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Comparison of community and hospital-acquired bacteremia in a Greek university hospital: One year experience

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All bacteraemic cases, from August 2006 to September 2007 were identified by reviewing all positive blood culture results from the microbiology department of our hospital. One thousand three hundred and sixty six cases were detected in 1336 patients. The rate of true bacteremia which was 13.1 and 10.7% of cultures were contaminated. Of the 1366 episodes of bloodstream infection, 55.3% were community-acquired and 44.7% were health-care associated. Gram-positive bacteria prevailed (58.5%), followed by gram negative bacilli (38.5%). Polymicrobial bacteremia was detected in 2.2% of cases. Coagulase-negative staphylococci (CoNS) were the leading cause (550/1366 = 40.3%), whilst enterococci, *Staphylococcus aureus* and Streptococci represented 8, 6.4 and 3.8% respectively. *Pseudomonas aeruginosa* was the commonest gram -negative isolate (155/1366 = 11.3%), followed by *Escherichia coli* (8.2%) and *Acinetobacter* sp. (7.3%) . Fungi were isolated in the 3% of the isolates and *Candida albicans* accounted for the 70.7% of them. Fatal outcome due to bloodstream infections was 15.3% and 5.7% in hospital (HA) and community-acquired (CA) episodes, respectively (P < 0.0005) .The highest mortality occurred in patients with bacteremia due to *Acinetobacter* (41%) in HA episodes, and in patients with bacteremia due to *S. aureus* (34.0%) in CA incidents.

Keywords: Bacteraemia, pathogens, antimicrobial resistance.

INTRODUCTION

Septicaemia is a major cause of morbidity and mortality among hospitalised patients and this has slightly been changed in the last years (Tariq et al., 2009). Although, presenting symptoms and signs are helpful in identifying possible sources of infection, they possess inadequate specificity. There is no other test that is more essential for the physician than blood cultures (Lippincott and Wilkins, 2003; Lee et al., 2007). While only 5 to 15 % of blood cultures drawn in febrile patients are positive, the discovery of pathogens in the bloodstream offers crucial clinical information that consecutively directs to a precise and often life- saving treatment (Weinstein, 2003). Blood culture results are usually not available without delay. For that reason, physicians' familiarity with the epidemiologic and antimicrobial susceptibility patterns of common pathogens, both in the community and hospital settings are invaluable for judicious management decisions. The aim of this retrospective study was to compare the epidemiologic, clinical, microbiological characteristics and mortality rates between CA and HA infections in our tertiary care University hospital.

METHODS

The present study examined all sources, microbiological aetiology and incidence of bacteremia, and also pathogen resistance patterns in Patras University hospital. Our institution is a tertiary care medical facility with 700 inpatient beds, in Western Greece. All forms of acute medical care were provided during the study period, including adult and paediatric medicine, surgery, obstetrics/ gynaecology, haematology, oncology and also a lively kidney and

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bone marrow transplant program. The hospital has four intensive care units (ICUs) for critically ill patients: coronary, adult (medical and surgical), neonatal and bone marrow transplant.

During the survey period, 49945 patients were admitted. At least, two sets of cultures from 8935 patients were drawn from two separate venipunctures and incubated aerobically and anaerobically for 5 - 7 days (unless prolonged incubation was requested). All these patients were suspected to suffering from a bacteremic episode as they were presented with signs and symptoms such as chills and fever > 38.3°C, malaise, nausea, vomiting and diarrhoea, abdominal pain, anxiety, shortness of breath and confusion.

The automated Bactec 9240 system of continuous evaluation (Becton Dickinson, Sparks, MD, USA) was used. Bacterial isolates were identified using standard methods and tested for their susceptibility to the antimicrobial agents, using the Kirby-Bauer disk diffusion test according to the NCCLS recommendations (Jones, 2003). The isolates were classified as contaminants or as resulting from CA or nosocomial infection based on Centres for Disease Control and Prevention (CDC) criteria (Garner et al., 1998). Isolates that normally consist of skin flora (e.g., coagulase negative staphylococci, *Bacillus* sp., *Propionibacterium* sp.), were considered significant if there were clinical symptoms present, and either the organism was isolated from at least two separate blood cultures and/ or a physician instituted appropriate antimicrobial therapy.

Patients' records were systematically reviewed using an extended study form for the collection of demographic information, severity of illness categorized as sepsis, severe sepsis, or septic shock (Bone, 1991). Furthermore, underlying diseases and their severity according to the McCabe and Jackson groups (McCabe and Jackson, 1962), the presence of intravenous or central venous catheters, urinary bladder catheter, mechanical ventilation, and neutropenia if they were present at the time of infection, invasive medical procedures including surgery if they were performed in the three days prior to the bacteraemic incident, previous antimicrobial therapy at least two weeks prior to the event, polymicrobial infection and inadequate treatment if the patient did not receive appropriate antibiotic for at least 7 days, were also recorded. Patients were considered cured if they had been discharged after the completion of hospital antimicrobial treatment. Bacteremia was held responsible for a fatal outcome if it had occurred during the active period of the infection or the patient was under antimicrobial treatment. None of those patients got involved more than once in this study.

