

Impact of an Infective Endocarditis Team on Management and Outcomes: A Retrospective Cohort Study

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Purpose: Multidisciplinary team approaches have been reported to improve the management of infective endocarditis (IE). This study evaluated changes in management and outcomes after the establishment of an IE team at a tertiary care facility in Japan.

Patients and Methods: A retrospective study was conducted on inpatients aged ≥ 18 years with definite IE between November 2015 and October 2023. The primary outcome was 90-day all-cause mortality. Secondary outcomes included in-hospital mortality, unplanned cardiac surgery, new cerebral embolism, bacteremia relapse within 90 days of admission, and duration of antibiotic therapy. Outcomes were compared between patients admitted before (control period) and after (intervention period) the implementation of the IE team in November 2019.

Results: Characteristics were comparable between the two periods. No significant differences were found in 90-day mortality (15.2% vs 17.0%, $P > 0.99$), in-hospital mortality (19.6% vs 12.8%, $P = 0.54$), or new cerebral embolism (8.7% vs 2.1%, $P = 0.20$). The rate of unplanned cardiac surgery was lower in the intervention period (17.4% vs 2.1%, $P = 0.02$), while the duration of antibiotic therapy was longer (6.0 weeks vs 7.5 weeks, $P = 0.02$). No bacteremia relapse occurred.

Conclusion: Although no significant differences were observed in 90-day mortality, the rate of unplanned surgery was significantly lower in the intervention period, supporting the usefulness of an IE team. The longer duration of antibiotic therapy in the intervention period may reflect a higher prevalence of complicated infections including muscle abscesses.

Keywords: infective endocarditis, IE team, endocarditis team, multidisciplinary management, cardiac surgery

Introduction

Infective endocarditis (IE) is an infection of the heart valves or endocardium that can lead to complications in multiple organs. A survey conducted between 1990 and 2019 revealed a global increase in the incidence of IE.¹ Risk factors for IE include poor oral hygiene, central venous catheter use, hemodialysis, intravenous drug use, valvular heart disease, and prosthetic heart valves, and the incidence of IE is higher among older adults.^{2–10} IE can occur on both native valves and those affected by rheumatic heart disease (RHD), but in high-income countries the incidence of RHD has declined, and consequently RHD-associated IE has become less common.^{4,11,12} Beyond RHD, IE can develop in any type of valvular lesion, but it is more frequent in regurgitant than in stenotic lesions,^{7,11,13} and its occurrence in prosthetic valves has been increasing.¹⁴ Left-sided infective endocarditis is more common than right-sided disease, with the latter reported to account for approximately 10% of cases.^{15,16} A study using a Japan nationwide administrative database reported that the annual incidence of IE increased from 2.02 per 100,000 population in 2016 to 2.59 per 100,000 in 2021.¹⁷ The disease predominantly affects elderly individuals and is associated with an in-hospital mortality rate of 15%.¹⁷ The mortality rate of IE remains high worldwide, with in-hospital mortality ranging from approximately 15–20%.^{17–20} In cases involving

prosthetic valves, the in-hospital mortality rate increases further, ranging from 20% to 40%.^{21–24} Therefore, early diagnosis and prompt therapeutic intervention are crucial for managing IE. However, the clinical manifestations of IE are diverse, and approximately 10–20% of patients present with negative blood cultures, complicating the diagnosis.^{25–28} Delayed diagnosis or treatment may contribute to the development of complications and adversely affect the clinical prognosis.²⁹ Moreover, treatment often requires complex decision-making regarding the choice and duration of antibiotic therapy, surgical intervention, and multidisciplinary care planning.^{4,30,31} The management of IE requires specialized and multidisciplinary expertise. Consequently, a collaborative approach among specialists from various fields is essential for optimal patient care.

The 2023 European Society of Cardiology Guidelines recommend that care for patients with IE be managed by an IE team, whose core members include cardiologists, cardiovascular surgeons, infectious disease specialists, internal medicine specialists with expertise in infectious diseases, and microbiologists.⁴ Comprehensive management by an IE team comprising specialists from various fields can potentially reduce in-hospital mortality and shorten the length of hospital stays.^{32–35} Among the various risk factors for poor outcomes in IE, age plays a particularly important role. Age is associated with the risk of mortality in IE, with older adults being at higher risk.^{17,36–39} Japan has the largest aging population worldwide,^{40,41} and findings from Japanese studies could offer valuable insights for other countries that are expected to undergo similar demographic shifts in the future. However, the effectiveness of IE teams in Japan has not been fully evaluated.^{42,43} Therefore, this study aimed to assess changes in the management and outcomes of IE following the establishment of an IE team at a tertiary care facility in Japan.

