OUTCOMES FOLLOWING VALVE REPLACEMENT IN PATIENTS WITH RHEUMATIC MITRAL VALVE DISEASE WITH PREOPERATIVE PULMONARY HYPERTENSION AT KENYATTA NATIONAL HOSPITAL

THIS DISSERTATION IS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF THE MASTER OF MEDICINE IN THORACIC AND CARDIOVASCULAR SURGERY DEGREE AT THE UNIVERSITY OF NAIROBI

SUBMITTED BY

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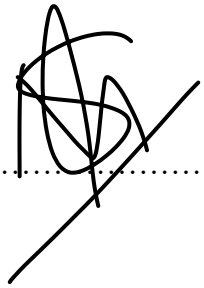
DECLARATION

I declare that this study is my original work and has not been presented for an award at any institution.



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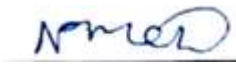
Signed: 

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DEPARTMENTAL APPROVAL

This is to certify that this dissertation is the original work of Dr. Hassan M. Ibrahim which was presented at a departmental meeting held on 2nd of June 2022 and thereafter approved by the Kenyatta National Hospital- University of Nairobi Ethics and Research Committee.

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ACRONYMS AND ABBREVIATIONS

COPD- Chronic Obstructive Pulmonary Disease

KNH – Kenyatta National Hospital

LMIC- Low and Middle-Income Countries

MVR – Mitral Valve replacement

RHD- Rheumatic Heart Disease

MS- Mitral Stenosis

MR- Mitral Regurgitation

PH- Pulmonary Hypertension

PAH – Pulmonary arterial hypertension PH-LHD- Pulmonary

Hypertension related to Left Heart Disease UoN – University of

Nairobi

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ABSTRACT

Background

Pulmonary Hypertension (PH) complicates cardiac disease, and its presence corresponds to the severity of the disease process. PH may complicate almost any heart disorder including diseases of the mitral valve. PH is known to be a prognostic factor in surgery, particularly heart surgery where it portends increased morbidity and mortality. There is a dearth of data in Kenya and the region on the impact of PH on outcomes after MVR.

Objectives

To describe the association between preoperative PH with morbidity and mortality after prosthetic Mitral Valve Replacement among patients with rheumatic mitral valve disease at the Kenyatta National Hospital.

Methodology

Using a retrospective study model, consecutive patients who had mitral valve replacement surgery between January 2012 and December 2021 at KNH, and who had preoperative Echocardiograms were recruited. Data analysis included both descriptive and inferential analysis. Logistic regression was used to identify independent risk factors for mortality. Results of the regression model were reported in Odds ratios as well as the corresponding confidence intervals. The findings were considered significant whenever $p<0.05$.

Results

A total of 54 patients were included in the study. Majority 63% (n =34) were female. The median age was 31(IQR: 20 – 42.5) years with 51.9% (n =28) being aged ≥30 years. Most of the patients, 85.2% (n =46) had mitral regurgitation with 51.9% (n =28) of the patients classified as severe. The prevalence of pulmonary hypertension among patients undergoing MVR was 75.9% (n =41), 95%CI: 62.4% - 86.5%. Among those with PH, 51.2% (n =21) of the patients had severe disease, 26.8% (n =11) had moderate while 22% (n =9) had mild disease. Female patients(OR =10.33, 95%CI:2.37 – 45.12, p =0.002), those who had mitral stenosis (OR =6.60, 95%CI:1.70 – 25.67, p =0.012) and hospital stay (>30days)(OR =6.98, 95%CI: 1.76 – 27.63, p =0.006) were associated with increased PH. Patients who had history of alcohol use (OR =12.0, 95%CI:1.43 –

100.39, p =0.009), mitral stenosis(OR =23.11, 95%CI:5.01 – 106.57, p<0.001), NYHA class III-IV (OR =8.03, 95%CI:1.61 – 40.09, p =0.011) and PH (OR= 6.98, 95%CI: 1.76 – 27.63, p =0.006) were significantly associated with longer hospital stay (>30 days). In-hospital mortality rate was 9.3%.

Conclusion and recommendations

The prevalence of PH in patients with mitral valve disease is high and is significantly higher in female patients, patients with mitral stenosis. Increasing PH severity is associated with longer hospital stay. The in-hospital mortality rate has also been found to be high. Thus, close monitoring of patients with Pulmonary Hypertension following MVR for the development of known complications such as acute right ventricular failure and PH crisis is crucial. This can include caring for these patients for longer periods in critical care or high-dependency units after MVR.

CHAPTER 1: INTRODUCTION

1.0 INTRODUCTION

Pulmonary Hypertension (PH) where it complicates heart disease is related to disease severity (1). Pulmonary hypertension is a complication of congenital cardiac disease seen in one-tenth of these patients. Pre-operative PH among cardiac surgical patients predisposes to increased risk for complications following surgery (2) as well as increased morbidity and mortality (3).

Rheumatic heart disease (RHD) on the other hand is a burden mainly in developing countries. Each year RHD contributes to a quarter of a million deaths globally (4).

Symptomatic patients with mitral and aortic valve disease are frequently found to have PH. This is most notable with chronic diseases of the mitral valve.

About 4% of valvular heart disease is due to mitral valve disease (5). Mitral stenosis is associated with risk factors such as rheumatic fever, kidney disease, and osteoporosis, among traditional cardiovascular risk factors (6). Mitral valve disease affects millions of people with the best practice treatment being valve repair or valve replacement (7).

Recent studies point to more favorable outcomes in patients with severe PH. These newer studies evidence reduced mortality rates in the perioperative period (8). However, evidence on the same is controversial, with other studies claiming PH is a risk factor for increased mortality, yet other papers conclude that severe PH does not affect mortality. Outcomes of patients with severe PH who receive prosthetic mitral valve replacement (MVR) remain unclear, especially in the long term (9).

Endemic poverty, overcrowding due to inadequate housing, poor nutrition, and lack of access to medical care, among other causes makes RHD more prevalent in Kenya and other low and middle-income countries. In a 2016 study by Rebecca H. Lumsden et al., two-thirds (64%) of patients attending the cardiology clinic at a referral hospital in Western Kenya had RHD (10).

Rheumatic heart disease is the result of an autoimmune reaction that follows infections caused by g*roup A streptococci*. It often is inflammatory sequelae of upper respiratory tract infection. Acutely the inflammation causes pancarditis. Valve disease is a hallmark of chronic disease. This usually affects the mitral, aortic, tricuspid, and pulmonary valves in that order.

Both mitral regurgitation and mitral stenosis involve Pulmonary Arterial Hypertension as part of a decompensated state of disease. Pulmonary hypertension arises due to the back transmitted raised left atrial pressure. In MS and MR, valve disease directly impacts the LA, as opposed to the case with Aortic valve disease. Surgery to correct the valvular disease does not always attenuate pulmonary hypertension and, as discussed above, portends an increased postoperative risk.

The poor quality of life of Rheumatic mitral valve disease patients means surgeons and anesthesiologists often have to anticipate a challenging perioperative period due to the established impact of PH on morbidity and mortality following surgery.

There exists little local and no meaningful regional data on this area of interest to help assess the effect PH has on outcomes after Mitral Valve surgery. We determined to observe the association of PH with postoperative in-hospital morbidity and mortality following Mitral Valve Replacement at KNH.

CHAPTER 2: REVIEW OF LITERATURE

2.1 Epidemiology of Pulmonary Hypertension

In Africa, the epidemiology of PH is yet to be adequately described. The distribution of the multitude of etiologies of PH is also not well known. The existing body of information on PH in Africa is mainly derived from one major study, a prospective review that involved four nations in sub-Saharan Africa, that is South Africa, Nigeria, Cameroon, and, Mozambique.

The prevalence of PH in Africa is higher when compared to other non-African populations. This higher prevalence of PH is likely explained by certain risk factors that are unique and endemic to Africa (16, 17, and 18).

The worldwide burden of PH remains unknown. Estimates place this prevalence at 1% of the world's population. Undoubtedly most patients with PH are found in LMICs. People younger than 65 years of age are disproportionately affected. Pulmonary hypertension is considered an uncommon disease. A review in the Netherlands found an estimated prevalence of PH based on echo at 2.6 in every 100 people (11) and 6.6–15.0 cases per million in Great Britain (13).

A national audit on PH done in 2014 in the UK revealed that the diagnosis of PAH was made at a median age of above 50 years for both males and females. Notably, more than a quarter of the patients were in their seventh decade of life.

