

# Bacteremia and septicemia in Qatar

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## ABSTRACT

**Objectives:** The aims of the study are to define the pattern of bacteremia and septicemia in Hamad Medical Corporation in relation to the susceptibility of the implicated microbes to various antimicrobial agents.

**Methods:** During a period of 12 months of study, blood cultures were performed on 9074 patients in Hamad Medical Corporation, Qatar, with clinical signs of infection. Among these, 789 (9%) episodes of septicemia were diagnosed, which corresponds to 20/1000 hospital admissions.

**Results:** About 59% of the episodes were due to Gram positive organisms, the most common of which were coagulase negative staphylococci (31%), *Staphylococcus aureus* (7%) and *Candida* spp (6%), and other Gram positive organisms. Gram negative organisms implicated in 40% of episodes were mainly *Salmonella* spp (8%), *Escherichia coli* (7%), *Klebsiella* spp (5%) and other Gram negative organisms. The antibiotic resistance pattern of the organisms showed that *S.aureus* had the highest incidence of drug resistance. The case fatality rate among 66 episodes of septicemia was 24%, which increased with age, but was not influenced by sex.

Polymicrobial septicemia carried the highest mortality rate. The case fatality rate of Gram positive septicemia was higher than that of Gram negative. Patients with underlying conditions, such as malignancy, chronic liver diseases, diabetes mellitus, renal failure, heart failure and conditions requiring surgery had higher mortality rates. The chance of survival increased with the use of appropriate therapy and absence of underlying disease. None of the patients with underlying conditions survived after receiving inappropriate therapy as compared with 50% who were previously healthy.

**Conclusions:** Factors such as patients age, type of microorganism involved, the presence of underlying disease and the appropriateness of antibiotic therapy all influence the outcome of septicemia. While some patients with an underlying condition die of the consequences of septicemia despite appropriate antimicrobial therapy, other patients without any underlying disease tolerate septicemia reasonably well.

**Keywords:** Microbiology, septicemia.

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The diverse microbial etiology of septicemia has always caused concern for effective management of patients. Despite advancement in diagnostic facilities and antibiotic chemotherapy, mortality from septicemia has not been significantly reduced compared with that of the pre-antibiotic era. The outcome of septicemia is influenced by various factors, such as underlying condition and patients age, the microorganisms involved and its source as well as the choice of antibiotic therapy. While in developed countries septicemia is mainly hospital acquired reports from developing countries indicate

widespread community acquired pathogens particularly *Salmonella* spp. Qatar represents a unique situation, while development and sophistication of medical and health services provide fertile soil for opportunistic infections, various infectious diseases including enteric fever and tuberculosis still prevail in the community.

The state of Qatar lies halfway along the Western coast of the Arabian Gulf, with an area of 11.437 sq km. It has a moderate desert climate with a long hot summer and short winter with little rain. The population is about 500,000 most of them live in the

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capital city. Foreign expatriates number more than Qatari nationals, and most of them come from the Indian subcontinent.<sup>1,2</sup> Health care is provided free of charge for all citizens and residents alike.

Hamad Medical Corporation (HMC) is comprised of 3 major hospitals. These 3 hospitals are the main hospitals in the state of Qatar with a total capacity of 1292 beds. They are Hamad General Hospital (660 beds) encompassing the Departments of Medicine, Surgery and Pediatrics, in addition to specialized intensive care units, Cardiology and Dialysis units; The Women's Hospital (288 beds) with Obstetrics and Gynecology and a Neonatal Care Unit; and the 3rd is Rumailah Hospital, which provides care to the elderly and disabled people in Qatar.<sup>3</sup>

Information on the microbial nature of septicemia and the susceptibility of the isolates to antibiotics in Qatar has not been previously investigated. The present study aims to define the pattern of bacteremia and septicemia in HMC in relation to the susceptibility of the implicated microbes to various antimicrobial agents. An approach similar to that described by Weinstein et al<sup>4</sup> was followed to determine the case fatality rate (CFR) of septicemia in Qatar as well as the influence of various risk factors and the choice of antimicrobial therapy on the outcome.

