Predictors of Short-Term Mortality after Heart Valve Surgery: A Single-Center Study; Retrospective analysis

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Research article

Keywords: Predictors, valve surgery, emergency surgery

DOI: https://doi.org/10.21203/rs.3.rs-23317/v1

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Abstract

Objective
To investigate predictors of short-term mortality after valve surgery at our center.

Methods
The study cohort included 346 patients who underwent different types of valve surgery, excluding redo and Bentall operations. All operations were performed through a median sternotomy using cardiopulmonary bypass.

Results
Mean patient age was 51.6 ± 16.1 years, and 51% were male. Approximately 21% had diabetes, and 44.6% were hypertensive. Aortic valve replacement (AVR) was performed in 125 patients (37%), mitral valve replacement (MVR) in 95 (28%), combined AVR and MVR in 42 (13%), AVR plus coronary artery bypass grafting (CABG) in 19 (6%), and MVR plus CABG in 32 (10%). Operative mortality was 5.8% ($n = 20$). In the bivariate-level analysis, older age, operation type, hypertension, emergency surgery, use of a biological valve in the aortic or mitral position, pump time greater than 120 minutes, and aortic clamp time greater than 60 minutes were significant predictors of 30-day mortality. Use of angiotensin-converting enzyme inhibitors, digoxin, beta-blockers, statins, and loop diuretics was associated with mortality. Older age, emergency/salvage surgery, use of beta-blockers for less than 1 month preoperatively, and use of a biological valve in the aortic position were significant and independent predictors of 30-day mortality.

Conclusion
Older age, emergency valve surgery, use of a biological valve, and use of beta-blockers for less than 1 month before surgery were all found to be independent predictors of mortality in patients undergoing valve surgery.

Introduction
Valvular heart disease, both stenosis and regurgitation, can cause a wide range of symptoms, including shortness of breath, chest pain, fatigue, syncopal attacks, and even sudden death. Surgical valve replacement is still the gold-standard treatment for symptomatic valve disease. In Jordan, similar to most developing countries, rheumatic valve disease is still the leading pathology, although the incidence is declining [1].
Several studies have evaluated predictors of mortality after valve replacement surgery [2–4]. In patients undergoing aortic or mitral valve surgery, older age, high creatinine, coronary artery disease and congestive heart failure (HF) were significant independent predictors of in-hospital mortality [3]. We have previously investigated predictors of mortality and morbidity following coronary artery bypass surgery (CABG) in the north of Jordan; these included older age, female sex, HF, prolonged inotropic support, increased left atrial size, and mitral regurgitation [5–7]. Valve surgery is associated with significant mortality; however, predictors have not yet been investigated in the Jordanian population.

In this study, we investigated preoperative, intraoperative, and postoperative predictors of mortality after valve replacement surgery in Jordanian patients.

**Patients And Methods**

**Patients**

From 2002 to 2017, 346 patients underwent isolated aortic valve replacement (AVR), isolated mitral valve replacement (MVR), AVR plus CABG, MVR plus CABG, or combined AVR and MVR with or without CABG at King Abdullah University Hospital (KAUH), located in the north of Jordan. Patients who had previous cardiac surgery and those with aortic dissection requiring aortic root replacement as well as valve repair were excluded, leaving a study cohort of 346 patients for analysis. Mean age was 51.6 ± 16.1 years, and 51% (n = 178) were male.

Clinical, echocardiographic, and surgical data from the electronic medical records of eligible patients were abstracted and reviewed. Prior use of medications was documented and stratified by duration of less than or more than one month. Short-term mortality was defined as all-cause mortality within 30 days after surgery. Preoperative coronary angiography was performed for patients with an indication and for those older than age 35. The study was approved by the Institute Research Board at KAUH and Jordan University of Science and Technology.

**Operative Procedure**

All patients had a median sternotomy, cardiopulmonary bypass, and ascending aortic cannulation. A two-stage venous cannula was used in patients undergoing AVR and bicaval cannulation in those undergoing MVR. In patients undergoing valve replacement plus CABG, distal anastomoses to the right coronary artery and circumflex artery were done using 7/0 continuous polypropylene sutures. This was followed by valve replacement and left internal thoracic artery to left anterior descending anastomoses. AVR was performed through a transverse incision in the proximal ascending aorta about 1.5 cm distal to the origin of the right coronary artery, while MVR was performed through an interatrial incision. Pledgeted polyester (2/0) interrupted sutures were used in both the aortic and mitral positions after excision of the valve cusps/leaflets and proper decalcification. Age 65 years was used as the cutoff for choosing a mechanical or biological valve.

