Abstract # 1019

Using prediction modeling to inform risk-adjustment strategy for hospital antibiotic use: Can we predict who gets an inpatient antibiotic?

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Abstract

Background: Hospital antibiotic stewardship assessments based on comparisons of antimicrobial use (AU) among multiple hospitals are difficult to interpret without risk-adjustment for patient case mix. We aimed to determine if variables of varying complexity, derived retrospectively from the electronic health record (EHR), were predictive of inpatient antimicrobial exposures.

Methods: We performed a retrospective study of EHR-derived data from adult and pediatric inpatients within the Duke University Health System from October 2015 to September 2017. We used Random Forests machine learning models on two antimicrobial exposure outcomes at the encounter level: binary (ever/never) exposure and days of therapy (DOT). Antibiotic groups were defined by the NHSN AU Option 2017 baseline. Analyses were stratified by pediatric/adult, location type (ICU/ward), and antibiotic group. Candidate variables were categorized into four tiers based on feasibility of measurement from the EHR. Tier 1 (easy) included demographics, season, location, while Tier 4 (hard) included all variables from Tier 1-3 and laboratory results, vital signs, and culture data. Data was split into 80/20 training and testing sets to measure model performance using AUC for the binary outcomes and absolute error for the DOT outcomes.

Results: The analysis dataset included 170,294 encounters and 204 candidate variables from three hospitals. A total of 80,190 (47%) encounters had antimicrobial exposure; 64,998 (38%) had 1-6 DOT, and 15,192 (9%) had 7 or greater DOT. Models strongly predicted the binary outcome, with AUCs ranging from 0.70 to 0.95 depending on the stratum (Figure A, B). The addition of more complex variables increased accuracy modestly (Figure Model Tiers 1-4). Model performance varied based on location and antibiotic group. Models for infrequently used groups performed better due to zero-inflated data. (Figure C, D). Models underestimated DOTs of encounters with extreme long lengths of stay.

Conclusion: Models utilizing EHR-derived variables strongly predicted antimicrobial exposure. Risk-adjustment strategies incorporating encounter-level measures of patient mix would improve benchmark comparisons for use in Antimicrobial Stewardship Program assessments.

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Background

- Hospital antibiotic stewardship assessments based on comparisons of antimicrobial use (AU) among multiple hospitals are difficult to interpret without risk-adjustment for patient case mix.
- AIM: Determine if variables of varying complexity, derived retrospectively from the EHR, were predictive of inpatient antimicrobial exposures.

Methods

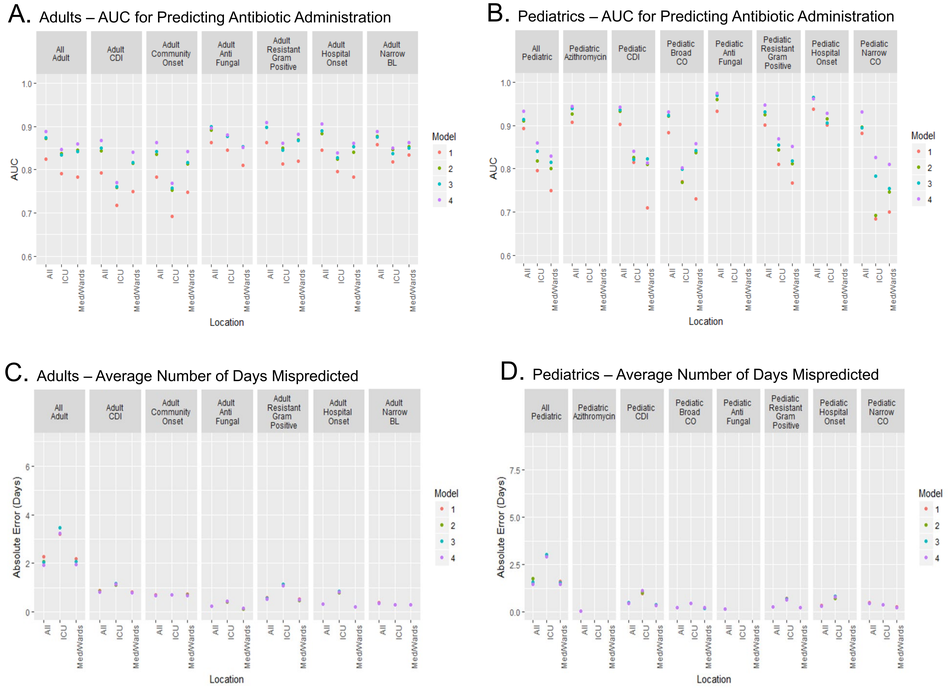
- Duke Health System; Oct 2015 to Sept 2017. All adult and pediatric inpatient encounters with at least 1 day on an inpatient unit, summarized by encounter.
- Random Forest models by Feasibility Tier. Tiers were cumulative (i.e. Tier 4 included variables from Tiers 1-3)
- 2-stage modeling: first predicted antibiotic use as ever/never and then DOT
- 80/20 split for training/testing datasets; performance evaluated by AUC and absolute error

Model Tier	Variables
1-Easy	Demographics, DRG, Season, Location/LOS
2	Comorbidities and Diagnoses (ICD-10),Procedures
3	Non-antibiotic Medications, Allergies
4-Hard	Laboratory results, culture data, vital signs

Results

- 170,294 encounters and 204 variables in one academic and two community hospitals; 80,192 (47%) received at least one antimicrobial.
- Models strongly predicted the binary outcome, with AUCs ranging from 0.70 to 0.95 depending on the stratum (Figure A, B).
- The addition of more complex variables increased accuracy modestly (Figure Model Tiers 1-4).
- Model performance varied based on location and antibiotic group. Models for infrequently used groups performed better due to zero-inflated data. (Figure C, D).
- Models underestimated DOTs of encounters with extremely long lengths of stay.

Figure. Model performance by Adult/Pediatric, SAAR group, Location, Feasibility Tier



Conclusions

- Models utilizing EHR-derived variables strongly predicted antimicrobial exposure at the encounter level.
- Risk-adjustment strategies incorporating encounter-level measures of patient mix could improve benchmark comparisons for use in Antimicrobial Stewardship Program assessments.