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# Bacterial Pathogens Isolated from Patients with Blood Stream Infection: 5-Year Occurrence and Antimicrobial Susceptibility Patterns from the SENTRY Antimicrobial Surveillance Program in Latin America

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## ABSTRACT

**Background:** Occurrence and antimicrobial susceptibility (S) patterns of nosocomial bacteria vary significantly according to geographic region. **Methods:** A total of 9,059 strains from blood stream infections (BSI) collected in 14 Latin America (LA) centers (7 nations) from January 1997 to December 2001. The isolates were tested by NCCLS broth microdilution methods. **Results:** The 8 most frequently isolated species were (n/%): *S. aureus* (SA – 1,921/21.2%), *E. coli* (1,620/17.9%), coagulase-negative staphylococci (CNS - 1,221/13.5%), *Klebsiella* spp. (KSP - 840/9.3%), *P. aeruginosa* (PSA - 589/6.5%), *Enterobacter* spp. (517/5.7%), *Acinetobacter* spp. (ASP - 381/4.2%), and *Enterococcus* spp. (280/3.1%). S to oxacillin was 68.5% for SA and only 23.8% for CNS. Vancomycin and linezolid were active against 100% of staphylococci. Gatifloxacin inhibited 90.4% of SA (70.3% for ciprofloxacin) and 94.6% of CNS. Enterococci showed high S rates to ampicillin (91.8%) and vancomycin (97.4%). The prevalence of ESBL-producing *E. coli* and KSP remained very high in the region during the period evaluated. In general, 6.4% of *E. coli* and 45.0% of KSP showed an ESBL phenotype with high rates of cross-resistance (R) to other compounds. The most active antimicrobials against PSA were (MIC50 in µg/mL / % S): meropenem (MER - 0.5 / 84.6), imipenem (1 / 83.4), piperacillin/tazobactam (P/T - 8 / 78.9), amikacin (4 / 75.4) and cefepime (4 / 71.0%). A trend toward increasing R (p<0.05) to ceftazidime, P/T and MER during this 5-year period was detected. Only the carbapenems showed reasonable activity against ASP (89.5% S to MER). **Conclusion:** The main R problems in LA have been the emergence of multi-drug resistant Gram-negative bacilli, especially carbapenem-R PSA and ESBL-producing Enterobacteriaceae. Surveillance remains essential to monitor regional interventions.

## INTRODUCTION

The interactions of extremely ill patients, modern medical technology and heavy antimicrobial use have increased the frequency of serious infections and antimicrobial resistance among many nosocomial pathogens. Nosocomial bloodstream infection (BSI) is one of the most common nosocomial infections. Many BSIs are related to the use of intravascular devices and the prudent use of such devices usually minimizes these infections. However, in the United States (USA) nosocomial BSI causes as many as 3.5 million additional hospital day stays per year, accounting for 3.5 billion dollars in costs. In addition, the mortality rate directly attributable to the BSIs varies from 14% to as high as 38%.

The SENTRY Antimicrobial Surveillance Program is a longitudinal surveillance program designed to monitor antimicrobial resistance worldwide. Frequent reports have been generated to guide empiric therapy in the local environment. In addition, multiresistant strains and other pathogens of interest are being evaluated by molecular typing techniques to provide microbiologists and physicians critical information for managing control of intra- and inter-hospital dissemination of resistant pathogens.

This report focuses on the antimicrobial susceptibility of BSI isolates in the Latin American participant centers.

## MATERIALS AND METHODS

Participant Institutions. Ten Latin American laboratories participated in the study each year. The laboratories were distributed throughout six countries: São Paulo, Rio de Janeiro, Florianopolis, Porto Alegre, and Brasilia, Brazil; Buenos Aires and San Isidro, Argentina; Santiago (two centers), Chile; Medellin, Colombia; Mexico City, Mexico; and Montevideo, Uruguay. In 1998, the center located in Montevideo was replaced by a center in Caracas, Venezuela; and in 1999 the Brazilian center located in Rio de Janeiro was replaced by a center in Porto Alegre, which is also located in the South region of Brazil. Finally, the center located in Medellin was replaced by a center in Brasilia, Brazil, in 2001. The selection of participant centers was based on the principle that they should be sentinel in their respective geographic region.