**Statistical Analysis**
Data were analyzed using SPSS version 22. Categorical variables are summarized as frequencies and percentages and continuous variables as mean ± standard deviation. Distribution of independent variables for 30-day mortality is presented using $X^2$ or independent sample t-test, as appropriate. P-values for the bivariate analyses are reported. Independent variables that were significantly associated with mortality ($P < 0.05$) were entered in a backward conditional logistic regression model (entry at $P = 0.05$, removal at $P = 0.1$). Adjusted odds ratios (AOR) and P-values were reported. Alpha level was set at 0.05 for all analyses.

At the bivariate level, variables that were significantly associated with 30-day mortality were included in the logistic regression model. These included operation type, hypertension, emergency surgery, preoperative and intraoperative aortic balloon-pumping, type of aortic or mitral valve used, pump time, aortic clamp time, re-exploration, and prior use of medications, including aspirin, angiotensin-converting enzyme (ACE) inhibitors, digoxin, beta-blockers, statins, and loop diuretics.

**Results**

**Patient Characteristics**

Approximately 21% of patients had diabetes, 44.6% were hypertensive (Table 1), 31.6% had coronary artery disease, and 22.5% had HF. AVR was performed in 125 patients (37%), MVR in 95 (28%), combined AVR and MVR in 42 (13%), AVR plus CABG in 19 (6%), and MVR plus CABG in 32 (10%). Operative mortality was 5.8% ($n = 20$). Cause of death was multi-system organ failure in 10, sepsis in 6, stroke in 1, and undocumented in 3. Most patients were on standard medical therapy for treatment of comorbidities: aspirin (33.3%), clopidogrel bisulfate (16.2%), statins (25.2%), beta-blockers (35.4), ACE inhibitors (27.8%), and loop diuretics (48.5%).
Table 1

Represents demographic data, Pre- Intra- and Postoperative predictors of mortality. The results of the bivariate and multivariate analysis is presented as well.

|                      | Not dead | Dead | OR | P-value |
|----------------------|----------|------|----|---------|
|                      | Total    | n    | %  | n      | %  |     |
| Overall              | 346      | 326  | 94.20 | 20 | 5.80% | -- | -- |
| Age in years (mean (SD)) | 51.56 (16.1) | 50.7 (1601) | 65.6 (8.8) | 1.09 | 0.000 |
| Gender               | Females  | 168  | 94.6% | 9  | 5.4% | Ref | 0.462 |
|                      | Male     | 178  | 93.8% | 11 | 6.2% | 1.16 |
|                      | Total    | 346  | 94.2% | 20 | 5.8% |
| Operation type       | AVR      | 125  | 96.0% | 5  | 4.0% | Ref | 0.024 |
|                      | MVR      | 95   | 95.8% | 4  | 4.2% | 1.05 |
|                      | AVR + MVR| 42   | 100.0% | 1 | 0.0% | 1.12 |
|                      | AVR + CABG | 19  | 78.9% | 4  | 21.1% | 6.40 |
|                      | MVR + CABG | 32  | 87.5% | 4  | 12.5% | 3.43 |
|                      | Other    | 33   | 95.5% | 1  | 4.5% | 1.14 |
|                      | Total    | 335  | 94.6% | 18 | 5.4% |
| Stable Angina        | No       | 253  | 96.0% | 10 | 4.0% | Ref | 0.249 |
|                      | Yes      | 76   | 93.4% | 5  | 6.6% | 1.71 |
|                      | Total    | 329  | 95.4% | 15 | 4.6% |
| Histort of CAD       | No       | 225  | 94.7% | 12 | 5.3% | Ref | 0.246 |
|                      | Yes      | 104  | 97.1% | 3  | 2.9% | 0.53 |
|                      | Total    | 329  | 95.4% | 15 | 4.6% |