**Methods. Blood cultures.** A total of 1,1994 blood cultures were performed between 1 January to 31 December, 1994 at HMC in the state of Qatar. These samples were analyzed and records of 66 patients with diagnosed septicemia, during the above period, were reviewed. Blood cultures were collected from 9074 patients with clinical signs of infection treated at HMC hospitals. Of these, 789 (9%) had bacteriological proven septicemia. Out of these, 66 patients were selected at random on the basis of age, sex and type of microorganism isolated and studied fully. Thirty-seven of them were male and 29 were female. Their ages ranged from 6 days to 90 years with a mean age of 22 years. They were divided into seven age groups (0-1, 1-4, 5-14, 15-19, 20-39, 40-60, >60). Fifteen of them were previously healthy and 51 had underlying conditions (malignancy 2, diabetes mellitus 10, renal transplant 1, surgery 5, and chronic liver disease 6 and miscellaneous 27). The miscellaneous underlying conditions consisted of heart failure, renal failure and debility.

**Blood culture procedures.** All blood samples for culture were taken after cleaning the blood collection site with povidone iodine in 70% ethyl alcohol. Ten ml of blood was then drawn using a new disposable syringe. For each patient, 2 samples were collected for aerobic and anaerobic cultures and processed. Blood cultures were performed by the Bact/Alert system (Organon Technician, Belgium) in which patients' samples were placed in disposable sterile

bottles, for monitoring. Each bottle contains an internal colorimetric sensor that detects carbon dioxide (CO<sub>2</sub>) as a measure of microbial growth. In the presence of CO<sub>2</sub> the sensor changes from green to yellow. Each bottle sensor is continuously monitored by the Bact/Alert instrument using solid state reflectometers.

After receiving blood samples, they are checked against the patient's request form and given a number. The aerobic culture bottle was vented after wiping the rubber cap with 70% alcohol. The bar code labels were applied for bottle identification and entered in the computer and the specimen was then placed in the Bact/Alert incubator (unit).

Positive culture were signaled immediately upon detection. A sample was determined negative, if after 10 days no microbial growth became apparent. When brucellosis was suspected, bottles were incubated for 21 days. Positive bottles were removed from the unit and smears were prepared from them, stained by Gram stain and examined microscopically under oil emersion (x 100 objective). Subcultures were then made onto chocolate agar, MacConkey agar and 2 blood agar plates. One blood agar was incubated anaerobically in gas pack jars (BBL, USA) and the 2nd was incubated together with the MacConkey and chocolate plates in 5-10% CO<sub>2</sub>. All plates were incubated at 36°C for 24 hours, except the anaerobic plate, which was kept for 48 hours. The cultures were interpreted according to the type of microorganism, frequency of isolation and the clinical relevance of the isolate. Cultures were repeated, when the significance of the isolate could not be determined.

**Identification of microorganisms.** The bacterial isolates were then identified according to their colonia appearance, Gram reaction, morphology, biochemical reactions and, if required, by agglutination with specific antisera. Oxidase test was performed on non-lactose fermenting Gram negative bacteria. The API20 NE (bioMerieux, France) identified those giving positive reactions. Oxidase negative microorganisms and Lactose fermenters were identified by the API 20 E system. Microorganisms identified by API as *Salmonella* spp were further tested with O and H specific *Salmonella* antisera (Welcome Diagnostics, Dartford, England) and confirmed by Kauffmann and White Scheme.<sup>5</sup> Staphylococci were tested by the Maststaph (Mast Diagnostics Ltd. England) test and were accordingly identified as *S.aureus* or coagulase negative *Staphylococcus* sp. Streptococci/enterococci were identified by their appearance on blood agar, sensitivity to optochin, bile esculin, growth in 6.5 NaCl and by API Strep Test (bioMerieux, France). Lanfield grouping was performed on all B-Hemolytic streptococci. Optochin sensitive streptococci were further typed by the slidex pneumo test. Yeasts were identified according to

morphological appearance and those giving a positive germ tube reaction were labelled as *Candida albicans*.

