Update on Infective Endocarditis

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Infectious Endocarditis is a disease almost invariably fatal if it is not treated in the proper manner. A review is presented of the cardiac abnormalities and procedures associated with its development as well as the most recent classification of the different modalities of endocarditis. The clinical manifestation, the causative organisms and diagnostic procedures are summarized. The American Heart Assciation and the American College of Cardiology (AHA/ACC) recommendations for management of native valve endocarditis, infective endocarditis in drug users, prosthetic valve endocarditis and culture negative endocarditis are summarized. The conditions that justify surgical interventions are also presented.

Key words: Infective endocarditis, Prosthetic valve endocarditis, Native valve endocarditis, Intravenous drug users endocarditis, Culture negative infective endocarditis.

Infectious Endocarditis (IE), one of the greatest masquerades in medicine, is capable of mimicking a wider variety of illness involving almost any organ system. The clinician have always been fascinated with the study of this infection of the heart, and as of today maybe a popular topic of a clinical pathological conference, a sure sign of its complexity.

Despite several decades of diagnostic and therapeutic advances, it remains a life threatening disease always fatal without appropriate treatment. The mortality rates are across the wide spectrum of presentations is in the range of 12% to 15%(1).

In spite of the decline in rheumatic heart disease and the use of antibiotic prophylaxis, there is no evidence that the incidence of infective endocarditis is decreasing. In fact, some data suggest it may be increasing. Several factors explain this apparent paradox: higher prevalence of degenerative heart disease (aging of the population); increase in nosocomial infection; increase in intravenous drug abusers; increasing application of cardiac surgery (greatest number of cardiac and vascular prosthesis); increased use of indwelling lines and implantable devices, among others. Finally, the increased application of echocardiography has probably increased the rate of which IE is diagnosed (2). Current incidence rate in the United States ranges from 15,000 to 20,000 new cases per year.

Although IE has been caused by virtually any microbial species, most occurrences are due to a relatively small number of species. Still the gram-positive organisms, particularly Streptococci viridans and Staphylococci aureus predominate, but infection with gram-negative and fungi have been increasingly recognized.

In this article, we will review the current status of IE emphasizing on the prompt diagnosis and aggressive management of this clinical entity.

Definition. IE is an active intracardial microbial infection involving one or more heart valve apparatus surfaces. Other cardiac structures may be primarily or secondarily involved: mural endocardium, myocardium and pericardium. Endovascular infection can also occur at more remote sites in the circulation in association to coarctation of the aorta, patent ductus arteriosus or surgically constructed vascular shunts. Analogous infections called infective endaortitis and infective endarteritis can occur on the endothelial surface of the aorta and large arteries respectively. The characteristic lesions of intracardiac infection are called vegetations.

Pathogenesis. The development of infection of the endocardial tissue surface depends on a combination of several factors: loss of cellular or tissue integrity (scarring or direct trauma); hemodynamic factors, creating turbulence (high velocity jet stream, flow from a high to low pressure chamber and narrow orifices); bacteremia (virulence, duration/magnitude) and immunologic impairment.

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Animal experiments have repeatedly demonstrated the difficulty of initiating endocardial infection by intravascular injection of very high titers of pyogenic bacteria, unless the cardiac valve structure is altered. Although virulent organisms may cause IE on normal valves, IE usually occurs in the setting of 70% to 75% of patients with pre-existing cardiac disorders (Table 1). Known cardiac disorders identify candidates for prophylaxis when they are undergoing a procedure that may cause bacteremia and present a substantial risk for IE (Table 2).

Table 1. Cardiac Abnormalities Associated to Infective Endocarditis

High risk	Moderate risk
Prosthetic heart valves	Congenital cardiac malformation
Prior bacterial endocarditis	other than high risk
Complex cyanotic	Acquired valve dysfunction
congenital heart disease	Hypertrophic cardiomyopathy
Surgically constructed	Mitral valve prolapse with
systemic-pulmonary	valvular regurgitation and/or
shunts	thickened leaflets

Table 2. Procedures for Which Endocarditis Prophylaxis is Required

Prophylaxis Recommended
Dental procedures
Surgery, root planning, scaling, and probing
Dental implant, reimplantation of teeth
Root canal
Intraligamentary local anesthetic injection
Any procedure with bleeding anticipated
Respiratory tract
Bronchoscopy with rigid bronchoscope
Operation involving mucosal
Gastrointestinal tract
Esophageal varices (sclerotherapy)
Dilation of esophageal stricture
Endoscopic Retrograde Cholangiography with biliary obstruction
Biliary tract surgery
Surgery involving mucosal
Genitourinary tract
Prostate surgery
Urethral dilation
Cystoscopy