Data are presented as mean (SD) for continuous variables or percentages for categorical variables. AOR: adjusted odd ratio, AVR: aortic valve repair, MVR: mitral valve repair, CABG: coronary artery bypass surgery, CAD: coronary artery disease, MI: myocardial infarction, COPD: chronic obstructive pulmonary disease, PVD: peripheral vascular disease, AF: atrial fibillation, MR: mitral regurgitation, TR: tricuspid regurgitation, AR: aortic regurgitation, ER: emergency surgery, Pre op: pre-operative, Post op: post-operative, IABP: intra-aortic balloon pump, TIA: transient ischemic attach, POAF: post-operative atrial fibillation.
|                          | Not dead |        |        |        |       |       |
|--------------------------|----------|--------|--------|--------|-------|-------|
|                          | Total    | n      | %      | n      | %     | OR    | P-value |
| Recent MI                |          |        |        |        |       |       |
| No                       | 325      | 311    | 95.7%  | 14     | 4.3%  | Ref   | 0.311   |
| Yes                      | 8        | 7      | 87.5%  | 1      | 12.5% | 3.17  |         |
| Total                    | 333      | 318    | 95.5%  | 15     | 4.5%  |       |         |
| Ever Smoking             |          |        |        |        |       |       |
| No                       | 234      | 222    | 94.9%  | 12     | 5.1%  | Ref   | 0.339   |
| Yes                      | 93       | 90     | 96.8%  | 3      | 3.2%  | 0.62  |         |
| Total                    | 327      | 312    | 95.4%  | 15     | 4.6%  |       |         |
| COPD                     |          |        |        |        |       |       |
| No                       | 319      | 304    | 95.3%  | 15     | 4.7%  | Ref   | 0.494   |
| Yes                      | 15       | 15     | 100.0% | 0      | 0.0%  | 0.95  |         |
| Total                    | 334      | 319    | 95.5%  | 15     | 4.5%  |       |         |
| Hypertension             |          |        |        |        |       |       |
| No                       | 185      | 182    | 98.4%  | 3      | 1.6%  | Ref   | 0.005   |
| Yes                      | 149      | 137    | 91.9%  | 12     | 8.1%  | 5.31  |         |
| Total                    | 334      | 319    | 95.5%  | 15     | 4.5%  |       |         |
| Hyperlipidemia           |          |        |        |        |       |       |
| No                       | 276      | 264    | 95.7%  | 12     | 4.3%  | Ref   | 0.609   |
| Yes                      | 45       | 43     | 95.6%  | 2      | 4.4%  | 1.02  |         |
| Total                    | 321      | 307    | 95.6%  | 14     | 4.4%  |       |         |
| Diabtes                  |          |        |        |        |       |       |
| No                       | 259      | 248    | 95.8%  | 11     | 4.2%  | Ref   | 0.381   |
| Yes                      | 68       | 64     | 94.1%  | 4      | 5.9%  | 1.41  |         |
| Total                    | 327      | 312    | 95.4%  | 15     | 4.6%  |       |         |
| Orthopnia                |          |        |        |        |       |       |
| No                       | 255      | 244    | 95.7%  | 11     | 4.3%  | Ref   | 0.470   |
| Yes                      | 74       | 70     | 94.6%  | 4      | 5.4%  | 1.27  |         |
| Total                    | 329      | 314    | 95.4%  | 15     | 4.6%  |       |         |
| PVD                      |          |        |        |        |       |       |
| No                       | 314      | 301    | 95.9%  | 13     | 4.1%  | Ref   | 0.114   |

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|                        | Not dead       | Dead        | OR | P-value |
|------------------------|----------------|-------------|----|---------|
|                        | Total          | n           | %  | n       | %  |     |
| Yes                    | 13             | 11          | 84.6% | 2     | 15.4% | 4.21 |
| Total                  | 327            | 312         | 95.4% | 15    | 4.6%  |     |
| AF                     | No             | 273         | 260 | 95.2% | 13    | 4.8% | Ref 0.515 |
|                        | Yes            | 56          | 54  | 96.4% | 2     | 3.6% | 0.74 |
| Total                  | 329            | 314         | 95.4% | 15    | 4.6%  |     |
| Pre OP renal impairment| No             | 306         | 292 | 95.4% | 14    | 4.6% | Ref 0.418 |
|                        | Yes            | 11          | 10  | 90.9% | 1     | 9.1% | 2.09 |
| Total                  | 317            | 302         | 95.3% | 15    | 4.7%  |     |
| MR                     | No             | 141         | 133 | 94.3% | 8     | 5.7% | Ref 0.332 |
| Grage 1                | 60             | 56          | 93.3% | 4     | 6.7%  | 1.19 |
| Grage 2                | 55             | 55          | 100.0% | 0     | 0.0%  | 0.00 |
| Grage 3                | 40             | 39          | 97.5% | 1     | 2.5%  | 0.43 |
| Grage 4                | 25             | 23          | 92.0% | 2     | 8.0%  | 1.45 |
| Total                  | 321            | 306         | 95.3% | 15    | 4.7%  |     |
| TR                     | No             | 219         | 208 | 95.0% | 11    | 5.0% | Ref 0.153 |
| Grage 1                | 43             | 40          | 93.0% | 3     | 7.0%  | 1.42 |
| Grage 2                | 36             | 36          | 100.0% | 0     | 0.0%  | 0.00 |
| Grage 3                | 15             | 15          | 100.0% | 0     | 0.0%  | 0.00 |
| Grage 4                | 4              | 3           | 75.0% | 1     | 25.0% | 6.30 |

