Trends in Antimicrobial Susceptibility of Bacterial Pathogens Isolated from Pediatric and Adult Patients with Blood Stream Infections in North America: SENTRY 1997-2000

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Abstract

From January 1997 through December 2000, 25,747 BSI due to bacterial pathogens were reported from SENTRY hospitals in Canada and the USA. *S. aureus, E. coli* and coagulase-negative staphylococci (CoNS) were the most common pathogens, together accounting for 55% of all BSI pathogens during this time period. Among the four different age groups (< 1yr, 1-5 yr, 6-18 yr, and > 18 yr) the most common BSI pathogen was CoNS (< 1 yr), *S. pneumoniae* (1-5 yr), and *S. aureus* (6-18 yr and > 18 yr). Eighteen key organism: antimicrobial agent combinations were evaluated for differences in antimicrobial susceptibility among the various age group categories. No significant differences were observed among the 4 age group categories for *E. coli* and ceftazidime (98 - 100% susceptible), cefepime (99 - 100%); *P. aeruginosa* and ceftazidime (83 - 90%); *Enterobacter* spp. and ceftazidime (72 - 78%) and cefepime (97 - 100%). Isolates causing BSI in patients < 1 yr were less susceptible than those isolated from patients >18yr for CoNS and oxacillin (19% susceptible vs. 28%) and *S. pneumoniae* and penicillin (74% vs. 84%). Isolates causing BSI in patients < 1 yr were more susceptible than those isolated from patients > 18 yr for *S. aureus* and oxacillin (80% susceptible vs. 70%); *Enterococcus* spp. and vancomycin (100% vs. 85%); *P. aeruginosa* and cefepime (94% vs. 88%) and imipenem (96% vs. 90%). These data demonstrate differences in the spectrum of pathogens and in antimicrobial resistance among the pediatric and adult age groups in North America. Antimicrobial resistance was especially pronounced among the Gram-positive pathogens. Ongoing surveillance remains essential and will enhance efforts to limit the extent of resistance among the various age groups.

Introduction

The past several years have seen the proliferation of antimicrobial resistance surveillance programs [1]. These programs have provided useful information regarding resistance trends and pathogen distribution among various countries and types of infections. Considerable attention has been given to blood stream infections (BSI) where reports concerning the potency and spectrum of new and established antimicrobial agents have focused on various pathogens, resistance trends over time and by country, and differences in the frequency of occurrence and susceptibility of nosocomial versus community-acquired pathogens and of intensive care unit (ICU) and non-ICU patients [2]. Thus far, none of the reports on BSI have provided information on the distribution of species and susceptibility profiles of BSI pathogens stratified according to the age of the patient.

The SENTRY Antimicrobial Surveillance Program has been active continuously since January 1997 and has reported antimicrobial susceptibility and pathogen data for more than 40,000 episodes of BSI in 72 medical centers representing 22 nations [1, 3]. Participating centers submit isolates representing consecutive episodes of BSI each month along with limited demographic data including age, sex, medical service and ICU stay. In the present report, we examine the frequency of pathogen occurrence and antimicrobial susceptibility profiles of key sentinel antimicrobial-organism combinations [4] as they occur in four different age groups: < 1 yr, 1-5 yr, 6-18 yr and > 18 yr. The BSI isolates include all those submitted to the central monitoring laboratory from North American SENTRY participants (30 US and 8 Canadian centers) during the four-year period from 1997-2000.

Materials and Methods

Study design: The SENTRY Antimicrobial Surveillance Program was established to monitor the prominent pathogens and antimicrobial resistance patterns of nosocomial and community-acquired infections via a broad network of sentinel hospitals distributed by geographic location and size. The monitored infections include bacteremia and fungemia (Objective A), outpatient respiratory infections (Objective B), pneumonia in hospitalized patients (Objective C), wound infections (Objective D), and urinary tract infections in hospitalized patients (Objective E). Participating North American institutions 1997-2000 included 30 medical centers in the US and 8 in Canada. Each participating center contributed results (organism identification, date of isolation, and antimicrobial susceptibility profile) for the first 20 consecutive episodes per month of each bacteremia. All isolates were saved on agar slants and sent to the University of Iowa College of Medicine (Iowa City) for storage and for further characterization by reference identification and susceptibility testing methods.

Identification of Organisms: All isolates were identified at the participating institution by the routine methodology in use at each laboratory. On receipt at the University of Iowa, isolates were subcultured to blood agar to ensure viability and purity. Confirmation of species identification was done by use of Vitek (bio Merieux Vitek, St. Louis, MO) or API (bio Merieux) products and standard reference methods (Isenberg, Handbook of Clinical Microbiology). Isolates were frozen at -70°C until processed.