Microbes must attach to an endocardial surface and they must persist and multiply when the endothelium is damaged. When endothelium is damaged, subendothelial connective tissue containing collagen is exposed, which promotes formation of sterile accumulation of platelet and fibrin. Further deposition of fibrin and platelets causes creation of vegetations, so-called nonbacterial thrombotic endocarditis (NBTE), which then provide a hospitalable environment (nidus) for microorganism replication and colonization, forming the classic vegetation, where accessibility of microorganisms to the antimicrobial action of antibiotics, phagocytes and antibodies are hindered. Vegetations may be single or multiple, vary from small (<1mm) warty nodules to large several centimeters. Vegetations also vary in color (from white to tan greenish-gray), consistency, and gross appearance. The heart valve most commonly involved by IE is the mitral valve, followed by the aortic, tricuspid, and pulmonary valve.

The vegetations generally are located along the line of closure of the damaged valve leaflet on the ventricular surfaces of semilunar valves and on the atrial surfaces of the atrioventricular valves, distal to the stenosis of a coarctation of the aorta; on the low-pressure side of an intracardiac shunt or at the jet stream impact area on the ventricular wall of a ventricular septal defect.

Classification. From a clinical practice point of view the IE may be classified in four categories:

1. Native valve infectious endocarditis (NVE)
2. IE in intravenous drug users (IVDUE)
3. Prosthetic valve endocarditis (PVE)
4. Culture-negative endocarditis (CNE)

The course of above mention IE may be acute infective endocarditis (AIE) or subacute infective endocarditis (SIE). Acute IE is most often caused by highly virulent and invasive organism (most often *S. aureus*), characterized by fulminant illness, toxicity, and evidence of valve destruction and evolves over a period of days to 1 or 2 weeks. The organisms of AIE can attack normal heart valves and the mural endocardium.

The SIE is caused by a variety of relatively avirulent organisms (most often streptococcal), a more indolent disease, developing over weeks or months and is more often associated with immunologic phenomena. In the practice there is an overlapping between these two poles. In addition the IE can be defined as community acquired or nosocomial.

Clinical manifestations. The clinical manifestation of IE can be quite variable, depending on the predisposing cardiac lesion (Table 1), if occurs in intravenous drug abuser patients and the class of causative organism. These manifestations can be grouped under 4 categories:

- Infectious process itself
- Embolic phenomena: mycotic aneurysm, Janeway lesions, splinter hemorrhage, petechiae
- Immunologic phenomena: glomerulonephritis, rheumatoid factor, Osler's nodes, Roth spots
- Cardiovascular consequences

Although fever is the most commonly reported and sign, many of the constitutional symptoms of IE are nonspecific; such as fatigue, anorexia, malaise, feverishness, musculoskeletal complaints, and confusion, among others.

Emboli generally may be sterile in SBE and sterile or septic in ABE. The embolic manifestations range from trivial to life-threatening, distributing randomly throughout the circulation. The emboli of IE tend to affect small and medium-sized arteries such as brain, renal, spleen, coronaries, mesenteric, lung, etc. Pulmonary emboli arising from right-sided IE are a common feature in intravenous drug users. Major vessels emboli are more frequently encountered in fungal endocarditis.

The immunologic phenomena are relatively non-specific consequences of IE. Classic findings of Osler's nodes are small (2 to 15 mm) painful purplish subcutaneous nodules on the pulp of the palms and soles. Janeway lesions are hemorrhagic painless macules on the palms and soles. Roth spots are oval pale retinal lesions surrounded by hemorrhage. The above-mentioned peripheral stigmata usually disappear within hours or days. Clubbing fingers may also be found, depending on the duration of disease. Cardiovascular consequences include a new or changing heart murmurs caused by distorted or damaged valves. This has long been considered a classic finding in IE, but it may be absent with right-sided endocarditis, mural infection, and in the elderly patient population. More than 90% of patients who demonstrate a new regurgitant murmur (aortic or mitral) will develop significant congestive heart failure, the leading cause of death in IE (3).