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|                   | Not dead |         | Dead |         | OR  | P-value |
|-------------------|----------|---------|------|---------|-----|---------|
|                   | Total    | n | %   | n | %   |       |         |
| Total             | 317      | 302 | 95.3% | 15 | 4.7% | Ref   | 0.126   |
| AR                | no       | 190 | 181 | 95.3% | 9   | 4.7% | Ref   | 0.126   |
|                   | Grage 1  | 55  | 51  | 92.7% | 4   | 7.3% | 1.58   |
|                   | Grade 2  | 42  | 40  | 95.2% | 2   | 4.8% | 1.01   |
|                   | Grade 3  | 25  | 25  | 100.0% | 0  | 0.0% | 0.00   |
|                   | Grade 4  | 34  | 29  | 85.3% | 5   | 14.7% | 3.47   |
| Total             | 346      | 326 | 94.2% | 20 | 5.8% |       |         |
| ER                | electiv e | 309 | 294 | 95.1% | 15 | 4.9% | Ref   | 0.041   |
|                   | urgent   | 16  | 13  | 81.3% | 3   | 18.8% | 4.52   |
| Total             | 325      | 307 | 94.5% | 18 | 5.5% |       |         |
| ASA               | No       | 212 | 206 | 97.2% | 6   | 2.8% | Ref   |         |
|                   | Yes      | 106 | 98  | 92.5% | 8   | 7.5% | 2.80   |
| Total             | 318      | 304 | 95.6% | 14 | 4.4% |       |         |
| Plavix            | No       | 273 | 263 | 96.3% | 10 | 3.7% | Ref   | 0.178   |
|                   | Discont inued 7 days or less | 53 | 49  | 92.5% | 4   | 7.5% | 2.15   |
| Total             | 326      | 312 | 95.7% | 14 | 4.3% |       |         |
| Warfarin          | No       | 239 | 229 | 95.8% | 10 | 4.2% | Ref   | 0.548   |
|                   | Yes      | 88  | 84  | 95.5% | 4   | 4.5% | 1.09   |
| Total             | 327      | 313 | 95.7% | 14 | 4.3% |       |         |

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| Drug                     | Total | n   | %   | n   | %   | OR | P-value |
|--------------------------|-------|-----|-----|-----|-----|----|---------|
| **ACE Inhibitors**       |       |     |     |     |     |    |         |
| No                       | 238   | 227 | 95.4% | 11  | 4.6% | Ref | 0.027   |
| less than a month        | 19    | 16  | 84.2% | 3   | 15.8% | 3.87 |         |
| More than a month        | 73    | 72  | 98.6% | 1   | 1.4% | 0.29 |         |
| **Digoxin**              |       |     |     |     |     |    |         |
| No                       | 211   | 201 | 95.3% | 10  | 4.7% | Ref | 0.008   |
| less than a month        | 15    | 12  | 80.0% | 3   | 20.0% | 5.03 |         |
| More than a month        | 100   | 98  | 98.0% | 2   | 2.0% | 0.41 |         |
| **Aldosterone antagonist** | 269   | 258 | 95.9% | 11  | 4.1% | Ref | 0.218   |
| less than a month        | 5     | 4   | 80.0% | 1   | 20.0% | 5.86 |         |
| More than a month        | 51    | 48  | 94.1% | 3   | 5.9% | 1.47 |         |
| **B Blockers**           |       |     |     |     |     |    |         |
| No                       | 212   | 207 | 97.6% | 5   | 2.4% | Ref | 0.000   |
| less than a month        | 32    | 26  | 81.3% | 6   | 18.8% | 9.55 |         |
| More than a month        | 84    | 81  | 96.4% | 3   | 3.6% | 1.53 |         |

