart surgery have in fact been done in Africa with satisfactory results [43,44]. In fact, interventions of local centers of heart surgery have shown that operations could be done locally at relatively low costs [45,46]. This process nevertheless has to be methodical and well planned [21,39]. In this case, a very close collaboration with western countries is essential. They will help first of all to train cardiologists and cardiac surgeons of the south and mentor them until their complete independence. In our series, very complex malformations such as transposition of great vessels and truncus arteriosus were systematically operated abroad by better equipped and experimented teams. Meanwhile, costs will in any case remain way beyond the reach of the average African. Local centers to ensure their survival are obliged to demand a minimum fee from the families which are often out of the reach for a majority of them. The creation of such structures should be accompanied by a system of financing and guaranteeing their long life. A universal insurance system would have found full benefit; it would have enabled these patients suffering from cardiopathies to be saved.

In the final analysis, prevention remains the best weapon available to the poor population. Nevertheless to be effective, it would necessitate deep transformations in societies. These measures risk being very difficult to put in place because of low levels of literacy of the populations and poverty [32,37]. In fact, rheumatic fever responsible for destruction of valves is a poverty related illness [15]. Screening and early correct treatment of tonsillitis constitute the key method of prevention. Harmful cultural practices prevent the correct management of tonsillitis in our context [47,48]. The fight against illiteracy, poverty as envisaged in the MDGs and relayed by the SDGs would be the key to success [16].

As concerns congenital cardiopathies, the higher the birth rate, the higher the number of children with congenital cardiopathies will be. In Africa, the natality rate is highest, rendering the financial burden on families much heavier [49,50]. Nevertheless a program of early screening for childhood cardiopathies has to be put in place.

Conclusion

The epidemiological transition affects many domains of health in the child. Vaccination and other health programs enabled us to press down the former plagues which were once responsible for the high mortality of the African child. Today some which were ignored are emerging at a moment that governments are not prepared to face them. New challenges are showing up already and demand heavy investments in terms of healthcare personnel and infrastructure. The management of childhood cardiac diseases is one of the major wings of these challenges. A new looks on children's health programs on this part of the world is a call for concern once more. A better organization of the health policy and especially of the system of its financing in Africa in general is necessary for an acceptable and durable level of health.

