Effects of pathogenic factors on prognosis in patients with prosthetic valve endocarditis

Elżbieta Abramczuk, Tomasz Hryniewiecki, Janina Stępińska

Department of Acquired Valvular Heart Disease, Institute of Cardiology, Warsaw, Poland

Abstract

Introduction: Despite progress in medicine, the prevalence of infective endocarditis (IE) in patients with prosthetic valves (PVE) has not decreased. Positive blood and valve cultures are one of the most important diagnostic criteria of IE. There are no unambiguous data regarding the influence of pathogenic factors on prognosis.

Aim: To analyse blood and valve cultures in patients with PVE and assess their impact on the risk of early and late deaths as well as IE relapse.

Methods: The study group consisted of 71 PVE patients. Infective endocarditis was diagnosed based on the Polish Cardiac Society guidelines. Early and late mortality as well as IE relapse were analysed in patients hospitalised between 1988 and 1998.

Results: Positive blood cultures were found in 55 (77.5%) patients. Early mortality was 15.5% (11 deaths). Coagulase-negative *Staphylococcus* infection was an independent risk factor of early death (p=0.02). During long-term follow-up 8 (13.3%) patients died. The risk of late death increased with positive valve culture (p=0.04). Recurrence of IE was diagnosed in 6 (10%) patients. *Staphylococcus epidermidis* was a risk factor of disease relapse (p=0.03). Six-year survival was 73%.

Conclusions: 1. Coagulase-negative *Staphylococcus* aetiology increases the risk of early death in patients with PVE. 2. Pathogenic factors did not influence the risk of late death. 3. The risk of late death was increased with positive valve culture with negative blood cultures. 4. *Staphylococcus epidermidis* aetiology increases the risk of PVE relapse.

Key words: prosthetic valve infective endocarditis, pathogenic factors, prognosis

Kardiol Pol 2007; 65: 115-122

Introduction

Infective endocarditis (IE) is one of the most threatening and dramatic complications of implantation of prosthetic heart valves. It affects 1.4-3.1% of patients [1]. The highest risk of IE on prosthetic valves (PVE) falls on the 5^{th}-6^{th} week post cardiac surgery and remains elevated for up to 6 months [2]. Mortality ranges between 13% and 56% according to different sources [3-6].

All diagnostic criteria of IE available so far have attributed the major importance to blood cultures. Aetiology of PVE is predominated by *Staphylococcus epidermidis*, which is a coagulase-negative strain constituting normal bacterial flora of the skin and mucosa. It causes 8-33% of IE, in particular on the prosthetic valves in the early postoperative period [1, 2, 7]. The infection is most commonly intraoperative with patient's own or operating personnel's bacterial flora. Severe infections and therapeutic difficulties are caused by meticillin resistant *Staphylococcus epidermidis* (MRSE). The typical sign is formation of abscesses most often in the mitro-aortic tissue as well as common occurrence of perivalvular leaks. Infective endocarditis of MRSE aetiology frequently requires surgical intervention [1, 3].

Recent guidelines of the European Society of Cardiology (ESC) presented in the European Heart Journal in 2004 classify terminology associated with IE,

Address for correspondence:
Tomasz Hryniewiecki MD, Klinika Wad Nabytych Serca Instytutu Kardiologii, ul. Alpejska 42, 04-628 Warszawa,
tel.: +48 22 343 44 77, fax: +48 22 343 45 09, e-mail: hryniewiecki@ikard.pl
Received: 26 July 2006. **Accepted:** 18 October 2006.

including prosthetic valves, and distinguish early PVE, when it occurs within the first year after surgery, and late, when it occurs after this period [7].

There is no doubt that positive blood cultures are important for the diagnosis of IE and for further therapeutic decisions (pharmacological and surgical treatment). However, no unequivocal data are available regarding the risk of early and late mortality and relapse of IE depending on type of pathogen cultured or negative blood and/or valve cultures.

The aim of the study was to analyse blood and valve cultures in patients with PVE and assess their impact on risk of early and late deaths as well as IE relapse.

