Stewardship and Infection Prevention and Benjamin Goldstein, Duke Center for Antimicrobial Stewardship and Infection Prevention

Background: External comparisons of antimicrobial use (AU) may be more informative if adjusted for encounter characteristics. Optimal methods to define input variables for encounter-level risk-adjustment models of AU are not established. **Methods:** This retrospective analysis of electronic health record data included 50 US hospitals in 2020-2021. We used NHSN definitions for all antibacterials days of therapy (DOT), including adult and pediatric encounters with at least 1 day present in inpatient locations. We assessed 4 methods to define input variables: 1) diagnosis-related group (DRG) categories by Yu et al., 2) adjudicated Elixhauser comorbidity categories by Goodman et al., 3) all Clinical Classification Software Refined (CCSR) diagnosis and procedure categories, and 4) adjudicated CCSR categories where codes not appropriate for AU risk-adjustment were excluded by expert consensus, requiring review of 867 codes over 4 months to attain consensus. Data were split randomly, stratified by bed size as follows: 1) training dataset including two-thirds of encounters among two-thirds of hospitals; 2) internal testing set including one-third of encounters within training hospitals, and 3) external testing set including the remaining one-third of hospitals. We used a gradient-boosted machine (GBM) tree-based model and two-staged approach to first identify encounters with zero DOT, then estimate DOT among those with >0.5 probability of receiving antibiotics. Accuracy was assessed using mean absolute error (MAE) in testing datasets. Correlation plots compared model estimates and observed DOT among testing datasets. The top 20 most influential variables were defined using modeled variable importance. **Results:** Our datasets included 629,445 training, 314,971 internal testing, and 419,109 external testing encounters. Demographic data included 41% male, 59% non-Hispanic White, 25% non-Hispanic Black, 9% Hispanic, and 5% pediatric encounters. DRG was missing in 29% of encounters. MAE was lower in pediatrics as compared to adults, and lowest for models incorporating CCSR inputs (Figure 1). Performance in internal and external testing was similar, though Goodman/Elixhauser variable strategies were less accurate in external testing and underestimated long DOT outliers (Figure 2). Agnostic and adjudicated CCSR model estimates were highly correlated; their influential variables lists were similar (Figure 3). **Conclusion:** Larger numbers of CCSR diagnosis and procedure inputs improved risk-adjustment model accuracy compared with prior strategies. Variable importance and accuracy were similar for agnostic and adjudicated approaches. However, maintaining adjudications by experts would require significant time and potentially introduce personal bias. If findings are confirmed, the need for expert adjudication of input variables should be reconsidered.

Disclosure: Elizabeth Dodds Ashley: Advisor- HealthTrackRx. David J Weber: Consultant on vaccines: Pfizer; DSMB chair: GSK; Consultant on disinfection: BD, GAMA, PDI, Germitec

