ORIGINAL ARTICLE

ลักษณะทางคลินิกและผลลัพธ์ของภาวะเยื่อบุหัวใจอักเสบติดเชื้อ: ประสบการณ์ตลอด 5 ปี ในโรงพยาบาลเจ้าพระยาอภัยภูเบศร

Clinical Presentation and Outcome of Infective Endocarditis: A Five–year Experience at Chaophya Abhaibhubejhr Hospital, A Provincial Community Hospital in Thailand

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บทคัดย่อ

ที่มาของปัญหา: เยื่อบุหัวใจอักเสบติดเชื้อ (Infective Endocarditis) เป็นภาวะที่มีอาการแสดงทางคลินิกหลากหลาย และสามารถส่งผลกระทบต่ออวัยวะอื่นๆ ได้ ภาวะนี้พบได้บ่อยในประเทศกำลังพัฒนา ภาวะนี้อาจนำไปสู่การตัดผ่าเปิดหัวใจ และก่อให้เกิดภาวะแทรกซ้อนรุนแรง เช่น โรคหลอดเลือดสมอง (Stroke) หรือแม้กระทั่งการเสียชีวิต

วัตถุประสงค์: เพื่อวิเคราะห์ลักษณะทางคลินิก ข้อมูลประชากร และข้อมูลทางคลินิกของผู้ป่วยเยื่อบุหัวใจอักเสบติดเชื้อ รวมถึงค้นหาปัจจัยที่ทำนายผลลัพธ์ทางคลินิกที่อาจเกิดขึ้น

วิธีการศึกษา: เป็นการศึกษาระยะยาว (prospective cohort study) ในผู้ป่วยที่เข้ารับการตรวจคลื่นเสียงสะท้อนหัวใจ (Echocardiography) ตั้งแต่วันที่ 1 ตุลาคม พ.ศ. 2560 ถึงวันที่ 30 พฤศจิกายน พ.ศ. 2565 และได้รับการวินิจฉัยว่าเป็นเยื่อบุหัวใจอักเสบติดเชื้อ เก็บข้อมูลด้านประชากรและทางคลินิก เช่น อาการแสดง ภาวะแทรกซ้อน ผลการตรวจทางห้องปฏิบัติการ และการรักษา นำมาสรุปและวิเคราะห์ โดยใช้สถิติวิเคราะห์แบบถดถอยโลจิสติก เพื่อหาปัจจัยเสี่ยงต่ออัตราการเสียชีวิตในโรงพยาบาลและการเกิดภาวะลิ่มเลือดหลุดอุดตัน

ผลการศึกษา: จากผู้ป่วย 8,098 ราย ที่ได้รับการตรวจ Echocardiography พบ 65 ราย (ร้อยละ 0.8) เป็นเยื่อบุหัวใจอักเสบติดเชื้อ ส่วนใหญ่เป็น เพศชาย (ร้อยละ 67.7) อายุมัธยฐาน 51 ปี (IQR 41-62) โดยมีโรคร่วมที่พบได้บ่อย ได้แก่ ความดันโลหิตสูง (ร้อยละ 40), โรคไตเรื้อรัง (ร้อยละ 24.6), เบาหวาน (ร้อยละ 20) และร้อยละ 12.3 ต้องได้รับการฟอกไต อาการสำคัญ ได้แก่ ร้อยละ 95.4 มีอาการไข้, ระยะเวลาไข้ มัธยฐาน 72 ชม. (48-336), ร้อยละ 53.5 มีภาวะหัวใจล้มเหลว, และร้อยละ 21.5 ต้องเข้าหอผู้ป่วยวิกฤติ (ICU) ตำแหน่งลิ้นหัวใจที่พบบ่อยคือ Mitral (ร้อยละ 63.1), Aortic (ร้อยละ 27.7), และ Tricuspid (ร้อยละ 9.2) เชื้อก่อโรคหลักคือ *Streptococcus* spp. (ร้อยละ 40) และ *Staphylococcus* spp. (ร้อยละ 35.4) อัตราการเสียชีวิตในโรงพยาบาลอยู่ที่ร้อยละ 12.3 โดยภาวะแทรกซ้อนที่พบบ่อยที่สุดคือ โรคหลอดเลือดสมอง (ร้อยละ 23.1) และเยื่อหุ้มสมองอักเสบ (ร้อยละ 18.5) ผลวิเคราะห์พบว่า โรคไตเรื้อรังสัมพันธ์กับการเสียชีวิต (OR 23.51, p=0.04) และระดับความรู้สึกตัวลดลงสัมพันธ์กับโรคหลอดเลือดสมอง (OR 17.67, p=0.004)