Methods

Study group

The analysis involved 71 PVE patients treated at the Institute of Cardiology in Warsaw between 1988 and 1998. Diagnosis of IE was confirmed according to the current guidelines of the Polish Cardiac Society [8]. Infective endocarditis was diagnosed when confirmed intraoperatively or on autopsy or when the following clinical criteria were met: 2 major signs, 1 major and 3 minor signs or 5 minor signs present. Indications for surgery were: unsuccessful antibiotic therapy, worsening of heart failure, presence of large bacterial vegetations (>1 cm), abscess or perivalvular tissue infiltration and dysfunction of the prosthetic valve.

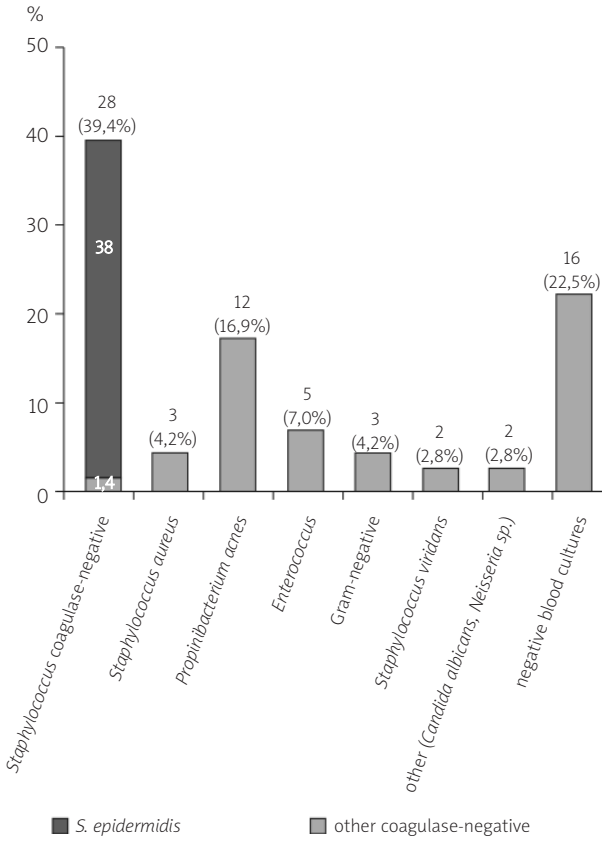

Figure 1. Distribution of the aetiological factors

Analysed parameters

The number of early and late deaths and IE recurrences were analysed. Univariate analysis was used to evaluate the impact of pathogen type on the prognosis of IE patients. Early deaths were defined as in-hospital deaths. Late mortality was defined as deaths after discharge from hospital. Infective endocarditis relapse was each next endocardium infection following recovery from the primary episode and negative control blood cultures after the end of antibiotic therapy. Follow-up period ranged from 9 months to 15 years (mean 6 years). End of follow-up was 15 Feb. 2004. Analysis endpoint was the date of early death, date of late death, date of relapse or date of final examination.

Statistical analysis

Analysis of impact of positive and negative blood/valve cultures on the rate of early and late deaths as well as on the relapse rate was performed with chi-square test. Fisher's exact test was used for an expected population count below 5. Univariate Cox proportional hazard model (PHREG) was applied for selection of risk factors of early and late deaths and relapses. Analysis of variance (ANOVA) was used for evaluation of quantitative (continuous) variables. Survival time and time to recurrence were illustrated with Kaplan-Meier curves, tested with survival test (LIFETEST) and analysed with Cox proportional hazard model (PHREG). Statistical analyses were performed using SAS v.8.2 statistical software. The significance of hypothesis verification was found for $p < 0.05$.

Results

Study group characteristics and localisation of infection are described in Table I.

Early deaths – aetiology

Of all 71 patients positive blood or valve cultures were found in 55 (77.5%) subjects. The most common pathogen was *Staphylococcus epidermidis* (38%), followed by *Propionibacterium acnes* (17%) (Figure 1). It was found that infection caused by coagulase-negative *Staphylococcus* markedly increased early mortality. The remaining pathogens did not have any significant influence on in-hospital mortality (Table II).

