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PERIOPERATIVE CHARACTERISTICS AND EARLY OUTCOMES OF SURGERY FOR INFECTIVE ENDOCARDITIS: A RETROSPECTIVE COHORT

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ABSTRACT

Background. Surgery for active infective endocarditis combines valvular destruction and extracardiac organ injury. Anesthesia and critical-care data from North Africa are scarce. We characterized perioperative management and early outcomes at a Moroccan tertiary center.

Methods. Retrospective single-center cohort, January 2023 to September 2025. Consecutive adults admitted to ICU after surgery for active infective endocarditis were included. Primary outcome was in-hospital mortality within 30 days after surgery; analyses were descriptive with Wilson 95% confidence intervals.

Results. Of 273 valvular surgical admissions, 20 underwent surgery for infective endocarditis (7.3%). Mean age was 44 years; 80% were men, 45% had rheumatic and 30% congenital heart disease, and Euro SCORE II was >5% in 40%. Blood cultures were positive in 55%. Vegetations were surgically confirmed in all patients and detected by preoperative transthoracic echocardiography in 19/20 (95%). Cerebral ischemic lesions were present preoperatively in 35%. Eighty per cent underwent urgent or emergency surgery after a mean of 21 days of antimicrobial therapy. Mean cardiopulmonary bypass and cross-clamp times were 86 ± 21 and 63 ± 12 minutes. All patients received noradrenaline plus dobutamine at bypass separation; two required rescue adrenaline. Anuric acute kidney injury occurred in 15%, new postoperative ischemic stroke in 10%, and in-hospital mortality within 30 days was 20% (4/20; 95% CI 8.1–41.6).

Conclusions. Surgically treated infective endocarditis involved young patients with substantial embolic burden and intensive hemodynamic support. The antimicrobial-to-surgery interval raises a hypothesis regarding delays along the diagnostic and referral pathway but does not identify their location.

Keywords: Infective Endocarditis; Valve Surgery; Cardiac Anesthesia; Intensive Care; Cardiopulmonary Bypass; Vasoactive Support; Morocco

1 INTRODUCTION

Infective endocarditis (IE) remains a severe cardiovascular infection with substantial early and late mortality despite advances in microbiology, multimodality imaging, antimicrobial therapy and cardiac surgery [1–6]. Its epidemiology is increasingly heterogeneous: older age, prosthetic material, intracardiac devices and health-care exposure predominate in many high-income settings, whereas rheumatic and congenital valve disease remain the principal substrates across much of the low- and middle-income world [4,5,7]. Diagnosis is now framed by the 2023 Duke–International Society for Cardiovascular Infectious Diseases (Duke-ISCVID) criteria, while the 2023 European Society of Cardiology (ESC) guideline emphasizes multidisciplinary management and timely surgery for heart failure, uncontrolled infection and prevention of embolism [2,3]. Once a surgical indication is established, delay permits further valvular destruction, embolization and clinical deterioration [2,8–10].

The perioperative period is uniquely demanding. Patients may reach the operating room with acute severe regurgitation, pulmonary oedema, cardiogenic or septic shock, renal dysfunction, cerebral embolism, coagulopathy or ongoing bacteremia. Cardiopulmonary bypass (CPB) superimposes inflammatory and hemostatic stress on an already activated systemic response, and separation from CPB is frequently complicated by ventricular dysfunction or vasoplegia [11–13]. Anesthesia, intraoperative echocardiography, surgical source control and postoperative critical care therefore form a continuous therapeutic pathway rather than isolated technical steps [8,11–13].

African perioperative data remain limited. A 2022 systematic review documented persistent rheumatic heart disease, low microbiological yield and in-hospital mortality exceeding 20% across the continent [7]. A recent cohort from northern Morocco reported a mean age of 46 years, a 59% culture-negative rate and 12.5% overall mortality, but only a minority of patients underwent surgery [14]. Detailed anesthetic and intensive-care data for surgically treated Moroccan patients are essentially absent from the literature. We therefore aimed to characterize the preoperative profile, operative risk, surgical indications and timing, anesthetic and CPB course, vasoactive requirements, postoperative complications and early mortality of surgically treated IE at a tertiary university center in Fez.

2 METHODS

2.1 Design, setting and population

This retrospective, single-center observational cohort study was conducted at Hassan II University Hospital, Fez, Morocco, over 32 months from January 2023 to September 2025. Data were extracted from the computerized clinical database and medical records of the services jointly involved in perioperative cardiac care: the multidisciplinary anesthesia–intensive care unit (ICU A1), cardiovascular surgery and cardiology. The study is reported in accordance with the STROBE statement [15]; the completed checklist is provided as Supplementary Material.

Eligible patients were consecutive adults admitted to ICU A1 immediately after cardiac surgery for active IE, including those in whom IE was identified intraoperatively on the basis of a previously unsuspected vegetation. Exclusion criteria were death in the operating room, absence of immediate postoperative ICU admission, cardiac surgery for an indication other than IE, and incomplete records. The cohort therefore represents surgically treated patients surviving to postoperative ICU admission and should not be read as an unselected population of all patients with IE or all surgical candidates. Patient selection is shown in Figure 1.

2.2 Definitions and diagnostic assessment

IE was diagnosed from the clinical, microbiological and echocardiographic findings documented in the records, and classified as definite or possible using the Duke criteria as recorded by the treating clinicians at the time of diagnosis [3]. Because the study period began in January 2023 and the Duke-ISCVID revision was published in mid-2023, the criteria applied in the source records were not uniform across the whole period, and cases were not re-adjudicated retrospectively. This distinction matters: the Duke-ISCVID framework counts direct intraoperative evidence of endocarditis as a major criterion, so postoperative reclassification would place nearly the entire cohort in the definite category and would not be comparable with the preoperative classification recorded here.

