

Variation in Hospitalist-Specific Antibiotic Prescribing at Four Hospitals: A Novel Tool for Antibiotic Stewardship

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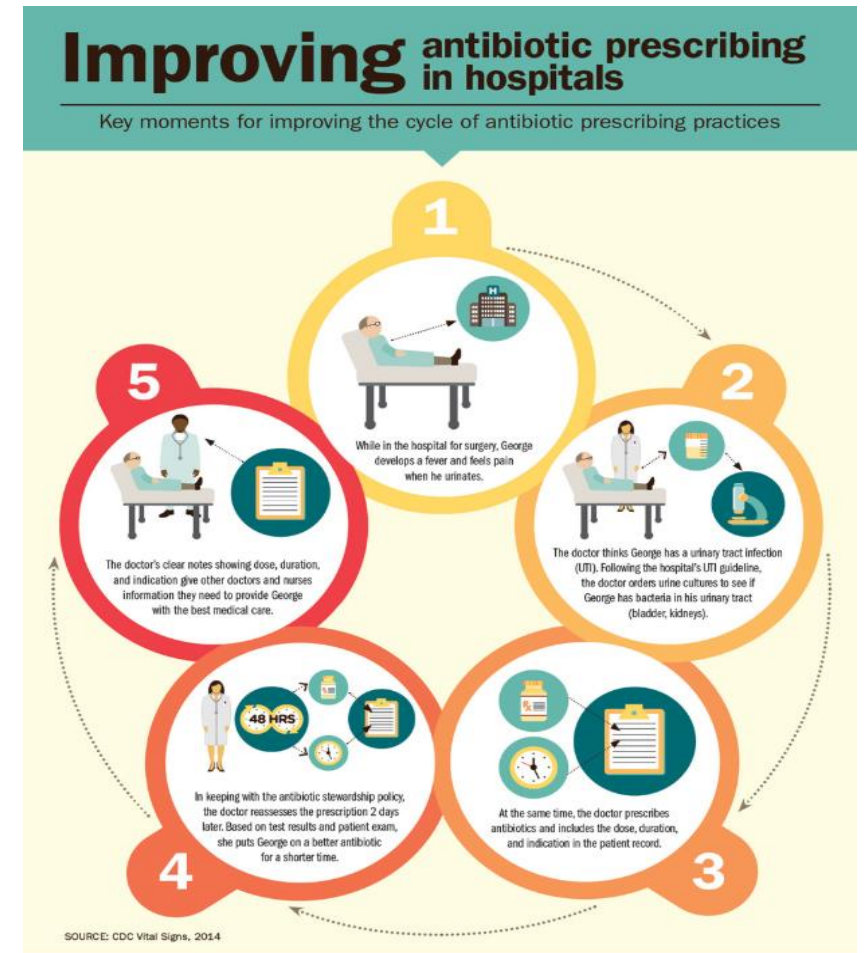
Disclosures

The study authors have nothing to disclose.



Hospitalist Role in Inpatient Antibiotic Prescribing

- Hospitals are major consumers of antibiotics
 - 30-50% of those antibiotics are unnecessary or inappropriate
- Hospitalists play a critical role in antibiotic stewardship
 - Primary antibiotic prescriber and educator
 - Limited access to ID specialists
 - Only 8,518 ID specialists compared to +44,000 hospitalists in U.S in 2015
 - Open to receiving feedback on performance



(1) Making Health Care Safer, <https://www.cdc.gov/vitalsigns/antibiotic-prescribing-practices/index.html>

(2) Salsberg E et al. The Future Supply and Demand for Infectious Disease Physicians. *Infectious Diseases Society of America* 2017.

(3) Lines TH et al. Driving antimicrobial use improvement: attitudes of providers of adult hospital care on optimal attribution and feedback. *Infect Control Hosp Epidemiol* 2018; 39(8): 983-985



Barriers to Peer Comparisons of Antibiotic Prescribing

- Difficult to perform peer comparisons of antibiotic prescribing in the inpatient setting
 - Multiple providers per patient, shared responsibility
 - Attribution to single provider difficult
- Varying patient mix and time on service, “unfair” to compare by provider

(1) Zhuo A et al. Opportunities and challenges to improving antibiotic prescribing practices through a One Health approach: results of a comparative survey of doctors, dentists and veterinarians in Australia. *BMJ Open* 2018; 8(3): e020439

(2) Jones T et al. Antibiotic Prescribing Feedback: Description of Denominator Metrics to Standardize Prescribing Rates for Peer Comparison. *ID Week* 2018.



