

Hemodynamic changes in infective endocarditis

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ABSTRACT

Hemodynamic disturbances in patients with infective endocarditis (IE) are complex and might be consequences of various pathogenic processes. Congestive heart failure (CHF) is a major contributor of hemodynamic derangements, but since IE is often a septic disease, reversible myocardial dysfunction as well as septic shock might sometimes dominate or represent additional contributing factors of disturbed hemodynamics. The major cause of CHF is malfunction of affected valves. It occurs with an incidence of 32 % and is often severe. This is why CHF is the most important risk factor associated with poor patient outcome. Results of the project 'International Collaboration on Endocarditis' related to the characteristics of CHF in patients with IE are presented.

Key words: infective endocarditis, congestive heart failure, sepsis, Staphylococcus aureus

Infective endocarditis (IE) is still a serious disease with a high mortality (16 – 20%) overall. It is a localized infection involving the heart valves in the majority of patients, but it is also often a generalized infection associated with the systemic inflammatory response syndrome and numerous septic metastases in various parts of the body. Due to this, there is a diversity of pathogenic mechanisms involved in the hemodynamic changes in IE.

The clinical and microbiological spectra of IE have been evolving continually from the first descriptions of the disease at the beginning of the 20th century. The changing profile of IE is nowadays well established and documented (table 1). (1-3)

During the first seventy years of the twentieth century IE was usually of a subacute clinical course because less pathogenic bacteria, like alpha-hemolytic streptococci of the viridans group, dominated as major pathogens. They did not induce a pronounced inflammatory response. Rheumatic valve dis-

ease was the major underlying cause. Nowadays, the course of IE is mostly acute, septic and the most common pathogen is Staphylococcus aureus. The incidence of enterococcal or Streptococcus bovis infections has risen. Atherosclerotic valvular disease is the most common form of valvular disease due to the increased incidence of degenerative valvular lesions associated with an ageing population. IE occurs in patients without previously known cardiac disease in up to almost 50% of patients. The average age of patients with IE has increased over time resulting in a shift towards the eighth or even ninth decade of life. Other more prevalent risk factors associated with IE, are patients with implanted intracardiac devices (pacemakers, defibril-

lators) although, fortunately, there is a decreased incidence in patients with prosthetic valve infective endocarditis (PVIE). A horrific increase in the number of intravenous drug addicts has led to a greater incidence of right-sided IE. Recently, some other epidemiological characteristics of IE have emerged. Although community-acquired infections still dominate, health care associated infections are growing, particularly those associated with dialysis, implantation of Hickman's and Broviac catheters and other invasive procedures. (4) All these changes affect the hemodynamics in patients with IE in regard to its pathogenesis and incidence (figure 1). While hemodynamic derangements associated with valvular or paravalvular dysfunctions are well known, changes

Table 1. Changing aspects of IE.

- Increasing average age
- Lower number of patients with previously recognized valve disease
- Decrease in the incidence of PVIE
- Increase in the incidence of S. Aureus and BHS 'D' infections
- Health care associated IE increased
- IE in iv. addicts increased
- Earlier cardiac surgery
- Better prognosis

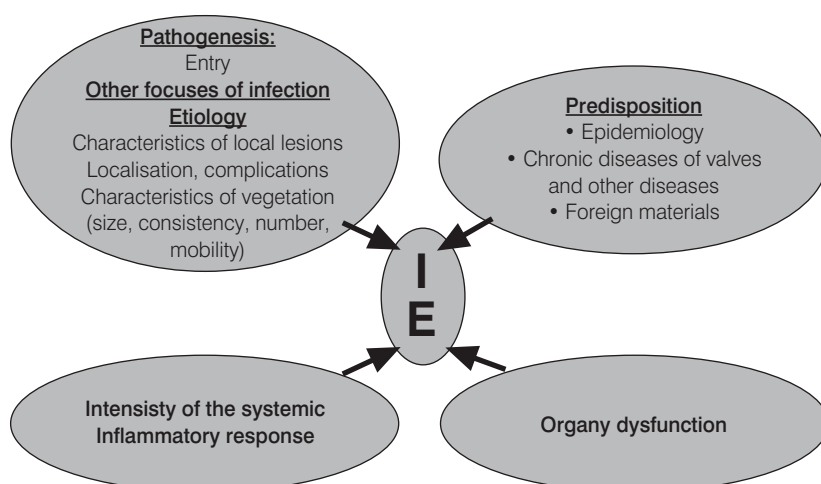


Figure 1. Pathogenesis of hemodynamic derangements in patients with infective endocarditis (IE).

