Infective Endocarditis in French West Indies: A 13-Year Observational Study

Elisabeth Fernandes,^{1*} Claude Olive,^{2,3} Jocelyn Inamo,⁴ François Roques,⁵ André Cabié,^{3,6,7} and Patrick Hochedez^{3,7}

¹Department of Infectious Diseases, Medicine B, Hospital of Basse Terre, Guadeloupe, France; ²Laboratory of Bacteriology, University Hospital of Martinique, Fort-de-France, France; ³Université des Antilles, EA 4537, Fort-de-France, France; ⁴Department of Cardiology, University Hospital of Martinique, Fort-de-France, France; ⁵Department of Thoracic and Cardiovascular Surgery, University Hospital of Martinique, Fort-de-France, France; ⁶INSERM, CIC1424, Cayenne, France; ⁷Department of Infectious Diseases, University Hospital of Martinique, Fort-de-France, France

Abstract. We conducted an observational study to describe the characteristics of infective endocarditis (IE) in French West Indies (FWI) and to identify variables associated with in-hospital case fatality. The records of the patients admitted for IE to the University Hospital of Martinique between 2000 and 2012 were collected using an electronic case report form. Only Duke-Li definite cases were considered for this analysis. Variables associated with in-hospital mortality were tested using univariate logistic regression analysis. The analysis included 201 patients (median age 58 years, sex ratio: two males to one female). There was no previously known heart disease in 45.8%, a prosthetic valve in 21.4%, and previously known native valve disease in 32.8% of the cases. Community-acquired IE represented 59.7% of all cases, health-care-associated IE represented 38.3% and injection-drug-use-acquired IE represented 1.5%. Locations of IE were distributed as follows: 42.3% were mitral valve IE, 34.8% were aortic valve IE, and 7% were right-sided IE. Microorganisms recovered from blood cultures included 30.4% streptococci, 28.9% staphylococci, and 5% enterococci. Blood cultures were negative in 20.9% of the cases. Surgical treatment was performed in 53% of the patients. In-hospital case fatality rate was 19%. Advanced age, *Staphylococcus aureus* IE, and health-care-associated IE were associated with in-hospital case fatality. The epidemiological and microbiological profile of IE in FWI is in between those observed in developed countries and developing countries: patients were younger, blood cultures were more frequently negative, and IE due to group D streptococci and enterococci were less common than in industrialized countries.

INTRODUCTION

Since Osler's first descriptions in 1885,¹ there has been great progress in the diagnosis and therapeutics of infective endocarditis (IE); however, its mortality and morbidity are still high.^{2,3} With an annual incidence between 30 and 100 cases per million inhabitants depending on the countries,^{4–9} IE is an uncommon disease but nonetheless serious, with an in-hospital case fatality rate around 20% and 1-year mortality remains at 30%.^{3–5,10–13}

The epidemiological profile of patients affected with IE has changed within the last decades. In developed countries, health-care-associated IE accounts for 25–30% of contemporary cohorts^{3,6,9} and patients are older, with an annual incidence reaching 145 cases per million inhabitants when between 70 and 80 years of age.⁴ There is an increase in degenerative valve disease, in prosthetic valves and in indwelling cardiac devices, and a decrease in rheumatic heart disease.^{2,3}

The incidence of staphylococcal IE increased in industrialized countries, a trend that follows the increase of *Staphylococcus aureus* risk factors, such as contact with health-care systems, invasive procedures, intravascular device, hemodialysis, diabetes, and injection drug use (IDU).^{14–17} In the same time, oral streptococcal IEs have considerably decreased in industrialized countries.^{14,18}

The annual incidence of IE in France is considered to be around 33 cases per million inhabitants, and the epidemiological and microbiological profile of IE is similar to that in other developed countries.^{5,6}

The epidemiological profile of patients affected with IE changes according to the country's level of industrialization. Hence, IE-affected patients in developing countries are younger and have higher risk to develop IE upon congenital or rheumatic heart disease; moreover, the incidence of blood culture-negative IE (BCNIE) and mortality are higher.^{19–21}

To date, no study has described the current features of IE in French West Indies (FWI). The aim of the present study was to describe the epidemiology, clinical characteristics, and outcome of IE in FWI, and to identify the factors associated with in-hospital mortality.

MATERIALS AND METHODS

Study population and protocol. This retrospective cohort study was conducted at the University Hospital of Martinique, a large tertiary-care teaching hospital with 1,300 beds, in Martinique, FWI. About 40,000 patients are admitted each year and it includes the only thoracic and cardiovascular surgery department in the FWI.

Patients were included in the study according to the following criteria: 1) definitive diagnosis of IE according to the modified Duke criteria,²² (2) and admission to the University Hospital of Martinique between January 1, 2000 and December 31, 2012.