This rebuts an erstwhile-held notion that PAH is mainly a disease of young people (14). Among 482 patients found to have PAH in a prospective study, the incidence was 1.1 cases per million per year (15).

PH prevalence in Kenya is not been well defined. Available studies involve only selected patient populations, and this prevalence lies between 5.5% and 49.4% (19). There is a need therefore to fully investigate the prevalence of PH.

Ngunga M. et al in a retrospective review at Aga Khan University Hospital in Nairobi (2014-2017) reported that RHD caused PH in 6.6% of the 659 patients (23) which is a significant rate. The study also revealed that the commonest etiology of PH was related to diseases of the left side of the heart at 58%. The study also revealed high mortality rates with moderate and severe PH, where 33% of the respondents succumbed within two years of diagnosis. Surprisingly, rheumatic heart disease and significant cardiac valve disease did not affect mortality.

Closer home, Awori Mark et al. (2017) in a validation study of the Euroscore, a risk stratification model, found that pulmonary hypertension was prevalent at 58.6% in the study population. This was extremely out of range when compared to the European population upon which the Additive Euroscore was based. This finding made it apparent that the Euroscore could not be generalized to the Kenyan population.

2.2 Epidemiology of PH with left heart valve disease

In a 2018 Swiss review of literature, Micha T. Maede et al. found out that the prevalence of PH with mitral and aortic valve disease depended on the severity of valve pathology, as well as other critical associations like the presence of LV/ LA dysfunction. Other facts, including patient age and cardiac rhythm, also contributed to the prevalence. Right heart catheterization which is the criterion standard of diagnosis was not performed in the majority of studies.

Instead, most information on the prevalence of PH was from Echocardiographic studies. The same Swiss review yielded a valuable comparison of contemporary studies that looked at the prevalence of PH in both mitral and aortic diseases. For mitral stenosis (MS), substantial PH was found in **30–40%** of patients. In mitral regurgitation (MR) (moderate or severe), the prevalence of PH ranged between **15–32%**.

In contrast, among patients with aortic regurgitation (AR), one study found a prevalence of 16%. In aortic stenosis (AS), the prevalence of PH was noted in echo studies to vary between 9% - 34%.

2.3 Etiology of PAH in Mitral Valve Disease

Table 1: Pulmonary Hypertension Classification [Galie et al. (60)]

Group	Hemodynamic constellation
1 Pulmonary arterial hypertension	**Pre-capillary** PH: mPAP ≥25 mmHg, mPAWP ≤15 mmHg
2 PH due to left-sided heart disease	**Post-capillary** PH: mPAP ≥25 mmHg, mPAWP >15 mmHg
2.1. Left ventricular systolic dysfunction	• Isolated post-capillary (IpcPH): PVR ≤3 WU
2.2. Left ventricular diastolic dysfunction	• Combined pre- and post-capillary (CpcPH): PVR >3 WU
2.3. Valvular disease	
2.4. Left heart inflow/outflow tract obstruction	
2.5. Pulmonary vein stenosis	
3 PH due to lung disease and/or hypoxia	**Pre-capillary** PH: mPAP ≥25 mmHg, mPAWP ≤15 mmHg
4 Chronic thromboembolic PH and other pulmonary artery obstructions	**Pre-capillary** PH: mPAP ≥25 mmHg, mPAWP ≤15 mmHg
5 PH associated with unclear and/or multifactorial mechanisms	**Pre-capillary and post-capillary** forms of PH

mPAP: mean pulmonary artery pressure, mPAWP: mean pulmonary artery wedge pressure, PVR: pulmonary vascular resistance (in Wood units, WU)

The World Health Organization (WHO) has a classification for Pulmonary Hypertension. This is perhaps the most widely used system. In an update from 2008 class II is now reclassified into 3 as shown in the table above.

For this review, we shall reference the Group 2 WHO class of PH where mitral valve disease falls.

2.4 Pathophysiology of PAH in Rheumatic Valvular Mitral Disease

2.4.1 Mitral Regurgitation

C Yuko-Jowi and M Bakari (53), in 2005 at the Kenyatta National Hospital, found that RHD in the pediatric age often presented as mitral regurgitation or a combination of aortic and mitral regurgitation. Their study also revealed that in mitral valve disease, PH was the commonest complication.

Mitral regurgitation is the most prevalent cardiac valve pathology at the early stages of RHD (54). This isolated pure MR is noted to improve with prompt and adequate treatment of inflammatory myocarditis. In the real sense, however, the valve pathology in established RGD is often a mixed MR/MS due to the extensive fibrosis associated with fused commissures and restricted mobility of the retracted leaflets.

Several mechanisms are believed to cause MR in RHD. The structural disruption of the valve and the sub-valvular apparatus is one mechanism. The volume overload in the left heart chambers occasioned by the systolic unloading results in annular dilatation occasioning the MR. Atrial fibrillation is associated with LA enlargement. This Atrial Fibrillation is associated with a functional MR.

The natural progression to chronic severe MR follows three phases that often lead to each other. First, the initial compensated period where regurgitant volume into the LA with the systolic unloading causes the LV to adapt by transforming into a sizeable compliant chamber to maintain total stroke volume. There is concentric LV hypertrophy. However, the LV contractile function is preserved. The LA also enlarges and becomes dilated. This is to accommodate the regurgitant volume.

This compensatory enlargement makes it, so the LA pressure is preserved, and therefore the pulmonary arterial pressures are maintained. The patient at this time is asymptomatic. The LVEF is maintained in this phase.

Next follows a transitional phase that is not as distinct. However, at this stage, the LV contractile function starts deteriorating, heralding LV systolic and diastolic dysfunction. Elevation of LA pressures is noted. And as a result, PH starts developing during this period.

The final phase is the decompensated phase, where the compensatory adaptive mechanisms are lost. There is established LV dysfunction with declined LV contractile function. The significantly elevated LA pressures are back-transmitted, resulting in worsening pulmonary hypertension. The patient at this point is quite symptomatic and likely in cardiogenic shock.

At the microscopic level, persistently elevated pulmonary venous pressure results in leakage from capillaries and edema in the alveoli. This sudden stress failure and the resulting leakage and edema are completely reversible. The persistent elevated pulmonary pressure may induce permanent remodeling of the membrane between the alveoli and capillary with type IV collagen deposition.

These progressive and irreversible microstructural changes to the pulmonary vasculature are mediated by potent compounds such as *endothelin-1,* a vasoconstrictor. The consequence of this mediation is vasoconstriction and elevation of systolic PAP. This causes RV dilation and hypertrophy (26, 27)

2.4.2 Mitral Stenosis (MS)

RHD is the commonest cause of MS.

The normal mitral valve orifice area is accepted at 4-6cm^2. Mitral stenosis is considered to be present when this orifice area is less than 2.5 cm^2.

The degree of stenosis is as follows;

1. Mild MS 1.5-2.5cm2
2. Moderate MS 1-1.5cm2
3. Severe MS Less than 1cm2
4. Critical MS Less than 0.5cm2

As the MS progresses, the mitral valve area (MVA) decreases which in turn causes the LA pressure to increase. Gradually further reduction in the MVA due to worsening MS results in further elevation of LA pressure. Ultimately, this high LA pressure is transmitted through the pulmonary veins. As pulmonary arterial pressure increases, the RV becomes pressure overloaded, and right heart failure may occur. Right ventricular dilation and a subsequent functional tricuspid regurgitation may develop.

2.5 Effects of Pulmonary Hypertension

The elevated pulmonary pressures in addition to persistently raised afterload results in changes seen in the right ventricle. This usually involves hypertrophy and dilation. There usually is an initial phase that involves RV remodeling. This is an adaptive response to the increased afterload. Following this phase is the development of RV hypertrophy with cor pulmonale.

Anesthesia administration in patients with PH is challenged by the risk of hyper-reactive airways. Right ventricular (RV) failure is also a major risk at this time. A dreaded complication seen in patients with PH is Pulmonary Hypertensive Crisis.

Following surgery in the ICU, these patients have a risk of developing pulmonary vasoconstriction (PH Crisis), arrhythmias, pulmonary thromboembolism, and RV failure. These complications, individually and collectively serve to increase the morbidity and mortality associated with PH.

2.6 Mitral valve replacement (MVR)

The presence of PH is a class IIA indication for mitral valve surgery in asymptomatic patients. This is per the AHA guidelines.

In the setting of severe PH, MVR is considered safe on condition that the pulmonary arterial pressures are not supra-systemic.

Mitral valve replacement is associated with a notable decline in the PH and vascular resistance (36). Although MVR is known to improve pulmonary artery pressures as well as RV function, information concerning the relation of pre-procedure PH with clinical outcomes after MVR is limited (37).