Table I. Clinical characteristics of patients

Parameter	Total n=71 (100%)	Pharmacotherapy only n=28 (39.4%)	Surgical treatment n= 43 (60.6%)
Early PVE	18 (25.4%)	12 (42.9%)	5 (11.6%)
Late PVE	53 (74.6%)	16 (57.1%)	38 (88.4%)
Females	31 (44%)	12 (42.9%)	19 (44.2%)
Males	40 (56%)	16 (57.1%)	24 (55.8%)
Age [years]	18-71 (mean 51)	34-70 (mean 60)	18-71 (mean 56)
IE location after cardiac surgery			
Aortic valve	28 (39.4%)	9 (32.1%)	19 (44.3%)
Mitral valve	35 (49.3%)	17 (60.7%)	18 (41.8%)
Aortic and mitral valves	7 (9.9%)	2 (7.2%)	5 (11.6%)
After VSD repair	1 (1.4%)	0	1 (2.3%)
Heart failure – NYHA class			
I	0	0	0
II	13 (18%)	8 (28.6%)	5 (11.7%)
III	37 (52%)	16 (57.1%)	21 (48.8%)
IV	21 (30%)	4 (14.3%)	17 (39.5%)
Positive blood/valve cultures	55 (77.5%)	18 (64.3%)	37 (86%)

Abbreviations: PVE – prosthetic valve infective endocarditis, VSD – ventricular septal defect

Table II. Early mortality with respect to aetiology

Aetiology	Total n=71	Early death n (%)	p
Coagulase negative *Staphylococcus*	28	8 (28.6)	0.02
including: *Staphylococcus epidermidis*	27	7 (25.9)	NS
Staphylococcus aureus	3	0	NS
Propionibacterium acnes	12	0	NS
Enterococcus	5	1 (20)	NS
Gram-negative	3	0	NS
Streptococcus viridans	2	0	NS
Other pathogens*	2	1 (50)	NS
Negative cultures (of blood and valves)	16	1 (6.3)	NS

** Other pathogens: Candida albicans, Neisseria sp.*

Surgical treatment was performed in 43 (60.6%) patients and 28 (39.4%) subjects were treated only medically. Of 43 re-operated patients seven (16.3%) died. In the group of 28 patients receiving only pharmacotherapy 4 patients (14.3%) died. In total, in-hospital mortality comprised 11 deaths (15.5%). Infective endocarditis aetiology in patients with early deaths, treated with surgery was predominately coagulase-negative *Staphylococcus*. The most common cause of death was central nervous system damage.

Only four patients from the group of pharmacotherapy died: two of them due to neurological complications, 1 of refractory heart failure and 1 patient died while awaiting surgery. In this last case death was caused by dissection of the aorta. Re-operation was not considered in the remaining 24 patients with echocardiographic evidence of <1 cm vegetations and no signs of dysfunction of the prosthetic valves; one patient had minor periaortic leak. In all patients clinical effectiveness of antibiotic therapy was confirmed.

Two patients were operated on during the long-term follow-up: one due to the recurrence of IE and the other due to the progression of aortic perivalvular leak. A total number of 60 (85%) patients recovered and discharged home. Hospitalisation duration ranged between 6 and 150 days (mean 54 days).

Recurrences

After successful healing of PVE, relapse was found in 6 (10%) patients. Mean time to the recurrence of PVE was 6.9 months (3 weeks – 19.9 months). Patients with the highest risk of relapse were those with IE caused by Staphylococcus epidermidis (p=0.01) (Table III). Relapse of the disease was not observed in any patient with *Staphylococcus aureus* or *Propionibacterium acnes* positive or negative blood cultures.

There were 5 recurrences observed in 36 patients in whom primary PVE was successfully treated with surgery. *Staphylococcus epidermidis* was each time found to be a pathogen in the primary process. In 4 patients aetiology of the relapse remained the same. All those patients were re-operated with good early and late outcomes and were in NYHA I or II class. In the fifth patient primary, PVE was caused by MSSE, while blood cultures were negative on relapse. The patient was transferred to our institution in very severe condition and died of extreme multiorgan distress syndrome on the 3rd day of hospitalisation. In 24 PVE patients with successful pharmacological treatment, recurrent IE was observed in one case. Aetiology of both episodes was the same – *Enterococcus fecalis*. This patient was selected for re-operation which produced good early and late outcomes; he remained in NYHA class II.

