Transplant International ISSN 0934-0874

ORIGINAL ARTICLE

Severe endocarditis in transplant recipients – an epidemiologic study*

Elfriede Ruttmann,[1] Hugo Bonatti,[2] Christina Legit,[1] Hanno Ulmer,[3] Ingrid Stelzmueller,[2] Herwig Antretter,[1] Raimund Margreiter,[2] Guenter Laufer[1] and Ludwig C. Mueller[1]

1 Department of Cardiac Surgery, Innsbruck Medical University, Innsbruck, Austria
2 Department of General and Transplant Surgery, Innsbruck Medical University, Innsbruck, Austria
3 Department of Medical Statistics, Informatics and Health Economics, Innsbruck Medical University, Innsbruck, Austria

Keywords
infective endocarditis, solid organ transplantation.

Correspondence
Elfriede Ruttmann MD, Department of Cardiac Surgery, University Hospital Innsbruck, Anichstr. 35, 6020 Innsbruck, Austria. Tel.: +43 512 504 3806; fax: +43 512 504 2528; e-mail: elfriede.ruttmann@uibk.ac.at

*Presented in part at the XXth Congress of the Transplantation Society, Vienna, Austria, September 5–10, 2004.

Received: 20 October 2004
Revised: 10 November 2004
Accepted: 10 February 2005

doi:10.1111/j.1432-2277.2005.00120.x

Summary

Infective endocarditis (IE) is reported with an incidence of 6/100 000 inhabitants in the general population. Even though immunosuppression predisposes to systemic infection, reports regarding IE after solid organ transplantation (SOT) are sparse. From 1989 to 2004, 2556 patients underwent SOT at the University Hospital Innsbruck. During this period, 27 transplant recipients were diagnosed IE. Nine patients (33.3%) were diagnosed at autopsy, eight patients (29.6%) were cured by antibiotic treatment and 10 patients (37.1%) underwent surgery. Overall mortality was 44.4% (12 patients). *Staphylococcus* was the predominant microorganism in 16 cases (59.3%), fungal infection was present in four patients (14.8%). Incidence of IE was 1% (95% CI: 0.67–1.49), indicating a 171-fold risk compared with the overall population. IE after SOT constitutes a significant problem and is associated with an excessive high mortality. Alertness to this condition is indicated, as we might diagnose more cases of IE in the future.

Introduction

Infective endocarditis (IE) is a rare disease reported to occur with an incidence of approximately 6/100 000 inhabitants in the general population [1].

Although intensive antibiotic treatment can cure endocarditis in some instances, complications such as extension of the infection into surrounding cardiac structures, progressive valvular dysfunction, or even septic embolism often require cardiac surgery [2,3]. Prior to the introduction of echocardiography [4], diagnosis of IE was mainly based on clinical suspicion [5,6]. Therefore, most cases of IE were discovered through the appearance of secondary complications in an advanced stage when surgical treatment was associated with a high perioperative mortality.

Immunosuppressive treatment in transplant recipients predisposes to infections, nevertheless, unspecific symptoms of IE, such as fever, lassitude, weight loss, and signs of inflammation may often be misinterpreted as acute rejection episode. Little is known about the incidence of IE as a complication after solid organ transplantation (SOT). However, Paterson *et al.* identified 10 cases of IE in a series of 591 liver transplant recipients, indicating an incidence of IE of 1.7% in this subpopulation [7].

Beyond this study no incidence data of IE in SOT have been published. In order to address the question whether the risk for IE in transplant recipients is increased compared with the risk of the overall population we performed a retrospective analysis of 2556 consecutive patients who underwent SOT between 1989 and 2004. Furthermore, we wanted to investigate potential risk factors for the development of IE and to raise alertness to this complication after SOT.