2.6.1 Effects of surgery

McIlduff J. B et al. (1980) (58) described the post-operative immediate hemodynamic changes in patients with PH (severe) as well as those without PH following mitral valve replacement (systolic pressure more than 50 mm Hg). Amongst those patients with severe PH, MVR was associated with a notable decline in their pulmonary pressures. The initially low Cardiac index was also noted to significantly increase. Pulmonary vascular resistance is also reduced. The MVR seemed to not affect their heart rate as this was unchanged. The findings supported the concept of reversible PH.

A systolic pulmonary artery pressure of 110 mmHg or greater had for a long time been considered an absolute contraindication to mitral valve replacement according to Barclay et al. (1972).

Privalova et al. in the year 2000 observed that residual PH was noted after surgery in patients operated on for rheumatic mitral heart disease that was complicated by PH (21).

Awori Mark, Mehta Nikita, Mitema Fred, et al. 2017 in a validation of the Additive Euroscore (51) at the Kenyatta National Hospital found that the local prevalence of PAH was much higher (58.7% v 2%) as compared to the Additive Euroscore population. The presence of PAH was not found to have a statistically significant impact on post-operative outcomes after cardiac surgery. These findings line up with studies done outside of the continent.

For instance, Omer Farooq, et al. (55) found that increasing severity of pulmonary hypertension did not significantly increase early postoperative complications defined as prolonged ICU stay, prolonged ventilation, re-intubation, reopening for bleeding tamponade, and postoperative stroke following MVR. The patients did not have any further prolonged length of hospital stay.

Xiaochun Song et al. (56) described excellent results after MVR in 32 patients with severe PH. They showed a decrease in pulmonary arterial systolic pressure, LA diameter, and LV end-diastolic diameter, but with no change in LVEF after MVR.

Najafi et al. (57) described a strong causal relationship between perioperative mortality and the degree of PAH. The mortality rate was 16 % in patients with mild PAH and as high as 60 percent among patients with severe PAH.

Elevations in pulmonary pressure as well as right heart failure are consequences of pulmonary hypertension during the perioperative period. As a result, it is recommended that intense postoperative monitoring should be conducted and guided by the extent of the surgical trauma. Patients should be monitored for at least 24 hours in mild interventions and several days following major surgeries.

Depending on the patient's baseline status, close hemodynamic monitoring after surgery is necessary (43).

In the 1970s, the overall mortality related to surgery for mitral stenosis confounded by severe PH was 30% (44). Recent studies show more favorable mortality rates of between 6 to 12 percent. Nonetheless, severe PH remains a concern for cardiac surgeons preparing their patients for mitral valve surgery (36).

Many studies report that severe PAH returns to normal after MVR (45, 46). Operative mortality for mitral valve surgery depends on the procedure involved. Mitral valve repair confers 2% mortality. This doubled to 4% for mitral valve replacement surgery. The operative mortality of MVR in older patients (above 80 years) is high at 17% (47). The Society of Thoracic Surgery (STS) quotes mortality rates of 1.5% following repair and 5.5% after replacement of mitral valve respectively (48).

2.7 Problem statement

Rheumatic disease of the mitral valve (regurgitation and stenosis) involves Pulmonary Hypertension as part of a decompensated state of disease. The presence of PH has been described as a marker of poor prognosis after mitral valve replacement.

Surgery to correct the valvular disease does not always attenuate pulmonary hypertension and, as discussed above, may, in fact, portend an increased postoperative risk.

Surgeons, anesthesiologists, and other healthcare workers often have to anticipate a challenging perioperative period due to the established risk of PH on morbidity and mortality.

It was thus our intention to find out specifically what impact the presence of PH preoperatively has on outcomes after MVR at Kenyatta National Hospital.

2.8 Justification

Understanding the perioperative risks and challenges in these patients would help improve surgical care and outcome, planning post-operative care, and obtaining informed consent.

2.9 Research questions

1. What are the outcomes after Mitral Valve Replacement among patients with Preoperative Pulmonary Hypertension at KNH?

2.9.1 Null Hypothesis

1. Preoperative pulmonary hypertension does not affect morbidity and mortality after MVR

2.9.2 Alternate Hypothesis

1. Preoperative pulmonary hypertension has a negative impact on morbidity and mortality after MVR.

2.10 Objectives

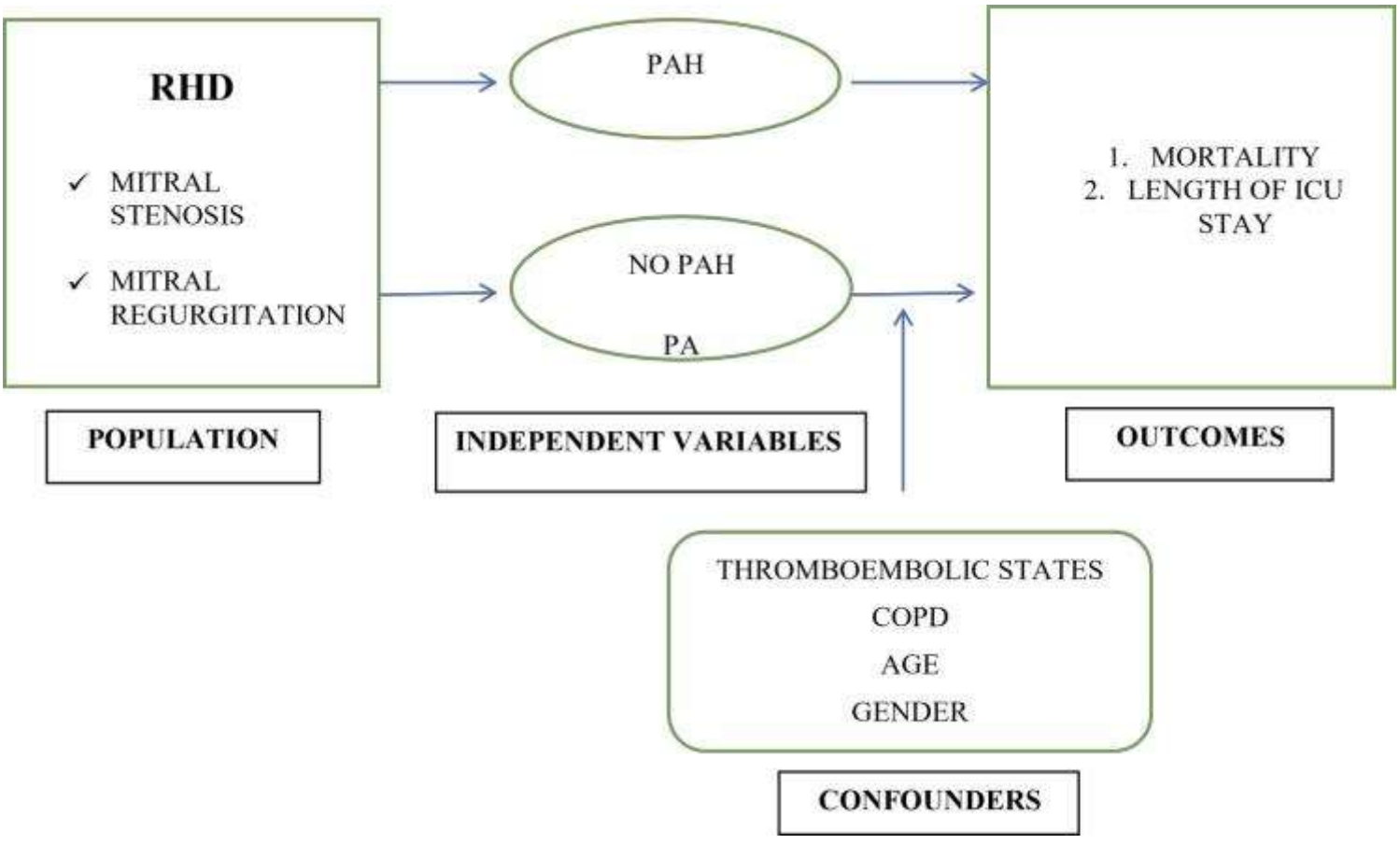
2.10.1 Broad objective

1. To describe the prevalence and association of preoperative PH with morbidity and mortality after prosthetic Mitral Valve Replacement among patients with rheumatic mitral valve disease at the Kenyatta National Hospital

2.10.2 Specific objectives

1. To determine the prevalence of PH in patients undergoing MVR at Kenyatta National Hospital.
2. To establish the duration of postoperative ICU stay in patients with PH after MVR at Kenyatta National Hospital.
3. To establish the in-hospital mortality rate of patients after MVR at Kenyatta National Hospital.