Late deaths

During long-term follow-up of 60 patients 8 (13.3%) subjects died: 7 were re-operated and 1 treated conservatively. No differences were noted in the incidence of late deaths with respect to the pathogens cultured (Table IV). However, there was a difference between positive blood and positive valve cultures. Late death rate was significantly higher in patients with positive valve cultures and negative blood cultures (Table V).

Table III. Infective endocarditis recurrence with respect to aetiology

Aetiology	Total n=60	Recurrence n (%)	p
Staphylococcus epidermidis	20	5 (25)	0.01
Staphylococcus aureus	3	0	NS
Streptococcus viridans	2	0	NS
Propionibacterium acnes	12	0	NS
Enterococcus	4	1 (25)	NS
Gram-negative	3	0	NS
Other pathogens	1	0	NS
Negative cultures (of blood and valves)	15	0	NS

Table IV. Late mortality with respect to aetiology

Aetiology	Total n=60	Late deaths n (%)	p
Staphylococcus epidermidis	20	3 (15)	NS
Staphylococcus aureus	3	0	NS
Propionibacterium acnes	12	2 (16.7)	NS
Enterococcus	4	1 (25)	NS
Gram-negative	3	1 (33.3)	NS
Streptococcus viridans	2	0	NS
Other pathogens	1	1 (100)	NS
Negative cultures (of blood and valves)	15	0	NS

Table V. Late mortality with respect to the blood or valve culture

		n	Late deaths n (%)	p
Positive blood culture	Yes	38	5 (13.2)	NS
	No	22	3 (13.6)	
Positive valve culture	Yes	8	3 (37.5)	0,03
	No	52	5 (9.6)	
Positive blood or valve culture	Yes	45	8 (17.8)	NS
	No	15	0	
Negative cultures	Yes	15	0	NS
	No	45	8 (17.8)	

Mortality was the highest during the first 6 months following discharge. Two deaths were related to past IE: one patient died of recurrent PVE and the other one, with recurrence of fever after about 6 months past IE, died outside of our Institute. Other causes included refractory heart failure (4 patients) and sudden death (2 patients).

Univariate Cox proportional risk analysis showed that coagulase-negative *Staphylococcus* aetiology increased the risk of early death, whereas *Staphylococcus epidermidis* increased the risk of relapse. Aetiology did not affect late mortality. The risk of late death was increased with positive culture of valvular material removed intraoperatively. Long-term follow-up involved 96% of study patients: survival after a mean of 6 years was 73%.

Discussion

Identification of causes of increased risk of death and IE recurrence may improve management and prognosis of this group of patients. Analyses of our PVE patients showed that *Staphylococcus epidermidis* was the major pathogenic factor. This has not changed for almost 20 years. These results are consistent with the reports of other investigators [6, 8-11].

In-hospital PVE-related mortality in the United Kingdom is 16.6% [6] and in the US it has decreased from 20% to 10% [4]. According to the report of Delay et al. from Canada deaths did not occur in the PVE group [11]. It is the only publication in which the authors reported no early deaths in the most difficult to treat PVE group. It may result from a management strategy including transferring patients soon after surgery to other sites or early discharge from hospital. This may be supported by the very high annual mortality reaching 26% in this group [11].

Mortality in IE and PVE populations tends to markedly decrease compared to mortality rates reported in the 1980s. [4]. This has been achieved by more adequate and improved qualification of patients for cardiac surgery than it was previously [1, 7]. The report by Tornos et al. on the follow-up of patients with late PVE between 1975 and 1989 showed that 83% of patients received medical treatment only. Mortality was 21%, whereas of 17% surgical patients, 33% died [3]. Current published data indicate mortality of re-operated PVE patients to be 10-19% [4-6].

