CLINICAL RESEARCH

Long-term prognosis of left-sided native-valve *Staphylococcus aureus* endocarditis

Pronostic à long terme de l’endocardite infectieuse à staphylocoque doré sur valve native du cœur gauche

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**KEYWORDS**

Infective endocarditis; *Staphylococcus aureus*; Left-sided native valve; Prognosis

**Summary**

**Background.** — *Staphylococcus aureus* infective endocarditis (SAIE) is a serious and common disease.

**Aims.** — To assess the clinical and echocardiographic characteristics and prognostic factors of left-sided native-valve SAIE, and to compare these characteristics between two periods (1990—2000 vs. 2001—2010).

**Methods.** — This was a retrospective analysis of 162 cases of left-sided native-valve SAIE among 1254 patients hospitalized for infective endocarditis (IE) between 1990 and 2010.

**Results.** — SAIE represented 18.1% of all cases of IE and 22.9% of cases of native-valve IE. Complications included heart failure in 44.7% of cases, acute renal failure in 23.3%, sepsis in 28.5%, neurological events in 35.8%, systemic embolic events in 54.9% and in-hospital mortality in 25.3%. Factors associated with in-hospital mortality were heart failure (odds ratio [OR] 2.5; ...

**Abbreviations:** CI, confidence interval; HR, hazard ratio; IE, infective endocarditis; MRSA, methicillin-resistant *Staphylococcus aureus*; OR, odds ratio; SAIE, *Staphylococcus aureus* infective endocarditis; TOE, transoesophageal echocardiography; TTE, transthoracic echocardiography.

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Background

Infected endocarditis (IE) is a serious disease, with an annual incidence of 3–10/100,000 in European countries and in North America [1]. Despite improvements in diagnosis and effective therapeutic techniques, morbidity and mortality rates remain high. According to some authors [2,3], *Staphylococcus aureus* is currently the main microorganism responsible for IE in western countries, and is associated with a poorer prognosis than with other microorganisms. The incidence of *S. aureus* infective endocarditis (SAIE) ranges between 19% and 38% [2,3], and has shown a rise in recent decades [4,5], which can be explained by increased use of invasive procedures and intravascular devices and improved diagnostic techniques [6]. In the literature, SAIE is associated with high mortality rates, ranging from 17% to 46% [3,7–9]. Current guidelines recommend early surgical treatment of SAIE [10] because of its severe prognosis. However, only one study [3] has assessed the prognosis of left- and right-sided native-valve SAIE, and right-sided SAIE appears to be a very different clinical, echocardiographic, prognostic and therapeutic entity. The aim of this study was to determine the clinical and echocardiographic characteristics and prognostic factors of left-sided native-valve SAIE, and to compare these characteristics between two periods (1990–2000 vs. 2001–2010).

Methods

Between January 1990 and December 2010, 1254 consecutive patients from two French centres (Amiens: 542 patients;
Marseille: 712 patients) with confirmed IE according to the Duke criteria [11,12] were referred to our echocardiographic laboratory. The Duke criteria were applied retrospectively to patients hospitalized before their publication. All patients were examined by transthoracic echocardiography (TTE) and transoesophageal echocardiography (TOE). SAIE accounted for 22.9% of cases of native-valve IE. A total of 162 patients (16.3%) had blood or valve cultures that were positive for S. aureus with definite acute left-sided native-valve IE (mitral and aortic valves), and were included in this study (Fig. 1). These 162 patients were divided into two groups and compared: 64 patients (39.5%) hospitalized between 1990 and 2000 (group 1); and 98 patients (60.5%) hospitalized between 2001 and 2010 (group 2). Early surgical intervention was defined as surgery performed during hospitalization for management of IE [1,10], and was divided into three periods [10]: emergency procedures on the first day after diagnosis; urgent procedures, between the second day and the eighth day; and elective procedures, after the eighth day. This study was approved by the local ethics committee of the two centres.