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|                              | Not dead |        |        |        |        |
|------------------------------|----------|--------|--------|--------|--------|
|                              | Total n  | %      | n      | %      |        |
| Total                        | 328      | 314    | 14     | 4.3%   |        |
| Statins                      | No 246   | 237    | 9      | 3.7%   | Ref    | 0.036  |
|                              | less than a month 28 | 24 | 4 | 14.3% | 4.39 |
|                              | More than a month 55 | 53 | 2 | 3.6% | 0.99 |
| Total                        | 329      | 314    | 15     | 4.6%   |        |
| Loop_Diuretics               | No 151   | 143    | 8      | 5.3%   | Ref    | 0.003  |
|                              | less than a month 26 | 22 | 4 | 15.4% | 3.25 |
|                              | More than a month 152 | 150 | 2 | 1.3% | 0.24 |
| Total                        | 329      | 315    | 14     | 4.3%   |        |
| Pre Op IABP                  | No 310   | 299    | 11     | 3.5%   | Ref    | 0.000  |
|                              | Yes 1    | 0      | 1      | 100.0% | 0.04  |
| Total                        | 311      | 299    | 12     | 3.9%   |        |
| Type valve used              | Aortic   |        |        |        |        |
|                              | Mechanical 129 | 228 | 7 | 3.0% | Ref | 0.001 |
|                              | Biological 62 | 98 | 13 | 11.7% | 4.30 |
| Total                        | 191      | 326    | 20     | 5.8%   |        |
| Type valve                   | Mitral   |        |        |        |        |
|                              | Mechanical 120 | 214 | 8 | 3.6% | Ref | 0.029 |

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|                          | Not dead |       |       |       |       |
|--------------------------|----------|-------|-------|-------|-------|
|                          | Total    | n     | %     | n     | %     |       |
|                          |          |       |       |       |       |       |
| Biophysical              | 67       | 112   | 90.3% | 12    | 9.7%  | 2.90  |
| Total                    | 187      | 177   | 94.2% | 20    | 5.8%  |       |
| Pump time                |          |       |       |       |       |       |
| < 120 min                | 224      | 216   | 96.4% | 8     | 3.6%  | Ref   | 0.030 |
| > 120 min                | 56       | 53    | 89.9% | 6     | 10.2% | 3.05  |
| Total                    | 346      | 269   | 95.1% | 14    | 4.9%  |       |
| Aorta_Clamp              |          |       |       |       |       |       |
| No                       | 247      | 237   | 96.0% | 10    | 1.0%  | Ref   | 0.028 |
| Yes                      | 99       | 89    | 89.9% | 10    | 10.1% | 2.67  |
| Total                    | 346      | 326   | 94.2% | 20    | 5.8%  |       |
| Intra Op Transf.         |          |       |       |       |       |       |
| No                       | 258      | 246   | 95.3% | 12    | 4.7%  | Ref   | 0.687 |
| Yes                      | 58       | 56    | 96.6% | 2     | 3.4%  | 0.73  |
| Total                    | 316      | 302   | 95.6% | 14    | 4.4%  |       |
| Reexploration            |          |       |       |       |       |       |
| No                       | 312      | 299   | 95.8% | 13    | 4.2%  | Ref   | 0.070 |
| Yes                      | 10       | 8     | 80.0% | 2     | 20.0% | 5.75  |
| Total                    | 322      | 307   | 95.3% | 15    | 4.7%  |       |
| Prolonged support        |          |       |       |       |       |       |
| No                       | 266      | 256   | 96.2% | 10    | 3.8%  | Ref   | 0.180 |
| Yes                      | 52       | 48    | 92.3% | 4     | 7.7%  | 2.13  |
| Total                    | 318      | 304   | 95.6% | 14    | 4.4%  |       |
| Post Op Renal Failure    |          |       |       |       |       |       |
| No                       | 311      | 298   | 95.8% | 13    | 4.2%  | Ref   | 0.102 |
| Yes                      | 12       | 10    | 83.3% | 2     | 16.7% | 4.58  |
| Total                    | 323      | 308   | 95.4% | 15    | 4.6%  |       |