Material and Methods

Ethical Considerations

This study was conducted in accordance with the Declaration of Helsinki and approved by the Research Ethics Committee of Dokkyo Medical University (R838J). The requirement for written informed consent was waived due to the opt-out process. The participants were provided with the detailed information on the Dokkyo Medical University Hospital website. All personal data were anonymized to ensure privacy, and no financial compensation was provided to the participants.

Study Design

This retrospective cohort study was conducted at the Dokkyo Medical University Hospital in 2024, using data from patients hospitalized between November 2015 and October 2023. Patients were divided into two cohorts according to the time of admission: the control period (before November 2019) and the intervention period (after November 2019, following the establishment of the IE team).

IE Team at the Dokkyo Medical University Hospital

The Dokkyo Medical University Hospital is a 1,200-bed university hospital located in the Tochigi Prefecture, Japan, which has a population of approximately 1.87 million. It is one of two core university hospitals in the region and serves as a tertiary referral center for cardiovascular and infectious diseases. The hospital has comprehensive clinical departments, including cardiovascular surgery, and patients with suspected infective endocarditis are often referred from other hospitals in the prefecture. In 2019, an IE team was established at this hospital, composed of specialists from the departments of cardiology, cardiovascular surgery, infection control, and general internal medicine. The team developed a flowchart for IE management, emphasizing the identification of blood culture-positive cases, information sharing on confirmed or suspected IE cases, and discussions on treatment strategies. The team held regular meetings every two weeks to discuss and coordinate patient management. The general internal medicine department is responsible for diagnosing IE, evaluating complications, and managing antibiotic therapy.

Diagnosis Procedure Combination (DPC)

The Japanese DPC database is a nationwide inpatient administrative claims database widely used across Japan.⁴⁴ It includes information such as age, sex, primary diagnosis coded according to the International Classification of Diseases, Tenth Revision (ICD-10), comorbidities present at admission, diseases occurring after admission, and admission and discharge dates.

Participants

Using the DPC database, patients aged ≥ 18 years who were hospitalized with a diagnosis of IE (ICD-10 code: I33) between November 1, 2015, and October 31, 2023, were identified. Cases that fulfilled the modified Duke criteria for a definitive diagnosis of IE were selected. If a patient was readmitted for IE within 90 days of the initial discharge, subsequent admission was excluded from the analysis. Additionally, in cases of duplicate records, only the first instance was retained. Patients with incomplete follow-up data were also excluded.

Definition

Implanted prosthetic devices were defined as prosthetic valves, artificial blood vessels, or completely implantable venous access ports. The suspected portal of entry was defined as any plausible entry point for bacteremia based on medical record documentation or reasonably inferred by the investigators. Septic shock was defined according to Sepsis-3 criteria as a condition requiring vasopressor therapy, in addition to fluid resuscitation, to maintain a mean arterial pressure of ≥ 65 mmHg, and associated with a serum lactate level >2 mmol/L.⁴⁵ Time to surgery was calculated as the duration from the date of hospital admission to the day of surgery, excluding elective surgeries performed after the completion of antibiotic treatment. Cardiac sequelae were defined as persistent heart failure symptoms (eg, dyspnea, edema, or jugular vein distension) or a sustained left ventricular ejection fraction $<50\%$ immediately following the completion of IE treatment. Neurological sequelae were defined as new neurological abnormalities (eg, motor deficits, sensory deficits, or cognitive impairments) that were not present before the onset of IE but were observed immediately after the completion of IE treatment. Unplanned cardiac surgery was defined as surgery initially considered unnecessary during early hospitalization but ultimately performed. New-onset embolic events were identified in patients who developed symptomatic embolic events during hospitalization after the initiation of treatment, with the date of diagnosis confirmed by imaging used as the onset date. Relapse of bacteremia was defined as the recurrence of positive blood cultures occurring >2 weeks after blood cultures first became negative. IE team intervention was defined as cases managed after November 2019 in which the case was discussed during an IE team conference or where medical records documented the involvement of three or more departments from the IE team in the diagnosis or treatment of IE.

