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Morbi Mortality after Cardiac Surgery for Rheumatic Valvulopathy in Mali: Correlation with AMBLER Prognostic Score

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Abstract

Introduction: Rheumatic heart disease remains a major public health problem worldwide. African populations pay a heavy price for this condition because of socio-economic and health conditions responsible for delayed diagnosis, and limited access to cardiac surgery. **Objective:** To report the morbidity and mortality of a series of patients operated on for rheumatic valvular disease and to compare its correlation with Ambler's prognostic score. **Patients and Methods:** Descriptive and analytical study of all patients operated on for rheumatic valvulopathy from 01/01/2019 to 31/12/2021. **Results:** 160 patients were included. The mean age of patients was 23.93. Females predominated at 56.3%. Delay in treatment was between 1 and 3 years in 49.4% of patients. At pre-operative assessment, Systolic Pulmonary Arterial Pressure was >60 mmHg in 43.1% of our patients. The mean Ambler score was 6.68, equivalent to a mean risk of peri-operative mortality of 4.1%. Mitral valve replacement was performed in 81.9%; aortic valve replacement in 18.8%. The average extubation time was between 3 and 5 hours in 43.1% of patients. We recorded a peri-

operative mortality of 6.9% and a late mortality of 8.1% (36 months). Post-operative hemodynamic complications were correlated with the time to management of valve disease: p = 0.036; the presence of preoperative PAH was correlated with the post-operative occurrence of respiratory complications: p = 0.029; the presence of preoperative complete arrhythmia due to atrial fibrillation (CAF) was correlated with the post-operative occurrence of renal failure p = 0.017. There was no correlation between Ambler score and peri-operative mortality in our series. **Conclusion:** Cardiac surgery faces many difficulties in sub-Saharan Africa. Risk stratification scores in cardiac surgery are not adapted. The establishment of a pan-African exchange network would be a way of improving this surgical practice in our countries.

Keywords

Rheumatic Fever, Cardiac Surgery, Sub-Saharan Africa, Morbidity-Mortality, Prognostic Scores

1. Introduction

Rheumatic heart disease remains a major public health problem worldwide. Its prevalence is estimated at 15.6 million people globally, mainly affecting socially and economically disadvantaged populations, and accounting for up to 233,000 deaths per year [1]. African populations pay a heavy price for this mortality due to socio-economic and health conditions that lead to delayed diagnosis and limited access to cardiac surgery [2]. The average incidence of rheumatic heart disease is 0.6/1000 in developing countries, ranging from 0.2/1000 in South America, 0.3/1000 in China, to 1.4/1000 in Africa, where it is on the rise again [3]. There is great disparity across the world in terms of epidemiology (patient age, types of valve damage), treatment modalities (delays, surgical techniques, etc.), and the prognosis for valvular heart disease.

The practice of cardiac surgery faces many difficulties in low-income countries. These are political, organizational, technical, and financial in nature and inevitably impact patient prognosis.

Objective: Our objective was to report the morbidity and mortality of a series of patients who underwent surgery for rheumatic valve disease and to compare their correlation with the Ambler prognostic score.

Patients and methods: This is a retrospective, descriptive, and analytical observational study of all patients who underwent elective valve replacement surgery at the Mother and Child University Hospital "LE LUXEMBOURG," Bamako over a 36-month period from January 1, 2019, to December 31, 2021. All of our patients underwent mechanical valve replacement under cardiopulmonary bypass (CPB). Preoperative characteristics (epidemiological, clinical, paraclinical), intraoperative characteristics (extracorporeal circulation data, transfusion, extubation time, stay in intensive care, complications, death, etc.) and post-operative characteris-

tics were recorded in a pre-established database. The follow-up period for all surviving patients was 36 months. The CHI 2 test was used to identify factors associated with mortality; the p-value was significant when it was ≤0.005. After adjustment, a multivariate logistic regression was performed to formally identify the factors associated with morbidity and mortality.