Clinical variables

Age, sex, presence of co-morbidity (history of diabetes, cancer, haematological malignancy, cirrhosis, renal failure, dialysis, heart failure or coronary artery disease), valvular heart disease, cardiac surgery and the presence of an intravascular device (venous catheter, pacemaker or dialysis device) were analysed. A co-morbidity index, taking into account the patient’s age and history, was calculated [13]. The following acute clinical events present on admission or occurring during hospitalization were recorded: heart failure, neurological event, embolism and severe sepsis. The portal of entry of the infection was investigated. Embolic events were diagnosed based on clinical signs and data derived from a non-invasive procedure (brain, chest and abdomen computed tomography). A neurological event was defined as the development of neurological symptomatic complications, such as ischaemic stroke with hemiplegia, haemorrhagic stroke, transient ischaemic attack, brain abscess, and features of encephalopathy or coma. Severe sepsis was defined as a systemic inflammatory syndrome secondary to an infectious process, leading to organ dysfunction, signs of hypoperfusion or hypotension.

Echocardiography

All patients were systematically assessed by TTE and by TOE. All echocardiographic studies were performed according to standard techniques and by experienced physicians during the acute phase of IE, without any complications. Standard definitions were used for vegetations, abscesses and other cardiac infective lesions [14,15]. All TOE recordings were reviewed by an experienced physician to measure the maximum length of vegetations in various planes. The mobility of vegetations was graded on a scale from 1 to 4, with severe mobility corresponding to grade 4 [16]. Valvular regurgitation was quantified by Doppler echocardiography using standard methods [17].

Follow-up

Follow-up data included surgical treatment and death occurring during hospitalization or follow-up. In-hospital mortality was defined as death occurring during the initial hospitalization for IE. Long-term mortality included death occurring during hospitalization and during follow-up. Follow-up was complete in 100% of cases, with a mean follow-up of 29 ± 34.3 months.

Statistical analysis

Statistical analysis was performed with SPSS software, version 21.0 (IBM, Armonk, NY, USA). Quantitative variables are expressed as means ± standard deviations. Comparisons between groups were carried out using Student’s t-test or the Chi² test. The cumulative probability of survival was estimated using the Kaplan–Meier actuarial method at 1-month intervals and reported as mean estimated survival ± standard error. The log-rank test was used to determine any significant differences. Multivariable analyses were performed, incorporating — as potential predictors of mortality — variables that correlated with mortality in univariate analysis, with P values ≤0.10. A multivariable logistic regression model was used for in-hospital mortality, and a Cox multivariable model was used for long-term mortality.
Results

Baseline characteristics

Of the 162 patients studied (105 men/57 women, mean age 56.9 ± 15 years), 29.0% had pre-existing valve disease (Table 1). Forty patients (24.7%) had diabetes and 14.8% had neoplasia, with a mean co-morbidity index of 3.19 ± 2.7. IE involved the aortic valve in 38.8% of cases, the mitral valve in 53.8% of cases and both the mitral and aortic valves in 7.4% of cases. The main complications were heart failure (44.7%), acute renal failure (23.3%), sepsis (28.5%), neurological events (35.8%) and systemic embolism (54.9%). *S. aureus* was resistant to methicillin (MRSA) in 15.2% of cases. The portal of entry was identified in 69.1% of cases, with a predominance of cutaneous portals of entry (57.5%) (Table 1). Vegetations were present in 92.0% of cases. The valve abscess, valve perforation and valve regurgitation rates were 27.3%, 24.1% and 49.4%, respectively (Table 1). Early surgery was performed for 74 patients (45.7%). The main surgical procedure was bioprosthetic valve replacement. Thirty-eight procedures were performed on the aortic valve, 32 procedures on the mitral valve and 14 procedures on both the mitral and aortic valves. Operative mortality was 36.5% (Table 1).

In-hospital mortality

The in-hospital mortality rate was 25.3%. Factors associated with in-hospital mortality in univariate analysis (Table 2) were age (P = 0.004), heart failure (P = 0.006), acute renal failure (P = 0.04), severe sepsis (P = 0.001), neurological complications (P = 0.05) and MRSA infection (P = 0.01). Early surgery was associated with significantly lower in-hospital mortality (P = 0.04), especially emergency surgery in the first 24 hours (P = 0.03). Multivariable analysis (Table 4)
### Table 2  Univariate analysis of in-hospital mortality.

