THIRTY DAY MORTALITY AND RELATED VARIABLES IN OPEN HEART PATIENTS AT THE KENYATTA NATIONAL HOSPITAL, NAIROBI

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ABSTRACT

Objective: To determine the thirty-day mortality of open-heart patients at the Kenyatta National Hospital in Nairobi from June 1973 to October 2000 and; to look at likely variables related to mortality.

Design: A retrospective analysis of data from the unit database. Data on this database were collected prospectively from September 1997 to the time of study. Data in respect of the period prior to this were collected retrospectively from patient files, ward and theatre records.

Setting: Kenyatta National Hospital (KNH), Nairobi.

Patients: A total of 563 open-heart patients operated at the KNH were included in the study.

Results: The thirty-day mortality rate calculated at 17.4% for the study period compared to a hospital mortality rate of 16.9%. Surgical repair for complex congenital pathology, surgery on patients with a left atrial (LA) dimension or a left ventricular end systolic dimension (LVESD) greater than 5 cm or/and a cross clamp time greater than 60 minutes all had a significantly greater risk of mortality on bivariate analysis. This is compared to surgery for simple hole in the heart, LA and LVESD dimensions less than 5cm and cross clamp times less than 60 minutes (p<0.05). The increased risk of mortality with these variables was 3.33, 3.95, 3.18 and 1.8 times greater than their counterparts, respectively. For patients having surgery for an acquired pathology, only a cross clamp time greater than 60 minutes and a left atrial size greater than 5cm were independent risk factors for thirty day mortality using logistic regression analysis. For patients having surgery for correction of a congenital defect, only a cross clamp time of more than 60 minutes was an independent predictor of mortality (p <0.05).

Conclusions: The higher mortality rate is amongst others, probably related to the late presentation of our patients for surgery when their myocardial function is below the optimum for surgery. There is a need to bring down the mortality through more stringent patient selection, preoperative preparation and reduction of surgical ischaemic times, however without depriving the patients in need of surgery.

INTRODUCTION

Operative mortality related to open heart surgery has continued to decline gradually since the first heart operation. This decline in mortality has arisen as a result of improvements in myocardial protection, improvements in surgical instruments and techniques as well as improvements in peri-operative care(1). It must, however, be noted this improvement has been slow in the last few years(2).

Today, the generally accepted thirty-day mortality varies depending on a wide number of factors and ranges from almost nil to approximately 30%. This mortality depends largely on the form the surgery takes and the patient selection(1-4). As the learning curve improves the rewards are expressed in the form of reduced mortality. However with this improved learning curve the frontiers of surgical exploration are expanded to include patients

with greater risks. Great strides have been made since the first heart operation as both older patients and neonatal (and foetal) surgery advances. These extremes introduce new parameters into the equation for mortality.

This study analyses the thirty-day mortality within the cardiothoracic unit of the KNH over the last 25 years. Of interest is the 30-day mortality rate and the variables associated with mortality and to determine which are independent predictors of 30-day mortality for our patients.

MATERIALS AND METHODS

This study is a retrospective review of the unit database of cardiac patients who have had open-heart surgery at the Kenyatta National Hospital, Nairobi from the period 14th June 1973 to 3rd October 2000. The database was established in August 1997 and data relating to events before that period were collected retrospectively from patient files, the theatre register and the ward or ICU registers. From September 1997 onwards, for all

patients planned for open heart surgery, data were collected prospectively from the pre-operative period and continued till discharge from the post-operative outpatient clinic, death or loss to follow up.

Data retrieved from the database included all deaths occurring within thirty days from surgery and variables likely to be associated with these mortalities. All deaths beyond this period irrespective of where they occurred were excluded from the study. However, deaths occurring on the operating table were included. The other variables collected included amongst others, the types of surgery, age and gender of the patient. Details of various chamber dimensions and chamber volumes from the echocardiogram data, the necessity of re-exploration for bleeding as well as the body surface area (BSA).

All the variables selected were initially analysed for mortality by bivariate analysis using the Chi square test. All variables found significant were further subjected to logistic regression analysis to determine which of the variables were independent predictors of risk for 30-day mortality.

A p-value of < 0.05 was considered to be significant for both tests. All data were analysed on computer using Statistical software version 4.3.

