Antibiotic Utilization and Antimicrobial Stewardship in Community Hospitals

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Abstract

Background: Overuse of antibiotics has been associated with the emergence of antibiotic resistance. This study aims to evaluate trends in antibiotic utilization as defined by days of therapy per 1000 patient days (DOT/1000 PD) in various community hospitals across the US.

Methods: Eighteen network hospitals provided antibiotic utilization data (2012-2016) on overall antibiotic use and the following classes: narrow-spectrum β-lactams (ampicillin, nafcillin, oxacillin, cefazolin, and cephalexin), non-carbapenem antipseudomonal β-lactams (piperacillin/tazobactam, ceftazidime, and cefepime), carbapenems, anti-methicillin-resistant *Staphylococcus aureus* (MRSA) agents (vancomycin, linezolid, daptomycin, and tigecycline), and fluoroquinolones. Antibiotic utilization and change in utilization trend during the study period was calculated using linear regression (β coefficient).

Results: Hospitals were primarily urban (72%) with an average of 209 total beds and 22 ICU beds. All hospitals have antimicrobial stewardship programs established during the study period. A decrease in antipseudomonal β-lactams and fluoroquinolones was observed during the study period, all other antibiotic classes had increased use.

Conclusion: Overall antibiotic utilization increased over five years, particularly carbapenems and anti-MRSA agents with the highest utilization being reported with the latter. Efforts are needed to halt or decrease the use of these broad spectrum antimicrobials.

Background

- The emergence of antimicrobial resistance (AMR) is a global threat. Increased widespread use of antibiotics, particularly when not indicated, has resulted in unfavorable consequences including the emergence of AMR.[1,2]

- The continuous evolve of AMR sparked the concern of the medical community to seek means to alleviate and prevent these outcomes. While infection control was in place to help preventing these problems from developing, it was not completely successful alone. Therefore, additional means were needed to foster infection control efforts, and thus the concept of antimicrobial stewardship was initiated and established.[3]

- Antimicrobial stewardship initiatives have demonstrated improved patient outcomes, decreased rates of antibiotic resistance (or increased antibiotic susceptibilities), decreased adverse events including reduced *Clostridium difficile* infection rates, improved antibiotic utilization, as well as cost savings.[3,4]

- Numerous studies have showed the positive impact of certain antimicrobial stewardship practices on reducing antibiotic utilization. However, most of these studies were conducted in single hospitals or single healthcare institutions. Additionally, none of these studies evaluated the relationship of hospitals characteristics with antibiotic utilization.

## Objectives

This study aims to:
- Evaluate trends in antibiotic utilization as defined by days of therapy per 1000 patient days (DOT/1000 PD) in various community hospitals across the US.
- Assess the correlation of different hospital demographics with DOT/1000 PD.

Methods

- Hospitals pharmacies managed by Cardinal Health, Inc were evaluated for their demographics and the availability of DOT/1000 PD data from 2012 to 2016 for the following antibiotics classes:
  - Narrow-spectrum β-lactams (ampicillin, nafcillin, oxacillin, cefazolin, and cephalexin)
  - Non-carbapenem antipseudomonal β-lactams (piperacillin/tazobactam, ceftazidime, and cefepime)
  - Carbapenems
  - Anti-methicillin-resistant *Staphylococcus aureus* (MRSA) agents (vancomycin, linezolid, daptomycin, and tigecycline),
  - Fluoroquinolones

- Antibiotic utilization and change in utilization trend during the study period was calculated using linear regression (β coefficient).

- Potential correlation between each hospital demographic and antibiotic utilization as DOT/1000 PD were assessed using Pearson coefficient for categorical variables and linear regression for continuous variables.

- Microsoft Excel (Microsoft, Corp., Redmond, WA) was used to calculate means ± SD, and β coefficients. SPSS statistics package (IBM, Inc., Armonk, NY) was used to calculate Pearson and linear regression coefficients. A P value of 0.05 was considered significant.

Results

- Of the hospitals evaluated, 18 matched the inclusion criterion and provided antibiotic utilization data for the period 2012-2016.

- Hospitals are primarily urban (72%) and 33% are non-profit.

- Two-thirds of the hospitals provid tertiary healthcare services (67%) while the other one-thirds provide primary and secondary healthcare services (33% for each healthcare type).

- Average total bed size is 209 beds (range 65-484 beds) with average 22 intensive care unit (ICU) beds (range 0-65 beds).

- Mean number of pharmacists in these hospitals is 9 pharmacists (range 2-31 pharmacists) with a mean pharmacist:bed ratio of 0.05 (i.e., 20 beds per pharmacist).

- All hospitals have an antimicrobial stewardship programs (ASPs) established during the study period but only 78% and 22% had infectious diseases (ID) physician and ID pharmacist on staff, respectively.

- The following figure demonstrates additional hospital demographics data:

ID, infectious diseases; ASP, antimicrobial stewardship program
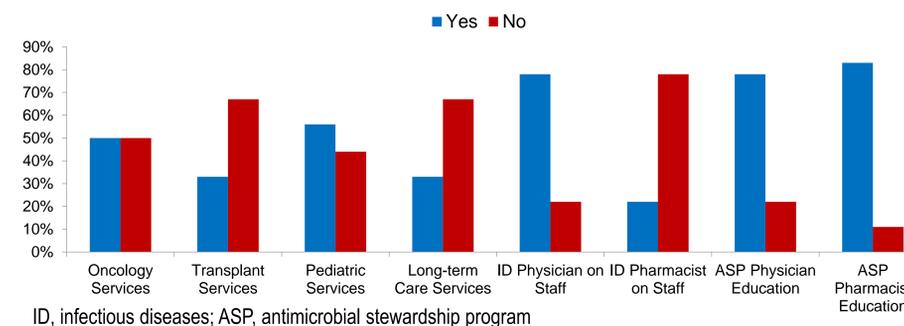
Results

- A decrease in antipseudomonal β-lactams and fluoroquinolones was observed during the study period, all other antibiotic classes had increased use.

- The following table illustrates mean utilization in terms of DOT/1000 PD for the 5-year study duration (2012-2016) as well as the β coefficients for the change in utilization for all antibiotics and specific classes:

Antibiotic Class	Mean Utilization (Range), DOT/1000 PD	Mean β Coefficient
All Antibiotics	62.3 (49.4-80.6)	2.7
Narrow-spectrum β-lactams	122.8 (64.5-207.2)	18
Antipseudomonal β-lactams*	129.6 (35-191.6)	-1.2
Carbapenems	46.7 (145-82)	2.7
Anti-MRSA	156.9 (84.7-272.3)	5.5
Fluoroquinolones	151.9 (88.5-207.6)	-2.6

* Excluding carbapenems

- Assessment of correlation of each hospital demographic variable with antibiotic utilization showed no significance (P value > 0.05 for all comparisons) indicating lack of correlation between variables.

Conclusions

- Overall antibiotic utilization increased over five years with the most dramatic increase observed with narrow spectrum β-lactams. A reduction in utilization of broad spectrum agents such as antipseudomonal β-lactams and fluoroquinolones was demonstrated.

- Limitations to this study include the retrospective nature of data collection, the lack of microbiological data or resistance trends to correlate with antibiotic utilization, and inability to identify which stewardship strategies were implemented at each hospital.

References

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Disclosures