Echocardiographic variables comprised valve involvement, presence, size and mobility of vegetations, peri-valvular abscess, valve perforation, intracardiac fistula, chordal rupture, left ventricular dimensions and ejection fraction, and severe pulmonary hypertension. All patients underwent transthoracic echocardiography on admission; transesophageal echocardiography was not available during the study period. The presence of vegetations was subsequently confirmed in every patient by direct inspection of the valve at surgery, providing surgical confirmation of vegetation presence for descriptive comparison with preoperative transthoracic findings. Extracardiac extension was assessed by cerebral, thoracic, abdominal and vascular imaging according to clinical indication. Cardiac computed tomography, positron emission tomography and radiolabeled leucocyte scintigraphy were not available for this cohort.

2.3 Perioperative management

Anesthesia was balanced general anesthesia in all patients, combining a moderate-dose opioid (fentanyl 200–300 µg), propofol 80–200 mg, rocuronium 40–60 mg and, frequently, intravenous lidocaine 50–100 mg, with sevoflurane 1–2.5% for maintenance. In patients judged at risk of instability, catecholamine support was initiated before or during induction when clinically indicated. Monitoring included electrocardiography, invasive arterial pressure, central venous catheterization, temperature, urine output and serial blood gases, electrolytes and coagulation testing.

Postoperative care followed local protocols comprising restrictive crystalloid-based resuscitation guided by invasive monitoring and serial echocardiography, titrated vasoactive support, multimodal analgesia, early prophylactic-dose unfractionated heparin according to the institutional protocol, daily chest physiotherapy and continuation of pathogen-directed antimicrobial therapy. Per institutional protocol, patients who were extubated early and remained hemodynamically stable were transferred from the ICU to the cardiac surgery ward after 48 hours; patients requiring continued respiratory or hemodynamic support remained in the ICU until weaning was achieved. ICU length of stay therefore reflects a protocol-driven transfer threshold and is not directly comparable with series in which ICU discharge is determined solely by clinical readiness.

2.4 Variables, outcomes and analysis

Collected variables spanned the preoperative period (demographics, comorbidities and predisposing conditions, symptoms, New York Heart Association [NYHA] class, laboratory results, blood cultures, antimicrobial therapy and duration, echocardiography, extracardiac complications, EuroSCORE II [16], surgical indication and timing), the intraoperative period (procedures, operative, CPB and cross-clamp durations, hemodynamic events, vasoactive requirement, transfusion) and the postoperative period (admission hemodynamics and laboratory results, mechanical ventilation, catecholamine doses and durations, organ complications, transfusion, ICU and hospital stay, outcome).

Prolonged mechanical ventilation was defined as ventilation for more than 24 hours after ICU admission. ICU length of stay was defined as the interval from postoperative ICU admission to ICU discharge or death; total hospital stay comprised the ICU stay and the subsequent stay on the cardiac surgery ward. Acute kidney injury terminology followed KDIGO criteria [17]; because stage-by-stage analysis was not the focus of this small descriptive cohort, renal outcomes are reported as anuric acute kidney injury and requirement for renal replacement therapy.

The primary outcome was in-hospital mortality occurring within 30 days after surgery; secondary outcomes were perioperative morbidity, duration of mechanical ventilation, duration of vasoactive support and organ-support requirements. Given the retrospective design and small sample, analyses were descriptive and no multivariable modelling was undertaken. Categorical variables are reported as counts and percentages; continuous variables as means with observed ranges, with standard deviations given only where the underlying distribution supports them. For descriptive presentation only, EuroSCORE II values were grouped as 1–2%, 3–5% and >5%; these strata were not treated as validated risk categories. Wilson 95% confidence intervals (CI) were computed for the proportion of IE among valvular surgical admissions, for the TTE detection rate among surgically confirmed vegetations and for in-hospital mortality within 30 days after surgery. Percentages are based on the full cohort (N = 20) unless stated otherwise.

2.5 Ethics

The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of Hassan II University Hospital. It was based on retrospective review of medical records and a computerized clinical database, with no additional intervention or patient contact. The requirement for individual informed consent was waived by the Institutional Review Board because of the retrospective nature of the study.

3 RESULTS

3.1 Cohort, baseline characteristics and operative risk

During the 32-month period, 273 patients were admitted for valvular cardiac surgery and 20 were operated for active IE, corresponding to 7.3% of valvular surgical admissions (95% CI 4.8–11.0). No patient met an exclusion criterion (Figure 1).

Nineteen patients (95%) had native valve endocarditis; one (5%) had prosthetic valve endocarditis involving a mechanical mitral prosthesis. Mean age was 44 years (range 19–70), with the largest concentration in the fifth decade, and 16 patients (80%) were men. Rheumatic valve disease was documented in 9 patients (45%), four with combined aortic and mitral involvement, and congenital heart disease in 6 (30%). Two patients had chronic kidney disease, one on maintenance haemodialysis. No patient reported injection drug use or carried a cardiac implantable electronic

device. A portal of entry was identified in 8 patients, most often dental. Nineteen patients (95%) had exertional dyspnoea — NYHA class II in 3, class III in 6 and class IV in 10. Clinical heart failure was present in 16 (80%) and two patients presented in cardiogenic shock. A neurological deficit was found in 5 patients (25%) and cutaneous signs of IE in 3 (15%). C-reactive protein was raised in every patient. EuroSCORE II values were 1–2% in 5 patients (25%), 3–5% in 7 (35%) and >5% in 8 (40%). Baseline characteristics are detailed in Table 1.