Data Collection and Outcomes

TSakamoto investigated various factors including sex, age, presenting symptoms, presence of implanted prosthetic devices, Charlson Comorbidity Index, cardiac infection site, presence of perivalvular complications, infected organs, presence of septic shock, estimated glomerular filtration rate, Hemoglobin A1c, lactate levels, brain natriuretic peptide, microorganisms identified from cultures, suspected portal of entry, imaging studies (computed tomography, magnetic resonance imaging, and echocardiography), surgical intervention, time to surgery, duration of antibiotic therapy, length of hospital stay, discharge destination, in-hospital mortality, cardiac and neurological sequelae, all-cause mortality within 90 days of admission, unplanned cardiac surgery within 90 days of admission, occurrence of new-onset embolic events within 90 days of admission, and relapse of bacteremia caused by IE pathogens within 90 days of treatment initiation.

TSakamoto and TH independently assessed heart failure severity based on the New York Heart Association (NYHA) functional classification and clinically suspected portals of entry. In cases of disagreement, a final decision was reached through discussion.

The primary outcome was all-cause mortality within 90 days of admission among all patients who met the inclusion criteria. Secondary outcomes included in-hospital mortality, unplanned cardiac surgery within 90 days of admission, occurrence of new-onset embolic events within 90 days of admission, relapse of bacteremia caused by the pathogen

within 90 days of treatment initiation, surgical rate, time to surgery, duration of antibiotic therapy, length of hospital stay, cardiac and neurological sequelae, and discharge destination. Outcomes were compared between patients admitted before (control period) and after (intervention period) the implementation of the IE team in November 2019.

Sample-Size Calculation

The IE team was implemented in November 2019, necessitating a comparison of clinical outcomes before and after its implementation. Therefore, the study period was set from November 1, 2015, to October 31, 2023. A preliminary investigation identified 139 patients with IE who received inpatient treatment during this period. Based on a prior study,³³ the required sample size was calculated using G*Power to determine difference in mortality rates between two periods via logistic regression analysis, assuming a power of 80%, a significance level of 5%, and an odds ratio (OR) of 0.26. The required sample size was estimated at 130, confirming the feasibility of including 139 patients in this study.

Statistical Analysis

Categorical variables were compared using the χ^2 -test or Fisher's exact test, depending on sample size. Continuous variables were compared using Student's *t*-test or the Mann–Whitney *U*-test, based on the normality of data distribution. A univariate logistic regression model was used to calculate OR and 95% confidence intervals (CI) for association between each variable and the outcomes. Multivariable logistic regression analysis was conducted to evaluate all-cause mortality within 90 days of admission. Based on previous studies,^{32,46,47} the variables included in the analysis were heart failure, septic shock, and cardiac surgery, in addition to IE team intervention. A *p*-value <0.05 was considered statistically significant. All statistical analyses were performed using the R software (version 4.3.2; R Foundation for Statistical Computing, Vienna, Austria).

Results

Study Population and Baseline Characteristics

A total of 139 patients registered with a diagnosis of IE were identified from the DPC database. Of these, 18 cases were excluded for non-IE diagnoses, 12 cases for missing data, nine for duplicate records, five for being classified as possible IE, and one for being under 18 years of age. Ultimately, 93 patients were included in this study (Figure 1).