Patients and methods

As the introduction of our transplant program in 1974, approximately 4100 SOTs (including 430 retransplanta-

tions) have been performed. Our transplant center is experienced in transplantation of the heart, heart–lung, lung, liver, kidney, pancreas, small intestine, as well as multivisceral transplantation, and transplantation of the hand. Our center is responsible for SOT in the western regions of Austria and northern parts of Italy with approximately 1.5 million inhabitants.

Data sources and study sample

All cases of endocarditis occurring at the University Hospital Innsbruck from January 1989 to November 2004 that were hospitalized and evaluated using the hospital admission/discharge records (Minimum Basic Data Set, MBDS) of our center. Cases being hospitalized for IE were identified by the corresponding International Classification of Diseases (ICD) codes (9th and 10th modification) at admission and/or discharge. Only cases that met the Duke's criteria of definitive IE [6] were included into this study. In addition, echocardiographic examination was performed in all patients being diagnosed alive. As a second data source, the cardiac surgery registry of our department was used to validate the incidence of the MBDS. The local transplant administration provided further data supplementing the information of the two administrative databases.

Autopsy reports of all hospitalized transplant recipients who showed signs of infection and subsequently died during a hospital stay were reviewed.

Statistical analysis

Patients characteristics were described using descriptive statistical methods. Comparison of categorical variables was performed by the use of the chi-square test. Incidence of IE in transplant recipients was estimated by calculating 95% confidence intervals (CI) based on the binomial distribution. The odds ratio (OR) was calculated in order to quantify the magnitude of IE incidence in SOT compared with its incidence in the overall population. This incidence was assumed to be 6/100 000 inhabitants/year as described by Yankah *et al.* [1]. Data documentation and statistical analysis was performed using SPSS version 12.0 (Chicago, IL, USA).

Results

Incidence of infective endocarditis in solid organ transplantation

From January 1989 to November 2004, a total of 2556 patients underwent SOT at our center. Table 1 gives an overview of all SOT during the study period stratified by organ systems. During this 16-year study period, 27 patients were diagnosed IE. Thus, the incidence of IE in all transplant recipients was 1.0% (95% CI: 0.67–1.49). As described in the epidemiologic study by Yankah *et al.* [1], incidence of IE was assumed to be 6/100 000 cases/year in the general population. In our series, incidence of IE remained stable over the study period, i.e. before the year 2000 there were 15 IE cases among 1388 transplant recipients (1.08%), later there were 12 cases among 1168 recipients (1.03%, $P = 0.89$). IE occurred on average in a rate of 1.6 cases/160 transplant recipients per year. Thus, estimated incidence was 1015 cases per 100 000 transplant recipients (95% CI: 670–1490 patients), indicating a 171-fold risk of transplant recipients compared with the overall population.

Table 1. Overview transplantations, transplanted patients and retransplantations at our hospital (January 1989–November 2004).

	Transplantations	Patients	Retransplantations
Kidney	1748	1425	323
Kidney pancreas/ pancreas transplant alone	148	133	15
Liver	666	638	28
Heart	235	230	5
Heart–lung	6	6	0
Lung	111	104	7
Small bowel	24	20	4
Total number	2938	2556	382

Differences in organ-specific IE incidence were not statistically significant ($P = 0.22$). Incidence of IE was 0.98% (14 of 1425 patients) in kidney recipients, 3% in kidney–pancreas recipients (four of 133), 1.1% in liver transplant recipients (seven of 638), 0.96% in lung transplant recipients (one of 104; 3.7%), and 0.4% in cardiac recipients (one of 230).

Autopsy rates decreased during the study period, i.e. before the year 2000, eight of 15 cases were identified at autopsy (53.3%), after that only one male liver transplant recipient (of 12 cases during this period) was diagnosed IE postmortem at autopsy (8.3%, $P = 0.014$).

