



Predictors of Total Antibiotic Use among a National Network of Academic Hospitals

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UPDATED ABSTRACT

Introduction: The Centers for Disease Control and Prevention National Healthcare Safety Network provides hospitals with a mechanism to report antibiotic use data to benchmark against peer institutions and direct antibiotic stewardship efforts. Differences in patient populations need to be adjusted for to ensure unbiased comparisons across hospitals. Our objective was to identify predictors of total antibiotic use across a nationwide network of hospitals.

Methods: Data from 126 academic hospitals were extracted from the Vizient Clinical Data Base Resource Manager (CDB/RM) for adult inpatients (age ≤ 18 years) in 2015. Antibiotic use was expressed as total antibiotic days of therapy/patient days. We constructed a negative binomial regression model to explore potential predictors of antibiotic use, including age, race, sex, case mix index, hospital bed size, length of stay, geographic region, transfer cases, service line, and illness severity. A backwards stepwise approach based on likelihood ratio test was used to identify significant ($p < 0.05$) predictors and construct the final, parsimonious model. We calculated a deviance-based pseudo R^2 to assess the performance of the full and final models.

Results: A total of 3,076,394 total admissions representing 17,544,763 patient days were included. Factors identified as significant predictors in the final model are shown in Table 1. The deviance-based pseudo R^2 for the full and final models was 11.4% and 10.3%, respectively.

Conclusion: The current NHSN antibiotic risk adjustment metric, the Standardized Antimicrobial Administration Ratio (SAAR), has been developed separately for different antibiotic groupings and adjusts for a limited set of facility characteristics. Further work is needed to assess if the independent predictors identified in this model can improve upon the performance of existing SAAR metrics and aid in directing stewardship strategies.

INTRODUCTION

- ❖ Comparisons of antibiotic use across hospitals can direct antimicrobial stewardship strategies
- ❖ Differences in patient mix and facility characteristics impact antibiotic use
- ❖ Risk adjustment is necessary to ensure benchmarking of antibiotic use for inter-hospital comparisons is unbiased

OBJECTIVE

To identify predictors of total antibiotic use across a nationwide network of hospitals to improve upon current SAAR risk adjustment

METHODS

Design:
❖ Cross sectional, secondary analysis of electronic pharmacy data from facilities contributing to Vizient Clinical Data Base Resource Manager

Inclusion/Exclusion Criteria

❖ Adult inpatients (age ≥ 18 years) in calendar year 2015 with complete pharmacy data

Outcome

❖ Total antibiotic use expressed as total antibiotic days of therapy per 1000 patient days

Analysis

- ❖ Negative binomial regression model constructed to explore potential predictors of total antibiotic use
 - Predictors aggregated at facility level:
 - Proportion of admissions by sex, race, age, transfers
 - Proportion of attributable patient days by service line and illness severity
 - Case mix index (CMI), mean length of stay, hospital bed size and geographic region
- ❖ Backwards stepwise approach based on likelihood ratio test to identify significant ($p < 0.05$) predictors and construct final, parsimonious model
- ❖ Deviance-based pseudo R^2 calculated to assess model performance

RESULTS

Population: 126 hospitals contributed data for calendar year 2015

- ❖ 3,076,394 total admissions (median 23,522; IQR: 13,427 - 33,135) representing 17,544,763 total patient days (median 140,108; IQR: 72,221 - 189,595)

Table 1. Facility-level characteristics of hospitals (n=126)

Characteristic	Mean (SD)
Proportion female	0.54 (0.04)
Proportion white cases	0.68 (0.19)
Proportion age >65	0.36 (0.10)
Proportion transfer cases	0.11 (0.08)
Service line	
Proportion surgery	0.29 (0.08)
Proportion medicine	0.45 (0.09)
Proportion immunosuppressed	0.07 (0.09)
Proportion other	0.16 (0.07)
Severity of illness*	
Proportion extreme	0.08 (0.03)
Proportion major	0.30 (0.04)
Proportion moderate	0.39 (0.03)
Proportion minor	0.23 (0.05)
Case Mix Index (CMI)	1.82 (0.34)
Mean length of stay (days)	5.66 (1.18)
Bed size	584.57 (357.84)
Region (n (%))	
West	24 (19.1)
Midwest	35 (27.8)
Northeast	42 (33.3)
South	25 (19.8)

*Categorized according to All Patients Refined Diagnosis Related Groups (APR DRG) classification. All data are reported as mean (SD) unless otherwise indicated.

Final, parsimonious model:

- ❖ $Total\ antibiotic\ days = -0.52 + 0.29\ CMI + 0.09\ Midwest - 0.04\ Northeast + 0.11\ South - 1.30\ Transfer\ cases - 0.61\ Surgery\ service\ line$
- ❖ Identified significant patient- and facility-level predictors of total facility antibiotic use per patient days (Table 2)

Model performance: Deviance-based pseudo R^2

- ❖ Full model: 11.4%; Final model: 10.3%

Table 2. Independent predictors of total facility antibiotic use per patient days

	Relative Risk	95% Confidence Interval
Case Mix Index	1.36	1.16, 1.60
Region		
West	Ref	-
Midwest	1.05	0.92, 1.20
Northeast	0.92	0.81, 1.04
South	1.07	0.94, 1.23
Transfer cases	0.31	0.15, 0.63
Surgery service line	0.45	0.25, 0.81

DISCUSSION

- ❖ CDC National Healthcare Safety Network (NHSN) released web-based antibiotic use reporting module in 2014
 - Purpose: provide mechanism for facilities to report and analyze antimicrobial usage as part of stewardship efforts
 - Voluntary monthly reporting of antibiotic use and resistance data
- ❖ Standardized Antimicrobial Administration Ratio (SAAR): developed using 2014 data from 77 hospitals; used for benchmarking hospital performance
 - SAAR = SIR (standardized incidence ratio)
 - Constructed using indirect standardization approach using multivariable regression to generate ratio of observed to expected days of therapy

$$SAAR = \frac{\text{Observed antibiotic use}}{\text{Expected antibiotic use}}$$

- SAAR = 1: antibiotic use is as expected
- SAAR < 1: antibiotic use is less than expected
- SAAR > 1: antibiotic use is more than expected
- ❖ Risk adjustment with SAAR likely suboptimal as many relevant patient- and facility-level covariates not considered for inclusion in current NHSN models
- ❖ Model based on Vizient data identified significant predictors of total antibiotic use not included in current NHSN model
- ❖ Model performance between full and final models was similar based on deviance-based pseudo R^2

Limitations

- ❖ Unable to replicate NHSN SAAR model identically; we did not have patient location data
- ❖ Our model cannot be compared directly with the one developed by CDC to generate expected antibiotic use for SAAR
 - ❖ Different datasets used
- ❖ Future research will structure data to reflect NHSN patient location predictors and explore other potential predictors to refine SAAR models

CONCLUSION

- ❖ Current NHSN SAAR metric developed separately and adjusts for limited set of facility characteristics
- ❖ Incorporation of significant predictors identified in this study may aid in more meaningful inter-hospital comparisons of total antibiotic use
- ❖ Further research needed to assess if these independent predictors improve upon the performance of existing SAAR metrics; thus aiding in development of stewardship interventions

DISCLOSURE

- ❖ None of the authors has a financial or personal relationship with organizations that could inappropriately influence or bias the content of this study.

