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Frequency of isolation and antimicrobial susceptibility of bacteria isolated from bloodstream infections at Children's Medical Center, Tehran, Iran, 1996–2000

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Abstract

Antimicrobial susceptibility patterns of major bloodstream pathogens from Iran provide essential information regarding the selection of antibiotic therapy for patients with bloodstream infections (BSIs) living in Iran. Unfortunately, data regarding the isolation frequency and antimicrobial susceptibility patterns of endemic BSI pathogens are scarce in Iran. To shed some light on the susceptibility patterns of BSI pathogens endemic to Tehran, Iran, we investigated the antimicrobial susceptibility patterns of 2248 bloodstream isolates from patients in Children's Medical Center (CMC) Hospital in Tehran between January 1996 and December 2000. Microbiology reports of 24 600 blood specimens collected from inpatients in CMC Hospital were retrospectively reviewed. Specimen culture, bacterial identification and disk diffusion susceptibility testing were performed according to National Committee for Clinical Laboratory Standards guidelines. Overall, Gram-positive bacteria comprised 72% (1627/2248) of recovered isolates and Gram-negative bacteria comprised 28% (621/2248). Coagulase-negative staphylococci (CoNS) comprised 48.4% of all isolates, followed by *Staphylococcus aureus* (16.7%) and *Klebsiella* spp. (8.5%). Among the 621 Gram-negative organisms, *Klebsiella* spp. (31%) were the most frequently isolated, followed by *Escherichia coli* (21%) and *Pseudomonas aeruginosa* (17%). The rates of oxacillin resistance for *S. aureus* and CoNS isolates were similar (60% versus 61%); however, the rate of *S. aureus* vancomycin resistance was almost twice that of CoNS resistance (21% versus 11%). Over 55% of *S. pneumoniae* were resistant to penicillin and co-trimoxazole. Although all isolates of enterococci were susceptible to vancomycin, only 21% were susceptible to gentamicin. Among Gram-negative isolates, amikacin was shown to be very effective, with susceptibility rates of 84%. The susceptibility of *Klebsiella* spp. to ampicillin and co-trimoxazole was 1% and 39%, respectively. The susceptibility of *Klebsiella* spp., *E. coli* and *Enterobacter* spp. to ceftriaxone was 47%, 86% and 67%, respectively. There were notable differences in the order of the five most common organisms isolated from blood cultures, which can help set priorities for focused control efforts. Our findings highlight the importance of a nationwide surveillance programme to monitor the trends in isolation frequency of bacteria and their antimicrobial resistance patterns throughout Iran.

Keywords: Bloodstream infections; Antimicrobial susceptibility; Iran

1. Introduction

Bloodstream infections (BSIs) cause significant morbidity and mortality worldwide, and they are amongst the most common healthcare-associated infections in Iran [1–3]. In the USA alone, ca. 10–20% of nosocomial infections are estimated to involve the bloodstream, resulting in ca. 90 000 fatal cases each year [4]. Appropriate antimicrobial treatment of BSIs is critical in decreasing morbidity and mortality due to BSIs [5]; however, bacterial resistance to antibiotics is a frequent reason for treatment failure of BSIs in Iran.

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Surveillance reports have pointed to a trend of increasing antimicrobial resistance among prevalent BSI pathogens such as coagulase-negative staphylococci (CoNS) and *Staphylococcus aureus,* which are the most common bacteria isolated from blood cultures of Intensive Care Unit patients [6]. In addition, widespread resistance among common BSI pathogens such as *Enterococcus* spp., *Candida albicans* and *Enterobacter* spp. has been shown against antimicrobial agents that are frequently used to treat BSIs [6]. Microbiological identification of BSI bacterial pathogens, combined with determination of antimicrobial susceptibility of the bacteria that are endemic to a region, can help clinicians to select an appropriate and effective antimicrobial agent(s) for rigorous empirical treatment of BSIs [7].