Results: During the period, 160 patients underwent surgery for rheumatic valve disease. The mean age of the patients was 23.93 ± 11.28; the 10 - 19 age group accounted for 41.9% of the series. Females predominated at 56.3%. Table 1 reports the epidemiological, clinical, and paraclinical characteristics of our patients. The time to treatment was between 1 and 3 years in 49.4% and >5 years in 25% of our patients. The main functional signs were: exertional dyspnea: 100%; palpitations: 50%; cough: 12.5%; edematous syndrome: 4.4%. A history of stroke was found in 3.1% of our patients. Malnutrition with a BMI < 18.5 kg/m^2 was present in 55% of cases. At preoperative assessment, 30.6% had complete arrhythmia due to atrial fibrillation, 5.6% of patients had repolarization disorders on ECG, and 43.1% of our patients had systolic pulmonary artery pressure (SPAP) > 60 mmHg. All patients had rheumatic valvular heart disease. The main diagnoses were: mitral stenosis: 50%; mitral regurgitation: 45%; aortic regurgitation: 21.9%; aortic stenosis: 1.9%; tricuspid regurgitation was associated in 33.8%. All our patients were on diuretics before surgery. The main preoperative therapies are reported in Table 2. The mean Ambler score was 6.68 ± 1.34, equivalent to a mean peri-operative mortality risk of 4.1% (Table 3). All patients underwent cardiopulmonary bypass (CPB); the mean MAP during CPB was 50-70 mmHg in 65.6% of patients. The mean aortic clamping times are reported in Table 4. Transfusion was performed in the operating room in 45% of our patients; this involved PFC in 20% of patients, CGR in 18.8% of patients, and PFC + CGR in 6.3% of patients. The drugs used for weaning from CPB were: Dobutamine: 66.3%; Noradrenaline: 26.9%; Milrinone: 25.6%; Adrenaline: 14.4%. Mitral valve replacement was performed in 81.9% of cases; aortic valve replacement in 18.8%; and tricuspid valve repair in 37.5%. Post-operative characteristics are reported in Table 5. The mean time to extubation was between 3 and 5 hours in 43.1% of patients. The mean length of stay in intensive care varied between 4 and 7 days in 65.6% of patients. Immediate post-operative complications were hemodynamic, respiratory, infectious, renal, hematological, digestive, and neurological. We recorded a peri-operative mortality rate of 6.9%. Our patients were followed up for an average of 36 months, during which time we recorded a late mortality rate of 8.1%, giving an overall mortality rate of 15%. Table 6 shows the various morbidity and mortality factors found: post-operative hemodynamic complications were correlated with the delay in treating valvular heart disease: p = 0.036; the presence of preoperative pulmonary arterial hypertension (PAH) was correlated with the post-operative occurrence of respiratory complications: p = 0.029; the presence of preoperative atrial fibrillation was correlated with the post-operative occurrence of renal failure p = 0.017 and post-operative neurological complications p = 0.031. There was no correlation between

the Ambler score and peri-operative mortality in our series.

Table 1. Epidemic-clinical and paraclinical characteristics.

Reason for consultation	Frequency (n = 160)	Percentage
Exertional dyspnea	**160**	**100**
Palpitations	80	50.0
Cough	20	12.5
Chest pain	10	6.25
Edematous syndrome	7	4.4
Orthopnea	4	2.5
Hemoptysis	3	1.9
Hepatalgia	3	1.9
Medical history	**Frequency (n = 160)**	**Percentage**
Rheumatic fever	**69**	**43.1**
Sickle-cell disease	6	3.8
stroke	5	3.1
BMI: Kg/m²	**Frequency**	**Percentage**
<16.5	**61**	**38.1**
[16.5 - 18.5[	27	16.9
[18.5 - 25[	55	34.4
[25 - 30[	11	6.9
≥30	6	3.8
Total	**160**	**100.0**
Preoperative echocardiography result	**Frequency (n = 160)**	**Percentage**
PAH	**111**	**69.4**
Dilated Left Atrium	68	42.5
Dilated Left Ventricle	35	21.9
Dilated Right Atrium	20	12.5
Dilated Right Ventricle	18	11.3
Pericardial effusion	12	7.5
Presence of intracavitary thrombus	2	1.2
Presence of spontaneous contrast	1	0.6
Systolic pulmonary artery pressure preoperative in mmHg	**Frequency**	**Percentage**
<35	33	20.6
[35 - 60[	42	26.3
≥60	**69**	**43.1**