<table>
<thead>
<tr>
<th>Variable</th>
<th>All patients</th>
<th>Survival</th>
<th>Death</th>
<th>P(^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 162)</td>
<td>(n = 121)</td>
<td>(n = 41)</td>
<td></td>
</tr>
<tr>
<td>Men/women (n/n)</td>
<td>105/57</td>
<td>79/42</td>
<td>26/15</td>
<td>0.85</td>
</tr>
<tr>
<td>Age (years)</td>
<td>56.9 ± 16.5</td>
<td>54.7 ± 17</td>
<td>63 ± 14</td>
<td>0.004</td>
</tr>
<tr>
<td>Valve disease</td>
<td>47 (29.0)</td>
<td>33 (27.3)</td>
<td>14 (34.1)</td>
<td>0.42</td>
</tr>
<tr>
<td>Diabetes</td>
<td>40 (24.7)</td>
<td>28 (23.1)</td>
<td>12 (29.3)</td>
<td>0.5</td>
</tr>
<tr>
<td>Cancer</td>
<td>24 (14.8)</td>
<td>18 (14.9)</td>
<td>6 (14.6)</td>
<td>1</td>
</tr>
<tr>
<td>Heart failure</td>
<td>72 (44.7)</td>
<td>46 (38.3)</td>
<td>26 (63.4)</td>
<td>0.006</td>
</tr>
<tr>
<td>Acute renal failure</td>
<td>35 (22.3)</td>
<td>28 (18.1)</td>
<td>14 (34.1)</td>
<td>0.04</td>
</tr>
<tr>
<td>Sepsis</td>
<td>45 (28.5)</td>
<td>23 (19.5)</td>
<td>22 (53.7)</td>
<td>0.001</td>
</tr>
<tr>
<td>Neurological event</td>
<td>58 (35.8)</td>
<td>38 (31.4)</td>
<td>20 (48.8)</td>
<td>0.05</td>
</tr>
<tr>
<td>Systemic embolism</td>
<td>89 (54.9)</td>
<td>66 (54.5)</td>
<td>23 (56.1)</td>
<td>1</td>
</tr>
<tr>
<td>MRSA</td>
<td>22 (15.2)</td>
<td>11 (10.4)</td>
<td>11 (28.2)</td>
<td>0.01</td>
</tr>
<tr>
<td>Aortic endocarditis</td>
<td>68 (42.0)</td>
<td>48 (39.7)</td>
<td>20 (48.8)</td>
<td>0.36</td>
</tr>
<tr>
<td>Mitral endocarditis</td>
<td>92 (56.8)</td>
<td>68 (56.2)</td>
<td>24 (58.5)</td>
<td>0.8</td>
</tr>
<tr>
<td>Mitral-aortic endocarditis</td>
<td>12 (7.4)</td>
<td>8 (6.6)</td>
<td>4 (9.8)</td>
<td>0.5</td>
</tr>
<tr>
<td>Vegetations</td>
<td>149 (92.0)</td>
<td>110 (90.9)</td>
<td>39 (95.1)</td>
<td>0.5</td>
</tr>
<tr>
<td>Abscess</td>
<td>44 (27.3)</td>
<td>34 (28.3)</td>
<td>10 (24.4)</td>
<td>0.7</td>
</tr>
<tr>
<td>Early surgery</td>
<td>74 (35.9)</td>
<td>61 (50.4)</td>
<td>13 (31.7)</td>
<td>0.04</td>
</tr>
<tr>
<td>Emergency: on day 1</td>
<td>21 (13.0)</td>
<td>20 (16.5)</td>
<td>1 (2.4)</td>
<td></td>
</tr>
<tr>
<td>Urgent: day 2 to day 8</td>
<td>30 (17.9)</td>
<td>23 (18.2)</td>
<td>7 (17.1)</td>
<td></td>
</tr>
<tr>
<td>Elective: after day 8</td>
<td>23 (14.2)</td>
<td>18 (14.9)</td>
<td>5 (12.2)</td>
<td></td>
</tr>
</tbody>
</table>

Data are expressed as mean ± standard deviation or number (%), unless otherwise indicated. MRSA: methicillin-resistant *Staphylococcus aureus*.

\(a\) Significant P value ≤ 0.1.