Proportion of transplant recipients in infective endocarditis

During the study period, 365 patients were hospitalized because of IE, 173 patients (47.4%) were treated by antibiotic treatment alone, 192 patients (52.6%) underwent urgent or emergent valvular operation because of acute IE. Because 18 transplant recipients could be identified alive suffering an acute episode of IE, the proportion of transplant recipients in IE amounted 4.9%. Eight of these patients (29.6%) could be cured by antibiotic treatment

Table 2. Overview hospitalized patients for infective endocarditis based on the International Classification of Diseases (ICD) codes taken from the Minimum Basic Data Set (MBDS) and the cardiac surgery registry of our department.

	MBDS, local data	Transplant recipients
Conservative treatment only	173 patients	8 patients (4.6%)
Cardiac surgery (for infective endocarditis only)	192 patients	7 patients (3.6%)
Autopsy finding, diagnosis postmortem	Cannot be answered	9 patients
Valve surgery in chronic-healed endocarditis	Cannot be answered	3 patients
Total number (diagnosis alive)	365 patients	18 patients (4.9%)

alone, the remaining 10 patients (37.1%) underwent cardiac surgery for IE. Urgent or emergent cardiac surgery, due to failure of conservative therapy, was performed in seven patients. In three patients elective valvular surgery was necessary because of resulting valvular incompetence in chronic-healed endocarditis.

Detailed overview about IE at our center is given in Table 2.

Patient description

The 27 IE patients' mean age at the time of transplantation was 48.6 ± 9.7 years. Median time from transplantation (or retransplantation) was 21.7 months, ranging from 1.1 months to 13 years.

In 15 patients (55.6%), infection had to be classified 'hospital-acquired', in 12 recipients (44.4%) 'community-acquired'. Staphylococcal infection (see Tables 3–5) was present in 16 patients (59.3%), in 10 patients (37%) more than one microorganism could be identified in blood specimen or valve tissue. Fungal infection was present in four cases (14.8%). In three patients (11.1%), the infective agent could not be identified by blood or valve tissue, however, patients were treated empirically.

The mitral valve was involved in 11 cases (40.7%), the aortic valve in eight recipients (29.6%), the tricuspid valve in one patient (3.7%), and seven patients were diagnosed a double valve endocarditis, affecting the aortic and mitral valve (25.9%).

Overall mortality was 44.4% (12 patients). Three patients suffering from community-acquired infection (25% of community-acquired infections), and nine patients (60% of hospital-acquired infection) died perioperatively or were diagnosed after death. There was a trend toward higher mortality in patients suffering from hospital-acquired infection ($P = 0.069$).

Conservative treatment group

Eight patients were diagnosed IE during hospital stay and could be treated successfully by antibiotic therapy alone (Table 3). Seven patients (88%) had undergone a previous kidney transplantation, one of them kidney retransplantation, another male patient (12%) had undergone a combined kidney pancreas transplantation for type I diabetes and terminal renal failure. Mean age at the time of transplantation was 49.7 ± 9.9 years. Median time from transplantation to the infective episode was 49 months (range from 12 to 98 months). In three of these patients, infection caused irreversible loss of allograft function. One female patient underwent kidney retransplantation 1 year after the infective event and is well without any signs of recurrence.

Cardiac surgery group

In seven patients urgent or emergent cardiac surgery had to be performed due to failure of conservative treatment (Table 4). Mean age at the time of transplantation was

Table 3. Patients being diagnosed definitive infective endocarditis that could be managed by antibiotic treatment alone (1989–2004).

