Journal of Medicine in Scientific Research

Volume 3 | Issue 2 Article 11

Subject Area:

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Recommended Citation

Ali, Ahmed S. (2020) "Predictors of mortality in valvular infective endocarditis: A single-center study," *Journal of Medicine in Scientific Research*: Vol. 3: Iss. 2, Article 11.
DOI: https://doi.org/10.4103/JMISR.JMISR_47_20

Predictors of mortality in valvular infective endocarditis: a single-center study

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Abstract

Background

Valvular infective endocarditis (IE) may occur in association with either native or prosthetic valves, with great risk of mortality and morbidity. Surgical management is an essential part of the therapeutic process in these patients.

Objectives

This study aims at evaluation of early outcomes of surgically treated patients with native or prosthetic IE together with determining predictors of mortality.

Patients and methods

Outcomes of 60 patients who underwent surgery for native or prosthetic valve endocarditis at National Heart Institute during a 3-year period (April 2016 to March 2019) were studied prospectively. Preoperative, intraoperative, and postoperative data were tested as possible predictors for mortality. All patients were followed for at least 6 months after surgery.

Results

The hospital mortality rate was 11 (18.3%) patients, and total mortality rate after 6-month follow-up was 17 (28.3%) patients. Native valve endocarditis was present in 36 (60.0%) patients and prosthetic valve endocarditis in 24 (40.0%) patients. The commonest involved valve was mitral valve in 19 (31.7%) followed by aortic valve in 14 (23.3%). The commonest isolated organisms were *Staphylococcus* spp., which was found in 19 (31.6%) patients, followed by *Streptococcus* spp. and Gram negative bacteria, which were found in nine (15.0%) patients each. Mean Euro score II was 6.21 ± 2.54 in the surviving group. Duration of bypass time was 144.75 ± 35.81 min in dead patients and 104.56 ± 20.43 min in the surviving patients. Congestive heart failure, embolization, and periannular extension of infection were the most powerful predictors of in-hospital mortality. Periannular extension of infection was the most powerful predictor of 6-month mortality.

Conclusion

Surgery for IE is risky, especially in redo cases. Extensive infection carried the worst prognosis. Euro score II is a reliable indicator for hospital and early mortality. Valve repair can be performed in selected cases.

Keywords: Analysis, infective endocarditis, mortality predictors, surgical outcomes

Introduction

Infective endocarditis (IE) is a rare but serious complication, which carries a substantial risk for high morbidity and mortality. Recently, although there has been great advancement in diagnostic technologies and improvement in treatment modalities, yet the associated mortality and morbidity of this condition is still significant. To improve outcomes, early surgical intervention should be combined with aggressive long-term antibiotic therapy. This synergism has found to improve prognosis in the long term [1]. The incidence of prosthetic valve endocarditis (PVE) ranges between 1 and 6% of patients who underwent mechanical valve replacement and it represents 16–34% of whole endocarditis cases [2–4].

Access this article online	
Quick Response Code:	**Website:** www.jmsr.eg.net
	DOI: 10.4103/JMISR.JMISR_47_20

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Submitted: 04-Apr-2020 **Revised:** 04-Apr-2020 **Accepted:** 19-Apr-2020 **Published:** 24-Aug-2020

How to cite this article: Ali AS. Predictors of mortality in valvular infective endocarditis: a single-center study. J Med Sci Res 2020;3:150-6.

When it comes to complicated cases of PVE and according to the guidelines [5], surgical intervention is preferable, especially in the presence of prosthetic valve dysfunction, periannular involvement, or hemodynamic instability. However, different aspects of treatment strategies such as the suitable time of surgery and the role of conservative management are still controversial [6].

In severe cases with periannular affection, removal of all infected tissues is recommended to eradicate infection and prevent recurrence. The choice between mechanical and biological prosthesis should rely on clinical and individual bases as both valves have similar operative mortality, and extrinsic materials should be avoided as much as possible [7]. In persistent and recurrent cases where failure to eradicate infection takes place, cardiac transplantation should be reckoned [8].