RESULTS

A total of 563 patients were included in the study. The mean age for the group was 18.7 years and the median age was 16.0 years (range: 3 months to 76 years). The male to female ratio for the sample was 1:0.958.

Ninety five hospital deaths occurred within this period (16.86%), out of which 13 were operating table deaths. The thirty-day mortality for the same period was 98 deaths (17.41%).

Forty three deaths were for patients having surgery for congenital pathology (out of 241). Similarly, there were 47, one and six deaths for valve replacement surgery, mitral valve repair and coronary artery bypass surgery, respectively. These latter deaths were out of a total of 296, four and seven patients, respectively. The occurrence of the mortality as per the type of surgery is illustrated in Table 1.
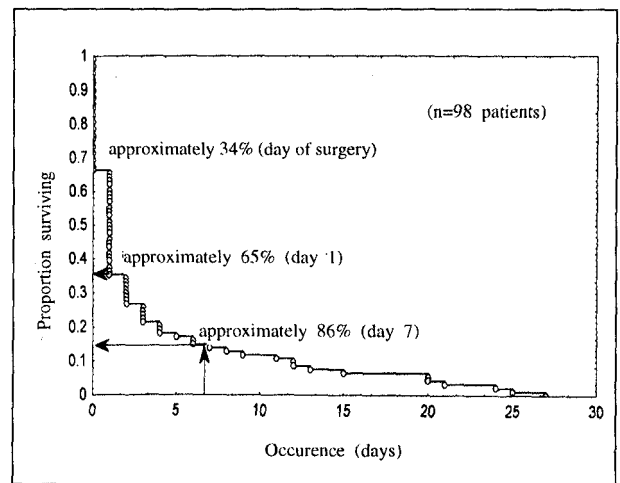
Table 1

Distribution of mortality within the different operative procedures

Procedure	Mortality	Total eligible population	%
Congenital surgery	43	241	17.84
Valve replacement	47	296	15.88
Mitral repair	1	4	25.00
CABG	6	7	85.71
Misc.	1	15	6.67

The occurence of mortality exhibits an initial rapid phase (with a high hazard function) followed with a gradual tapering off with time. This time related occurence of mortality is shown in Figure 1. Up to one third of the mortality occurred on the day of surgery (35%) while by 24 hours, 65% of the total mortality had occured.

Figure 1

Operative mortality occurence

The mortality figures were subjected to bivariate analysis (Chi-square test). Only four comparisons were found to be statistically significant (Table 2). Simple congenital surgery (ASD and VSD) with more complex congenital surgery as well as a left atrial size greater than 5cm had significant mortality differences on bivariate analysis. In addition a left ventricular end systolic dimension greater than 5cm had a significant difference to one less than 5cm. Cross-clamp times greater than 60 minutes were also found to have a statistically significant greater mortality.

Table 2

Bivariate analysis

Variable	Positive mortality	No mortality	χ^2 test (p value)	Odds ratio
Male:female	54:44	233:232	0.3687	
≤15 years:				
>15 years	44:51	221:237	0.7308	
Congenital:				
valve surgery	43:55	198:267	0.8136	
Simple congenital:				
complex congenital	30:13	172:25	0.0043	2.98
Single valve replacement:				
double valve replacement	41:6	214:35	0.8143	
BSA (≤1m²:>)	68:28	340:101	0.8484	
EF (≤40%:>)	25:3	139:8	0.2921	
LA size				
(≤5cm:>5 cm)	16:9	45:100	0.0015	3.95
LVESD				
≤5cm:>5cm)	7:20	14:127	0.0213	3.18
ESV				
(≤60 ml:>60 ml)	3:8	6:21	Fisher 0.5211	
X-clamp				
(≤60 min:>60 min)	22:64	157:254	0.0267	1.8
PHT				
(≤60mmHg:>60mmHg)	4:3	14:27	Fisher 0.5294	
Re-exploration for bleeding	5:9	10:455	0.0992	

The odds of mortality were 3.33 greater for complex congenital as compared to simple closure of a hole in the

heart. Likewise the risk of mortality were 3.95 times greater with a left atrial (LA) size greater than 5cm and 3.18 more with a left ventricular end systolic dimension (LVESD) of more than 5cm. The lowest increased risk was of 1.8 times with a cross-clamp time of greater than 60 minutes compared to less than 60 minutes. Subjecting these four variables to logistic regression analysis, the analysis was first performed for all patients irrespective of their surgery. Subsequent analysis followed for congenital and acquired surgery independently.