Patient	Tx	Valve	Time from Tx to endocarditis	Immunosuppression	Organism	Loss of organ
37 years, female	Second kidney	Mitral	8 years	Tac/cort	*Enterococcus faecium*	Yes, re-Tx 1 year later
67 years, male	Kidney	Aortic	2 years and 7 months	CyA	*Escherichia coli*, *Enterococcus faecium*	No
38 years, male	Kidney–pancreas	Mitral	1 year and 7 months	Tac/myc	Unknown, pneumonia	No
55 years, male	Kidney	Aortic	7 years and 10 months	CyA/aza	*Streptococcus viridans*, aortic stenosis	No
52 years, female	Kidney	Mitral	1 year and 10 months	Tac/myc	*Salmonella* D, after enteritis	No
51 years, male	Kidney	Mitral	6 years and 6 months	CyA/aza	KNS, *Pseudomonas*, central venous line	Yes
51 years, female	Kidney	Mitral	8 years and 1 month	CyA/aza	*Staphylococcus aureus*, *Candida*	Yes
45 years, female	Kidney	Mitral	1 year	CyA/myc/cort	KNS	No

Tac, tacrolimus; cort, corticosteroids; CyA, cyclosporin A; aza, azathioprine; myc, mycophenolate mofetil; Tx, transplantation; KNS, coagulase-negative *Staphylococcus*.

Table 4. Patients undergoing cardiac surgery for acute and chronic-healed endocarditis (1989–2004).

Previous solid organ transplantation	Patient characteristics	Time from transplant to endocarditis	Affected heart valve	Microbiologic findings	Intraoperative microbiologic findings
Valve surgery for acute endocarditis (urgent or emergent cardiac procedure)					
Bilateral lung transplantation	41 years, male	100 days	Mitral valve	MRSA	Positive
Cardiac transplantation	58 years, male	12 years and 4 months	Tricuspid valve, pacemaker-related infection	Unknown	Negative
Kidney transplantation	56 years, female	13 years	Mitral valve, prosthetic valve endocarditis	*Staphylococcus aureus*	Positive
	49 years, female	4 months	Aortic and mitral valve endocarditis	MRSA, *Aspergillus fumigatus*	Positive
Kidney–pancreas transplantation	49 years, female	46 days	Mitral valve	KNS	Positive
Liver transplantation	49 years, female	1 year and 2 months	Aortic and mitral valve endocarditis	*Enterobacter*, KNS	Positive
	51 years, male	3 weeks	Aortic valve endocarditis	*Staphylococcus aureus*	Positive
					Time from endocarditis to cardiac surgery
Valve surgery for chronic-healed endocarditis (elective surgery)					
Kidney transplantation	37 years, female, third kidney transplant	1 year and 8 months	Mitral valve	KNS	6 months, mitral valve repair
	57 years, female	5 months	Aortic and mitral valve, rheumatic valve stenosis	KNS	4 months, mechanical double valve replacement
	48 years, male	3 years and 2 months	Aortic valve	*Klebsiella*, *Escherichia coli*	5 months, mechanical aortic valve replacement

KNS, coagulase-negative *Staphylococcus*; MRSA, methicilline-resistant *Staphylococcus aureus*.

Table 5. Patients diagnosed valve endocarditis after death at autopsy (1989–2004).

Patient	Organ	Time post-transplant	Affected valve	Immunosuppression	Infective organism	Possible focus	Tx cause
25 years, male	Kidney	5 years and 11 months	Mitral	Tac/myc	*Staphylococcus aureus*	Pneumonia	Glomerulonephritis
53 years, male	Liver	3 months	Aortic and mitral	Tac/myc/cort	KNS, *Enterococcus*	Central venous line	Fatty liver cirrhosis
44 years, female	Kidney–pancreas, second kidney	8 years and 11 months	Aortic and mitral	Tac/myc/cort	MRSA	Urosepsis	Diabetes
62 years, female	Kidney–pancreas	1 year and 9 months	Aortic and mitral	Tac/myc/cort	*Aspergillus*, *Pseudomonas*	Invasive pulmonal aspergillosis	Diabetes
54 years, female	Kidney	2 years and 5 months	Aortic	CyA/aza	MRSA	Breast cancer, chemotherapy	Shrunken kidneys
56 years, male	Liver	11 months	Aortic and mitral	Tac/myc	Unknown	PTLD, chemotherapy	Fatty liver cirrhosis
40 years, male	Liver	7 years and 1 month	Aortic	CyA/myc	MRSA, *Aspergillus*	Pneumonia, sepsis	Hepatitis C cirrhosis
60 years, male	Liver	11 months	Aortic	Rapa/myc	KNS, *Aspergillus*	Pneumonia	Hepatitis C cirrhosis
60 years, male	Liver	10 months	Aortic and mitral	CyA/myc	*Enterococcus*	Sepsis after CMV enteritis	Fatty liver cirrhosis