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References

1. You D, Jin NR, Wardlaw T (2012) Levels and trends in child mortality.
2. Gruat JV (1990) Social Security Schemes in Africa-Current Trends and Problems. *Int Labour Rev* 129: 405.
3. Sekhri N, Savedoff W (2004) Private health insurance: Implications for developing countries. *World Health Organ* 83: 127-134.
4. Mills A, Ataguba JE, Akazili J, Borghi J, Garshong B, et al. (2012) Equity in financing and use of health care in Ghana, South Africa, and Tanzania: implications for paths to universal coverage. *The Lancet* 380: 126-133.
5. OMS (2015) Report on the global status of NCDs 2014: executive summary.
6. Gaziano TA (2005) Cardiovascular disease in the developing world and its cost-effective management. *Circulation* 112: 3547-3553.
7. Cloninger CR, Salvador-Carulla L, Kirmayer LJ, Schwartz MA, Appleyard J, et al. (2015) A time for action on health inequities: Foundations of the 2014 Geneva declaration on person-and people-centered integrated health care for all. *Int J Pers Cent Med* 4: 69-89.
8. Deaton AS, Tortora R (2015) People In Sub-Saharan Africa Rate Their Health And Health Care Among The Lowest In The World. *Health Aff (Millwood)* 34: 519-527.
9. Ly A (2015) Politiques internationales et maladies non transmissibles: actes manqués et objectifs de développement durable. *African J Cancer* 7: 94-100.
10. Hák T, Janoušková S, Moldan B (2016) Sustainable Development Goals: A need for relevant indicators. *Ecol Indic* 60: 565-573.
11. Chelo D, Wawo E, Siaha V, Anakeu A, Ndong FA, et al. (2015) Cardiac anomalies in a group of HIV-infected children in a pediatric hospital: an echocardiographic study in Yaounde, Cameroon. *Cardiovasc Diagn Ther* 5: 444-453.
12. Chelo D, Nguetack F, Menanga AP, Ngo Um S, Gody JC, et al. (2015) Spectrum of heart diseases in children: an echocardiographic study of 1,666 subjects in a pediatric hospital, Yaounde, Cameroon. *Cardiovasc Diagn Ther*.
13. Ekpe EE, Ikpe MC, Umoh I (2015) Echocardiographic pattern of acquired heart diseases in Nigeria. *Niger Med J* 56: 253-257.
14. Botto LD (2015) Epidemiology and prevention of congenital heart defects. *Congenital Heart Disease* pp: 28-45.
15. Carapetis JR (2007) Rheumatic Heart Disease in Developing Countries. *N Engl J Med* 357: 439-441.
16. Marijon E, Ou P, Celermajer DS, Ferreira B, Mocumbi AO, et al. (2007) Prevalence of Rheumatic Heart Disease Detected by Echocardiographic Screening. *N Engl J Med* 357: 470-476.
17. Kumar RK (2009) The nuts and bolts of pediatric cardiac care for the economically challenged. *Ann Pediatr Cardiol* 2: 99-101.
18. Shumacker HB (1992) The Evolution of Cardiac Surgery. Indiana University Press p: 508.
19. Raisky O, Vouhé P (2005) Nouveautés en chirurgie cardiaque pédiatrique. *E-Mém L'Académie Natl Chir* 4: 5-8.
20. Hewitson J, Brink J, Zilla P (2002) The challenge of pediatric cardiac services in the developing world. In: *Seminars in thoracic and cardiovascular surgery*. Elsevier 14: 340-345.
21. Mocumbi AO, Lameira E, Yaksh A, Paul L, Ferreira MB, et al. (2011) Challenges on the management of congenital heart disease in developing countries. *Int J Cardiol* 148: 285-288.
22. Yacoub MH (2007) Establishing Pediatric Cardiovascular Services in the Developing World A Wake-Up Call. *Circulation* 116: 1876-1878.
23. de Luna AB (1999) International cooperation in world cardiology the role of the World Heart Federation. *Circulation* 99: 986-989.
24. Chen S, Ravallion M (2008) The developing world is poorer than we thought, but no less successful in the fight against poverty. *The World Bank Development Research Group*.
25. (2011) General healthcare personnel census.
26. Budzee SA, Tchoumi JCT, Ambassa JC, Gimberti A, Cirri S, et al (2010) The Cardiac Center of Shisong Hospital: the first cardio-surgical center in West and Central Africa is inaugurated in Cameroon. *Pan Afr Med J* 4: 4.