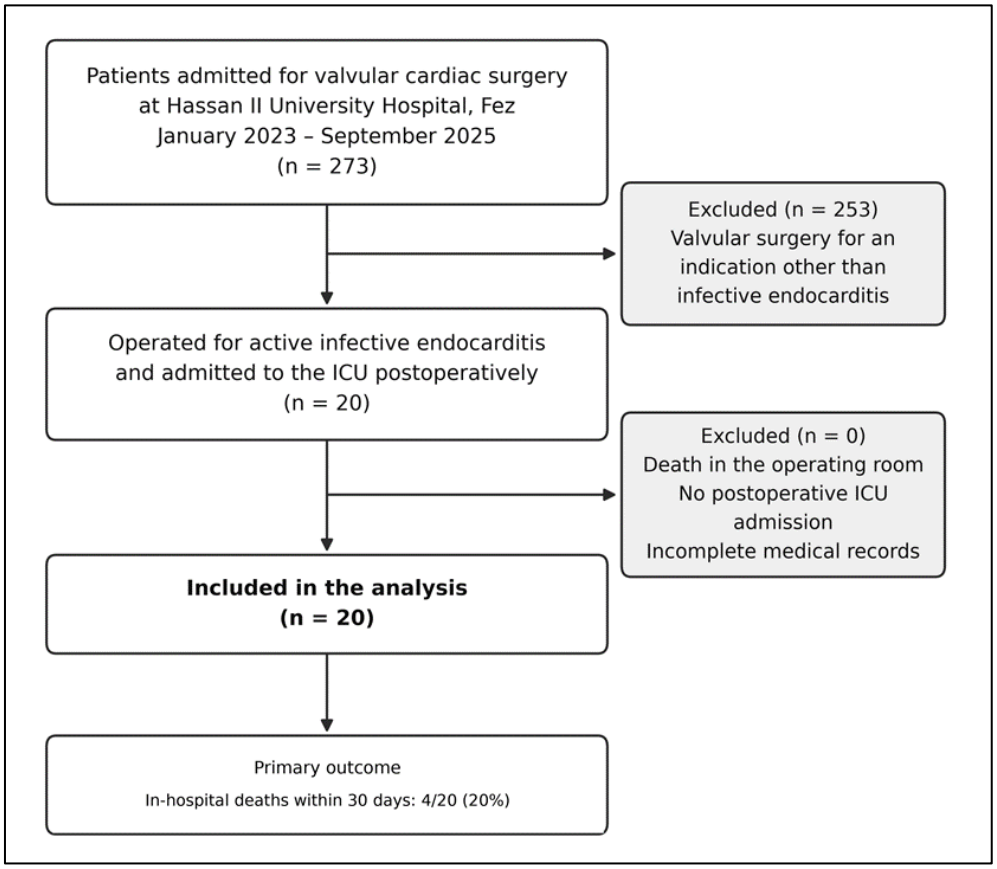

Figure 1: Patient selection (STROBE flow diagram). ICU, intensive care unit.

Figure 1 Patient selection (STROBE flow diagram). Of 273 patients admitted for valvular cardiac surgery at Hassan II University Hospital, Fez, between January 2023 and September 2025, 20 were operated for active infective endocarditis and admitted to the intensive care unit postoperatively. No patient met a pre-specified exclusion criterion. ICU, intensive care unit.

Table 1: Baseline characteristics, clinical presentation and preoperative risk profile (N = 20)

Variable	n	% or value
Type of endocarditis		
Native valve endocarditis	19	95%
Prosthetic valve endocarditis (mechanical, mitral)	1	5%
Demographics		
Age, years — mean (range)	—	44 (19–70)
Male sex	16	80%
Predisposing cardiac conditions		
Rheumatic valve disease	9	45%
Congenital heart disease	6	30%
Bicuspid aortic valve	4	20%

Patent ductus arteriosus	1	5%
Ventricular septal defect	1	5%
Degenerative valve disease	1	5%
Chronic kidney disease (1 on haemodialysis)	2	10%
Injection drug use / cardiac device	0	0%
Identified portal of entry	8	40%
Dental / urinary / cutaneous / catheter	3 / 2 / 2 / 1	15 / 10 / 10 / 5%
Clinical presentation		
Exertional dyspnoea	19	95%
NYHA class II / III / IV	3 / 6 / 10	15 / 30 / 50%
Clinical heart failure	16	80%
Cardiogenic shock on admission	2	10%
Neurological deficit on examination	5	25%
Cutaneous signs of IE	3	15%
Laboratory findings		
Anaemia — mean haemoglobin, g/dL	17	85%; 9.21 ± 1.14
Leucocytosis — mean count, /mm^3	15	75%; 12 471 ± 4 605
C-reactive protein, mg/L — mean ± SD	20	146 ± 58
Impaired renal function	7	35%
Creatinine clearance < 30 mL/min	2	10%
Preoperative EuroSCORE II distribution		
EuroSCORE II 1–2%	5	25%
EuroSCORE II 3–5%	7	35%
EuroSCORE II >5%	8	40%

IE, infective endocarditis; NYHA, New York Heart Association; SD, standard deviation