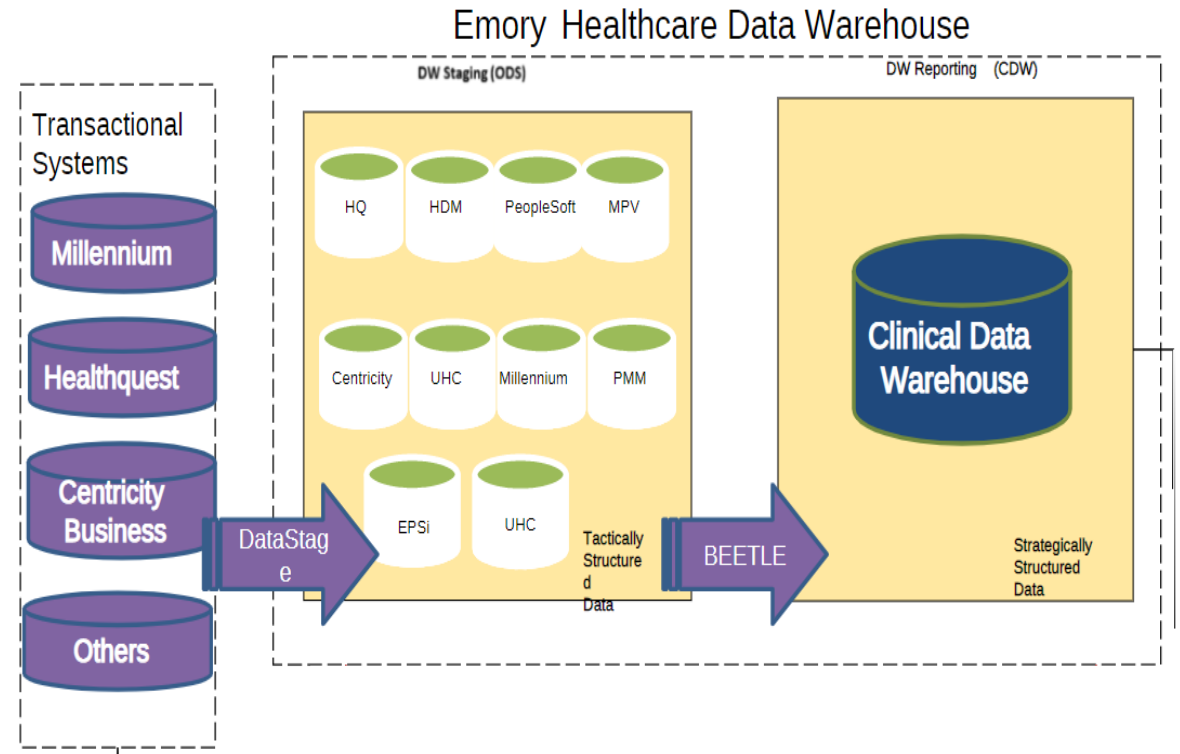
Objective

Describe antibiotic prescribing variation among hospitalists within a healthcare system and develop a risk-adjusted benchmark for peer comparison

