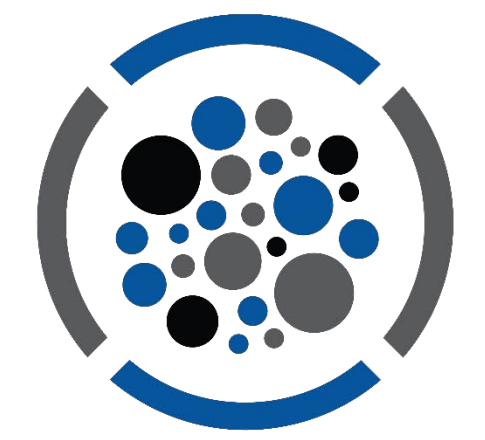


# Defining phenotypes of antibiotic-exposure for development of risk-adjustment strategy in assessments of antibiotic use among hospitals



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## Abstract

**Background:** Comparison of antibiotic use (AU) rates among hospitals can identify areas to investigate and intervene for antibiotic stewardship programs. Hospital AU interpretation is difficult without risk-adjustment for patient mix. Identifying high- or low-risk phenotypes for receipt of antimicrobials using data from electronic health records (EHR) could help define risk-adjustment factors for comparing AU among hospitals.

**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. Encounters were included if the patient spent time in an inpatient location. The analysis aimed to identify subpopulations that were high- or low-risk for antibiotic exposure based on EHR data summarized on the encounter level. Antimicrobial days of therapy (DOT) and days present, representing length of stay (LOS), were defined as in the 2018 NHSN AU Option. Location exposures were defined in binary variables if patients were housed at least 1 day on a hospital unit type during the encounter. We compared antibiotic-exposed to unexposed patients as well as DOT among various factors including demographics, location, non-antibiotic medications, labs, ICD-10 codes, and diagnosis-related groups (DRG).

**Results:** The EHR-derived dataset included 170,294 encounters and 204 variables in one academic and two community hospitals; 80,192 (47%) received at least one antimicrobial totaling 483,567 DOT. Distributions of both LOS and DOT were zero-inflated and skewed by long outliers (Figure). Encounters with long,  $\geq 7$  DOT made up 63% of total DOT, but only 9% of inpatient encounters. Patient phenotypes with highest DOT included those with long lengths of stay, older age, exposures to stem cell transplant, pulmonary, and critical care units, and DRG that included transplant, respiratory, or infectious diagnoses. Zero DOT phenotypes included those with short lengths of stay, exposure to labor and delivery or medical wards, and DRG that included birth and pregnancy.

**Conclusion:** Future work in defining relevant and feasible risk-adjustment factors for hospital AU data comparisons should include factors associated with low- as well as high-risk patient phenotypes.

## Background

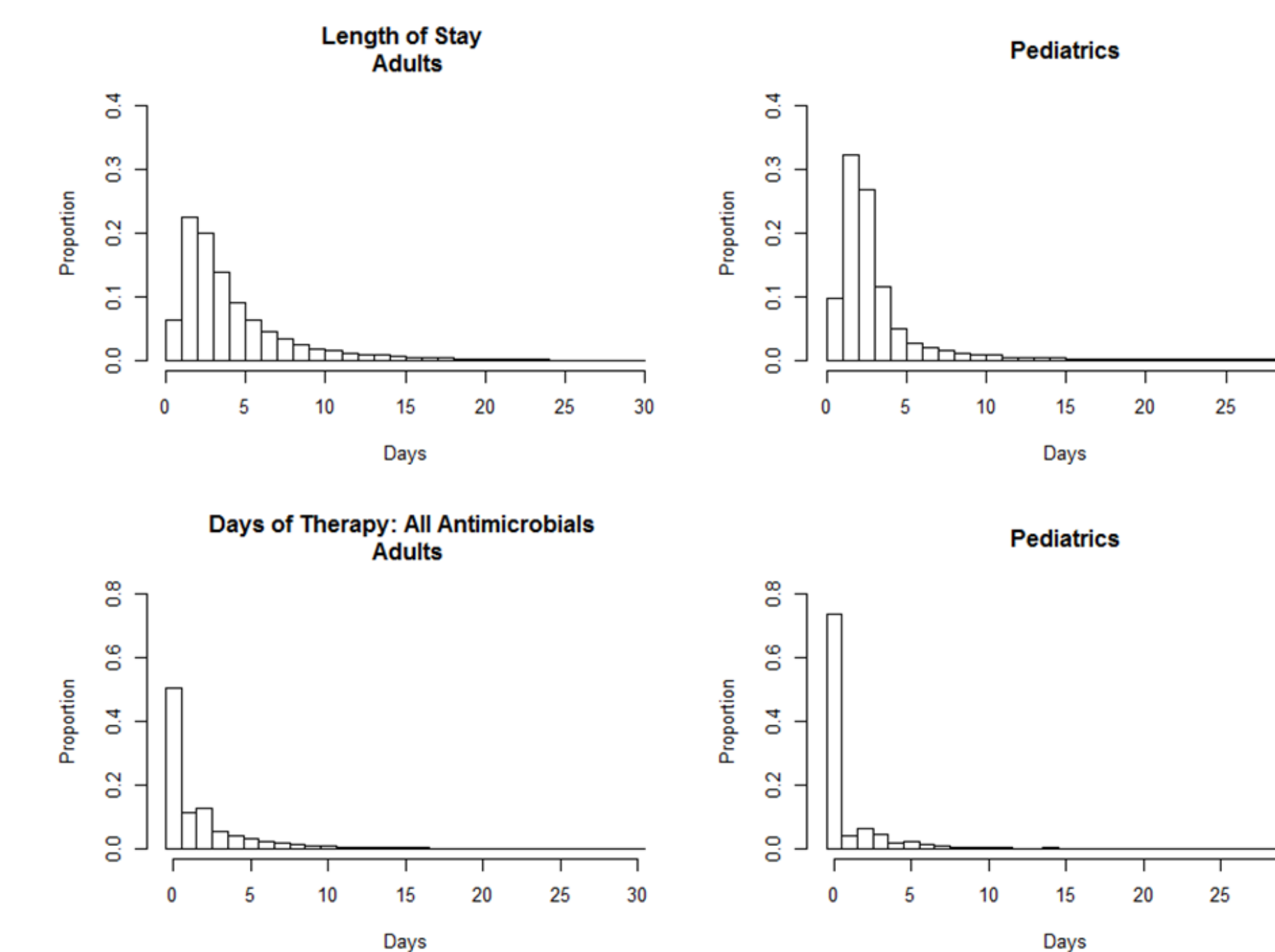
- Hospital AU interpretation is difficult without risk-adjustment for patient mix.
- Identifying high- or low-risk phenotypes for receipt of antimicrobials using data from electronic health records (EHR) could help define risk-adjustment factors for comparing AU among hospitals.
- AIM:** Identify subpopulations that were high- or low-risk for antibiotic exposure based on EHR data summarized on the encounter level