2.11 Conceptual Framework



CHAPTER 3: STUDY METHODOLOGY

3.1 Study Site

The study was conducted at the Kenyatta National Hospital in Nairobi City, Kenya. The KNH is the National Referral Hospital which in addition serves close to 10 million Kenyans who live in the general Nairobi Metropolitan area. KNH is also one among only 3 public hospitals in the Republic of Kenya that offer cardiac surgery services. KNH is also the teaching hospital for the University of Nairobi's College of Health Sciences. It was built in 1901 and currently boasts a bed capacity of 1800 patients.

Patients who are deemed to require cardiac surgery are referred to the Thoracic and Cardiovascular surgery clinic from where they are admitted to the cardiothoracic ward at KNH and operated on. After their surgery, the patients are admitted to the specialized Cardiothoracic ICU.

For our retrospective study therefore, details of all patients who are admitted to the cardiothoracic ward for MVR surgery, in the study period, were obtained from the ward register as well as the Cardiothoracic ICU register. These details were thereafter presented to the KNH Health Information and Records department for retrieval of the patient files.

3.2 Study design

A retrospective study analyzing medical records of patients who underwent MVR surgery in the ten years from January 2012 through December 2021

3.3 Study population

Participants included records of patients who underwent Open Heart Surgery with Mitral Valve Prosthetic Replacement surgery at the Kenyatta National Hospital in the period from 1st January 2012 to 31st December 2021.

3.4 Inclusion and Exclusion Criteria

3.4.1. Inclusion criteria

- Patients undergoing mitral valve replacement at Kenyatta National Hospital.
- Patients aged 18 years and older.

3.4.2 Exclusion Criteria

- Patients with inadequate data in their medical records.
- Patients who underwent multiple valve procedures

3.5 Sample Size Determination

A complete enumeration of all patients who underwent open heart surgery with mitral valve prosthetic replacement surgery at the Kenyatta National Hospital in the period from 1st January 2012 to 31st December 2021 was recruited. A total sample size of 54 patients with MVR surgery was identified within the study period.

3.6 Sampling procedure

A consecutive sampling technique was used in this study. All the files of patients who met the inclusion criteria within the study population were recruited into the study.

3.7 Data Collection and research instruments

Reports of Echocardiograms performed within 30 days of surgery were examined. The patient's pulmonary artery systolic pressure was derived from the latest preoperative echocardiography as follows;

1. No or mild PH (PASP < 30mmHg)
2. Moderate PH (PASP 31–55mmHg)
3. Severe PH (PASP > 55 mmHg). These cut-offs are based on the EuroSCORE II system (49).

A review of medical records was then done to identify the duration of ICU stay, and all-cause mortality rates after the surgery.

Complications were defined according to guidelines used to report morbidity and mortality following cardiac surgery (50). Operative mortality was defined as in-hospital death.

Demographic data were extracted from the patient's records. This included age, sex, as well as other existing comorbid diseases.

A structured data collection form was used to collate data from the patient files. Files were retrieved from the hospital's registry.

3.7.1 Training Procedures

Two trained data collectors who were medical students from the undergraduate level were recruited and trained for a day on implementing the study protocol.

Activities included:

- Collecting data from patient files and aiding the principal investigator in collecting the data,
- Compiling, and
- Entering it into the data collection sheet.

3.8 Study variables

Table 2: Study variables

Objective	Dependent variables	Independent variables
To establish the duration of postoperative ICU stay in patients with PH after MVR at Kenyatta National Hospital.	Duration of ICU stay	
2. To establish the in-hospital mortality rate of patients with PH after MVR at Kenyatta National Hospital.	Mortality	Age, sex, the severity of the disease

3.9 Data management

The participants were assigned a uniquely identifiable number, and all listed information was handled with the highest confidentiality from the point of collection to sample analysis and results.

Sharing the results was only made when necessary between the principal investigator, supervisors, and study participants. The filled questionnaire was cross checked at the end of each interview to ensure it is filled correctly and completely.

Collected data was entered into a password-protected Ms. Access document. Only the principal investigator and the authorized personnel accessed the data.

3.10 Data analysis

Data was collected on an online Google form, from which it was converted to a Microsoft Excel spreadsheet for data analysis.

Stata version 16 was used in analyzing the data. Characteristics of the study participants were described by way of means, median, standard deviations, ranges for continuous data, and proportions and frequencies for categorical data.

Patients were classified into two groups according to the presence of PAH according to the Echocardiographic report. Logistic regression was used to investigate factors associated with PH. Odds ratios were used to interpret the associations. Any finding of p less than 0.05 was considered significant.

3.11 Ethical Approval

This dissertation was presented for review to the KNH/UoN Ethics Review Committee. Unique identity codes were assigned to the data collection tools to ensure the anonymity of the data to be collected. The findings were treated with the utmost confidentiality.

The findings of this study were used to develop patient treatment protocols for mitral valve disease patients with PH in the region and beyond. Participants' hospital file numbers were included in the datasheet to enable easy tracking of the records and to aid in acquiring any information that may be missed during data collection.

3.12 Study results dissemination plan

Once data was analyzed and the manuscript developed, the study results were disseminated through seminars, surgical conferences, and the publication of the manuscript in a peer-reviewed journal.

3.13 Study Limitations

The diagnosis of PH as used in this study was based on echo-derived measurements. Right heart catheterization is the gold standard method of diagnosis.

Missing information due to the usage of files as the primary source of data, missing information from files on various parameters of interest may negatively impact the study results. However, files with key missing information were excluded, and only those with all relevant information shall be included.

Secondly, in our study, the cut-offs were based on definitions used in EuroSCORE. Awori M et al., in a validation study of the EuroSCORE carried out at KNH, determined that the method did not apply to patients in Kenya. They recommended that a local risk-scoring system be developed (51).

CHAPTER 4: RESULTS

The study sought to investigate the prevalence and association of preoperative pulmonary hypertension and morbidity after prosthetic Mitral Valve Replacement among patients with rheumatic mitral valve disease at the Kenyatta National Hospital.

A total of 54 files were retrieved within the study period, and these were analyzed.

4.1 Characteristics of patients undergoing MVR at Kenyatta National Hospital

In investigating the characteristics of patients, 63% (n =34) were female. The median age was 31(IQR: 20 – 42.5) years with 51.9% (n =28) being aged ≥30 years. The median duration from admission to surgery was 14 (IQR: 7 – 33.5) years as shown in Table 1.

Table 3: Characteristics of patients undergoing MVR at Kenyatta National Hospital

Disease Factors	Frequency	Percent
Gender		
Female	34	63.0
Male	20	37.0
Age, Median(IQR)	**31.0(20 – 42.3)**	
<30 years	26	48.1
≥30 years	28	51.9
Smoking history		
No	50	92.6
Yes	4	7.4
Alcohol use history		
No	39	72.2
Yes	15	27.8
Duration from admission to surgery, Median (IQR)	**14(7 – 33.5)**	

4.2 Rheumatic Mitral Valve Disease-related characteristics among patients undergoing MVR at Kenyatta National Hospital

Most of the patients, 85.2% (n =46) had mitral regurgitation with 51.9% (n =28) of the patients classified as severe. Further, 70.4% (n -38) had mitral stenosis with 55.6% (n =30) while 63% (n =34) had aortic valve disease. In investigating the NYHA classification, 59.3% (n =32) of the patients were classified as NYHA class II as shown in Table 2.

Table 4: Rheumatic mitral valve disease-related characteristics among patients undergoing MVR at KNH

Disease factors	Frequency	Percent
Mitral regurgitation		
No	8	14.8
Yes	46	85.2
Classification (n =46)		
Mild	11	23.9
Moderate	7	15.2
Severe	28	60.9
Mitral stenosis		
No	16	29.6
Yes	38	70.4
Classification (n =38)		
Mild	4	10.6
Moderate	4	10.6
Severe	30	78.9
Aortic valve disease		
No	20	37.0
Yes	34	63.0
Classification (n =34)		
Mild AR	25	46.3
Moderate AR	4	7.4
Severe AR	5	9.3
Other cardiac lesions		
No	14	25.9
Yes	40	74.1
Identified lesion (n =40)		
Mild TR	15	27.8
Moderate TR	11	20.4
Severe TR	11	20.4
Trivial TR	3	5.6

Rheumatic processes		
No	3	5.6
Yes	51	94.4
Pre-existing conditions		
No	52	96.3
Yes	2	3.7
NYHA classification		
NYHA 1	3	5.6
NYHA 2	32	59.3
NYHA 3	17	31.5
NYHA 4	2	3.7

4.3 The prevalence of PH in patients undergoing MVR at Kenyatta National Hospital

The prevalence of pulmonary hypertension among patients undergoing MVR was 75.9% (n =41), 95%CI: 62.4% - 86.5% as shown in Figure 1.