Continued

Not feasible	19	10.0
Total	**160**	**100.0**
Duration of discovery of the disease in years	**Frequency**	**Percentage**
1 - 3	**79**	**49.4**
4 - 5	41	25.6
>5	40	25.0
Total	**160**	**100.0**

Table 2. Preoperative therapeutics.

Type of medical care	Frequency (n = 160)	Percentage
Diuretic	**160**	**100.0**
Sildenafil	111	69.4
Angiotensin Converting Enzyme (ACE)	80	50.0
Angiotensin Receptor Blockers	10	6.3
Digoxine	88	55.0
Beta blocking	68	42.5
Amiodarone	2	1.3
vitamin K antagonist (VKA)	60	37.5
Aspegic	16	10.0
Antibiotics	36	22.5

Table 3. Ambler score.

Ambler Score	Frequency	Percentage
4	6	3.8
5	23	14.4
6	**48**	**30.0**
7	45	28.1
9	19	11.9
11	1	0.6
Total	**160**	**100.0**

Table 4. Aortic clamping time during CPB.

Aortic Clamping Time (min)	Frequency	Percentage
<30	1	0.6
30 - 59	16	10.0
60 - 119	111	69.4
>119	**32**	**20.0**
Total	**160**	**100.0**

Table 5. Post-operative characteristics.

Extubation delay (h)	Frequency	Percentage
<3	65	40.6
3 - 5	**69**	**43.1**
>5	16	10.0
Not extubated	**10**	**6.3**
Total	**160**	**100.0**
Length of stay in intensive care during the day	**Frequency**	**Percentage**
<4	30	18.8
4 - 7	105	65.6
>7	**25**	**16.6**
Total	**160**	**100.0**
Immediate post-op complications	**Frequency (n = 160)**	**Percentage**
Haemodynamics	**80**	**50.0**
Respiratory	52	32.5
Infectious	42	26.3
Renal	33	20.6
Hematological	31	19.4
Digestive	25	15.6
Neurological	22	13.8
Hemodynamic complications	**Frequency (n = 80)**	**Percentage**
Post-operative bleeding	**27**	**33.8**
Arrhythmias	12	15
Hypo-kinesis	10	12.5
High blood pressure HBP	9	11.2
Tamponade	3	3.7
Right Ventricle Dysfunction	3	3.7
Left Ventricle dysfunction	2	2.5
Valve dysfunction	1	1.2
Respiratory complications	**Frequency (n = 52)**	**Percentage**
Atelectasis	**36**	**69.2**
Pneumopathy	7	13.5
Pleurisy	2	3.8
Pneumothorax	2	3.8
Neurological complications	**Frequency (n = 22)**	**Percentage**
Behavioral disorders	**13**	**59.1**
Ischemic stroke	4	18.2

Continued

Seizures	4	18.2
Transient vision disorder	**3**	13.6
Death in peri op	**Frequency**	**Percentage**
Non	149	93.1
Yes	**11**	**6.9**
Total	**160**	**100.0**
Late mortality	**Frequency**	**Percentage**
Non	137	91.9
Yes	**12**	**8.1**
Total	**149**	**100.0**

Table 6. Morbidity factors found.

