*Renal Failure*, 29:973–978, 2007

ISSN: 0886-022X print / 1525-6049 online
DOI: 10.1080/08860220701641702

informa
healthcare

**CLINICAL STUDY**

# Comparison of Bacterial Isolates Cultured from Hemodialysis Patients and Other Patients with Diabetic Foot and Their Antimicrobial Resistance

**Meryem Cetin**
Mustafa Kemal University, Department of Microbiology and Clinical Microbiology, Hatay, Turkey

**Sabahattin Ocak**
Mustafa Kemal University, Department of Infectious Diseases and Clinical Microbiology, Hatay, Turkey

**Guven Kuvandik**
Mustafa Kemal University, Department of Emergency, Hatay, Turkey

**Bahadir Aslan**
Ceyhan State Hospital, Department of Orthopaedics and Traumatology, Ceyhan, Turkey

The aim of this study was to compare microbial findings and their resistance to antibiotics between hemodialysis patients and patients without end-stage renal failure with diabetic foot infections. An 18-month-long descriptive study analyzed bacterial isolates obtained from 32 hemodialysis (HD) patients with diabetic foot infection in an Antakya hemodialysis center and 65 patients with diabetic foot infection admitted to the Education and Research Hospital of Mustafa Kemal University, Turkey. No significant difference in the mean number of pathogens per patient was found between the dialysis patients and other patients (2.3 vs. 2.1, respectively) ($p > 0.05$). While the occurrence of gram-positive bacteria in the HD patients was found to be 59.0%, this rate in the other patients was 53.1% ($p > 0.05$). While most frequent bacterial species isolated in the HD patients were *S. aureus* (22.9%), followed by coagulase-negative *Staphylococcus* spp. (CNS) (19.7%), the microorganisms in the other patients were found as CNS (20.7%), followed *S. aureus* (18.0%). The data recommend that antibiotic therapy in HD patients with diabetic foot infection should be more closely guided by culture findings and antimicrobial susceptibility results.

**Keywords** diabetes mellitus, foot infection, hemodialysis, microbial findings, antimicrobial resistance

Address correspondence to Dr. Meryem Cetin, Mustafa Kemal University, Faculty of Medicine, Dept. of Microbiology and Clinical Microbiology, 31100 Antakya/Hatay, Turkey; E-mail: meryemcetin55@yahoo.com

## INTRODUCTION

The diabetic foot is a commonly encountered clinical problem. It arises from the association of macroangiopathy with neuropathy, which leads to undetected injuries, delayed healing, and infection.[1] Impaired immune functions, especially polymorphonuclear functions, may increase infection incidence in diabetic patients.[2]

Diabetic ulcerations are infected more frequently by a variety of pathogens than nondiabetic ulcerations.[3,4] Foot ulcers occur in 5–15% of the diabetic patients during their lifetime and are associated with increased morbidity and mortality, with up to 3% having a lower limb amputation.[5–7] Infection is a common sequela of diabetic foot ulceration and trauma, which, once established, progressively worsens and becomes more difficult to treat.[7] Diabetic foot infection is the complication that requires medical attention. Infection is the main cause of amputations in 25–50% of diabetic patients.[8]

Bacterial involvement in diabetic foot infections may be polymicrobial.[1,7,9] Infection present in the diabetic foot must be treated aggressively and promptly, as it can be limb-threatening, and in special groups of patients (e.g., transplant and dialysis patients), it could even be life-threatening.[8,10] Increased incidence of infection is one the main causes of the increased mortality in hemodialysis (HD) patients.[8,11] Diabetic patients suffering from end-stage renal failure are at particular risk of infection, as well

as foot ulcers due to neuropathy and impaired immune functions.[8,12]

Diabetic patients with foot wounds have several factors that may be associated with a high risk of multidrug-resistant organism carriage.[13] Several studies were found methicillin-resistant *S. aureus* in as many as 15–30% of diabetic foot wounds.[6,14] However, because bacterial culture is not performed routinely and reliable culture data may be lacking, initial therapy of diabetic foot infection is frequently empiric.

The evaluation of differences in microbial findings and resistance to antibiotics between HD patients and other patients with the diabetic foot may be important for the selection of an appropriate antibiotic therapy strategy. The aim of our study was to compare microbial findings and their resistance to antibiotics in HD patients and patients without end-stage renal failure with diabetic foot infection.