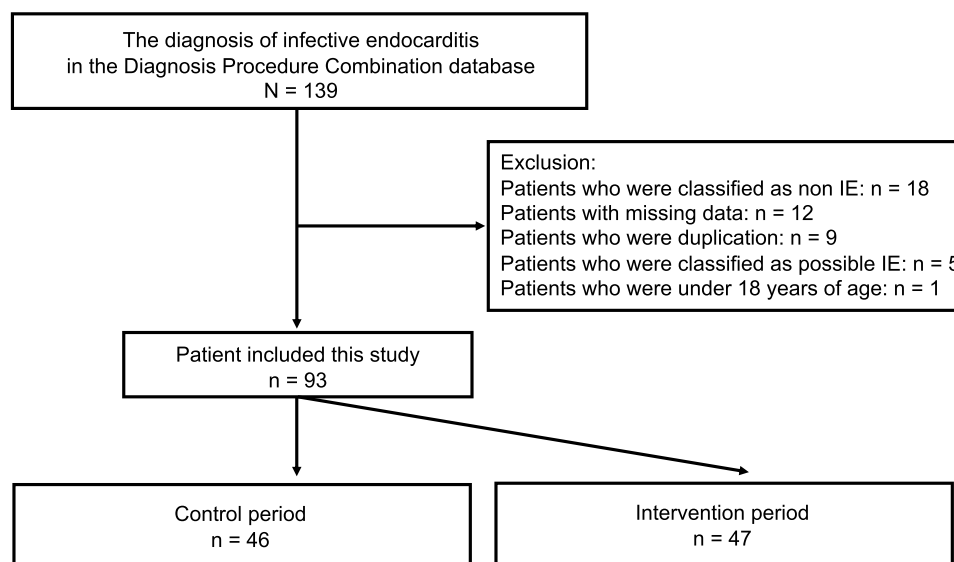


Figure 1 Flowchart of participant selection.

Abbreviations: IE, infective endocarditis; DPC, Diagnosis Procedure Combination; NYHA, New York Heart Association; ICD-10, International Classification of Diseases, Tenth Revision.

The characteristics of patients are presented in Tables 1 and 2. The median age of patients was 68 years (interquartile range, 17) and 62 (66.7%) were male. Fifteen patients (16.1%) had diabetes, seven patients (7.5%) were receiving hemodialysis, and five patients (5.4%) had a medical history of IE. Implanted prosthetic devices were observed in 17 patients (18.3%). The most common clinical symptom was fever, observed in 70 patients (75.3%). Eight patients (8.6%) presented with septic shock. Heart failure, classified as NYHA class III or higher, was observed in 32 cases (34.4%). The sites of cardiac infection, including overlapping cases, were as follows: native aortic valve in 41 cases (44.1%), native mitral valve in 63 cases (67.7%), native tricuspid valve in 6 cases (6.5%), and prosthetic valve in 14 cases (15.1%).

Table 1 Clinical Characteristics of the Study participants

Patient Characteristics	All Patients (n = 93)	Intervention Period (n = 47)	Control Period (n = 46)	P
Age, median (IQR)	68.0(57.0–74.0)	69.0(62.0–74.5)	67.5(55.0–74.0)	0.41
Male sex, n (%)	62(66.7)	31(66.0)	31(67.4)	> 0.99
History and risk factor				
Diabetes mellitus, n (%)	15(16.1)	8(17.0)	7(15.2)	> 0.99
Hemodialysis, n (%)	7(7.5)	4(8.5)	3(6.5)	> 0.99
Cancer, n (%)	14(15.1)	12(25.5)	2(4.4)	< 0.05
History of IE, n (%)	5(5.4)	2(4.3)	3(6.5)	0.68
Implanted prosthetic devices, n (%)	17(18.3)	9(19.1)	8(17.4)	> 0.99
Charlson Comorbidity Index score, median(IQR)	2.0(1.0–3.0)	2(2.0–3.5)	1.5(1.0–2.0)	< 0.05
Clinical findings				
Fever, n (%)	70(75.3)	39(83.0)	31(67.4)	0.13
Chill, n (%)	10(10.8)	4(8.5)	6(13.0)	0.52
Malaise, n (%)	16(17.2)	8(17.0)	8(17.4)	>0.99
Loss of appetite, n (%)	16(17.2)	10(21.3)	6(13.0)	0.44
Dyspnea, n (%)	17(18.3)	10(21.3)	7(15.2)	0.63
Lower back pain, n (%)	23(24.7)	15(31.9)	8(17.4)	0.17
Arthralgia, n (%)	9(9.7)	6(12.8)	3(6.52)	0.49
Unconsciousness, n (%)	18(19.4)	8(17.0)	10(21.7)	0.75
Limb paresis, n (%)	12(12.9)	7(14.9)	5(10.9)	0.79
Heart failure (NYHA $\geq$ 3), n (%)	32(34.4)	19(40.4)	13(28.3)	0.31
Septic shock, n (%)	8(8.6)	4(8.5)	4(8.7)	>0.99
Biological findings				
eGFR, mean (SD)	58.6(30.4)	60.2(30.3)	57.0(30.7)	0.61
HbA1c, median (IQR)	5.8(5.4–6.3) ※n = 91	5.8(5.5–6.2)	5.9(5.3–6.4)	0.87
Lactate, median (IQR)	1.4(1.0–2.4) ※n = 66	1.6(1.1–2.1)	1.3(1.0–2.4)	0.61
BNP, median (IQR)	309.2(156.7–598.6) ※n = 66	319.5(164.9–685.9)	297.8(154.1–585.7)	0.31