Against this background, we reviewed our experience of surgically treated patients with native or PVE, analyzing early outcomes and determining independent predictors for early mortality.

Patients and methods

A single-center prospective observational study was carried out at National Heart Institute, Cairo, Egypt, during the period of April 2016 to March 2019. A total of 60 consecutive patients who underwent surgery for either native or PVE were evaluated for postoperative outcome and analyzed for predictors of mortality.

Identifying patients with IE depends on strict fulfillment of modified Duke's criteria in association with careful examination by IE team in our institute. The study was subjected to inclusion criteria, such as patients with native valve endocarditis, patients with PVE, involvement of mitral, aortic, or tricuspid valve either isolated or combined, and patients accepting to participate in the study, and exclusion criteria, such as patients experiencing irreversible septic shock with failed medical treatment, patients with severe neurological insult such as deep coma or intracranial hemorrhage, patients with severe comorbidities such as mycotic aneurysm, patients with poor ejection fraction (<30%), and patients refusing to participate in the study.

Before surgery, assessment of all patients was carried out, including full history taking and clinical examination, as well as identifying associated comorbidities such as diabetes mellitus, renal failure, chronic obstructive pulmonary disease, liver dysfunction, anemia, and intravenous addiction. Estimations of Euro score II, chest radiography, detailed echocardiographic assessment, and full laboratory investigation, including blood culture and sensitivity (three sequent blood cultures at least 1 h apart), together with identifying associated complications such as embolization (e.g., cerebrovascular accidents and peripheral), heart failure, and pericardial effusion, were done.

The timing of surgery was decided according to different factors, such as: hemodynamic stability of the patient, eradication of infection from blood (negative blood culture), and presence or absence of complication (e.g., embolization). During surgery, all infected tissues were excised to prevent recurrence. The excised tissue was sent for culture and sensitivity examination.

Postoperatively, assessments of duration of mechanical ventilation, inotropic support, and the development of complications, such as reopening, low cardiac output syndrome, neurological complications, arrhythmias, deep wound infection, and mortality, were taken in consideration. Laboratory workup, including serial total leukocyte count, C-reactive protein, repeated blood culture, and sensitivity to ensure complete eradication of infection, together with frequent echocardiographic assessment to detect cardiac function and reveal any relapse, was performed. All patients were subjected to 6-month follow-up after surgery.

Multidisciplinary approach

The IE team is the entrusted body dealing with patients with IE at our institute. It was established in 2012. The goal was to improve survival of patients with IE. It consists of two cardiologists, one microbiologist, one cardiac imaging specialist, one cardiac surgeon, and an IE specialist nurse coordinator. Fig. 1 summarizes the referral pathway of patients with suspected IE. In addition to that, an addiction team was founded and consisted of a specialized psychiatry unit to

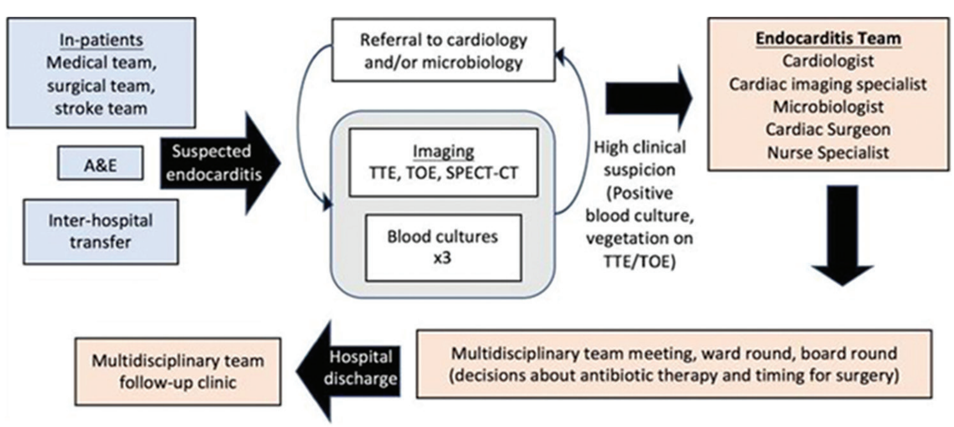

Figure 1: Infective endocarditis patient pathway.

manage patients who proved to be addicts. We believe that a coordinated IE/addiction team offers enormous potential to provide addictions care and harm reduction services for patients with IE who inject drugs.

