JOURNAL OF THE AMERICAN COLLEGE OF CARDIOLOGY VOL. 74, NO. 2, 2019

PUBLISHED BY ELSEVIER

Prevalence of Infective Endocarditis in *Enterococcus faecalis* Bacteremia

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ABSTRACT

BACKGROUND *Enterococcus faecalis* is the third most frequent cause of infective endocarditis (IE). Despite this, no systematic prospective echocardiography studies have examined the prevalence of IE in patients with *E. faecalis* bacteremia.

OBJECTIVES This study sought to determine the prevalence of IE in patients with *E. faecalis* bacteremia. The secondary objective was to identify predictors of IE.

METHODS From January 1, 2014, to December 31, 2016, a prospective multicenter study was conducted with echocardiography in consecutive patients with *E. faecalis* bacteremia. Predictors of IE were assessed using multivariate logistic regression with backward elimination.

RESULTS A total of 344 patients with *E. faecalis* bacteremia were included, all examined using echocardiography, including transesophageal echocardiography in 74% of the cases. The patients had a mean age of 74.2 years, and 73.5% were men. Definite endocarditis was diagnosed in 90 patients, resulting in a prevalence of 26.1 ± 4.6% (95% confidence interval [CI]). Risk factors for IE were prosthetic heart valve (odds ratio [OR]: 3.93; 95% CI: 1.76 to 8.77; $p = 0.001$), community acquisition (OR: 3.35; 95% CI: 1.74 to 6.46; $p < 0.001$), ≥3 positive blood culture bottles (OR: 3.69; 95% CI: 1.88 to 7.23; $p < 0.001$), unknown portal of entry (OR: 2.36; 95% CI: 1.26 to 4.40; $p = 0.007$), monomicrobial bacteremia (OR: 2.73; 95% CI: 1.23 to 6.05; $p = 0.013$), and immunosuppression (OR: 2.82; 95% CI: 1.20 to 6.58; $p = 0.017$).

CONCLUSIONS This study revealed a high prevalence of 26% definite IE in patients with *E. faecalis* bacteremia, suggesting that echocardiography should be considered in all patients with *E. faecalis* bacteremia.
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Enterococcus faecalis is the third most frequent cause of infective endocarditis (IE), a disease with high morbidity and mortality (1,2). A recent review found enterococci to be the most frequent cause of endocarditis in patients undergoing transcatheter aortic valve replacement (3). Despite this, no systematic prospective echocardiographic studies have examined patients with *E. faecalis*

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Manuscript received February 27, 2019; revised manuscript received April 8, 2019, accepted April 22, 2019.

ISSN 0735-1097/$36.00 https://doi.org/10.1016/j.jacc.2019.04.059

ABBREVIATIONS AND ACRONYMS

IE = infective endocarditis

OR = odds ratio

TEE = transesophageal echocardiography

bacteremia to determine the prevalence of IE. There are only a few retrospective and case-control studies showing an estimated IE prevalence ranging from 5% for mixed enterococcal bacteremia to 13% for monomicrobial *E. faecalis* bacteremia (4–7). All studies were limited by low rates of echocardiography, with transesophageal echocardiography (TEE) rates as low as 12% (6). The prevalence of IE was lowest in the studies with the lowest echocardiographic examination rates (4–7). Several studies have shown that *E. faecalis* IE is increasing (8–10), and the low prevalence of IE in some studies of *E. faecalis* bacteremia may be biased by low rates of echocardiography (6). The increase in *E. faecalis* IE is likely related to an aging population with more comorbidities, more implanted prosthetic material in the heart, and an increasing number of surgical procedures in the urinary and gastrointestinal tract (11–13). Echocardiography is the cornerstone imaging technique in diagnosing IE (14). The important question is whether current medical practice with rather low echocardiography rates results in missed cases of endocarditis. Given the limited evidence of the actual prevalence of IE in patients with *E. faecalis* bacteremia, we conducted the present study with systematic echocardiographic screening in all patients with *E. faecalis* bacteremia. The objectives of the study were to prospectively estimate the prevalence of IE in patients with *E. faecalis* bacteremia and to identify predictors of IE.