Bacterial Isolates. A total of 9,059 bacterial isolates were analyzed in this study. Each participant laboratory contributed 20 consecutive bacterial isolates per month. They were collected consecutively from blood cultures in the period of January 1997 through December 2001. All isolates were from hospitalized patients and only one isolate per patient was included. The isolates were identified by the routine methodology used at each laboratory. Upon receipt at the coordinator center, isolates were subcultured onto blood agar to ensure viability and purity. Confirmation of species identification was performed with Vitek (bioMerieux Vitek, Saint Louis, MO) or conventional methods, as required.

Antimicrobial Susceptibility Testing. Antimicrobial susceptibility testing was performed using the reference broth microdilution method as described by the National Committee for Clinical Laboratory Standards [NCCLS 2002]. Antimicrobial agents were obtained from the respective manufacturers. Quality control was performed by testing *Escherichia coli* ATCC 25922 and 35218, *Staphylococcus aureus* ATCC 29213, *Pseudomonas aeruginosa* ATCC 27853, *Enterococcus faecalis* ATCC 29212, *Haemophilus influenzae* ATCC 49247 and 49766, and *Streptococcus pneumoniae* ATCC 49619.

*Klebsiella pneumoniae* and *E. coli* isolates with increased MICs (≥ 2 µg/mL) for ceftazidime and/or ceftriaxone and/or aztreonam were considered as extended-spectrum beta-lactamase (ESBL) producing phenotypes according to NCCLS criteria [NCCLS 2002]. The ESBL phenotype was confirmed by using the ESBL Etest strips™ (AB BIODISK, Solna, Sweden), which evaluates the variation of the ceftazidime MIC when clavulanic acid is added at 2 µg/mL. A decrease in the ceftazidime MIC of ≥3 log2 dilutions in the presence of clavulanate was considered a positive test for an ESBL enzyme [Cormican et al., 1996]. Comparisons of antimicrobial resistance rates were evaluated by chi-square test for trend.

## RESULTS

- The 12 most frequent pathogens account for more than 90% of the infections evaluated (Table 1). In contrast to the data published for the North American participant centers [Diekema et al., 1999], the Gram-negative bacilli represented the majority of isolates causing BSI in the Latin American centers with approximately 55% of the infections evaluated.

- Cefepime and ceftriaxone were as active as cefazolin against staphylococci; however, ceftazidime (56.4% susceptibility) was less active than those cephalosporins against *S. aureus* (Table 2).

- The novel des-fluoro(6) quinolone garenoxacin (formerly BMS-284756) and gatifloxacin showed higher activities than either levofloxacin or ciprofloxacin against Gram-positive cocci, especially against *S. aureus* (Table 2).

- Among 352 *S. pneumoniae* recovered from BSI in the Latin American medical centers, 72.7% were susceptible to penicillin (MICs, ≤ 0.06 µg/mL), 18.3% showed intermediate-resistance (MICs, 0.12-1 µg/mL), and 10.0% showed high-level resistance to this compound (MICs, ≥ 2 µg/mL). On the other hand, resistance to amoxicillin ($MIC_{90}$, 1 µg/mL; 99.7% susceptibility and 0.0% resistance) was not detected (Table 3). The discrepancy between penicillin and amoxicillin resistance rates is due to differences in the breakpoints, since both compounds have similar potency against pneumococci [NCCLS 2002].

**Table 1.** Occurrence of the 25 major pathogens isolated from blood stream infections in Latin America Hospitals (SENTRY Program, 1997 to 2001).

