462

Correlation between antibiotic utilization and resistance rates within a hospital system: results of the Antimicrobial Resistance Management (ARM) Program

John G. Gums, PharmD, University of Florida, Gainesville, Florida, USA, and Vivien W. Ng, RPh, CCP, VHA East Coast, Trevose, Pennsylvania, USA

John G. Gums, PharmD
625 SW Fourth Avenue
University of Florida, Gainesville, FL 32601 USA
Tel: +1.352-392-4541 Fax: +1.352-392-7766
E-mail: gums@chfm.ufl.edu

What is the Antimicrobial Resistance Management (ARM) Program?

PURPOSE

- The Antimicrobial Resistance Management (ARM) Program is an ongoing study to document trends in antimicrobial susceptibility patterns in inpatient and outpatient isolates and to identify relationships between antibiotic use and resistance rates
- Hospitals can delineate if and when antimicrobial resistance occurs
  - Allows strategic intervention
  - Provides data for local, regional, national benchmarks
  - Has potential to reduce costs of antibiotics associated with inappropriate use
- A total of 353 institutions have enrolled as of August 29, 2005
  - 282 (79%) nonteaching
  - 77 (21%) teaching
- For the purposes of comparison, US hospitals are grouped in 6 geographic regions
- The number of hospitals included from each region is as follows:
  - North Central: 14%
  - Northeast: 30%
  - Northwest: 2%
  - South Central: 16%
  - Southeast: 30%
  - Southwest: 8%

DATA COLLECTION

- Each hospital provides a minimum of 3 years of antibiogram or sensitivity report data
- To date, the total number of isolates compared in the database is 28.6 million
- Data are captured on 48 individual antibiotics and 19 organisms
- At www.armprogram.com, a Web-based analysis tool allows comparisons between antibiotic use and resistance rates for any number of parameters

WHAT IS VHA?

- VHA delivers industry-leading supply chain management services and facilitates the development of member networks that bring members together to solve clinical and operational challenges and drive sustainable results
- VHA Inc. is a healthcare provider alliance with corporate headquarters in Irving, Texas, that serves not-for-profit health care organizations nationwide
- VHA has 2,400 members in 48 states and the District of Columbia. Approximately 1,400 hospitals, or 25% of the nation's community hospitals are VHA members
- VHA East Coast is one of 18 VHA regional offices and includes institutions in New Jersey and southeastern Pennsylvania

UPDATED ABSTRACT

***PURPOSE:** Antibiotic use is one of the major drivers of resistance. However, restricting one drug to reduce resistance among microorganisms can result in increased resistance among others. Studies have suggested that specific types and volume of antimicrobial agents used can play key roles in determining resistance rates. Development of a program to correlate how usage of specific antibiotics affects changes in resistance patterns can help address issues of significance to clinical pharmacy.*

***METHODS:** ARM is an ongoing program to document trends in antibiotic use and resistance rates. Total number of isolates compared nationally (1990-2005) is 28.6 million. Institutions enrolling in ARM provide at least 3 years of antibiogram data. Participants receive a customized analysis of antimicrobial susceptibility trends within their hospital/system. The trends are benchmarked against national, regional, and state comparators. While this analysis identifies that a resistance problem may be occurring, it does not address what may be driving such resistance.*

***RESULTS:** Working with the VHA East Coast, a hospital alliance that serves nonprofit hospitals in New Jersey and southeastern Pennsylvania, ARM collaborated on a pilot utilization review program to help evaluate the effect of antimicrobial use on antimicrobial susceptibilities. In addition to antibiograms, each participating hospital provided at least 3 years of gross amount of drug used. Total drug use per year was determined and the percentage change in use of each antibiotic from year 1 to year 2 and year 2 to year 3 was calculated and susceptibility and utilization as a percentage of total antibiotics used were determined.*

***CONCLUSIONS:** ARM utilization review data can be used to address clinical pharmacy issues within a hospital system by identifying modifications to infection control measures and proactive changes to the antimicrobial formulary. This utilization review program can easily be adapted to any clinical pharmacy setting and has the potential to have a significant effect on local resistance rates.*