SEE PAGE 202

METHODS

STUDY SETUP. In a multicenter setup with 10 hospitals in the Capital Region of Denmark covering a catchment area of approximately 1.5 million people, all adult patients (>18 years of age) with *E. faecalis* bacteremia were considered for inclusion during the 3-year study period (January 1, 2014, to December 31, 2016). Consecutive inclusion of all patients with *E. faecalis* bacteremia was ensured by daily contact between the principal investigator and the different departments of clinical microbiology. Completeness of data was further validated by continuously drawing lists of patients with *E. faecalis* bacteremia from the microbiological database twice a week. In this way all patients with *E. faecalis* bacteremia were considered for inclusion. Patients dying before the results of the blood cultures were available and patients considered so terminally ill that clinicians terminated all treatment were excluded. Follow-up control blood cultures were performed only if clinicians suspected continued bacteremia and thus not performed routinely in all patients.

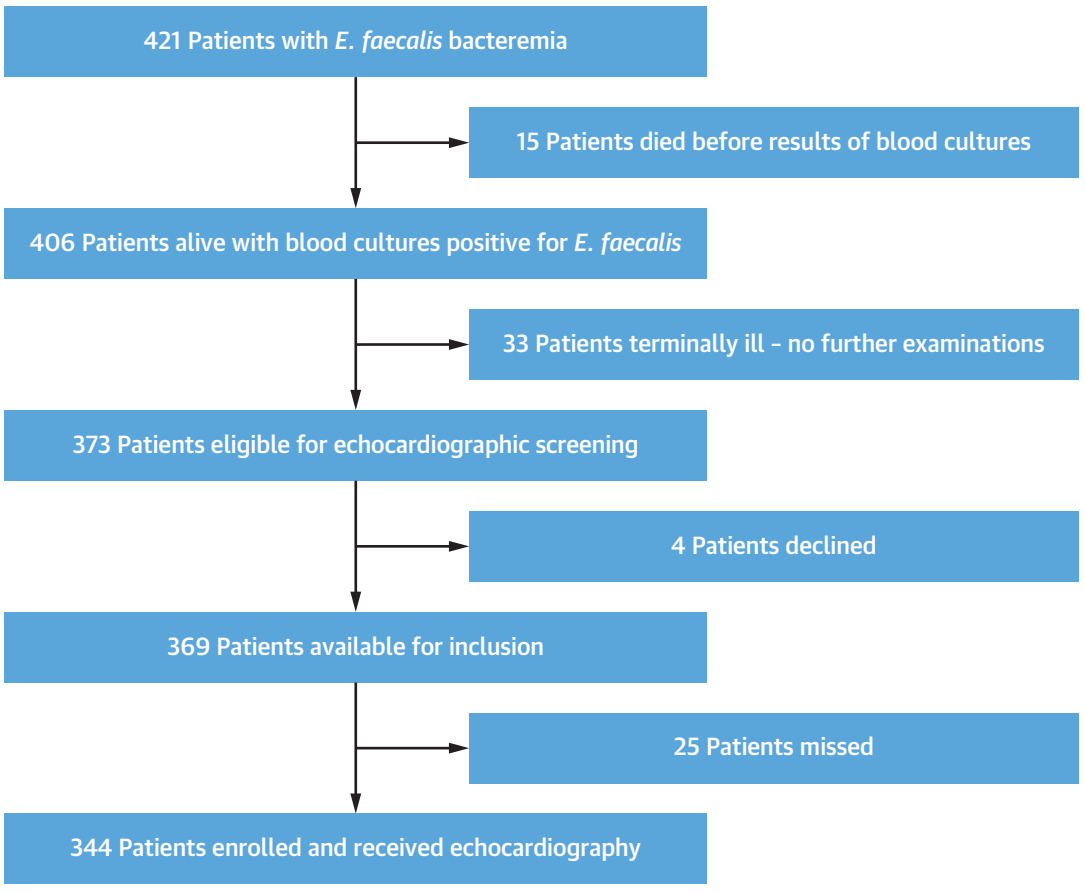
Two of the hospitals were referral centers for endocarditis, and all hospitals have videoconferences with a tertiary center. Patients with complicated IE were transferred to an IE center and evaluated for cardiothoracic surgery.