## Methods

- Duke Health System (1 Academic, 2 community hospitals); Oct 2015 to Sept 2017.
- All adult and pediatric inpatient encounters with at least 1 day on an inpatient unit
- EHR variables discretely captured as part of clinical operations were summarized on the encounter level
- Outcome: Antibiotic DOT using NHSN AU Option definitions
- Compared antibiotic-exposed to unexposed patients as well as DOT among various EHR-derived factors

## Results

- 170,294 encounters and 204 variables in one academic and two community hospitals; 80,192 (47%) received at least one antimicrobial totaling 483,567 DOT.
- Distributions of both LOS (in days present) and DOT were zero-inflated and skewed by long outliers (Figure)
- Encounters with antibiotic DOT  $\geq 7$  made up 63% of total DOT, but only 9% of inpatient encounters.
- High DOT phenotypes: long lengths of stay, older age, exposures to stem cell transplant, pulmonary, and critical care units, and diagnoses of transplant, respiratory, or infectious diseases.
- Zero DOT phenotypes: short lengths of stay, exposure to labor and delivery, and diagnoses of birth and pregnancy.



**Figure.** LOS and antimicrobial DOT per inpatient encounter

Variable	DOT=0	DOT 1-6	DOT $\geq$ 7
N (%)	90,104 (53)	64,998 (38)	15,192 (9)
<b>Age (years)</b>			
<1	11695 (13)	1950 (3)	653 (4)
1-17	5867 (7)	3172 (5)	977 (6)
18-65	48274 (54)	34170 (53)	8201 (54)
>65	24268 (27)	25706 (40)	5361 (35)
Female	51212 (57)	34514 (53)	7165 (47)
<b>Length of Stay (days)</b>			
1	8811 (10)	2528 (4)	0
2	25637 (28)	14446 (22)	18 (0)
3	22003 (24)	12895 (20)	192 (1)
4-7	25724 (29)	24381 (38)	3757 (25)
8-14	6212 (7)	7922 (12)	5231 (34)
>15	1717 (2)	2769 (4)	5992 (39)
<b>Location</b>			
Labor Ward	8995 (10)	2177 (3)	178 (1)
Neurology Ward	2464 (3)	2449 (4)	385 (3)
Neurosurgery Ward	3952 (4)	3856 (6)	611 (4)
Surgery Ward	14924 (17)	17059 (26)	3545 (23)
Medical Ward	40213 (45)	34119 (52)	8923 (59)
Med or Surg ICU	4695 (5)	5775 (9)	3854 (25)
Pulmonary Ward	974 (1)	1159 (2)	830 (5)
Stem Cell Txp Ward	270 (0)	527 (1)	724 (5)
<b>DRG/MDC group</b>			
Pregnancy/Childbirth	10382 (12)	2253 (3)	98 (1)
Musculoskeletal	3251 (4)	13277 (20)	985 (6)
Kidney/Urinary Tract	2242 (2)	4010 (6)	658 (4)
Endocrine/Metabolic	3500 (4)	1429 (2)	263 (2)
Nervous System	7368 (8)	3837 (6)	804 (5)
Skin/Breast	441 (0)	1532 (2)	331 (2)
Newborns/Neonates	10400 (12)	1423 (2)	362 (2)
Respiratory System	3363 (4)	6268 (10)	1793 (12)
Digestive System	6680 (7)	3533 (5)	1127 (7)
Blood disorders	1626 (2)	1005 (2)	459 (3)
Infectious Diseases	581 (1)	4139 (6)	2880 (19)
Transplant	116 (0)	433 (1)	1425 (9)

## Conclusions

- A minority of inpatient encounters were responsible for the majority of antibiotic days.
- Specific EHR-derived variables characterized encounters with high or zero antibiotic use. Variables that help identify these populations may be most helpful in risk-adjustment.