| Organisms in rank order | No. of organisms | % of occurrence |
|---|---|---|
| 1. *S. aureus* | 1,921 | 21.2 |
| 2. *Escherichia coli* | 1,620 | 17.9 |
| 3. CoNS | 1,221 | 13.5 |
| 4. *Klebsiella pneumoniae* | 840 | 9.3 |
| 5. *Pseudomonas aeruginosa* | 589 | 6.5 |
| 6. *Enterobacter spp.* | 517 | 5.7 |
| 7. *Acinetobacter spp.* | 380 | 4.2 |
| 8. *Streptococcus pneumoniae* | 352 | 3.9 |
| 9. *Enterococcus spp.* | 280 | 3.1 |
| 10. *Salmonella* spp. | 179 | 2.0 |
| 11. *Serratia* spp. | 157 | 1.7 |
| 12. Group B Streptococcus | 102 | 1.1 |
| 13. *Klebsiella oxytoca* | 95 | 1.0 |
| 14. *Proteus* spp. | 92 | 1.0 |
| 15. *Stenotrophomonas matophilia* | 86 | 0.9 |
| 16. Group A *Streptococcus* | 65 | 0.7 |
| 17. *Citrobacter* spp. | 50 | 0.6 |
| 18. Viridans group *Streptococcus* | 45 | 0.5 |
| 19. Burkholderia cepacia | 43 | 0.5 |
| 20. *Morganella morganni* | 32 | 0.4 |
| 21. *Pantoea agglomerans* | 31 | 0.3 |
| 22. *Streptococcus bovis* | 28 | 0.3 |
| 23. *Neisseria meningitidis* | 27 | 0.3 |
| 24. *Haemophilus influenzae* | 26 | 0.3 |
| 25. *Pseudomonas* spp. | 19 | 0.2 |

**Table 2.** Antimicrobial activity and spectrum of drugs tested against the most prevalent Gram-positive pathogens causing blood stream infections in Latin America (SENTRY Program 1997 to 2001).

| Antimicrobial class/agent | Pathogen (prevalence rank/ no. tested) *S. aureus* (1/1921) $MIC_{50/90}$ | % Susc. | CoNS (3/1221) $MIC_{50/90}$ | % Susc. | *Enterococcus* spp. (8/280) $MIC_{50/90}$ | % Susc. |
|---|---|---|---|---|---|---|
| Cephalosporins | | | | | | |
| Cefazolin | ≤2/>16 | 68.5[a] | ≤2/>16 | 23.8[a] | >16/>16 | --- |
| Ceftriaxone | 4/>32 | 68.5[a] | 16/>32 | 23.8[a] | >32/>32 | --- |
| Cefepime | 4/>16 | 68.5[a] | 4/>16 | 23.8[a] | >16/>16 | --- |
| Ceftazidime | 8/>16 | 57.3 | >16/>16 | 23.8[a] | >16/>16 | --- |
| Other ß-lactams | | | | | | |
| Oxacillin | 0.5/>8 | 68.5 | 8/>8 | 23.8 | >8/>8 | --- |
| Ampicillin | 16/>16 | 7.0 | 8/>16 | 11.5 | ≤2/8 | 91.8 |
| Penicillin | 16/>32 | 8.5 | 8/>32 | 9.3 | 2/16 | 84.6 |
| Amoxicillin/Clavulanate | ≤2/>16 | 68.5[a] | ≤2/>16 | 23.8[a] | ≤2/4 | 84.6[b] |
| Piperacillin/Tazobactam | 2/>64 | 68.5[a] | 2/64 | 23.8[a] | 4/>64 | 84.6[b] |
| Imipenem | ≤0.06/>8 | 68.5[a] | 0.5/>8 | 23.8[a] | 2/8 | --- |
| $MLS_B$ | | | | | | |
| Clindamycin | 0.25/>8 | 72.0 | 0.25/>8 | 55.8 | >8/>8 | --- |
| Erythromycin | 0.5/>8 | 54.6 | >8/>8 | 36.0 | 8/>8 | 9.3 |
| Quinupristin/Dalfopristin | 0.25/0.5 | 99.6 | 0.25/0.5 | 98.6 | 4/>8 | 12.1 |
| Fluoroquinolones | | | | | | |
| Garenoxacin | 0.03/1 | | 0.06/2 | | 0.25/4 | |
| Gatifloxacin | 0.12/2 | 90.7 | 0.12/2 | 94.6 | 0.5/>4 | 72.1 |
| Levofloxacin | 0.25/4 | 72.9 | 0.25/>4 | 66.2 | 1/>4 | 67.2 |
| Ciprofloxacin | 0.5/>2 | 70.3 | 0.5/>2 | 58.0 | 2/>2 | 48.2 |
| Others | | | | | | |
| Gentamicin | ≤1/>16 | 67.4 | 8/>16 | 44.8 | >8/>16 | --- |
| Gentamicin (HL)[c] | --- | --- | --- | --- | ≤500/>1000 | 73.9 |
| Streptomycin (HL)[c] | --- | --- | --- | --- | ≤1000/>2000 | 88.2 |
| Rifampin | ≤0.25/2 | 80.4 | ≤0.25/>2 | 72.5 | >2/>2 | 25.4 |
| Chloramphenicol | 8/>16 | 68.0 | 8/>16 | 62.2 | 8/>16 | 66.4 |
| Tetracycline | ≤4/>8 | 75.0 | ≤4/>8 | 77.1 | >8/>8 | 36.1 |
| Doxycycline | ≤0.5/>4 | 87.0 | 1/>4 | 87.7 | >4/>4 | 47.5 |
| Trimethoprim/Sulfamethoxazole | ≤0.5/>1 | 79.4 | 0.5/>2 | 51.1 | ≤0.5/>1 | --- |
| Vancomycin | 1/1 | 100.0 | 2/2 | 100.0 | 1/2 | 97.4 |
| Teicoplanin | 1/2 | 99.5 | 2/8 | 90.6 | 0.25/0.5 | 97.5 |
| Linezolid | 2/4 | 100.0 | 1/2 | 100.0 | 2/2 | 96.1 |