For all cases combined (563 patients), when subjected to regression analysis only two variables were found to be significant independent risk predictors for mortality in our patients, and these were left atrial size of more than 5cm and cross-clamp time greater than 60 minutes (Table 3a). In logistic regression analysis for acquired surgery, the same variables were independent predictors of 30-day mortality (Table 3b). However, for congenital surgery the only independent predictor of 30-day mortality is a cross clamp time greater than 60 minutes (p < 0.001).

Table 3a

Logistic regression analysis to determine independent predictors of mortality (all patients)

N=153 patients
Deaths = 24 (15.68%)   Survivors=129 (84.32%)
Casewise deletion of missing data
R=0.41331

Independent predictor	P value	Significance
Operation*	0.337658	N/S
X-clamp time	0.023468	Significant
LA size	0.000625	Significant
LVESD	0.716724	N/S

*All the different forms included in analysis and not just simple and complex congenital analysed

Table 3b

Logistic regression analysis to determine independent predictors of mortality (valve surgery only)

N=322
R=0.25213
Deaths = 55 (17.08%)   Survivors=267 (82.92%)
Substitution of missing data with means

Independent predictor	P value	Significance
Operation	0.962452	N/S
X-clamp time	0.009257	Significant
LA size	0.000758	Significant
LVESD	0.10220	N/S

For congenital surgery the only significant variable on logistic regression analysis is the cross clamp time, p=0.000117

Sixty one patients out of 170 with data on LA size had an LA dimension of greater than 5cm, while 179 patients out of a total of 497 with cross clamp data had a time greater than 60 minutes. Only four patients had both a cross clamp time greater than 60 minutes and a left atrial

size of more than 5cm. Thus, approximately two thirds of our patients had one or other of the risk factors against them.

DISCUSSION

Operative mortality in the immediate post-operative stage is related to a number of well-known variables. Once selected for surgery patients need to be prepared to optimise their cardiac condition so as to enable them to withstand the surgical procedure with minimal morbidity or mortality.

In the international literature, the post-operative mortality for open-heart patients varies greatly from almost none to up to 30% for high risk operations like repair of post infarction ventricular septal defects(1-4). For relatively uncomplicated congenital and valve surgery, the mortality range from none to about five to ten per cent. We at the KNH therefore have a higher than normal mortality. What are some of the possible causes of this anomaly?

A large number of our patients present late for surgery. In aortic valve disease for example, where timing of surgery for aortic incompetence is critical, late presentation is associated with an increased risk of mortality of up to 20%(5,6). Late presentation is associated with deterioration in the myocardial function as exhibited by the ejection fraction, LVESD, NYHA functional class and increased pulmonary pressures, amongst others.

The occurence of mortality is classically exhibited with an early rapid phase and this gradually tapers off with time(7). This phenomenon is more prominent with valve replacement surgery and less for mitral valve repairs, ventricular septal defects and atrial septal defects. These latter tend to exhibit an almost constant hazard function from the day of surgery throughout their follow up period(1). A similar phenomenon of a high initial risk for death is exhibited in this study at the KNH. Up to 65% of the 30-day mortality occur within the first twenty four hours of surgery (Figure 1).

The most common cause of early mortality is low output failure and this accounts for over 50% of early deaths(2,8). In order to reduce the influence of the low output failure on mortality, it is important that in addition to the myocardium being in optimal preoperative condition it is protected appropriately perioperatively. Other causes include, the preoperative myocardial function on top of which is added the trauma of surgery. As the resulting physiological changes take time to equilibrate following surgery the immediate postoperative phase has a greater detrimental effect than the later phase.

As well as cardiac failure, there will be other factors having an influence on the surgical mortality. These include the patient age(8-10), extent of left ventricular enlargement(11) and left atrial size(12). In addition, pulmonary hypertension(13), the functional class (New York Heart Association class) of the patient(2) and the global myocardial ischaemic time during surgery will also have an influence.