DEFINITIONS. The diagnosis of IE versus non-IE was made by the multidisciplinary IE expert team, assessing all available information including clinical data, laboratory data, cardiac imaging, and data to evaluate the modified Duke criteria. The assessment of cardiac imaging was not done blinded to clinical data. The decision was made during admission when the necessary information was available to confirm or reject the diagnosis of IE. The expert team used the modified Duke criteria (15) and the current version of the guidelines of the European Society of Cardiology to evaluate the diagnosis (16,17). According to this, positron emission tomography/computed tomography was included in the expert team evaluation on the basis of the findings of Saby et al. (18). Cases with Duke-definite IE were all diagnosed with definite IE by the expert team. Cases with Duke-possible IE were included in the non-IE group except for 3 cases with obvious clinically confirmed IE (large vegetations but only 1 positive blood culture) resulting in the IE expert team's diagnosing them with definite IE and including them in the IE group.

The mode of acquiring *E. faecalis* bacteremia was defined as previously described (19) on the basis of the most used international definitions in IE studies distinguishing between community acquired, health care-associated, and in-hospital acquired (1,20,21). The presumed portal of entry was determined as follows: 1) microbiologically established if *E. faecalis* was cultured from a clinically plausible entry site; 2) clinically established if there were clear signs and symptoms of localized infection entry and/or a clear temporal link to a proceeding surgical procedure; or 3) when none of these categories were fulfilled, the presumed portal of entry was registered as unknown. To assess comorbidity we calculated the Charlson comorbidity index on the basis of the algorithm proposed by Quan et al. (22). Immunosuppression was defined as active treatment with immunosuppressant medication such as corticosteroids (any dose), chemotherapy, or antirheumatic drugs affecting the immune system.

Relapse *E. faecalis* infection was defined as within 6 months, and reinfection with *E. faecalis* was defined as occurring between 6 and 12 months after primary infection.

FIGURE 1 Patient Enrollment



A total of 421 adult patients were diagnosed with *Enterococcus faecalis* bacteremia. Fifteen patients died before the results of the blood cultures and were excluded. Additionally, 33 patients were considered so terminally ill that all treatment and examinations were terminated, and therefore they were excluded. From the remaining 373 patients, 4 patients declined echocardiography, and 25 patients missed screening because of rapid discharge.

FOLLOW-UP. In Denmark, all patients have a unique social security number, making 100% follow-up possible through electronic patient charts, microbiological databases, and the Danish registry of death. Relapse and reinfection with *E. faecalis* as well as death of any cause were registered.

STATISTICAL ANALYSIS. Categorical data are expressed as frequencies and percentages and were compared between groups using chi-square and Fisher exact tests as appropriate. Continuous data are expressed as mean ± SD or median and interquartile range, and groups were compared using 2-sample Student's *t*-tests or Mann-Whitney *U* tests, respectively. Clinical variables expected to be potentially important predictive variables of the outcome (IE) on the basis of published research were included in the univariate logistic regression. All variables were allowed entry in the multivariate logistic regression. Independent predictors were determined using backward elimination with a significance level of $p < 0.05$ for a variable to stay in the model. A 2-sided p value <0.05 was considered to indicate statistical significance in all analyses. All statistical analyses were completed using IBM SPSS version 24.0 (SPSS, Chicago, Illinois) and SAS version 9.4 (SAS Institute, Cary, North Carolina).

SENSITIVITY ANALYSES. To limit the risk for tautology from allowing variables in the multivariate logistic regression that are also part of the modified Duke criteria, we conducted a 2-step sensitivity analysis. In the first part, we used a method from Tubiana et al. (23), excluding all patients with definite

TABLE 1 Clinical Characteristics of *Enterococcus faecalis* Bacteremia Versus Endocarditis