a. Susceptibility is predicted by the oxacillin result.
b. Susceptibility is predicted by the penicillin result.
c. HL – High level aminoglycoside resistence screen.

## RESULTS

- Decreased susceptibility to fluoroquinolones was extremely rare among pneumococci in the present study. In addition, garenoxacin ($MIC_{90}$, 0.06 µg/mL) was 16-fold more potent than levofloxacin ($MIC_{90}$, 1 µg/mL) and 8-fold more potent than gatifloxacin ($MIC_{90}$, 0.5 µg/mL) against this pathogen (Table 3).

- The percentage of *E. coli* and *K. pneumoniae* producing ESBLs was much higher than those reported in other regions evaluated by the SENTRY Program. Utilizing the screening concentrations recommended by the NCCLS, 6.4% of *E. coli* and 45.0% of *K. pneumoniae* met these criteria (Table 4).

- *Pseudomonas aeruginosa* was the third most common Gram-negative pathogen (5th overall) with 589 isolates evaluated. This pathogen showed extremely high rates of resistance to the majority of the antimicrobial agents tested. The spectrum rank order of the antimicrobial agents against *P. aeruginosa* in terms of percentage of susceptibility was: meropenem (84.6%) > imipenem (83.4%) > piperacillin/tazobactam (78.9%) > amikacin (75.4%) > cefepime (71.0%) > ceftazidime (69.1%)(Table 4).

**Table 3.** The antimicrobial activity of selected parenteral and orally administered drugs tested against *S. pneumoniae* isolated from blood stream infections in Latin American participant centers (SENTRY Program, 1997 to 2001).

| Antimicrobial agents (no. tested) | $MIC_{50}$ (µg/mL) | $MIC_{90}$ (µg/mL) | % susceptible[a] | % resistant |
|---|---|---|---|---|
| Penicillin (352) | 0.03 | 1 | 72.7 | 10.0 |
| Amoxicillin/Clavulanate (350) | ≤0.06 | 1 | 99.7 | 0.0 |
| Ceftriaxone[b] (263) | ≤0.25 | 1 | 98.6 | 0.0 |
| Cefepime (352) | 0.12 | 1 | 97.7 | 0.3 |
| Erythromycin (352) | ≤0.06 | 1 | 88.1 | 10.8 |
| Clindamycin (352) | ≤0.06 | 0.12 | 96.0 | 3.7 |
| Garenoxacin (263) | ≤0.06 | 0.06 | 100.0 | 0.0 |
| Gatifloxacin (352) | 0.25 | 0.5 | 99.7 | 0.3 |
| Levofloxacin (228) | 1 | 1 | 100.0 | 0.0 |
| Ciprofloxacin (352) | 1 | 2 | -- | -- |
| Chloramphenicol (351) | ≤2 | 4 | 98.3 | 1.7 |
| Tetracycline (352) | ≤4 | >8 | 80.4 | 19.6 |
| Trimethoprim/sulfamethoxazol(347) | ≤0.5 | >2 | 64.3 | 21.3 |
| Quinopristin/dalfopristin (352) | 0.5 | 0.5 | 100.0 | 0.0 |
| Vancomycin (352) | 0.25 | 0.5 | 100.0 | 0.0 |

a. Interpreted by NCCLS [2002] criteria, where available. Criteria for susceptibility of garenoxacin was defined as ≤ 2µg/mL [Fung-Tomc et al., 2000].
b. Also indicates spectrum of cefotaxime.