(a)

Immediate post-op complications	Duration of discovery of the disease in year			Total (%)	P		
	1 - 3 (%)	4 - 5 (%)	>5 (%)			Khi2	ddl
Haemodynamics	**35 (43, 8)**	**18 (22, 5)**	**27 (33, 8)**	**80 (50, 0)**	**0.036**	**8.650**	**3**
Respiratory	26 (50, 0)	12 (23, 1)	14 (26, 9)	52 (32, 5)	0.854	2.518	3
Infectious	19 (45, 2)	12 (28, 6)	11 (26, 2)	42 (26, 3)	0.430	2.908	3
Renal	14 (42, 4)	11 (33, 3)	8 (24, 2)	33 (20, 6)	0.421	0.483	3
Hematological	17 (54, 8)	7 (22, 6)	7 (22, 6)	31 (19, 4)	0.911	0.531	3
Digestive	13 (52, 0)	6 (24, 0)	6 (24, 0)	25 (15, 6)	0.675	1.552	3
Neurological	10 (45, 5)	6 (27, 3)	6 (27, 3)	22 (13, 8)	0.503	2.504	3

(b)

Immediate post-op complications	Preoperative Atrial fibrillation		Total (%)	P		
	Non (%)	Yes (%)			Khi2	ddl
Hemodynamics	54 (67, 5)	26 (32, 5)	80 (50, 0)	0.715	0.665	2
Respiratory	33 (63, 5)	19 (36, 5)	52 (32, 5)	0.260	2.510	2
Infectious	27 (64, 3)	15 (35, 7)	42 (26, 3)	0.405	1.637	2
Renal	**14 (42, 4)**	**19 (57, 6)**	**33 (20, 6)**	**0.017**	**19.383**	**2**
Hematological	20 (64, 5)	11 (35, 5)	31 (19, 4)	0.513	0.890	2
Digestive	21 (84, 0)	4 (16, 0)	25 (15, 6)	0.084	3.479	2
Neurological	**10 (45, 5)**	**12 (54, 5)**	**22 (13, 8)**	**0.031**	**7.080**	**2**

(C)

Immediate post-op complications	Preoperative PAH			Total (%)	p		
	<25 (%)	25 - 50 (%)	>50 (%)			Khi2	ddl
Hemodynamics	1 (10, 0)	1 (10, 0)	8 (80, 0)	10 (52, 6)	0.138	3.449	2
Respiratory	**0 (0, 0)**	**0 (0, 0)**	**7 (100, 0)**	**7 (36, 8)**	**0.029**	**5.115**	**2**

Continued

Infectious	0 (0, 0)	2 (28, 6)	5 (71, 4)	7 (36, 8)	0.620	0.619	2
Renal	0 (0, 0)	0 (0, 0)	4 (100, 0)	4 (21, 1)	0.173	2.338	2
Hematological	0 (0, 0)	0 (0, 0)	5 (100, 0)	5 (26, 3)	0.101	3.132	2
Digestive	0 (0, 0)	0 (0, 0)	3 (100, 0)	3 (15, 8)	0.282	1.644	2
Neurological	0 (0, 0)	1 (50, 0)	1 (50, 0)	2 (10, 5)	0.694	0.705	2

2. Discussion

Approximately 75% of the world's population does not have access to cardiac surgery when needed, due to a lack of infrastructure, human resources, and financial coverage [4]. There is a global disparity in the distribution of cardiac surgery centers and the number of cardiothoracic surgeons per capita. Africa, with only one cardiothoracic surgeon per 4 million inhabitants, accounts for only 1% of total global capacity [5] [6].

In sub-Saharan Africa, excluding South Africa, there is only one cardiac surgery center per 38 million inhabitants [7]. In Asia, there is only one for every 25 million inhabitants, while North America and Europe have one for every 120,000 inhabitants [8].