In developed countries, nationwide surveillance programmes such as the National Nosocomial Infections Surveillance (NNIS) System [5] monitor the prevalence of bacterial pathogens and their antimicrobial resistance patterns and periodically publish reports. Regrettably, in many parts of the world, including Iran, such national surveillance programmes are absent and information regarding the prevalence of BSI pathogens and their antimicrobial susceptibility patterns is scarce. Epidemiological studies like SENTRY [8] have demonstrated that data regarding susceptibility patterns of bacteria from a geographical region are essential for controlling the local spread of bacterial resistance as well as preventing the spread of resistance in a geographical region [8,9]. Moreover, updated bacterial susceptibility data are particularly crucial to physicians and infection control practitioners in countries such as Iran where over-the-counter antimicrobial consumption and abuse of prescribed antibiotics are widespread. In this study we report the prevalence and antimicrobial susceptibility profiles of blood culture isolates from patients in Children's Medical Center (CMC) Hospital in Tehran, Iran.

2. Materials and methods

2.1. Study design

This investigation was the first phase of a 10-year comprehensive retrospective study conducted in two 5-year phases. The first phase was conducted by utilising the microbiology laboratory records of 24 600 blood cultures from CMC Hospital during the 1996–2000 period. In addition to being a referral tertiary care centre, CMC Hospital is one of the teaching hospitals of Tehran University of Medical Sciences. CMC Hospital admits patients from all regions of Iran, representing a wide spectrum of socioeconomic levels.

2.2. Microbiology data

Microbiology records were reviewed and data were included according to the following criteria. All isolates were recovered from aerobic blood culture bottles and only one isolate was allowed from each patient. Information on each isolate regarding its source and antimicrobial susceptibility profile was collected and recorded. Owing to annual changes in the hospital formulary, antimicrobials utilised and tested varied slightly from year to year. However, data regarding the clinical significance of each isolate and whether the BSI was community or hospital acquired was not available. The antimicrobial agents selected for analysis were those commonly included in the treatment of BSI or septicaemic patients in Iran. Antimicrobial susceptibility results were rounded down if <0.5 and were presented as whole numbers if ≥ 0.5.

2.3. Organism identification and susceptibility testing

All bacterial isolates were microbiologically identified in the microbiology laboratory of CMC using standard biochemical identification methods [10,11]. Antimicrobial susceptibility testing was performed by the Kirby–Bauer disk diffusion method, which has been the predominant method employed in Iran, in accordance with National Committee for Clinical Laboratory Standards (NCCLS) guidelines current at the time of the study [12,13]. Quality control organisms were utilised routinely in the CMC microbiology laboratory to ensure accurate performance of the susceptibility tests. Owing to the high risk of BSI morbidity and mortality, bacterial isolates that showed intermediate susceptibility to an antimicrobial agent were categorised as resistant isolates for data analysis and presentation.

3. Results

3.1. Frequency of occurrence among blood culture microorganisms

Of 24 600 blood cultures examined in this investigation, 2248 (9.1%) were positive for bacterial growth. Table 1 lists the 15 most common bacterial species or groups isolated from these blood cultures, which accounted for 99.4% of all isolates. The frequency of isolation of Gram-positive bacteria was 72% (1627 of 2248) of all isolated microorganisms, and the remaining 28% (621 of 2248) were Gram-negative.

Overall, staphylococci were the most frequent group of organisms recovered from our blood cultures, comprising 1463 (65%) of all bacteria recovered from blood cultures (Table 1). Five groups of organisms, including CoNS, *S. aureus*, *Klebsiella* spp., *Escherichia coli* and *Pseudomonas aeruginosa* were the most frequently isolated organisms or groups of organisms recovered from blood specimens of patients with BSI in this study, collectively accounting for almost 84% of the total number of BSI isolates cultured.

Approximately 90% of all Gram-positive organisms recovered from our blood cultures were *Staphylococcus* spp., making this group of organisms by far the most frequently isolated Gram-positive bacteria recovered from blood cultures in

Table 1
Frequency of occurrence of bacterial species or groups isolated from blood cultures of hospitalised patients in Children's Medical Center, Tehran, Iran

Rank	Bacterial species or group	No. of isolates	Percent of isolates
1	Coagulase-negative staphylococci	1087	48.4
2	*Staphylococcus aureus*	376	16.7
3	*Klebsiella* spp.	190	8.5
4	*Escherichia coli*	130	5.8
5	*Pseudomonas aeruginosa*	104	4.6
6	*Enterobacter* spp.	91	4.0
7	*Salmonella* spp.	61	2.7
8	*Enterococcus* spp.	46	2.0
9	*Streptococcus pneumoniae*	45	2.0
10	Viridans group streptococci	44	2.0
11	*Streptococcus pyogenes*	29	1.3
12	*Acinetobacter* spp.	13	0.6
13	*Haemophilus* spp.	8	0.4
14	*Neisseria meningitidis*	7	0.3
15	*Brucella* spp.	4	0.2
16	Others	13	0.6
Total		2248	100

our study. The other Gram-positive bacteria such as *Enterococcus* spp. (2.8%), *Streptococcus pneumoniae* (2.8%), viridans group streptococci (2.7%) and *Streptococcus pyogenes* (1.8%) comprised only 10% of the Gram-positive organisms isolated.