Tac, tacrolimus; myc, mycophenolate mofetil; cort, corticosteroids; CyA, cyclosporin A; aza, azathioprine; rapa, rapamycine; KNS, coagulase-negative *Staphylococcus*; MRSA, methicilline-resistant *Staphylococcus aureus*; Tx, transplantation; CMV, cytomegalovirus; PTLD, post-transplant lymphoproliferative disease.

45.3 ± 6.4 years. Median time from transplantation to diagnosis of IE was 14.3 months (ranging from 3 weeks to 13 years).

In three kidney recipients, infection could be cured by single antibiotic treatment first, however remaining valvular incompetence required cardiac procedure 4, 5 and 6 months after the infective event, respectively.

Autopsy findings

In nine patients (33.3%) IE was diagnosed at autopsy (Table 5). Five patients had previous liver transplantation, two patients had combined kidney–pancreas transplantation (one of them kidney retransplantation) and two recipients had previous kidney transplantation. Two patients had received chemotherapy, one liver transplant recipient because of PTLD and one female kidney recipient because of breast cancer. Another male liver transplant recipient developed enterococcal sepsis while being treated for cytomegalovirus (CMV) enteritis. Again, *Staphylococcus* was the predominant infective microorganism in six cases (66.6%). Mean age at transplantation had been 50.5 ± 12.2 years, median time from transplantation to death was 21 months (3 months to 9 years).

Discussion

In our long-term single center experience from 1989 to 2004, 1.0% of all transplant recipients acquired acute IE. Conversely, 4.9% of all patients (18 of 365 patients) who were hospitalized for active IE had previous SOT.

The incidence of IE in transplant recipients remained stable during the past few years, however, the proportion of transplant recipients who were diagnosed IE at autopsy decreased significantly. This concludes that approximately one-third of IE cases in transplant recipients have previously been missed. Nevertheless, we know from epidemiologic studies [8,9] that improvements in health care have almost eradicated classical 'community-acquired' IE. Yet, we have generated a new group at risk and epidemiology of this disease has dramatically shifted toward hospital-acquired IE. In total, incidence of IE has not decreased during the past 20 years.

Because of the infrequent diagnosis of this disease, even high-volume transplant centers may have limited experience in diagnosis and therapy of IE in transplant recipients. Few case reports are available in the medical literature, mainly reporting transplanted patients with IE that were successfully treated with antibiotic medication alone [10–14]. Several published cases describe rare organisms and even fungal contamination to be the cause of infection [14–18]. Up to date, no epidemiologic studies with sufficient sample size and follow up have been published investigating IE in transplant recipients.

Therefore, little is known about mode of infection and predisposing risk factors in this special population. Immunosuppression is necessary in transplant surgery; however, augmented immunosuppression for therapy of

acute rejection may enhance the risk of systemic infection. In our series, three patients developed sepsis after a rejection episode that had been treated with corticosteroids. Four patients experienced overimmunosuppression either because of aggressive basic immunosuppression for a high immunologic risk or unintentional excessive drug levels, two patients may have been overimmunosuppressed as concomitant chemotherapy was given.