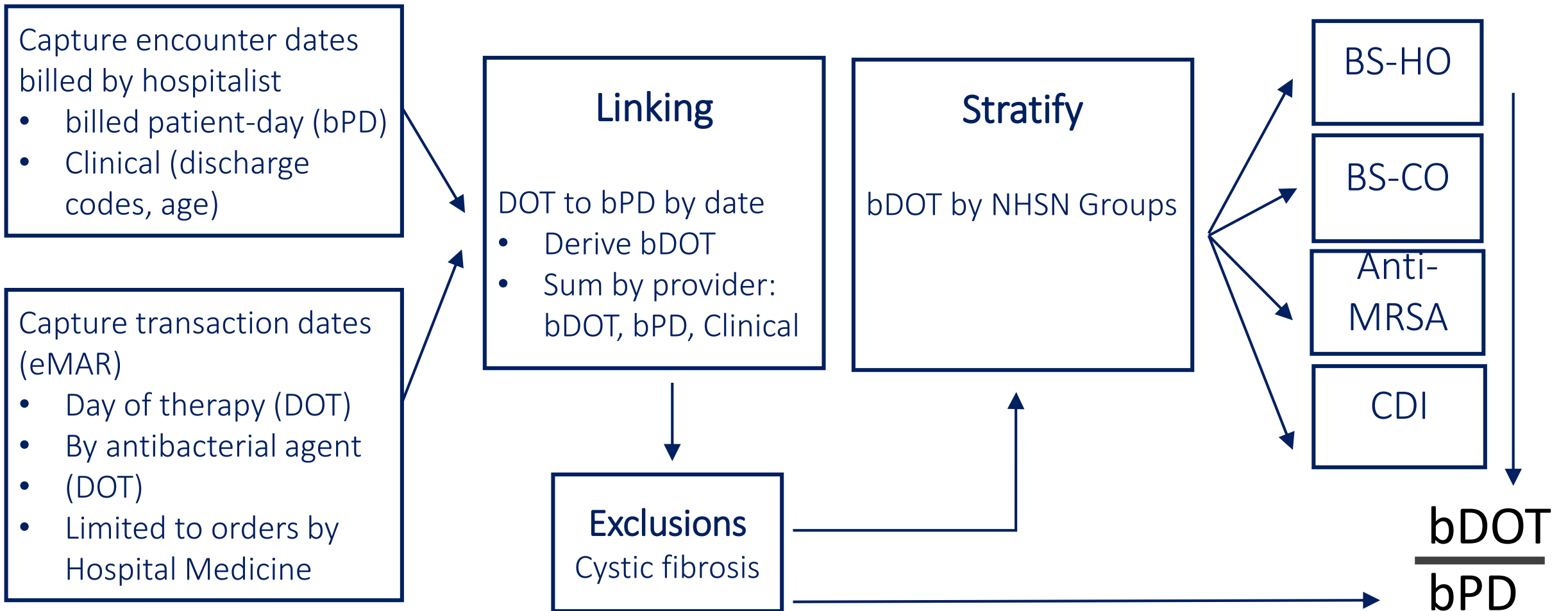


Methods

- Setting: four hospitals within Emory Healthcare
 - 587-bed academic (AMC1)
 - 475-bed academic (AMC2)
 - 375-bed community (CH1)
 - 125-bed community (CH2)
- Population
 - Hospitalists who billed for inpatient care
- Time Frame
 - January 2016 – December 2018
- Data Source: Clinical Data Warehouse



Methods – Hospitalist Prescribing Metric



Hospitalist-Specific Summary Data

- Aggregated all bDOT and bPD per hospitalist and antibiotic category to create hospitalist-specific metric – **bDOT/1000 bPD**
- Aggregated all bPD attributed to patients with confounders
 - Age \geq 65, CCM $>$ 2, ESRD, malignancy, neurological conditions (Neuro), sepsis, pneumonia (PNEU), UTI
 - Calculated % of bPD attributed to patients with each confounder for each hospitalist
- Excluded hospitalists with $<$ 80 bPD



Predictive Modeling and Comparative Analysis

- Generated hospital and antibiotic category-specific models (16 models)
 - Best subsets regression
- Predicted hospitalist-specific bDOT for each antibiotic category
 - Calculated **observed:expected (O:E)** ratios for each hospitalist and antibiotic category
- Kruskal-Wallis & pairwise Wilcoxon rank-sum tests determined significant differences between hospitalist-specific bDOT/1000 bPD and O:E