Furthermore, *Klebsiella* spp. were the most prevalent Gram-negative BSI pathogen isolated, comprising 31% of the Gram-negative organism bloodstream isolates, followed by *E. coli* (21%), *P. aeruginosa* (17%), *Enterobacter* spp. (15%) and *Salmonella* spp. (10%). These groups of organisms accounted for ca. 93% of the Gram-negative bacilli recovered from blood cultures in the present study.

3.2. Antimicrobial susceptibility of Gram-positive microorganisms

Table 2 shows the antimicrobial susceptibility rates for the Gram-positive bacterial species recovered from blood cultures. The rates of oxacillin resistance among staphylococcal species were similar (60% for *S. aureus* versus 61% for CoNS); however, the rate of *S. aureus* vancomycin resistance was nearly twice the rate of CoNS vancomycin resistance (21% versus 11%). Further comparison of staphylococcal isolates showed that *S. aureus* were more susceptible than CoNS to clindamycin (81% versus 73%), co-trimoxazole (52% versus 33%) and ceftriaxone (75% versus 58%).

Over 55% of *S. pneumoniae* were resistant to penicillin and co-trimoxazole, whilst this organism's susceptibility rate to ceftriaxone and cefalothin exceeded 80% (Table 2). Among viridans group streptococci, susceptibility to ceftriaxone was greater than susceptibility to ceftizoxime (100% versus 75%). Chloramphenicol showed a high activity against nearly 97% of the Gram-positive isolates in our study, including staphylococci, *S. pneumoniae*, viridans group streptococci and *S. pyogenes*, with the susceptibility rates ranging from 81%

Table 2
In vitro antimicrobial susceptibility of Gram-positive bacterial species or groups isolated from blood cultures in Children's Medical Center, Tehran, Iran

Gram-positive bacteria	Antimicrobial	Total No.	Percent susceptible
Coagulase-negative staphylococci	Ampicillin	972	18
	Cefazolin	28	96
	Ceftriaxone	76	58
	Chloramphenicol	886	81
	Ciprofloxacin	22	87
	Clindamycin	307	73
	Co-trimoxazole	969	33
	Erythromycin	887	57
	Gentamicin	956	53
	Oxacillin	896	39
	Penicillin	917	9
	Vancomycin	520	89
Staphylococcus aureus	Amikacin	304	75
	Ampicillin	365	8
	Cefazolin	10	60
	Ceftriaxone	12	75
	Chloramphenicol	331	83
	Ciprofloxacin	13	69
	Clindamycin	90	81
	Co-trimoxazole	367	52
	Erythromycin	324	57
	Gentamicin	353	56
	Oxacillin	324	40
	Penicillin	326	5
	Vancomycin	155	79
Enterococcus spp.	Chloramphenicol	43	74
	Erythromycin	42	55
	Gentamicin	44	21
	Penicillin	44	30
	Vancomycin	31	100
Streptococcus pneumoniae	Ampicillin	45	62
	Ceftriaxone	5	80
	Cefalothin	45	82
	Clindamycin	18	72
	Chloramphenicol	44	89
	Co-trimoxazole	45	31
	Erythromycin	44	82
	Penicillin	45	44
	Vancomycin	24	96
Viridans group streptococci	Ceftriaxone	6	100[a]
	Ceftizoxime	12	75
	Clindamycin	20	90
	Chloramphenicol	44	93
	Erythromycin	44	82
	Penicillin	44	46
	Vancomycin	26	100[a]
Streptococcus pyogenes	Amikacin	18	33
	Cefalothin	24	71
	Chloramphenicol	23	91
	Erythromycin	21	67
	Gentamicin	24	33
	Penicillin	24	58

[a] Total susceptibility.

