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Antimicrobial resistance among hospitals in Puerto Rico: results of the Antimicrobial Resistance Management (ARM) Program

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ABSTRACT

PURPOSE: The Antimicrobial Resistance Management Program was established in 1997 as an ongoing project to document trends in antimicrobial susceptibility patterns in inpatient/outpatient isolates and track resistance that may occur with specific antibiotic use.

METHODS: Institutions provide at least 3 years of antibiogram data. Between 1996-2003, data on 328,837 isolates were collected from 11 hospitals throughout Puerto Rico (PR), as were aggregate data on 5,388,897 isolates from 46 institutions in Florida (FL) and 24,951,098 isolates from 358 US institutions for comparative purposes. Organisms reviewed for antibiotic susceptibility (no. of antibiotics tested against) were *Enterococcus faecalis* (7), *Enterococcus faecium* (5), *Enterococcus spp* (4), *Escherichia coli* (24), *Klebsiella pneumoniae* (24), *Proteus mirabilis* (22), *Pseudomonas aeruginosa* (14), *Serratia marcescens* (22), *Staphylococcus aureus* (23), and *Streptococcus pneumoniae* (9).

RESULTS: Vancomycin-resistant *Enterococci* levels were significantly less in PR (23.2%) vs FL (50.7%) or US (56%). For *E coli*, ampicillin resistance was 48% in PR, higher than FL (42%) or US (38%). *E coli* isolates were also more resistant to fluoroquinolones (eg, ciprofloxacin 16.9% in PR, 9% FL, 6.7% US). Similar resistance rates were observed for *K pneumoniae* for the fluoroquinolones. *P mirabilis* resistance to a wide spectrum of antibiotics was significantly less in PR than in FL/US. *P aeruginosa* susceptibilities to gentamicin are suppressed compared with tobramycin or amikacin, consistent with FL/US. Activity from *S marcescens* was suppressed against all antibiotics tested compared with FL/US. Higher MRSA levels and *S aureus* vancomycin resistance was observed in PR. Differences in *S pneumoniae* susceptibility to cefotaxime (71.4%) vs ceftriaxone (100%) was consistent with that previously reported in FL/US.

CONCLUSIONS: This broad analysis represents the first summary of antimicrobial resistance among hospitals in Puerto Rico from 1996-2003. The analysis provides important baseline data for sentinel surveillance programs and in determining strategies for intervention.

PURPOSE

- The Antimicrobial Resistance Management (ARM) Program was established at the University of Florida in 1997 to document trends in antimicrobial susceptibility patterns in inpatient/outpatient isolates using an antibiogram-based surveillance system
- The ARM Program can track resistance that may occur with specific antibiotic use

METHODS

- Institutions are enrolled in the ARM Program at no charge
- Each institution provides a minimum of 3 years of antimicrobial susceptibility data in a HIPAA-compliant non-identifying format
- To date, the ARM Program has enrolled 358 institutions
- The national aggregate database includes 28.3 million isolates, categorized by 48 antibiotics and 19 organisms
- Between 1996-2003, data on 328,837 isolates were collected from 11 hospitals throughout Puerto Rico
- For comparative purposes, data were also collected on:
  - 5,388,897 isolates from 46 institutions in Florida
  - 24,951,098 isolates from 358 US institutions
- The 10 organisms reviewed for susceptibility to commonly prescribed antibiotics are summarized in Table 1

Table 1. Organisms and Antibiotics Tested Against from Hospitals in Puerto Rico, 1996-2003