3.2 Microbiology

All patients had at least three sets of blood cultures drawn; cultures were positive in 11 (55%), yielding 12 isolates and therefore one polymicrobial case. *Streptococcus* spp. and *Staphylococcus* spp. predominated. Empirical therapy combined a beta-lactam, an anti-staphylococcal agent and an aminoglycoside, and was narrowed once susceptibility results were available. Four isolates were multidrug-resistant — two meticillin-resistant *Staphylococcus aureus*, one multidrug-resistant *Pseudomonas aeruginosa* and one multidrug-resistant *Escherichia coli* — and required directed therapy. In the nine culture-negative patients, broad-spectrum empirical therapy was continued under close clinical, biochemical and echocardiographic surveillance. Mean preoperative antimicrobial duration was 21 ± 14 days and mean total duration 34 ± 12 days. The diagnostic pathway and the distribution of isolates, including resistance status, are shown in Figure 2 and Table 2.

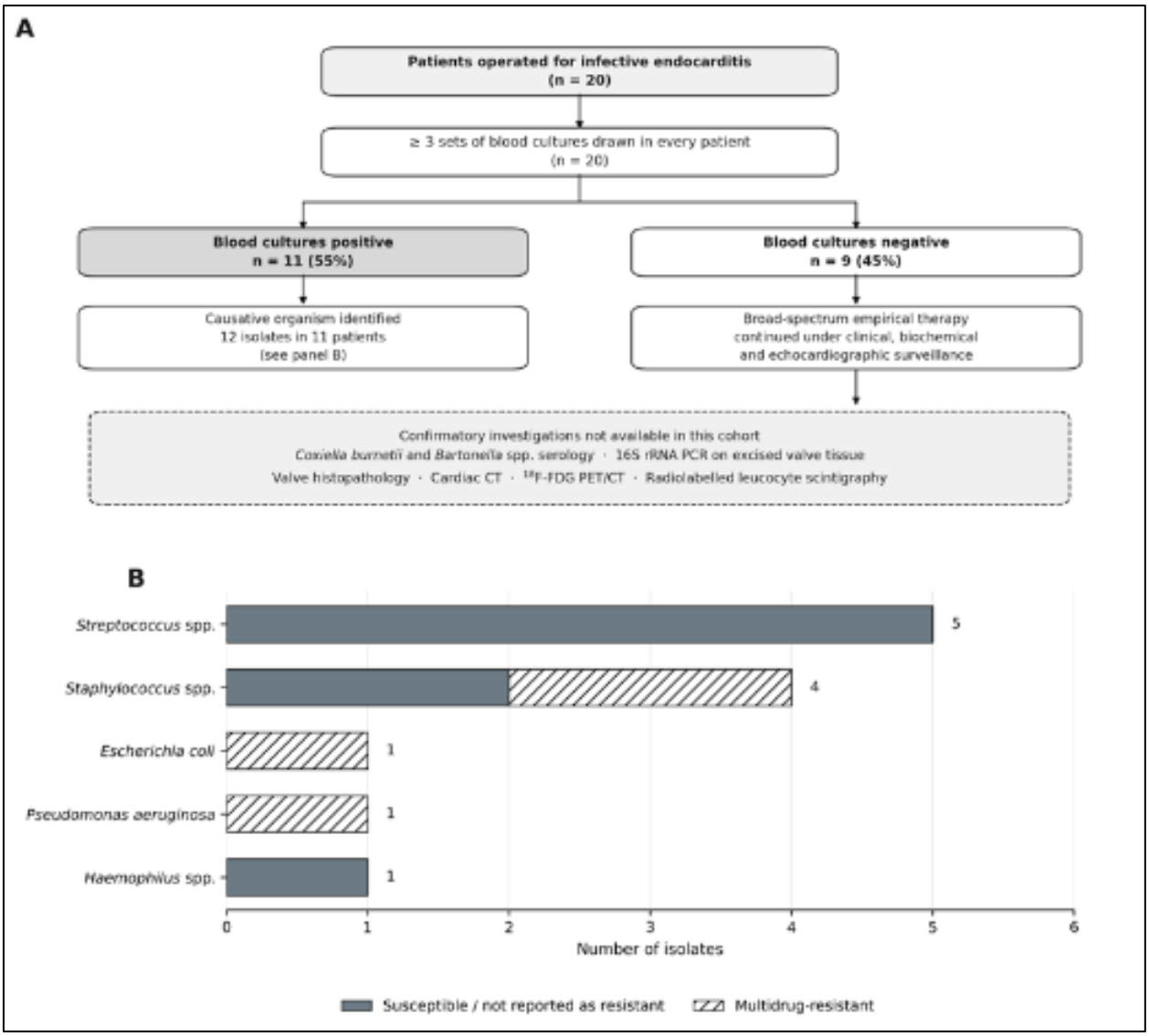

Figure 2: Microbiological diagnosis and distribution of isolates.

Figure 2 Microbiological diagnosis and distribution of isolates. (A) Diagnostic pathway. At least three sets of blood cultures were drawn in every patient; cultures were positive in 11 (55%) and negative in 9 (45%). The confirmatory investigations recommended for culture-negative endocarditis by the 2023 ESC guideline and the Duke-ISCVID criteria were not available at the centre during the study period. (B) Distribution of the 12 isolates recovered from the 11 patients with positive cultures; hatched segments denote multidrug-resistant organisms. Because 12 isolates were recovered from 11 patients, one case was polymicrobial. CT, computed tomography; ESC, European Society of Cardiology; FDG, fluorodeoxyglucose; PCR, polymerase chain reaction; PET, positron emission tomography; rRNA, ribosomal RNA.