Patients were excluded from the study if 1) their medical record was not available, or 2) affected by non-IE, or 3) affected by a "possible infective endocarditis" according to the modified Duke criteria.²²

A retrospective search was done in the records of the hospital for all cases of IE that were diagnosed during the study period. Clinical data, microbiological data, and echocardiography reports were reviewed and the diagnosis of IE was verified according to the modified Duke criteria. The following information were collected using an electronic case report form: sex, date of birth, place of residence,

* Address correspondence to Elisabeth Fernandes, Department of Infectious Diseases, Medicine B, Hospital of Basse Terre, Av. Gaston Feuillard, 97110 Basse Terre, Guadeloupe, France. E-mail: fernandes.elisabeth@free.fr

transfer from or to another facility, history of heart disease, procedures and situations at risk for IE, comorbidities, clinical signs and symptoms, laboratory and imaging examinations, echocardiographic data, microbiological data, medical and surgical treatment, and outcome.

Definition of variables. A health-care-associated IE was defined as non-nosocomial or nosocomial:

- A non-nosocomial IE was defined as IE diagnosed within the first 48 hours of hospitalization in a patient exposed to health-care procedures: 1) care with home nurses, 2) hemodialysis or intravenous chemotherapy within the 30 days before the onset of IE, 3) hospitalization in an acute care hospital in the 90 days before the onset of IE, 4) residency in nursing home or long-term care facility, or 5) invasive procedure and surgery within the year prior to infection.
- A nosocomial IE was defined as IE developing in a patient hospitalized for more than 48 hours before the onset of signs or symptoms consistent with IE.

A community-acquired IE was defined as IE diagnosed upon admission (or within the first 48 hours of hospitalization) in a patient that had not been exposed to care procedures.

The IE was considered as associated to the use of intravenous drugs in IDU patients who were active when IE was diagnosed.

Statistical analysis. The variables are presented using median with the first and third quartiles for the quantitative variables, and as effectives and frequencies for the qualitative variables. The Fisher's exact test was used to compare

categorical data. The Mann-Whitney test was used to compare continuous data between groups. When appropriate, odds ratio and 95% confidence interval were computed. Groups were compared by the log-rank test. The risk of error of the first kind was 5% ($\alpha = 0.05$) for all the tests. All statistical analyses were performed using STATA software, version 12 (StataCorp, College Station, TX).

RESULTS

A total of 308 medical records with an IE diagnosis were identified. Eleven patients (3.6%) had a cardiac device infection without associated IE and five patients (1.6%) were affected by non-IE: three Libman-Sacks endocarditis and two marasmic endocarditis. Seventy patients (22.7%) were excluded because IE was invalidated during hospitalization. Twenty-one patients (6.8%) had a possible IE. Finally 201 patients (65.3%) were included with a definite IE according to the modified Duke criteria (Figure 1). Five of these 201 patients had two IE episodes, from which only the first one was used for the statistical analysis.

Baseline characteristics and predisposing factors are presented in Table 1. The median age was 58 years (45–71), and 135 patients (67%) were men. The most common underlying conditions were arterial hypertension (103 patients, 52%), overweight (54 patients, 32.5%), and diabetes mellitus (45 patients, 22.6%). The main extracardiac predisposing conditions were recent invasive procedure (56 patients, 33.3%), recent dental care (26 patients, 20.2%), and the presence of long-term intravenous line (33 patients, 16.4%).

FIGURE 1. Flow chart.

TABLE 1
Characteristics of infective endocarditis-affected patients

Patients characteristics	No. of patients (%)
Age $\geq$ 70 years	57 (28.4)
Male gender	135 (67.1)
First symptoms diagnosis $\leq$ 28 days	124/185 (67)
Medical history	103/199 (52)
Hypertension	54/166 (32.5)
Overweight (BMI $\geq$ 25)	45/199 (22.6)
Diabetes mellitus	24/124 (19.4)
Tabagism	34/184 (18.5)
Coronaropathy	23/166 (14)
Obesity (BMI $\geq$ 30)	12/87 (13.8)
Alcoholism	25/198 (12.6)
Acute rheumatic fever	24 (12)
Chronic kidney disease	19 (9.5)
Malignancy	17 (8.46)
Hemodialysis	12/200 (6)
Immunosuppressive therapy	5/192 (2.6)
HIV infection	56/168 (33.3)
Extracardiac predisposing factors	26/129 (20.2)
Invasive procedures within 12 months	33 (16.42)
Dental care within 3 months	4/104 (3.8)
Chronic intravenous access	43 (21.4)
IDU	92 (45.8)
Cardiac history	66 (32.8)
Underlying HD	13/189 (7)
Prosthetic valve	19 (9.5)
No previously HD	120 (59.7)
Previously known HD without prosthetic valve	77 (38.3)
Previous IE	3 (1.5)
Intracardiac device (PM or ICD)	1 (0.5)
Mode of acquisition	107 (53.2)
Community-acquired IE	38 (18.9)
Health-care-associated IE	
IDU-associated IE	
IE of unknown origin	
Outcomes	
Cardiac surgery	
In-hospital death	

BMI = body mass index; HD = heart disease; HIV = human immunodeficiency virus; ICD = implantable cardioverter defibrillator; IDU = intravenous drug use; IE = infective endocarditis; PM = pacemaker. The denominator appears when the data were not available for the 201 patients; it indicates the number of patients for whom the data were available.

The median time between first symptoms and diagnosis of IE was 15 days (8–37).

One hundred and nine patients (54.2%) had a previously known heart disease. Community-acquired IE represented 59.7% of all cases, health-care-associated IE represented 38.3% (non-nosocomial [30.8%] and nosocomial [7.5%]) and injection-drug-use-acquired IE represented 1.5% of all cases.

