1436

Utility and Limitations of an Aggregate Community Antibiogram Dallas County, Texas, 2009 – 2015

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BACKGROUND

- Effective antimicrobial stewardship requires knowledge of local antibiotic resistance patterns, given geographic variations in antimicrobial susceptibility.
- Aggregating hospital antibiogram data has been recommended as a feasible, accurate and non-resource intensive method of monitoring community-specific antimicrobial resistance trends.
- We describe our experience with the practical utility, sustainability, challenges and limitations of such community-level antibiograms over 6 years in Dallas County, an area with a population of 2.5 million and 43 acute care hospitals.

METHODS

- From 2010 to 2015, the county health department collected existing cumulative hospital antibiograms from the preceding calendar year from 100% (19/19) of the non-pediatric, short-term acute care hospitals which had facility antibiograms.
- Aggregated antimicrobial susceptibility data were analyzed annually and presented according to Clinical and Laboratory Standard Institute (CLSI) guidelines to generate a county-wide antibiogram disseminated to healthcare providers.
- Trends in proportions of resistant isolates were analyzed using SAS version 9.4. Chi-square tests were used to determine the significance of variations in trends.
- Physicians and infection preventionists from participating hospitals were surveyed with standardized questionnaires regarding their perceived usefulness of this community antibiogram.

DALLAS COUNTY HEALTH AND HUMAN SERVICES
COUNTY – WIDE 2014 ANTIBIOGRAM

Gram Negative Organisms (All Sources)	Total Isolates tested	Aminoglycosides			Penicillins			Cephalosporins						Fluoro-quinolones		Carbapenems			Other		
		Gentamicin	Tobramycin	Amikacin	Ampicillin	Ampicillin/ Sulbactam	Piperacillin/ Tazobactam	Cefazolin	Cefuroxime	Cefotaxime	Ceftazidime	Ceftriaxone	Cefepime	Levofloxacin	Ciprofloxacin	Ertapenem	Imipenem	Meropenem	Trimethoprim/ Sulfamethoxazole	Aztreonam	Nitrofurantoin (Urine Only)
Acinetobacter baumannii	438	63	83	83		63					48		53	47	51			60	62		
Enterobacter cloacae[1]	1265	94	94	99			81			77	75	76	93	86	89	96	98	99	85	77	24
Escherichia coli[1] (all sources)	21440	87	87	99	41	47	96	84	85	88	93	92	92	70	70	>99	>99	>99	64	91	95
- *E. coli* (urine only)	7350	87	87	99	41	46	96	84	89	92	95	92	93	69	71		>99		61		96
Klebsiella pneumoniae[1]	4841	94	93	99		78	94	88	85	89	93	92	92	93	92	99	99	99	88	91	39
Proteus mirabilis[1]	2858	89	90	99	73	81	99	84	96	98	98	96	97	69	70	99	95	98	73	94	
Pseudomonas aeruginosa	3603	81	92	93			82				84		82	69	73		80	82		72	
Serratia marcescens[1]	451	97	91	98			66			66	75	87	98	94	90	99	99	99	94	83	

Gram Positive Organisms (All Sources)	Total Isolates tested	Penicillins					Cephalosporins				Other								
		Penicillin	Penicillin (meningitis)	Penicillin (non-meningitis)	Ampicillin	Oxacillin	Cefazolin	Ceftriaxone	Ceftriaxone (meningitis)	Ceftriaxone (non-meningitis)	Erythromycin [3]	Tetracycline	Trimethoprim/ Sulfamethoxazole	Clindamycin [4]	Levofloxacin	Linezolid	Vancomycin	Daptomycin	Gentamicin Synergy Screen	Meropenem
Enterococcus faecalis	4914				99							19				91	97	100	68	
Enterococcus faecium	955				14							16				98	34	93	90	
Staphylococcus aureus (all)	9752					52	52				44	91	91	78	59	100	>99	>99		
- *MSSA*	5071					100	>99	>99			67	94	97	88	91	100	100	>99		
- *MRSA*[2]	4931					0	0	0			13	91	96	68	34	100	>99	>99		
Staphylococcus epidermidis	787					36	38				34	74	56	56	41	100	98	100		
Streptococcus pneumoniae	640	87*	65 (230)	88 (319)				97	92 (285)	99 (295)	55	82	71	90	98	100	100			76
Streptococcus viridans group	89	79			71			97			46			93			100			