Data are presented as mean (SD) for continuous variables or percentages for categorical variables. AOR: adjusted odd ratio, AVR: aortic valve repair, MVR: mitral valve repair, CABG: coronary artery bypass surgery, CAD: coronary artery disease, MI: myocardial infarction, COPD: chronic obstructive pulmonary disease, PVD: peripheral vascular disease, AF: atrial fibrillation, MR: mitral regurgitation, TR: tricuspid regurgitation, AR: aortic regurgitation, ER: emergency surgery, Pre op: pre-operative, Post op: post-operative, IABP: intra-aortic balloon pump, TIA: transient ischemic attach, POAF: post-operative atrial fibrillation.
| Patients characteristics | OR    | P value |
|--------------------------|-------|---------|
| Age, yrs.                | 1.06  | 0.028   |
| Emergency surgery        | 7.12  | 0.034   |
| Use of B-blockers < one month | 8.59 | 0.006   |
| Use of B blockers > one month | 1.52 | 0.612   |
| Type of aortic valve Biologic | 7.09 | 0.007   |
| Type of mitral valve Biologic | 2.17 | 0.269   |

## Predictors of Mortality

Data are presented as mean (SD) for continuous variables or percentages for categorical variables. AOR: adjusted odd ratio, AVR: aortic valve repair, MVR: mitral valve repair, CABG: coronary artery bypass surgery, CAD: coronary artery disease, MI: myocardial infarction, COPD: chronic obstructive pulmonary disease, PVD: peripheral vascular disease, AF: atrial fibrillation, MR: mitral regurgitation, TR: tricuspid regurgitation, AR: aortic regurgitation, ER: emergency surgery, Pre op: pre-operative, Post op: post-operative, IABP: intra-aortic balloon pump, TIA: transient ischemic attack, POAF: post-operative atrial fibrillation.
Table 1 presents univariate and multivariate predictors of mortality 30 days after surgery. At the bivariate level, older age (P < 0.0001), operation type (P = 0.024), hypertension (P = 0.005), emergency/salvage surgery (P = 0.041), use of a biological valve in the aortic (P = 0.001) or mitral (P = 0.029) position, pump time greater than 120 minutes, and aortic clamp time greater than 60 minutes were significant predictors of 30-day mortality. Use of medications—ACE inhibitors (P = 0.027), digoxin (P = 0.008), beta-blockers (P < 0.001), statins (P = 0.036), and loop diuretics (P = 0.003)—was also associated with mortality.

We also used logistic regression to identify independent predictors of mortality, adjusting for other variables or potential confounders. Older patients (P = 0.028, AOR = 10.6), emergency/salvage surgery (P = 0.034, AOR = 7.12), use of beta-blockers for less than a month before surgery (P = 0.006, AOR = 8.59), and a biological valve in aortic position (P = 0.007, AOR = 7.09) were significant and independent predictors of 30-day mortality (Table 1).

**Discussion**

Valve replacement surgery is the second most commonly performed open heart surgery in Jordan, after CABG. However, independent predictors of mortality after valve operations have not been studied as widely as predictors after CABG. This paucity of data might be due to fewer valve operations being performed than CABG procedures; valve operations require more time and/or more centers to accumulate enough cases to draw conclusions. In addition, a wide range of valve procedures are performed, and the risk of mortality may vary with the type of procedure [8]. We have evaluated predictors of mortality and morbidity for patients undergoing CABG [5–7]. Predictors of mortality include age > 65 years, female sex, HF, left ventricular ejection fraction (LVEF) ≤ 35%, prolonged inotropic support, mechanical ventilation > 2 hours, postoperative pneumonia, and postoperative stroke, as well as enlarged left atrial size and mitral regurgitation [5–7]. Previous studies have identified predictors of mortality in different patient populations undergoing valve surgery. In those undergoing mitral valve replacement, postoperative higher creatinine, low cardiac output, small mitral valve size, and new-onset atrial fibrillation were significant independent predictors of morality [9].

Our study highlights important preoperative, intraoperative, and postoperative predictors that might increase risk of mortality in patients undergoing various types of valve surgery. Consistent with previous studies [3, 4], increased age was found to be a predictor of 30-day mortality in our study population. Older patients have multiple comorbidities with deterioration of organ function. In patients > 80 years old, emergency surgery and CABG were the most important predictors of early mortality after mitral valve surgery (both repair and replacement), with estimated mortality of 18% [10]. Similarly, in patients undergoing AVR, emergency surgery, atrial fibrillation, and older age were the strongest predictors of mortality [11]. Most of our cases were rheumatic in nature (89%). This usually starts at a young age, and over time patients develop progressive deterioration in left ventricular function. Left ventricular dysfunction was shown to be a strong predictor of mortality after valve replacement surgery [1].
Emergency/salvage surgery was found to be an independent predictor of 30-day mortality, similar to other study results [10, 11, 7]. The pathologies that mandate emergency valve surgery, including acute mitral incompetence following acute myocardial infarction or acute valve incompetence secondary to infective endocarditis, put the patient in a state of acute HF, increasing the risk of death.

