

Pranita D. Tamma, MD, MHS<sup>1</sup>, Gwen L. Robinson, MPH<sup>2</sup>, Jeffrey S. Gerber, MD, PhD<sup>3</sup>, Jason G. Newland, MD<sup>4</sup>, Chloe M. DeLisle<sup>1</sup>, and Aaron M. Milstone, MD, MHS<sup>1</sup>

<sup>1</sup> The Johns Hopkins University School of Medicine, Baltimore, MD; <sup>2</sup>The University of Maryland School of Medicine, Baltimore, MD; <sup>3</sup>The Children’s Hospital of Philadelphia, Philadelphia, PA; <sup>4</sup>Children’s Mercy Hospital, Kansas City, MO

## Introduction

- Antimicrobial susceptibility patterns across US pediatric healthcare institutions have not been previously evaluated
- Pooling antibiograms from a sampling of US pediatric hospitals could:
  - Identify nationwide patterns in antimicrobial resistance
  - Allow across-hospital benchmarking
  - Provide useful data to guide empiric antimicrobial therapy for under-resourced institutions unable to generate antibiograms

## Methods

- In January 2012, a survey and request for submission of pediatric antibiograms between 2005-2011 was sent to 233 institutions:
  - 1) All members of the Society for Healthcare Epidemiology of America Research Network
  - 2) All Pediatric Infectious Diseases Society members
  - 3) All institutions (not captured through the above mechanisms) with pediatric residency programs identified through the American Medical Association
- Data for select clinically important Gram-positive and Gram-negative organisms from January 2010-December 2011 were pooled to create a summary antibiogram
- For institutions with separate antibiograms for special populations such as ICU patients, cystic fibrosis patients, or outpatients, all available antibiograms for a given year for the institution were combined to develop a composite antibiogram
- To evaluate trends over time, susceptibility data from 2010-2011 were compared to data from 2005-2006 using chi-square testing

## Results

**Table 1:** Responses from 55 institutions submitting pediatric antibiograms\*

Update antibiograms annually	91%
Eliminate duplicate cultures	91%
Exclude surveillance cultures	91%
Require ≥30 isolates for each organism-antibiotic combination	16%
Prepare unit-based antibiograms	38%
Separate antibiograms for urine isolates	38%
Separate antibiograms for outpatients	27%
Separate antibiograms for cystic fibrosis patients	31%
Incorporated 2010 CLSI recommendations for third-generation cephalosporins against Enterobacteriaceae	24%
Incorporated 2011 CLSI recommendations for piperacillin-tazobactam against <i>P. aeruginosa</i>	0%

\*Of 200 (85%) institutions responding to our survey, 78 (39%) reported generating pediatric antibiograms, and 55 (71%) submitted antibiograms

## Results

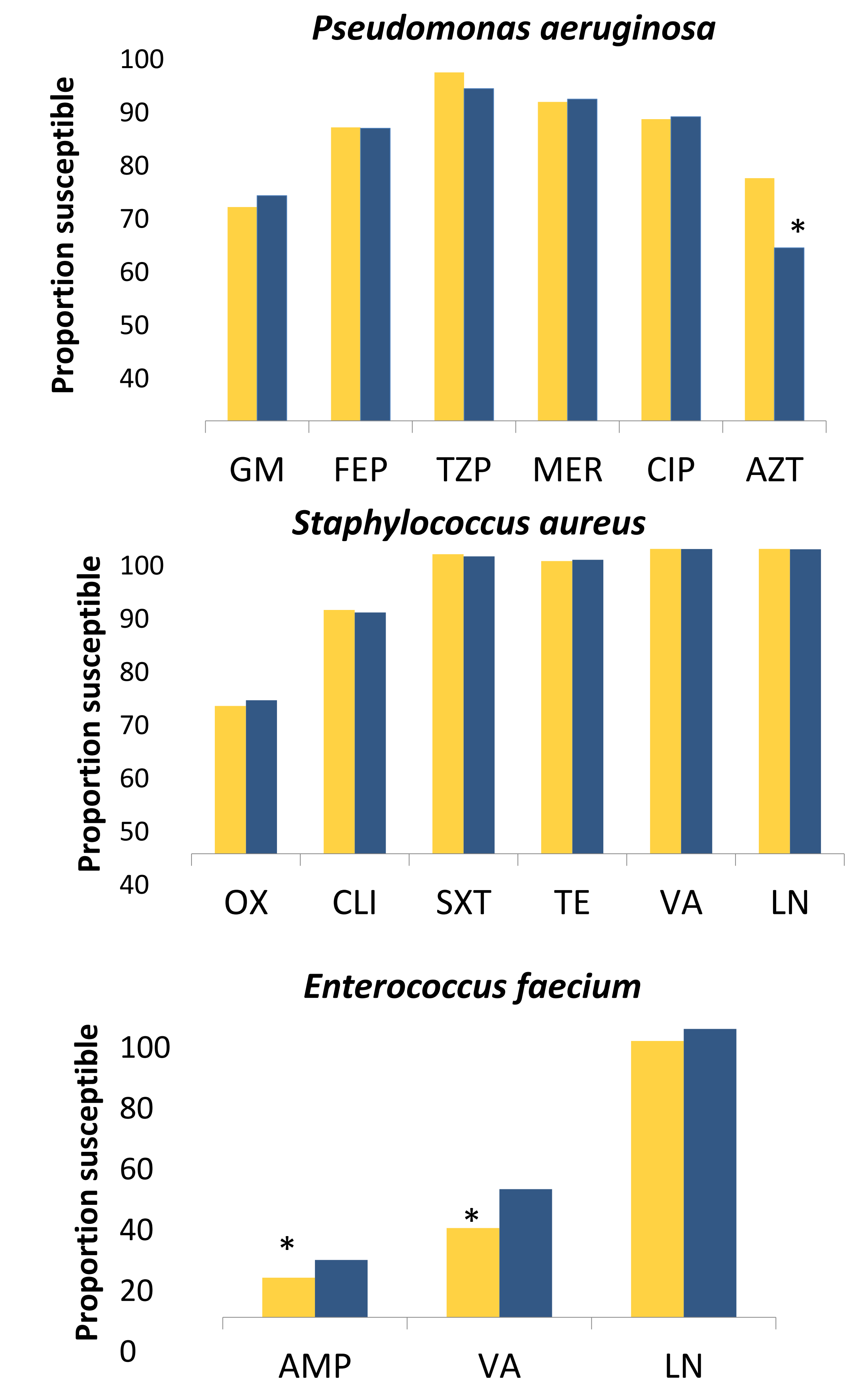
**Table 2:** Susceptibility percent (number of isolates tested) for Gram-negative organisms from 2010-2011 pediatric antibiograms amongst 55 participating institutions