สรุป: การศึกษานี้พบว่าผู้ป่วยเยื่อบุหัวใจอักเสบติดเชื้อส่วนใหญ่อาการแสดงด้วยไข้และภาวะหัวใจล้มเหลว โดยอายุมัธยฐานที่ได้รับการวินิจฉัยคือ 51 ปี และลิ้นหัวใจที่ตรวจพบเยื่อหุ้มหัวใจอักเสบติดเชื้อบ่อยที่สุดคือลิ้นหัวใจ Mitral ภาวะนี้มีอัตราการเสียชีวิตในโรงพยาบาล ร้อยละ 12.3 อัตราการนอนในหอผู้ป่วยวิกฤติ ร้อยละ 21.5 ผู้ป่วยที่มีภาวะไตวายเรื้อรังมีการพยากรณ์โรคที่เลวร้ายกว่า

คำสำคัญ: เยื่อหุ้มหัวใจอักเสบ, ปัจจัยเสี่ยง, การติดเชื้อที่เยื่อหุ้มหัวใจ, ภาวะแทรกซ้อน

Thaiclinicaltrials.org number, TCTR20250216015

ABSTRACT

BACKGROUND: Infective endocarditis has a broad clinical manifestation with multi-organ involvement. Infective endocarditis is common in developing countries and can lead to open heart surgery as well as other serious complications such as stroke, or death.

OBJECTIVES: This study investigates the clinical characteristics, outcomes, and predictors of adverse events in patients diagnosed with IE at Chaophya Abhaibhubejhr Hospital.

METHODS: We conducted a prospective cohort study among patients who underwent echocardiography from October 1, 2017, to November 30, 2022, and were diagnosed with infective endocarditis. Demographic and clinical data, such as signs, symptoms, complications, laboratory results, and treatment, were collected and summarized. Risk factors for inpatient mortality and embolic phenomenon were determined by logistic regression analysis.

RESULTS: Of the 8,098 patients who underwent transthoracic echocardiography, 65 patients (0.8%) with infective endocarditis were identified. Forty-four were men (67.7%) with a median (Interquartile range (IQR) age of 51 years (41-62). A total of 26 (40%) had essential hypertension, 16 (24.6%) had chronic kidney disease, 8 (12.3%) received renal replacement therapy, and 13 (20%) had diabetes. Fever was present in 95.4% of cases, with a median (IQR) fever duration of 72 hours (48–336) before diagnosis. Heart failure was observed in 35 patients (53.5%), 14 (21.5%) needed an intensive care unit at presentation, and the median (IQR) APACHE II score was 11 (6-16). The majority were native valves (95.4%), and valve involvement comprised mitral valves (63.1%), aortic valves (27.7%), and tricuspid valves (9.2%), respectively. The Median (IQR) vegetation size was 9 millimeters (5-12), and the left ventricular ejection fraction was 64% (57-68%). Causative pathogens were *Streptococcus* spp. (40%) followed by *Staphylococcus* spp. (35.4%), and the median (IQR) time to positive hemoculture was 12 hours. Overall inpatient mortality was 12.3%. The common embolic phenomenon was ischemic stroke (23.1%), followed by meningitis (18.5%). By multivariate analysis, the associated factor for inpatient mortality was chronic renal failure (odds ratio 23.51, p=0.04), and the associated factor for stroke was the alteration of consciousness at presentation (odds ratio 17.67, p=0.004).

CONCLUSIONS: At the authors' center, patients with infective endocarditis typically present with fever and congestive heart failure. The average age at diagnosis is 51 years, with the mitral valve being the most affected. The inpatient mortality rate is 12.3%, and 21.5% require ICU admission. Chronic renal failure is also a predictor of poor outcomes.