Eighty-eight patients (44%) had been transferred from another hospital, 47 patients from Guadeloupe, 25 patients from another hospital of Martinique, and 16 patients from French Guiana. The comparison between the 138 patients initially hospitalized in Martinique and the 63 patients transferred from Guadeloupe or from French Guiana showed significant differences: 1) transferred patients were younger (53.3 years of age [41.6–65.3]) than patients from Martinique (61.8 years of age [48.3–74]) ($P < 0.01$), and 2) transferred patients had surgery procedure more frequently: 76% of transferred patients versus 42% of patients from Martinique ($P < 0.01$).

One hundred and seven patients (53%) had surgery. Median time between diagnosis and surgical treatment was 21 days (9–44). Ninety-five patients (89%) had early surgery (defined as surgery during antibiotic therapy) and 12 patients

TABLE 2
Location of IE and echocardiographic data

Location of IE and echocardiographic data	No. of patients (%)
Location of IE	
Native valve IE	150 (74.6)
Prosthetic valve IE	39 (19.4)
Mitral valve	85 (42.3)
Aortic valve	70 (34.8)
Aortic and mitral valves	16 (8)
Tricuspid valve	12 (6)
Pulmonary valve	2 (1)
Bilateral IE	4 (2)
On indwelling cardiac device	10 (5)
Associated with a tricuspid native valve IE	2 (1)
Isolated	8 (4)
Undetermined*	4 (2)
Cardiac lesions of IE	166/197 (84)
Vegetation	69/166 (35)
Vegetation $<$ 10 mm	49/166 (25)
Vegetation 10–15 mm	48/166 (24)
Vegetation $>$ 15 mm	108/165 (66)
Mobile vegetation	87/194 (45)
Regurgitation	55/180 (31)
Pulmonary hypertension	10/46 (22)
Prosthesis disinsertion	34/195 (17)
Cardiac abscess	31/187 (17)
Low LVEF	55/85 (65)
Other anomalies (aneurysms, perforations, fistulas)	

IE = infective endocarditis; LVEF = left ventricular ejection fraction. The denominator appears when the data were not available for the 201 patients; it indicates the number of patients for whom the data were available.

* Nonoperated patients with lack of echocardiographic evidence of endocardial involvement.

(11%) had late surgery. Surgical indications for patients who had surgery were 1) heart failure for 81 patients (76%), 2) prevention for embolic risk in 40 patients (37%), 3) ablation of indwelling cardiac device in eight patients (7%), and 4) uncontrolled infection in two patients (2%). In-hospital mortality was 19% with a median delay of 13.5 days (5–31) between diagnosis and death.

Location of IE and echocardiographic data. One hundred and eighty patients of 195 (92%) had both a transthoracic echocardiography and a transesophageal echocardiography, 10 patients (5%) had had a TTE only, and five patients (3%) had had a TEE only. The most common echographic data found were the presence of vegetations (84%), mobile vegetations (66%), regurgitation (45%), and pulmonary hypertension (31%) (Table 2). When the first echocardiography was negative, a second TTE/TEE had been done in 97% of the cases. Locations of IE were distributed as follows: 42.3% were mitral valve IE, 34.8% were aortic valve IE, 8% were aortic and mitral valve IE, and 7% were right-sided IE. Left-sided IEs (85.1%) were more frequent than right-sided IEs and mixed IEs. Native valve IEs (74.6%) were more frequent than prosthetic valve IEs (PVEs) (Table 2). Of 39 PVEs, 31 IEs were developed on prosthetic valve implanted for more than 1 year and eight on prosthetic valve implanted for less than 1 year. Five of these eight PVEs were nosocomial with multiresistant microorganisms and three were health-care-associated non-nosocomials.

Causative microorganisms. One hundred and fifty-nine patients (79%) had positive blood cultures. Gram-positive cocci were predominant (64.3%) with identification of *Streptococcus*, *Staphylococcus*, and *Enterococcus* species in 30.4%, 28.9%, and 5%, respectively (Table 3).

TABLE 3

Microorganisms identified in blood-positive IE patients

Microorganisms	No. of patients (%)
Streptococci	61 (30.3)
Oral streptococci	31 (15.4)
Group D streptococci	12 (5.9)
Other streptococci*	18 (9)
Enterococci	10 (5)
Staphylococci	58 (28.9)
<i>Staphylococcus aureus</i>	46 (22.9)
Methicillin susceptible	42 (20.9)
Methicillin resistant	4 (2)
Coagulase-negative staphylococci	12 (6)
Methicillin resistant	6 (3)
HACEK†	8 (4)
≥ 2 microorganisms‡	8 (3.9)
Other§	14 (7)
No microorganism identified by blood culture	42 (20.9)
Serological identification	2 (1.1)
Heart valve culture	7 (3.4)
No microorganism identified	33 (16.4)

IE = infective endocarditis. The denominator appears when the data were not available for the 201 patients; it indicates the number of patients for whom the data were available.

* Twelve *Streptococcus agalactiae*, one *Streptococcus* spp., and five *Streptococcus pneumoniae*.