## MATERIALS AND METHODS

### Study Population

Patients with diabetic foot infection admitted to Education and Research Hospital of Mustafa Kemal University and to Antakya Hemodialysis Center, Turkey, between January 2004 to June 2005 were included this study. The patients were divided into two groups: 65 patients (without end-stage renal failure, diabetes duration 18 ± 10.2 years, 4.6% Type 1 diabetics) and 32 HD patients (diabetes duration 21 ± 12.3 years, 6.3% Type 1 diabetics) with diabetic foot ulcers.

### Study Design

This was an 18-month-long descriptive study. Age, sex, metabolic control, wound type, and its localization and Wagner grade were documented for all patients. The Wagner classification was used for the comparison of the diabetic foot ulcer characteristics.[15] Patients with Wagner grade 1 were excluded from the study, as these lesions normally harbor skin contaminants that often lead to false-positive results. The patients receiving any antimicrobial therapy 30 days prior to taking the cultures also were excluded from the study.

### Microbiologic Methods

Culture materials from the diabetic foot wounds were collected, either by applying a sterile cotton swab to the wound, washing the wound with 100 $cm^3$ of sterile physiological saline and then making a puncture-aspiration at the bottom of the wound, or culturing biopsies. The materials obtained were cultured in the microbiology laboratory. The specimens obtained from HD center were immediately placed in transport medium (Cary and Blair media) and transported to the processing laboratory and cultured in microbiology laboratory.

Bacterial identification was based with biochemical and automated methods (ID 32E API, BioMerieux, Marcy I'Etoile, France). Susceptibility testing was performed with disc diffusion methods using the Clinical and Laboratory Standards Institute (CLSI) criteria.[16] Disk diffusion method was performed on Mueller-Hinton agar plate at 37°C with antibiotic-containing disks (Oxoid Limited, Basingstoke, Hampshire, England).

### Statistical Analysis

Statistical analysis was performed using chi-square test and fisher exact tests. *p* values less than 0.05 were considered statistically significant. Statistical Package for Social Sciences (SPSS, ver. 10.0) software was used for the data analyses.

## RESULTS

Of 32 HD patients with diabetic foot ulcer, 18 were men and 14 of them were women, which had 58 ± 12.2 years mean age. A total of 65 other patients with diabetes foot infection 43 were men and 22 of them were women, which had 57 ± 13.4 years mean age. Of a total of 32 HD patients, 13 (40.6%) were classified as Wagner stage 2, 9 (28.1%) as stage 3, 7 (21.9%) as stage 4, and 3 (9.4%) as stage 5. Thirty-three (50.7%) of the patients without end-stage renal failure were classified as Wagner stage 2, 18 (27.7%) as stage 3, 12 (18.5%) as stage 4, and 2 (3.1%) as stage 5 (see Table 1).

Among the specimens taken from 97 patients, 18 were culture-negative while 79 yielded 172 microorganisms. Of the 32 HD patients, 5 of them were culture-negative and 27 of them yielded 61 bacterial isolates. Among 67 other patients, no bacteria were cultured from 13 of them, but 111 bacterial isolates were obtained from 54 of them. In 35 positive cultures (44.3%) among all patients, polymicrobial etiology was encountered. The microorganisms isolated in the study are shown in Table 2.

The spectrum of bacterial species was found to be similar in dialysis patients compared to the other patients. No significant difference in the mean number of pathogens

***Table 1***
Distributions of bacteria isolated from different Wagner grade diabetic foot ulcers in 32 hemodialysis patients and 65 other patients

| | Dialysis patients | | | | Other patients | | | |
|---|---|---|---|---|---|---|---|---|
| Evaluated pathogens | W2 | W3 | W4 | W5 | W2 | W3 | W4 | W5 |
| Total number of patients | 13 | 9 | 7 | 3 | 32 | 18 | 13 | 2 |
| *Staphylococcus aureus* | 6 | 5 | 2 | 1 | 11 | 5 | 3 | 1 |
| CNS | 5 | 5 | 1 | 1 | 14 | 6 | 2 | 1 |
| *Enterococcus* species | 3 | 2 | 1 | — | 5 | 4 | — | — |
| *Streptococcus* species | 2 | 2 | — | — | 5 | 2 | — | — |
| *Escherichia coli* | 3 | 3 | 1 | — | 6 | 3 | 1 | — |
| *Klebsiella pneumoniae* | 2 | 2 | — | — | 3 | 3 | — | — |
| *Morganella morgani* | 1 | 2 | — | — | 4 | 2 | 1 | — |
| *Proteus mirabilis* | 1 | 1 | — | 1 | 4 | 2 | — | — |
| *Enterobacter* species | 1 | 1 | — | — | 5 | 3 | 1 | — |
| *Pseudomonas* species | 2 | 2 | — | — | 6 | 2 | 1 | — |
| *Clostridium subterminale* | 1 | — | — | — | — | 1 | — | — |
| *Bacteroides ureoltyticum* | — | 1 | — | — | — | 1 | 1 | — |
| *Leuconostos* spp. | 1 | — | — | — | — | — | 1 | — |