Native Valve Endocarditis

Streptococcus viridans are responsible for 30% to 65% of cases of NVE. The presence of *S. bovis* as the causative organism, strongly suggests gastrointestinal pathology such as malignancy, polyp formation or diverticular disease. Gastrointestinal studies are necessary. The enterococci are responsible for 10% to 20% of cases of NVE (4). These organisms can infect normal valves and they typically originate from genitourinary, gastrointestinal or skin ulcers of diabetic patients.

Left-sided NVE with *S. aureus* is associated with high mortality rates (35%-40%), which is likely due to ability of this organism to destroy normal and abnormal valves and its propensity to embolize and cause metastatic infection at remote sites. Fungal NVE is uncommon. Whenever presence it is associated with large and bulky vegetations that can obstruct valve orifices and that embolize to large vessels.

Infective Endocarditis in Intravenous Drug Users

The risk for the development of IE among IDUs is as high as 5% per patient per year. It frequently follows an acute course, reflecting the high frequency of *S. aureus* and the majority– two thirds– have no clinical evidence of preexisting underlying heart disease. Other encountered organisms are Streptococci, Enterococci, Gram-negative rods and fungi. The outstanding clinical feature of IE in IDUs is the high prevalence of tricuspid valve infection in 60% to 70%. The pulmonary valve is rarely involved.

Also, in this population (IDUs) in as many as 40% of cases, the left-sided disease alone are infected and is associated with strikingly higher morbidity and mortality rates.

Tricuspid vegetations commonly embolize to the lungs, causing septic pulmonary infarcts. In IDUs with fever and multiple focal lung opacities by chest x-rays suggests right-sided IE.

Because of the higher risk of contamination of water, additives, needles and other paraphernalia, IDU endocarditis differs from that of non-addicts with a higher prevalence of *S. aureus*, gram-negative organisms, fungi and unusual pathogens, including pseudomonas plus regional variabilities in the spectrum of the causative agent.

Prosthetic Valve Endocarditis

Prosthetic valve endocarditis (PVE) has been reported to occur in up to 10% of patients during the lifetime of the prosthesis. PVE has been classified arbitrarily from a microbiologic perspective into "early" when it occurs within the first sixty days after implantation and "late" when it occurs after sixty days. Some investigators have recommended that the time limit for early PVE be extended to six months or even one year. In the early (within 2 months of surgery) PVE the causative organism, *S. epidermidis* (30%) results from valve nosocomial contamination during the perioperative period. In the late (more than 2 months after surgery) PVE the causative organisms are appearing similar to that of native valve endocarditis, generally related to the community acquired disease. Mortality associated with PVE is 30% to 80% in the early form and 20% to 40% in late PVE. Valve-ring abscess is a serious complication of PVE. Extension of the abscess beyond the valve ring may result in myocardial abscess, septal perforation or purulent pericarditis.

Transesophageal echocardiography (TEE) is the preferred study for diagnosis of prosthetic valve endocarditis. Because PVE is inherently more invasive

than native valve endocarditis medical cure with antibiotic alone is more difficult. Organisms responsible for PVE are *S. viridans*, *S. bovis*, coagulase positive and negative Staphylococci, Gram-negative organisms, Enterococci and fungi.

Culture-Negative Infective Endocarditis

CNE refers to active IE with repeatedly negative blood culture. This accounts for a small proportion of cases (<5%). It may occur because of several factors. These include as the principal reason a history of recent antimicrobial therapy. It also includes a slow growth of fastidious organisms such as member of the HACEK group, Brucella spp. or nutritionally variant streptococci, fungal IE and intracellular microorganisms such as Bartonella spp., Chlamydia spp. and perhaps viruses.

Management of patient with suspected culture negative IE requires clinical judgment, re-evaluation of the initial empiric choice of antibiotic, and serial reassessment.

Diagnosis of Infective Endocarditis

Although the diagnosis of IE may be obvious in patients with preexisting heart disease who present with fever and peripheral emboli phenomena, the classic findings are frequently absent. Usually the clinical presentation can be quite diverse and may mimic an array of other diseases such as a central nervous system picture, fever of unknown origin, pneumonia, glomerulonephritis, myocardial infarction etc. Consequently a high index of suspicion must be maintained. The diagnosis of IE is based upon a careful history and physical examination, blood cultures, other laboratory tests, ECG, chest x-ray, and an echocardiogram.