Abbreviations: P, p-value; IQR, interquartile range; IE, infective endocarditis; NYHA, New York Heart Association; eGFR, estimated glomerular filtration rate; SD, standard deviation; HbA1c, hemoglobin A1c; BNP, brain natriuretic peptide; ※, number of patients with available data.

Table 2 Infection Characteristics of the Study participants

Patient Characteristics	All Patients (n = 93)	Intervention Period (n = 47)	Control Period (n = 46)	P
Heart valve affected with endocarditis				
Native aortic valve, n (%)	41(44.1)	22(46.8)	19(41.3)	0.74
Native mitral valve, n (%)	63(67.7)	33(70.2)	30(65.2)	0.77
Native tricuspid valve, n (%)	6(6.5)	2(4.3)	4(8.7)	0.43
Prosthetic valve, n (%)	14(15.1)	8(17.0)	6(13.0)	0.81
Perivalvular complications, n (%)	19(20.4)	7(14.9)	12(26.1)	0.28
Infected organs				
Brain, n (%)	64(68.8)	35(74.5)	29(63.0)	0.33
Vertebra, n (%)	15(16.1)	11(23.4)	4(8.7)	0.09
Muscle, n (%)	9(9.7)	8(17.0)	1(2.17)	0.03
Kidney, n (%)	13(14.0)	9(19.1)	4(8.7)	0.23
Spleen, n (%)	24(25.8)	16(34.0)	8(17.4)	0.11
Lung, n (%)	4(4.3)	3(6.4)	1(2.2)	0.62
Aneurysm, n (%)	4(4.3)	3(6.4)	1(2.2)	0.62
Other organs, n (%)	6(6.5)	2(4.3)	4(8.7)	0.43
Suspected portal of entry				
Oral, n (%)	31(33.3)	16(34.0)	15(32.6)	> 0.99
Skin, n (%)	14(15.1)	8(17.0)	6(13.0)	0.81
Urinary tract, n (%)	3(3.2)	3(6.4)	0	0.24
Gastrointestinal tract, n (%)	3(3.2)	2(4.3)	1(2.2)	>0.99
Unknown, n (%)	42(45.2)	18(38.3)	24(52.2)	0.26
Causative microorganisms				
<i>Streptococcus species</i> , n (%)	41(44.1)	20(42.6)	21(45.7)	0.93
<i>Staphylococcus aureus</i> , n (%)	18(19.3)	11(23.4)	7(15.2)	0.46
Culture negative, n (%)	12(12.9)	5(10.6)	7(15.2)	0.73
<i>Enterococcus faecalis</i> , n (%)	10(10.8)	5(10.6)	5(10.9)	> 0.99
<i>Coagulase-negative staphylococci</i> , n (%)	9(9.7)	4(8.5)	5(10.9)	0.74
Other, n (%)	3(3.2)	2(4.3)	1(2.2)	>0.99

Abbreviation: P, p-value.

Perivalvular complications, including valve ring abscesses, were observed in 19 cases (20.4%). Acute cerebral embolism, either asymptomatic or symptomatic, occurred in 64 patients (68.8%). Other complications, including abscesses and infarctions, were identified in the vertebrae (16.1%), muscles (9.7%), kidneys (14.0%), and spleen (25.8%). Intracranial infectious aneurysms were identified in 4 patients (4.3%). The most frequently identified causative microorganism was *Streptococcus species* in 41 cases (44.1%), followed by *Staphylococcus aureus* in 18 cases (19.3%). When comparing the

control and intervention periods, the intervention period showed a significantly higher proportion of patients with cancer (4.4% vs 25.5%, $P < 0.05$) and a higher Charlson Comorbidity Index score (1.5 vs 2.0, $P < 0.05$). Additionally, the incidences of muscle abscesses and pyogenic myositis were significantly higher in the intervention period (2.2% vs 17.0%, $P = 0.03$).