† Five *Haemophilus parainfluenzae*, one *Haemophilus aphrophilus*, one *Aggregatibacter* (previously *Actinobacillus) actinomycetemcomitans*, and one undetermined HACEK group bacteria.

‡ *Staphylococcus aureus* and *Escherichia coli*; *Klebsiella pneumoniae* and *Candida albicans*; *Enterococcus faecalis* and *E. coli*; *Streptococcus mutans* and *Streptococcus mitis*; *Aeromonas sobria* and *Streptococcus bovis*; *S. aureus* and *Enterococcus faecalis*; coagulase-negative *Staphylococcus* and unidentified hyphae; *Enterobacter aerogenes* and *Pseudomonas aeruginosa*.

§ Five *E. coli*, one *Enterobacter aerogenes*, one *Pseudomonas aeruginosa*, one *Acinetobacter*, one *Moraxella lacunata*, two *Klebsiella pneumoniae*, one *Salmonella* spp., one *Pasteurella*, one *Corynebacterium* spp.

Blood cultures were negative in 20.9% of the cases, and no microorganism was identified in 16.4% of the cases.

Of the 42 patients (20.9%) with negative blood cultures, 16 (38%) had received antibiotics within 7 days of the blood culture. The recommended serology testing performed in seven patients of the 42 patients with BCNIEs resulted in the identification of a case of IE due to *Bartonella henselae* and a case of IE due to *Coxiella burnetii*. Direct examination and surgical sample analysis (valve resection or embolectomy) were required in 90% of the operated patients and allowed identification of seven BCNIEs: one mycotic aneurysm and two valves were positive with gram-positive cocci, one valve was positive with hemolytic group F *Streptococcus*, one valve with gram-negative bacilli, one valve with coagulase-negative *Staphylococcus*, and one with *Penicillium* spp.

Microorganisms found in the community-acquired IE were staphylococci in 23.2% of the cases and oral streptococci in 30.5%, whereas in health-care-associated IE, staphylococci were found in 56.3% of the cases and oral streptococci in 3.1%. In the nosocomial cases of IE, staphylococci were found in 78.6% of the cases, whereas none had oral streptococci. Methicillin-susceptible *S. aureus* was the microorganism found in the three IDU patients.

Complications. The main complications identified were heart failure (58.7%), acute renal failure (24%), and metastatic infection (including embolization, metastatic abscess, and mycotic aneurysm) (22.4%) (Table 4).

In-hospital mortality. Factors associated with in-hospital fatality are presented in Table 5. The following variables were associated with a decrease in in-hospital mortality: surgical treatment, community-acquired IE, and streptococcal IE.

TABLE 4

Prevalence of complications in patients with IE

Complications	No. of patients (%)
Cardiac complications	141 (70)
Heart failure	118 (58.7)
Others (abscess, perforations, prosthetic dysfunction)	23 (11.3)
Extracardiac complications	113 (56)
Acute renal failure	48 (24)
Metastatic infection	45 (22.4)
Stroke	29 (14.4)
Musculoskeletal complications	24 (11.9)
Spondylodiscitis	8 (4)

IE = infective endocarditis. The denominator is indicated when the data were not available for the 201 patients; it shows the number of patients for whom the data were available.

DISCUSSION

Despite the medical advances in the diagnosis and treatment of IE, mortality and morbidity remain high. A better understanding of demographic, clinical, therapeutic, and prognostic characteristics of the disease can result in better diagnosis and treatment of patients. Our work represents the largest study conducted in patients with IE in FWI and gives an update of the characteristics of the disease.

Patients with IE in FWI are mainly old men—however, younger than in studies carried out in metropolitan France—mainly without history of valve disease as in the other industrialized countries.^{3,4,11} Degenerative valve disease and valve prostheses represent the majority of underlying heart diseases in our study. The important portion of patients without underlying heart diseases is probably linked to 1) the decrease in acute rheumatic fever that had an incidence of 19.6/100,000 inhabitants in Martinique aged over 20 years at the beginning of the eighties,²³ 2) a better prevention among high-risk patients, and also (3) a lack of diagnosis for degenerative valve disease in older patients.

As in other studies, most IEs were located on native valve and the mitral valve was most frequently affected.^{3,21} The important proportion of health-care-associated IE (38.3%) in our study was also reported in many regions of the world and is linked to the increase in invasive medical care.^{3,6,14,16}

In our study such as in several studies published since 2000,^{3,6,14,16} *S. aureus* was the most frequently identified microorganism (22.9%). Although risk factors for *S. aureus*-associated IE are widespread, Murdoch's study shows the importance of geographical variations. Indeed *S. aureus* is the causative bacteria in 31% of the cases while considering the whole cohort reported, but this rate reaches 43% in the United States and only 17% in South America.³ Interestingly in our study, *Streptococcus* species were more frequently responsible for IE than *Staphylococcus* species. Furthermore, the proportion of BCNIEs was more frequent, whereas IEs due to group D streptococci or enterococci were less common than in developed countries.^{3,24} Similar results were found in South America and in Jamaica^{3,25} which suggests that the epidemiological and microbiological profile of IE in our study is between developing and developed countries' epidemiological profile.