**Antibiotic sensitivities.** Bacterial isolates were tested for susceptibilities to various antimicrobial agents by disc diffusion on Mueller Hinton Agar, using reference strains of *E. Coli* (NCTC 10418) and *S.aureus* (NCTC 6571) as control strains. The antibiotics were those appropriate to the microorganism under test. The isolates were then categorized as sensitive, moderately resistant or resistant according to the criteria laid down by the National Committee of Clinical Laboratory Standard (NCCLS) and the guide to sensitivity testing.<sup>4</sup>

**Definitions.** Some of the 9074 episodes of septicemia were recorded and analyzed. When an organism was isolated its significance was assessed. The clinical data was obtained from patients' records. Septicemia was defined as isolation of microbial species from the blood of a patient who had shown clinical signs of sepsis such as clinical deterioration, fever, unstable hemodynamic parameters or coagulopathy. However, strict pathogens, such as *Brucella* spp or *Salmonella typhi* were considered significant even if they were isolated from a single blood culture bottle. An episode of septicemia was defined by the first positive blood culture or by a new positive blood culture more than 7 days after the preceding one. Factors that can influence the outcome of septicemia, such as underlying disease, patient's age, the microorganism involved and its source were recorded as present or absent in each episode. Those featuring in our reported episodes were malignancy, diabetes mellitus, organ transplant, chronic liver disease, surgery and miscellaneous (chronic renal failure, heart failure and debility).

Appropriate antimicrobial therapy was defined as the administration of an agent shown to be effective in vitro against the infective microorganism and considered to be an acceptable drug of choice, given in sufficient dosage and by an acceptable route of administration. Therapy was considered to be inappropriate if the patients did not receive any antibiotic or was treated by an antibiotic given in an insufficient dose or by an unacceptable route of administration or to which the organism isolated was resistant.

**Data analysis and interpretation.** Microbiological and patients data was entered on a data base computer program and then analyzed. The pattern of septicemia and susceptibilities of the isolate to the commonly used antimicrobial agents were recorded. The outcome of septicemia was evaluated in relation to the patient's age, sex, underlying condition, the causative agent and the administered antimicrobial chemotherapy. Death was attributed to septicemia if it takes place within 7 days of the last blood positive culture for the relevant pathogen and if no other

explanation for death is evident in the Hospital record. Clinical response will be assessed as cure when clinical symptoms and signs subside with complete resolution of active infection during the treatment period.

**Statistical analysis.** The incidence of septicemia was determined by dividing the total number of positive cultures by the number of patients admitted to HMC Hospitals during the study period and multiplied by 100 to obtain a percentage. CFR was determined by dividing the number of patients who died by the total number of episodes of septicemia multiplied by 100. All the data collected was entered in the computer program provided by the Statistical Package for the Social Science (SPSS). The Chi square test was used to compare values of 2 variables.