PURPOSE

- Use of specific types and volume of antimicrobial agents are known to affect resistance rates, with wide variability in antimicrobial use occurring from hospital to hospital[1-2]
- To help clinical pharmacy address resistance patterns that may be occurring within a hospital system, the ARM Program and VHA East Coast developed a pilot program that combined antibiogram and antibiotic utilization data to correlate specific agents with resistance over time

METHODS

- The total number of isolate/drug combinations compared nationally within the ARM Program is 28,562,098 (1990-2005)
- The most significant organisms are summarized in Table 1

Table 1. Significant Organisms in the ARM Program Aggregate Database*

Organism	Isolates (n)
Escherichia coli	11,607,450
Staphylococcus aureus	5,211,374
Pseudomonas aeruginosa	2,745,401
Klebsiella pneumoniae	2,722,769
Streptococcus pneumoniae	209,057

*as of August 29, 2005

- ARM Program participants receive a customized analysis of antimicrobial susceptibility trends within their hospital/system with trends benchmarked against national, regional, and state comparators
- While this analysis identifies that a resistance problem may be occurring, only by including data on actual antibiotic use can what drives such resistance be addressed

RESULTS

- The ARM Program and the VHA East Coast collaborated to develop a pilot utilization review program to help evaluate the effect of antimicrobial use on antimicrobial susceptibilities, called the "Bugs and Drugs" project
- Hospitals in New Jersey and southeastern Pennsylvania that are members of VHA East Coast provided at least 3 years of antibiograms and data on gross amounts of antibiotics used, which was based on wholesale purchase data. The accepted premise was that a hospital only purchased antibiotic that it used
- Given that rates of fluoroquinolone resistance among *P aeruginosa* is increasing in US hospitals,[1] the ARM Program database was interrogated to determine National, Northeast, and VHA East Coast susceptibility data for ciprofloxacin and levofloxacin for individual years from 2001 to 2003 (Figure 1)

Figure 1. P aeruginosa Isolate Susceptibility to Ciprofloxacin (Figure 1A) and Levofloxacin (Figure 1B) in the National, Northeast, and VHA East Coast, 2001-2003

Figure 1A. Ciprofloxacin

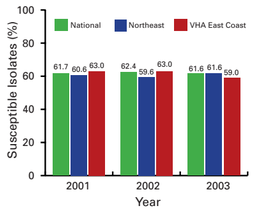
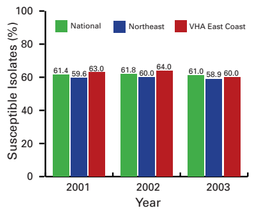


Figure 1B. Levofloxacin



- *P aeruginosa* isolate susceptibility to ciprofloxacin and levofloxacin was calculated for VHA East Coast as a regional system and for each of the individual member hospitals for 2001-2003 collectively (Figure 2)

Figure 2. VHA East Coast Region System P aeruginosa Isolate Susceptibility to Ciprofloxacin (Figure 2A) and Levofloxacin (Figure 2B), 2001-2003

Figure 2A. Ciprofloxacin

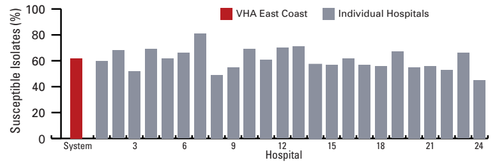
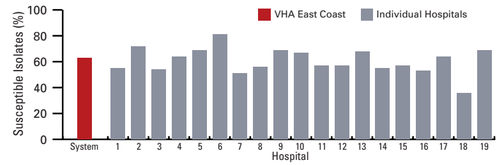


Figure 2B. Levofloxacin



- Susceptibility data of *P aeruginosa* isolates to ciprofloxacin and levofloxacin for a representative hospital within VHA East Coast regional aggregate was compared to the overall susceptibility data (Figure 3)

Figure 3. P aeruginosa Susceptibility to Ciprofloxacin (Figure 3A) and Levofloxacin (Figure 3B) in the VHA East Coast Regional Aggregate System Overall Compared with a Representative Hospital, 2001-2003

Figure 3A. Ciprofloxacin

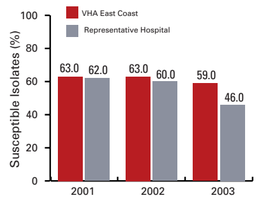
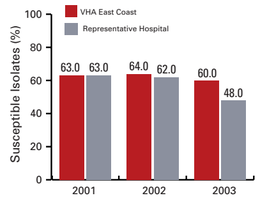