In Mali, there is only one cardiac surgery center, which has been in existence since 2018. The cost of surgery and the constraints related to the capacity of the only cardiac surgery center are the main factors delaying treatment. These difficulties in accessing surgery are common in some African series. Kingué *et al.* reported that patients were seen late and 40% of them had heart failure and were in NYHA class III or IV [1]. Coulibaly *et al.* [2] reported in a series of patients who underwent cardiac surgery in Mali that the delay in treatment was between 1 and 3 years for 39.7% of patients and > 3 years for 39.7% of them. Preoperative cardiac status determines the outcome and post-operative consequences; indeed, the team of Yangni-Angate *et al.* [9] found the following risk factors for low cardiac output after surgery: NYHA functional class III and IV ($P = 0.001$), mean pulmonary artery pressure greater than 25 mmHg ($P \leq 0.01$), and aortic clamping time greater than one hour. A delay in treatment of more than 3 years was also found to be a factor associated with death after mitral valve surgery.

In our series, more than half of the patients underwent surgery after a delay of 3 years from the onset of the disease. The main complications attributed to delayed treatment were: stroke, malnutrition, complete arrhythmia due to atrial fibrillation (CAF), and PAH.

Mortality alone is not an adequate marker of quality of care or cost-effectiveness, as it does not correlate with complication rates and length of hospital stay [10]. However, analyzing mortality allows for an overall assessment of patient outcomes after surgery, taking into account variables such as age, type of pathology, preoperative cardiac status, organization of care systems, post-operative follow-up, etc. Mortality after cardiac surgery varies greatly depending on the country,

the center, and the type of patient.

A Jordanian series [11] reported a peri-operative mortality rate of 5.8%; in sub-Saharan Africa, following valve replacement surgery, the following was observed: a peri-operative mortality rate of 16% in Ivory Coast [9]; Mirabel *et al.* [12] reported an immediate post-operative mortality rate of 6.10% in Mozambique, with 9.65% dying subsequently (23 months); in our series, we recorded a peri-operative mortality rate of 6.9% and a late mortality rate (36 months) of 8.1%, giving an overall death rate of 15%. It should be noted that one of the difficulties in developing countries is post-operative follow-up and anticoagulation management. 112 patients, or 14.6%, were lost to follow-up 30 days after surgery in Mozambique [12]. The main factor identified for this loss to follow-up was the distance between home and the cardiac surgery center, which was >1000 km in 21.94% of patients.

Preoperative risk stratification is essential for making sound surgical decisions. Risk scores allow results to be compared between institutions and surgeons in order to standardize communication in clinical research. These scores were developed in the US or Europe using parameters such as advanced age, ejection fraction, NYHA classification, presence of PAH, concomitant coronary artery disease, etc. [13].

Some of the scores used in valve surgery include Euro SCORE I and II, the Society of Thoracic Surgeons (STS) score, and the Ambler score.

The Euro SCORE I is based on European data from 19,000 patients, 29% of whom underwent valve surgery. It was replaced in 2011 by the Euro SCORE II, based on data from 22,381 patients in 43 countries, 46% of whom underwent valve surgery [14].

The STS score was developed from US data, dividing three large cohorts of more than 100,000 patients each. In groups 2 and 3, only valve surgery and valve surgery combined with coronary artery bypass grafting were included, respectively [15].

The Ambler score, based on 32,839 patients in Great Britain and Ireland, was specifically designed for heart valve surgery (aortic and mitral) with or without coronary artery bypass grafting, which made it possible to discuss the differences between diseases and the risks associated with various procedures [16]. The aims of the risk model of Ambler prognostic score are to provide information to clinicians and patients about the risk of in-hospital mortality after surgery and to facilitate a fairer comparison of institutional performance.

He evaluates age, BMI, gender, site of valve surgery, concomitant CABG and tricuspid valve surgery, renal failure, diabetes, hypertension, poor ejection fraction, arrhythmias, number of previous cardiac operations, and priority of surgery as important predictors of in-hospital mortality. The strongest predictors were operative priority, followed by renal failure, age, and operation sequence. These findings are supported by previous studies [16].