In our group early mortality was 15.5%. This is comparable with worldwide results. Mortality remains quite high; however, it is significantly lower compared to the data published 10 to 15 years ago. Such effective treatment of IE is the result of modern antibiotic therapy, early selection for surgery, the experience of cardiac surgeons and adequate perioperative care. As early as in the 1980s first generation cephalosporins in combination with netilmicin were introduced into therapy. The use of netilmicin was associated with its potential lower toxicity compared to gentamicin. In complicated streptococcal infections and staphylococcal infections with MRSE strains, vancomycin was then used. Infective endocarditis caused by gram-negative flora or anaerobic bacteria was treated with imipenem-cilastatin. Teicoplanin was introduced into therapy of IE of enterococcal and staphylococcal aetiology (with MRSE strains) as early as in 1996. Such antibiotic therapy preceded current standards by several years [1].

Many authors state that infection with *Staphylococcus aureus* increases the risk of death. Delahaye et al. [12] and Netzer et al. [13] published these data derived from the follow-up of patients with IE on native and prosthetic valves in 1980s. Kuyvenhoven et al. reached the same conclusion after analysis of data on PVE patients [14]. In our study *Staphylococcus aureus* infection did not increase the

risk of early death; however, such aetiology was found only in 3 patients, which is too few to draw reliable conclusions. The analysis showed that coagulase--negative *Staphylococcus* increased the risk of in-hospital death in this group of patients. The most common of coagulase-negative *Staphylococcus* was *Staphylococcus epidermidis*. It is likely that the large number of patients in this group meant that a statistical difference was not found for *Staphylococcus epidermidis* itself. However, Renzuli et al. denied an influence of positive or negative blood or valve cultures on in-hospital death rate [9]. Considering positive or negative blood cultures as definite maesures of the outcome may be inappropriate and may lead to false conclusions. It seems that in IE each aetiological factor should be considered separately.

Results regarding late deaths are very interesting. The incidence of late deaths after recovery of PVE was not related to the aetiology of infection. Mansur et al. presented results of IE treatment in 420 patients in 1978-1994 and documented that microbe type did not affect long-term prognosis. Risk factors included elderly and recurrent IE [15]. Vlesis et al. on the basis of analysis of 140 IE patients hospitalised between 1982 and 1992 concluded that pathogenic factors did not impact survival [16]. Our analysis showed that the risk factor of late death of PVE patients was positive culture of valve excised during re-operation regardless of the bacteria type cultured. Positive valve cultures usually indicate no or poor penetration of antibiotic to the infection foci. According to the new ESC guidelines, a positive valve culture suggests active IE. As these patients should be treated as the highest risk group, elective control blood cultures should be considered after discharge of the patient from hospital, which admittedly is not recommended by the ESC experts. Among others, McGiffin et al. [17] found that the first 6 months remain the period in which there is the highest risk of relapse following primary surgical treatment of IE. The results showing significance of positive valve cultures in PVE patients differ from those found in the literature. Renzulli et al. described IE patients hospitalised in 1978--1998. They analysed separately patients with positive blood cultures, valve cultures and negative cultures and concluded that neither microbes nor positive or negative blood/valve cultures influenced late outcomes [9].

It is well recognised that patients with past and recovered IE are at risk of IE relapse [1, 15]. The definition of recurrent IE has changed over the years. Differences concern both whether the recurrent infection may be caused by the same pathogen as well as the time period that must pass from the recovery from primary IE to the diagnosis of recurrent and not persistent IE. Some authors suggest that recurrent IE may be caused by the same pathogen [8, 13], while others claim that a different microorganism is required [1, 12, 14]. Time from the recovery from the primary IE to diagnosis of recurrent IE varies between investigators, from 17 to 180 days [4, 8, 12-14, 16]. According to the current ESC guidelines, recurrent IE is another IE occurring after one year following surgical treatment [7]. Some investigators claim that the highest risk of recurrence is within the first 6 months following recovery of the primary IE [17]. Netzer et al. defined IE relapse as a new process after the patient's recovery and discharge from hospital [13]. In our study, IE relapse was defined as another IE episode after prior clinically, biochemically and microbiologically documented recovery of IE.