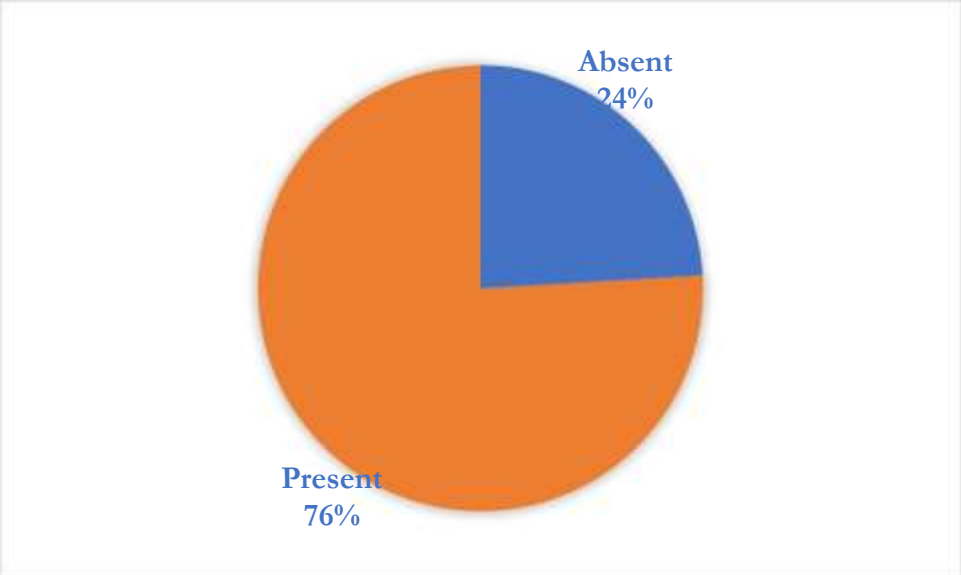


Figure 1: The prevalence of PH in patients undergoing MVR

4.4 Classification of PH in patients undergoing MVR at Kenyatta National Hospital (n =41)

Classification of PH showed that 51.2% (n =21) of the patients had severe disease, 26.8% (n =11) had moderate and 22% (n =9) had mild disease as shown in Figure 2.

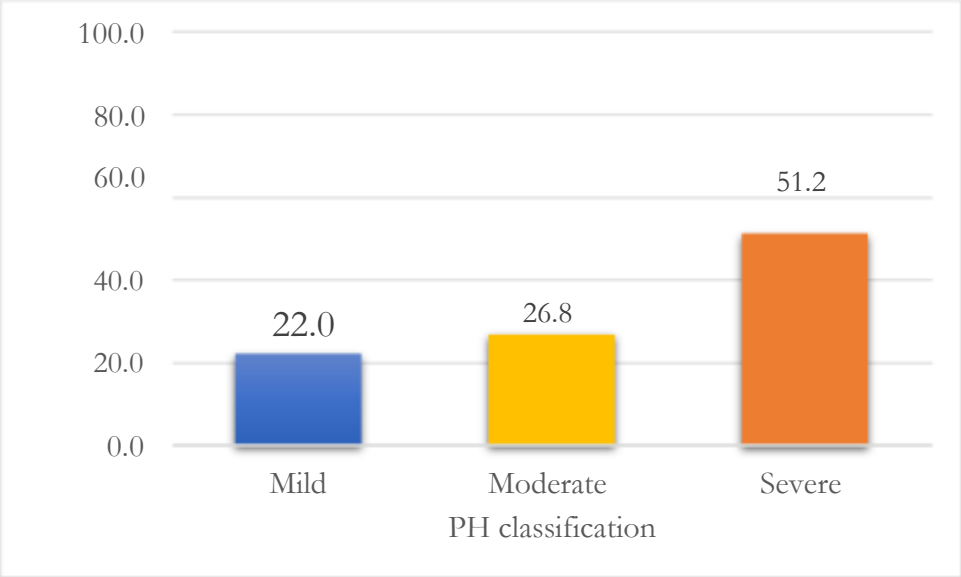


Figure 2: PH classification in current study population

4.5 Factors associated with PH among patients undergoing MVR at Kenyatta National Hospital

The findings from binary logistic regression established that gender, mitral stenosis, and length of hospital stay were significantly associated with pulmonary hypertension. Female patients were 10 times more likely to have pulmonary hypertension compared to male patients, OR =10.33, 95% CI: 2.37 – 45.12, p =0.002.

Those who had mitral stenosis were 6.6 times more likely to have pulmonary hypertension compared to those without, OR =6.60, 95% CI: 1.70 – 25.67, p =0.012.

Patients who stayed in the hospital for <30 days were 7 times more likely to have pulmonary hypertension compared to those who stayed in the hospital for less than 30 years, OR =6.98, 95%CI: 1.76 – 27.63, p =0.006 as shown in Table 3.

Table 5: Factors associated with PH among patients undergoing MVR at Kenyatta National Hospital

Factors	Pulmonary hypertension Present n(%)	Absent n(%)	OR(95%CI)	P-value
Age				
<30 years	19(73.1)	7(26.9)	0.74(0.21 - 2.59)	0.754
≥30 years	22(78.6)	6(21.4)	Ref	
Gender				
Female	31(91.2)	3(8.8)	10.33(2.37 - 45.12)	0.002
Male	10(50)	10(50)	Ref	
Smoking history				
No	38(76.0)	12(24)	Ref	
Yes	3(75)	1(25)	1.06(0.10 - 11.12)	0.681
Alcohol history				
No	29(74.4)	10(25.6)	Ref	
Yes	12(80.0)	3(20.0)	0.73(0.17 - 3.11)	0.481
Mitral regurgitation				
No	8(100)	0		
Yes	33(71.7)	13(28.3)		
Mitral stenosis				
No	8(50.0)	8(50.0)	Ref	
Yes	33(86.8)	5(13.2)	6.60(1.70 - 25.67)	0.012
Aortic valve disease				
No	15(75)	5(25)	Ref	
Yes	26(76.5)	8(23.5)	0.92(0.26 - 3.34)	0.576
Rheumatic processes				
No	1(33.3)	2(66.7)	Ref	
Yes	40(78.4)	11(21.6)	0.14(0.01 - 1.66)	0.14
NYHA classification				
I-II	28(80)	7(20.0)	Ref	
III - IV	13(68.4)	6(31.6)	1.85(0.52 - 6.60)	0.506
Length of hospital stay (days				
≤30 days	31(88.6)	4(11.4)	Ref	
>30 days	10(52.6)	9(47.4)	6.98(1.76 - 27.63)	0.006

4.6 The duration of postoperative ICU stay in patients with PH after MVR at Kenyatta National Hospital

The average duration of stay in the ICU was 4.3 (SD ±2.2) days. The average duration of endotracheal intubation was 1.13(SD±0.82). Further, the duration of the overall postoperative length of hospital stay was 34.9 (SD±210.5) days as shown in Table 4.

Table 6: Duration of postoperative ICU stay in patients with PH after MVR at Kenyatta National Hospital

Duration	Frequency	Percentage
Duration of ICU stay, Mean(SD) days	4.3±2.2	
<4 days	24	44.4
≥4 days	30	55.6
Duration of endotracheal intubation, Mean (SD) days	1.13±0.82	
≥ 1	48	88.9
>1 day	6	11.1
Length of Hospital stay, Mean (SD) days	34.9±10.5	
≤30 days	35	64.8
>30 days	19	35.2

4.7 Factors associated with length of hospital stay among patients undergoing MVR at Kenyatta National Hospital

Patients who had a history of alcohol use were 12 times more likely to stay in the hospital for >30 days, OR =12.0, 95% CI: 1.43 – 100.39, p =0.009. Patients who had mitral stenosis were 23 times more likely to have >30 days length of hospital stay, OR =23.11, 95% CI: 5.01 – 106.57, p<0.001.

Patients who had been classified as stage III- IV based on NYHA classification were 8 times more likely to have >30 days of hospital stay, OR =8.03, 95%CI:1.61 – 40.09, p =0.011.