Statistical analysis

Values were expressed as prevalence rates. Conventional chi-squared and Fisher's exact tests were used to analyze qualitative differences. $P < 0.05$ was considered significant. Statistical analysis was performed with SPSS 8.0 statistical software.

RESULTS

During the study period (August 2006 to September 2007), 49.945 patients were hospitalized in our hospital and 19.038 blood cultures sets were drawn from 8.935 patients (17.9%), aged 0 - 98 years old, with clinical characteristics suggestive of blood stream infections. Two thousands nine hundred and seven (15.3%) blood culture sets revealed significant bacteraemia, 1.788 (9.4%) sets identified as contaminated and 14.343 (75.3%) sets showed no growth. The average age of patients with bacteraemia was 68.2 ± 15 years. The most frequent source was lower respiratory tract infections (39.1%). Urinary tract, primary bloodstream, surgical site, gastrointestinal infections and upper respiratory tract infections were found in 25.7, 19.5, 7.2, 4.2 and 3.1% of patients, respectively. The total incidence of bacteraemia was 26.7 per 1000 admissions or 6.6 per 1000 patient days when using patient days as a denominator. More than one third of the patients (35.3%) was hospitalized in the internal medicine division with bacteraemia occurring in 45.0 per 1000 admissions (4.5%) and most of these incidents (598/800 = 74.5%) were CA. The highest incidence of bacteremia was depicted in both bone marrow transplant unit (647.0 per 1000 admissions or 64.7%) and ICU (519.3 per 1000 admissions or 51.9%). All episodes in bone marrow transplant and 183 out of 209 (87.5%) of the bacteremic incidents in ICU were HA. In total, 1.366 episodes of true bacteremia were recorded in 1.336 patients (CA = 755 (55.3%) and HA = 611 (44.7%)) and polymicrobial bacteremias were detected in 2.2% of all cases (HA = 26 (4.2%) and CA = 4 (0.5%)).

Although CoNS, *Escherichia coli*, *Pseudomonas aeruginosa*, enterococci and *Staphylococcus aureus*, were found to be the most commonly isolated pathogens in CA bloodstream infections, CoNS, *P. aeruginosa*, *Acinetobacter* sp. and enterococci comprised the majority of the isolates in nosocomial bacteraemias (Table 1).

Gram-positive bacteremia

Amongst the 1.366 bacteremic episodes, gram- positive isolates (799/1.366, 58.5%) prevailed (Table 1). Prevalence of gram-positive isolates was significantly higher in CA infections (487/755 = 64.5%) when compared with HA infections (312/611 = 51.1%, $P < 0.0005$). Between the 799 isolated gram-positive strains, 68.8% were ascribed to CoNS, 13.6% to enterococci, 11.0% to *S. aureus* and 6.5% to non-enterococcal streptococci. Between the non-enterococcal streptococci, *Streptococcus viridans* was responsible for 4.4% and *Streptococcus pneumoniae* for only 1.2% of all gram-positive incidents. The vast majority of *S. pneumoniae* (90%) and *S. viridans* (71.4%) bacteremias were CA.

Streptococcus epidermidis was accountable for the vast majority (96.5%) of CoNS bacteremias (CA = 62.5% and HA = 37.5%). *S. aureus* bacteraemias were CA in 59.1% and HA in 40.9%. Other group D streptococci were isolated in only 0.9% of all gram-positive strains and 50% of them represented nosocomial isolates. Noso-comial enterococcal strains and group D streptococci were slightly predominated (51.7%) over the CA ones (48.3%). In comparison with the 51.4% of the hospital originated enterococcal isolates, the nosocomial non-enterococcal and non-group D streptococcal strains represented 24.4%.

Table 1. Bacterial isolates.

Pathogens	%	CA (%)	HA (%)
Total gram-positive	799/1366 (58.5)	487/755 (64.5)[a]	312/611 (51.1)
CoNS*	550 (40.3)	344 (45.6)	206 (33.7)
Enterococcus sp.	109 (8)	53 (7.0)	56 (9.2)
S. aureus	88 (6.4)	52 (6.9)	36 (5.9)
Other gram-positive**	45 (3.3)	34 (4.5)	11 (1.8)
Total gram-negative	526/1366 (38.5)	256/755 (33.9)	270/611 (44.2)
Pseudomonas aeruginosa	155 (11.3)	58 (7.7)	97 (15.9)
E. coli	112 (8.2)	95 (12.6)	17 (2.8)
Acinetobacter sp.	100 (7.3)	20 (2.6)	80 (13.1)
Klebsiella sp.	66 (4.8)	32 (4.2)	34 (5.6)
Enterobacter sp.	37 (2.7)	9 (1.2)	28 (4.6)
Other gram-negative***	54 (3.9)	40 (5.3)	14 (2.3)
Fungi	41/1366 (3.0)	12/755 (1.6)	29/611 (4.7)
Total	1366 (100)	755 (55.3)	611 (44.7)

Isolates less than two are not depicted in the table, but included in the total number.
[a]CA versus HA gram-positive infections: P < 0.0005.
CoNS*: Coagulase-negative staphylococci. Other gram-positive**: *S. viridans*, *S. pneumoniae* Other gram-negative***: *Proteus* sp., *Brucella melitensis*, *Salmonella* sp., *Serratia marcescens*, *Morganella morganii*, *Listeria monocytogenes*, *Providencia stuartii*, *Neisseria meningitidis*, *Citrobacter freundii*.