Figure 3B. Levofloxacin



- Susceptibility of *P aeruginosa* was calculated for each hospital within the VHA East Coast and utilization of ciprofloxacin and levofloxacin as a percentage of total antibiotic use was calculated (Figure 4)

Figure 4. VHA East Coast P aeruginosa Isolate Susceptibility to Ciprofloxacin (Figure 4A) and Levofloxacin (Figure 4B) with Utilization as a Percentage of Total Antibiotic Use by Hospital, 2001-2003

Figure 4A. Ciprofloxacin

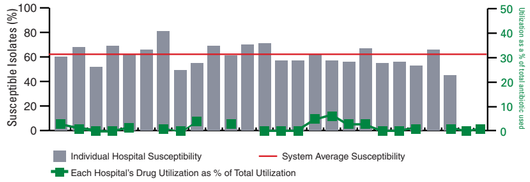
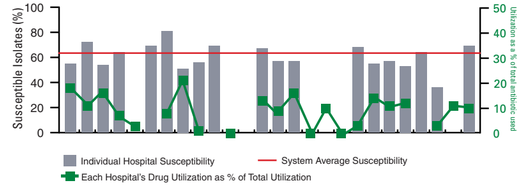


Figure 4B. Levofloxacin



- Total drug use per year was determined and the percentage change in use of each antibiotic from year 1 to year 2 and year 2 to year 3 was calculated (Figure 5)

Figure 5. Drug Utilization vs Antibiogram Report Data for Ciprofloxacin (Figure 5A) and Levofloxacin (Figure 5B) for Isolates of All Organisms for a Representative Hospital in the VHA East Coast

Figure 5A. Ciprofloxacin

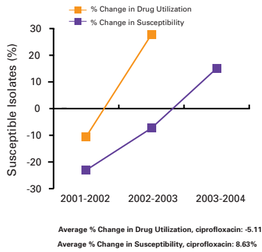
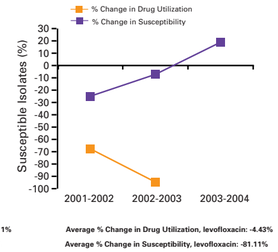


Figure 5B. Levofloxacin



CONCLUSIONS

- Clinical pharmacy infectious disease issues within a hospital system can be identified by using ARM utilization review data
- ARM data can identify changes in susceptibility and drug utilization to help determine whether modifications should be made to infection control measures as well as proactively to the antimicrobial formulary
- The ARM utilization review program can easily be adapted to any clinical pharmacy setting, with the potential to have a significant effect on local resistance rates
- The inverse relationship observed for levofloxacin for an individual hospital suggests this type of analysis appears to be helpful in identifying cause-and-effect relationships for some—but not all—antibiotics, mandating the need for local, customized surveillance reporting
- The "Bugs and Drugs" project can serve as a platform for collaborative work within and among healthcare organizations, both to focus clinical staff and to build a multidisciplinary approach for reviewing antimicrobial resistance and optimizing antibiotic use
- Since microbial resistance is influenced by antibiotic use and flora within the community, it may be advantageous for healthcare organizations within a geographic area to engage in projects such as "Bugs and Drugs"

REFERENCES

1. Polk RE, Johnson CK, McClish D, Wenzel RP, Edmond MB. Predicting hospital rates of fluoroquinolone-resistant Pseudomonas aeruginosa from fluoroquinolone use in US hospitals and their surrounding communities. *Clin Infect Dis*. 2004;39(4):497-503.
2. Polk RE. Antimicrobial formularies: can they minimize antimicrobial resistance? *Am J Health Syst Pharm*. 2003;60(10 Suppl 1):S16-19.

ACKNOWLEDGMENTS

The authors would like to thank the participating institutions in the ARM Program, which make data collection possible, and the following individuals, who made the "Bugs and Drugs" project possible: Brenda Sistrom, John Tovar, Mark Winner, Paul Benyo, Richard Epstein, Joe Alessandrini, Kathleen Roye-Horn, and Deborah Fry.

www.armprogram.com

A project run by the University of Florida

Presented at the 2005 American College of Clinical Pharmacy (ACCP) Annual Meeting, October 26, 2005, San Francisco, California