3.3 Echocardiographic findings

Ten patients (50%) had single-valve involvement, 7 (35%) two valves and 3 (15%) three. Vegetations were present in all 20 patients, confirmed by direct inspection at surgery. Preoperative transthoracic echocardiography detected the surgically confirmed vegetation in 19 of 20 patients (95%; 95% CI 76.4–99.1); the single false negative occurred in the patient with a mechanical mitral prosthesis, in whom acoustic shadowing precluded assessment of the prosthesis and no transesophageal study was available. Vegetations were mitral in 8 patients, aortic in 7, both mitral and aortic in 4 and tricuspid in 1, and were mobile in 18 of the 19 visualized on transthoracic echocardiography. Mean vegetation size was 13 mm (range 7–28). A peri-annular abscess, invariably aortic, was found in 3 patients (15%) and valve perforation in 6 (30%), affecting the aortic cusps in half and the anterior mitral leaflet in half. An intracardiac fistula, a chordal rupture and an ascending aortic aneurysm were each observed once. The patient with a mechanical mitral prosthesis had a significant Para prosthetic leak with a trans prosthetic gradient of 22 mmHg. Findings are detailed in Table 2.

Table 2: Microbiological and echocardiographic findings (N = 20)

Variable	N	% or value
Microbiology		
Positive blood cultures	11	55%
Streptococcus spp.	5	25%
Staphylococcus spp.	4	20%
Escherichia coli / *P. aeruginosa* / *Haemophilus* spp.	1 / 1 / 1	5 / 5 / 5%
Culture-negative endocarditis	9	45%
Multidrug-resistant isolate	4	20%
— meticillin-resistant *S. aureus*	2	10%
— multidrug-resistant *P. aeruginosa*	1	5%
— multidrug-resistant *E. coli*	1	5%
Preoperative antimicrobial therapy, days	—	21 ± 14
Total antimicrobial therapy, days	—	34 ± 12
Valve involvement		
Single / two / three valves	10 / 7 / 3	50 / 35 / 15%
Aortic regurgitation	12	60%
Mitral regurgitation	9	45%
Tricuspid regurgitation	6	30%
Aortic / mitral stenosis	1 / 2	5 / 10%
Vegetation and destructive lesions		
Vegetation confirmed at surgery	20	100%
Vegetation visualised on preoperative TTE	19	95%
Mitral / aortic / both / tricuspid	8 / 7 / 4 / 1	40 / 35 / 20 / 5%
Mobile vegetation (of those visualised)	18	18/19 (94.7%)
Vegetation size, mm — mean (range)	—	13 (7–28)
Peri-annular abscess (aortic)	3	15%
Valve perforation	6	30%
Intracardiac fistula / chordal rupture	1 / 1	5 / 5%
Ventricular function and remodelling		
LV end-diastolic / end-systolic diameter, mm	—	63 ± 10 / 42 ± 10
LVEF < 50%	4	20%
Severe pulmonary hypertension	4	20%

LV, left ventricular; LVEF, left ventricular ejection fraction; TTE, transthoracic echocardiography.

3.4 Extracardiac extension

Cerebral imaging, performed in 16 patients (80%), demonstrated ischemic lesions in 35% of the cohort and intracranial hemorrhage in 5%. Vascular imaging, performed in 90%, identified cerebral mycotic aneurysms in 20% and septic emboli in 5%. Thoracic computed tomography in 6 patients revealed pulmonary embolism in two and a pulmonary abscess in one; abdominal imaging in 13 patients showed splenic or renal complications in 15% and a mesenteric mycotic aneurysm in one. One further patient had popliteal arterial embolism causing acute limb ischemia. Taken together, these findings indicate a substantial systemic embolic burden before surgery.

3.5 Surgical indication, timing and operative course

The leading operative indication was hemodynamic deterioration in 8 patients (40%), followed by high embolic risk in 6 (30%) and uncontrolled infection in 4 (20%); two further patients were operated for IE complicating an uncorrected congenital lesion. One patient (5%) underwent emergency surgery, 15 (75%) urgent surgery, 3 (15%) non-urgent surgery during the same admission after stabilisation, and 1 (5%) elective surgery after the index hospitalization. Preoperatively, 16 patients (80%) received heart failure therapy, 7 (35%) were transfused and 4 (20%) on direct oral anticoagulants were bridged to low-molecular-weight heparin.

All operations included wide debridement of infected tissue, with abscess drainage in 3 patients. Surgery was performed through median sternotomy with CPB and warm blood cardioplegia in 19 patients; one operation was performed on the beating heart. All 20 patients required positive inotropic or vasoactive support at separation from CPB. Intraoperative hemodynamic instability requiring escalation of vasoactive therapy occurred in 3 patients, bradycardia at separation from bypass managed with intermittent adrenaline boluses in 1, and atrial fibrillation requiring cardioversion in 1. Operative details are given in Table 3.