Outcomes

All-cause mortality within 90 days of admission was 15.2% in the control period and 17.0% in the intervention period, with no statistically significant difference between the two groups (OR 1.14, 95% CI 0.38–3.46, $P > 0.99$) (Table 3). In-hospital mortality was 19.6% and 12.8% in the control and intervention periods, respectively, although the difference was not statistically significant (OR 0.60, 95% CI 0.20–1.85, $P = 0.54$). Unplanned cardiac surgery within 90 days of admission occurred in 17.4% of patients in the control period and 2.1% in the intervention period, showing a significant decrease in the intervention period (OR 0.10, 95% CI 0.01–0.86, $P = 0.02$). No significant difference was observed in the occurrence of new-

Table 3 Management and Outcome

	All Patients (n = 93)	Intervention Period (n = 47)	Control Period (n = 46)	P	OR (95% CI)
Cardiac surgery	76(81.7)	39(83.0)	37(80.4)	0.96	1.19 (0.41–3.40)
Time to Surgery, median days (IQR)	6.5(1.0–23.5) ※n = 76	6.0(1.0–20.5) ※n = 39	7.0(2.0–27.0) ※n = 37	0.63	
Total length of antibiotics treatment, median weeks (IQR)	7.0(6.0–8.5) ※n = 75	7.5(6.0–10.0) ※n = 38	6.0(6.0–8.0) ※n = 37	0.02	
Total length of antibiotics treatment during hospitalization, median weeks (IQR)	6.0(6.0–7.8) ※n = 78	7.0(6.0–8.0) ※n = 41	6.0(5.0–7.0) ※n = 37	0.10	
Change to oral antibiotics, n (%)	17(18.3)	12(25.5)	5(10.9)	0.12	2.81 (0.90–8.76)
Length of hospital stay, median days (IQR)	53.0(43.0–65.0)	51(45.0–63.5)	53.5(40.2–66.5)	0.92	
Discharge destination					
Home, n (%)	59(63.4)	31(66.0)	28(60.9)	0.77	1.25 (0.53–2.90)
Transfer to other hospital, n (%)	19(20.4)	10(21.3)	9(19.6)	>0.99	1.11 (0.40–3.05)
Outcome					
In-hospital mortality, n (%)	15(16.1)	6(12.8)	9(19.6)	0.54	0.60 (0.20–1.85)
Cardiac sequelae, n (%)	6(7.7) ※n = 78	3(7.3) ※n = 41	3(8.1) ※n = 37	> 0.99	0.89 (0.17–4.73)
Neurological sequelae, n (%)	17(21.8) ※n = 78	10(24.4) ※n = 41	7(18.9) ※n = 37	0.76	1.38 (0.47–4.11)
All-cause mortality within 90 days, n (%)	15(16.1)	8(17.0)	7(15.2)	> 0.99	1.14 (0.38–3.46)
Unplanned cardiac surgeries within 90 days, n (%)	9(9.7)	1(2.1)	8(17.4)	0.02	0.10 (0.01–0.86)
New-onset embolic events within 90 days, n (%)	5(5.4)	1(2.1)	4(8.7)	0.20	0.23 (0.02–2.12)
Relapse of bacteremia caused by IE pathogens within 90 days, n (%)	0	0	0	NA	NA

Abbreviations: CI, confidence interval; OR, odds ratio; P, p-value; IQR, interquartile range; IE, infective endocarditis; NA, not applicable; ※, number of patients with available data.

Table 4 Multivariable Analysis of All-Cause Mortality Within 90 days

Variable	OR (95% CI)	P
Cardiac surgery	0.09 (0.02–0.36)	0.001
Septic shock	2.28 (0.38–12.83)	0.35
NYHA ≥ 3	6.91 (1.71–36.29)	0.01
Intervention period	0.94 (0.24–3.60)	0.92

Abbreviations: CI, confidence interval; OR, odds ratio; P, p-value; NYHA, New York Heart Association.