### Table 3  Univariate analysis of long-term mortality.

<table>
<thead>
<tr>
<th>Variable</th>
<th>All patients</th>
<th>Survival</th>
<th>Death</th>
<th>HR</th>
<th>95% CI</th>
<th>Cox univariate P value(^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men/women ratio</td>
<td>1.6</td>
<td>2.2</td>
<td>0.87</td>
<td>(0.52—1.43)</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>54 ± 16</td>
<td>60 ± 15</td>
<td>1.02</td>
<td>(0.52—1.43)</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Valve disease</td>
<td>22 (25.9)</td>
<td>25 (33.8)</td>
<td>1.4</td>
<td>(0.86—2.3)</td>
<td>0.17</td>
<td></td>
</tr>
<tr>
<td>Diabetes</td>
<td>19 (22.4)</td>
<td>21 (28.2)</td>
<td>1.14</td>
<td>(0.68—1.91)</td>
<td>0.61</td>
<td></td>
</tr>
<tr>
<td>Cancer</td>
<td>9 (10.3)</td>
<td>15 (19.7)</td>
<td>1.5</td>
<td>(0.85—2.7)</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Heart failure</td>
<td>31 (35.7)</td>
<td>41 (56.3)</td>
<td>1.8</td>
<td>(1.1—2.9)</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Acute renal failure</td>
<td>17 (20.0)</td>
<td>18 (23.9)</td>
<td>1.5</td>
<td>(0.89—2.7)</td>
<td>0.12</td>
<td></td>
</tr>
<tr>
<td>Sepsis</td>
<td>13 (15.5)</td>
<td>32 (47.1)</td>
<td>2.7</td>
<td>(1.6—4.43)</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td>Neurological event</td>
<td>30 (35.3)</td>
<td>28 (39.4)</td>
<td>1.2</td>
<td>(0.77—2.2)</td>
<td>0.35</td>
<td></td>
</tr>
<tr>
<td>Systemic embolism</td>
<td>53 (61.2)</td>
<td>36 (49.3)</td>
<td>0.5</td>
<td>(0.75—1.2)</td>
<td>0.12</td>
<td></td>
</tr>
<tr>
<td>Abscess</td>
<td>26 (30.6)</td>
<td>18 (23.9)</td>
<td>0.8</td>
<td>(0.4—1.4)</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Vegetations</td>
<td>85 (94.1)</td>
<td>64 (93.0)</td>
<td>0.9</td>
<td>(0.38—2.3)</td>
<td>0.76</td>
<td></td>
</tr>
<tr>
<td>MRSA</td>
<td>5 (6.7)</td>
<td>17 (24.6)</td>
<td>2.2</td>
<td>(1.2—3.9)</td>
<td>0.006</td>
<td></td>
</tr>
<tr>
<td>Aortic endocarditis</td>
<td>32 (38.8)</td>
<td>32 (46.5)</td>
<td>1.14</td>
<td>(0.7—1.8)</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>Mitral endocarditis</td>
<td>50 (61.2)</td>
<td>37 (54.9)</td>
<td>0.92</td>
<td>(0.57—3.9)</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td>Mitral-aortic endocarditis</td>
<td>8 (9.4)</td>
<td>4 (5.6)</td>
<td>0.72</td>
<td>(0.3—2.3)</td>
<td>0.72</td>
<td></td>
</tr>
<tr>
<td>Early surgery</td>
<td>50 (55.3)</td>
<td>24 (33.8)</td>
<td>0.49</td>
<td>(0.3—0.8)</td>
<td>0.005</td>
<td></td>
</tr>
</tbody>
</table>

CI: confidence interval; HR: hazard ratio; MRSA: methicillin-resistant *Staphylococcus aureus*.

\(a\) Significant P value ≤ 0.1.

\(b\) Data are expressed as mean ± standard deviation or number (%), unless otherwise indicated.
showed that heart failure (odds ratio [OR] 2.5; \( P = 0.04 \)) and severe sepsis (OR 5.3; \( P = 0.001 \)) were factors significantly associated with in-hospital mortality, and a trend toward significance was observed for acute renal failure (OR 2.5; \( P = 0.08 \)).

**Long-term mortality**

Long-term 5-year survival was 49.6 ± 4.9%. Predictors of long-term mortality in univariate analysis (Table 3) were age \( (P = 0.01) \), cancer \( (P = 0.1) \), heart failure \( (P = 0.01) \), severe sepsis \( (P = 0.001) \) and MRSA \( (P = 0.006) \). Early surgery was a factor associated with lower long-term mortality \( (P = 0.005) \). Multivariable analysis (Table 4) showed that heart failure \( (OR 1.7; P = 0.032) \), severe sepsis \( (OR 3; P = 0.0001) \) and absence of early surgery \( (OR 0.43; P = 0.003) \) were factors associated with long-term mortality.