	Endocarditis (n = 90)	No Endocarditis (n = 254)	p Value
Age, yrs	74.6 ± 12	74.1 ± 13	0.716
Male	71 (79)	182 (72)	0.181
Charlson comorbidity index	2.0 (1–4)	3.0 (1–4)	0.078
Predisposing conditions			
Cardiac device	21 (23)	34 (13)	0.027
Prosthetic valve	25 (28)	15 (6)	<0.001
Other valve disease	8 (9)	18 (7)	0.578
Previous endocarditis	3 (3)	4 (2)	0.384
Immunosuppression	13 (14)	25 (10)	0.231
Mode of acquisition			
Community acquired	40 (44)	39 (15)	<0.001
Health care associated	47 (52)	160 (63)	0.073
In-hospital acquired	3 (3)	55 (22)	<0.001
Presumed portal of entry			
Urinary tract	33 (37)	140 (55)	0.003
Other*	10 (11)	30 (12)	0.859
Gastrointestinal	6 (7)	36 (14)	0.063
Unknown	41 (46)	48 (19)	<0.001

Values are mean ± SD, n (%), or median (interquartile range). *Intravenous catheter, dialysis catheter, wound infection, respiratory system, and dental focus.

IE in whom the definite classification was dependent on the presence of the modified Duke criteria prosthetic valve or continuous *E. faecalis* bacteremia (included in the statistical model as potential predictors of IE). In the second part, we excluded the variables prosthetic valve and/or number of positive blood cultures to evaluate the other predictors without including the variables possibly influenced by tautology.

SAMPLE SIZE CALCULATION. On the basis of earlier retrospective studies (5,7) finding an IE prevalence of 10% to 15% in *E. faecalis* bacteremia, we used an estimated IE prevalence of 15% to calculate the sample size. To obtain a 95% confidence interval around an IE estimate of 15 ± 5%, a minimum sample size of 196 patients with *E. faecalis* bacteremia was required.

ETHICS AND PERMISSIONS. Treatment followed normal clinical routines referring to European Society of Cardiology and national guidelines, and echocardiography was offered and recommended as part of the examination program for *E. faecalis* bacteremia as advised by the Danish Society of Cardiology (24). Data were collected with the approval of the Danish Health and Medicines Authorities with journal numbers 3-3013-764/1, 3-3013-764/2, and 3-3013-764/3 and handled according to approval by the Danish Data Protection Agency with journal number GEH-2014-036.

RESULTS

Patient inclusion is shown in Figure 1. During a 3-year period (January 1, 2014, to December 31, 2016), a total of 421 adult patients were diagnosed with *E. faecalis* bacteremia. After exclusion, all remaining 344 patients were examined with echocardiography, including TEE in 253 patients (74%). Ninety patients were diagnosed with definite endocarditis by the IE team, resulting in an IE prevalence of 26.1 ± 4.6% (95% confidence interval). The diagnosis of IE versus non-IE was made on median day 3 after positive blood cultures (interquartile range: 2 to 6 days). Sixty-seven patients (19%) were classified as having possible IE according to the modified Duke criteria. Sixty-four of these Duke-possible IE cases (96%) were diagnosed as bacteremia only by the IE expert team and included in the non-IE group. The remaining 3 patients (4%) with Duke-possible IE were diagnosed as having certain IE by the IE expert team and included in the IE group. These 3 patients with IE were diagnosed on the basis of large vegetations (>10 mm) and 1 of 2 blood cultures with *E. faecalis* (Duke minor).

The mean age of the patients was 74 years, and 26% of patients were women, without any significant difference between patients with and those without IE (Table 1). Both groups carried a moderate to high degree of comorbidity, with a nonsignificantly higher Charlson comorbidity index in patients without IE. Patients diagnosed with IE had a significantly higher rate of prosthetic heart valves and cardiac devices (Table 1).

CHARACTERISTIC OF INFECTION. The mode of acquiring the infection was dominated by health care-associated infections in both groups. Community acquired infection was more common in patients with IE, whereas in-hospital acquisition was more common in those with bacteremia without IE. The urinary tract was the most frequent presumed portal of entry, followed by the gastrointestinal tract. Unknown portal of entry was frequent and significantly more common in patients with IE (Table 1).