Number represents the percentage of isolates susceptible to the antibiotic. Indicates high level of resistance or drug not indicated. * Includes CSF and non-CSF isolates.
Organisms represented are first clinical isolate per patient regardless of source.
Data collected January - December 2014 from 19 area hospitals. *Summary excludes patients under 18 years of age.*

[1] Due to recent changes in CLSI interpretive criteria, not all laboratories are yet using the revised MIC breakpoints to determine Enterobacteriaceae resistance to cefazolin, 3rd generation cephalosporins, carbapenems, and aztreonam. The number of discrepant interpretations as a result of these differences is expected to be small and should not greatly impact the validity of this antibiogram.
[2] MRSA are assumed to be resistant to all beta-lactam antibiotics.
[3] Erythromycin predicts susceptibility for azithromycin and clarithromycin.[4] Does not reflect D-test results. D-test should be requested if clindamycin therapy considered, since erythromycin resistance is associated with inducible clindamycin resistance.

https://dallas-cms.org/miamis/dcms/assets/files/CommunityHealth/DCMS_Antibiogram.pdf

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RESULTS

Fig. 1. *E. coli* susceptibility

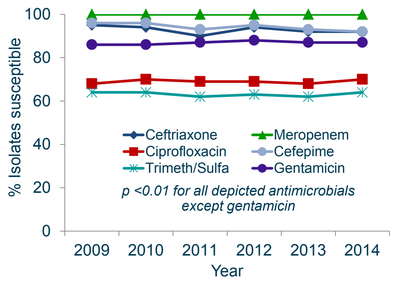


Fig. 2. *K. pneumoniae* susceptibility

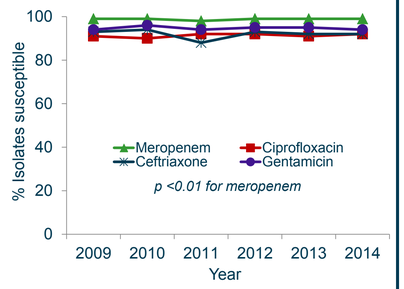


Fig. 3. *P. aeruginosa* susceptibility

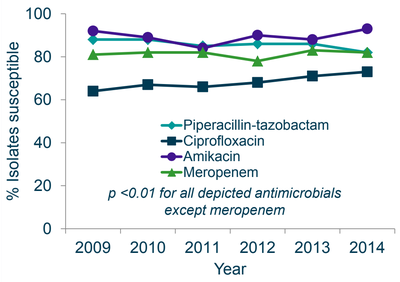
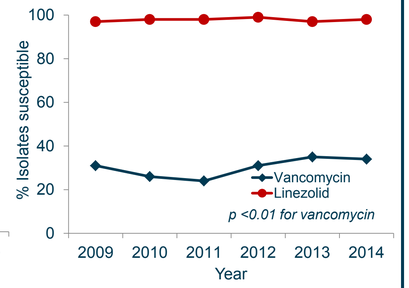


Fig. 4. *E. faecium* susceptibility



Selected antimicrobial susceptibility trends from 2009—2014*:

No increases in antimicrobial resistance were observed for the following organisms in 2014, compared to the prior 5 years: *E. cloacae, K. pneumoniae, E. faecium, E. faecalis, S. pneumoniae*

Slight increases in resistance to at least one antimicrobial were observed for the following organisms in 2014, compared to the prior 5 years: *A. baumannii, E. coli, P. aeruginosa*

A. baumannii (n=438): Increase in resistance to ciprofloxacin (from 37% to 49%)
- Increases in susceptibility to ampicillin/sulbactam (from 44% to 63%); amikacin (from 63% to 83%)
- Resistance to meropenem declined from 49% to 40%, which is lower than national rates of 49%**

E. cloacae (n=1,265): Susceptibility to cefipime (95%) and meropenem (99%) stable through 2014

E. coli (n=21,440): Carbapenem resistance remained <1%, consistent with nationally reported rates
- Slight decreases in susceptibility to ceftriaxone (from 95% to 92%) and cefipime (from 96% to 92%)
- Resistance to TMP/SMX (36%) and ciprofloxacin (32%) remain high, similar to national rates