Gram-negative bacteremia

Gram -negative isolates represented 38.5% of all positive blood cultures and HA episodes (HA: 270/526 = 51.3% versus CA: 256/526 = 48.7%) prevailed (Table 1). *P. aeruginosa* was the most common of the isolated gram-negative pathogens (29.5%) and 62.6% of these strains were HA. *E. coli* ranked second with 21.3% and most of the isolates (84.9%) were CA, followed by *Acinetobacter* sp. with 19.0 and 80% of them were nosocomial isolates. Prevalence of gram-negative isolates was higher in HA (270/611 = 44.2%) when compared with CA infections (256/755 = 33.9%, P < 0.0005). The frequency of fungi was 3 and 70.7% of the isolates were nosocomial.

Antimicrobial resistance

Antibiotic resistance amongst significant bacterial isolates is depicted in Table 2. Overall, 14.9% of CoNS and 27.3% of *S. aureus* isolates were resistant to oxacillin. Oxacillin resistance rates were significantly higher amongst both CoNS and *S. aureus* nosocomial isolates (P < 0.0005 and P < 0.003 accordingly). No resistance to vancomycin was noticed.

Enterococcus faecalis resistance to vancomycin showed no significant differences between CA and HA isolates, while resistance rates for nosocomial *Enterococcus faecium* strains were significantly higher (P = 0.002).

P. aeruginosa resistance rates between CA and HA isolates showed significant differences concerning imipenem, ciprofloxacin, amikacin, piperacillin/tazobactam (P < 0.0005) and ceftazidime (P = 0.001). Furthermore, remarkable differences were depicted amongst the resistance rates of CA and nosocomial *Acinetobacter* sp. isolates relating to imipenem, ciprofloxacin, ceftazidime, and amikacin (P < 0.0005). Although, *E. coli* resistance rates among CA and HA strains did not significantly differ regarding amoxicillin/clavulanate, ciprofloxacin, ceftazidime and amikacin, it is worth mentioning that resistance to ciprofloxacin and ceftazidime was higher in the CA compared to the nosocomial *E. coli* strains, though this difference was not significant. All CA *E. coli* isolates were susceptible to imipenem compared to the 5.9% resistance rate observed between the nosocomial isolates (P = 0.018). Remarkably, *Klebsiella* sp. resistance rate to imipenem for the CA strains was surprisingly high (34.3%), though nosocomial isolates demonstrated also high resistance (44.1%, NS). Furthermore, CA and HA Klebsiella resistance rates to ciprofloxacin (P = 0.031), ceftazidime (P < 0.0005) and amikacin (P = 0.006), were found significantly different.

Mortality rates and patients' outcome

Overall mortality rate was 9.9% and mortality rates attributable to nosocomial bloodstream infections prevailed (CA = 5.7% versus HA = 15.3%, P < 0.0005). Both in CA and HA incidents, mortality was significantly

Table 2. Antibiotic resistance amongst gram-positive and -negative isolates

Pathogens	Antibiotic	CA	HA	P value
		Resistant strains/ %		
CoNS *	Oxacillin	3/344 (0.9)	79/206 (38.3)	P < 0.0005
S. aureus	Oxacillin	8/52 (15.4)	16/36 (44.4)[b]	P < 0.003
E. faecalis	Vancomycin	0/25 (0)	3/28 (10.7)	NS
E. faecium	Vancomycin	2/27 (7.4)	13/29 (44.8)	P = 0.002
P. aeruginosa	Imipenem	2/58 (3.4)	44/97 (45.4)	P < 0.0005
	Ciprofloxacin	7/58 (12.1)	47/97 (48.5)	P < 0.0005
	Ceftazidime	1/58 (1.7)	21/97 (21.6)	P < 0.001
	Amikacin	4/58 (6.9)	45/97 (46.4)	P < 0.0005
	Piperacillin/ Tazobactam	1/58 (1.7)	42/97 (43.3)	P < 0.0005
Acinetobacter sp.	Imipenem	1/20 (5)	67/80 (83.8)	P < 0.0005
	Ciprofloxacin	2/20 (10)	72/80 (90.0)	P < 0.0005
	Ceftazidime	1/20 (5)	71/80 (88.8)	P < 0.0005
	Amikacin	1/20 (5)	63/80 (78.8)	P < 0.0005
E. coli	Amoxicillin/ Clavulanic	16/95 (16.8)	5/17 (29.4)	NS
	Imipenem	0/95 (0)	1/17 (5.9)	P = 0.018
	Ciprofloxacin	29/95 (30.5)	4/17 (23.5)	NS
	Ceftazidime	7/95 (7.3)	1/17 (5.9)	NS
	Amikacin	3/95 (3.1)	1/17 (5.9)	NS
Klebsiella sp.	Imipenem	11/32 (34.3)	15/34 (44.1)	NS
	Ciprofloxacin	4/32 (12.5)	12/34 (35.3)	P = 0.031
	Ceftazidime	2/32 (6.3)	16/34 (47.1)	P < 0.0005
	Amikacin	3/32 (9.4)	13/34 (38.2)	P = 0.006