SYMPTOMS AND CLINICAL AND LABORATORY FINDINGS. Upon admission, the most frequently reported symptom was fever. Patients with endocarditis presented with more unspecific symptoms and a clinical picture with only moderately elevated white blood cell count and C-reactive protein and less often with systemic inflammatory response syndrome (Online Table 1). Microbiological findings showed that patients with IE more often had monomicrobial *E. faecalis* bacteremia (90%) and ≥3

positive blood culture bottles (84%) (Online Table 2). High-level gentamicin resistance (minimal inhibitory concentration ≥256 mg/l) was significantly more common in *E. faecalis* strains causing IE (17%) compared with strains causing bacteremia only (6%) (p = 0.009). Few *E. faecalis* strains (3%) were resistant to penicillin (minimal inhibitory concentration >8 mg/l), and none of the strains were resistant to vancomycin or ampicillin (Online Table 2).

ECHOCARDIOGRAPHIC FINDINGS IN PATIENTS WITH ENDOCARDITIS. The 90 patients with definite IE were diagnosed primarily on the basis of vegetations (83%) (Table 2). Twenty-three patients had small vegetations (≤5 mm), 25 patients had medium-size vegetations (5 to 10 mm), and 27 patients had large vegetations (≥10 mm). The remaining patients were diagnosed on the basis of intracardiac abscess (n = 6), significant new paravalvular leak or dehiscent prosthetic valve (n = 4), pseudoaneurysm or perforation (n = 3), and findings on positron emission tomography/computed tomography (n = 2). Most frequent was aortic valve endocarditis, followed by mitral endocarditis and combined aortic and mitral valve endocarditis. Less frequent were isolated pacemaker lead endocarditis, tricuspid valve endocarditis, and pulmonary valve endocarditis. Of the 75 patients with vegetations, transthoracic echocardiography missed vegetations in 35 cases (47%) in which TEE found vegetations.

PREDICTORS OF ENDOCARDITIS. Predictive factors for endocarditis were prosthetic heart valve, community acquisition, ≥3 positive blood culture bottles, unknown portal of entry, monomicrobial infection, and immunosuppression (Figure 2).

The first part of the sensitivity analysis performed in a subset of 318 patients resulted in a model with no differences regarding 5 of the independent variables: community acquisition, unknown origin, prosthetic heart valve, immunosuppression, and ≥3 positive blood culture bottles. Only monomicrobial infection (not part of the modified Duke criteria) was insignificant and therefore removed from the model (Online Table 3). The second part of the sensitivity analysis demonstrated that the predictive factors in the statistical model remained significant after excluding prosthetic valve and/or ≥3 positive blood culture bottles (Online Table 4).

Dividing the patients into a low-risk group (0 risk factors), an intermediate-risk group (1 or 2 risk factors), and a high-risk group (3 to 6 risk factors), the IE prevalence was 3.4%, 13.9%, and 56.1%, respectively (Central Illustration).

TABLE 2 Echocardiographic Findings, Treatment, Complications, and Outcomes

	Endocarditis (n = 90)	No Endocarditis (n = 254)	p Value
Echocardiographic findings			
Large vegetations (>10 mm)	27 (30)	–	
Medium-size vegetations (5–10 mm)	25 (28)	–	
Small vegetations (<5 mm)	23 (26)	–	
Intracardiac abscess	6 (7)	–	
Aortic valve IE	51 (57)	–	
Mitral valve IE	22 (24)	–	
Aortic and mitral valve IE	10 (11)	–	
Pacemaker lead IE	3 (3)	–	
Tricuspid or pulmonary valve IE	4 (4)	–	
Treatment			
Antibiotic treatment, days	42 (29–45)	9 (6–12)	<0.001
Heart valve surgery	17 (19)	0 (0)	<0.001
Cardiac device removal	8 (9)	0 (0)	<0.001
Complications			
Osteomyelitis	6 (7)	2 (1)	0.005
Stroke	8 (9)	5 (2)	0.007
Other embolic event	7 (8)	1 (0.4)	<0.001
AV block	2 (2)	0 (0)	0.068
Acute heart failure	8 (9)	0 (0)	<0.001
Outcomes			
Relapse infection at 6 months	6 (7)	10 (4)	0.380
Reinfection between 6 and 12 months	1 (1)	3 (1)	1.000
Mortality in hospital	16 (18)	25 (10)	0.046
Mortality at 1 yr (discharged alive)*	17 (23)	82 (36)	0.041

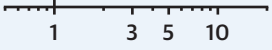
Values are n (%) or median (interquartile range). *n = 74 (endocarditis) and n = 229 (no endocarditis), excluding patients dying in the hospital.
AV = atrioventricular; IE = infective endocarditis.