Patients who received biological valves were usually older than those who received mechanical valves. However, our model identified both age and biological valves as significant, yet independent, predictors of mortality after adjusting for other variables. In a sub-analysis in which we excluded age from the regression model, the effect of valve type was almost identical to that reported with age in the model, suggesting that 30-day mortality is affected by age independent of valve type and vice-versa.

Beta-blockers are key medications for treating HF, myocardial infarction, and atrial fibrillation and are useful adjuncts for hypertension. Beta-blockers can antagonize the effects of an overactive sympathetic nervous system, which is responsible for development and progression of HF. These medications reduce myocardial oxygen demand and improve LVEF in patients with HF [12] and control heart rate in patients with mitral stenosis [13].

Due to their negative inotropic and chronotropic effects, beta-blockers may initially worsen edema, hypotension, bradycardia, and LVEF before improvement is seen, but subsequent improvement often occurs after 6 to 12 months of therapy [14]. The incidence and severity of beta-blockers’ adverse effects are usually dose dependent [15]. Thus, patients should be clinically monitored and their dose titrated carefully to avoid adverse outcomes. Given the different effects of beta-blockers, increasing the dosage may cause unintended side effects and significant morbidity, particularly in patients with hypotension and bradycardia, without additional benefits [15].

In our study, most patients were on high doses of beta blockers. Interestingly, use of beta-blockers for less than 1 month before surgery increased the risk of mortality relative to that of non-users, suggesting that short-term use might worsen symptoms and increase mortality risk. To test this hypothesis, we evaluated the correlation between use of beta-blockers for less than 1 month and LVEF as well as presence of orthopnea and found a positive correlation. Current guidelines recommend beta-blocker therapy for patients with mild to moderate compensated HF, with stable New York Heart Association class II/III symptoms and on standard therapy for HF (diuretics and an ace inhibitor) [16]. Intriguingly, beta-blockers were found to increase risk of sudden cardiac death and need for surgery in patients with chronic, severe, non-ischemic MR [17].

Taylor et al. found postoperative atrial fibrillation (POAF) to be a predictor of mortality after valve replacement surgery [4], whereas AlWaqfi et al. found no relation [5]. Similarly, we did not find a correlation between POAF and mortality. This might be due to the low prevalence of POAF (12%) in our study.

Limitations
This is a retrospective study with a limited sample size and some missing data. Data were extracted from a single center, which may not represent short-term mortality in all centers in Jordan.

**Conclusion**

Age, emergency valve surgery, use of a biological valve, and use of beta-blockers for less than 1 month before surgery were all found to be independent predictors of mortality in patients undergoing valve surgery. Further prospective multicenter studies may be needed to provide a comprehensive assessment of mortality in patients undergoing valve surgery in Jordan.

**Abbreviations**

AVR  
Aortic Valve Replacement.  
MVR  
Mitral Valve Replacement  
CABG  
Coronary Artery Bypass Grafting  
HF  
Heart Failure  
AOR  
Adjusted Odds Ratio  
ACE  
Angiotensin Converting Enzyme  
LVEF  
Left Ventricular Ejection Fraction  
POAF  
Post Operative Atrial Fibrillation  

**Declarations**

- **Ethical Approval and Consent to participate:** The study was approved by the Institute Research Board at KAUH and Jordan University of Science and Technology.  
- **Consent for publication:** All authors gave consent to publish this article  
- **Availability of supporting data:** Any data needed is available upon request  
- **Competing interests:** No author has a conflict of interest with the material presented in this study.  
- **Funding:** This study did not receive any kind of funding  
- **Authors’ contributions:**
  - Substantial contributions to conception and design, data acquisition, or data analysis and interpretation: All Authors.
Drafting the article or critically revising it for important intellectual content: All Authors
Final approval of the version to be published: All Authors
Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of the work are appropriately investigated and resolved: Khalid Ibrahim.

Acknowledgements: Not applicable

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