CA: Community acquired, HA: hospital acquired, CoNS*: coagulase-negative staphylococci, NS: non-significant.

linked (P < 0.05) to ultimately and rapidly fatal disease, septic shock, the presence of an urinary bladder catheter, intravenous lines, previous invasive procedures, mechanical respiratory support, neutropenia and inadequate treatment (Table 3). In CA bacteremias, mortality was also associated (P < 0.05) with severe sepsis and the presence of central venous catheters. However, in HA bacteremias mortality was significantly higher in patients with previous antimicrobial treatment (P < 0.05). No significant differences were noticed in mortality rates between patients with and without polymicrobial infection both in CA and in HA bacteremias. Forty one out of 100 (41%) patients with *Acinetobacter* bacteraemia succumbed, and this pathogen was found to be significantly connected (P < 0.0005) with a fatal outcome in nosocomial events. On the other hand, 30 out of 88 (34.0%) patients with *S. aureus* bloodstream infections died, and this isolate was significantly connected (P < 0.0005) with death in CA bacteremias.

DISCUSSION

As physicians rely a great deal on blood cultures, few results can possess such a profound consequence on patient care as a flawed blood culture report. Ideally, contamination rate should not surpass 2 - 3% in a hospital, but eliminating all suspected false positives blood cultures is not a realistic goal (Weinbaum, 1997). Our contamination rate was high (9.4%) and this problem most probably aroused from inappropriate collection practices. At least 10 ml of blood per bottle were drawn in each suspected bacteraemic episode of our patients and the average number of blood cultures sets obtained per patient was 2.5 ± 1.1. The optimal yield is attained with two or three sets of blood cultures (Isaacmanet al., 1996; Beekmannet al., 2003).

The high ratio of admissions to blood cultures acquired (3:1), observed in our survey is probably credited to therapeutic procedures supported by the recent guiding

Table 3. Patients' outcome.

	Community-acquired (n = 755)		Hospital-acquired (n = 581)	
	Survivors (n = 712)	**Deaths (n = 43)**	**Survivors (n = 492)**	**Deaths (n = 89)**
McCabe and Jackson				
Non-fatal (%)	598 (84)	12 (27.9)	402 (81.7)	17 (19.1)
Ultimately fatal [ab] (%)	79 (11.1)	17(39.5)	38 (7.7)	31 (34.8)
Rapidly fatal [ab] (%)	35 (4.9)	14 (32.6)	52 (10.6)	41 (46.1)
Severity				
Sepsis (%)	672 (94.4)	15 (34.9)	418 (80.1)	63(70.8)
Severe sepsis [c] (%)	31 (4.4)	19 (44.2)	77 (14.8)	13(14.6)
Septic shock [a,b] (%)	9 (1.3)	9 (20.9)	27 (5.2)	13(14.6)
Central venous catheter [c] (%)	34 (4.7)	8 (18.6)	64 (13.0)	12(13.4)
Intravenous line [ab] (%)	106 (14.8)	12 (27.9)	435 (83.4)	87(97.7)
Urinary bladder catheter [ab] (%)	131 (18.3)	19 (44.1)	412 (83.7)	86(96.6)
Previous antibiotic use [d] (%)	197 (27.6)	16 (37.2)	205 (41.6)	68(76.4)
Previous invasive procedures [ab] (%)	24 (3.3)	12 (27.9)	57 (11.5)	28 (31.4)
Ventilator [ab] (%)	27 (3.7)	12 (27.9)	69 (14.0)	27(30.3)
Neutropenia [ab] (%)	19 (2.6)	13 (30.2)	108 (21.9)	32(35.9)
Polymicrobial infection (%)	3 (0.4)	1(2.3)	21 (4.2)	5(5.6)
Inadequate treatment [ab] (%)	25 (3.5)	12 (27.9)	51(10.3)	43(48.3)

[a]For community-acquired episodes: $P < 0.05$.
[b]For hospital-acquired episodes: $P < 0.05$.
[c]For community-acquired episodes: $P < 0.05$.
[d]For hospital-acquired episodes: $P < 0.05$.

principles that recommend obtaining blood cultures in a variety of patient populations (Gross et al., 1994; Martin et al., 2003). This study found a total incidence of bacteraemia of 26.7 per 1000 admissions or 6.6 per 1000 patient, which is well above most of the reported ranges for University hospitals in the developed world (Brun-Buisson et al., 1996; Al-Zamil, 2008). The increasing incidence of bacteraemia has also been demonstrated in many reports (Elhanan et al., 1995; Sylvetsky et al., 2002) from large and crowded tertiary care institutions, like our hospital. Moreover, the high incidence in our study may have also been influenced by the high ratio of admissions to blood cultures obtained, as it has been suggested in other studies (Bryan, 1989).