Statistical analysis

Results were collected, tabulated, and statistically analyzed by IBM personal computer and statistical package for the social sciences, version 20 (IBM, SPSS inc, Chicago, United States). Two types of statistics were done as follows:

(1) Descriptive statistics: for example, percentage (%), mean, and SD.

(2) Analytic statistics:

(a) Student *t* test is a test of significance used for comparison between two groups having quantitative variables

(b) χ^2 was used to study association between two qualitative variables

(c) A *P* value of less than 0.05 was considered statistically significant.

Results

The in-hospital mortality rate was 11 (18.3%) patients. A total of nine patients were redo cases (prosthetic valve) and two patients were first do cases (native valve) (Table 5). Moreover, 36 (60.0%) of the involved valves were native, whereas 24 (40.0%) were prosthetic. The mitral and tricuspid valves were the most common sites for IE presented in 19 (31.7%) and 15 (25.0%) of patients respectively. The most common isolated organisms were *Staphylococcus* spp., which was found in 19 (31.6%) patients, followed by *Streptococcus* spp. and Gram negative bacteria, which were found in nine (15.0%) patients each (Table 1). The most common organism involved with the mitral valve was *Staphylococcus aureus* (six, 31.5%) whereas the commonest organisms involved with tricuspid valve were fungal infections (four, 26.6%). The relation between causative organism and the involved valves is detailed in Table 2.

The indications for surgical intervention were variable with congestive heart failure being the commonest and occurred in 38 (63.3%) of patients, followed by the presence of large vegetation (>10 mm in size) in 27 (45.0%) of patients. Fixed vegetations were found in 16 (26.7%) patients, whereas highly mobile vegetations were found in 24 (40.0%) patients. Abscess formation was seen in 12 (20.0%) patients, pseudoaneurysm in 11 (18.3%), and fistulae in two (3.3%), which were the commonest forms of periannular extension of infection. Other indications of surgery and echocardiographic findings are listed in Table 1.

Intraoperatively, the mean cardiopulmonary bypass time was 104.56 ± 20.43 in the surviving group (Table 5). A total of 17 (22.4%) patients underwent mitral valve replacement whereas two patients had mitral valve repair. Moreover, 12 (20.0%) patients had aortic valve replacement, whereas two (3.3%) patients had aortic root replacement; 11 (18.4%) patients had double valve replacement, whereas one (1.7%) patient underwent aortic valve replacement together with mitral valve repair; 10 (16.7%) had tricuspid valve replacement; and five (8.3%) patients had tricuspid valve repair. Detailed intraoperative procedures are listed in Table 3.

Postoperative fever was the most common complication after surgery, seen in six (10.0%) patients, followed by

Table 1: Indications of surgery and echocardiographic findings in patients with infective endocarditis