27. Cheitlin MD, Alpert JS, Armstrong WF, Aurigemma GP, Beller GA, et al (1997) ACC/AHA Guidelines for the Clinical Application of Echocardiography. A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on Clinical Application of Echocardiography) Developed in collaboration with the American Society of Echocardiography. *Circulation* 95: 1686.
28. Zühlke L, Mirabel M, Marijon E (2013) Congenital heart disease and rheumatic heart disease in Africa: recent advances and current priorities. *Heart* 99: 1554-1561.
29. Saidu H, Sani MU, Mijinyawa MS, Yakasai AM (2015) Echocardiographic pattern of heart diseases in a North-Western Nigerian tertiary health institution. *Niger J Basic Clin Sci* 12: 39.
30. Yusuf S, Reddy S, Öunpuu S, Anand S (2001) Global burden of cardiovascular diseases part I: general considerations, the epidemiologic transition, risk factors, and impact of urbanization. *Circulation* 104: 2746-2753.
31. Seckeler MD, Hoke TR (2011) The worldwide epidemiology of acute rheumatic fever and rheumatic heart disease. *Clin Epidemiol* 3: 67-84.
32. Bordes C (2008) The Antisophiste: Health and poverty in developing countries development. *The Antisophiste*.
33. Sinclair-Smith CC, Dinsdale F, Emery J (1976) Evidence of duration and type of illness in children found unexpectedly dead. *Arch Dis Child* 51: 424-429.
34. Koffi AK, Libite PR, Moluh S, Wounang R, Kalter HD (2015) Social autopsy study identifies determinants of neonatal mortality in Doume, Nguemendouka and Abong-Mbang health districts, Eastern Region of Cameroon. *Global Journal of Health Science*.
35. Zaman MM, Rouf MA, Haque S, Khan LR, Chowdhury NA, et al (1998) Does rheumatic fever occur usually between the ages of 5 and 15 years? *Int J Cardiol* 66: 17-21.
36. Norman M, Mellander M, Sunnegardh J (2006) Failure to diagnose critical heart malformations in newborns before discharge: an increasing problem? *Acta Paediatr* 95: 407-413.
37. Bonnemains L (2008) Influence of training on echocardiographers Screening for congenital heart disease (12 years of study in the population General).
38. Chauvet J, G Kacou, Andoh J (1985) The pediatric cardiology consultation: activities, screening problems, prospects. *Too Cardiol* 12: 13-17.
39. Mocumbi AO (2012) Lack of focus on cardiovascular disease in sub-Saharan Africa. *Cardiovasc Diagn Ther* 2: 74-77.
40. Beghetti M (2006) Pulmonary Hypertension heart disease congenital. *Rev Mal Respir* 23: 49-59.
41. Diop IB, Ba SA, Ba K, Sarr M, Kane A, et al (1994) Congenital cardiopathies: anatomo-clinical, prognostic, and therapeutic features apropos of 103 cases seen at the Cardiology Clinic of the Dakar University Hospital Center. *Dakar Med* 40: 181-186.
42. Diarra MB, Ba HO, Sanogo KM, A Diarra, Toure K (2006) The cost of cardiovascular surgical evacuation and treatment needs and Interventional Mali. *Too Cardiol* 32: 66-68.
43. Budzee SA, Tchoumi JT, Giamberti A, Ambassa JC, Cirri S, et al. (2012) African experiences of humanitarian cardiovascular medicine: The Cardiac Centre of St. Elizabeth Catholic General Hospital, Shisong. *Cardiovasc Diagn Ther* 2: 165-168.
44. Ndiaye M, O Diarra, PA Dieng, O Kane, Mbodji YF, et al. (2006) Heart Disease congenital operated at Dakar. About 102 cases.
45. Kalkou-Guikahue M, Yangni-Angate, Kramoh KE, Kangah KM, Koffi J, et al. (2008) Approche Therapeutique de la Tetralogie De Fallot en Afrique noire Sub-Saharienne: A Propos De 130 cas Hospitalises a l Institut De Cardiologie D' Abidjan (ICA) Cote D' Ivoire. *Chirurgie Cardiaque/Cardiac Surgery* 3: 39-44.
46. Anyanwu CH, Ihenacho HN, Okoroma EO, Nwafo DC, Umeh BU, et al. (1982) Initial experience with open heart surgery in Nigeria. *Trop Cardiol* 8: 123-127.
47. Thomas Pezzella (2002) Global Expansion of Cardiothoracic Surgery- The African Challenge.
48. Koubaa C, Zaafour M, Bouhadiba M, Mhadhbi N, Ghariani L, et al (1996) Observance au traitement des angines. *Maghreb Méd* 300: 34-36.

49. Houéto D (2008) La promotion de la santé en Afrique subsaharienne : état actuel des connaissances et besoins d'actions. *Promot Educ* 15: 49-53.

50. Hoffman JI (2013) The global burden of congenital heart disease: review article. *Cardiovasc J Afr* 24: 141-145.