Patients who presented with pulmonary hypertension were 7 times more likely to stay in the hospital >30 days compared to those without, OR= 6.98, 95%CI: 1.76 – 27.63, p =0.006) as shown in Table 7

Table 7: Factors associated with length of hospital stay among patients undergoing MVR at KNH

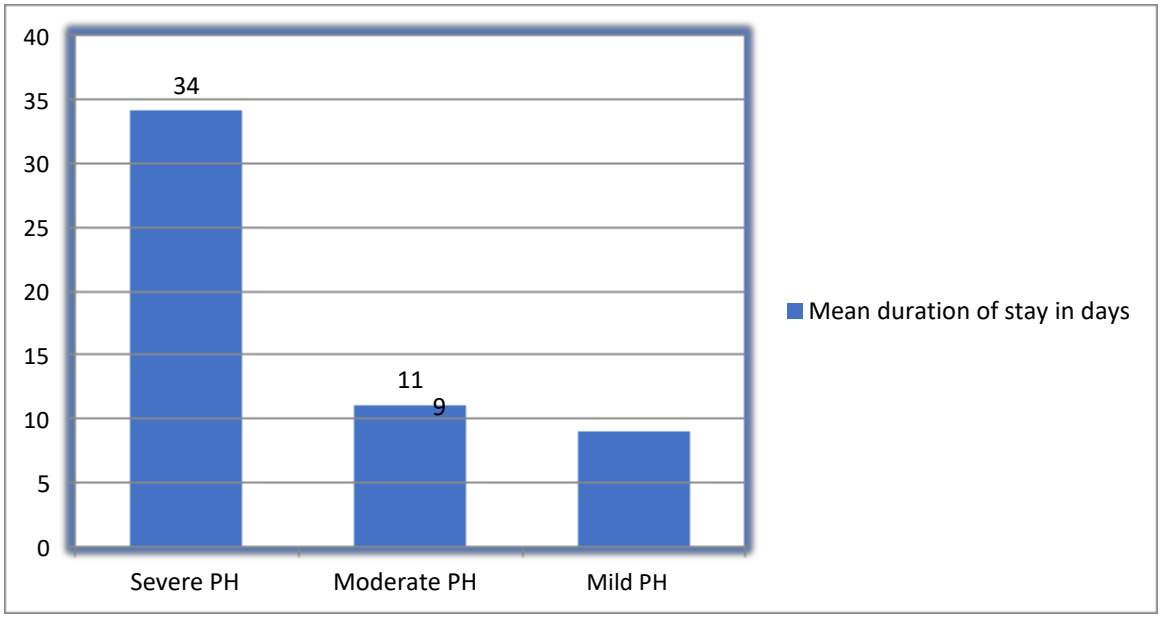
	Length of hospital stay			
Factors	**≤30 days n(%)**	**>30 days n(%)**	**OR(95%CI)**	**P-value**
Age				
<30 years	16(61.5)	10(38.5)	0.76(0.25 - 2.32)	0.777
≥30 years	19(67.9)	9(32.1)	Ref	
Gender				
Female	23(67.6)	11(32.4)	1.39(0.44 - 4.39)	0.769
Male	12(60)	8(40)	Ref	
Smoking history				
No	32(64)	18(36)	Ref	
Yes	3(75)	1(25)	0.59(0.06 - 6.13)	0.559
Alcohol history				
No	21(53.8)	18(46.2)	Ref	
Yes	14(93.3)	1(6.7)	12.0(1.43 - 100.39)	**0.009**
Mitral regurgitation				
No	4(50)	4(50)	Ref	
Yes	31(67.4)	15(32.6)	0.48(0.11 - 2.21)	0.431

Mitral stenosis				
No	3(18.8)	13(81.3)	Ref	
Yes	32(84.2)	6(15.8)	23.11(5.01 - 106.57)	**<0.001**
Aortic valve disease				
No	12(60.0)	8(40.0)	Ref	
Yes	23(67.6)	11(32.4)	0.72(0.23 - 2.26)	0.769
Rheumatic processes				
No	2(66.7)	1(33.3)	Ref	
Yes	33(64.7)	18(35.3)	1.09(0.009 - 12.87)	0.72
NYHA classification				
I-II	18(51.4)	17(48.6)	Ref	
III - IV	17(89.5)	2(10.5)	8.03(1.61 - 40.09)	**0.011**
Pulmonary hypertension				
Absent	4(30.8)	9(69.2)	Ref	
Present	31(75.6)	10(24.4)	6.98(1.76 - 27.63)	**0.006**

4.8 The mean hospital stay after MVR at Kenyatta National Hospital

The current study revealed that the mean hospital stay for patients with pulmonary hypertension was 35.4 days versus 31.6 days for those patients without pulmonary hypertension. Further broken down, the mean duration of hospital stay for those with severe PH was 34 days, 11 days for those with moderate PH and 9 days for those with mild pulmonary hypertension.

Table 8: Average duration of hospital stay following MVR at Kenyatta National Hospital



4.9 The in-hospital mortality rate of patients after MVR at Kenyatta National Hospital

In-hospital mortality rate after MVR was 9.3%, 95% CI: 3.1% - 20.3% as shown in Figure 3. All of the patients (100%) who died had pulmonary hypertension. None of the patients without pulmonary hypertension died following MVR. This finding shows that PH is associated with increased mortality following MVR.

Figure 3: In Hospital mortality after MVR at KNH

4.10 Severity of Pulmonary hypertension among patients who died

The findings established that most of the patients who died 60% (n =3) had severe PH while 40%(n =2) had moderate PH as shown in Figure 4.

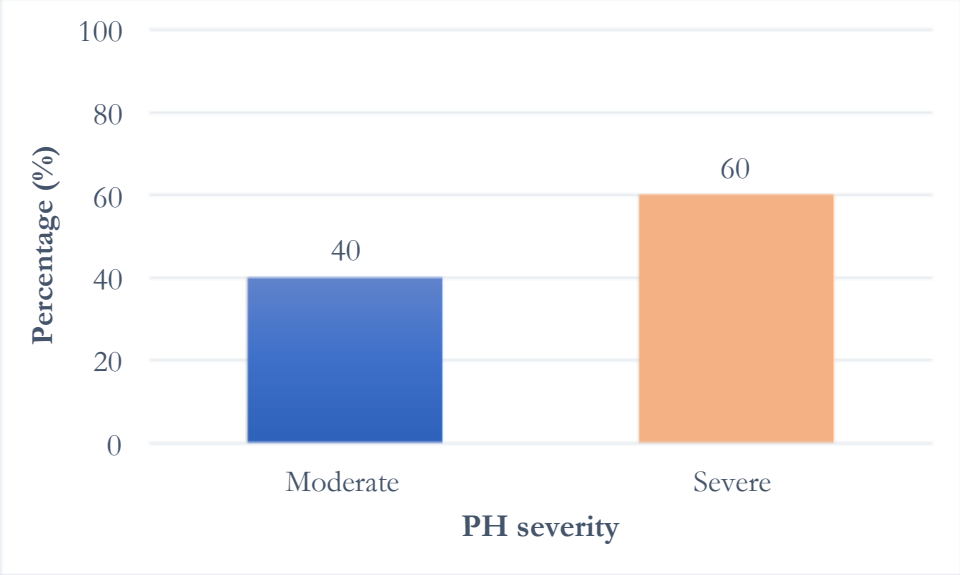


Figure 4: Severity of Pulmonary hypertension among patients who died

4.11 Factors associated with mortality among patients with pulmonary hypertension

The findings from binary regression established that among patients who had PH, those who had history of smoking were nine times more likely to die as compared to those without history of smoking (OR =8.71, 95%CI:2.11 – 38.11, p =0.012. Further those who had history of alcohol use were 14 times more likely to die as compared to those without history of alcohol use, (OR =14.0, 95%CI:1.37 – 143.59, p =0.020) as shown in Table 9.