onset embolic events within 90 days of admission between the two periods (8.7% vs 2.1%, OR 0.23, 95% CI 0.02–2.12, $P = 0.20$). Relapse of bacteremia caused by the pathogen within 90 days of treatment initiation was not observed in either period. In cases with intracranial infectious aneurysms complicated by subarachnoid hemorrhage and requiring cardiac surgery, delayed surgery was selected, and treatment strategies did not differ between the two groups. Intracranial aneurysms were not associated with in-hospital mortality in either group. Cardiac surgery was performed in 80.4% and 83.0% of patients during the control and intervention periods, respectively, with no significant difference between the groups (OR 1.19, 95% CI 0.41–3.40, $P = 0.96$). Similarly, the time from admission to surgery did not differ significantly (7.0 days vs 6.0 days, $P = 0.63$). The duration of antibiotic therapy was significantly longer in the intervention period (6.0 weeks vs 7.5 weeks, $P = 0.02$), although the duration of inpatient antibiotic administration did not differ significantly (6.0 weeks vs 7.0 weeks, $P = 0.10$). The overall length of hospital stay was also comparable between the periods (53.5 days vs 51.0 days, $P = 0.92$). Cardiac sequelae were observed in 8.1% of patients in the control period and 7.3% in the intervention period (OR 0.89, 95% CI 0.17–4.73, $P > 0.99$), whereas neurological sequelae were seen in 18.9% and 24.4% of patients, respectively (OR 1.38, 95% CI 0.47–4.11, $P = 0.76$). Regarding discharge destination, 60.9% of patients in the control period and 66.0% in the intervention period were discharged home (OR 1.25, 95% CI 0.53–2.90, $P = 0.77$). Transfers to other hospitals occurred in 19.6% and 21.3% of cases in the control and intervention periods, respectively (OR 1.11, 95% CI 0.40–3.05, $P > 0.99$), with no significant differences between the groups. In the multivariable analysis, IE team intervention was not associated with all-cause mortality within 90 days, even after adjusting for confounding factors (Table 4).

Discussion

This study demonstrated no significant difference in 90-day all-cause mortality among patients hospitalized with IE before and after the establishment of an IE team at a tertiary care facility. However, the intervention period was associated with a significant reduction in the incidence of unplanned cardiac surgery and an increase in the duration of antibiotic therapy.

To the best of our knowledge, no previous studies have investigated the impact of multidisciplinary team interventions on mid-term mortality, particularly all-cause mortality within 90 days of admission. One study has reported that the involvement of infectious disease specialists in IE management did not significantly alter 90-day mortality,⁴⁸ which is consistent with the findings of the present study. Previous studies have examined in-hospital mortality and mortality at 6 and 12 months before and after multidisciplinary team interventions. Reported in-hospital mortality rates after such interventions range from 4% to 23%,^{32–34,47,49–53} 6-month mortality rates from 16% to 24%,^{32,49} 1-year mortality rates from 8% to 29%,^{32,34,49,53} and 3-year mortality rates of approximately 28%.³³ Although some studies have demonstrated reduced mortality associated with the implementation of IE teams, others have reported no significant changes. However, meta-analyses suggest a general trend toward reduced mortality with multidisciplinary team interventions.⁵⁴ In this study, two possible explanations may account for the lack of differences in 90-day and in-hospital mortality before and after the establishment of the IE team. First, even prior to the formation of the IE team, the departments that would later constitute the team were already participating in the management of IE. Although a formal protocol had not yet been established, multidisciplinary collaboration was already practiced in the care of patients with IE. This may have minimized the

observable impact of team formalization. Establishing a more structured protocol, implementing rigorous management for patients with suspected IE, involving intensivists and neurologists in the team, and holding weekly team meetings to discuss clinical status may contribute to improved mortality outcomes.^{4,35,47,49,50} In addition, expanding IE team activities to include public awareness campaigns and online collaboration with regional facilities could help reduce mortality.⁵³ Second, differences in patient backgrounds may have influenced the results. After the establishment of the IE team, a higher proportion of patients with cancer, higher Charlson Comorbidity Index scores, and more cases of muscle abscesses were observed. IE in patients with cancer or a high comorbidity burden is associated with a poor prognosis.^{4,55} Moreover, secondary psoas abscesses have a reported mortality rate of 19%, which can increase to 100% if left untreated.⁵⁶ Factors related to patient background and complications may have contributed to the lack of significant differences in mortality between the two periods.