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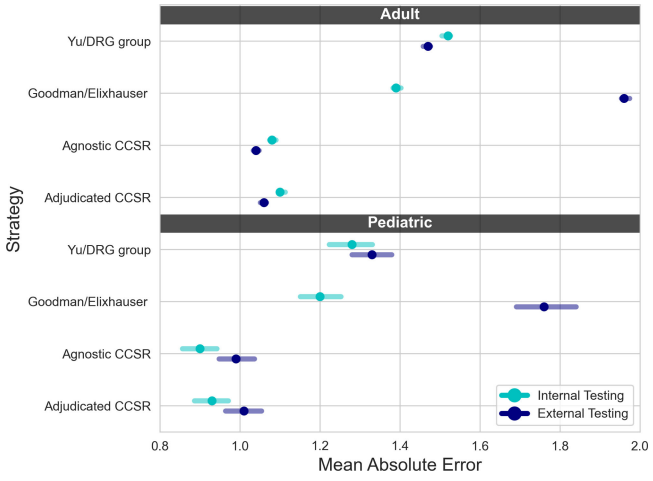
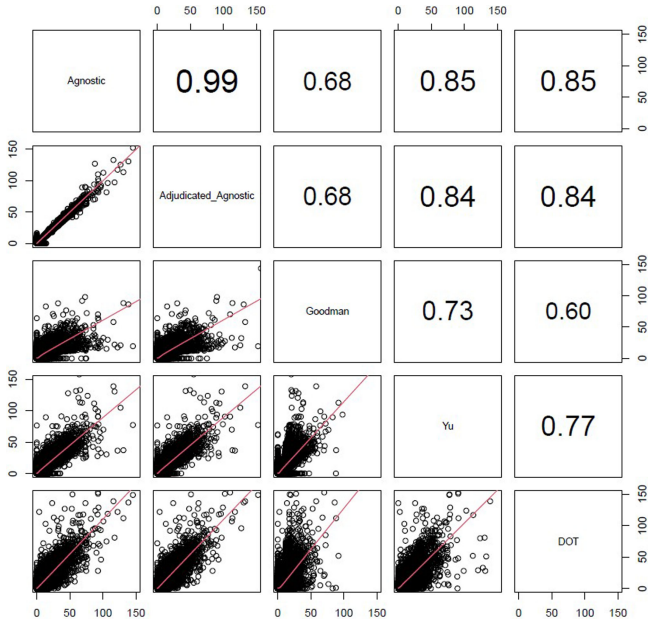
Yu/DRG Group	Goodman/Elixhauser	Agnostic CCSR	Adjudicated CCSR
N Days Present	N Days Present	N Days Present	N Days Present
DRG Group4	Infection On Admission, Present on Admission (POA)	Infection On Admission, Regardless of POA	Infection On Admission, Regardless of POA
DRG Group2	MedSurg Ward Days Percent	CCS_CM_INF003 (Bacterial Infections)	CCS_CM_INF003 (Bacterial Infections)
MedSurg Ward Days Percent	Elixhauser Total Score	CCS_PCS_CAR024 (Venous and arterial catheter placement)	CCS_PCS_CAR024 (Venous and arterial catheter placement)
ICU Days Percent	Elixhauser Weight Loss	CCS_CM_SKN001 (Skin and subcutaneous tissue infections)	CCS_CM_SKN001 (Skin and subcutaneous tissue infections)
Maternity Days Percent	ICU Days Percent	CCS_CM_PRG030 (Maternal outcome of delivery)	CCS_CM_PRG002 (Gestational weeks)
DRG Group1	Elixhauser Leukemia	CCS_CM_MUS002 (Osteomyelitis)	CCS_CM_MUS002 (Osteomyelitis)
Perioperative Days Percent	Age, in years	CCS_PCS_RES001 (Diagnostic bronchoscopy)	CCS_CM_DIG016 (Peritonitis and Intra-abdominal abscess)
Stepdown Days Percent	Elixhauser Liver Severe	CCS_CM_DIG016 (Peritonitis and Intra-abdominal abscess)	CCS_CM_NEO060 (Leukemia - acute myeloid leukemia - AML)
DRG Group3	Elixhauser Dementia	CCS_PCS_CAR003 (Coronary artery bypass grafts - CABG)	CCS_PCS_CAR003 (Coronary artery bypass grafts - CABG)
Pediatric ICU Days Percent	Hem-Onc Days Percent	CCS_CM_NEO060 (Leukemia - acute myeloid leukemia - AML)	CCS_PCS_RES013 (Lung Transplant)
Pediatric Med Surg Ward Days Percent	Elixhauser Other Neurologic Disorder	CCS_PCS_RES013 (Lung Transplant)	CCS_CM_END011 (Fluid and electroly disorders)
	Elixhauser Diabetes mellitus, No Complications	CCS_CM_END011 (Fluid and electroly disorders)	Post-partum Ward Days Percent
	Elixhauser Obesity	CCS_PCS_ADM012 (Chemotherapy)	CCS_PCS_ADM012 (Chemotherapy)
	Elixhauser Cerebrovascular, POA	CCS_CM_CIR004 (Endocarditis and endocardial disease)	CCS_CM_INF004 (Fungal infections)
	Elixhauser Congestive Heart Failure, POA	CCS_PCS_MST020 (Subcutaneous tissue and fascia excision)	CCS_CM_INF012 (COVID-19)
	Elixhauser Metastatic Cancer	CCS_CM_INF004 (Fungal infections)	CCS_CM_CIR004 (Endocarditis and endocardial disease)
	Elixhauser HIV/AIDS	CCS_CM_INJ037 (Complication of other surgical or medical care, injury, initial encounter)	CCS_PCS_MST020 (Subcutaneous tissue and fascia excision)
	Elixhauser Renal Failure Severe, POA	CCS_CM_END008 (Malnutrition)	CCS_PCS_PGN003 (Cesarian section)
	Elixhauser Liver Mild	CCS_CM_RSP010 (Aspiration pneumonitis)	CCS_CM_BLD008 (Immunity disorders)