Indications	*n* (%)
CHF	38 (63.3)
Large vegetations	27 (45.0)
Uncontrolled infection	22 (36.6)
Prosthetic valve dysfunction	21 (35.0)
Recurrent emboli	10 (16.6)
Abscess	9 (15.0)
Pathological findings	
Type of valve	
Native valve	36 (60.0)
Prosthetic valve	24 (40.0)
Onset of prosthetic IE	
Early PVE (<1 year)	10 (41.7)
Late PVE (>1 year)	14 (58.3)
Site of IE	
Mitral valve	19 (31.7)
Aortic valve	14 (23.3)
Mitral and aortic valves	12 (20.0)
Tricuspid valve	15 (25.0)
Vegetations	
Fixed	16 (26.7)
Mobile	20 (33.3)
Highly mobile	24 (40.0)
Periannular extension of infection	
Abscess	12 (20.0)
Pseudoaneurysm	11 (18.3)
Fistula	2 (3.3)
Paravalvular leak	14 (23.3)
Causative organism	
Staphylococcus spp.	19 (31.6)
Staphylococcus aureus	16 (26.6)
Coagulase negative staph	3 (5.0)
Streptococcus spp.	9 (15.0)
Streptococcus viridans	8 (13.3)
Streptococcus pneumoniae	1 (1.7)
Enterococcus faecalis	2 (3.3)
Gram negative bacteria	9 (15.0)
Hacek	3 (5.0)
Escherichia. Coli	3 (5.0)
Klebsiella	2 (3.3)
Brucella	1 (1.7)
Fungi	5 (8.3)
Aspergillus	3 (5.0)
Candida albicans	2 (3.3)
Polymicrobial	2 (3.3)
No microorganism identified	14 (23.3)

* = Significant *P* value. *P* value < 0.05. CHF, congestive heart failure; IE, infective endocarditis; PVE, prosthetic valve endocarditis.

Table 2: Relation between causative organism and valve

	Mitral valve (n=19) [n (%)]	Aortic valve (n=14) [n (%)]	Double valves (n=12) [n (%)]	Tricuspid valve (n=15) [n (%)]
Staphylococcus aureus	6 (31.5)	4 (28.5)	3 (25.0)	3 (20.0)
Coagulase negative staph	1 (5.2)	1 (7.1)	1 (8.3)	0
Streptococcus viridans	3 (15.7)	2 (14.2)	1 (8.3)	2 (13.3)
Streptococcus pneumoniae	0	1 (7.1)	0	0
Enterococcus faecalis	0	1 (7.1)	0	1 (6.7)
Gram negative bacteria	3 (15.7)	2 (14.2)	3 (25.0)	1 (6.7)
Fungi	1 (5.2)	0	0	4 (26.6)
Polymicrobial	1 (5.2)	0	1 (8.3)	0
No microorganism identified	4 (21.1)	3 (21.4)	3 (25.0)	4 (26.6)

low cardiac output syndrome, renal impairment, and chest infection, seen in four (6.7%) patients each. The preoperative hospital stay was 18.35 ± 9.37 days, whereas postoperative hospital stay was 22.52 ± 14.06 days. The total hospital stay was 40.50 ± 17.42 days. On the contrary, cardiogenic shock was the most common cause of in-hospital mortality, seen in four (6.7%) patients, followed by systemic sepsis, seen in two (3.3%) patients. Other causes of hospital mortality and postoperative complications are listed in Table 3.

On analysis, seven variables were found to have statistical significance as predictors of in-hospital mortality (Table 4). Three operative and eight postoperative variables were found to have statistical significance as predictors of in-hospital mortality (Table 5). Six patients died during the follow-up period, yielding an overall 6-month mortality of 17 (28.3%) patients. Predictors of 6-month mortality using univariate analysis are listed in Table 5.

Discussion

The indications of surgical intervention and other valuable recommendations regarding prevention and treatment of IE are listed in guidelines published by the European Society of Cardiology in 2015 [9]. These guidelines were our cornerstone to determine the beginning of surgical management. In our study, intractable heart failure owing to severe valve regurgitation was the main cause that necessitated surgical intervention in both native and PVE (63.3%). This was similar to Rekik *et al.* [10] who noticed that the indication for surgical intervention in their study was mainly owing to severe valvular dysfunction with the subsequent uncompensated heart failure in 52.3% of patients.

In this study, PVE was found to be a significant predictor for increased in-hospital mortality among our patient's population, and nine of 11 patients who died after surgery were had PVE. This was analogous to other studies like David *et al.* [11] and Manne *et al.* [12] who noticed a similar trend of increased risk for early mortality between patients with PVE during their research.

Musci *et al.* [13] have pointed to the relation between abscess formation and the increased risk of postoperative mortality in their study. This was more or less similar to our study, as we found that periannular spread of infection was a major risk factor for early mortality postoperatively, and nearly two-third of our mortality cases experienced this condition. Moreover, fungal infections were found to be a significant predictor of in-hospital mortality, especially in tricuspid position, as three of five patients with this condition died postoperatively [13].