If the epidemiological conditions are probably similar in Martinique and Guadeloupe, both Caribbean islands, the particular epidemiology of French Guiana must be taken into account, especially in BCNIE. The high number of

TABLE 5
Factors associated with in-hospital mortality among patients with infective endocarditis

Variables	OR (95% CI)	P value
Age > 50 years	3.84 (1.42–10.38)	< 0.01
Arterial hypertension	3.61 (1.60–8.13)	< 0.01
Immunosuppressive therapy	7.09 (2.11–23.79)	< 0.01
Cancer	3.68 (1.36–9.93)	0.01
Chronic kidney disease	4.70 (1.91–11.58)	< 0.01
Wearer of valve prosthesis (-es)	2.69 (1.25–5.83)	0.012
Indwelling cardiac device	3.72 (1.64–8.42)	< 0.01
Hemodialysis	3.45 (1.22–9.78)	0.019
Invasive procedure within 12 months	2.89 (1.31–6.36)	< 0.01
Health-care-associated IE (nosocomial and non-nosocomial)	4.71 (2.21–10.08)	< 0.01
Nosocomial IE	3.61 (1.17–11.12)	0.025
Community-acquired IE	0.21 (0.09–0.45)	< 0.01
Heart complications	7.74 (2.28–26.21)	< 0.01
Neurological signs at the time of diagnosis	3.63 (1.36–9.65)	0.01
Cerebrovascular accident	2.71 (1.14–6.44)	0.024
Acute renal failure	2.21 (1.04–4.73)	0.04
<i>Staphylococcus aureus</i> IE	3.45 (1.63–7.29)	< 0.01
Enterococcal IE	3.38 (1.01–11.29)	0.048
Streptococcal IE	0.27 (0.1–0.74)	0.011
Surgical treatment	0.21 (0.09–0.46)	< 0.01

CI = confidence interval; IE = infective endocarditis; OR = odds ratio.

BCNIEs found in our study (20.9%) is due to several factors: mainly to antibiotic therapies prior to blood culture, but also to a lack of investigations. We observed that serological tests were not systematically reported for patients with BCNIE, and that surgical sample analyses were not systematically required. According to a retrospective study conducted in French Guiana, in 2005, the annual incidence rate of acute Q fever was estimated at 150/100,000 persons.^{26–28} In two seroprevalence studies conducted in Brazil, it appears that *Coxiella burnetii* seroprevalence was 3.9%, *B. henselae* seroprevalence was 13.7%, and *Bartonella quintana* seroprevalence was 12.8% in the Brazilian population.^{29,30} Frankel and others reported an increase in Q fever in France and the study of Murdoch and others also specified that most cases of Q fever and *Bartonella* IE came from Europe.^{3,31}

Few bacterial serologies are recommended by the European Society of Cardiology for cases of BCNIE. Given the available epidemiological data about the Amazon region and the lack of seroprevalence study in the FWI, the microbiological analysis of surgical specimens, as well as the serology for *Bartonella* spp. and *Coxiella burnetii*, should be systematic in BCNIE cases in our region. Thanks to new techniques in molecular biology, a microbiological diagnosis can be performed in cases of BCNIE and in cases of possible IE.³² However, because of an increasing number of immunocompromised persons, fungal IE or IE with atypical microorganism must be considered. In a recent review on 270 cases of fungal endocarditis, the three main fungi identified were *Candida* (52%), *Aspergillus* (24%), and *Histoplasma* (6%).³³ The FWI and French Guiana region is an endemic area for histoplasmosis and, although no endocarditis has been reported to date, this localization has been described in the literature and is a potential etiology of BCNIE.^{34,35}

In-hospital case fatality rate in our study was of 19%, which corresponds to other studies' results in which in-hospital fatality is around 20%.^{3–5,10,11} We have found several factors

that were associated with in-hospital fatality, such as age > 50 years, presence of valve prosthesis and implantable cardioverter defibrillator, IE due to *S. aureus*, health-care-associated IE, and cardiac complications. These prognostic factors associated with in-hospital fatality in our study are similar to the ones described in the literature.^{3,7}

We have found that streptococcal IE and surgical treatment were associated with decreased in-hospital fatality. Indications and timing for surgical intervention were recently discussed in several articles with conflicting results.^{10,36,37} Early surgery during antibiotic therapy has been reported as a protective factor for in-hospital mortality in several studies but the appropriate timing of surgery remains controversial.^{10,38–40}

The study has several limitations. First, it consisted of a retrospective study with patients lost to follow up and missing data. Moreover, it was based only on the medical reports from the University Hospital of Martinique. There is probably a selection bias with patients initially hospitalized in Martinique on one hand, and patients transferred from French Guiana and Guadeloupe on the other hand. It was indeed found that these two groups were heterogeneous and had different characteristics, with more transferred patients undergoing surgery. Second, there was no systematic serological assessment and an analysis of the surgical specimens for all BCNIEs because there was no standardized diagnostic protocol shared between the different actors during the study period. After the current study, each IE case in FWI and French Guiana is expected to be included in a multicenter cohort study and diagnosis and treatment options are discussed within an "endocarditis team" as recommended by recent guidelines.⁴¹

In conclusion, the epidemiological and microbiological profile of IE in FWI is between those observed in developing and developed countries: patients were younger, blood cultures were more frequently negative, and IEs due to group D streptococci and enterococci were less common than in industrialized countries. Treatment of IE in the FWI

and French Guiana would benefit from implementation of endocarditis team, aiming to improve diagnosis and treatment procedure, adapted to local epidemiological features.