**Results.** During the one year study period (1994), about 11994 blood cultures were collected from 9074 patients with clinical signs of infection. Out of these cases, 789 (9%) were found positive, which corresponds to a rate of 20/1000 hospital admissions. Four hundred and ninety-six (63%) of the patients were male and 292 were female (37%). The types of microorganisms and the frequency of isolation in relation to age are shown in (Table 1). Four hundred and twenty-two (53.5%) bacterial isolates were gram positive, 279 (35.4%) were Gram negative, 47 (6%) were *Candida* spp and the remaining 41 (5%) episodes were caused by multiple organisms (polymicrobial). The most common isolate among the Gram positive organisms were coagulase negative *Staphylococcus* spp, accounting for 31%, followed by *S.aureus* (7%). The most frequently encountered Gram negative organisms were *Salmonella* spp. (8%), *E.coli* (7%) and *Klebsiella* spp (5%). Some organisms were found more frequently in certain age groups. Coagulase negative *Staphylococcus* spp, *Streptococcus* spp, *E.faecalis*, *Enterobacter* spp and *Candida* spp were more commonly isolated from infants, while *S.aureus*, and *E.coli* were more frequently recovered from patients at age groups 40-60 and > 60. *Salmonella* spp was more often isolated from the age groups 15-19 and 20-39 and *Brucella* spp from the age group 20-39. The results of the antibiotics susceptibility tests of the microorganisms isolated from the majority of the 66 patients are shown in Table 2. *Staphylococcus aureus* showed the highest incidence of drug resistance, while *Salmonella* spp, *Pseudomonas* spp and *Klebsiella* spp were less so. On the other hand, strains of *S.marcescens* were found to be multiresistant to a variety of drugs. The susceptibilities of *E.faecalis*, *Acinetobacter* spp and *E.coli* showed some variation.



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Table 1 - The number of patients who their blood cultures grew microorganisms.

Microorganisms	Patient Age group							Total	% Strain
	0-1	1-4	5-14	15-19	20-39	40-60	>60		
<b>Gram +ve Bacteria</b>									
<i>Staphylococcus aureus</i>	10	3	1	0	8	17	19	58	7
Coagulase neg <i>Staph</i>	95	14	8	11	39	39	46	252	31
<i>Streptococcus</i> spp	15	4	0	4	6	3	8	40	5
<i>Corynebacterium</i> spp	5	4	4	2	9	8	10	42	5
<i>Enterococcus faecalis</i>	10	3	0	0	2	1	4	20	2.5
<i>Micrococcus</i> spp	3	0	0	0	2	1	3	9	1
<i>Clostridium</i> spp	0	0	0	0	0	0	1	1	1
Other gram positive-Bacilli	5	1	2	1	4	2	2	17	2
<b>Total</b>	(143)	(29)	(15)	(18)	(70)	(71)	(93)	(439)	56
<b>Gram - ve Bacteria</b>									
<i>Pseudomonas</i> spp	9	2	1	2	6	8	7	35	4
<i>Acinetobacter</i> spp									3
<i>Enterobacter</i> spp	12	0	1	0	4	5	5	27	77
<i>Salmonella</i> spp	0	7	7	22	21	4	0	61	7
<i>Escherichia coli</i>	10	0	1	0	8	21	18	58	5
<i>Klebsiella</i> spp	13	1	1	1	7	8	7	38	1
<i>Hemophilus influenza</i>	3	1	0	0	1	0	0	5	3
<i>Brucella</i> spp	0	1	3	3	14	5	1	27	0.3
<i>Proteus</i> spp	0	0	0	0	0	1	1	2	1
Unidentified GNB	0	1	0	0	1	3	0	5	0.4
<i>Serratia marcescens</i>	2	1	0	0	0	0	0	3	
<b>Total</b>	(49)	(14)	(14)	(29)	(62)	(55)	(39)	(262)	33.2
<b>Polymicrobial spp</b>	14	1	1	4	10	5	6	41	5
<b>Candida spp</b>	23	1	0	0	11	7	5	47	6
<b>Grand Total</b>	229	45	30	51	138	143	143	789	100

Table 2 - Susceptibilities of microorganism isolated from blood to various antimicrobial agent.