In the current study, Euro score II was used to predict and discriminate in-hospital and 6-month mortality within patients with IE who underwent surgical intervention. Other studies done by Di Dedda *et al.* [14] and Borracci *et al.* [15] have used the same score, as it showed a reliable ability to predict mortality among patients undergoing heart valve surgery.

It is well known that patients with renal impairment and high creatinine levels are at increased risk of postoperative mortality. Rekik *et al.* [10] have agreed this in their study. In our study, we followed a certain regimen in dealing with renal impaired patients trying to avoid fluid overload on one hand and maintaining high mean blood pressure during cardiopulmonary bypass on the other hand.

In a study done by Ohara *et al.* [16], they used C-reactive protein level as a univariate predictor of in-hospital mortality. They noticed a strong correlation between high levels of C-reactive protein and in-hospital mortality. Moreover, Heiro *et al.* [17] concluded that high CR*P* values (≥100 mg/l) at presentation strongly affect both short-term and 1-year mortality. This was consistent with our study, as mean values of CRP were almost doubled in the mortality group in comparison with the survival group. Of course, active infection during surgery is associated with fragile tissues, which increase the operative technical difficulty [16,17].

It is well known that eradication of infection before surgery is favorable and is associated with better postoperative outcomes. Hence, the majority of our patients were operated upon on elective or urgent basis (81.6%). Emergency surgery was limited to patients with hemodynamic instability despite high inotropic support either owing to sepsis or severe valve dysfunction with intractable congestive heart failure. It was not surprising that emergency surgery was considered as a significant univariate predictor of both in-hospital and 6-month mortality. In the same context, the study by Musci *et al.* [13]

Table 3: Operative procedures, types of implanted valves, causes of hospital mortality, and major postoperative complications and morbidities in patients with infective endocarditis

Operative procedures	*n* (%) (total=60)	Types of implanted valves
MV		
MVR	7 (11.7)	Mechanical (5), bioprosthetic (2)
MVR+TV repair	10 (16.7)	Mechanical (7), bioprosthetic (3)
MV repair+TV repair	2 (3.3)	–
AV		
AVR	12 (20.0)	Mechanical (11), bioprosthetic (1)
Aortic root surgery	2 (3.3)	Mechanical (2)
DV		
DVR	4 (6.7)	Mechanical (8)
DVR+TV repair	7 (11.7)	Mechanical (14)
AVR+MV repair	1 (1.7)	Mechanical (1)
TV		
TVR	10 (16.7)	Mechanical (1), bioprosthetic (9)
TV repair	5 (8.3)	–
Preoperative hospital stay (days) (mean±SD)	18.35±9.37	
Postoperative hospital stay (days) (mean±SD)	22.52±14.06	
Total hospital stay (days) (mean±SD)	40.50±17.42	
Causes of hospital mortality	11 (18.3)	
Cardiogenic shock	4 (6.7)	
Systemic sepsis	2 (3.3)	
Respiratory failure	1 (1.7)	
Renal failure	1 (1.7)	
Cerebral hemorrhage	1 (1.7)	
Failure of CBP weaning	2 (3.3)	
Postoperative complications		
Postoperative fever	6 (10.0)	
Low COP syndrome	4 (6.7)	
Re-exploration for bleeding	3 (5.0)	
CVA	2 (3.3)	
Renal impairment	4 (6.7)	
Chest infection	4 (6.7)	
Systemic sepsis	2 (3.3)	
Systemic embolization (rather than CNS)	1 (1.7)	
Recurrent endocarditis	1 (1.7)	

* = Significant *P* value. *P* value < 0.05. AV, aortic valve; AVR, aortic valve replacement; CNS, Central nervous system; COP, cardiac output; CVA, cerebrovascular accident; DV, double valve; DVR, double valve replacement; MV, mitral valve; MVR, mitral valve replacement; TV, tricuspid valve; TVR, tricuspid valve replacement.

was similar to ours in that emergency surgery was a significant predictor of in-hospital mortality.