Table 3: Surgical indication, timing and intraoperative data (N = 20)

Variable	N	% or value
Indication for surgery		
Haemodynamic deterioration	8	40%
High embolic risk	6	30%
Uncontrolled infection	4	20%
IE on uncorrected congenital lesion	2	10%
Timing of surgery		
Emergency / urgent	1 / 15	5 / 75%
Non-urgent, same admission	3	15%
Elective, after index admission	1	5%
Procedures performed		
Debridement of infected tissue	20	100%
Peri-valvular abscess drainage	3	15%
Aortic valve replacement	6	30%
Mitral valve replacement	6	30%
Combined aortic and mitral replacement	5	25%
Tricuspid annuloplasty	6	30%
Congenital lesion repair	2	10%
Intraoperative course		
Median sternotomy with CPB	19	95%
Beating-heart procedure	1	5%
Operative duration, min — mean ± SD	—	240 ± 60
CPB duration, min — mean ± SD	—	86 ± 21
Aortic cross-clamp duration, min — mean ± SD	—	63 ± 12
Vasoactive/inotropic support at CPB separation	20	100%
Red cell transfusion	6	30%
Fresh frozen plasma	5	25%

CPB, cardiopulmonary bypass; IE, infective endocarditis; SD, standard deviation.

3.6 Postoperative course and vasoactive support

On ICU admission, mean heart rate was 83.7 ± 17.1 beats/min, mean systolic and diastolic arterial pressures 110.8 ± 16.9 and 64.8 ± 8.6 mmHg, mean urine output over 24 hours 1.48 ± 0.53 mL/kg/h, mean arterial pH 7.40 ± 0.07 and mean lactate 3.89 ± 2.87 mmol/L. Mean postoperative hemoglobin was 8.97 ± 1.42 g/dL and mean prothrombin activity 69 ± 15.6%.

Every patient received vasoactive or inotropic support from separation from cardiopulmonary bypass onwards, and noradrenaline and dobutamine were administered to all 20 patients as first-line agents. Adrenaline was reserved as rescue therapy for shock refractory to maximal doses of noradrenaline and dobutamine and was given as a continuous infusion in 2 patients (10%), for 48 and 96 hours respectively. One further patient received intermittent adrenaline boluses for bradycardia at separation from bypass without continuous infusion. Doses and durations are given in Table 4. Sixteen patients (80%) were successfully weaned from catecholamines, before the third to fifth postoperative day. Prophylactic-dose unfractionated heparin, according to the institutional protocol, was started within six hours in 18 patients (90%).

Thirteen patients (65%) were extubated a mean of 3.5 hours after ICU admission, in accordance with the institutional earl extubation protocol. The remaining 7 (35%) required prolonged mechanical ventilation (> 24 hours) because of delayed awakening after stroke, respiratory failure or shock, for up to 192 hours in the patient who died on the eighth postoperative day. Mean ICU length of stay was 3.1 ± 1.8 days (range 1–8), reflecting the 48-hour institutional transfer threshold in uncomplicated patients and prolonged stays in those requiring continued organ support, and mean total hospital stay was 9.6 days (range 1–36).

Table 4: Vasoactive and inotropic support from separation from cardiopulmonary bypass (N = 20)

Agent	n (%)	Mean dose, μg/kg/min	Duration, h
Noradrenaline	20 (100)	0.4 ± 0.22	30.0 ± 22.4 (range 1–96)
Dobutamine	20 (100)	6.11 ± 3.96	54.5 ± 43.8 (range 4–192)
Adrenaline (rescue)	2 (10)	0.9	48 and 96

SD, standard deviation. Noradrenaline and dobutamine were administered to all patients as first-line agents from separation from cardiopulmonary bypass. Adrenaline was used for shock refractory to maximal noradrenaline and dobutamine. Only two patients received continuous adrenaline, the two treatment durations are reported individually rather than as a mean with standard deviation. One further patient received intermittent adrenaline boluses for bradycardia at separation from bypass and is not included, as no continuous infusion was administered.

3.7 Complications and early outcome

Hemodynamic complications comprised cardiogenic shock in 3 patients (15%), hemorrhagic shock in 2 (10%), one requiring surgical re-exploration, and low cardiac output syndrome in 2 (10%). Three patients (15%) developed anuric acute kidney injury and 2 (10%) required renal replacement therapy. Respiratory, rhythm and neurological complications are detailed in Table 6.

In-hospital mortality within 30 days after surgery was 20% (4/20; 95% CI 8.1–41.6). Two patients died of refractory cardiogenic shock on the second and fourth postoperative days despite maximal noradrenaline, dobutamine and rescue adrenaline. A third died of cardiorespiratory arrest complicating severe acute respiratory distress within the same interval. The fourth improved initially and was weaned from catecholamines, then deteriorated with refractory cardiogenic shock and died at 196 hours despite re-escalation of vasoactive support (Table 5).

Table 5: Timing and mechanism of death among the four non-survivors

Patient	Time of death	Mechanism
A	Day 2	Refractory cardiogenic shock despite noradrenaline, dobutamine and rescue adrenaline
B	Day 4	Refractory cardiogenic shock despite noradrenaline, dobutamine and rescue adrenaline
C	Between day 2 and day 4	Cardiorespiratory arrest complicating severe acute respiratory distress

D	Day 8	Deterioration with refractory cardiogenic shock after initial improvement and weaning from catecholamines, requiring re-escalation of vasoactive support

Table 6: Postoperative complications and early outcomes (N = 20)

Variable	N	% or value
Haemodynamic		
Cardiogenic shock	3	15%
Haemorrhagic shock (1 re-exploration)	2	10%
Low cardiac output syndrome	2	10%
Hypertensive episode	5	25%
Renal		
Anuric acute kidney injury	3	15%
Renal replacement therapy	2	10%
Respiratory		
Pleural effusion (2 drained)	3	15%
Pneumothorax requiring drainage	2	10%
Atelectasis	2	10%
Prolonged mechanical ventilation (> 24 h)	7	35%
Rhythm, conduction and neurological		
New atrial fibrillation	2	10%
Ventricular tachycardia	1	5%
First-degree atrioventricular block	1	5%
New postoperative ischaemic stroke	2	10%
Delayed awakening	1	5%
Infectious and outcome		
Documented postoperative infection	1	5%
ICU length of stay, days — mean ± SD (range)	—	3.1 ± 1.8 (1–8)
Hospital length of stay, days — mean (range)	—	9.6 (1–36)
In-hospital mortality within 30 days after surgery	4	20% (95% CI 8.1–41.6)

CI, confidence interval; ICU, intensive care unit; SD, standard deviation. One patient was discharged from the ICU within 24 hours, below the institutional 48-hour transfer threshold.