**Table 4.** Antimicrobial activity and spectrum of drugs tested against the five most prevalent gram-negative pathogens causing blood stream infections in Latin America (SENTRY Program, 1997- 2001).

| Antimicrobial class/agent | Pathogen (prevalence rank/ no. tested) *E. coli* (2/1620) $MIC_{50/90}$ | % Susc. | *K. pneumoniae* (4/840) $MIC_{50/90}$ | % Susc | *P. aeruginosa* (5/589) $MIC_{50/90}$ | % Susc | *Enterobacter* spp. (6/517) $MIC_{50/90}$ | % Susc | *Acinetobacter* spp. (7/381) $MIC_{50/90}$ | % Susc |
|---|---|---|---|---|---|---|---|---|---|---|
| Cephalosporins | | | | | | | | | | |
| Cefazolin | ≤2/>16 | 83.8 | >16/>16 | 47.5 | >16/>16 | --- | >16/>16 | 5.2 | >16/>16 | --- |
| Cefuroxime | 4/16 | 88.5 | 8/>16 | 52.7 | >16/>16 | --- | >16/>16 | 37.7 | >16/>16 | --- |
| Cefoxitin | 4/8 | 93.4 | 4/16 | 84.7 | >32/>32 | --- | >32/>32 | 0.9 | >32/>32 | --- |
| Ceftriaxone | ≤0.25/≤0.25 | 94.7 (6.1)[a] | ≤0.25/>32 | 60.7 (45.0)[b] | >32/>32 | 5.1 | ≤0.25/>32 | 67.1 | >32/>32 | 21.5 |
| Ceftazidime | 0.25/≤2 | 95.7 (6.4)[a] | ≤2/>16 | 65.2 (45.0)[b] | 4/>16 | 69.1 | 1/>16 | 66.9 | >16/>16 | 40.2 |
| Cefepime | ≤0.12/0.25 | 97.2 | 0.25/>16 | 75.7 | 4/>16 | 71.0 | ≤0.12/8 | 90.3 | 16/>16 | 46.2 |
| Other ß-lactams | | | | | | | | | | |
| Ampicillin | >16/>16 | 39.8 | >16/>16 | 3.7 | >16/>16 | --- | >16/>16 | 5.4 | >16/>16 | --- |
| Aztreonam | ≤0.12/0.25 | 94.9 (6.2)[a] | 0.25/>16 | 60.2 (44.0)[b] | 8/>16 | 51.3 | 0.25/>16 | 67.1 | >16/>16 | 12.1 |
| Ticarcillin/ Clavulanate | 8/128 | 66.7 | 32/>128 | 48.9 | 64/>128 | 62.8 | 8/>128 | 55.3 | 64/>128 | 35.7 |
| Piperacillin/ Tazobactam | 2/8 | 92.5 | 4/>64 | 65.4 | 8/>64 | 78.9 | 4/>64 | 67.9 | 64/>64 | 37.8 |
| Imipenem | 0.12/0.25 | 100.0 | 0.12/0.5 | 99.9 | 1/>8 | 83.4 | 0.5/1 | 99.8 | 0.5/8 | 89.0 |
| Meropenem | ≤0.06/≤0.06 | 100.0 | ≤0.06/0.12 | 99.8 | 0.5/>8 | 84.6 | ≤0.06/0.25 | 99.8 | 1/8 | 89.5 |
| Aminoglycosides | | | | | | | | | | |
| Amikacin | 2/8 | 97.0 | 2/32 | 78.6 | 4/>32 | 75.4 | 2/>32 | 82.6 | 32/>32 | 43.3 |
| Gentamicin | ≤1/4 | 90.4 | 1/>16 | 62.5 | 2/16 | 65.5 | ≤1/>8 | 74.5 | 8/>16 | 44.4 |
| Tobramycin | 1/8 | 88.7 | 4/>16 | 50.6 | 1/>16 | 64.8 | 1/>16 | 63.8 | 4/>16 | 52.5 |
| Fluoroquinolones | | | | | | | | | | |
| Ciprofloxacin | 0.06/>2 | 85.5 | ≤0.25/2 | 88.1 | 0.25/>2 | 66.2 | ≤0.25/>2 | 83.2 | >2/>2 | 43.0 |
| Garenoxacin | 0.03/>4 | --- | 0.12/4 | --- | 2/>4 | --- | 0.12/>4 | --- | 4/.4 | --- |
| Gatifloxacin | ≤0.03/>4 | 86.2 | 0.06/2 | 91.2 | 1/>4 | 63.7 | 0.06/4 | 85.3 | 4/>4 | 45.7 |
| Levofloxacin | 0.25/>4 | 86.1 | 0.25/2 | 90.1 | 1/>4 | 65.7 | ≤0.5/>4 | 84.5 | 4/>4 | 45.1 |
| Others | | | | | | | | | | |
| Tetracycline | ≤4/>8 | 53.7 | ≤4/>8 | 65.3 | >8/>8 | 1.5 | ≤4/>8 | 68.3 | ≤4/>8 | 60.0 |
| Trimethoprim/ sulfanethoxazole | --- | 50.9 | --- | 66.1 | --- | 2.2 | --- | 70.7 | --- | 42.5 |