Abbreviations: CNS = coagulase-negative *Staphylococcus* species, W = Wagner grade.

***Table 2***
A comparison of incidence of isolated pathogens in 32 hemodialysis and 65 other patients with diabetic foot infection

| Evaluated pathogens | Dialysis patients (%) | Other patients (%) | All patients (%) | *p* |
|---|---|---|---|---|
| *Staphylococcus aureus* | 22.9 | 18.0 | 19.8 | NS |
| CNS | 19.7 | 20.7 | 20.3 | NS |
| *Enterococcus* species | 9.8 | 8.1 | 8.7 | NS |
| *Streptococcus* species | 6.5 | 6.3 | 6.4 | NS |
| *Escherichia coli* | 11.5 | 9.0 | 9.9 | NS |
| *Klebsiella pneumoniae* | 6.5 | 5.4 | 5.8 | NS |
| *Morganella morgani* | 4.9 | 6.3 | 5.8 | NS |
| *Proteus mirabilis* | 4.9 | 5.4 | 5.2 | NS |
| *Enterobacter* species | 3.1 | 8.1 | 6.4 | NS |
| *Pseudomonas* species | 6.5 | 8.1 | 7.6 | NS |
| *Clostridium subterminale* | 1.6 | 0.9 | 1.2 | NS |
| *Bacteroides ureoltyticum* | 1.6 | 1.8 | 1.7 | NS |
| *Leuconostos* spp. | 0 | 1.8 | 1.2 | NS |
| Sterile culture | 15.6 | 20.0 | 18.5 | NS |
| Polymicrobial infection | 44.4 | 44.2 | 44.3 | NS |

Abbreviation: CNS = coagulase-negative *Staphylococcus* species.
*p* value: hemodialysis patients vs. the other patients. NS = not significant.

per one patient was found between the dialysis and other patients with the diabetic foot (2.3 vs 2.1, respectively; $p > 0.05$).

Coagulase negative *Staphylococci* (20.3%), *S. aureus* (19.8%), *Escherichia coli* (9.9%), and *Enterococcus spp* (8.7%) were the most common the bacterial species isolated from all patients. While the occurrence of gram-positive bacteria in the HD patients was 59.0%, this rate in the other patients was 53.1% ($p > 0.05$). While the most frequent bacterial species appearing in the HD patients were *S. aureus* (22.9%), followed by CNS (19.7%) and *Enterococcus spp*. (9.8%), the microorganisms in the other patients were found as CNS (20.7%), followed *S. aureus* (18.0%) and *Enterococcus spp*. (8.1%).

The most frequent gram-negative pathogens isolated in all patients were *E. coli* (9.9%), followed by *Pseudomonas spp.* (7.6%). Among gram-negative bacteria isolated from the HD patients, *E. coli, Klebsiella pneumoniae, Pseudomonas spp.,* and *Morganella morgani* were found as 11.5%, 6.5%, 6.5%, and 4.9%, respectively. The most common gram-negative bacterial species isolated from the other patients were *Escherichia coli* (9.0%), *Pseudomonas spp.* (8.1%), *Enterobacter spp.* (8.1%), and *M. morganii* (6.3%).

Seven anaerobic isolates were obtained from all specimens, of which three were *Bacteroides ureoltyticum* belonging to two patients with Wagner grade 3 (n = 1) and Wagner grade 4 (n = 2), two were *Clostridium subterminale* belonging to Wagner grades 3, and two were *Leuconostos spp*. belonging to patients with Wagner grades 3 (n = 1) and 4 (n = 1).