The average age for the study group is 18 years, which is a relatively young age group. The influence of age on the operative mortality is more often noted in the two extremes of age. Older age at the time of surgery is probably related to the poor tolerance to trauma and increased risk of pulmonary complications. Similarly, in the young the tissues tend to be immature and as a result pulmonary conditions commonly occur in addition to total body fluid retention following bypass. This effect has been shown to affect both the thirty-day mortality as well as in the long-term survival of these patients(2,14,15).

In our study the patient age group is relatively young, and all other variables being constant would be better expected to tolerate trauma well. The bivariate analysis showed no increased risk of mortality with increased age (>15 years) for our patient group. Independent predictors of mortality in the elderly from other studies include age over 75 years, left ventricular failure, ECG rhythm anomalies, emergency surgery, prolonged respiratory support and re-exploration for tamponade(10).

Left ventricular enlargement expressed as the LVESD is one of the more commonly used factors that identify poor ventricular function. This is a well-known risk factor for early as well as delayed mortality and an end systolic dimension of 5.5cm is the upper limit of reversible ventricular dilatation beyond which myocardial damage is likely to occur(16). Patients with enlarged left ventricles in this study had a significantly increased risk of mortality by a factor of 3.18 times as opposed to less than 5cm dilatation. A high proportion of our patients (approximately 30%) are noted to have a left ventricular size greater than 5cm preoperatively. Impaired preoperative ventricular function is associated with postoperative low cardiac output, a significant cause of early mortality.

Enrique-Sarano *et al*(17) demonstrated that the preoperative ejection fraction (EF) and the left ventricular end systolic volume (LVESV) were independent predictors of mortality postoperatively for mitral valve patients(17). He and others have pointed out that end systolic volume is indeed a more useful index for evaluation of left ventricular dysfunction in patients with valvular regurgitation than ejection fraction, end diastolic volume or end diastolic pressure(18). In the present study, this variable was not found to be significant on bivariate analysis. This is probably as a result of the low number of valve patients with LVESV recorded and combined stenotic and regurgitant lesions in patients. Ejection fraction was also found not to be significant on Chi-square test.

Simple repairs of a hole in the heart have a 30-day mortality approaching zero in most centers around the world. However complex congenital surgery not surprisingly is associated with a greater mortality. This finding has been documented to be associated in part with the complexity of the anatomy (and physiology) and also the more perfect myocardial protection required for these patients(1). Patients undergoing complex congenital repairs show a similar high hazard function as the valve patients(19). This picture is mirrored in the patients for the KNH as complex congenital surgery shows an increased risk of mortality compared to simple closure of a hole in the heart.

For all the heart patients at KNH presenting for surgery, patients with increased LA size greater than 5cm, the patients having complex congenital surgery, LVESD greater than 5cm and cross clamp times greater than 60 minutes were identified as having an increased mortality on bivariate analysis. Increased LA size is a common occurrence with valvular lesions. This variable is an independent predictor of mortality for the patients operated at the Kenyatta National Hospital for acquired pathology. It has been documented that the increased LA size carries the same risk of mortality postoperatively as an elevated LVESD(12). The risk of mortality associated with increased LA size for our patients is slightly greater than that for LVESD as illustrated with the ODDS ratio (Table 2). However, unlike other studies our LVESD on multivariate analysis is not an independent predictor of mortality. Up to one third of the patients in our study group with data on LA size were noted to have left atria of greater than 5cm in diameter.

The other independent risk factor is a cross clamp time greater than 60 minutes. This is a reflection of the myocardial ischaemic time. Prolonged ischaemic times are associated with greater ischaemic damage of the myocardium and a poorer postoperative myocardial function. Prolonged cross clamp times therefore would be anticipated to be associated with increase myocardial damage and mortality postoperatively. Reduction in cross clamp times and improvements in myocardial protection are the only options to better results based on mortality-related to cross clamp times. This study was not able to look into all the variables influencing of 30-day mortality and crucial variables have been omitted. Factors like the socioeconomic status of our patients, operative numbers, peri-operative patient care, myocardial protection techniques among others, all have an influence the mortality figures.

In order to be able to assess all these additional variables and their impact on 30-day mortality, a well formulated prospective study will need to be initiated. In addition formulating a scoring system appropriate for our patients similar to the Parsonnete scoring system(20) would be an ideal so as to appropriately quantify the myocardial state of our preoperative patients.

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