Presentation Type:
Poster Presentation - Oral Presentation
Subject Category: Surveillance

Evaluation of minimum inhibitory concentration data in National Healthcare Safety Network's Antimicrobial Resistance Option

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Background: Clinical laboratories perform antimicrobial susceptibility testing (AST) primarily by determining the minimum inhibitory concentration (MIC) for an organism–antimicrobial combination and comparing it with established breakpoints to generate interpretations. The Antimicrobial Resistance (AR) Option of CDC's National Healthcare Safety Network (NHSN) permits hospitals to submit clinical isolate AST data, including test values and interpretations (Figure 1). The Clinical and Laboratory Standards Institute (CLSI) periodically revises breakpoints, but their adoption by clinical laboratories can be delayed, potentially affecting national AR surveillance data accuracy. Using MIC values, instead of

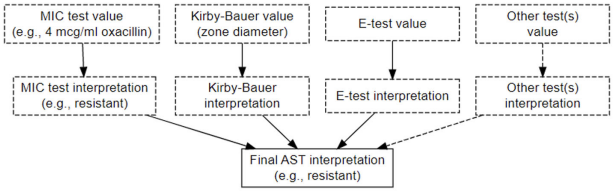

FIGURE 1. Schematic of testing cascade for antimicrobial susceptibility testing (AST) data reported per clinical isolate to the National Healthcare Safety Network (NHSN) Antimicrobial Resistance (AR) Option. Example of oxacillin minimum inhibitory concentration (MIC) testing for *Staphylococcus aureus* denoted in parentheses. Dashed boxes represent optionally reportable results; dashed arrows represent uncaptured results.

E. coli–fluoroquinolones (ciprofloxacin or levofloxacin)		Per 2021 CLSI breakpoints on MIC values			
		Resistant	Not resistant	Unclassifiable[a]	
Per lab's MIC interpretation	Resistant	45,911	29	92	46,032
	Not resistant	777	111,185	14,018	125,980
		45,988	112,214	15,010	172,012

S. aureus–methicillin (oxacillin or cefoxitin)		Per 2021 CLSI breakpoints on MIC values			
		Resistant	Not resistant	Unclassifiable[a]	
Per lab's MIC interpretation	Resistant	8,354	344	7,808	16,506
	Not resistant	41	21,972	0	22,013
		8,395	22,316	7,808	38,519

[a] MIC values could not be classified if they were reported as intervals spanning the breakpoint (e.g., ≤1 µg/ml ciprofloxacin for *E. coli* or >2 µg/ml oxacillin for *S. aureus*).