- *Acinetobacter* spp. was the fifth most frequent Gram-negative genus (7th overall) isolated in general (4.2% of the isolates). Only the carbapenems showed reasonable activity against this pathogen, with around 90% susceptibility ($MIC_{90}$, 8 µg/mL for both imipenem and meropenem; Table 4).

**Table 5.** Antimicrobial activity and spectrum of drugs tested against *E. coli* and *K. pneumoniae* according to the ESBL phenotype.

| Antimicrobial class/agent | *E. coli* (no.=1,620) Non-ESBL (no.=1,496) $MIC_{50/90}$ | % Susc. | ESBL (no.=124) $MIC_{50/90}$ | % Susc. | *Klebsiella* spp. (no.=840) Non-ESBL (no.=436) $MIC_{50/90}$ | % Susc. | ESBL (no.=404) $MIC_{50/90}$ | % Susc. |
|---|---|---|---|---|---|---|---|---|
| Cephalosporins | | | | | | | | |
| Cefuroxime | 4/8 | 94.9 | >16/>16 | 12.1 | 2/8 | 94.3 | >16/>16 | 7.9 |
| Cefoxitin | 4/8 | 95.1 | 8/>32 | 60.5 | 2/8 | 93.3 | 4/32 | 75.2 |
| Ceftriaxone | ≤0.25/≤0.25 | 100.0 | 32/>32 | 30.6 | ≤0.25/≤0.25 | 100.0 | >32/>32 | 18.3 |
| Ceftazidime | 0.25/>2 | 100.0 | 16/>16 | 44.4 | 0.25/>2 | 100.0 | >16/>16 | 27.7 |
| Cefepime | ≤0.12/≤0.12 | 100.0 | 4/>16 | 63.7 | ≤0.12/≤0.12 | 99.8 | 16/>16 | 49.5 |
| Other ß-lactams | | | | | | | | |
| Aztreonam | ≤0.12/0.25 | 100.0 | >16/>16 | 33.9 | ≤0.12/≤0.12 | 100.0 | >16/>16 | 17.3 |
| Ticarcillin | >128/>128 | 43.7 | >128/>128 | 2.4 | 128/>128 | 4.8 | >128/>128 | 0.5 |
| Ticarcillin/Clavulanate | 8/64 | 71.1 | 128/>128 | 14.5 | 4/32 | 87.8 | >128/>128 | 6.9 |
| Piperacilin | 64/>128 | 46.2 | >128/>128 | 5.6 | 8/>128 | 81.4 | >128/>128 | 1.0 |
| Piperacillin/Tazobactam | 2/4 | 95.7 | 16/>64 | 54.0 | 2/8 | 94.0 | >64/>64 | 34.4 |
| Imipenem | 0.12/0.25 | 100.0 | 0.12/0.5 | 100.0 | 0.12/0.5 | 100.0 | 0.25/0.5 | 99.8 |
| Meropenem | ≤0.06/≤0.06 | 100.0 | ≤0.06/0.12 | 100.0 | ≤0.06/≤0.06 | 100.0 | ≤0.06/0.25 | 99.5 |
| Aminoglycosides | | | | | | | | |
| Amikacin | 2/4 | 99.3 | 8/>32 | 70.2 | 1/2 | 96.6 | 16/>32 | 59.2 |
| Gentamicin | 1/2 | 94.3 | 8/>16 | 44.4 | 1/2 | 92.9 | >16/>16 | 29.7 |
| Tobramycin | 1/4 | 94.2 | >16/>16 | 28.3 | 0.5/2 | 91.1 | >16/>16 | 12.0 |
| Fluoroquinolones | | | | | | | | |
| Ciprofloxacin | 0.03/2 | 88.2 | 0.25/4 | 53.2 | 0.03/0.25 | 96.1 | 0.25/4 | 79.5 |
| Gatifloxacin | 0.03/4 | 88.6 | 0.5/>4 | 58.1 | 0.06/0.25 | 97.0 | 0.12/>4 | 84.9 |
| Levofloxacin | 0.03/4 | 88.5 | 0.5/>4 | 57.3 | 0.03/0.5 | 96.6 | 0.5/>4 | 83.2 |
| Others | | | | | | | | |
| Trimethoprim/ Sulfathoxazole | ≤0.5/>2 | 53.0 | >1/>1 | 25.8 | ≤0.5/>1 | 85.9 | >1/>1 | 44.4 |
| Polymyxin B | ≤1/≤1 | 98.6 | ≤1/≤1 | 100.0 | ≤1/≤1 | 97.2 | ≤1/2 | 92.8 |