4 DISCUSSION

4.1 Principal findings

This study describes the perioperative pathway of a small, highly selected cohort of surgically treated IE patients admitted postoperatively to a tertiary ICU in Morocco. Four observations stand out. Patients were young and frequently carried a rheumatic or congenital structural substrate, and EuroSCORE II was >5% in 40%. Microbiological yield was modest despite severe disease, while echocardiography demonstrated advanced destructive lesions and preoperative imaging revealed a heavy burden of cerebral embolic complications. Most operations were performed on an emergency or urgent basis, yet were preceded by a mean of three weeks of antimicrobial therapy. Finally, every patient required

combined noradrenaline and dobutamine at separation from CPB, postoperative organ complications were frequent, and in-hospital mortality within 30 days after surgery was 20%.

4.2 A young cohort with a persistent structural substrate

The mean age of 44 years is substantially lower than in contemporary European and ICU cohorts, where IE increasingly affects older patients with degenerative disease, prosthetic material and health-care exposure [4,6,18,19], but is close to the mean age of 46 years reported in a recent northern Moroccan cohort [14]. Rheumatic valve disease in 45% is consistent with the African meta-analysis of Noubiap et al., in which rheumatic heart disease remained the dominant adult risk factor [7], and congenital heart disease in 30% further distinguishes this substrate. The complete absence of injection drug use and of cardiac implantable devices underlines how different the aetiological landscape remains from that of high-income settings.

This pattern carries direct perioperative consequences. Young age does not confer low surgical risk when disease presents late with severe regurgitation, embolic complications, anemia and renal dysfunction: the EuroSCORE II distribution, with values >5% in 40%, illustrates that operative risk was not uniformly low. Multivalvular involvement in half the cohort, and combined aortic and mitral replacement in a quarter, also increase operative complexity and the likelihood of prolonged postoperative support.

4.3 Culture-negative disease, diagnostic capability and the interval to surgery

Blood cultures were positive in only 55% despite at least three sets in every patient. This yield is close to the pooled 48.6% positivity reported across African IE studies [7] and higher than the approximately 41% implied by the 59% culture-negative rate in the northern Moroccan cohort [14]. Prior antimicrobial exposure and fastidious organisms plausibly contribute, but so does diagnostic capability: no patient underwent *Coxiella* or *Bartonella* serology, molecular testing of excised valve tissue, cardiac computed tomography, positron emission tomography or radiolabeled leucocyte imaging, all of which have been given expanded diagnostic roles by the 2023 ESC guideline and the Duke-ISCVID criteria [2,3]. A standardized culture-negative pathway would materially improve aetiological classification and antimicrobial stewardship.

A second observation deserves emphasis because it is specific to this setting. Although 80% of operations were classified as emergency or urgent, patients received a mean of 21 days of preoperative antimicrobial therapy. The antimicrobial-to-surgery interval alone cannot distinguish late presentation, delayed diagnosis, referral delay or waiting after a surgical indication has been established. Contemporary guidance emphasizes that once a surgical indication is established, delay permits further valvular destruction, embolization and progression of heart failure [2,8–10]. The distribution of surgical indications here mirrors the three central indications of the ESC recommendations [2,8], but these data raise a hypothesis that potentially modifiable delays may occur somewhere along the preoperative pathway. Prospective work should therefore measure the intervals from symptom onset to first medical contact, diagnosis, surgical indication, referral and operation separately.

Neurological disease was frequent, with preoperative cerebral ischemic lesions in 35%, intracranial hemorrhage in 5% and cerebral mycotic aneurysm in 20%. These proportions underline the importance of systematic neurological assessment and multidisciplinary discussion of surgical timing after stroke. Current recommendations generally do not require delaying indicated surgery after uncomplicated ischemic stroke when meaningful neurological recovery is expected, whereas intracranial hemorrhage demands individualized timing weighing bleed severity against competing cardiac and infectious urgency [2,8,20].

4.4 Universal vasoactive requirement at separation from bypass

Every patient received inotropic or vasoactive support at separation from CPB, most likely reflecting a combination of preoperative ventricular loading conditions, active systemic inflammation, anesthetic and CPB-related vasodilatation, ischemia–reperfusion injury and the abrupt hemodynamic consequences of valve correction. In this cohort, noradrenaline and dobutamine were used together as first-line support from separation from bypass in all patients, while adrenaline was reserved as rescue therapy in two. This uniform dual-support pattern is therefore best interpreted as both a marker of the local hemodynamic strategy and a feature of a clinically severe surgical cohort, and direct comparison with centers using different thresholds for vasoactive initiation should be cautious.