During the study period, 17.643 patients (35.3%) were hospitalized in Internal Medicine wards and more than half (58.5%) of the bacteremic episodes originated from this division. These rates are comparable to other studies (Elhanan et al., 1995) and this possibly mirrors the more rigorous practices carried out on older severely ill patients in the overcrowded medical wards of our hospital.

Three hundred eighty seven patients (0.8%) were hospitalized in ICU and 209 episodes of bacteremia (15.3%) originated from 201 ICU patients. The vast majority (87.6%) of them were HA, representing 29.9% of all nosocomial bacteraemic incidents. These rates are in accordance with those reported in other trials of bacteremia in ICU patients (Sligl et al., 2006; Japoni et al., 2009; Wroblewska et al., 2006), which ranged from 2.5 to 26%. The highest incidence of bacteremia was depicted in bone marrow transplant unit (647.0 per 1000 admissions or 64.7%) and all were HA episodes, representing 4.4% of all nosocomial incidents. It is known that bacteremias remain a frequent complication, particularly in allogeneic bone marrow transplantation, even long after hospital discharge and between 10 and 59% of these patients experience at least one episode of bacteremia (Donnelly, 1995; Craig et al., 2007). Polymicrobial bacteremias were detected in 2.2% (HA = 4.2% and CA = 0.5%) of all cases and these rates are lower compared to those of other studies where the reported incidence ranges between 4 - 10% of all bacteremias (Ljungman et al., 1984) . Other studies (Esel et al., 2003) have designated that in large urban and university hospitals about 50% to two thirds of the bacteremic incidents are nosocomial. In contrast to these findings, CA bacteremic episodes predominated in our study (55.3 vs. 44.7%). Our results are in conformity, with those recently reported by Garcia et al. (2006), who found CA and nosocomial bacteremic episodes in 53.7 and 46.3% of their cases, respectively. Gram-positive bacteria were responsible for the 64.5% of CA episodes

and CoNS was predominating (45.6%). Our figures of CA CoNS bacteremia are two to three times higher than those reported by Weinstein (1996) but similar to other recent reports (Finkelstein et al., 2002). Furthermore, Thylefors (1998), in his extensive literature's review concerning CoNS bacteraemia, concluded that though these isolates still represent the most usual contaminants, the proportion of all bloodstream infections and the overall incidence of true bacteraemias caused by these strains are increasing. Gram-positive cocci also predominated (51.1%) amongst the HA bacteremic incidents, and nosocomial CoNS strains were also the leading microorganisms (66%), amongst the HA gram-positive isolates representing 33.7% of all HA pathogens.

Enterococci and S. aureus were implicated in 9.2% and 5.9% of all HA incidents. Over the last two decades, nosocomial bacteremias have considerably increased with gram-positive isolates and yeast being mainly accountable for this alteration (Lyytikainen et al., 2002). Our results are consistent to other studies (Karchmer, 2000), and mirror the advancements in medical care and support, the increasing pool of severely ill and immunocompromised patients, the increased virulence of gram-positive isolates and the overuse of broad-spectrum antibiotics like 3rd generation cephalosporins.

Elhanan et al. (1995) demonstrated similar rates of enterococcal bacteraemias in their university hospital (13.6 vs. 15.1%) but in contrast to their results we noticed much higher rates of staphylococcal incidents (79.8 vs. 49.4%) with CoNS causing 68.8% of them, and non-enterococcal streptococci were responsible to a much lesser extend (3.8 vs. 34.1%) in our institution. In contrast to other surveys (Lark et al., 2000), 33 out of 41 isolates were *Candida albicans* species, and *Candida parapsilosis*, *Candida tropicalis* and *Trichosporon* sp. were responsible for 4, 3 and 1 episodes respectively. This increasing importance of non-albicans species as a cause of candidemia documented in other medical facilities may be correlated with the increased use of fluconazole (Nguyen et al., 1996).

P. aeruginosa ranked first in our survey among the nosocomial gram-negative isolates (15.9%), whilst in a recent prospective analysis from the United States (Wisplinghoff et al., 2004), *Pseudomonas* accounted for 4%, and was the third leading cause of gram -negative infections. *Acinetobacter* sp. ranked second (13.1%) confirming the general trend of increasing incidence of *Acinetobacter* infections, especially in our region (Meric et al., 2005).