KEYWORDS: endocarditis, prognostic factor, infective endocarditis, complications

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INTRODUCTION

Infective endocarditis (IE) is a severe, life-threatening condition caused by microbial colonization of the endocardium, primarily affecting heart valves[1]. Despite advancements in medical care, IE remains associated with significant morbidity and mortality, with a global incidence of 3–10 cases per 100,000 people and an in-hospital mortality rate of 20–25%[2-3]. In Thailand, in-hospital mortality ranges from 17.7% to 25%[4].

The clinical presentation of IE varies widely, from non-specific symptoms like fever and malaise to severe complications such as sepsis, embolic events, and heart failure. Classical signs include fever, heart murmurs, petechiae, Osler nodes, Janeway lesions, and Roth spots[5]. Embolic complications may involve the brain, lungs, spleen, or kidneys, further delaying diagnosis. Known risk factors include pre-existing valvular disease, prosthetic valves, congenital heart defects, intravenous drug use, and chronic comorbidities such as diabetes and chronic kidney disease[6].

The common pathogens causing IE are viridans streptococci, *Streptococcus gallolyticus*, HACEK organisms, *Staphylococcus aureus*, and *Enterococcus* spp., with *Enterococcus* spp. remaining a frequent cause of community-acquired infections[5]. The modified Duke criteria remain the cornerstone of IE diagnosis, integrating clinical, microbiological, and imaging findings[7]. Echocardiography, particularly transesophageal echocardiography (TEE), is essential for detecting valvular involvement, and advanced imaging modalities like PET/CT and MRI further aid in identifying complications[8].

The epidemiology of IE varies globally. High-income countries report increasing cases associated with prosthetic valves, healthcare settings, and intravenous drug use, while rheumatic heart disease remains a predominant risk factor in low- and middle-income countries[9-10]. Delays in treatment due to healthcare access limitations and low health literacy contribute to poorer outcomes[10-11].

Thailand presents a distinct epidemiological landscape where both traditional and emerging risk factors coexist. While rheumatic heart disease persists, industrialization and urbanization have increased the prevalence of healthcare-associated IE and degenerative valve diseases. Additionally, cultural and occupational exposures, such as undercooked pork and pig farming, have led to *Streptococcus suis* infections, responsible for approximately 6.4% of IE cases in the country[12-13].

Identifying the predictors of poor outcomes in IE remains crucial, particularly in resource-limited settings where early recognition and intervention can improve survival. This study investigates the clinical characteristics, outcomes, and factors associated with mortality and other adverse events in patients diagnosed with infective endocarditis (IE) at Chaophya Abhaibhubejhr Hospital. By identifying modifiable risk factors, the authors aim to enhance diagnostic and therapeutic strategies, particularly in resource-limited settings, ultimately improving patient outcomes and informing health policy decisions in developing countries.

METHODS

A prospective cohort study was carried out on adults (≥18 years old) diagnosed with infective endocarditis (IE) at Chaophya Abhaibhubejhr Hospital, Thailand, between October 1, 2017, and November 30, 2022. IE was diagnosed based on the modified Duke criteria. Patients were included if they had undergone transthoracic echocardiography (TTE) for suspected IE, valvular disease, pulmonary hypertension, or left ventricular ejection fraction (LVEF) assessment. This study was approved by the ethics committee of the hospital (Certificate Number IRB-BHUBEJHR-073), and written informed consent was obtained from all participants prior to enrollment.

Exclusion criteria included patients who declined participation or were unable to provide consent. The sample size was calculated to predict mortality in IE, assuming a 25% mortality rate, 80% power, and a 5% significance level. Stemming from logistic regression-based sample size estimation, the minimum required sample size was 57 patients, which was adjusted to 63 patients to account for a 10% loss to follow-up.