In our study, we evaluated the Ambler score and compared the morbidity and mortality rates observed with those predicted by the Ambler score for patients.

There was no statistical correlation, with the observed mortality rate significantly higher than that predicted by the Ambler score. In fact, we recorded a peri-operative mortality rate of 6.9% and a long-term mortality rate (36 months) of 8.1%, giving an overall mortality rate of 15%; however, the average Ambler score for our patients was 6.68 ± 1.344, which predicts an average mortality risk of 4.1%.

There are several reasons for these discrepancies. These prediction scores were developed based on European or American series, and we now know that these are not the same types of patients. In addition, beyond epidemiological and clinical characteristics, many other considerations must be taken into account to explain these results.

These are socio-demographic: our patients are relatively young, mostly from poor backgrounds, sometimes with parents who have not attended school, and are therefore less compliant with treatment and the management of certain medications such as anticoagulants, and do not receive adequate post-operative follow-up.

Health considerations: there is limited access to cardiac surgery, so there is a long delay in treatment, which is responsible for preoperative complications and comorbidities with fragile conditions impacting surgical outcomes (weight loss, cardiac liver, PAH, etc.); these types of complicated and fragile patients are operated on by a relatively young team with little experience.

Finally, certain operational realities are common to almost all cardiac surgery centers in sub-Saharan Africa: difficulties in obtaining labile blood products, coagulation factors, certain antibiotics, nitric oxide, etc.

The realities of cardiac surgery in Africa (insufficient access to surgery, relatively long waiting times for treatment, cardiac conditions at the time of treatment with pulmonary hypertension, congestive hepatic failure, etc.) are factors specific to our regions that could explain why risk stratification scores designed for other patient profiles are not suitable for our context.

Cardiac surgery risk stratification scores are not adapted to our patients in sub-Saharan Africa. The establishment of a pan-African exchange network to develop treatment protocols and propose adapted stratification scores would be one way of improving this surgical practice in our countries.

3. Conclusion

Acute rheumatic fever remains a public health problem in Mali, Africa, and certain developing countries. Morbidity and mortality following valve surgery are high in these countries. This morbidity and mortality are multifactorial: difficulty accessing surgery, delays in treatment, preoperative comorbidities, difficulties in supplying medicines, consumables, and inputs, poor compliance with post-operative follow-up and treatment, and finally, the failure to adapt surgical risk stratification scores.

Ethical Considerations

Patient confidentiality was respected throughout the conduct of this work. Pa-

tients or their legal representatives authorized the use of their data in this work. Authorization from the local ethics committee of the "LE LUXEMBOURG" Mother and Child University Hospital, Bamako was obtained prior to the conduct of this work.

Conflicts of Interest

The authors report no conflicts of interest in relation to this work.

References

[1] Kingué, S., Ba, S.A., Balde, D., Diarra, M.B., Anzouan-Kacou, J., Anisubia, B., *et al.* (2016) The VALVAFRIC Study: A Registry of Rheumatic Heart Disease in Western and Central Africa. *Archives of Cardiovascular Diseases*, **109**, 321-329. https://doi.org/10.1016/j.acvd.2015.12.004

[2] Coulibaly, M., Koita, S.A., Doumbia, M., Diallo, B., Traore, S.I., Diarra, B.I., *et al.* (2022) First Malian Series of Surgery for Rheumatic Valve Disease: Opening of the Centre, Clinical Features and Peri-Operative Realities. *Cardiovascular Journal of Africa*, **33**, 41-45. https://doi.org/10.5830/cvja-2021-042

[3] Babatasi, G., Deloche, A., *et al.* (2006) Nouveaux challenges de la chirurgie cardiaque dans les pays en voie de développement.