K. pneumoniae (n=4,841): Carbapenem resistance remained <1%, compared to nationally reported rates of 7.9%

P. aeruginosa (n=3,603): Increased resistance to piperacillin-tazobactam (from 12% to 18%), higher than resistance rates of 9% reported nationally
- Resistance to amikacin remained stable overall (7%), lower than the 2014 national rates of 9.6%
- Increase in ciprofloxacin susceptibility (from 65% to 73%), compared to 2014 national rates of 79%
- Meropenem resistance of 18% was unchanged, similar to nationally reported rates of 19%

E. faecium (n=955): Vancomycin-resistance (VR) declined slightly (from 69% to 66%), lower than national rates of 77%; VR *E. faecium* accounted for 81% of all VRE, lower than the national prevalence of 88%
- Susceptibility to linezolid (98%) was unchanged

S. aureus (n=9,752): Proportions of MRSA isolates remained unchanged in 2014 from 2009 (51%)

S. pneumoniae (n=640): Increase in susceptibility to penicillin, similar to national trends.

** p <0.01 for all increases and decreases described*

*** Data for national comparisons from CDC Antibiotic Resistance Patient Safety Atlas, 2014 HAI data (http://gis.cdc.gov/grasp/PSA/MapView.html)*

Table 1. Development of community antibiogram: resources and activities

Necessary Elements	Supporting Activities
Health department workforce capacity	• Expertise: Epidemiologist with clinical microbiology background for Year-1 recruitment of hospital laboratories, evaluation of submitted data, development of sustainable analysis template • Ongoing dedicated staff time: Annual compilation and analysis (~160 hours/year); formal microbiology training not necessary
Complete participation of area hospitals which have facility-specific antibiograms	• Prior to requests for data, presentations given to area infectious disease physicians, infection preventionists, and microbiology directors and to explain rationale and importance of antibiogram • Persistent follow-up with any non-participating hospitals • De-identification of data and maintenance of confidentiality
Accessible clinical microbiology subject matter expertise	• Prior to development, identified microbiology directors of academic & community hospitals willing to provide consultation
Healthcare community awareness of antibiogram	• Website posting and electronic distribution of antibiogram • Presentations to medical directors, infection preventionists

Table 2. Hospital survey responses regarding utility of county antibiogram

Successes and Benefits	Yes/ Agree
• Helpful to monitor antimicrobial resistance trends on a community level *Comments: - Fills an "information void" and provides a surveillance mechanism to detect and monitor emerging trends of concern in a region* *- Used as a teaching tool for medical trainees*	100%
• Enables comparison of facility-specific antimicrobial resistance profiles to the county	100%
• Both county and hospital antibiograms are reviewed and compared at least once a year	100% (MD)
Limitations and Challenges	
• Serves as a useful resource for healthcare facilities that do not have their own antibiogram *Comments: Potential value, but actual awareness and use in such facilities is limited*	80%
• County antibiogram has prompted action or initiative(s) within hospital or IP departments	0%

**Survey participants from 12 hospitals: 8 Infectious disease physicians (medical directors of infection prevention) and 8 infection preventionists*

CONCLUSIONS

- An aggregate county-wide antibiogram has been a sustainable and efficient public health tool to conduct surveillance of local trends in antimicrobial resistance among bacteria of public health importance and to provide awareness of baseline trends.
- The community antibiogram has limited direct impact on clinical practice changes, but it supports educational efforts about the need for regional approaches to counter antimicrobial resistance within interconnected networks of healthcare facilities.
- Community antibiograms may provide a valuable mechanism to measure the efficacy of regional efforts to reduce antimicrobial resistance (e.g. antimicrobial stewardship initiatives, inter-facility transfer communications).
- Local public health agencies can be ideally positioned to compile regional antibiograms because of their relationships with and ease of outreach to area hospitals for participation, particularly in the absence of mandates for reporting.
- From our experience, the requisite public health workforce capacity for initial development of the county-wide antibiogram included clinical microbiology expertise, ongoing dedicated epidemiology staff time to maintain annual aggregate antibiograms, and infectious disease physician involvement and oversight.

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