Data collection included structured patient interviews, real-time clinical observations, and electronic medical record reviews. Collected variables encompassed demographic characteristics (age, sex, socioeconomic status), medical history (comorbidities, prior antibiotic use), laboratory data (blood cultures, inflammatory markers, renal function, complete blood count), echocardiographic findings (valve involvement, vegetation size, abscess formation), and treatment details (antibiotics, surgical interventions, supportive care such as renal replacement therapy or mechanical ventilation). APACHE II scores were recorded at admission to assess disease severity, but they were analyzed as predictors rather than primary outcomes, ensuring consistency with the study objectives and findings.

Statistical analyses were conducted using Stata 18.0 (StataCorp LLC, College Station, TX). Continuous variables were summarized as medians and interquartile ranges (Shapiro-Wilk test confirmed non-normal distribution), while categorical variables were expressed as frequencies and percentages. The Wilcoxon rank-sum test was applied to compare continuous variables, while chi-square or Fisher's exact tests were used for categorical variables. Univariate logistic regression identified predictors of adverse outcomes, including in-hospital mortality, ICU admission, and embolic events. Variables with p-value <0.10 in univariate analysis were included in a stepwise multivariate logistic regression to adjust for confounders, with results presented as odds ratios (OR) and 95% confidence intervals (CI). Kaplan-Meier survival analysis applied hospitalization duration and time to positive blood culture, as rapid microbial growth was presumed to correlate with disease severity, with differences analyzed using the log-rank test. Data validation was performed in Stata's data editor, with two independent statisticians verifying the statistical scripts for accuracy and reproducibility. A p-value<0.05 was considered statistically significant.

Results

Among 8,098 patients who underwent transthoracic echocardiography, 65 (0.8%) were diagnosed with infective endocarditis (IE). The median age was 51 years (IQR: 41–62), with 67.7% being male. Fever was the most common symptom (95.4%), with a median time to diagnosis of 72 hours (IQR: 48–336). Other reported symptoms included dyspnea (55.4%), musculoskeletal pain (23.1%), and altered consciousness (27.7%). Congestive heart failure was present in 53.8% of cases, with a significantly higher prevalence in non-survivors (87.5% vs. 49.1%, p=0.04). The median APACHE II score was 11 (IQR: 6–16), and non-survivors had significantly higher scores (18 vs. 10, p=0.002), indicating greater disease severity at presentation. Common comorbidities included hypertension (40%), chronic renal failure (24.6%), and diabetes mellitus (20%). Positive blood cultures were found in 84.6%, with a median time to positivity of 12 hours (IQR: 8–18). The most frequently isolated pathogens were *Streptococcus* spp. (40%) and *Staphylococcus aureus* (30.8%). The Kaplan-Meier survival curve depicts the time to positive hemoculture stratified by survival status. The median time to a positive blood culture was significantly shorter among non-survivors (8.5 vs. 14 hours, p=0.04), suggesting that rapid microbial growth may correlate with increased disease severity and poorer outcomes (Table 1, Figure 1).

Table 1 Clinical characteristics, comorbidities, and microbiological findings in patients with infective endocarditis