The most frequent pathogen isolated among all patients with diabetic ulcers was the coagulase negative *Staphylococcus* (20.3%), but its resistance to antibiotics did not differ between the HD patients and the other patients with the diabetic foot. While the ratio of the resistance to ampicillin and ciprofloxacin *Enterococcus* spp. isolated from HD patients was 33% and 67%; these rates for the other patients was 11% and 44%, respectively. However, no significant difference was found between HD patients and the others statistically ($p > 0.05$). The occurrence of resistance to antibiotics in isolates from HD patients was higher compared with the isolates cultured from other patients. Between *S. aureus* isolates from HD patients and the other patients susceptibilities of resistance to cefazolin, oxacillin, amoxicillin-clavulanate, and clindamycin, there was no significant difference statistically ($p > 0.05$; see Table 3)

There was no difference in the antimicrobial resistance pattern of *E. coli* isolates obtained from the HD patients and the other patients with the diabetic foot. The resistance to antibiotics of the *Pseudomonas spp.* was high in all patients, especially resistance to cefoperazone (38%), ciprofloxacin (46%), piperacillin (31%), and gentamicin (38%). While the ratio of the resistance to cefoperazone and piperacillin *Pseudomonas spp.* isolated from HD patients was 50% and 75%, the rate for the other patients was 33% and 22%, respectively. However, no significant difference was determined statistically ($p > 0.05$).

## DISCUSSION

Nowadays, diabetes mellitus is one of the world's most important health problems. With an increasing diabetic population worldwide, there is a significant rise in the prevalence of foot infections.

Lavery et al.[4] reported the presence of a higher number of bacterial organisms in diabetic ulcers in comparison with non-diabetic wounds (2.6 vs 1.3, respectively). In the current study, the mean number of pathogens isolated from the diabetic foot ulcers was found as 2.1 in patients without end-stage renal failure. Fejfarová et al.[8] reported that the mean number of pathogens isolated from the diabetic foot ulcers between the transplanted, dialysis, and other patients with the diabetic foot were found as 2.8, 2.0, and 3, respectively. In

***Table 3***
A comparison of antibiotic resistances for *S. aureus* between the hemodialysis patients and the other patients with the diabetic foot

| Variables | Dialysis patients (%) | Other patients (%) | *p* value |
|---|---|---|---|
| Number of detected *S. aureus* | 14 | 20 | |
| Types of antibiotics | | | |
| Amoxicillin-clavulanate | 50 | 25 | NS |
| Oxacillin | 43 | 30 | NS |
| Fusidic acid | 14 | 5 | NS |
| Vancomycin | 0 | 0 | |
| Imipenem | 36 | 40 | NS |
| Piperacillin | 29 | 25 | NS |
| Sefazolin | 43 | 15 | NS |
| Clindamycine | 50 | 30 | NS |
| Erythromycin | 36 | 30 | NS |
| Co-trimoxazole (TM-SXT) | 21 | 30 | NS |
| Gentamycine | 29 | 30 | NS |
| Ciprofloxacin | 29 | 35 | NS |

NS = Not significant.

this study, the mean number of microorganisms per patient between dialyzed and other patients with the diabetic foot was found as 2.3 and 2.1, respectively ($p > 0.05$). The results of this study were similar to above mentioned studies. On the other hand, our results were higher than in those obtained from diabetic foot infection by Shankara et al.[9] and Candel González et al.[1]

Polymicrobial infection in diabetic foot ulcers generally has been described. Reports on polymicrobial etiology in diabetic foot infection were similar.[1,7,9,17] On the other hand, Dhanasekaran et al.[18] documented that gram-negative bacteria in diabetic foot ulcers were mostly monomicrobial. In this study, 44.3% of positive cultures were polymicrobial. Polymicrobial flora in the HD and the other patients were 44.4% and 44.2%, respectively ($p > 0.05$).

Several other studies have shown that aerobic microorganisms were the most frequently isolated pathogens from diabetic ulcers.[1,8,9,19,20] However, some authors have reported a higher percentage of anaerobic isolates.[21,22] This difference could be related to the sample collection, transport system, and culture conditions. In the current study, only seven anaerobic isolates (4.1%) among all patients were isolated, of which four were from the patients with Wagner grade 3 and three were from the patients with Wagner grade 4.