In this study, oxacillin- resistant *S. aureus* (MRSA) rates were 44.4 and 15.4% in HA and CA bacteraemias, respectively. Our findings are in accordance with the generally high rates observed in the United States, Japan, and Southern Europe but are in disagreement with the very low rates (< 1%) reported in Scandinavia (Voss et al., 1994). Noteworthy, that in Greece residents of long-term care facilities are frequently transferred between their institutions and regional or/and tertiary care hospitals, generating an ongoing circuit of MRSA transmission, as in this patient population MRSA is also prevalent (Wisplinghoff et al., 2004). Furthermore, Greece recently topped the prescribing list of antibiotics in Europe, and cephalosporins were the most commonly administered antibacterial, a fact that is especially increasing the risk of CA-MRSA acquisition (Mölstad et al., 2002).

Not surprisingly, the resistance rates of nosocomial *P. aeruginosa*, *Acinetobacter* sp. and *Klebsiella* isolates, were higher than in the CA ones. The major driving force behind high levels of carbapenem resistance in our hospital has most probably been the heavy use of imipenem, aztreonam and third generation cephalosporins (Peleg et al., 2006). A disappointing finding in our survey was the high resistant rates of *E. coli* in beta-lactams, quinolones and aminoglycosides in both CA and nosocomial episodes. This is most probably reflecting the frequent and uncontrolled use of antimicrobials, including quinolones, in Greece.

Hospital-acquired bloodstream infections represent a leading cause of death, ranking eighth in a recent report from the United States (Wenzel and Edmond, 2001). Our findings agree with those results as we have noticed an overall mortality rate of 9.9% and the mortality rates due to nosocomial bloodstream infections were significantly higher compared to those attributable to CA bacteremic incidents ($P < 0.0005$).

In accordance with most of the recent studies, we have demonstrated that mortality, in both CA and HA incidents, was significantly correlated ($P < 0.05$) to severity of illness at onset of sepsis and especially to ultimately and rapidly fatal disease, and septic shock (Pittet et al., 1996), the presence of an urinary bladder catheter, intravenous lines (Vallés et al., 1997), previous invasive procedures, mechanical respiratory support (Vallés et al., 1997; Renaud and Brun-Buisson, 2001) neutropenia (Lin et al., 2008) and inadequate treatment (Ibrahim et al., 2000).

We want to emphasize that most of these variables are effortlessly weighed up at the bedside and should be routinely included in the assessment of patient and the implementation of new therapeutic approaches.

We also suggest that preventing catheter colonization is critical in reducing the bacteremic incidence, especially in the ICU setting, whereas improving patients' outcome relies on timely and appropriate management of septic shock and related impediments.

The highest mortality occurred in our patients with bacteremia due to *S. aureus* (34.0%) in CA episodes ($P < 0.0005$) . Our results are in contrast with the findings of Osmon et al. (2004), who have suggested that bloodstream infections due to *P. aeruginosa* have a greater risk of hospital mortality compared to bloodstream

infections due to *S. aureus* despite adequate antibiotic treatment.

Nonetheless, most recent trials have confirmed that *S. aureus* bacteremia is a common infection in both the community and nosocomial environment and is linked with significant mortality (Turnidge et al., 2009). It is advisable that a well organised nation-wide surveillance of *S. aureus* bacteremia and its outcome should be implemented as a pivotal part of a modern infection control network.

Furthermore, our study depicted that the highest mortality occurred in patients with bacteremia due to *Acinetobacter* (41%) in HA episodes ($P < 0.0005$). Although, Blot et al. (2003), argued that in seriously ill patients *Acinetobacter baumannii* bacteremia is not associated with a significantly increased mortality rate, many recent trials have established that nosocomial *Acinetobacter* bacteremia is associated with excessive mortality rates when adjusted for risk-exposure time and severity of disease at admission (Grupper et al., 2007).

Since, at least for the time being, most risk factors for an adverse outcome after bacteremia may not be changeable, preventive measures must centre on innovative and firm infection-control policies.

REFERENCES

Al-Zamil F (2008). Bacteremia in children at the University Hospital in Riyadh, Saudi Arabia. World J. Pediatr. 4(2): 118-122.

Beekmann SE, Diekema DJ, Chapin KC, Doern GV (2003). Effects of rapid detection of bloodstream infections on length of hospitalization and hospital charges. J. Clin. Microbiol. 41(7): 3119-3125.

Blot S, Vandewoude K, Colardyn F (2003). Nosocomial bacteremia involving Acinetobacter baumannii in critically ill patients: a matched cohort study. Intensive Care Med. 29(3): 471-475.

Bone RC (1991). Let's agree on terminology: definitions of sepsis. Crit. Care. Med. 19: 973-976.

Brun-Buisson C, Doyon F, Carlet J (1996). Bacteremia and severe sepsis in adults: a multicenter prospective survey in ICUs and wards of 24 hospitals. French Bacteremia-Sepsis Study Group Am. J. Respir. Crit. Care. Med. 154(3): 617-624.