TREATMENT, COMPLICATIONS, AND OUTCOMES. Patients with endocarditis were treated significantly longer with intravenous antibiotics (Table 2). Heart valve surgery because of endocarditis was completed in almost 20% of the patients, and approximately 10% of the patients with IE had their cardiac devices removed (Table 2). Relapse *E. faecalis* infection within 6 months and reinfection with *E. faecalis* between 6 and 12 months were comparable in the 2 groups. Patients with endocarditis had higher in-hospital mortality, whereas if discharged alive, the 1-year mortality was significantly lower in patients surviving endocarditis (Table 2). When combining mortality in-hospital and during the first year after discharge, there was no significant difference between the groups.

INTENTION TO SCREEN. None of the excluded patients underwent echocardiography, and therefore the echocardiography rate in the total cohort was 82% (344 of 421 patients). When including the patients declining echocardiography and those discharged before echocardiography could be performed, the total number of patients was 374. Two patients died

FIGURE 2 Predictors of Endocarditis

	Univariate Analyses		Multivariate Analysis			
Predictor for Endocarditis	**OR (95% CI)**	**P-Value**	**OR (95% CI)**	**OR (95% CI)**	**P-Value**	**IE in Subgroup**
Age, years	1.00 (0.98 - 1.02)	0.715				
Sex, male	1.48 (0.83 - 2.63)	0.183				
Community acquired	4.41 (2.58 - 7.55)	< 0.001		3.35 (1.74 - 6.46)	< 0.001	40 of 79 (51%)
Unknown origin of infection	3.59 (2.13 - 6.04)	< 0.001		2.36 (1.26 - 4.40)	0.007	41 of 89 (46%)
Previous endocarditis	2.16 (0.47 - 9.82)	0.321				
Cardiac device	1.97 (1.07 - 3.62)	0.029				
Prosthetic heart valve	6.13 (3.05 - 12.3)	< 0.001		3.93 (1.76 - 8.77)	0.001	25 of 40 (63%)
Known native valve disease	1.28 (0.54 - 3.05)	0.579				
Immunosuppression	1.55 (0.75 - 3.17)	0.234		2.82 (1.20 - 6.58)	0.017	13 of 38 (34%)
Monomicrobial infection	4.78 (2.29 - 9.96)	< 0.001		2.73 (1.23 - 6.05)	0.013	81 of 247 (33%)
≥3 positive blood culture bottles	4.71 (2.53 - 8.77)	< 0.001		3.69 (1.88 - 7.23)	< 0.001	76 of 212 (36%)