**Baseline characteristics**

Comparison of the two groups showed that the two populations were similar in terms of age \( (P = 0.8) \), sex \( (P = 0.5) \), co-morbidity index \( (P = 0.48) \) and pre-existing valve disease \( (P = 0.8) \) (Table 1). Heart failure rates \( (46.9\% \text{ vs. } 43.3\%; \text{not significant}) \) and neurological events \( (35.9\% \text{ vs. } 35.7\%; \text{not significant}) \) were similar in the two groups. The systemic embolism rate tended to increase \( (46.9\% \text{ to } 60.2\%; P = 0.09) \), and the sepsis rate decreased non-significantly from 34.9\% to 24.2\% \( (P = 0.15) \). In contrast, the rate of acute renal failure increased significantly between the two time periods from 8.1\% to 31.6\% \( (P = 0.001) \). Bivalvular mitral-aortic IE was more frequent in the second period \( (11.3\% \text{ in } 2001—2010 \text{ vs. } 1.7\% \text{ in } 1990—2000; P = 0.03) \). Significantly increases were observed for annular abscess

![Figure 2. Actuarial survival curves: long-term mortality. The red curve represents the first period (1990—2000); the green curve represents the second period (2001—2010); and the blue curve represents the overall study population. \( P \) corresponds to a statistically significant \( P \) value < 0.05.](image)

(21.9\% vs. 30.9\%; \( P = 0.28 \)) and valve perforation \( (18.8\% \text{ vs. } 27.7\%; P = 0.26) \), and a significant increase in valve regurgitation from 28.1\% to 63.2\% was observed between the two periods \( (P = 0.001) \). The comparison of the two periods showed a significant decrease in the frequency of MRSA \( (25.5\% \text{ vs. } 9.6\%; P = 0.041) \). The early surgery rate increased non-significantly between the two consecutive periods from 39.1\% to 50.0\% \( (P = 0.2) \). A significant decrease in mitral valve repair was observed between the two groups \( (P = 0.043) \) and, consequently, an increase in bioprosthetic mitral valve replacement. The number of mitral-aortic valve replacements increased significantly between the two periods from 1.6\% to 13.3\% \( (P = 0.009) \). The operative mortality rate (Table 1) remained stable between the two periods \( (35.3\% \text{ vs. } 37.5\%; P = 1) \).

**In-hospital and long-term mortality**

No significant decrease in in-hospital mortality (Table 1) was observed between the two periods \( (28.1\% \text{ vs. } 23.5\%; P = 0.58) \). The Kaplan–Meier survival curve showed no significant difference between the two groups in terms of long-term 5-year survival \( (45.0 ± 6.6\% \text{ in period 1 vs. } 57.1 ± 6.4\% \text{ in period 2}; P = 0.33) \) (Fig. 2).

**Discussion**

To our knowledge, this is the first study specifically devoted to the clinical and prognostic characteristics of left-sided native-valve SAE; the results show that the factors associated with in-hospital mortality are sepsis and heart failure, while the factors associated with long-term mortality are heart failure, severe sepsis and absence of early surgery. Comparison of the two time periods did not reveal any significant improvement in prognosis in terms of in-hospital mortality and long-term mortality, despite progress in surgical and anaesthesiology techniques. However, patients operated on during the second period had higher co-morbidity indices.
S. aureus is currently the main IE pathogen in industrialized countries [1,2]. In our experience, SAIE accounted for 18.1% of all cases of IE and 22.9% of cases of native-valve IE. In the literature, the SAIE rate ranges from 19% to 38% of IE [3,18–22]. SAIE often occurs in patients with poor clinical status and major co-morbidities (diabetes, neoplasia, etc.) [6,19]. Accordingly, a high mean co-morbidity index value (3.2) was observed in our series.