Routine laboratory tests. Mild leukocytosis with a low grade, variable elevation of polymorphonuclear leukocyte count, and a normochromic normocytic anemia is characteristic of SBE (5). Anemia occurs less often in ABE and may be due to hemolysis.

The erythrocyte sedimentation rate (ESR) is elevated in about 90% of the cases of IE. The median ESR on admission is about 65 mm/h. ESR may rise slightly during treatment and does not fall to normal until three to six months after diagnosis, so it is not useful to monitor the success of antibiotic therapy. The C-reactive protein is usually elevated (96%) and during successful treatment falls to normal more quickly than the ESR (6). Red blood cell casts and heavy proteinuria are found in those patients who develop immune complex glomerulonephritis, also associated with microscopic hematuria, and slight proteinuria in more than 50 percent of cases, even in the absence of specific renal complications (7).

Serologic tests. A positive rheumatoid factor is found in > 50 percent of cases of SBE with symptoms for longer than six weeks. A polyclonal increase in gammaglobulins is characteristic of active endocarditis and occasionally false positive serologic test for syphilis occurs.

Blood culture. The most important diagnostic test for endocarditis is a blood culture. Bacteremia in SBE is usually continuous, so a blood culture should be obtained even in afebrile patients. Three sets of blood cultures, obtained at intervals > 1 hour within the first 24 hours, is the norm; however, in selected patients, 5 to 6 sets of blood cultures may be needed. In cases of S. aureus endocarditis, greater than 95 percent of blood cultures would be positive, usually within 24 hours (8). If the diagnosis of endocarditis remains likely, and cultures are negative, culture should be incubated for three weeks and Gram's stains made at 5 days, 2 weeks, and 3 weeks even if no growth is apparent on inspection.

Electrocardiography. All patients with suspected IE should have baseline and follow up ECG. Conduction disturbances reflecting intramyocardial extension of infection may range from a prolonged PR interval to complete heart block (especially with prosthetic valve endocarditis) (9). A new AV block in IE carries a 77 percent positive predictive value for abscess formation.

Chest X rays. Congestive heart failure and pleural effusions can be seen. Also nonspecific infiltrates due to multiple septic pulmonary emboli can be present in right-sided IE.

Echocardiography. Positive echocardiographic findings, properly defined, constitute important criteria for the clinical diagnosis of endocarditis and, in the setting of positive blood cultures, essentially establish the diagnosis of IE.

The yield for visualization of vegetations for transthoracic echocardiography is 60% to 77%. All patients in whom IE is suspected should undergo baseline transthoracic echocardiography (TTE) to define cardiac abnormalities, to determine the size and location of vegetations and to explore the possibility of complications like aortic annular ring abscess. In selected cases, sensitivity can be improved to better than 96% by use of transesophageal echocardiography (TEE). TEE is better than TTE for evaluation of prosthetic valve endocarditis, especially involving mitral valves. False negatives may occur early in endocarditis or if vegetations are small. A negative TEE should never override strong clinical evidence of endocarditis.

Other imaging studies. Computed tomography and magnetic resonance imaging can be helpful in defining the cause of focal neurologic lesions in patients with

endocarditis, especially infarction, hemorrhage from mycotic aneurysm, and brain abscess. Cardiac catheterization is usually not necessary for patients who respond well to antimicrobial therapy without developing cardiac failure. When surgical intervention is considered, cardiac catheterization can expand and add to information provided by echocardiography. With the availability of the new comprehensive blood culture procedure known as the "three bottle system"(10), checking for aerobes, anaerobes and fungi, and echocardiography (TTE and TEE) clinicians are more likely to reach a diagnosis. In order to standardize a formal scheme for the diagnosis of IE, at the present time the best method utilized is the Duke Criteria with adaptations. A "definite" diagnosis of IE may be made with considerable accuracy if two major criteria, one major criteria and three minor criteria or five minor criteria are met as described in Table 3 (11). "Possible" IE falls short of "definite" but not "rejected".