Antibiotic	*Enterococcus faecalis*	*Enterococcus faecium*	*Enterococcus spp*	*Escherichia coli*	*Klebsiella pneumoniae*	*Proteus mirabilis*	*Pseudomonas aeruginosa*	*Serratia marcescens*	*Staphylococcus aureus*	*Streptococcus pneumoniae*
Penicillin	•	•							•	•
Ampicillin	•	•	•	•	•	•		•	•	
Ampicillin/sulbactam				•	•	•		•	•	
Nafcillin/oxacillin									•	•
Vancomycin	•	•	•						•	•
Cefazolin				•	•	•		•	•	
Cephalothin				•	•	•			•	
Cefuroxime				•	•	•		•	•	
Cefotetan				•	•	•		•	•	
Cefoxitin				•	•	•		•	•	
Cefotaxime				•	•	•		•	•	•
Ceftriaxone				•	•	•		•	•	•
Ceftazidime				•	•	•	•	•		
Cefepime				•	•	•	•	•	•	
Clindamycin									•	•
Erythromycin	•								•	•
Ciprofloxacin	•	•	•	•	•	•	•	•	•	
Ofloxacin				•	•	•	•	•	•	
Levofloxacin	•	•	•	•	•	•	•	•	•	•
Gatifloxacin				•	•		•	•	•	•
TMP/SMX				•	•				•	
Gentamicin				•	•	•	•	•	•	
Tobramycin				•	•	•	•	•	•	
Amikacin				•	•	•	•	•		
Imipenem	•			•	•	•	•	•	•	
Piperacillin				•	•	•	•	•		
Piperacillin/Tazobactam				•	•	•	•	•		
Ticarcillin				•	•	•	•	•		
Ticarcillin/clavulanate				•	•	•	•	•		

RESULTS

ENTEROCOCCUS FAECIUM

- Levels of vancomycin-resistant *Enterococci* were lower in hospitals in Puerto Rico than in those in Florida or the US (Table 2)
- *Enterococci* resistance to other antibiotics was also lower in Puerto Rico

Table 2. E faecium Susceptibility in Hospitals in Puerto Rico, Florida, and the US

Antibiotic	Susceptibility (%) Puerto Rico (n=1199)	Florida (n=22,152)	National (n=78,756)
penicillin	35.2	17.9	16.3
ampicillin	41.4	22.0	18.9
vancomycin	76.8	49.3	44.0
ciprofloxacin	15.3	12.1	10.9
levofloxacin	24.3	16.0	14.6

ESCHERICHIA COLI

- *E coli* resistance to ampicillin and ampicillin/sulbactam was greater in Puerto Rico than in Florida and the US (Table 3)
- *E coli* isolates from hospitals in Puerto Rico were also more resistant to the fluoroquinolones as a class than in Florida or US hospitals

Table 3. E coli Susceptibility in Hospitals in Puerto Rico, Florida, and US

Antibiotic	Susceptibility (%) Puerto Rico (n=80,227)	Florida (n=1,921,284)	National (n=10,581,097)
ampicillin	52.4	58.5	62.4
ampicillin/sulbactam	54.1	62.1	66.8
ciprofloxacin	83.1	91.0	94.3
ofloxacin	74.4	95.4	96.7
levofloxacin	81.9	89.6	92.8
gatifloxacin	62.6	81.8	88.6

KLEBSIELLA PNEUMONIAE

- While *K pneumoniae* resistance to the fluoroquinolones as a class was higher in hospitals in Puerto Rico hospitals than in those in Florida or nationally, the difference was not as great as that seen with *E coli* with the exception of gatifloxacin, which was 11.7% higher than Florida and 12.7% higher than US hospitals overall (Table 3)

Table 4. K pneumoniae Susceptibility in Hospitals in Puerto Rico, Florida, and US

Antibiotic	Susceptibility (%) Puerto Rico (n=38,028)	Florida (n=565,758)	National (n=2,468,468)
ciprofloxacin	90.6	94.2	94.8
ofloxacin	91.2	92.6	94.3
levofloxacin	90.0	94.1	93.7
gatifloxacin	80.0	91.7	92.7

PROTEUS MIRABILIS

- *P mirabilis* resistance in hospitals in Puerto Rico was comparable or lower to many antibiotics compared with hospitals in Florida and nationally (Table 4)
- A particularly wide discrepancy was observed with the fluoroquinolones, with resistance much higher in hospitals in Florida than in Puerto Rico or the US