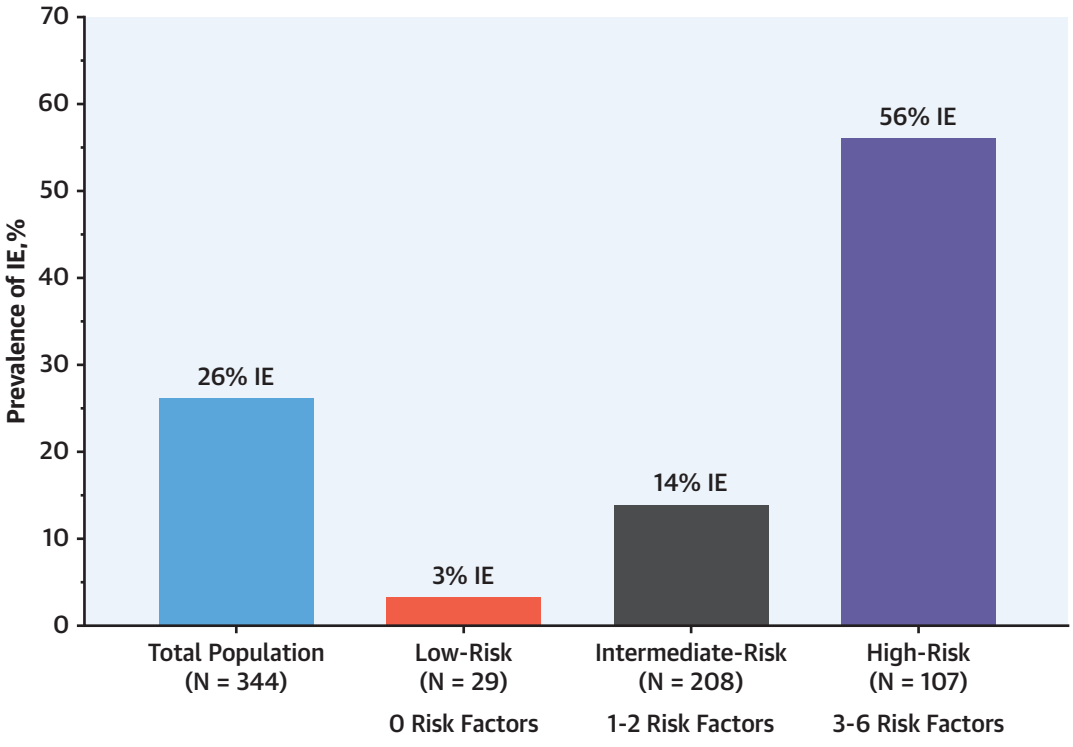
(Left) Univariate logistic regression with odds ratio (OR) and 95% confidence interval (95% CI) for endocarditis. **(Right)** Results of multivariate logistic regression with backward elimination. The **far right column** shows prevalence of infective endocarditis (IE) stratified according to the different risk factors.

in the hospital without undergoing echocardiography. None of the patients who missed screening died within 30 days of discharge or had a relapse of bacteremia within 6 months after discharge, and hence it could be assumed that they did not have IE. When including them in the non-IE group, the prevalence of IE would be 24.1 ± 4.3%. The remaining key results were not changed significantly by adding these patients to the non-IE group (data not shown).

DISCUSSION

The main finding of this study is a high IE prevalence of 26% in patients with *E. faecalis* bacteremia. This is the first study to systematically examine patients with *E. faecalis* bacteremia using echocardiography. It seems that the more extensively we examine using echocardiography, the higher the detection rate of IE. This is not surprising, but the question is, do we overlook cases of IE in the normal clinical routine? The discrepancy in IE prevalence between our prospective study and the previous studies (4-7) suggests a substantial underdiagnosis of *E. faecalis* endocarditis in the general everyday clinic represented by the earlier studies. This theory is supported by the fact that 2 of the earlier retrospective studies were performed in the same catchment area as the present study (5,7). In our study, the majority of the patients with endocarditis had extensive intracardiac infection with vegetations, abscesses, pseudoaneurysms, or dehiscent prosthetic valves. However, despite the severe infection, many patients with *E. faecalis* IE have unspecific symptoms and present with a complex clinical picture, with only moderately elevated white blood cell count and C-reactive protein and often without systemic inflammatory response syndrome. Therefore, these patients are challenging to diagnose, and there is risk for overlooking serious infection if they are not examined using echocardiography. If echocardiography is used more extensively, some cases of less severe cardiac infections will be diagnosed, and it can be difficult to distinguish between a small vegetation and a thickened degenerated valve. However, *E. faecalis* IE is a very serious disease, and diagnosing it in a milder and less invasive state and initiating appropriate treatment as early as possible may prevent serious complications such as valve destruction and abscess formation. The rate of complications in our study was relatively low compared with other studies (25-27). The relapse rate in the present study is comparable with a weighted average in a review based on 17 international *E. faecalis* IE studies (19). Earlier attempts have been made to create a risk score to reduce the need for TEE in *E. faecalis* bacteremia (6). The outcome of the NOVA score (incorporating the

CENTRAL ILLUSTRATION **Prevalence and Risk Factors of Infective Endocarditis in *Enterococcus faecalis* Bacteremia**