**Table 6.** Susceptibility rates of *Pseudomonas aeruginosa* causing blood stream infections in Latin America to selected antimicrobial agents according to the year of isolation - SENTRY Program, 1997- 2001.

| Antimicrobial class/agent | 1997 (n=92) | 1998 (no.=154) | 1999 (no.=119) | 2000 (no.=105) | 2001 (no.=119) | *p* value[a] |
|---|---|---|---|---|---|---|
| Cephalosporins | | | | | | |
| Ceftazidime | 71.7 | 70.1 | 68.1 | 67.6 | 68.1 | 0.03 |
| Cefepime | 72.8 | 74.7 | 71.4 | 68.6 | 66.4 | <0.001 |
| Other ß-lactams | | | | | | |
| Aztreonam | 65.2 | 53.2 | 47.9 | 43.8 | 47.9 | <0.001 |
| Ticarcillin | 75.0 | 60.4 | 59.7 | 58.1 | 58.8 | <0.001 |
| Ticarcillin/clavulanate | 72.8 | 62.3 | 63.0 | 58.1 | 59.7 | <0.001 |
| Piperacillin | 80.4 | 70.1 | 70.6 | 69.5 | 74.8 | 0.01 |
| Piperacillin/tazobactam | 85.9 | 81.2 | 73.9 | 74.3 | 79.8 | 0.16 |
| Imipenem | 84.8 | 85.7 | 83.2 | 83.8 | 79.0 | 0.17 |
| Meropenem | 94.6 | 85.7 | 80.7 | 82.9 | 80.7 | 0.009 |
| Aminoglycosides | | | | | | |
| Amikacin | 83.7 | 74.7 | 73.1 | 73.3 | 73.9 | 0.16 |
| Fluoroquinolones | | | | | | |
| Ciprofloxacin | 73.9 | 63.6 | 69.7 | 65.7 | 60.5 | 0.12 |
| Gatifloxacin | 71.7 | 61.7 | 65.5 | 65.7 | 56.3 | 0.08 |
| Levofloxacin | 73.9 | 63.0 | 68.1 | 65.7 | 60.5 | 0.14 |

a Chi-square for trend test.

## CONCLUSIONS

- Resistance rates to most antimicrobial agents evaluated were much higher among ESBL-producing *E. coli* and *K. pneumoniae* when compared to non-ESBL-producing strains of the same species. Only the carbapenems showed reasonable in vitro activity against ESBL-producing strains. The second most active class of compounds against ESBL-producing *K. pneumoniae* was the fluoroquinolones (84.9% susceptibility to gatifloxacin), while amikacin was the most active compound against ESBL-producing *E. coli* (70.2% susceptibility) after the carbapenems (Table 5).

- Multidrug-resistant *P. aeruginosa* represent the most worrisome antimicrobial resistance problem in the region, and resistance rates continue to increase for several antimicrobial agents (Table 6). Susceptibility rates decreased during the period evaluated for most antimicrobial agents, with a significant drop in activity for aztreonam, cefepime, ceftazidime, ticarcillin, ticarcillin/clavulanate, piperacillin, and meropenem.