[4] Vervoort, D., Meuris, B., Meyns, B. and Verbrugghe, P. (2020) Global Cardiac Surgery: Access to Cardiac Surgical Care around the World. *The Journal of Thoracic and Cardiovascular Surgery*, **159**, 987-996.e6. https://doi.org/10.1016/j.jtcvs.2019.04.039

[5] Turina, M. (2002) European Association for Cardio-Thoracic Surgery: Carrying the Torch. *European Journal of Cardio-Thoracic Surgery*, **22**, 857-863. https://doi.org/10.1016/s1010-7940(02)00731-5

[6] Vervoort, D. and Kpodonu, J. (2020) Cardiac Surgery in West Africa: The Tipping Point. *Cardiology in the Young*, **30**, 148-148. https://doi.org/10.1017/s104795111900310x

[7] Fynn-Thompson, F., Antunes, M., Edwin, F., Yuko-Jowi, C., Mendis, S., Thameur, H., *et al.* (2014) Cardiac Surgery Capacity in Sub-Saharan Africa: Quo Vadis? *The Thoracic and Cardiovascular Surgeon*, **62**, 393-401. https://doi.org/10.1055/s-0034-1383723

[8] Pezzella, A.T. (2010) Global Aspects of Cardiothoracic Surgery with Focus on Developing Countries. *Asian Cardiovascular and Thoracic Annals*, **18**, 299-310. https://doi.org/10.1177/0218492310370060

[9] Yangni-Angate, K.H., Meneas, C., Diby, F., Diomande, M., Adoubi, A. and Tanauh, Y. (2016) Cardiac Surgery in Africa: A Thirty-Five Year Experience on Open Heart Surgery in Cote D'ivoire. *Cardiovascular Diagnosis and Therapy*, **6**, S44-S63. https://doi.org/10.21037/cdt.2016.10.06

[10] Patra, C., Chamaiah Gatti, P. and Panigrahi, A. (2019) Morbidity after Cardiac Surgery under Cardiopulmonary Bypass and Associated Factors: A Retrospective Observational Study. *Indian Heart Journal*, **71**, 350-355. https://doi.org/10.1016/j.ihj.2019.07.004

[11] Ibrahim, K.S., Kheirallah, K.A., Mayyas, F.A., Alwaqfi, N.R., Alawami, M.H. and Aljarrah, Q.M. (2021) Predictors of Short-Term Mortality after Rheumatic Heart Valve Surgery: A Single-Center Retrospective Study. *Annals of Medicine and Surgery*,

62, 395-401. https://doi.org/10.1016/j.amsu.2021.01.077

[12] Mirabel, M., Lachaud, M., Offredo, L., Lachaud, C., Zuschmidt, B., Ferreira, B., *et al.* (2017) Cardiac Surgery in Low-Income Settings: 10 Years of Experience from Two Countries. *Archives of Cardiovascular Diseases*, **110**, 82-90. https://doi.org/10.1016/j.acvd.2016.05.006

[13] Casalino, R., Cordeiro de Paula, L.J., Bello Martins, E. and Tarasoutch, F. (2016) Valvular Heart Disease and Risk Score Systems in Clinical Practice. *EMJ Cardiology*, **4**, 103-106. https://doi.org/10.33590/emjcardiol/10313053

[14] Nashef, S.A.M., Roques, F., Sharples, L.D., Nilsson, J., Smith, C., Goldstone, A.R., *et al.* (2012) Euro SCORE II. *European Journal of Cardio-Thoracic Surgery*, **41**, 734-745. https://doi.org/10.1093/ejcts/ezs043

[15] Edwards, F.H., Clark, R.E. and Schwartz, M. (1994) Coronary Artery Bypass Grafting: The Society of Thoracic Surgeons National Database Experience. *The Annals of Thoracic Surgery*, **57**, 12-19. https://doi.org/10.1016/0003-4975(94)90358-1

[16] Ambler, G., Omar, R.Z., Royston, P., Kinsman, R., Keogh, B.E. and Taylor, K.M. (2005) Generic, Simple Risk Stratification Model for Heart Valve Surgery. *Circulation*, **112**, 224-231. https://doi.org/10.1161/circulationaha.104.515049