The current study showed that redo surgery was a significant univariate predictor of in-hospital mortality. Of 11 in-hospital mortality cases, nine (81.8%) had PVE. This clarifies the high risk associated with these conditions. Furthermore, redo surgery increases the overall operative and cardiopulmonary bypass time, which itself was considered as a significant univariate predictor of in-hospital mortality. The prolonged cardiopulmonary bypass time may be referred to the increased time needed for dissection and prosthetic valve extraction. Klieverik *et al.* [18] and Nayak *et al.* [1] in their study noticed that bypass time and cross-clamp time were significant univariate predictors of 30-day mortality and long-term mortality.

In the current study, six (10.0%) patients experienced postoperative fever. The onset of fever started first day postoperatively in all patients. Moreover, two patients had hectic fever and the other four patients had a continuous fever. Of these six patients, four (36.3%) died during the hospital stay. Similar to our results, postoperative fever was found as a good predictor of mortality by Rostagno *et al.* [19].

In our study, three of the four patients who experienced postoperative chest infection passed away, with a mortality rate of 75%, and only one patient managed to survive during the ICU period. Chest infection is a serious complication, which may progress to respiratory failure, especially with prolonged ventilation. Smith *et al.* [20] have clarified that postoperative pulmonary complications may be considered as reliable predictors of postoperative mortality. Moreover, systemic sepsis, which is considered as a significant predictor of in-hospital mortality, was associated with 100% mortality, as all patients who experienced this condition postoperatively died. In their study, Sheikh *et al.* [21] have stated that postoperative sepsis was a good predictor of postoperative mortality.

In our study, postoperative low cardiac output was observed in four (6.7%) patients, and three (27.2%) of these patients died during the ICU period. The presence of low cardiac output increases the risk of postoperative mortality, defective tissue perfusion, and the prolonged need of inotropic support precipitate for organ ischemia, especially the kidneys, with the development of new-onset renal failure. We observed that the presence of a new renal impairment was a significant predictor of postoperative mortality. Overall, four (6.7%) patients had postoperative new renal impairment (serum creatinine >1.3 g/dl) in our study. Only one patient required hemodialysis. Two patients (of these four patients; 50%) died during the ICU period, where only one patient died of renal failure after hemodialysis, whereas the other one died of low cardiac output syndrome. Smith *et al.* [20] have stated that renal complications may be considered as a predictor of in-hospital mortality [22].

In this study, the period of mechanical ventilation, inotropic support more than 48 h, and duration of ICU stay were all significant univariate predictors of in-hospital mortality. This is similar to the study by Perrotta *et al.* [23], which stated that prolonged intubation together with the need of prolonged inotropic support were independent predictors of postoperative in-hospital mortality.

Table 4: Preoperative predictive variables for hospital mortality

	Hospital mortality (*n*=11)	Hospital survival (*n*=49)	*P*
Preoperative assessment			
Previous cardiac surgery	9 (81.8)	15 (30.6)	0.001*
Euro score II (mean±SD)	26.89±8.33	6.21±2.54	<0.001*
Pathological findings			
Periannular extension of infection	5 (45.4)	6 (12.2)	0.010*
Abscess	5 (45.4)	7 (14.2)	0.019*
Fungal infection	3 (27.3)	2 (4.1)	0.011*
Laboratory findings			
Serum creatinine (mg/dl) (mean±SD)	2.34±0.52	1.23±0.42	<0.001*
CRP (mg/l) (mean±SD)	100.45±38.21	59.77±15.13	<0.001*
Preoperative IE complications			
CHF	8 (72.7)	30 (61.2)	0.770
Embolization	3 (27.2)	7 (14.2)	0.296

*$P < 0.05$ is statistically significant. CHF, congestive heart failure; CRP, C-reactive protein; IE, infective endocarditis.