Factors	Mortality	Alive	OR(95%CI)	P-value
Age				
<30 years	3(60.0)	16(44.4)	1.88(0.28 - 12.61)	0.649
>=30 years	2(40.0)	20(55.6)	Ref	
Gender				
Female	3(60)	28(77.8)	0.43(0.06 - 3.03)	0.58
Male	2(40.0)	8(22.2)	Ref	
Smoking history				
No	3(60)	35(97.2)	Ref	
Yes	2(40.0)	1(2.8)	8.71(2.11 - 38.11)	0.012
Alcohol use history				
Yes	4(80.0)	8(22.2)	14.0(1.37 - 143.59)	0.020
No	1(20)	28(77.8)	Ref	
Mitral regurgitation				
No	0	8(22.2)		
Yes	5(100)	28(77.8)		
Mitral stenosis				
No	0	8(22.2)		
Yes	5(100)	28(77.8)		
PH classification				
Moderate	2(40)	22(61.1)	Ref	
Severe	3(60)	14(38.9)	2.12(0.41 - 5.11)	0.412
NHYA				
III-IV	4(80)	24(66.7)	2.0(0.20 - 19.91)	0.486
I-II	1(20.0)	12(33.3)	Ref	
LOH				
≤30 days	5(100)	25(69.4)		
>30 days	0	11(30.6)		

CHAPTER 5: DISCUSSION

5.1 Characteristics of patients who underwent MVR

The study investigated the prevalence of pulmonary hypertension, duration of postoperative length of hospital stay, and in-hospital mortality after MVR. The present findings established that the median age of patients undergoing open heart surgery with Mitral Valve Prosthetic Replacement surgery was 31 years with more than half, 51.9% being aged 30 years and above. These findings however contrast those from Edwards et al. in a study conducted in the United Kingdom that was based on the UK Heart Valve Registry which revealed that the average age of patients who underwent first valve replacement open heart surgery was 58.7 years (range: 18-87 years) in 1986 and this rose to 64.7 years (range: 18-94 years) in 1997. (Edwards et al., 1999). This stark difference could be a result of the different disease burden and patterns. In Africa, for instance Rheumatic Heart Disease (RHD) is endemic (>0.15 deaths per 100,000 population) while it is classified as non-endemic in the developed world. (David A. Watkins, M.D, et al. 2017). The result of this is that RHD-related valve disease is the commonest indication for MVR in Africa, compared to degenerative valve disease for the developed world, where the UK is classified.

The findings from the current study also revealed that the majority (85.2%) of the patients had mitral regurgitation, 70.4% had mitral stenosis and 63% had aortic valve disease. The present findings were comparable to Nayana et al. who found that mitral regurgitation was the commonly occurring cardiac valve lesion, same as (Gomes et al., 2022).

These findings contrast those from Rudikyo et al. who found that isolated mitral stenosis was the most common valve lesion observed in this study (46.5%), followed by multiple valve lesions (aortic and mitral) (18.3%) and mixed mitral stenosis and regurgitation (17.7%) (Rudiktyo et al., 2022).

The present findings also established that most of the patients were classified as either class II or class III, 59.3% of the patients were classified as NYHA II while 31.5% were classified as NYHA class III.

These findings align with those from in the COAPT trial which found that the majority of the patients were classified as class II and class II NYHA where 52.5% were class III and 39.2% were class II (Giustino et al., 2020). The COAPT trial, a multicenter, randomized, controlled study was conducted in 78 study sites in the United States of America and Canada with a study population of 614 patients who had moderate to severe mitral regurgitation. The comparable finding of NYHA status in patients with mitral regurgitation in both Kenya and the US/Canada is reassuring considering that the GDP per capita of the US is 15 times that of Kenya ($60,200 v $4,200) as at 2020. This is reassuring that Kenya; a lower middle class country is at par with our developed sister countries and is on the right trajectory to improving our diagnostic capabilities.

Patients with more severe heart failure symptoms (higher NYHA functional class) may have a lower chance of success and a higher risk of adverse events after the procedure.

Healthcare providers need to consider the NYHA functional class when selecting patients for surgery and when counseling patients about their expected outcomes.

5.2 Prevalence of pulmonary hypertension among patients undergoing MVR

The present study showed that the prevalence of pulmonary hypertension among patients undergoing MVR was 75.9%. Further classification of PH revealed that 51.2% had severe PH, 26.8% had moderate and 22% had mild PH.

These findings are consistent with those from Walls et al. who found that 78% of patients undergoing mitral valve surgery had pulmonary hypertension (Walls et al., 2008). Awori et al (2018) found risk factor prevalence for pulmonary hypertension at 58.7% in a review conducted at KNH.

Similar findings were also found in a retrospective observational study in Pakistan by Farooq et al which found that 79.1% had PH although, in their population, 40.9% had moderate PH, 30.2% had severe while 8.8% had mild PH (Farooq et al., 2021).

5.3 Factors associated with PH

The findings from the present study established that female patients were more likely to have PH compared to male patients. These findings are comparable to those from Lakshmanan et al. in a study conducted in the United States which revealed that the overall prevalence of PH was higher among women than men (Lakshmanan et al., 2020). These findings have also been affirmed by Rodriguez-Arias & García-Álvarez who asserted the existing sex differences. They stated that PH includes a variety of diseases currently classified according to their etiology and hemodynamic profile.

Sex differences are observed in practically all groups of PH. The estrogen paradox in PAH refers to the fact that women present a higher risk of disease development but once affected, they present a better response to treatment and longer survival as compared to men,(Rodriguez-Arias & García-Álvarez, 2021)

The current study also established that patients who had mitral stenosis valve lesions were seven times more likely to have PH. These findings also align with those from Elliot and Palevsky who found that PH was a common complication of severe mitral valve disease (Elliott & Palevsky, 2004).

Pulmonary hypertension is a common complication of mitral stenosis, especially in patients who have severe narrowing of the valve or who have had the condition for a long time without treatment. The severity of pulmonary hypertension is usually assessed using echocardiography or right heart catheterization.

Length of hospital stay was also found to be significantly associated with pulmonary hypertension among patients who underwent MVR. Those who stayed in the hospital for 30 days or more were six times more likely to have PH.

A study by Murashita et al. identified that patients with pulmonary hypertension had a significantly longer hospital stay after MVR compared to patients without pulmonary hypertension.

The mean hospital stay was 15.2 days for patients with pulmonary hypertension versus 10.6 days for patients without pulmonary hypertension. The difference in hospital stay between these two groups was statistically significant (Murashita et al., 2015). The current study, on the other hand, revealed that the mean hospital stay for patients with pulmonary hypertension was 35.4 days versus 31.6 days for those patients without pulmonary hypertension. This reveals that on average, patients at our facility had a longer hospital stay following MVR, regardless of presence or absence of pulmonary hypertension.

Among patients with pulmonary hypertension, the study revealed that worsening pulmonary hypertension was associated with longer post-operative hospital stay; 34 days for severe, 11 days for moderate and 9 days for patients with mild PH.

5.4 Factors associated with length of hospital stay

The present findings revealed that patients who had a history of alcohol use were 12 times more likely to stay in the hospital for more than 30 days. These findings are comparable to those from Tønnesen who found that there is weak to moderate evidence of increased postoperative mortality, hospital stay, and re-operation (Tønnesen, 2003). The findings also revealed that those who had mitral stenosis were 23 times more likely to stay in the hospital for more than 30 days.

This is mainly because a majority of patients who had mitral stenosis presented with PH which was associated with an increased length of hospital stay. The present finding revealed that patients who had PH were seven times more likely to stay for more than 30 days. These findings align with those from Murashita et al. who found that those who had PH stayed longer in the hospital (Murashita et al., 2015). Thus, the longer hospital stay in patients with pulmonary hypertension may be related to the severity of the disease, the need for more intensive monitoring and treatment, and the increased risk of postoperative complications. Therefore, the presence of pulmonary hypertension should be carefully evaluated and managed in patients undergoing MVR, as it can impact both clinical outcomes and healthcare resource utilization.

Further, this current study established that those who were classified as III-IV using New York Heart Association were 8 times more likely to stay in the hospital for more than 30 days.

This is mainly because these patients were presenting with more advanced disease. These findings are comparable to those from Silaschi et al. who found that those who presented with NYHA class III and class IV were more likely to have adverse outcomes including longer duration of hospital stay (Silaschi et al., 2016).

The length of hospital stay after MVR can depend on various factors, including the patient's age, overall health status, the severity of the mitral valve disease, and the presence of any complications after the surgery (Moreira et al., 2021).

In general, patients with a higher NYHA class (III or IV) before MVR may have a longer hospital stay due to their more severe heart failure symptoms and potentially higher risk of complications after surgery. However, individual patient factors may also play a significant role in determining the length of hospital stay.

5.5 The in-hospital mortality rate of patients after MVR at Kenyatta National Hospital

The present study established that the in-hospital mortality rate of patients after MVR was 9.3% 95% CI: 3.1% - 20.3%. All of these patients had PH. These findings were comparable to a nationwide cohort study conducted in South Korea by Nam et al. which found that in-hospital mortality after MVR was 9.3% from a population of 5084 between 2009 and 2016 (Nam et al., 2022).

This finding reveals that outcomes after MVR at our facility are similar when compared to similar volume centers in a developed country such as South Korea. This is profoundly reassuring that surgical outcomes at the KNH after MVR are comparable to other world class centers.