	Ampicillin-Sulbactam	Ceftriaxone	Cefepime	Piperacillin-Tazobactam	Meropenem or Imipenem	Aztreonam	Ciprofloxacin	Gentamicin	Amikacin
<i>Escherichia coli</i>	58.6 (27814)	96.4 (39591)	98.4 (40595)	96.1 (46805)	99.6 (43277)	95.8 (13734)	89.7 (45025)	92.6 (50774)	99.0 (41321)
<i>Klebsiella pneumoniae</i>	83.0 (8119)	94.2 (10210)	95.4 (8920)	93.3 (10883)	98.4 (9992)	94.7 (3553)	94.5 (6452)	93.3 (11415)	98.1 (10418)
<i>Enterobacter cloacae</i>	19.1 (2844)	77.7 (4594)	96.1 (5621)	80.4 (6099)	97.9 (6244)	77.7 (2917)	95.6 (6096)	95.0 (6859)	98.7 (6077)
<i>Citrobacter freundii</i>	38.7 (1691)	81.2 (1923)	96.4 (1900)	80.9 (1945)	99.6 (2056)	85.1 (1281)	92.2 (2075)	88.1 (2235)	97.9 (1180)
<i>Serratia marcescens</i>	3.8 (1902)	95.3 (4238)	98.8 (3811)	92.1 (5225)	98.3 (5226)	94.6 (1807)	93.8 (5059)	88.9 (4580)	97.7 (3058)
<i>Pseudomonas aeruginosa</i>			83.5 (15876)	89.5 (18174)	88.5 (18400)	66.4 (9754)	85.0 (17526)	74.8 (19915)	88.9 (16368)

**Table 3:** Susceptibility percent (number of isolates tested) for Gram-positive organisms from 2010-2011 pediatric antibiograms amongst 55 participating institutions

	Ampicillin	Oxacillin	Clindamycin	Trimethoprim-sulfamethoxazole	Tetracycline	Vancomycin	Linezolid
<i>Staphylococcus aureus</i>		50.5 (73041)	78.8 (84027)	97.6 (85642)	95.3 (40765)	100.0 (85684)	99.9 (59304)
<i>Enterococcus faecalis</i>	99.7 (6775)					99.7 (7588)	97.6 (6137)
<i>Enterococcus faecium</i>	24.8 (1181)					44.6 (1124)	92.4 (1104)

**Figure 1:** Organism-antibiotic specific comparisons from 2005-2011; yellow=2005, blue=2011



GM=Gentamicin, FEP=Cefepime, TZP=Piperacillin-tazobactam, MER=Meropenem-Imipenem, CIP=Ciprofloxacin, AZT=Aztreonam, OX=Oxacillin, CLI=Clindamycin, SXT=Trimethoprim-Sulfamethoxazole, TE=Tetracycline, VA=Vancomycin, LN=Linezolid; \* indicates p<0.05

## Conclusions

- Antibiotic susceptibility trends for children in the US have remained stable for the majority of tested organisms over a 7-year period
- Notable observations for Gram-negative organisms:** No agent had >90% susceptibility against *P. aeruginosa*; *P. aeruginosa* susceptibility to aztreonam was inferior to all β-lactams and decreased from 2005 to 2011
- Notable observations for Gram-positive organisms:** *E. faecalis* resistance to linezolid resistance approximated 8% in children in our study; *S. aureus* susceptibilities remained relatively stable

We would like to thank all participants who contributed antibiograms from their institutions along with the Society for Healthcare Epidemiology of America Research Network and the Pediatric Infectious Diseases Society.