Factor	Total (n=65)	Survivors (n=57)	Non-Survivors (n=8)	*p*-value
Clinical Characteristic				
Median (IQR) age at the time of diagnosis, years	51 (41-62)	50 (41-62)	53.5 (44.5-60.5)	0.85
Male, n (%)	44 (67.7)	39 (88.6)	5 (11.4)	0.74
Clinical Presentation				
Fever, n (%)	62 (95.4)	54 (94.4)	8 (100)	0.51
Median (IQR) onset of fever to diagnosis, hours	72 (48-336)	84 (48-408)	60 (36-96)	0.13
Dyspnea, n (%)	36 (55.4)	32 (56.1)	4 (50)	0.74
Paroxysmal nocturnal dyspnea, n (%)	20 (30.8)	17 (24.8)	3 (37.5)	0.66
Musculoskeletal pain, n (%)	15 (23.1)	14 (24.6)	1 (12.5)	0.45
New cardiac murmur, n (%)	47 (72.3)	41 (71.9)	6 (75)	0.86
Palpitation, n (%)	13 (20.3)	13 (22.8)	0	0.16
Alteration of consciousness, n (%)	18 (27.7)	15 (26.3)	3 (37.5)	0.51
Dental caries, n (%)	22 (33.9)	21 (36.8)	1 (12.5)	0.17
Underlying disease				
Diabetes Mellitus, n (%)	13 (20)	8 (14.0)	5 (62.5)	0.001
Hypertension, n (%)	26 (40.0)	19 (33.3)	7 (87.5)	0.003
Chronic renal failure, n (%)	16 (24.6)	9 (15.8)	7 (87.5)	<0.001
End-stage renal disease received RRT, n (%)	8 (12.3)	1 (1.75)	7 (87.5)	<0.001
PLHIV, n (%)	5 (7.7)	5 (8.8)	0	0.38
Immunocompromised state, n (%)	11 (16.9)	10 (17.5)	1 (12.5)	0.72
Current smoker, n (%)	17 (26.2)	16 (28.1)	1 (12.5)	0.35
Current alcohol consumer, n (%)	20 (30.8)	20 (35.1)	0	0.04
Severity at presentation				
Need Intensive care unit, n (%)	14 (21.5)	13 (22.8)	1 (12.5)	0.51
Shock, n (%)	12 (18.5)	10 (17.5)	2 (25)	0.61
Congestive heart failure, n (%)	35 (53.9)	28 (49.1)	7 (87.5)	0.04
Renal failure, n (%)	23 (35.4)	15 (26.3)	8 (100)	<0.001
Respiratory failure, n (%)	22 (33.6)	17 (29.8)	5 (62.5)	0.06
Median (IQR) APACHE II score	11 (6-16)	10 (6-15)	18 (17-21)	0.002
Investigations				
Positive hemoculture, n (%)	55 (84.6)	47 (82.5)	8 (100)	0.20
Median (IQR) time to positive hemoculture, hours	12 (8-18)	14 (9-19)	8.5 (6-13.5)	0.04
Pathogen, n (%)				0.07
***Staphylococcus* spp.**	23 (35.4)	17 (29.8)	6 (75)	
Staphylococcus aureus	20 (30.8)	15 (26.3)	5 (62.5)	
Coagulase-negative Staphylococci	3 (4.6)	2 (3.5)	1 (12.5)	

Table 1 Clinical characteristics, comorbidities, and microbiological findings in patients with infective endocarditis (continue)

Factor	Total (n=65)	Survivors (n=57)	Non-Survivors (n=8)	*p*-value
Viridans group streptococci	10 (15.4)	10 (17.5)	0	
Beta-hemolytic streptococci (*S.pyogenase, S. agalactiae, S.dysagalactiae*)	10 (15.4)	9 (15.8)	1 (12.5)	
Streptococcus gallolyticus	2 (3.1)	2 (3.5)	0	
Streptococcus suis	3 (4.6)	3 (5.3)	0	
Streptococcus gordonii	1 (1.5)	1 (1.8)	0	
Enterococcus faecalis	3 (4.6)	3 (5.3)	0	
Corynebacterium striatum	2 (3.1)	1 (1.8)	1 (12.5)	
Citrobacter spp.	1 (1.5)	1 (1.8)	0	

IQR=Interquartile range, PLHIV=People living with HIV, RRT=Renal replacement therapy

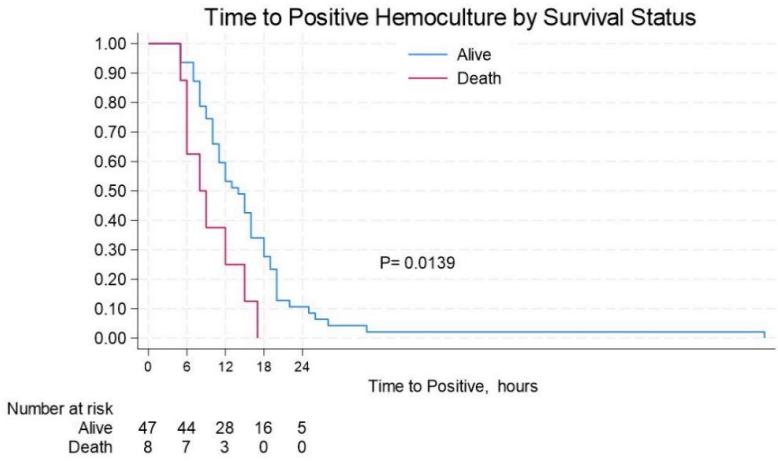

Figure 1 Kaplan-Meier survival curve showing time to positive hemoculture stratified by survival status