Selection of risk factors is more difficult due to the rare incidence of recurrences. McGiffin et al. identified one risk factor, which was duration of extracorporeal circulation [17]. Risk factors listed by Mansur et al., who described long-term results of 420 patients recovered from IE, were male gender and PVE within the first year after implantation of prosthetic valve [15]. Frequency of recurrences ranges from 1.1% to 13% [3, 8, 15, 18]. In our study, recurrent IE after PVE was observed in 10% of 60 patients. *Staphylococcus epidermidis* aetiology was a risk factor of IE relapse and coagulase-negative S*taphylococcus* increased the rate of early deaths and relapse. Also Langley et al., who reported relapses in 3.7% of PVE patients, pointed to their relationship with *Staphylococcus aureus* aetiology [18].

Long-term outcomes of concomitant treatment of IE including targeted antibiotic therapy and cardiac surgery are constantly improving. In our group six-year survival was 73%. This is similar to worldwide data where 5-year survival rate ranges from 59 to 82% [4, 8, 11].

Conclusions

1. Coagulase-negative *Staphylococcus* aetiology increases the risk of late deaths in patients with PVE.
2. Pathogenic factors did not influence the risk of late death.
3. The risk of late death was increased with positive valve culture and negative blood cultures.
4. *Staphylococcus epidermidis* aetiology increases the risk of PVE relapse.

References

1. Karchmer A. Infective endocarditis. In: Braunwald E. (ed.). Heart Disease. *WB Saunders Company* 2001; 1723-45.
2. Chastre J, Trouillet JL. Early infective endocarditis on prosthetic valves. *Eur Heart J* 1995; 16 (Suppl B): 32-8.

3. Tornos P, Sanz E, Permanyer-Miralda G, et al. Late prosthetic valve endocarditis. Immediate and long-term prognosis. *Chest* 1992; 101: 37-41.
4. Lytle B, Priest BP, Taylor PC, et al. Surgical treatment of prosthetic valve endocarditis. *J Thorac Cardiovasc Surg* 1996; 111: 198-210.
5. Castillo JC, Anguita MP, Torres F, et al. Long-term prognosis of early and late prosthetic valve endocarditis. *Am J Cardiol* 2004; 93: 1185-7.
6. Alexiou C, Langley SM, Stafford H, et al. Surgery for active culture-positive endocarditis: determinants of early and late outcome. *Ann Thorac Surg* 2000; 69: 1448-54.
7. Horstkotte D, Follath F, Gutschik E, et al. Guidelines on prevention, diagnosis and treatment of infective endocarditis executive summary; the task force on infective endocarditis of the European Society of Cardiology. *Eur Heart J* 2004; 25: 267-76.
8. Castillo JC, Anguita MP, Ramirez A, et al. Long term outcome of infective endocarditis in patients who were not drug addicts: a 10 year study. *Heart* 2000; 83: 525-30.
9. Renzulli A, Carozza A, Marra C, et al. Are blood and valve cultures predictive for long-term outcome following surgery for infective endocarditis? *Eur J Cardiothoracic Surg* 2000; 17: 228-33.
10. Wallace SM, Walton BI, Kharbanda RK, et al. Mortality from infective endocarditis: clinical predictors of outcome. *Heart* 2002; 88: 53-60.
11. Delay D, Pellerin M, Carrier M, et al. Immediate and long-term results of valve replacement for native and prosthetic valve endocarditis. *Ann Thorac Surg* 2000; 70: 1219-23.
12. Delahaye F, Ecochard R, de Gevigney G, et al. The long term prognosis of infective endocarditis. *Eur Heart J* 1995; 16: 48-53.
13. Netzer RO, Zollinger E, Seiler C, et al. Infective endocarditis: clinical spectrum, presentation and outcome. An analysis of 212 cases 1980-1995. *Heart* 2000; 84: 25-30.
14. Kuyvenhoven JP, van Rijk-Zwikker GL, Hermans J, et al. Prosthetic valve endocarditis: analysis of risk factors for mortality. *Eur J Cardiothorac Surg* 1994; 8: 420-4.
15. Mansur AJ, Dal Bo CM, Fukushima JT, et al. Relapses, recurrences, valve replacements, and mortality during the long-term follow-up after infective endocarditis. *Am Heart J* 2001; 141: 78-86.
16. Vlessis AA, Hovaguimian H, Jaggers J, et al. Infective endocarditis: ten-year review of medical and surgical therapy. *Ann Thorac Surg* 1996; 61: 1217-22.
17. McGiffin DC, Galbraith AJ, McLachlan GJ, et al. Aortic valve infection. Risk factors for death and recurrent endocarditis after aortic valve replacement. *J Thorac Cardiovasc Surg* 1992; 104: 511-20.
18. Langley SM, Alexiou C, Stafford HM, et al. Aortic valve replacement for endocarditis: determinants of early and late outcome. *J Heart Valve Dis* 2000; 9: 697-704.