Table 3. Modified Duke Criteria for the Diagnosis of Infective Endocarditis

Diagnostic Categories
Definite endocarditis* = either 2 major, 1 major + 3 minor, or 5 minor criteria
Possible endocarditis = either 1 major + 1 minor or 3 minor criteria
Major Criteria
1. Microbiologic (any of the following):Typical microorganism (including *Staphylococcus aureus*) grown from 2 blood culturesAny microorganism grown from persistently positive blood culturesPositive serologic test or single positive blood culture for *Coxiella burnetii* (the agent of Q fever)
2. Evidence of endocardial involvement (either of the following):Echocardiogram: oscillating intracardiac mass, abscess, or new partial dehiscence of a prosthetic valvePhysical examination: new valvular regurgitation (change in pre-existing murmur is not sufficient for diagnosis)
Minor Criteria
1. Predisposing heart condition or injection drug use
2. Fever>38.0°C (100.4°F)
3. Vascular phenomena: major arterial emboli, septic pulmonary infarcts, mycotic aneurysm, intracranial hemorrhage, conjunctival hemorrhages, or Janeway lesions (petechiae or splinter hemorrhages are not sufficient for making a diagnosis)
4. Immunologic phenomena: glomerulonephritis, Osler's nodes, Roth spots, positive rheumatoid factor
5. Microbiologic: serologic evidence of infection or positive blood cultures not meeting the major criterion (a single positive blood culture for coagulase-negative staphylococci is not sufficient for making a diagnosis)

*Culture or histologic specimens of a vegetation, embolus, or intracardiac abscess noted at surgery or autopsy can also diagnose definite endocarditis.

Treatment

Despite advances in antibiotic therapy and surgical techniques, the incidences of embolism remain about 30% to 40%. One must initially consider that all patients will have a devastating potentially fatal disease. Identification of the infecting organism is required for adequate optimal medical treatment of IE. Therefore, IE is best designated by naming the infecting organism, e.g., "*S. aureus* PVE" which is a specific and informative permitting useful inferences about treatment and prognosis of the patient.

The principles that underlie antibiotic therapy for IE include the following: the use of agents with demonstrated in vitro efficacy; parenteral administration in high concentration; and surveillance blood culture. Optimal management of IE patients usually requires the involvement of a primary care physician, infectologists, cardiologists, and cardiothoracic surgeon. The treatment of newly diagnosed IE requires the physician to make a decision promptly concerning empiric vs. specific therapy (wait up to when the organism has been isolated).

Empiric Therapy

Empirical treatment should be started until the etiologic organism is identified and the antibiotic sensitivities are known. It depends on whether the patient has acute (ABE) or subacute disease (SBE). ABE requires broad-spectrum therapy that covers *S. aureus* as well as many species of streptococci and gram-negative bacilli. SBE requires a regimen that treats most streptococci, including *E. faecalis*. To meet these requirements, the following suggestions are offered(12).

For ABE, nafcillin 2.0 g IV q 4 h plus ampicillin 2.0 g IV q 4 h plus gentamicin 1.5 mg/kg IV q 8 h should be administered. In methicillin-resistant *S. aureus* (MRSA) considered vancomycin 1.0 g IV q 12 h.

For SBE: ampicillin 2.0 g IV q 4 h plus gentamicin 1.5 mg/kg IV q 8 h.

For culture negative PVE: vancomycin 30 mg/kg per 24 h in 2 divided doses plus gentamicin 1 mg/kg IV or IM every 8 hr.

For PVE: ceftriaxone 2.0 g IV or IM q day may be added to cover HACEK organisms for >1 year postoperatively (Cefotaxime sodium or other 3rd generation cephalosporins may be substituted).

Treatment should be adjusted when the etiologic organism is identified and when antibiotic sensitivity is known. In those few cases where empiric therapy is administered as a therapeutic trial to help confirm a diagnosis, treatment should be continued without interruption or unnecessary change for at least 2 weeks.

Specific Therapy

Once the organism responsible for IE and its susceptibility to antibiotics has been identified, intensive treatment with the corresponding antibiotics must be instituted. The AHA/ACC has established guidelines for the correct therapy of the different modalities of infective endocarditis.

The following tables summarize the AHA/ACC guidelines for the treatment of staphylococcal endocarditis in the absence of prosthetic valves (Table 4), the therapeutic regimen for native valve endocarditis involving streptococci (Table 5), and endocarditis caused by HACEK group and other organisms (Table 6). Table 7 presents the recommendations of therapy for endocarditis due to fungi and for culture negative endocarditis.

The elaboration of these therapy guidelines has been a great help to the practicing physicians in order to provide the best management to their patients with infective endocarditis. The preferred route for the administration of antibiotics is intravenously. Each table provides the dosages, route of administration, and the duration of the antibiotic therapy.