Antibiotic	S.a	E.f.	Sal	Pseu	Aci	Kleb	E.coli	S.mer
Penicillin	0							
Cloxacillin	5*							
Cephalothin	6		2			6	2	0
Clindamycin	5		-					
Vancomycin	10							
Gentamicin	3		5	7	2	10	6	2
Imipenem	0	3	2		2	1	0	0
Cotrimoxazole			4		2	4		
Chloramphenicol			7					
Piperacillin				7				2
Ceftazidime				7	1	10	5	
Amikacin					1	6	3	
Ceftriazine							4	
<b>Total</b>	10	3	7	7	3	10	7	2

\*Number of sensitive isolates

S.a = *Staphylococcus aureus*, E.f = *Enterococcus faecalis*, Sal = *Salmonella* spp, Pseu = *Pseudomonas* spp, Aci = *Acinetobacter* spp, Kleb = *Klebsiella* spp, E.coli = *Escherichia coli*, S.mer = *Serratia marcescens*

Table 3 - The outcome of septicemia by age group.

Age group	<1	1-14	15-44	45-64	>65
No. of patients	16	4	24	8	14
No. of who died	0	0	4	1	6
CFR	0	0	17	12.5	43

Table 4 - The outcome of septicemia with reference to the microorganism isolated from the blood.

Microorganism	Patients Total	No. who died	CFR
<b>Gram positive bacteria</b>			
<i>Staphylococcus aureus</i>	12	3	25
<i>Enterococcus faecalis</i>	2	1	50
<b>Total</b>	14	4	28.5
<b>Gram Negative bacteria</b>			
<i>Salmonella</i> spp	8	1	12.5
<i>Enterobacter</i> spp	1	1	
<i>Citrobacter</i> spp	1	0	
<i>Pseudomonas</i> spp	6	1	2
<i>Acinetobacter</i> spp	3	0	
<i>Klebsiella</i> spp	7	1	14
<i>Secretia marcescens</i>	2	0	
<i>Brucella</i> spp	11	0	
<i>Escherichia coli</i>	7	2	29
<b>Total</b>	46	5	11
<b>Polymicrobial</b>	6	3	50
<b>Grand Total</b>	66	14	21

The overall CFT attributed to septicemia was 24%. There was no significant difference in CFR between male and female patients. Table 3 shows the CFR accordingly to age group. None of the patients in age groups 0-1 and 1-14 died. However, the CFR was highest amount the > 65 age group (43%). CFR of the other age groups ranged from 12.5% to 17%. There was a significant increase in CFR with higher age (P=0.053). The outcome of septicemia also varied according to the type of organism (Table 4). There was higher CFR among patients infected with Gram positive organisms (30%) than those infected with Gram negative organisms (12%). The CFR of polymicrobial septicemia (50%), however, was significantly higher than that caused by a single organism (P=0.017).

The CFR was significantly higher among patients with underlying conditions (31%) than the previously healthy patients (6%) (P = 0.05). It was highest among patients with malignancy (100%) followed by the chronic liver disease (67%), diabetes mellitus (30%) miscellaneous group (22%) and surgery (20%) (Table 5). Fifty-one patients (77%) received appropriate antibiotic therapy and 15 (23%) received inappropriate therapy. The CFR was significantly higher among patient who received inappropriate therapy (93%) than among those who were appropriately treated (6%) (P < 0.001). In the former group, apart from one patient with renal transplant, the CFR ranged from 20% in surgery to 100% in malignancy.

**Discussion.** This is the first report analyzing blood cultures of patients in the state of Qatar. There is much in common between Gulf States, in

Table 5 - The outcome of Septicemia in relation to the underlying condition and antibiotic therapy.