Received June 22, 2016. Accepted for publication February 15, 2017.

Published online April 10, 2017.

Authors' addresses: Elisabeth Fernandes, Department of Infectious Diseases, Medicine B, Hospital of Basse Terre, Guadeloupe, France, E-mails: fernandes.elisabeth@free.fr or elisabeth.fernandes@ch-labassetterre.fr. Claude Olive, Laboratory of Bacteriology, University Hospital of Martinique, Fort-de-France, France, E-mail: claude.olive@chu-fortdefrance.fr. Jocelyn Inamo, Department of Cardiology, University Hospital of Martinique, Fort-de-France, France, E-mail: jocelyn.inamo@chu-fortdefrance.fr. François Roques, Department of Thoracic and Cardiovascular Surgery, University Hospital of Martinique, Fort-de-France, France, E-mail: francois.roques@chu-fortdefrance.fr. André Cabié and Patrick Hochedez, Department of Infectious Diseases, University Hospital of Martinique, Fort-de-France, France, E-mails: andre.cabie@chu-fortdefrance.fr and patrick.hochedez@chu-fortdefrance.fr.

REFERENCES

- Osler W, 1885. The Gulstonian lectures, on malignant endocarditis. *BMJ* 1: 467–470.
- Habib G, Hoen B, Tornos P, Thuny F, Prendergast B, Vilacosta I, Moreillon P, de Jesus Antunes M, Thilen U, Lekakis J, Lengyel M, Müller L, Naber CK, Nihoyannopoulos P, Moritz A, Zamorano JL; ESC Committee for Practice Guidelines, 2009. Guidelines on the prevention, diagnosis, and treatment of infective endocarditis (new version 2009): the Task Force on the Prevention, Diagnosis, and Treatment of Infective Endocarditis of the European Society of Cardiology (ESC). *Eur Heart J* 30: 2369–2413.
- Murdoch DR, Corey GR, Hoen B, Miró JM, Fowler VG Jr, Bayer AS, Karchmer AW, Olaison L, Pappas PA, Moreillon P, Chambers ST, Chu VH, Falcó V, Holland DJ, Jones P, Klein JL, Raymond NJ, Read KM, Tripodi MF, Utili R, Wang A, Woods CW, Cabell CH; International Collaboration on Endocarditis-Prospective Cohort Study (ICE-PCS) Investigators, 2009. Clinical presentation, etiology, and outcome of infective endocarditis in the 21st century: the International Collaboration on Endocarditis-Prospective Cohort Study. *Arch Intern Med* 169: 463–473.
- Hoen B, Alla F, Selton-Suty C, Béguinot I, Bouvet A, Briançon S, Casalta JP, Danchin N, Delahaye F, Etienne J, Le Moing V, Leport C, Mainardi JL, Ruimy R, Vandenesch F; Association pour l'Etude et la Prévention de l'Endocardite Infectieuse (AEPEI) Study Group, 2002. Changing profile of infective endocarditis: results of a 1-year survey in France. *JAMA* 288: 75–81.
- Duval X, Delahaye F, Alla F, Tattévin P, Obadia JF, Le Moing V, Doco-Lecompte T, Celard M, Poyart C, Strady C, Chirouze C, Bes M, Cambau E, lung B, Selton-Suty C, Hoen B; AEPEI Study Group, 2012. Temporal trends in infective endocarditis in the context of prophylaxis guideline modifications: three successive population-based surveys. *J Am Coll Cardiol* 59: 1968–1976.
- Selton-Suty C, Célard M, Le Moing V, Doco-Lecompte T, Chirouze C, lung B, Strady C, Revest M, Vandenesch F, Bouvet A, Delahaye F, Alla F, Duval X, Hoen B; AEPEI Study Group, 2012. Preeminence of *Staphylococcus aureus* in infective endocarditis: a 1-year population-based survey. *Clin Infect Dis* 54: 1230–1239.
- Thuny F, Grisoli D, Collart F, Habib G, Raoult D, 2012. Management of infective endocarditis: challenges and perspectives. *Lancet* 379: 965–975.
- Bin Abdulhak AA, Baddour LM, Erwin PJ, Hoen B, Chu VH, Mensah GA, Tleyjeh IM, 2014. Global and regional burden of infective endocarditis, 1990–2010: a systematic review of the literature. *Glob Heart* 9: 131–143.
- Cahill TJ, Prendergast BD, 2016. Infective endocarditis. *Lancet* 387: 882–893.
- Bannay A, Hoen B, Duval X, Obadia JF, Selton-Suty C, Le Moing V, Tattévin P, lung B, Delahaye F, Alla F; AEPEI Study Group, 2011. The impact of valve surgery on short- and long-term mortality in left-sided infective endocarditis: do differences in methodological approaches explain previous conflicting results? *Eur Heart J* 32: 2003–2015.