Patients undergoing IE surgery are recognized as particularly vulnerable to postoperative low-output and vasoplegic syndromes [11–13]. Belletti et al. showed that high-dose postoperative inotropic support identifies a group with substantial morbidity and mortality [21]; Lim et al. reported vasoplegic syndrome in approximately one third of such patients [22]; and recent work has explored the vasoactive–inotropic score as a risk-stratification tool [23]. Our dataset did not permit calculation of a validated vasoactive–inotropic score, which limits quantitative comparison of postoperative hemodynamic support with other cohorts.

Three of the four deaths were attributable to refractory cardiogenic shock and one to severe respiratory failure. Two of the cardiogenic deaths occurred within the first four postoperative days, in the two patients who had required rescue adrenaline; the third followed an initial period of improvement with successful weaning from catecholamines before relapse into refractory shock at 196 hours. Because rescue adrenaline was used in only two patients, no prognostic inference can be drawn from this observation. Nevertheless, the pattern reinforces the value of structured hemodynamic phenotyping, serial echocardiography, cautious fluid administration and early discrimination between ventricular failure, vasoplegia, bleeding and mechanical causes of instability, and argues against interpreting successful weaning from catecholamines as a definitive endpoint.

Mean CPB and cross-clamp durations of 86 and 63 minutes are shorter than typically reported for endocarditis surgery, in which extensive debridement and peri-annular reconstruction commonly prolong bypass. Since peri-annular abscess was present in 15% and valve perforation in 30%, these durations may reflect a predominance of isolated valve replacement without complex root reconstruction in this series.

4.5 Early outcomes, limitations and research priorities

In-hospital mortality within 30 days after surgery was 20%, which lies within the range reported for severe and surgically treated IE, although comparison requires caution because populations and denominators differ. EURO-ENDO reported in-hospital mortality of 17.1% [6], the African meta-analysis pooled in-hospital mortality of 22.6% [7], and surgical series have reported early mortality of approximately 13–18% [24,25]. ICU cohorts including medically managed patients with severe organ failure have generally reported higher mortality [18,19]. Our cohort is further selected by design: patients dying in the operating room and those not admitted postoperatively to ICU were excluded, although in practice no patient met either criterion. The estimate should therefore not be read as the operative mortality of all surgical candidates at the institution.

Transthoracic echocardiography identified the vegetation in 19 of the 20 patients in whom a vegetation was subsequently confirmed at surgery. The single failure involved a mechanical mitral prosthesis, where acoustic shadowing precludes reliable transthoracic assessment. Transesophageal echocardiography is strongly recommended in suspected prosthetic valve endocarditis and would have addressed this limitation.

The limitations are substantial. The study is retrospective, single-center and small (N = 20), precluding reliable multivariable modelling and yielding wide confidence intervals around every estimate — the 95% CI for in-hospital mortality within 30 days after surgery spans 8.1% to 41.6%, so this cohort cannot statistically distinguish its own mortality from that of most published series. Only surgically treated patients admitted postoperatively to ICU were included, and no medically managed comparator was available. Echocardiographic assessment relied on transthoracic imaging alone. ICU length of stay is constrained by a protocol-driven 48-hour transfer threshold and therefore reflects local organization rather than illness severity; duration of mechanical ventilation and of vasoactive support are the more informative descriptors of the postoperative course. This cohort was almost exclusively native valve endocarditis, with a single case of prosthetic valve involvement, and the outcomes reported here should not be extrapolated to prosthetic valve endocarditis, whose perioperative course and mortality differ substantially. Set against these limitations, the principal strength is a perioperative focus spanning preoperative risk stratification, CPB, vasoactive management and immediate critical care in a setting where such data are almost entirely absent from the literature.

Three practical themes follow. Complicated IE should be routed early to an Endocarditis Team integrating cardiology, cardiac surgery, infectious diseases and microbiology, cardiac anesthesia, intensive care, imaging and neurology [2,8,11–13]. Culture-negative diagnostic pathways should be standardized and access to cardiac computed tomography and nuclear imaging expanded. Perioperative protocols should incorporate comprehensive transesophageal echocardiography, explicit hemodynamic targets, rational transfusion management and early discrimination of vasoplegia from ventricular failure; international surveys continue to show wide heterogeneity in these areas [26].

5 CONCLUSION

Surgically treated IE at this Moroccan tertiary center affected a relatively young population with frequent rheumatic and congenital valve disease, modest blood-culture yield, extensive valvular destruction and substantial embolic involvement; EuroSCORE II exceeded 5% in 40%. Most patients underwent urgent surgery, all received combined noradrenaline and dobutamine at separation from bypass, and cardiac, renal and neurological complications remained clinically important. In-hospital mortality within 30 days after surgery was 20%, broadly consistent with contemporary severe-IE literature though estimated with wide uncertainty. The interval of preoperative antimicrobial therapy preceding predominantly urgent surgery raises a hypothesis regarding delays somewhere along the diagnostic, referral or access-to-surgery pathway, but does not identify their location. Improved microbiological diagnosis, protocolized perioperative hemodynamic care and prospective multicenter data collection are priorities for strengthening the evidence base in North Africa.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

Disclosure of conflict of interest

The authors declare that they have no competing interests

Statement of ethical approval

This study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of Hassan II University Hospital.

Statement of informed consent

Given the retrospective review of existing medical records and the absence of any additional intervention or patient contact, the requirement for individual informed consent was waived by the Institutional Review Board.

Availability of data and materials.

The data supporting this study are not publicly available because of privacy and ethical restrictions. De-identified study data are available from the corresponding author upon reasonable request and with permission from Hassan II University Hospital and the institutional ethics committee

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