Susceptibility testing: Antimicrobial susceptibility testing of isolates was done by reference broth microdilution methods as described by the National Committee for Clinical Laboratory Standards (NCCLS). Antimicrobial agents were obtained from their respective manufacturers. Quality control was done by testing *E. coli* ATCC (American Type Culture Collection) 25922, *Staphylococcus aureus* ATCC 29213, *Pseudomonas aeruginosa* ATCC 27853, *Streptococcus pneumoniae* ATCC 49619, and *Enterococcus faecalis* ATCC 29212. Interpretive criteria for each antimicrobial tested were those published by the NCCLS.

Results

Frequency of occurrence of blood stream pathogens: During the four-year study period (January 1997 to December 2000), a total of 25,745 BSI were reported by North American SENTRY participants. Table 1 compares the frequencies of occurrence of the 10 most commonly isolated pathogens during this time period. These 10 organism and groups accounted for 91% of all BSI reported from North American study sites from 1997-2000. Overall, the rank order of the top five pathogens was unchanged from year-to-year. These five organisms or organism groups (*S. aureus, E. coli,* coagulase-negative staphylococci [CoNS], *Enterococcus* spp., and *Klebsiella* spp.) accounted for 73% of all BSI.

Comparing the frequency of isolation of specific pathogens by age group (Table 2), we found a very similar rank order in the 6-18 yr and > 18 yr age groups with *S. aureus, E. coli,* and CoNS constituting the top three pathogens (56% of all BSI). In contrast, the rank order of pathogens in the < 1 yr and 1-5 yr age groups were both different from the two older age groups and from one another. In the youngest age group (< 1 yr), CoNS (Rank 1; 25.7%) and BHS (Rank 5; 7.1%) were more common than in the other age groups, whereas *P. aeruginosa* (Rank 9; 3.1%) and *S. pneumoniae* (Rank 8; 4.2%) were less common. In the 1-5 yr age group, *S. pneumoniae* was the most common BSI isolate (19.9%) and E.coli ranked only 5th (6.4%). Overall, more than 70% of BSI in patients ≤ 5 yrs were due to Gram-positive cocci versus 63% in patients older than 18 yrs.

Difference in susceptibility among age groups for selected antimicrobial-pathogen combinations: In order to assess differences in important antimicrobial resistances among age groups, we selected a number of sentinel antimicrobial -organism combinations (adapted from Archibald et al. [4]). A comparison among the four age groups was made for each of these antimicrobial -organism combinations (Table 3).

Results – Continued

No significant differences were observed among the four age group categories for *E. coli* and ceftazidime (98 - 100% susceptible), cefepime (99 - 100% susceptible) and ciprofloxacin (97 - 100% susceptible); *Klebsiella* spp. and ceftazidime (98 - 98% susceptible) and cefepime (96 - 100% susceptible); *P. aeruginosa* and ceftazidime (83 - 90% susceptible); *Enterobacter* spp. and ceftazidime (72 - 78% susceptible) and cefepime (97 - 100% susceptible); *S. pneumoniae* and levofloxacin (99 - 100% susceptible); and BHS and penicillin (92 - 100% susceptible). Isolates causing BSI in patients < 1 yr were less susceptible than those isolated from patients > 18 yr for CoNS and oxacillin (19% susceptible vs. 28%); *S. pneumoniae* and penicillin (74% vs. 84%); BHS and erythromycin (76% vs. 81%); and VGS and penicillin (50% vs. 72%). In contrast, isolates from patients < 1 yr were more susceptible than those from patients > 18 yr for *S. aureus* and oxacillin (80% vs. 71%) and *Enterococcus* spp. and vancomycin (100% vs. 85%).

Isolates from patients in the 1-5 yr age group were considerably less susceptible than those from patients > 18 yr for VGS and penicillin (36% vs. 72%) and *P. aeruginosa* and imipenem (83% vs 90%).