Table 3
In vitro antimicrobial susceptibility for the most common Gram-negative bacterial species or groups isolated from blood cultures in Children's Medical Center, Tehran, Iran

Gram-negative bacteria	Antimicrobial	Total No.	Percent susceptible
Klebsiella spp.	Amikacin	177	88
	Ampicillin	177	1
	Cefazolin	18	44
	Ceftizoxime	65	60
	Ceftriaxone	32	47
	Cefalothin	176	13
	Chloramphenicol	170	37
	Co-trimoxazole	178	39
	Gentamicin	173	28
Escherichia coli	Amikacin	128	95
	Ampicillin	129	14
	Cefazolin	15	73
	Ceftizoxime	55	91
	Ceftriaxone	36	86
	Cefalothin	125	40
	Chloramphenicol	125	60
	Co-trimoxazole	126	40
	Gentamicin	128	73
Pseudomonas aeruginosa	Amikacin	99	77
	Ceftizoxime	44	34
	Ceftriaxone	33	48
	Chloramphenicol	91	28
	Ciprofloxacin	13	92
	Gentamicin	96	66
	Tobramycin	51	75
Enterobacter spp.	Amikacin	88	84
	Ampicillin	89	9
	Cefazolin	7	29
	Ceftizoxime	26	69
	Ceftriaxone	18	67
	Ciprofloxacin	6	100[a]
	Chloramphenicol	84	57
	Co-trimoxazole	90	49
	Gentamicin	90	56
	Tobramycin	24	50
Salmonella spp.	Amikacin	3	33.3
	Ampicillin	5	60
	Cefazolin	4	100[a]
	Cefalexin	4	50
	Cefalothin	61	61
	Chloramphenicol	67	91
	Co-trimoxazole	61	39
	Kanamycin	58	71
	Gentamicin	59	100[a]
	Penicillin	60	63
	Tobramycin	2	50
Acinetobacter spp.	Amikacin	12	92
	Ceftizoxime	8	50
	Chloramphenicol	13	15
	Gentamicin	13	77
	Tobramycin	9	67
Haemophilus spp.	Amikacin	8	25
	Ceftizoxime	6	83
	Ceftriaxone	5	80
	Chloramphenicol	6	100[a]
	Co-trimoxazole	8	25
	Erythromycin	7	57
	Gentamicin	8	50
	Kanamycin	4	75
	Penicillin	8	0
	Tobramycin	5	40
Neisseria meningitidis	Amikacin	6	100[a]
	Ceftriaxone	2	100[a]
	Cefalothin	7	86
	Chloramphenicol	5	100
	Cloxacillin	4	75
	Co-trimoxazole	7	29
	Erythromycin	5	100[a]
	Gentamicin	7	56
	Penicillin	7	71
Brucella spp.	Amikacin	3	100[a]
	Chloramphenicol	4	100
	Co-trimoxazole	3	33
	Gentamicin	4	100[a]
	Kanamycin	3	100[a]
	Penicillin	3	0

[a] Total susceptibility.

to 93%. Among *Enterococcus* spp., 74% were susceptible to chloramphenicol but all were susceptible to vancomycin (Table 2).

3.3. Antimicrobial susceptibility of Gram-negative isolates

Table 3 shows that almost 88% of *Klebsiella* spp. recovered from our blood cultures were susceptible to amikacin; however, resistance to gentamicin, ceftriaxone and ceftizoxime among *Klebsiella* spp. was as high as 72%, 53% and 40%, respectively. On the other hand, among *E. coli* isolates examined in the current study, amikacin, ceftriaxone and ceftizoxime were quite effective, with susceptibility rates of 95%, 86% and 91%, respectively (Table 3). Although susceptibility of our *P. aeruginosa* isolates to aminoglycosides ranged from 66% to 77%, as shown in Table 3, only 8% of these isolates were resistant to ciprofloxacin, indicating the effectiveness of this antibiotic against our *P. aeruginosa* isolates. After ciprofloxacin, amikacin was the most effective antimicrobial agent against *Enterobacter* spp., with a susceptibility rate of 84%. However, in contrast, ca. 30% of *Enterobacter* spp. isolates were resistant to members of third-generation cephalosporin antibiotics such as ceftriaxone and ceftizoxime.

Regarding the infrequently isolated Gram-negative organisms such as *Haemophilus* spp., the rate of resistance to ceftizoxime and ceftriaxone was 17% and 20%, respectively, but all *Haemophilus* isolates (6/6) were susceptible to chloramphenicol. Although nearly 30% of *Neisseria meningitidis* isolates studied were resistant to penicillin, none (0/5) of the isolates were resistant to chloramphenicol. Interestingly, chloramphenicol also showed high activity against some Gram-negative microorganisms, including *Salmonella* spp.

and *Brucella* spp., with susceptibility rates of 91% (61/67) and 100% (4/4), respectively.