It has been reported that gram-positive aerobic microorganisms were isolated most frequently from diabetic foot infections.[1,8,9,20] We also found that gram-positive bacteria predominated among positive cultures obtained from all patient, and CNS (20.3%), *S. aureus* (19.8%), and *Enterococcus spp.* (8.7%) were the most frequent microorganisms isolated. While the most frequent bacterial species appearing in the HD patients were *S. aureus* (22.9%), in the other patients, CNS were the predominant species (20.7%).

Furthermore, unlike the studies mentioned previously, some studies have reported that gram-negative isolates was found predominant, especially *P. aeruginosa*, in diabetic foot infection.[9,23] On the contrary, in this study, the prevalence of gram-negative bacteria isolated in the HD patients and the other patients were found as 37.7% and 42.3%, respectively ($p > 0.05$). Among gram-negative bacteria isolated in HD patients and the other patients, *Escherichia coli* (11.5% and 9.0%, respectively) was found most frequently, followed by *P. aeruginosa* (6.5% and 8.1%, respectively).

To our knowledge, there is only one other study addressing diabetic foot infection in HD patients.[8] They reported that an almost identical spectrum of bacterial species was found in transplant and dialysis patients as in patients with the diabetic foot without end-stage renal failure, and that the study groups were found significantly different in the occurrence of gram-positive bacteria (80% in dialysis patients, and 63% in other patients). Similarly, our results showed that no significant differences were found in the occurrence of individual microorganisms between the dialyzed and the other patients. However, the frequencies of gram-positive aerobic bacteria in HD patients and the other patients were found as 59.0% and 53.1%, respectively ($p > 0.05$).

Some studies have shown a higher risk of developing a methicillin-resistant *S. aureus* infection in patients with the diabetic foot. It has been reported that this resistant pathogen was present especially in patients after repeated or prolonged hospitalizations.[6,24] The results of this study showed differences in microbial susceptibility to antibiotics tested between the HD patients and the other patients. Higher resistances to antibiotics of the *S. aureus*, *Enterococcus spp.*, and *Pseudomonas spp.* were found in the HD patients compared with the other group. Patients with chronic HD suffer from general immune incompetence, resulting in a high incidence of infectious and metabolic complications. Prolonged hospitalization and long-term or repeated antibiotic treatment of other infectious complications may lead to a selective antibiotic pressure.[8,25,26] This status could be a possible cause of the high bacterial resistance of some pathogens, especially *S. aureus*, in the HD patients.

Our data showed that oxacillin, cefazolin, clindamycin, and piperacillin due to the higher occurrence of resistance were not suitable for the antibiotic treatment of diabetic foot ulcers in the HD patients (see Table 3). Ciprofloxacin and co-trimoxazole could be recommended for the therapy due to lower resistance to these antibiotics in HD patients. For these reasons, our data suggest that empiric antibiotic treatment based on data from the general diabetic population may need to be modified in HD patients with the diabetic foot due to higher bacterial resistance.

In conclusion, a similar occurrence of different bacterial agents was found in the HD patients and other patients with the diabetic foot infection. However, a higher bacterial resistance rate to the tested antibiotics was observed in the HD patients. The results of this study recommend that antibiotic therapy in HD patients with diabetic foot infections should be more closely guided by culture findings and antimicrobial susceptibility of the associated bacterial isolates.

## REFERENCES

1. Candel González FJ, Alramadan M, Matesanz M, Diaz A, González-Romo F, Candel I, Calle A, Picazo JJ. Infections in diabetic foot ulcers. *Eur J Intern Med*. 2003;14(5):341–343.