associated with systemic inflammatory response syndrome (SIRS) and organ dysfunctions are not adequately addressed in clinical research of IE. It is often forgotten that IE is only one segment of a generalized, acute systemic inflammatory response – sepsis.

The most established hemodynamic changes are associated with infections of valves and surrounding tissues and consequent valve dysfunction. The most important and most severe complication is congestive heart failure (CHF) which may rapidly progress due to the dysfunction of heart valves (rapid progression of aortic and/or mitral regurgitation), valve perforation, formation of a paravalvular abscess and fistulation, paravalvular leak due to dehiscence of prosthetic valves (table 2). Congestive heart failure demands earlier surgical intervention, which is one of the most important factors today contributing to a better prognosis.

CHF, along with embolizations, is the most common complication of IE. The incidence of CHF in patients with IE is 30% to 40%. Despite this, CHF has not been particularly evaluated in separate studies because it is a well-known complication with few unresolved questions. Our center in the Hospital for Infectious Diseases is actively involved in a project known as the 'International Collaboration on Endocarditis Prospec-

tive Surveillance'. A global database has been formed which includes over 5000 patients from all continents. The center of the project is at Duke University. I will present here an analysis of the incidence and characteristics of patients with CHF. There have been, up until now, 2787 patients with definite IE according to Duke criteria. The mean age is 56+-18 years; males dominate (68%). CHF occurred in 877 (32%) of patients. The severity of CHF was reported in 761 patients (193 missing values) according to NYHA classification (figure 2). These data suggest that CHF is a severe, life threatening complication in the majority of patients in whom it occurred. However, it is not easy to interpret these data because often patients with IE are septic and symptoms of sepsis overlap symptoms and signs of CHF.

Does CHF occur more often in elderly patients? Despite a slight tendency towards a greater incidence in the group of patients older than 74 years, the difference was not statistically significant (figure 3). This is in accordance with other ICE reports.

One might expect that because of a worse prognosis for patients with PVIE, the incidence of CHF is higher compared to native valve disease. We were not able to confirm this. The incidence of CHF was 621 out of 1906 (32.6%) patients with NVIE and 175 out of 564 (31%) patients with PVIE.

Is localization of IE associated with CHF? Sexton and al. showed that aortic valve disease is more commonly associated with CHF than mitral valve involvement (28% vs. 20%). (5) In our group of patients with left-sided NVIE the incidence of CHF was significantly higher if both valves were affected (53.7%) than if only the aortic valve (37.5%) or mitral valve (31.1%) were involved.

Since *S. aureus* is the most common pathogen causing IE today with a worse prognosis than IE caused by other bacteria, we asked if *S. aureus* IE was associated with a greater incidence of CHF. Interestingly, there was a significant increase in the incidence of CHF among patients with staphylococcal NVIE (34.1% vs. 29.4%, $p=0.04$). That was not observed in PVIE (figure 4). There was no difference in the incidence of CHF in patients with IE caused with MSSA compared to MRSA.

Patients with CHF were more commonly subjected to cardiac surgery than patients without CHF (62% vs. 38.9%, $p<0.001$ in NVIE and 55.1% vs. 45.4%,

Table 2. Hemodynamic derangements in patients with IE.

Valve dysfunction	Changes associated with sepsis
<ul style="list-style-type: none"> • Regurgitation <ul style="list-style-type: none"> - Perforation - Rupture of chordae mitralis • Stenosis • Intracardiac shunt <ul style="list-style-type: none"> - Paravalvular 'leak' (dehiscence) - Fistulation (abscess) 	<ul style="list-style-type: none"> • Hyperdynamic phase • Reversible myocardial dysfunction • Septic shock

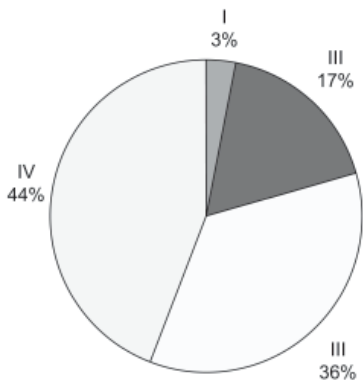


Figure 2. Severity of congestive heart failure (CHF) according to NYHA classification in patients with infective endocarditis (ICE study).