Characteristics of Echocardiogram

Native valve involvement was observed in 95.4% of cases, primarily affecting the mitral (63.1%), aortic (27.7%), and tricuspid (9.2%) valves. Non-survivors had a higher frequency of aortic valve involvement (50% vs. 24.6%, *p*=0.05) and tricuspid valve involvement (25% vs. 7%, *p*=0.05). They also had lower median left ventricular ejection fraction (LVEF) (54.5% vs. 65%, *p*=0.03). The median vegetation size was 9 mm (IQR: 5–12), with no significant difference between survivors and non-survivors (*p*=0.69) (Table 2).

Table 2 Transthoracic echocardiographic findings in patients with infective endocarditis

Factor	Total (n=65)	Survivors (n=57)	Non-Survivors (n=8)	*p*-value
Echocardiogram characters				
Native valve, n (%)	62 (95.4)	54 (94.7)	8 (100)	0.51
Prosthetic valve, n (%)	3 (4.62)	3 (5.3)	0	0.51

Table 2 Transthoracic echocardiographic findings in patients with infective endocarditis (continue)

Factor	Total (n=65)	Survivors (n=57)	Non-Survivors (n=8)	*p*-value
Valve involvement, n (%)				0.05
Aortic valve involvement	18 (27.7)	14 (24.6)	4 (50.0)	
Mitral valve involvement	41 (63.1)	39 (68.4)	2 (25)	
Tricuspid valve involvement	6 (9.2)	4 (7.0)	2 (25)	
Median (IQR) vegetation size, mm	9 (5-12)	9 (5-12)	10.5 (5.5-14.5)	0.69
Vegetation size ≥10 mm	31 (47.7)	26 (45.6)	5 (62.5)	0.37
Median (IQR) left ventricular ejection fraction (%)	64 (57-68)	65 (58-68)	54.5 (44.5-60.5)	0.03

IQR=Interquartile range

Factors for Inpatient mortality and clinical outcome (Table 3)

The inpatient mortality rate was 12.3%. Non-survivors were more likely to have chronic renal failure (87.5%, $p<0.001$), require renal replacement therapy (100%, $p<0.001$), or have diabetes (62.5%, $p=0.001$). They were also more likely to develop heart failure (87.5% vs. 49.1%, $p=0.04$) and renal failure (100% vs. 26.3%, $p<0.001$). Alcohol consumption was associated with lower mortality ($p=0.04$). ICU admission was higher among non-survivors (87.5% vs. 43.9%, $p=0.02$), although ICU stay duration did not differ significantly ($p=0.78$). Non-survivors had shorter hospital stays (median 20.5 vs. 42 days, $p=0.08$). Valve surgery was performed in 26.2% of patients, showing a trend toward survival benefit ($p=0.07$). Multivariate analysis identified chronic renal failure (OR=23.51, $p=0.04$) and altered consciousness at presentation (OR=17.67, $p=0.004$) as independent predictors of mortality.

Table 3 Clinical outcomes in patients with infective endocarditis

Factor	Total (n=65)	Survivors (n=57)	Non-Survivors (n=8)	*p*-value
Embolic phenomenon				
Stroke, n (%)	15 (23.1)	12 (21.5)	3 (37.5)	0.30
Meningitis, n (%)	12 (18.5)	9 (15.8)	3 (37.5)	0.14
Hematuria, n (%)	22 (33.9)	21 (36.8)	1 (12.5)	0.17
Others, n (%)	17 (26.2)	15 (26.3)	2 (25)	0.94
Intracardiac abscess/Valve perforation, n (%)	4 (6.2)	4 (7.0)	0	0.44
Outcome				
Median (IQR) length of stay, days	38 (28-44)	42 (29-44)	20.5 (14-46)	0.09
ICU admission, n (%)	32 (49.2)	25 (43.9)	7 (87.5)	0.02
Median (IQR) ICU, length of stay, days	6 (3-8)	6 (3-8)	6 (4-7)	0.78
Valve surgery, n (%)	17 (26.2)	17 (29.8)	0	0.07
Persistent hemoculture >48 hours, n (%)	13 (20)	11 (19.3)	2 (25)	0.71

IQR=Interquartile range

Factors for Stroke

Stroke occurred in 23.1% of patients, with higher frequency among non-survivors (37.5% vs. 21.5%, *p*=0.301). Embolic events were seen in 23.1%, highlighting the need for early intervention.