Bryan CS (1989). Clinical implications of positive blood cultures. Clin. Microbiol. Rev. 2: 329-353.

Craig M, Cumpston AD, Hobbs GR, DeVetten MP, Sarwari AR, Ericson SG (2007). The clinical impact of antibacterial prophylaxis and cycling antibiotics for febrile neutropenia in a hematological malignancy and transplantation unit. Bone Marrow Transplant 39: 477-482.

Donnelly JP (1995). Bacterial complications of transplantation: diagnosis and treatment. J. Antimicrob. Chemother. 36: 59-72.

Elhanan G, Raz R, Pitlik SD, Sharir R, Konisberger H, Samra Z, Kennes Y, Drucker M, Leibovici L (1995). Bacteraemia in a community and a university hospital. J. Antimicrob. Chemother. 36: 681-695.

Esel D, Doganay M, Alp E, Sumerkan B (2003). Prospective evaluation of blood cultures in a Turkish university hospital: epidemiology, microbiology and patient outcome. Clin. Microbiol. Infect. 9(10): 1038-1044.

Finkelstein R, Fusman R, Oren I, Kassis I, Hashman N (2002). Clinical and epidemiologic significance of coagulase-negative staphylococci bacteremia in a tertiary care university Israeli hospital. Am. J. Infect. Control 30(1): 21-25.

Garcia MA, Moya BR, Lopez JJ, Colmenero Castillo JD (2006). Epidemiological features of community- and nosocomial-acquired bacteremia in the hospitalized elderly patients. Am. Med. Intern. 23(2): 62-65.

Garner JS, Jarvis WR, Emori TG, Horan TC, Hughes JM (1998). CDC definitions for nosocomial infections. Am. J. Infect. Control. 16: 28-40.

Gross PA, Barrett TL, Dellinger EP, Krause PJ, Martone WJ, McGowan JE Jr, Sweet RL, Wenzel RP (1994). Quality standard for the treatment of bacteremia: Infectious Diseases Society of America. Clin. Infect. Dis. 18(3): 428-430.

Grupper M, Sprecher H, Mashiach T, Finkelstein R (2007). Attributable mortality of nosocomial Acinetobacter bacteremia. Infect. Control Hosp. Epidemiol. 28(3): 293-298.

Ibrahim EH, Sherman G, Ward S, Fraser VJ, Kollef MH (2000). The Influence of Inadequate Antimicrobial Treatment of Bloodstream Infections on Patient Outcomes in the ICU Setting. Chest 118(1): 146-155.

Isaacman DJ, Karasic RB, Reynolds EA, Kost SI (1996). Effect of number of blood cultures and volume of blood on detection of bacteremia in children. J. Pediatr. 128: 190-195.

Japoni A, Vazin A, Hamedi M, Davarpanah MA, Alborzi A, Rafaatpour N (2009). Multidrug-resistant bacteria isolated from intensive-care-unit patient samples Braz. J. Infect. Dis. 13(2): 118-122.

Jones ME (2003). Reinterpretation of Susceptibility Data Using Current NCCLS Breakpoint Criteria. Antimicrob Agents Chemother. 47(2): 830-831.

Karchmer AW (2000). Nosocomial bloodstream infections: organisms, risk factors and implications. Clin. Infect. Dis. 31(4): 139-143.

Lark RL, Chenoweth C, Saint S, Zemencuk JK, Lipsky BA, Plorde JJ. (2000). Four year prospective evaluation of nosocomial bacteremia: epidemiology, microbiology, and patient outcome. Diagn Microbiol. Infect. Dis. 38(3): 131-140.

Lee A, Mirrett S, Reller LB (2007). Weinstein MP. Detection of bloodstream infections in adults: How many blood cultures are needed? J. Clin. Microbiol. 45(11): 3546-3548.

Lin MY, Weinstein RA, Hota B (2008). Delay of Active Antimicrobial Therapy and Mortality among Patients with Bacteremia: Impact of Severe Neutropenia. Antimicrob. Agents Chemother. 5(9): 3188-3194.

Ljungman P, Malmborg AS, Nystrom B, Tillegard A (1984). Bacteremia in a Swedish university hospital: a one-year prospective study in 1981 and a comparison with 1975-1976. Infection 12: 243-247.

Lyytikainen O, Lumio J, Sarkinnen H, Kolho E, Kostiala A, Ruutu P (2002). Nosocomial bloodstream infections in Finnish hospitals during 1999-2000. Clin. Infect. Dis. 35: 14-19.

Martin GS, Mannino DM, Eaton S, Moss M (2003). The epidemiology of sepsis in the United States from 1979 through 2000. N. Engl. J. Med. 348: 1546-1554.

McCabe WR, Jackson GG (1962). Gram-negative bacteremia. I. Etiology and ecology. Arch. Intern. Med. 110: 847-855.