Table 5. P mirabilis Susceptibility in Hospitals in Puerto Rico, Florida, and US

Antibiotic	Susceptibility (%) Puerto Rico (n=13,530)	Florida (n=417,510)	National (n=1,589,906)
ampicillin	84.7	78.6	83.5
ampicillin/sulbactam	90.8	90.3	91.9
cefazolin	90.9	89.5	91.3
cephalothin	94.4	51.1	85.6
cefotetan	98.1	99.2	98.8
cefotaxime	99.0	98.7	99.2
ceftriaxone	96.5	99.2	99.3
ceftazidime	98.2	93.5	97.8
ciprofloxacin	94.2	72.9	80.3
ofloxacin	100	88.1	86.7
levofloxacin	95.4	75.6	80.5
gentamicin	94.1	90.1	92.1
tobramycin	95.3	92.7	94.1
amikacin	100	98.8	99.3
imipenem	98.2	95.7	97.3
ticarcillin	85.5	86.4	87.9

PSEUDOMONAS AERUGINOSA

- *P aeruginosa* susceptibilities to gentamicin in hospitals in Puerto Rico are suppressed compared with tobramycin or amikacin, consistent with that seen in Florida and US hospitals (Table 6)

Table 6. P aeruginosa Susceptibility in Hospitals in Puerto Rico, Florida, and US

Antibiotic	Susceptibility (%) Puerto Rico (n=60,047)	Florida (n=683,632)	National (n=2,395,327)
gentamicin	64.2	71.6	73.9
tobramycin	77.6	89.6	89.4
amikacin	84.5	91.2	91.8

SERRATIA MARCESCENS

- Activity from *S marcescens* was suppressed against the majority of antibiotics tested from hospitals in Puerto Rico compared with hospitals in Florida and the US (Table 7)

Table 7. S marcescens Susceptibility in Hospitals in Puerto Rico, Florida, and US

Antibiotic	Susceptibility (%) Puerto Rico (n=8323)	Florida (n=107,146)	National (n=409,382)
ampicillin	5.7	4.7	6.3
ampicillin/sulbactam	6.8	7.5	11.0
cefazolin	6.9	0.3	0.5
cefuroxime	0	0.9	3.2
cefotetan	100	98.8	97.7
cefoxitin	44.4	46.5	50.2
cefotaxime	91.6	91.7	90.0
ceftriaxone	59.2	88.2	91.6
ceftazidime	72.0	81.2	87.3
cefepime	90.8	95.6	95.9
ciprofloxacin	76.1	89.1	89.3
ofloxacin	60.0	86.9	85.1
levofloxacin	81.9	94.2	92.4
gatifloxacin	76.6	86.2	91.0
gentamicin	69.2	90.7	94.1
tobramycin	71.5	85.5	90.1
amikacin	86.1	95.7	97.4
imipenem	81.6	97.6	96.6
piperacillin	68.5	79.7	85.8
pip/taz	87.2	84.6	86.3
ticarcillin	68.3	80.2	80.8
ticarcillin/clavulanate	47.7	83.2	86.6

STAPHYLOCOCCUS AUREUS

- Higher MRSA levels (eg, resistance to nafcillin/oxacillin) and *S aureus* resistance to vancomycin was observed in hospitals in Puerto Rico compared with those in Florida and the US (Table 8)
- Susceptibility to the fluoroquinolones was higher in hospitals in Puerto Rico with the exception of ofloxacin

Table 8. S aureus Susceptibility in Hospitals in Puerto Rico, Florida, and US

Antibiotic	Susceptibility (%) Puerto (n=85,014)	Rico Florida (n=1,113,813)	National (n=4,421,014)
nafcillin/oxacillin	57.4	62.8	60.3
vancomycin	98.9	100	99.9
ciprofloxacin	66.7	58.4	59.2
ofloxacin	60.5	64.6	65.4
levofloxacin	68.8	57.9	55.5
gatifloxacin	61.5	48.1	57.6

STREPTOCOCCUS PNEUMONIAE

- Differences in *S pneumoniae* susceptibility to cefotaxime vs ceftriaxone were consistent with those previously reported in hospitals in the Florida and the US (Table 9)

Table 9. S pneumoniae Susceptibility in Hospitals in Puerto Rico, Florida, and US

Antibiotic	Susceptibility (%) Puerto Rico (n=1310)	Florida (n=34,160)	National (n=211,597)
cefotaxime	71.4	78.2	79.6
ceftriaxone	100	84.3	85.8

CONCLUSIONS

- This first broad analysis of antimicrobial resistance among hospitals in Puerto Rico from 1996-2003 provides important baseline data for sentinel surveillance programs and in determining strategies for intervention

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