In the general population, underlying structural valve deterioration is a main predisposing factor in approximately 50% of IE [19]. We identified only three patients with underlying structural valve disease (or prosthetic valve replacement) as the predisposing factor for IE. Additionally, none of the cases being found at autopsy had underlying valve disease. In conclusion with Paterson *et al.* [7], it seems to be a less relevant factor in the immunocomprimised host compared with the overall population. Conversely, Abbott *et al.* [20] and colleagues identified structural valve disease as the most important factor for hospitalization of IE in kidney recipients in the USA. However, autopsy cases were not included into this retrospective registry study. Based on the findings of our study, we assume that approximately one-third of patients might have been missed by Abbott *et al.*'s [20] study making it less likely that underlying structural valve disease is the most relevant factor in the development of IE.

Because of limited host defense, IE appears incurable without appropriate antibiotic therapy in transplant recipients, as no one of our surgical patients with healed endocarditis had been without medical therapy. IE requires urgent treatment because of rapid progression of infection. Timely surgical intervention reduces secondary complications such as septic embolism and perivalvular destructions, and therefore decreases the risk of recurrence [21,22]. All surgical cases operated in the active stage of IE (seven patients) were found by echocardiography during the recent 5 years. We assume that improved diagnostic measures, mainly the use of echocardiography, have led to an increased number of transplant recipients being diagnosed with IE alive, and we conclude that the majority of cases have previously been missed or were diagnosed postmortem. Dealing with an increasing number of transplant recipients and long-term post-transplant patients, alertness to IE is of major importance.

Despite the considerable proportion of more than 4.9% of all patients treated for IE at our hospital in this period (18 of 365 cases) and the estimated 171-fold higher incidence compared with the overall population, no guidelines are currently available for prevention, diagnosis, and treatment of IE in transplant recipients. Transplant recipients are not even classified as patients at risk for IE and are not mentioned by international task force groups [23,24]. Our data indicate, in concordance with Paterson *et al.*'s study [7] that alertness to IE and timely diagnosis of IE is of paramount importance after SOT. We therefore support Paterson *et al.*'s recommendation that IE ought to be documented as SOT-specific complications by multicenter registries.

In conclusion, clinical appearance and course of IE may be similar in transplant and in nontransplanted patients; however, in transplant recipients successful antibiotic and surgical treatment is compromised by limited host defense and high exposition to antibiotic-resistant organisms. This also suggests the low impact of underlying valve disease as a potential risk factor in this special population.

This series of 27 patients does not permit us to define regularities in clinical appearance and treatment of IE. Nevertheless, these clinical cases allow insight into epidemiology, clinical presentation and treatment options for IE and should raise alertness to a significant problem in SOT that is still associated with an excessive high mortality.

Acknowledgements

Authors wish to thank Ms Tamara Schullenberg from the TILAK administration for providing the MBDS data of our hospital. Additionally, authors wish to thank the transplant coordinators Mr Hermann Fetz, Mr Wolfgang Bichler, and Mr Paul Schobel for the outstanding help.

References

1. Yankah AC, Klose H, Petzina R, Musci M, Siniawski H, Hetzer R. Surgical management of acute aortic root endocarditis with viable homograft: 13-year experience. *Eur J Cardiothorac Surg* 2002; **21**: 260.
2. Kalra PR, Tang ATM, Morgan JM, Haw MP. Complex and extensive infective endocarditis: a novel surgical approach. *Eur J Cardiothorac Surg* 2002; **21**: 365.
3. Aoyagi S, Fukunaga S, Tayama E, Hayashida N, Kawara T. Surgical treatment of prosthetic valve endocarditis with left ventricular-aortic discontinuity: reconstruction of the left ventricular outflow tract with a xenopericardial conduit. *J Heart Valve Dis* 2001; **10**: 367.
4. Shapiro SM, Young E, De Guzman S, *et al.* Transesophageal echocardiography in diagnosis of infective endocarditis. *Chest* 1994; **105**: 377.
5. Von Reyn CF, Levy BS, Arbeit RD, Friedland G, Crumpacker CS. Infective endocarditis: an analysis based on strict case definitions. *Ann Intern Med* 1981; **94**: 505.
6. Durack DT, Lukes AS, Bright DK. New criteria for diagnosis of infective endocarditis: utilization of specific echocardiographic findings. *Am J Med* 1994; **96**: 200.