Table 4. Treatment for Staphylococcal Endocarditis in the Absence of Prosthetic Material

Antibiotic	Dosage and Route	Duration (wk)
Methicillin-Susceptible Staphylococci		
Nafcillin or Oxacillin	2 gm IV every 4 hr	4-6
plus gentamicin	1 mg/kg IM or IV q 8 hr	3-5 days
Cefazolin (or other first generation cephalosporins in equivalent dosages) plus gentamicin	2 gm IV q 8 hr 1 mg/kg IM or IV q 8 hr	4-6 3-5 days
Vancomycin	30 mg/kg/24 hr in two equally divided doses; not to exceed 2 gm/24 hr unless serum levels are monitored	4-6
Methicillin-Resistant Staphylococci	30 mg/kg/24 hr in 2 divided doses; not to exceed 2 gm/24 hr unless serum levels are monitored	4-6
Vancomycin		

IM = intramuscular; IV = intravenous

Table 5. Native Valve Endocarditis involving *Streptococcus viridans* and *Streptococcus bovis*

Antibiotic	Dosage and Route	Duration (wk)	Comments
Aqueous crystalline penicillin G sodium	18 million U/24 h IV either continuously or in 6 equally divided doses	4	Cefazolin or other first-generation cephalosporins may be substituted for penicillin in patients whose penicillin hypersensitivity is not of the immediate type
Plus gentamicin	1 mg/kg IM or IV q 8 h	2	
Vancomycin	30 mg/kg per 24 h IV in 2 equally divided doses, not to exceed 2 g/24 h unless serum levels are monitored.	4	Vancomycin therapy is recommended for patients allergic to β-lactams.

IM = intramuscular; IV = intravenous

Table 6. Therapy for Endocarditis Due to HACEK Microorganisms (Haemophilus parainfluenzae, Haemophilus actinomycetemcomitans, Cardiobacterium hominis, Eikenella corrodens, and Kingella kingae)

Antibiotic	Dosage and Route	Duration (wk)	Comments
Ceftriaxone sodium	2 g once daily IV or IM	4	Cefotaxime sodium or other third-generation cephalosporins may be substituted.
Ampicillin sodium	12 g/24 h IV either continuously or in 6 equally divided doses	4	
Plus gentamicin	1 mg/kg IM or IV every 8 h	4	

IM = intramuscular; IV = intravenous

Table 7. Fungal Endocarditis and Culture-Negative Endocarditis

Agent	Dosage and Route	Duration (wk)
Fungal endocarditis		
Amphotericin B	1 mg/kg per day IV (total dose	6-8
With or without	2.0-2.5 g)	
flucytosine	150 mg/kg per day PO in 4 divided doses	6-8
Culture-negative endocarditis		
Vancomycin plus	15 mg/kg IV every 12 h	6
gentamicin	1 mg/kg IM or IV every 8 h	6

IM = intramuscular; IV = intravenous

Surgical Therapy

Indications for surgery in patients with active infective endocarditis. Early consultation with a cardiovascular surgeon is recommended as soon as the diagnosis of aortic or mitral valve endocarditis is made so that the surgical team is aware of the patient who may suddenly need surgery. Major indications for surgery are moderate or severe heart failure, not responding to treatment, periannular or myocardial abscess, prosthetic valve devices (PVE), valvular obstruction, persistent bacteremia, and fungal infection. Surgery should proceed promptly even if the infection is still active. Patient with prosthetic valves receiving warfarin anticoagulation who develop endocarditis should have their warfarin discontinued and replaced with heparin, because the possibility of urgent surgery.

Tables 8 and 9 list the recent ACC/AHA recommendations for surgery in patients with NVE and PVE(13). Different series have shown improved survival with combination of medical and surgical treatment in the setting of heart failure.

Table 8. Recommendations for Surgery for Native Valve Endocarditis*

Indication
1. Acute AR or MR with heart failure.
2. Acute AR with tachycardia and early closure of the mitral valve.
3. Fungal endocarditis.
4. Evidence of annular or aortic abscess, sinus or aortic true or false aneurysm.
5. Evidence of valve dysfunction and persistent infection after a prolonged period (7 to 10 days) of appropriate antibiotic therapy, as indicated by presence of fever, leukocytosis, and bacteremia, provided there are no noncardiac causes for infection.
6. Recurrent emboli after appropriate antibiotic therapy.
7. Infection with gram-negative organisms or organisms with a poor response to antibiotics in patients with evidence of valve dysfunction.
8. Mobile vegetations > 10 mm.