4. Discussion

The spread of antimicrobial resistance among bacterial pathogens in Iran has emerged as an important challenge for the Iranian medical community. According to global surveillance reports, bloodstream isolates are the best candidates for the study of antimicrobial susceptibility of human bacterial pathogens [14–16]. Unfortunately, data regarding bacterial resistance to antimicrobial agents are scarce in Iran. The need for reliable and comprehensive data regarding antimicrobial susceptibility patterns of bloodstream isolates specific to Iran prompted this 10-year investigation. Our data bring to light the fact that a serious problem of antimicrobial resistance exists among bloodstream isolates in Tehran.

Overall, with the exception of *Proteus* spp., our list of 15 most commonly isolated BSI pathogens from paediatric patients included all common BSI pathogens previously identified by international surveillance reports [17]. Whilst bacterial causes of BSIs in adults and children are different, our data showed notable and unexpected differences in the order of our five most common bacterial groups recovered from blood cultures. Although common contaminants such as CoNS are usually overrepresented in studies of blood culture isolates, the list of most prevalent BSI pathogens from Iran can help set priorities for focused localised control efforts. Our data also point out that the prevalence of BSI pathogens in Iran differs from the prevalence reported by other countries [18–20]. For instance, in our study, *Klebsiella* spp. were identified as the most frequent Gram-negative isolates, whereas previous studies have shown *E. coli* as the most frequent Gram-negative bacteria isolated from hospitalised patients [17]. This finding might relate to the fact that most CMC Hospital patients had been hospitalised and had received antimicrobial treatment prior to admission.

In the current study, four groups of organisms, including CoNS, *S. aureus*, *Klebsiella* spp. and *E. coli*, were the most frequently isolated bacteria from blood cultures, collectively accounting for ca. 79% of isolates, which is consistent with other reports from the USA and Europe [8,21]. Nevertheless, the ranking of *Enterococcus* spp. as the eighth most common BSI pathogen in the current study is in notable contrast to many reports that have ranked enterococci among the top four most frequent BSI pathogens [17–19].

With regard to the susceptibility of Gram-positive organisms recovered from our blood cultures, although the oxacillin resistance rate of 60% for *S. aureus* is similar to rates reported from the USA, this resistance rate is almost 10 times higher than similar rates reported from Canada [20]. The oxacillin resistance rate of 61% among our CoNS blood isolates was 4–9% higher than the oxacillin resistance rate reported among CoNS blood isolates in the SENTRY study, but ca. 7% lower than the rates reported from Europe [20,21]. The alarmingly high rate of staphylococcal resistance to oxacillin, compared with the report of Pfaller et al. [20], raises concern about the use of oxacillin and related antimicrobials as an appropriate choice for treating staphylococcal infections in Iran. Compared with our isolates, the Canadian *S. aureus* isolates were, however, more susceptible to gentamicin, macrolides and co-trimoxazole [20]. Among European staphylococcal isolates, methicillin resistance was found in 28% and 68% of *S. aureus* and CoNS, respectively [21].

Vancomycin has been widely used in Iran for the treatment of infections caused by methicillin-resistant staphylococci. Although close to 75% of our staphylococci were intermediately susceptible to vancomycin, our data suggest that the rate of resistance to vancomycin among staphylococci is on the rise in Iran, like in many countries [22]. Conversely, in contrast to other regions of the world, all of our enterococci were susceptible to vancomycin during the period of the present study [22,23]. However, this finding is in sharp contrast to reports by Feizabadi et al. [24] who have recently shown a considerable 7% resistance rate among enterococci isolated from a small hospital in Tehran, indicating an alarming shift in vancomycin susceptibility among enterococci in Iran in recent years. Additional concern in the treatment of enterococcal infections in Iran is warranted because gentamicin resistance among our enterococcal isolates has also been shown to be much higher than the enterococci studied in other geographical areas [23,25]. Moreover, the nearly 12% vancomycin resistance rate among our *S. aureus* is 3–12% higher than the resistance rates reported from the UK and Wales, France, Egypt and Germany [19,22,26,27].