- Hoen B, Duval X, 2013. Clinical practice. Infective endocarditis. *N Engl J Med* 368: 1425–1433.
- Delahaye F, Chu VH, Altclas J, Barsic B, Delahaye A, Freiburger T, Gordon DL, Hannan MM, Hoen B, Kanj SS, Lejko-Zupanc T, Mestres CA, Pachirat O, Pappas P, Lamas C, Selton-Suty C, Tan R, Tattévin P, Wang A; International Collaboration on Endocarditis Prospective Cohort Study (ICE-PCS) Investigators, 2015. One-year outcome following biological or mechanical valve replacement for infective endocarditis. *Int J Cardiol* 178: 117–123.
- Munoz P, Kestler M, De Alarcon A, Miro JM, Bermejo J, Rodríguez-Abella H, Fariñas MC, Cobo Belaustegui M, Mestres C, Linares P, Goenaga M, Navas E, Oteo JA, Tarabini P, Bouza E; Spanish Collaboration on Endocarditis-Grupo de Apoyo al Manejo de la Endocarditis Infecciosa en España (GAMES), 2015. Current epidemiology and outcome of infective endocarditis: a multicenter, prospective, cohort Study. *Medicine (Baltimore)* 94: e1816.
- Cabell CH, Jollis JG, Peterson GE, Corey GR, Anderson DJ, Sexton DJ, Woods CW, Reller LB, Ryan T, Fowler VG Jr, 2002. Changing patient characteristics and the effect on mortality in endocarditis. *Arch Intern Med* 162: 90–94.
- Naimi TS, LeDell KH, Como-Sabetti K, Borchardt SM, Boxrud DJ, Etienne J, Johnson SK, Vandenesch F, Fridkin S, O'Boyle C, Danila RN, Lynfield R, 2003. Comparison of community- and health care-associated methicillin-resistant *Staphylococcus aureus* infection. *JAMA* 290: 2976–2984.
- Fowler VG Jr, Miro JM, Hoen B, Cabell CH, Abrutyn E, Rubinstein E, Corey GR, Spelman D, Bradley SF, Barsic B, Pappas PA, Anstrom KJ, Wray D, Fortes CQ, Anguera I, Athan E, Jones P, van der Meer JT, Elliott TS, Levine DP, Bayer AS; Investigators ICE, 2005. *Staphylococcus aureus* endocarditis: a consequence of medical progress. *JAMA* 293: 3012–3021.
- Le Moing V, Alla F, Doco-Lecompte T, Delahaye F, Piroth L, Chirouze C, Tattévin P, Lavigne JP, Erpelding ML, Hoen B, Vandenesch F, Duval X; VIRSTA Study Group, 2015. *Staphylococcus aureus* bloodstream infection and endocarditis: a prospective cohort study. *PLoS One* 10: e0127385.
- Cabell CH, Abrutyn E, 2002. Progress toward a global understanding of infective endocarditis. Early lessons from the International Collaboration on Endocarditis investigation. *Infect Dis Clin North Am* 16: 255–272 vii.
- Letaief A, Boughzala E, Kaabia N, Ernez S, Abid F, Ben Chaabane T, Ben Jemaa M, Boujnah R, Chakroun M, Daoud M, Gaha R, Kafsi N, Khalfallah A, Slimane L, Zaouali M, 2007. Epidemiology of infective endocarditis in Tunisia: a 10-year multicenter retrospective study. *Int J Infect Dis* 11: 430–433.
- Nkomo VT, 2007. Epidemiology and prevention of valvular heart diseases and infective endocarditis in Africa. *Heart* 93: 1510–1519.
- Nunes MC, Gelape CL, Ferrari TC, 2010. Profile of infective endocarditis at a tertiary care center in Brazil during a seven-year period: prognostic factors and in-hospital outcome. *Int J Infect Dis* 14: e394–e398.
- Li JS, Sexton DJ, Mick N, Nettles R, Fowler VG Jr, Ryan T, Bashore T, Corey GR, 2000. Proposed modifications to the Duke criteria for the diagnosis of infective endocarditis. *Clin Infect Dis* 30: 633–638.
- Bach JF, Chalons S, Forier E, Elana G, Jouanelle J, Kayemba S, Delbois D, Mosser A, Saint-Aime C, Berchel C, 1996. 10-year educational programme aimed at rheumatic fever in two French Caribbean islands. *Lancet* 347: 644–648.
- García-Granja PE, Lopez J, Vilacosta I, Ortiz-Bautista C, Sevilla T, Olmos C, Sarriá C, Ferrera C, Gómez I, Román JA, 2015. Polymicrobial infective endocarditis: clinical features and prognosis. *Medicine (Baltimore)* 94: e2000.
- Coard KC, Skeete DH, 2003. Infective endocarditis at the University Hospital of the West Indies. A revisit. *West Indian Med J* 52: 235–239.