Overall Rank	Pathogen	No. infections (%)				
		All ages	< 1 yr	1-5 yr	6-18 yr	> 18 yr
1	*S. aureus*	6504 (25.3)[a]	223 (14.3)[b]	89 (14.0)[c]	229 (28.4)[d]	5963 (26.2)[e]
2	*E. coli*	4465 (17.3)	193 (12.4)	41 (6.4)	100 (12.4)	4131 (18.2)
3	CoNS	3250 (12.6)	400 (25.7)	99 (15.5)	122 (15.1)	2629 (11.6)
4	*Enterococcus* spp.	2626 (10.2)	167 (10.7)	62 (9.7)	47 (5.8)	2347 (10.3)
5	*Klebsiella* spp.	1907 (7.4)	94 (6.0)	39 (6.1)	46 (5.7)	1728 (7.6)
6	*S. pneumoniae*	1271 (4.9)	66 (4.2)	127 (19.9)	45 (5.6)	1033 (4.5)
7	*P. aeruginosa*	1112 (4.3)	48 (3.1)	29 (4.6)	40 (5.0)	995 (4.4)
8	β-haem. streptococci	922 (3.6)	110 (7.1)	17 (2.7)	18 (2.2)	777 (3.4)
9	*Enterobacter* spp.	917 (3.5)	90 (5.8)	31 (4.9)	40 (5.0)	756 (3.3)
10	Viridans gr. strept	445 (1.7)	22 (1.4)	24 (4.4)	19 (2.4)	376 (1.7)

a. Percent of 25,745 isolates   c. Percent of 637 isolates   e. Percent of 22,743 isolates
b. Percent of 1,558 isolates   d. Percent of 807 isolates

Pathogen	Rank order by age (no. isolates)			
	All ages (25,745)	< 1 yr (1,558)	1-5 yr (637)	6-18 yr (807)	> 18 yr (22,743)
S. aureus	1	2	3	1	1
E. coli	2	3	5	3	2
CoNS	3	1	2	2	3
Enterococcus spp.	4	4	4	4	4
Klebsiella spp.	5	6	6	5	5
S. pneumoniae	6	8	1	6	6
P. aeruginosa	7	9	8	7	7
b-haem. strept .	8	5	10	10	8
Enterobacter spp .	9	7	7	8	9
Viridans gr. strept.	10	10	9	9	10

Organisms[a]	Antimicrobial Agent	% Susceptible (no. tested)			
		< 1 yr	1-5 yr	6-18 yr	> 18 yr
S. aureus	Oxacillin	80 (223)	85 (89)	87 (229)	71 (5963)
CoNS	Oxacillin	19 (400)	23 (99)	25 (122)	28 (2627)
Enterococcus spp.	Vancomycin	100 (167)	90 (62)	87 (47)	85 (2349)
S. pneumoniae	Penicillin	74 (66)	73 (127)	80 (45)	84 (1033)
	Levofloxacin	100 (52)	100 (93)	100 (36)	99 (745)
BHS	Penicillin	92 (110)	100 (17)	94 (18)	95 (777)
	Erythromycin	76 (110)	88 (17)	100 (18)	81 (777)
VGS	Penicillin	50 (22)	36 (28)	53 (19)	72 (376)
E. coli	Ceftazidime	100 (193)	98 (41)	98 (100)	99 (4127)
	Cefepime	100 (193)	100 (41)	100 (100)	99 (4126)
	Ciprofloxacin	99 (192)	100 (41)	98 (100)	97 (4126)
Klebsiella spp.	Ceftazidime	98 (94)	95 (39)	89 (46)	99 (1727)
	Cefepime	100 (94)	97 (39)	96 (46)	99 (1727)
P. aeruginosa	Ceftazidime	83 (48)	90 (29)	83 (40)	88 (995)
	Cefepime	94 (48)	97 (29)	83 (40)	88 (995)
	Imipenem	96 (48)	83 (29)	93 (40)	90 (995)
Enterobacter spp.	Ceftazidime	72 (90)	74 (31)	75 (40)	78 (756)
	Cefepime	100 (90)	97 (31)	98 (40)	99 (756)

a. Abbreviations: CoNS, coagulase -negative staphylococci; BHS, β-haemolytic streptococci; VGS, viridansgroup streptococci.

Summary and Conclusions

- Antimicrobial resistance surveillance programs provide important information, both for the development of empiric antimicrobial therapy recommendations and for design of programs to control antimicrobial resistance.
- The present study demonstrates differences in the spectrum of pathogens and in antimicrobial resistance among the pediatric and adult age groups in North America.
- Most common BSI pathogens
  - < 1 yr: CoNS (25.7%)
  - 1-5 yr: *S. pneumoniae* (19.9%)
  - 6-18 yr: *S. aureus* (28.4%)
  - > 18 yr: *S. aureus* (26.2%)
- Antimicrobial resistance was most pronounced among the Gram-positive pathogens.
- Ongoing surveillance is essential and will enhance efforts to limit the extent of resistance among the various age groups.

Selected References

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