Meric M, Willke A, Caglayan C, Toker K (2005). Intensive care unit-acquired infections: incidence, risk factors and associated mortality in a Turkish University Hospital. Jpn. J. Infect. Dis. 58: 297-302.

Mölstad S, Lundborg CS, Karlsson AK, Cars O (2002). Antibiotic prescription rates vary markedly between 13 European countries. Scand. J. Infect. Dis. 34(5): 366-371.

Nguyen MH, Peacock JE, Morris AJ, Tanner DC, Nguyen ML, Snydman DR, Wagener MM, Rinaldi MG, Yu VL (1996). The changing face of candidemia: emergence of non-Candida albicans species and antifungal resistance. Am. J. Med. 100: 617-623.

Osmon S, Ward S, Fraser VJ, Kollef MH (2004). Hospital mortality for patients with bacteremia due to Staphylococcus aureus or Pseudomonas aeruginosa. Chest 125(2): 607-616.

Peleg AY, Franklin C, Bell JM, Spelman DW (2006). Emergence of carbapenem resistance in Acinetobacter baumannii recovered from blood cultures in Australia. Infect. Control Hosp. Epidemiol. 27: 759-761.

Pittet D, Thievent B, Wenzel RP, Li N, Auckenthaler R, Suter PM. (1996). Bedside prediction of mortality from bacteremic sepsis. A dynamic analysis of ICU patients. Am. J. Respir. Crit. Care Med. 153(2): 684-693.

Renaud B, Brun-Buisson C (2001). ICU-Bacteremia Study Group.

Outcomes of primary and catheter-related bacteremia. A cohort and case-control study in critically ill patients. Am. J. Respir. Crit. Care Med. 163(7): 1584-1590.

Sciarra JL, McDonnell JG (Eds) (2003). Handbook of primary care procedures. Philadelphia: Lippincott Williams and Wilkins pp: 62 - 65

Sligl W, Taylor G, Brindley PG (2006). Five years of nosocomial Gram-negative bacteremia in a general intensive care unit: epidemiology, antimicrobial susceptibility patterns and outcomes. Intern. J. Infect. Dis. 10(4): 320-325 20.

Sylvetsky N, Raveh D, Schlesinger Y, Rudensky B, Yinnon AM. (2002) Bacteremia due to beta-hemolytic streptococcus group g: increasing incidence and clinical characteristics of patients. Am. J. Med. 112(8): 622-626.

Tariq M, Jafri W, Ansari T, Awan S, Ali F, Shah M, Jamil S, Riaz M, Shafqat S (2009). Medical mortality in Pakistan: experience at a tertiary care hospital. Postgrad. Med. J. 85: 470-474.

Thylefors JD (1998). Increasing bacteremia due to coagulase-negative staphylococci: fiction or reality? Infect. Control Hosp. Epidemiol. 19(8): 581-589.

Turnidge JD, Kotsanas D, Munckhof W, Roberts S, Bennett CM, Nimmo GR, Coombs GW, Murray RJ, Howden B, Johnson PD, Dowling K (2009). *Staphylococcus aureus* bacteraemia: a major cause of mortality in Australia and New Zealand. Med. J. Aust. 191(7): 368-373.

Vallés J, León C, Alvarez-Lerma F (1997). Nosocomial bacteremia in critically ill patients: a multicenter study evaluating epidemiology and prognosis. Spanish Collaborative Group for Infections in Intensive Care Units of Sociedad Espanola de Medicina Intensiva y Unidades Coronarias (SEMIUC). Clin. Infect. Dis. 24(3): 387-395.

Voss A, Milatovic D, Wallrauch-Schwarz C, Rosdahl VT, Braveny I. Methicillin (1994). Resistant *Staphylococcus aureus* in Europe. Eur. J. Clin. Microbiol. Infect. Dis. 13(1): 50-55.

Weinbaum FI, Lavie S, Danek M, Sixsmith D, Heinrich GF, Mills SS (1997). Doing it right, the first time. Quality improvement and the contaminant blood culture. J. Clin. Microbiol. 35(9): 563-565.

Weinstein MP (1996). Current blood culture methods and systems: clinical concepts, technology and interpretation of results. Clin. Infect. Dis. 23: 40-46.

Weinstein MP (2003). Blood culture contamination: Persisting problems and partial progress. J. Clin. Microbiol. 41(6): 2275-2278.

Wenzel RP, Edmond MB (2001). The impact of hospital-acquired bloodstream infections. Emerg. Infect. Dis. 7(2): 174-177.

Wisplinghoff H, Bischoff T, Tallent SM, Seifert H, Wenzel RP, Edmond MB (2004). Nosocomial bloodstream infections in US hospitals: analysis of 24,179 cases from a prospective nationwide surveillance study. Clin. Infect. Dis. 39(3): 309-317.

Wroblewska MM, Rudnicka J, Marchel H, Luczak M (2006). Multidrug-resistant bacteria isolated from patients hospitalised in Intensive Care Units. Int. J. Antimicrob. Agents 27(4): 285-289.