Like many reports, 80% of our pneumococcal isolates were susceptible to ceftriaxone; however, the rate of penicillin resistance of *S. pneumoniae* isolates is 13–19% higher than the rates reported from France, Egypt, USA and Canada, where they showed increased pneumococcal resistance to penicillin [19,22,25]. Furthermore, >4% resistance to vancomycin among our *S. pneumoniae* is higher than reported rates from the USA and Canada, where *S. pneumoniae* remains susceptible to vancomycin [20]. The high rate of methicillin resistance among *S. aureus* and penicillin-resistant *S. pneumoniae* isolates results in the frequent use of glycopeptides and third-generation cephalosporins [28,29]. The isolation of vancomycin-resistant *S. aureus* as well as fluoroquinolone-resistant *S. pneumoniae* in our study implies that infection control practitioners in Iran must enforce aggressive control measures to prevent the local spread of such resistant strains by identifying carriers of and/or patients infected with vancomycin-resistant *S. aureus*.

Regarding the Gram-negative organisms in this study, antibiotic resistance among our *Klebsiella* spp., *Enterobacter* spp., *Citrobacter* spp. and *P. aeruginosa* isolates was frequent, but our susceptibility rates were consistent with rates from other parts of the world [30–33]. However, our *Acinetobacter* spp. isolates were generally more susceptible to antibiotics than isolates from other regions of the world

[14,31]. Amikacin was the most active antimicrobial agent against most isolates of *E. coli*, *Klebsiella* spp., *Acinetobacter* spp. and *Enterobacter* spp. Our data demonstrate that chloramphenicol continues to have a high antimicrobial activity against a variety of bacteria that can cause meningitis. In light of the reports from Asia showing that chloramphenicol administration has not lead to the side effects previously described from the USA and Europe [33,34], chloramphenicol may remain a viable choice in antimicrobial therapy of paediatric patients in Asian countries such as Iran.

Generally, the antibiotic treatment of most CMC Hospital patients prior to admission may in part explain the overall high resistance among our BSI pathogens and the increased frequency of *Klebsiella* spp. compared with *E. coli.* Notably, the higher frequency of *Klebsiella* spp. compared with *E. coli* has been associated with increased risk of death among patients with BSIs due to Enterobacteriaceae [6]. In addition to the higher risk of BSI mortality, the high resistance of *Klebsiella* spp. to ceftriaxone and ceftizoxime is suggestive of the presence of extended-spectrum β-lactamases (ESBLs). Although the presence of ESBL enzymes was not genetically confirmed, current epidemiological studies of our isolates will determine whether such isolates exist in the community or remain largely confined to tertiary care hospitals. The increasing prevalence of ESBL-producing organisms in Iran may be similar to numerous countries where treatment of infections caused by these organisms has become progressively more difficult [35–38]. Thus, the Iranian medical community confronts a challenge in treating infections caused by ESBL-producing organisms resistant to currently available β-lactam agents (except imipenem), aminoglycosides, fluoroquinolones and, in some cases, piperacillin/tazobactam [34].

In the present study, *P. aeruginosa* isolates showed low susceptibility to ceftriaxone and ceftizoxime; however, the susceptibility of these isolates to ciprofloxacin was higher than that reported from the USA [17,20].

In conclusion, our data indicate that the prevalence of bloodstream pathogens is different in Iran compared with other parts of the world, and further show that antimicrobial resistance among Gram-positive cocci and Gram-negative bacilli isolated from blood cultures is widespread in Tehran. Our findings also highlight the importance of access for clinicians to updated bacterial susceptibility data regarding commonly prescribed agents in developing countries such as Iran. Continuous monitoring of changes in bacterial resistance will help set national priorities for local intervention efforts in Iran. The high risk of BSI due to antibiotic-resistant pathogens, particularly Gram-positive cocci, emphasises the importance of enforcing rational antibiotic prescription policies and new vaccine strategies in Iran.

Our report draws attention to the importance of the vigilance of physicians in identifying resistant bacteria during treatment of patients with BSI and underscores the need for devising a national strategy to control the spread of resistance in Iran. In view of the fact that reports of updated susceptibility data from Iran are sparse, we believe that our data, in conjunction with comprehensive surveillance data from all regions of Iran and the Middle East, will further strengthen the reliability of ongoing global surveillance programmes in developed countries and thus will enhance attempts at limiting the spread of bacterial resistance worldwide.

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