DISCUSSION

The clinical presentation of infective endocarditis (IE) in this study aligns with global trends, with fever (95.4%), dyspnea (55.4%), and heart failure (53.8%) being the most common symptoms. These findings are consistent with prior studies where heart failure remains a predominant complication of IE, contributing to adverse outcomes[2]. In comparison to previous cohorts, however, our study population exhibited a higher prevalence of chronic comorbidities, including hypertension, diabetes mellitus, and chronic kidney disease, reflecting the growing burden of noncommunicable diseases in low- and middle-income countries (LMICs)[2-3]. The late presentation of IE in resource-limited settings further complicates diagnosis and management, delaying definitive treatment and increasing complication rates. The recent 2023 update to the Duke criteria[14] raises questions about whether classification changes would have influenced the findings herein. Since this study was based on the modified Duke criteria available at the time, future research should assess the impact of these revisions on diagnostic accuracy and prognostication.

Microbiologically, *Streptococcus* spp. and *Staphylococcus* spp. were the most frequently identified pathogens, a finding consistent with global epidemiology[2]. However, this study observed a higher inpatient mortality associated with *Staphylococcus aureus* (62.5% in non-survivors, *p*=0.001), underscoring its virulence and rapid disease progression. The median time to positive blood culture was significantly shorter among non-survivors (8.5 vs. 14 hours, *p*=0.04), suggesting a higher bacterial load and more aggressive infection. This finding supports the importance of early microbiological diagnosis and prompt initiation of appropriate antimicrobial therapy. Though antimicrobial resistance was not explicitly evaluated, it remains a major concern, particularly in regions with high rates of antibiotic misuse.

Chronic kidney disease (CKD) has emerged as the strongest predictor of inpatient mortality, aligning with previous research demonstrating its impact on worse IE outcomes[15]. Renal dysfunction contributes to impaired immune response, altered antibiotic pharmacokinetics, and increased burden of comorbidity, all of which can exacerbate disease progression. These findings emphasize the need for early nephrology consultation and nephroprotective antibiotic regimens in IE patients with renal impairment[16]. Our cohort showed a higher rate of neurological complications than previous studies, with ischemic strokes occurring in 23.1% of cases, highlighting the need for increased awareness and intervention. Notably, altered consciousness was a key predictor of stroke risk (OR=17.67, *p*=0.004), reinforcing the importance of early neurological assessment and echocardiographic risk stratification[17].

Surgical intervention is a cornerstone of IE management in cases of refractory heart failure, persistent infection, or large vegetation. However, this study demonstrated a low surgical rate (26.2%), likely due to barriers such as limited access to cardiothoracic surgery and delayed referrals, a challenge previously documented in resource-limited settings. Addressing systemic barriers to cardiac surgery, including strengthening referral networks and expanding specialized surgical services, is crucial for reducing IE-related morbidity and mortality. Additionally, dental caries were identified in 33.9% of patients, suggesting a role for poor oral hygiene as a risk factor for IE. Incorporating dental hygiene education into primary care models could be a cost-effective prevention strategy, particularly in LMICs,

where routine dental care is often underutilized.

This study offers important insights into IE at a provincial community hospital in Thailand, with strengths including comprehensive data collection and a focus on a resource-limited setting. However, its single-center design and small sample size limit generalizability. Future multicenter studies should investigate antimicrobial resistance patterns, genetic predispositions, and long-term clinical outcomes to refine guidelines for IE management and public health policies. Strengthening healthcare systems, improving early diagnosis, and implementing multidisciplinary care approaches are essential for enhancing IE treatment and reducing mortality in resource-limited settings.

Conflicts of Interest: None

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