Status of therapy	ML	DM	KT	SG	MS	LD	Total	PH	Grand Total
Appropriate Therapy Patient number		7	1	5	23	3	39	13	51
No. who died		0	0	0	2	1	3	0	3
CFR		0	0	0	9	33	8	0	6
Inappropriate Therapy, Patient number	2	3		1	4	3	13	2	15
No. who died	2	3		1	4	3	13	1	14
CFR	100	100		100	100	100	100	50	93
Total Patient number	2	10	1	5	27	6	51	15	66
Number who died	2	3		1	6	4	16	1	17
CFR	100	30	0	20	22	67	31	6	24

CFR = Case fatality rate, ML = Malignancy, DM = Diabetes Mellitus, KT = Kidney Transplant, SG = Surgery, MS = Miscellaneous, LD = Chronic Liver Disease, PH = Previously Healthy

terms of socioeconomic and health standards, therefore, similar findings to those reported from Kuwait and Abu Dhabi<sup>6,7</sup> would be expected. The Gulf States attract workers from neighboring Arab and Asian countries. These people represent the majority of the population in Qatar. Most of these expatriates come from areas where infectious diseases such as typhoid prevail. Furthermore, brucellosis is endemic in most Gulf States including Qatar.<sup>8,9</sup> On the other hand, the health services in Qatar are served by only one hospital setting, catering for an entire population of 500,000. This accounts for the large number of blood cultures performed in these laboratories and for the relatively high incidence of septicemia found in this study. Reports from centers in other Gulf States, with smaller patient catchment areas gave a much lower incidence. A study from Abu Dhabi showed a incidence of 7/1000 hospital admissions<sup>7</sup> and another study from Kuwait showed an incidence of 11/1000 hospital admissions.<sup>6</sup> In contrast to developing countries, incidence and microbial etiology of septicemia has been extensively reported from Europe and North America. In the USA alone it is estimated that 200,000 cases of bacteremia occur annually with mortality as high as 50%.<sup>10</sup> In other studies septicemia is still a common serious illness, with mortality reported from 40% to 50%.<sup>11</sup> Generally the incidence of septicemia reported from industrial countries varied widely; from 3 to 28/1000 hospital admissions.<sup>4,12-17</sup>

In spite of the high incidence of *Salmonella* and *Brucella* infections among our patients septicemia due to Gram positive bacteria predominated over that caused by Gram negative bacteria, a finding that confirms reports from other centers, indicating reemergence of Gram positive bacteria as major causative agent of septicemia rather than Gram negative bacteria which were the major causative organisms of septicemia during the past 2 decades.<sup>1,18-21</sup> Perhaps, the increase in Gram positive septicemia in our hospital is related to the indiscriminate use of the cephalosporins, particularly third generation, which probably led to the selection of enterococci and methicillin resistant staphylococci (Elhag, KM, personal communication).

Most of the Gram positive septicemias in our series were caused by coagulase negative *Staphylococcus* spp, particularly among the newborn infants. In HMC there is a busy neonatal care unit with many premature and ill infants who are mostly on intravenous and central lines, where infections with coagulase negative staphylococci are known to occur.<sup>21,22</sup> The contamination associated with the feeding practice of total parental nutrition (TPN) could plausibly be one source of infection. Moreover, overuse of antibiotics, particularly cephalosporins in these infants has probably led to the selection of antibiotic resistant organisms, such as *E.faecalis* and *Candida* spp frequently encountered

among patients of this age group. There were two outbreaks of multiresistant *Enterobacter* infection in the neonatal unit in 1994 (Elhag, KM, personal communication), which most probably accounted for the increased isolation of *Enterobacter* spp from this age group. Streptococcal septicemia also was mostly encountered among the neonates, most of which was caused by Group B B-Hemolytic streptococcus. This strain is known to cause very early onset neonatal infection.<sup>22</sup>

The prevalence of *Salmonella* and *Brucella* infections among the young age groups reflects the social structure in this country. *S.Typhi/S.paratyphi* infections occurred mainly in the expatriate population, mainly those from the Indian Subcontinent, who constitute 40% of the population of Qatar.<sup>2</sup> These are mostly young male workers, who frequently travel to endemic areas and come back with infection (Elhag, personal communication). This finding is in agreement with reports from other Gulf states with similar socioeconomic structure.<sup>6,7</sup> *Brucella* spp on the other hand, although isolated from similar age groups, occurred mainly among indigenous population. Brucellosis is known to occur in this region and several reports have described the incidence and epidemiology of this disease among Bedouins and city dwellers alike.<sup>8,9</sup> *E.coli* septicemia occurred more often among middle age and elderly patients. We were not able to identify the source of septicemia in most of our patients, but one of the common sources of *E.coli* blood stream infection is the urinary tract.<sup>23,24</sup> Patients in these age groups are likely to suffer from prostate enlargement and subsequent obstruction and infection.