26. Grangier C, Debin M, Ardillon V, Mahamat A, Fournier PE, Simonnet C, Guillot G, Louvel D, Ravachol F, Perenhov V, Queuche F, Legrand E, Djossou F, Quénel P, Morvan J, Meynard JB, 2009. *Epidémiologie de la fièvre Q en Guyane, 1990–2006*. Bulletin de Veille Sanitaire n°10 2009: 2–4.
27. Edouard S, Mahamat A, Demar M, Abboud P, Djossou F, Raoult D, 2014. Comparison between emerging Q fever in French Guiana and endemic Q fever in Marseille, France. *Am J Trop Med Hyg* 90: 915–919.
28. Eldin C, Mahamat A, Demar M, Abboud P, Djossou F, Raoult D, 2014. Q fever in French Guiana. *Am J Trop Med Hyg* 91: 771–776.
29. da Costa PS, Brigatte ME, Greco DB, 2005. Antibodies to *Rickettsia rickettsii*, *Rickettsia typhi*, *Coxiella burnetii*, *Bartonella henselae*, *Bartonella quintana*, and *Ehrlichia chaffeensis* among healthy population in Minas Gerais, Brazil. *Mem Inst Oswaldo Cruz* 100: 853–859.
30. Lamas CC, Mares-Guia MA, Rozental T, Moreira N, Favacho AR, Barreira J, Guterres A, Bóia MN, de Lemos ER, 2010. *Bartonella* spp. infection in HIV positive individuals, their pets and ectoparasites in Rio de Janeiro, Brazil: serological and molecular study. *Acta Trop* 115: 137–141.
31. Frankel D, Richet H, Renvoise A, Raoult D, 2011. Q fever in France, 1985–2009. *Emerg Infect Dis* 17: 350–356.
32. Raoult D, Casalta JP, Richet H, Khan M, Bernit E, Rovey C, Branger S, Gouriet F, Imbert G, Bothello E, Collart F, Habib G, 2005. Contribution of systematic serological testing in diagnosis of infective endocarditis. *J Clin Microbiol* 43: 5238–5242.
33. Ellis ME, Al-Abdely H, Sandridge A, Greer W, Ventura W, 2001. Fungal endocarditis: evidence in the world literature, 1965–1995. *Clin Infect Dis* 32: 50–62.
34. Bhatti S, Vilenski L, Tight R, Smego RA Jr, 2005. *Histoplasma* endocarditis: clinical and mycologic features and outcomes. *J Infect* 51: 2–9.
35. Kauffman CA, 2007. Histoplasmosis: a clinical and laboratory update. *Clin Microbiol Rev* 20: 115–132.
36. Aksoy O, Sexton DJ, Wang A, Pappas PA, Kourany W, Chu V, Fowler VG Jr, Woods CW, Engemann JJ, Corey GR, Harding T, Cabell CH, 2007. Early surgery in patients with infective endocarditis: a propensity score analysis. *Clin Infect Dis* 44: 364–372.
37. Tleyjeh IM, Ghomrawi HM, Steckelberg JM, Hoskin TL, Mirzoyev Z, Anavekar NS, Enders F, Moustafa S, Mookadam F, Huskins WC, Wilson WR, Baddour LM, 2007. The impact of valve surgery on 6-month mortality in left-sided infective endocarditis. *Circulation* 115: 1721–1728.
38. Kiefer T, Park L, Tribouilloy C, Cortes C, Casillo R, Chu V, Delahaye F, Durante-Mangoni E, Edathodu J, Falces C, Logar M, Miró JM, Naber C, Tripodi MF, Murdoch DR, Moreillon P, Utili R, Wang A, 2011. Association between valvular surgery and mortality among patients with infective endocarditis complicated by heart failure. *JAMA* 306: 2239–2247.
39. Kang DH, Kim YJ, Kim SH, Sun BJ, Kim DH, Yun SC, Song JM, Choo SJ, Chung CH, Song JK, Lee JW, Sohn DW, 2012. Early surgery versus conventional treatment for infective endocarditis. *N Engl J Med* 366: 2466–2473.
40. Iung B, Doco-Lecompte T, Chocron S, Strady C, Delahaye F, Le Moing V, Poyart C, Alla F, Cambau E, Tattevin P, Chirouze C, Obadia JF, Duval X, Hoen B; AEPEI Study Group, 2016. Cardiac surgery during the acute phase of infective endocarditis: discrepancies between European Society of Cardiology guidelines and practices. *Eur Heart J* 37: 840–848.
41. Habib G, Lancellotti P, Antunes MJ, Bongiorni MG, Casalta JP, Del Zotti F, Dulgheru R, El Khoury G, Erba PA, Iung B, Miro JM, Mulder BJ, Plonska-Gosciniak E, Price S, Roos-Hesselink J, Snygg-Martin U, Thuny F, Tornos Mas P, Vilacosta I, Zamorano JL, Reviewers Document, Erol Ç, Nihoyannopoulos P, Aboyans V, Agewall S, Athanassopoulos G, Aytekin S, Benzer W, Bueno H, Broekhuizen L, Carerj S, Cosyns B, De Backer J, De Bonis M, Dimopoulos K, Donal E, Drexel H, Flachskampf FA, Hall R, Halvorsen S, Hoen B, Kirchhof P, Lainscak M, Leite-Moreira AF, Lip GY, Mestres CA, Piepoli MF, Punjabi PP, Rapezzi C, Rosenhek R, Siebens K, Tamargo J, Walker DM, 2015. 2015 ESC Guidelines for the management of infective endocarditis: The Task Force for the Management of Infective Endocarditis of the European Society of Cardiology (ESC). *Eur Heart J* 36: 3075–3128.