$p < 0.05$ in patients with PVIE). Cardiac surgery, in a number of studies, has been associated with better patient survival and CHF is often the commonest indication for surgery. Intra-hospital mortality was significant-

ly higher amongst patients with CHF (27.5% vs. 11.1% in NVIE and 33.5% vs. 18.3% in PVIE). Other ICE studies confirmed that CHF is the most important independent factor associated with intra-hospital death in patients with IE. These data explain why hemodynamic complications are, along with central-nervous system embolizations, the most important factor that necessitates admission of patients with IE to intensive care units (ICU). The incidence of CHF in patients admitted to ICU is 28% to 64%. (6,7)

Because of the striking evidence of the association between CHF and poor patient survival, other aspects of hemodynamic derangement have been less evaluated. It is often forgotten that IE is in the majority of patients a septic disease. Changes in peripheral vascular resistance, cardiac output and blood pressure add to derangements associated with valve failure. Revers-

ible myocardial dysfunction is further imposed on existing disturbances and should be taken into consideration in patients with IE. Severe CHF is associated with pulmonary edema, which is further complicated by ARDS and capillary leak syndrome, which accompany

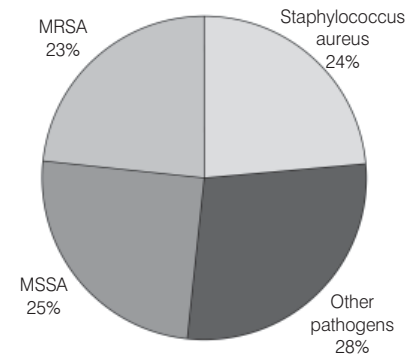


Figure 4. Congestive heart failure in patients with staphylococcal endocarditis (ICE study).

severe sepsis and septic shock. Central nervous system complications might be further complicated by neurogenic shock and renal failure with volume overload. All these hemodynamic consequences of IE are often superimposed on chronic cardiac diseases, particularly in elderly patients. The complexity of hemodynamic changes in patients with IE is also reflected in therapeutic options in septic patients. It is clear how treatment with fluids and sympathomimetics must be well balanced as well as invasive organ support such as mechanical ventilation and applied renal replacement therapy. However, many problems still remain and many aspects of IE need further clarification.

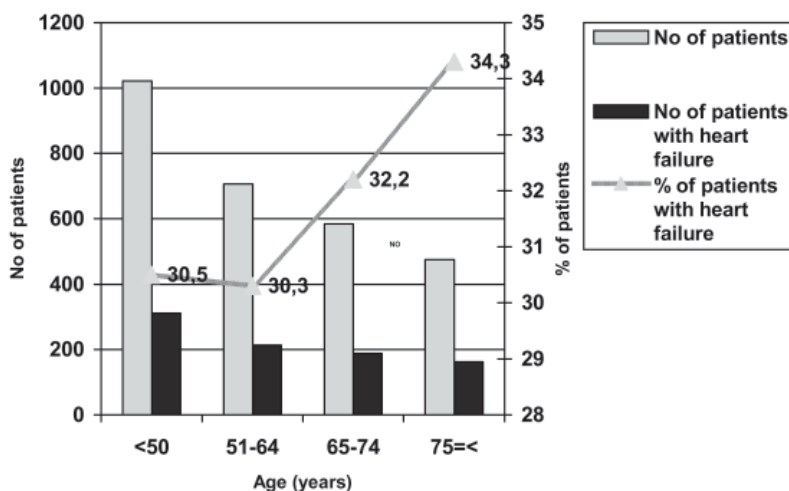


Figure 3. Influence of age on the incidence of congestive heart failure in patients with infective endocarditis (ICE study).

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