Our study showed that high white blood cell (WBC) count was a univariate predictor of 6-month mortality. The increased WBC count is usually associated with ongoing infection. The same finding was observed by Rostagno *et al.* [19], as they found that patients with WBCs beyond the normal values were at higher risk of mortality at both discharge and 6 months postoperatively. On the contrary, Heiro *et al.* [17] found that elevated WBC count did not predict in-hospital or 1-year mortality. However, other factors like extensive infection, high Euro score II, and elevated serum creatinine levels were found to be strong predictors of 6-month mortality in our study. Moreover, data analysis during the follow-up period revealed new six mortalities, yielding an overall 6-month mortality of 17 (28.3%) patients. An increased rate of recurrent infection may be owing to inadequate antibiotic treatment, resistant microorganisms, polymicrobial infection, empirical antimicrobial therapy for bacterial culture negative endocarditis, periannular extension, PVE, persistent metastatic foci of infection (abscesses), resistance to conventional antibiotic regimens, positive valve culture, persistence of fever at the seventh postoperative day, and chronic dialysis. Furthermore, recurrence of infection was observed in similar studies, such as that by Sheikh *et al.* [21].

Table 5: Operative and postoperative predictive variables and causes for 6-month mortality, in patients with infective endocarditis regarding surviving group after 6 months of follow-up

	Hospital mortality (*n*=11) [*n* (%)]	Hospital survival (*n*=49) [*n* (%)]	*P*
Timing of surgery			
Emergency	5 (45.4)	6 (12.2)	0.004*
Urgent	4 (36.3)	9 (18.3)	
Elective	2 (18.1)	34 (69.3)	
First do	2 (18.1)	15 (30.6)	0.001*
Redo	9 (81.8)	34 (69.4)	
Duration of bypass time (min) (mean±SD)	144.75±35.81	104.56±20.43	<0.001*
Postoperative complications			
Postoperative fever	4 (36.3)	2 (4.1)	0.001*
Low COP syndrome	3 (27.2)	1 (2.0)	0.002*
Renal impairment	3 (27.2)	1 (2.0)	0.002*
Chest infection	3 (27.2)	1 (2.0)	0.002*
Systemic sepsis	2 (18.1)	0	0.002*
Duration of mechanical ventilation (h)	256.92±83.19	23.47±5.29	<0.001*
Inotropic support			
No support	0	9 (18.4)	<0.001*
<48 h	2 (18.1)	29 (59.2)	
> 48 h	9 (81.8)	11 (22.4)	
Duration of ICU stay (days) (mean±SD)	8.33±3.23	4.58±2.98	<0.001*
	6-month mortality (*n*=6)	**6-month survival (*n*=43)**	***P***
Echocardiographic predictors			
Periannular extension of infection	3 (50.0)	3 (6.9)	0.002*
Abscess	4 (66.7)	3 (6.9)	<0.001*
Euro score II (mean±SD)	17.39±8.57	5.76±0.88	<0.001*
Laboratory predictors			
WBC count (10^3/μl) (mean±SD)	20.56±9.12	14.77±5.34	0.028*
Serum creatinine (mg/dl) (mean±SD)	2.62±1.23	1.54±0.42	<0.001*

*$P < 0.05$ is statistically significant. COP, cardiac output; WBC, white blood cell.

Conclusion

IE is a serious complication that carries a substantial risk of mortality and morbidity. Surgical management of this condition remains a challenging issue. Euro score II is a reliable parameter that has the ability to predict both in-hospital and 6-month mortality. Factors that influenced in-hospital mortality were prosthetic valve IE, periannular extension of infection, high serum creatinine, congestive heart failure, embolization, emergency surgery, prolonged cardiopulmonary bypass time, period of mechanical ventilation, inotropic support for more than 48 h, ICU stay, and postoperative complications. The observed predictors of in-hospital mortality were congestive heart failure, embolization, and periannular extension of infection.

Emergency surgery, increased serum creatinine levels, and periannular extension of infection were the most powerful risk factors influencing 6-month mortality in IE surgery. Valve repair can be considered in selected cases of IE.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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