*Criteria also apply to repaired mitral and aortic allografts or autografts valves. Endocarditis defined by clinical criteria with or without laboratory verification: there must be evidence that function of cardiac valve is impaired.
AR- aortic regurgitation; MR- mitral regurgitation

Prophylaxis of Infective Endocarditis

IE is always fatal if untreated and continuous to cause substantial morbidity and mortality despite appropriate medical and surgical treatment. Prevention is a priority and attempts should be made to prevent endocarditis in patients with predisposing or congenial heart disease before procedures that may cause bacteremia (Table 10). The antibiotic schedule and selection for endocarditis prophylaxis is determined by the ACC/AHA.

Table 9. Recommendations for Surgery for Prosthetic Valve Endocarditis*

Indication
1. Early prosthetic valve endocarditis (first 2 months or less after surgery).
2. Heart failure with prosthetic valve dysfunction.
3. Fungal endocarditis
4. Staphylococcal endocarditis not responding to antibiotic therapy.
5. Evidence of paravalvular leak, annular or aortic abscess, sinus or aortic true or false aneurysm, fistula formation, or new-onset conduction disturbances
6. Infection with gram-negative organisms or organisms with a poor response to antibiotics.
7. Persistent bacteremia after a prolonged course (7 to 10 days) of appropriate antibiotic therapy without noncardiac causes for bacteremia.
8. Recurrent peripheral embolus despite therapy.
9. Vegetation of any size on or near the prosthesis.

*Criteria exclude repaired mitral valves or aortic allografts or autograft valves. Endocarditis is defined by clinical criteria with or without laboratory verification.

Table 10. Suggested Regimens for Prophylaxis of Infective Endocarditis

Standard Regimen
For dental procedures and oral or upper respiratory tract surgery • Amoxicillin 2.0 g orally 1 h before procedure
Special Regimens
Parenteral regimen for high-risk patients; also for gastrointestinal (GI) or genitourinary (GU) tract procedures: • Ampicillin 2.0 g IM plus gentamicin 1.5 mg/kg IM or IV, 0.5 h before procedure, 6 h later, Ampicillin 1 g IM or IV or amoxicillin 1 g orallyParenteral regimen for Penicillin-allergic patients: • Vancomycin 1.0 g IV slowly over 1-2 h plus gentamicin 1.5 mg/kg IM or IV; complete within 30 min of starting the procedure • Oral regimen for penicillin-allergic patients (oral and respiratory tract only): • Clindamycin 600 mg orally 1 h before procedure • Oral regimen for minor GI or GU tract procedures: • Amoxicillin 2.0 g orally 1 h before procedure • Parenteral regimen for cardiac surgery including valve replacement: • Cefazolin 2.0 g IV on induction of anesthesia, repeated 8 and 16 h later or • Vancomycin 1.0 g IV slowly over 1 h starting on induction of anesthesia, then 0.5 g IV 8 and 16 h later

IM = intramuscular; IV = intravenous

Conclusion

In this article the pathogenesis and clinical manifestations of infective endocarditis have been discussed, focusing in the various presentations distributed in four groups: native valve endocarditis, prosthetic valve endocarditis, IE in intravenous drug users and culture-negative IE. Basic information for optimal diagnosis has been presented in order to help in the provision of the best management. The recent guidelines on indications and for surgical treatment developed by the American College of Cardiology and the American Heart Association have been summarized.

Resumen

La endocarditis infecciosa es una enfermedad casi invariablemente fatal si no es tratada de la manera apropiada. Este artículo presenta las anomalías cardiacas y los procedimientos asociados al desarrollo de las mismas, así como también la más reciente clasificación de las diferentes modalidades de la endocarditis. Se resumen la manifestación clínica, los organismos causantes y los procedimientos diagnósticos. Se indican las recomendaciones de la Asociación Americana del Corazón (AHA por sus siglas en inglés) y del Colegio Americano de Cardiología (ACC por sus siglas en inglés) para el manejo de la endocarditis de válvulas nativas, de válvulas prostésicas, de drogadictos y la endocarditis de cultivo negativo. También se presentan las condiciones que justifican las intervenciones quirúrgicas.

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