2. Delamaire M, Maugendre D, Moreno M, Le Goff MC, Allanic H, Genetet B. Impaired leukocyte functions in diabetic patients. *Diabet Med*. 1997;14:29–34.
3. Hunt JA. Foot infection in diabetes is rarely due to a single microorganism. *Diabet Med*. 1992;9:749–752.
4. Lavery LA, Walker SC, Harkless LB, Felder-Johnson K. Infected puncture wounds in diabetic and nondiabetic adults. *Diabetes Care*. 1995;18:1588–1591.
5. Dang CN, Prasad YD, Boulton AJ, Jude EB. Methicillin-resistant *Staphylococcus aureus* in the diabetic foot clinic: A worsening problem. *Diabet Med*. 2003;20(2):159–161.
6. Tentolouris N, Jude EB, Smirnof I, Knowles A, Boulton AJM. Methicillin-resistant *Staphylococcus aureus*: An increasing problem in a diabetic foot clinic. *Diabet Med*. 1999;16:767–771.
7. Motta RN, Oliveira MM, Magalhães PSF, Dias Aragão LP, Forti AC, Carvalho CBM. Plasmid-mediated extended-spectrum b-lactamase-producing strains of enterobacteriaceae isolated from diabetes foot infections in a Brazilian Diabetic Center. *Braz J Infect Dis*. 2003;7(2):129–134.
8. Fejfarová V, Jirkovskáa A, Petkovb V Boueka P, Skibováa J. Comparison of microbial findings and resistance to antibiotics between transplant patients, patients on hemodialysis, and other patients with the diabetic foot. *J Diabetes Complications*. 2004;18(2):108–112.
9. Shankara EM, Mohanb V, Premalathab G, Srinivasanb RS, Usha US. Bacterial etiology of diabetic foot infections in South India. *Eur J Intern Med*. 2005;16(8):567–570.
10. Apelqvist J, Bakker K, Van Houtum WH, Nabuurs-Fransen MH, Schaper NC. International Consensus on the Diabetic Foot. In *The International Working Group on the Diabetic Foot*. Amsterdam, The Netherlands, John Wiley & Sons, 1999; 55–65.
11. Ruiz P, Gomez F, Schreiber AD. Impaired function of macrophage Fc gamma receptors in end stage renal disease. *N Engl J Med*. 1990;322:717–722.
12. Rith Najarian S, Gohdes D. Preventing amputations among patients with diabetes on dialysis. *Diabetes Care*. 2000;9:1445–1446.
13. Hartemann-Heurtier A, Robert J, Jacqueminet S. Diabetic foot ulcer and multidrug-resistant organisms: risk factors and impact. *Diabet Med*. 2004;21(7):710–715.
14. Roghmann MC, Siddiqui A, Plaisance K, Standiford H. MRSA colonisation and the risk of MRSA bacteraemia in hospitalised patients with chronic ulcers. *J Hosp Infect*. 2001;47:98–103.
15. Wagner WF. The disvascular foot: A system for diagnosis and treatment. *Foot Ankle*. 1981;2:64–67.
16. Clinical and Laboratory Standards Institute. *Performance standards for antimicrobial susceptibility testing.* Fifteenth informational supplement M100-S15. Wayne, Pa.: Clinical and Laboratory Standards Institute; 2005.
17. Lipsky BA, Berendt AR. Principles and practice of antibiotic therapy of diabetic foot infections. *Diabetes Metab Res Rev*. 2000;16:42–46.
18. Dhanasekaran G, Sastry G, Viswanathan M. Microbial pattern of soft-tissue infections in diabetic patients in South India. *Asian J Diabet*. 2003;5:8–10.
19. Pittet D, Wyssa B, Herter-Clavel C, Kursteiner K, Vaucher J, Lew PD. Outcome of the diabetic foot infections treated conservatively. A retrospective cohort study with long-term follow-up. *Arch Intern Med*. 1999;159:851–856.
20. Caputo GM, Cavanagh PR, Ulbrecht JS, Gibbons GW, Karchmer AW. Assessment and management of foot disease in patients with diabetes. *N Engl J Med*. 1994;331:854–860.
21. Smith AJ, Daniels T, Bohnen JMA. Soft tissue infections and the diabetic foot. *Am J Surg*. 1996;172:7–12.
22. Joshi N, Caputo GM, Weitekamp MR, Karchmer AW. Infections in patients with diabetes mellitus. *N Engl J Med*. 1999;341:1906–1912.
23. Viswanathan V, Jasmine JJ, Snehalatha C, Ramachandran A. Prevalence of pathogens in diabetic foot infection in South Indian type 2 diabetic patients. *J Assoc Phys India*. 2002;50:1013–1016.
24. Day MR, Armstrong DG. Factors associated with methicillin resistance in the diabetic foot infections. *J Foot Ankle Surg*. 1997;36(4):322–325.
25. Tokars JI, Miller ER, Alter MJ, Arduino MJ. National surveillance of dialysis associated diseases in the United States, 1995. *ASAIO J*. 1998;44:98–107.
26. Malaponte G, Bevelacqua V, Fatuzzo P Rapisarda F, Emmanuele G, Travali S, Mazzarino MC. IL-1beta, TNFalpha and IL-6 release from monocytes in haemodialysis patients in relation to dialytic age. *Nephrol Dial Transplant*. 2002;17:1964–1970.