FIGURE 2. Consistency between the laboratory minimum inhibitory concentration (MIC) interpretation (classified as resistant or not resistant) compared to the interpretation derived by applying the reported MIC values to the 2021 Clinical and Laboratory Standards (CLSI) breakpoints for two antibiotic-resistance phenotypes among isolates reported in 2022: (1) fluoroquinolone-resistant *Escherichia coli* and (2) methicillin-resistant *Staphylococcus aureus*.

clinical laboratory interpretations, can improve surveillance data accuracy and overcome misclassification due to delayed uptake of revised breakpoints. We evaluated the completeness and consistency of MIC data submitted to the AR Option for fluoroquinolone-resistant Escherichia coli and methicillin-resistant Staphylococcus aureus (MRSA). **Methods:** We included data on (1) E. coli isolates tested for ciprofloxacin or levofloxacin susceptibility and (2) S. aureus isolates tested for oxacillin or cefoxitin susceptibility in 2022 and reported by October 1, 2023. We evaluated completeness among isolates reporting a final AST interpretation as the proportion of isolates reporting both an MIC value and interpretation. We evaluated consistency using percent agreement comparing the laboratory's MIC interpretation (classified as resistant or not resistant) with the interpretation derived by applying 2021 CLSI M100 breakpoints to the MIC values reported for the same isolate. **Results:** Across 974 hospitals, fluoroquinolone MICs and interpretations were reported for 172,012/393,359 E. coli isolates (43.7%), and oxacillin or cefoxitin MICs and interpretations were reported for 38,519/79,372 S. aureus isolates (48.5%). Of isolates with both MIC values and interpretations, 157,902 (91.8%) E. coli and 7,808(79.7%) S. aureus isolates had MICs that could be classified as resistant or non-resistant (i.e., intermediate or susceptible) per CLSI breakpoints (Figure 2). The remaining MICs were unclassifiable (reported as intervals spanning CLSI breakpoints, e.g., ≤1 µg/ml ciprofloxacin for E. coli). Among isolates with classifiable MICs, the agreement between the clinical laboratory and CLSI-based interpretation was 99.5% for E. coli and 99.7% for S. aureus. **Conclusion:** MIC values and interpretations were available for

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Extended-Spectrum Beta-Lactamase Producing Enterobacterales Infections in the United States, 2012-2021

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Background: The 2022 Special Report: COVID-19 U.S. Impact on Antimicrobial Resistance identified continued increases in the rate of extended- spectrum beta-lactamase producing (ESBL) infections in the United States from 2017 through 2020. Using similar data sources and methodology, we examined the trends of species-specific ESBL infections from 2012-2021. **Methods:** We identified a cohort of patients from the PINC AI and BD Research Insights databases with a clinical culture yielding a Klebsiella pneumoniae or Escherichia coli isolate with accompanying susceptibility testing. E. coli or K. pneumoniae isolates non-susceptible to ceftriaxone, cefotaxime, ceftazidime, or cefepime were considered suggestive of ESBL production. Isolates from patients with no culture yielding the same resistance phenotype of interest in the previous 14 days were counted as an incident case. Community-onset (CO) cultures were obtained ≤ day 3 of hospitalization; hospital-onset (HO) cultures were obtained ≥ day 4. We used a raking procedure to determine weights for extrapolating the number of discharges included in our sample to match the distribution of discharges, stratified by bed size, U.S. census division, urban/rural

Table 1. Unadjusted weighted rates per 10,000 discharges of extended-spectrum beta-lactamase producing (ESBL) Enterobacterales by location onset, 2012-2021

Phenotype	Year	All	Hospital-Onset	Community-Onset
ESBL *K. pneumoniae*	2012	9.54	2.52	7.02
	2013	9.92	2.48	7.44
	2014	11.06	2.70	8.36
	2015	11.77	2.79	8.97
	2016	11.01	2.61	8.40
	2017	10.97	2.30	8.68
	2018	11.09	2.33	8.76
	2019	12.26	2.60	9.66
	2020	14.39	3.58	10.81
	2021	15.28	4.06	11.22
ESBL *E. coli*	2012	30.18	5.14	25.03
	2013	32.87	4.87	27.99
	2014	34.52	5.20	29.32
	2015	40.33	5.54	34.79
	2016	42.01	5.53	36.48
	2017	43.41	5.74	37.67
	2018	43.52	5.79	37.73
	2019	48.34	6.04	42.30
	2020	51.32	7.71	43.61
	2021	47.81	7.52	40.28