Most of infections in this study were caused by a single organism (95%) and only in 5% of cases was septicemia of polymicrobial etiology, where 2 or more organisms were incriminated. Several workers have reported blood stream infection by several organisms with incidence ranging from 8% to 18%. These infections occurred in patients with severe underlying condition, particularly malignancy.<sup>6,8,16,17,19</sup> Obviously the incidence of polymicrobial septicemia in our study is lower than that reported from centers, where mainly severely ill patients are treated. Our hospital is a general one, where patients with malignancies and other severe underlying conditions are diluted by other patients. Nevertheless, in our series, polymicrobial septicemia occurred in the 2 extremes of age, where immunity to infection is known to be less. Moreover, the patients treated in the neonatal unit, where these infections occurred are very ill and often are subjected to invasive procedures.

Seventeen (24%) of the 66 patients died from septicemia and CFR increased with age. These findings are comparable to those reported from other centers<sup>12,15,16</sup> and confirm observation in various

clinical settings that mortality from septicemia increases with age.<sup>1,12,19,25,26</sup> However, there was no mortality among infants in our series, which is not in line with findings of other workers, who reported rather high mortality rate in this age group.<sup>12,27</sup> We have no clear explanation to this finding, but perhaps if we had studied a larger number of patients from this age group we could have obtained different results. The CFR of septicemia among patients with underlying diseases was significantly higher than among previously healthy patients. Malignancy, chronic liver disease, diabetes mellitus, and the miscellaneous groups (chronic renal failure, heat failure and disability) were associated with the highest CFR. These results confirm other reports.<sup>12,19,25,27,28</sup>

We have found significantly higher CFR among patients with polymicrobial septicemia than those infected by a single organism. Our results confirm those of Bates et al who found that polymicrobial septicemia was associated with the highest mortality rate with over 40%.<sup>11</sup> Septicemia due to Gram positive bacteria carried a higher CFR than that caused by Gram negative bacteria, which contradicts the report from Kuwait, but agrees with the report from Boston.<sup>11,12</sup> Several factors, including the microorganism involved and the patient population under investigation can influence the CFR. In our series a large proportion of patients were infected with *S.typhi* and *Brucella* spp, which carried no mortality. This could have contributed to the low mortality from Gram negative septicemia in our series.

Fifty-one patients received appropriate antibiotic therapy but 15 (23%) received inappropriate therapy, a figure similar to that reported from Kuwait.<sup>12</sup> All patients but one who received inappropriate antibiotic therapy died compared to 3 (6%), who were given the appropriate antibiotic therapy ( $P < 0.001$ ). An additional important factor in determining outcome of septicemia is the condition of the patient. Our findings agree with those of other workers,<sup>6,12,19,23,25,29,30</sup> who also concluded that the use of appropriate antibiotics in the treatment of septicemia improves the chances of survival. As expected none of the patients with underlying disease, who received inappropriate therapy survived.

It is concluded that factors such as patients age, type of microorganism involved, the presence of underlying disease and the appropriateness of antibiotic therapy all influence the outcome of septicemia. While some patients with an underlying condition die of the consequences of septicemia despite appropriate antimicrobial therapy, other patients without any underlying disease tolerate septicemia reasonably well. It seems that the contemporary failure to achieve a significant reduction in the mortality from septicemia compared with that in the pre-antibiotic era is due to a change in

the microbial etiology and the rise in immunocompromised patients in hospitals.

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