SAIE has been associated with both higher complication rates and higher early and long-term mortality [3,18–24]. In our study, the high in-hospital mortality rate was related to severe sepsis and congestive heart failure, while factors influencing long-term mortality were congestive heart failure, severe sepsis and absence of early surgery. Previous studies have reported a high incidence of heart failure, ranging from 28% to 41% [3,21–23]. In our series, native-valve SAIE was complicated by heart failure in 44.7% of cases. As previously reported in the only published series devoted to right- and left-sided native-valve SAIE [3], heart failure is a powerful predictor of in-hospital mortality. Neurological complications of native-valve SAIE were observed in 35.8% of cases in our study — a higher rate than those reported in the literature including all types of SAIE [3,24]. Garcia-Cabrera et al. [20] reported that 43.3% of patients with SAIE experienced at least one neurological complication — a rate 2 to 3 times higher than that observed with other pathogens. However, this series included 24% of patients with prosthetic-valve IE, which is associated with a high neurological complication rate. Thuny et al. [25] showed that S. aureus infection is a predictor of increased risk of systemic embolic events. Because cerebral and thoracoabdominal computed tomography scans were not performed in all patients, the true incidence of embolic events in the current study may have been underestimated. In the present study, we demonstrated a high incidence of severe sepsis (28.5% of cases). Severe sepsis is a major prognostic predictor of in-hospital mortality and long-term mortality [19], because of the risk of progression to multiple organ dysfunction as a result of the virulence of SA, especially MRSA. Moreover, severe sepsis is often the presenting sign of SAIE with predominantly extracardiac signs, consequently delaying diagnosis and appropriate care [18].

In this study, the in-hospital mortality rate of native-valve SAIE was 25.3%, and the long-term 5-year survival rate was 49.6 ± 4.9%. Similar data have been reported in the literature, ranging from 20% to 37% for in-hospital mortality in series, including all types of SAIE (i.e. prosthetic valve, pacemaker, etc.). Fiederspiel et al. [7] recently reported a nearly 60% increased risk of in-hospital mortality from SAIE compared with streptococcal and enterococcal endocarditis. Native-valve SAIE, therefore, remains a very serious disease. Early surgery was performed in our series in 45.7% of patients, compared with 26.2% in the only published series on both right- and left-sided native-valve SAIE [3]. It should be noted that emergency surgery was a risk factor associated with in-hospital mortality in univariate analysis, but no significant association was observed in multivariable analysis. In the present study, early surgery was an independent predictor of 5-year survival. Lalani et al. [26] reported that patients with SAIE undergoing early surgery had an absolute risk reduction in in-hospital mortality of 20.1% compared with patients treated medically. However, this series included both right- and left-sided IE. The operative mortality rate was 36.5% in our series compared with 16.4% in the series reported by Remadi et al. [22], which included all types of SAIE (i.e. native and prosthetic valves, pacemaker). Surgical decisions are often problematic because of lack of evidence from randomized controlled trials.

One strength of our study was the comparison of prognostic characteristics over two distinct periods; this showed no significant difference in terms of in-hospital mortality and 5-year survival between the two periods, which may be explained by the increased virulence of S. aureus, causing severe destruction of valve tissue. Bivalvular IE, valve regurgitation, acute renal failure rate and systemic emboli were more frequent during the second period. In fact, the increase in embolic events could be partially explained by an increased use of computed tomography during the second period. The absence of improvement in in-hospital mortality could be explained by the more serious clinical condition of the patients included in the second period.

Our study has a number of limitations. This was a retrospective study, although data collection was prospective. Prospective cohorts of left-sided SAIE are needed to evaluate the influence of surgical treatment on mortality, and to define its indications. However, it would be ethically and practically impossible to conduct a randomized study to determine the treatment of SAIE, as these patients are usually managed case by case. Also, we observed in our series a significant decrease in the frequency of resistant S. aureus in the second period. Unfortunately, we have no explanation for this result, which has not been demonstrated in previous studies; further studies are required to confirm this finding.

Conclusion

This is the first series specifically devoted to left-sided native-valve SAIE, which is a very serious disease with high mortality and morbidity. Based on a multidisciplinary team decision, emergency surgery and urgent surgery should be systematically considered, after initiation of effective antibiotic therapy, because of the “aggressive” nature of the microorganism, which can cause destructive lesions, heart failure, septic embolism and severe sepsis.

Disclosure of interest

The authors declare that they have no competing interest.

References

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