Wpływ czynnika patogenetycznego na rokowanie u chorych z infekcyjnym zapaleniem wsierdzia na sztucznych zastawkach

Elżbieta Abramczuk, Tomasz Hryniewiecki, Janina Stępińska

Klinika Wad Nabytych Serca, Instytut Kardiologii, Warszawa

Streszczenie

Wstęp: Pomimo postępu w medycynie częstość incydentów infekcyjnego zapalenia wsierdzia (IZW) u chorych z wszczepioną sztuczną zastawką (IZWSz) nie zmniejszyła się. Wyniki posiewów krwi i zastawek są jednym z ważniejszych kryteriów diagnostycznych IZW. Nie ma jednoznacznych danych mówiących o wpływie czynnika patogenetycznego na rokowanie.

Cel: Analiza wyników posiewów krwi i zastawek u chorych z IZWSz oraz ocena ich wpływu na ryzyko zgonu wczesnego, odległego i nawrotu IZW.

Metodyka: Grupę badaną stanowiło 71 chorych z IZWSz. Rozpoznanie IZW weryfikowano na podstawie standardów Polskiego Towarzystwa Kardiologicznego. Śmiertelność wczesną, odległą i nawroty IZW analizowano u chorych hospitalizowanych w latach 1988–1998.

Wyniki: Dodatnie posiewy krwi stwierdzono u 55 (77,5%) chorych. Śmiertelność wczesna wynosiła 15,5% (11 zgonów). Niezależnym czynnikiem ryzyka zgonu wczesnego był *Staphylococcus* koagulazoujemny (p=0,02). W obserwacji odległej zmarło 8 (13,3%) chorych. Ryzyko zgonu odległego zwiększał dodatni posiew z zastawki (p=0,04). Nawrót IZW wystąpił u 6 chorych (10%). Czynnikiem ryzyka nawrotu był *Staphylococcus epidermidis* (p=0,03). Przeżycie 6-letnie wynosiło 73%.

Wnioski: 1. Etiologia *Staphylococcus* koagulazoujemny zwiększa ryzyko zgonu wczesnego u chorych z IZWSz. 2. Czynniki patogenetyczne nie mają wpływu na ryzyko zgonu odległego. 3. Dodatni posiew z zastawki przy ujemnym posiewie z krwi zwiększa ryzyko zgonu odległego. 4. Etiologia *Staphylococcus epidermidis* zwiększa ryzyko nawrotu IZWSz.

Słowa kluczowe: infekcyjne zapalenie wsierdzia na sztucznych zastawkach, czynnik patogenetyczny, rokowanie

Kardiol Pol 2007; 65: 115-122

Adres do korespondencji:

doc. dr hab. Tomasz Hryniewiecki, Klinika Wad Nabytych Serca Instytutu Kardiologii, ul. Alpejska 42, 04-628 Warszawa,

tel.: +48 22 343 44 77, faks: +48 22 343 45 09, e-mail: hryniewiecki@ikard.pl

Praca wpłynęła: 26.07.2006. **Zaakceptowana do druku:** 18.10.2006.