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Vertical axis shows the prevalence of endocarditis as a percentage. **Horizontal axis** shows the total population and patient groups divided according to number of risk factors. In unselected patients with *Enterococcus faecalis* bacteremia, the prevalence of infective endocarditis (IE) is as high as 26%. On the basis of multivariate logistic regression, 6 independent risk factors were identified: community-acquired infection, unknown origin of infection, prosthetic heart valve, immunosuppression, monomicrobial infection, and ≥3 positive blood culture bottles. Low-risk patients have 0 risk factors, intermediate-risk patients have 1 or 2 risk factors, and high-risk patients have 3 to 6 risk factors. In the high-risk group, the prevalence of endocarditis was 56%.

number of positive blood cultures, origin of the bacteremia, previous valve disease, and auscultation of heart murmur) study was that the only 2 determinant factors determining whether TEE should be performed were ≥3 positive blood cultures with *E. faecalis* and unknown origin of infection (6). In contrast to the actual TEE rate of 12% in the study by Bouza et al. (6), their NOVA score estimated that a TEE rate of >70% would be needed to find all cases of IE. In our study, we confirm some of the known risk factors for *E. faecalis* IE: prosthetic heart valve, unknown origin of infection, 3 or more positive blood culture bottles with *E. faecalis*, community acquisition, and monomicrobial infection (6,7,28,29). As a novel finding, we discovered immunosuppressant therapy to be independently associated with the development of IE in *E. faecalis* bacteremia. The likely explanation for why immunosuppression is not significant in the univariate analysis is that none of these patients can end up in the community-acquired group because of definitions. Therefore, because community acquisition is a known strong predictor of IE, immunosuppression becomes insignificant in the univariate analysis. However, in the multivariate analysis when adjusting for mode of acquisition, immunosuppression becomes significant. All of these risk factors are central to the clinician when assessing individual patients with *E. faecalis* bacteremia.

Instead of creating another complex risk score, we advise that these factors be included in the combined clinical evaluation of each patient by the endocarditis team. In our study, <10% of the patients were in a true low-risk group (0 risk factors).

The higher in-hospital mortality found in patients with endocarditis is likely related to the acute course of infection with related complications and possible need for urgent high-risk surgery. However, if discharged alive, patients with IE had significantly better 1-year survival than those without IE. This could be explained partly by the slightly lower comorbidity score in the patients with IE as well as a selection bias, with only the strongest patients with IE surviving an extended admission.

On the basis of our findings, we recommend increasing the use of echocardiography in *E. faecalis* bacteremia. In *Staphylococcus aureus* bacteremia, the guidelines recommend TEE on the basis of screening studies finding an endocarditis prevalence of 22% to 25% (30,31). We find an endocarditis prevalence of 26% and propose that TEE should be considered in all patients with *E. faecalis* bacteremia, especially those with relevant risk factors.

STUDY LIMITATIONS. Our study was done in a specific geographic region in Scandinavia, with the possible limitation that findings could be different in other areas of the Western world. The properties of the *E. faecalis* strains, including virulence traits and resistance patterns, are likely related to geography. The study was done in a population-based setting considering all patients with *E. faecalis* for inclusion in an unselective approach.

The study could have been improved by performing systematic control blood cultures in all patients during and after the treatment to investigate more thoroughly for continuous and relapse bacteremia.

CONCLUSIONS

We found a high prevalence of 26% IE in patients with *E. faecalis* bacteremia and suggest an increase in the use of echocardiography in patients with *E. faecalis* bacteremia.

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PERSPECTIVES

COMPETENCY IN PATIENT CARE AND PROCEDURAL SKILLS: Patients with *E. faecalis* bacteremia have a high prevalence of IE and should undergo echocardiography.

TRANSLATIONAL OUTLOOK: Further research is needed to compare the prevalence of IE in patients with *E. faecalis* bacteremia in various geographic regions and to ascertain whether strains of *E. faecalis* with specific genomic traits are more likely to cause endocarditis.

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KEY WORDS blood cultures, community acquisition, echocardiography, prosthetic heart valve, risk factors, screening

APPENDIX For supplemental tables, please see the online version of this paper.