A previous study showed that the incidence of unplanned cardiac surgery within 90 days significantly decreased with the involvement of infectious disease specialists in IE management.⁴⁸ In the present study, a significant reduction in the number of unplanned cardiac surgeries was observed. This finding suggests that the implementation of an IE team may reduce the need for unexpected cardiac surgeries, potentially leading to cost savings.⁵⁷ Additionally, in the IE team of the present study, physicians from the general internal medicine department were deeply involved in the management of IE. The results of this study suggest the importance of the role played by general internal medicine in the IE team.

The duration of antibiotic therapy was significantly longer after the establishment of the IE team. This may be attributed to the higher proportion of patients with muscle abscesses and the trend toward more cases with vertebral osteomyelitis during the intervention period. Pyomyositis and psoas abscesses typically require 4 to 6 weeks of antibiotic treatment, and in cases with extensive or multiple lesions, or when drainage is insufficient, a longer duration of therapy may be necessary.^{58,59} Antibiotic treatment for vertebral osteomyelitis typically lasts approximately six weeks; however, in patients at a high risk of treatment failure, including those with Methicillin-Resistant *Staphylococcus aureus* infections or extensive disease, prolonged antibiotic therapy may be required.^{60,61} These factors likely contributed to the extended duration of therapy observed after team implementation.

Infectious aneurysms are an important complication of IE that can influence clinical decision-making.^{62–66} In this study, only four cases were identified, and all were managed without in-hospital mortality. Due to the limited number of cases, we were unable to assess whether the implementation of the IE team improved the detection or management of aneurysms. Previous studies have reported that infectious aneurysms occur in 2–9% of IE cases,^{67–69} and are less strongly associated with short-term mortality compared to other complications such as systemic embolism or uncontrolled sepsis.⁷⁰ Therefore, while their detection remains clinically important, their overall impact on short-term outcomes may be limited.

Limitations

This study has several limitations. First, as this was a retrospective study, selection and information biases may have been present owing to the single tertiary care facility setting and the potential incompleteness of medical records. Compared with the nationwide data reported by Okamoto et al,¹⁷ the patients in this cohort were slightly younger and had a lower prevalence of diabetes and history of IE. In contrast, this cohort had a higher proportion of patients with malignancy, higher Charlson Comorbidity Index scores, and a greater incidence of stroke. These differences in the baseline characteristics and complications suggest that the generalizability of the findings may be limited. Second, due to the observational nature of the study design, a causal relationship between the establishment of the IE team and the clinical outcomes cannot be definitively established. Third, patients who were not registered with a diagnosis of IE in the DPC system may not have been included in the study. Fourth, even before the IE team was formally established, multiple departments were already involved in IE management through collaborative efforts, which may have limited the ability to accurately evaluate the effectiveness of the team. Fifth, outcomes and follow-up data after discharge were collected from electronic medical records. However, unreported complications could not be fully documented, and the follow-up status was unknown for patients who transitioned to care at other facilities. In addition, we did not systematically collect detailed data on infectious aneurysms, as their clinical significance in the overall management of IE has been considered relatively low compared to other complications such as systemic embolism or uncontrolled sepsis in a prior study.⁷⁰ Future studies should evaluate their impact in more detail. Sixth, the sample size was small, and the statistical power may

have been insufficient to detect differences in clinical outcomes owing to the small number of events. Further large-scale, multicenter studies with longer follow-up periods are required to more accurately assess the effectiveness of multidisciplinary team interventions.

Conclusion

In this retrospective study conducted at a tertiary care facility in Japan, implementation of the IE team was not associated with a reduction in 90-day all-cause or in-hospital mortality. However, the incidence of unplanned cardiac surgery within 90 days of admission significantly decreased in the intervention period. This finding suggests that multidisciplinary team-based care may improve specific clinical outcomes. At the same time, the intervention period was also characterized by a significantly longer duration of antibiotic therapy, which may have been influenced by a higher prevalence of complications including muscle abscesses. Although infectious aneurysms were rare in our cohort, they remain an important complication to be addressed in future studies. Further large-scale, multicenter studies are warranted to evaluate the long-term benefits of IE team interventions.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

During the preparation of this work, the authors used ChatGPT (OpenAI) for the purpose of English language editing. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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Disclosure

The authors report no conflicts of interest in this work.

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