7. Paterson DL, Dominguez EA, Chang FY, Snydman DR, Singh N. Infective endocarditis in solid organ recipients. *Clin Infect Dis* 1998; **26**: 689.
8. Moreillon P, Que YA. Infective endocarditis. *Lancet* 2004; **363**: 139.
9. Hoen B, Alla F, Selton-Suty C, *et al.* Changing profile of infective endocarditis: results of a 1-year survey in France. *JAMA* 2002; **288**: 75.
10. Hyeong PJ, Kim YS, Kim MN, Kim JJ. Superior vena cava syndrome caused by *Aerococcus viridans* para-aortic abscess after heart transplantation. *Transplantation* 2002; **74**: 1475.
11. Zhang R, Zhang JW, Szerlip HM. Endocarditis and hemorrhagic stroke caused by *Cunninghella bertholletiae* infection after kidney transplantation. *Am J Kidney Dis* 2002; **40**: 842.
12. Kunst H, Paruchuru PK, Madden B. Bacterial endocarditis: a rare complication following orthotopic cardiac transplantation. *J Heart Lung Transplant* 2001; **20**: 483.
13. Thompson RL, Lavin B, Talbot GH. Endocarditis due to vancomycin-resistant *Enterococcus faecium* in an immunocomprimised patient: cure by administering combination therapy with quinupristin/dalfopristin and high-dose ampicillin. *South Med J* 2003; **96**: 818.
14. D'Cunha PT, Davenport DS, Fisher KA. Successful treatment of *Staphylococcus aureus* bacterial endocarditis in a renal transplant recipient. *Transpl Infect Dis* 2003; **5**: 144.
15. Avery RK, Barnes DS, Teran JC, *et al. Listeria monocytogenes* tricuspid valve endocarditis with septic pulmonary emboli in a liver transplant recipient. *Transpl Infect Dis* 1999; **1**: 284.
16. Rueter F, Hirsch HH, Kunz F, *et al.* Late *Aspergillus fumigatus* endomyocarditis with brain abscess as a lethal complication after heart transplantation. *J Heart Lung Transplant* 2002; **21**: 1242.
17. Gilbey JG, Chalermskulrat W, Aris RM. *Aspergillus* endocarditis in a lung transplant recipient. A case report and review of the transplant literature. *Ann Transplant* 2000; **5**: 48.
18. Urbina BY, Gohh R, Fischer SA. *Oerskovia xanthineolytica* endocarditis in a renal transplant patient: case report and review of the literature. *Transplant Infect Dis* 2003; **5**: 195.
19. McKinsey DS, Ratts TE, Bisno AL. Underlying cardiac lesions in adults with infective endocarditis: the changing spectrum. *Am J Med* 1987; **82**: 681.
20. Abbott KC, Duran M, Hypolite I, Ko CW, Jones CA, Agodoa LYC. Hospitalisation for bacterial endocarditis after renal transplantation in the United States. *JNEPHROL* 2001; **14**: 353.
21. Eishi K, Kawazoe K, Kuriyama Y, *et al.* Surgical management of infective endocarditis associated with cerebral complications. *J Thorac Cardiovasc Surg* 1995; **110**: 1745.
22. Pelletier LC, Baillot R, Auger P, Dyrda I. Early valve replacement in active infective endocarditis. *Can J Surg* 1984; **27**: 383.
23. Horstkotte D, Follath F, Gutschik E, *et al.* Guidelines on prevention, diagnosis and treatment of infective endocarditis. *Eur Heart J* 2004; **25**: 267.
24. Delahaye F, Hoen B, McFadden E, Roth O, de Gevigney G. Treatment and prevention of infective endocarditis. *Expert Opin Pharmacother* 2002; **3**: 131.