Similarly, another study in Brazil also found comparable findings which established that the overall in-hospital mortality was 11% (Fernandes et al., 2014).

These findings, however, were higher compared to findings from a retrospective study in Brazil by Moreira et al. who found that the overall mortality rate was 6.7% with cardiogenic shock causing 36.4% of the deaths, strokes causing 18.2% of deaths and one death was caused by chagasic cardiomyopathy (Moreira et al., 2021).

The findings have established that the in-hospital mortality rate of patients after Mitral Valve Replacement (MVR) can vary depending on various factors such as age, the overall health of the patient, the severity of the condition, and any underlying health conditions.

In general, MVR is a relatively safe procedure, and the mortality rate is relatively low. It is important to note that the success of MVR not only depends on the surgical procedure but also the management of the patient post-surgery. Appropriate follow-up care, including medication management, lifestyle modifications, and regular check-ups, can significantly impact the long-term outcomes of MVR (Moreira et al., 2021) (Murashita et al., 2015).

5.6 Characteristics of patients with pulmonary hypertension who died following MVR

The present findings established that alcohol use and cigarette smoking were associated with increased likelihood of mortality among patients with pulmonary hypertension after MVR. These findings are consistent with those from Qing et al. (2018) who found that cigarette smoke contains numerous toxic chemicals and particulate matter that can have detrimental effects on pulmonary endothelial cells, which are the cells that line the interior surface of blood vessels in the lungs. Thus, these findings illustrate that alcohol use and cigarette smoking can have detrimental effects on various aspects of health, including cardiovascular health.

In the context of patients with pulmonary hypertension after mitral valve replacement (MVR), these behaviors have been associated with an increased likelihood of mortality.

The present study did not find any association between severity of PH and mortality. The combination of underlying PH and the stresses associated with surgery can increase the risk of complications and mortality. Awori et al. (2018) in a validation study aimed at validating the Euroscore tool on cardiac surgery patients in Nairobi arrived at a similar conclusion where pulmonary hypertension was not a risk factor for operative mortality. In that study, only double valve replacement was a risk factor for operative mortality.

The findings from the present study did not find any association between NYHA classification and mortality. These findings however contrast those from Collins et al. (2022) who found that patients who were classified as III or IV were more likely to have adverse complications including mortality. The NYHA classification system is commonly used to assess the functional limitations and severity of symptoms in patients with heart disease, including PH. When patients with advanced PH undergo MVR, their already compromised cardiovascular system may struggle to cope with the stress of surgery and recovery. The surgery itself can be demanding, requiring general anesthesia and manipulation of the heart, which can pose challenges for individuals with severe PH (Moreira et al., 2021). Lack of association in the present study could be due to smaller sample size among patients with PH who died after MVR.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusion

The prevalence of pulmonary hypertension among patients undergoing MVR was high at 75.9%. Among those with PH, 51.2% of the patients had severe disease, 26.8% had moderate and 22% had mild disease.

Factors associated with pulmonary hypertension among patients undergoing MVR included female patients, patients presenting with mitral stenosis valve lesions and those who stayed in the hospital for more than 30 days.

Factors associated with longer hospital stay included a history of alcohol use, mitral stenosis, NYHA class III-IV, and pulmonary hypertension

The in-hospital mortality rate was high at 9.3%. All the patients (100%) who died had pulmonary hypertension. Alcohol use and cigarette smoking were significantly associated with increased likelihood of mortality among PH patients. Severity of PH and NYHA classification was not associated with mortality following MVR.

6.2 Recommendations

Before surgery, patients should undergo a thorough evaluation to determine the severity of PH. This includes a comprehensive physical examination, echocardiography, and right heart catheterization. This information will help guide the surgical approach and postoperative management.

Preoperative consent taking for patients with pulmonary hypertension planned for mitral valve replacement should be thorough and include the possibility of prolonged hospital stay.

Close monitoring of patients post-MVR procedure to mitigate the untoward complications of PH including the risk of developing pulmonary vasoconstriction (PH Crisis), arrhythmias, pulmonary thromboembolism, and RV failure. These complications, individually and collectively serve to increase the morbidity and mortality associated with PH.

This monitoring can include early post-operative echocardiography to assess ventricular function, tricuspid valve function, SPAP, LVEDd, ejection fraction, inotropic support, diuretic therapy, and right heart catheterization.

The use of pulmonary vasodilators, such as sildenafil (Hemang Gandhi et al 2014) or nitric oxide, may be beneficial in reducing PH.

Patients who have undergone MVR should receive regular outpatient follow-up care to monitor for the progression of PH or improvement thereof as well as related other complications.

A prospective study examining the topic of morbidity and mortality following open heart surgery with prosthetic mitral valve replacement is recommended to be conducted at Kenyatta National Hospital. This study will elucidate more risk factors and their impact on morbidity and mortality following mitral valve replacement.

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LIST OF APPENDICES

Appendix 1: Structured data tool

Study Title: OUTCOMES AFTER MITRAL VALVE REPLACEMENT IN PATIENTS WITH RHEUMATIC MITRAL VALVE DISEASE WITH PREOPERATIVE PULMONARY ARTERIAL HYPERTENSION AT KENYATTA NATIONAL HOSPITAL

	Questionnaire Serial Number		
1.	**Patient IP Number**		
2.	**Age**		
3.	**Sex**	**Male**	**Female**
4.	**County of origin**		
5.	**What was the patient' s date of admission**		
6.	**What was the patient's date of Surgery?**		
7.	**Does the patient have any smoking history?**	**Yes**	**No**
8.	**Does the patient have any alcohol use history?**	**Yes**	**No**
9.	**Was a PreoperativeYes ECHO done?**		**No**

10.	**If present, which Mitral Valve Disease was identified?**	**Mitral Regurgitation**	**Mitral Stenosis**

	What was the severity of the lesion in question 10 above? **i. Mild**		
	ii. Moderate		
	iii. Severe		
11.	**Was there any Aortic Valve Disease present on ECHO?**	**Yes**	**No**
	If Yes, Please specify the lesion identified		
12.	**Were there any other Cardiac lesions present?**		
13.	**Were there any Rheumatic processes present on the cardiac valves?**	**Yes**	**No**
14.	**Was there Pulmonary Hypertension according to the ECHO report?**	**Present**	**Absent**
15.	**If Pulmonary Hypertension was present, How was it classified? Tick as appropriate** **i) Mild**		

	ii) Moderate	
	iii) Severe	

	Did the patient have any Pre-existing illnesses, such as; Hypertension/Diabetes Mellitus/Thyroid Disease/Cancer	**Yes**	**No**
	If Yes, Please specify the illnesses present.	a…….. b……. c……. d…….	

17. What was the patient symptomatology at admission? Answer according to the New York Hear Association Grading. Tick as appropriate.

NYHA 1
NYHA 2
NYHA 3
NYHA 4

18.	**What was the exact Duration of ICU stay in days**	

19.	**What was the specific Duration of Endotracheal intubation in days**		
20.	**Did the patient have any reported re-intubation during ICU stay?**	**Yes**	**NO**
21.	**What was the patient's Date of discharge or Death?**		
22.	**What was the patient's total duration of hospital Stay before discharge or death? (days)**		
23.	**Did the patient require Dialysis following the surgery?**	Yes	**No**

Appendix 2: Letter to collaborating institution seeking permission to conduct study.

I, **Dr. Hassan M Ibrahim**, a post-graduate student in the University of Nairobi/Kenyatta National hospital Department of Surgery, Nairobi would like to seek consent from the Research and Administration department/Office of the Kenyatta National Hospital to Conduct a research study entitled, '**OUTCOMES FOLLOWING MITRAL VALVE REPLACEMENT IN PATIENTS WITH RHEUMATIC MITRAL VALVE DISEASE WITH PREOPERATIVE PULMONARY HYPERTENSION AT KENYATTA NATIONAL HOSPITAL'**

This study entails collecting data from patients' medical records for all the patients who underwent open heart surgery with mitral valve replacement at KNH during the period **1st January 2012 to December 31st 2021.**

No patient identifying information will be collected. Covid -19 prevention measures shall be **adhered to as per the hospital's recommendations.**

Result**s** of this study will be shared with the hospital management among other stakeholders to help improve local policies and guidelines on **Preoperative Consent Taking and Post-Operative Care Planning**

…….

Hospital representative

……

Principal Investigator

In case of any queries regarding this research please contact

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Research Review and Ethical approval

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Yours sincerely,

Hassan M Ibrahim