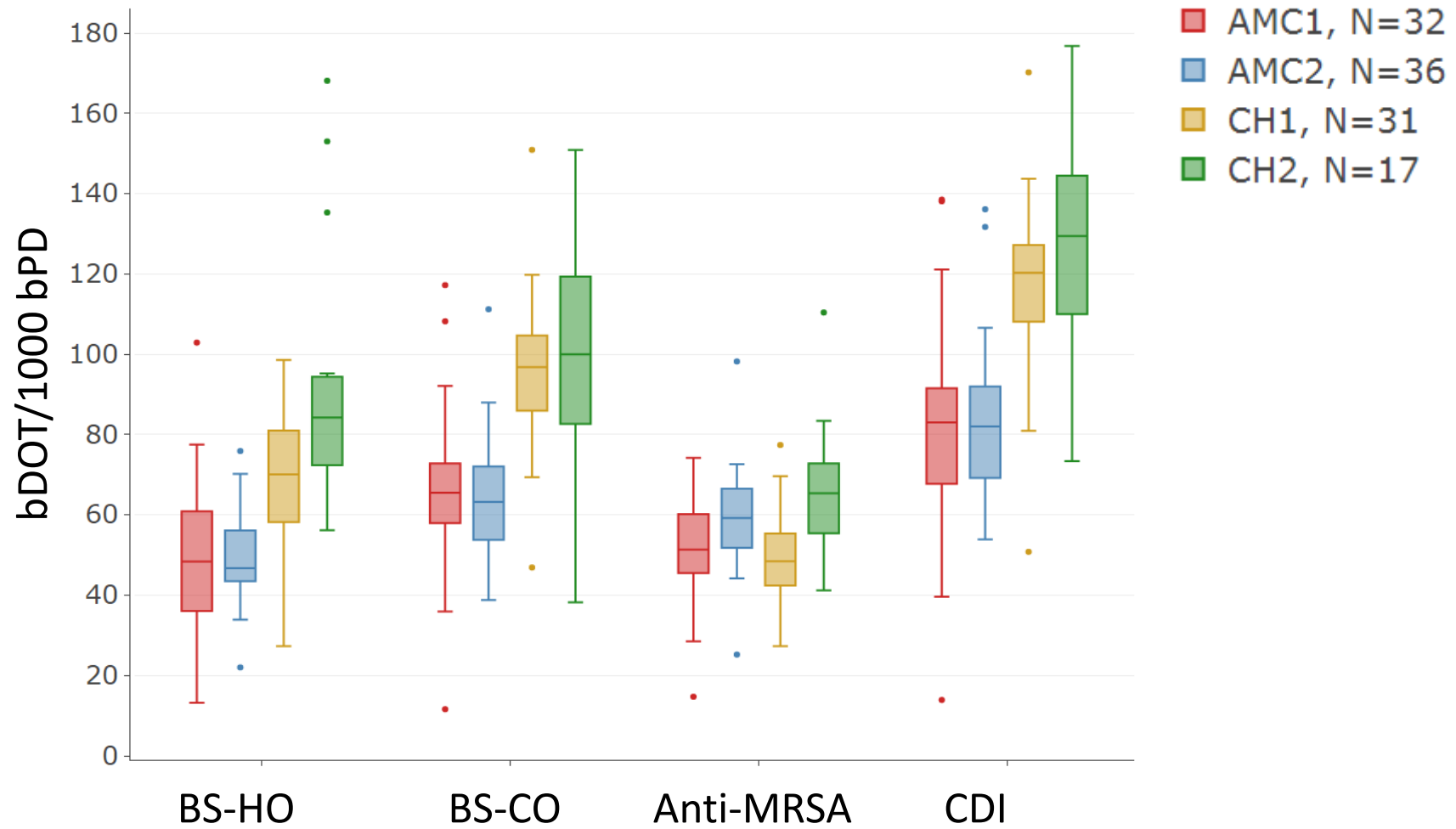


Total Pooled Hospitalist-Specific Prescribing Rate by Hospital

				Crude Prescribing Rate (bDOT/1000 bPD)		
Hospital	No. Hospitalists	Total bPD	Total bDOT	Median	Range	p-value
AMC1	32	119,202	19,679	158.4	12.4 – 262.0	Ref
AMC2	36	153,484	26,146	169.3	107.3 – 252.1	0.0009
CH1	31	105,557	23,595	221.4	101.6 – 278.2	< 0.0001
CH2	17	58,510	16,392	251.4	176.3 – 374.4	< 0.0001



Variation in Hospitalist-Specific Crude Antibiotic Prescribing Rate, by NHSN Category and Hospital



Predictive Models of Prescribing by NHSN Category - CH2

		Parameters								Model Fit		
Facility	ABX Group	Age ≥ 65	UTI	Sepsis	PNEU	ESRD	CCM > 2	Malignancy	Neuro	Adjusted R ²	F-Statistic	p-value
CH2	BS-HO	-			+		+			0.94	83.6	< 0.0001
	BS-CO	+	+				-		-	0.79	15.7	0.0001
	Anti-MRSA		+	+	-			-		0.76	13.7	0.0002
	CDI	+	+				+		-	0.80	16.7	< 0.0001

+ = positive parameter estimate; - = negative parameter estimate; blank = not included in model



Predictive Models of Prescribing by NHSN Category - AMC2

		Parameters								Model Fit		
Facility	ABX Group	Age ≥ 65	UTI	Sepsis	PNEU	ESRD	CCM > 2	Malignancy	Neuro	Adjusted R ²	F-Statistic	p-value
AMC2	BS-HO		+	-	+	+	-			0.48	7.53	0.0001
	BS-CO	+	+				-			0.43	9.89	< 0.0001
	Anti-MRSA		+			+	-		+	0.52	10.6	< 0.0001
	CDI	+	+				-			0.55	15.3	< 0.0001

+ = positive parameter estimate; - = negative parameter estimate; blank = not included in model

Predictive Models of Prescribing by NHSN Category - CH1

		Parameters								Model Fit		
Facility	ABX Group	Age ≥ 65	UTI	Sepsis	PNEU	ESRD	CCM > 2	Malignancy	Neuro	Adjusted R ²	F-Statistic	p-value
CH1	BS-HO							-		0.16	6.60	0.02
	BS-CO		+	-	+				-	0.50	8.35	0.0002
	Anti-MRSA		-		+		-		-	0.26	3.49	0.021
	CDI		+		+			-	-	0.50	8.02	0.0003

+ = positive parameter estimate; - = negative parameter estimate; blank = not included in model

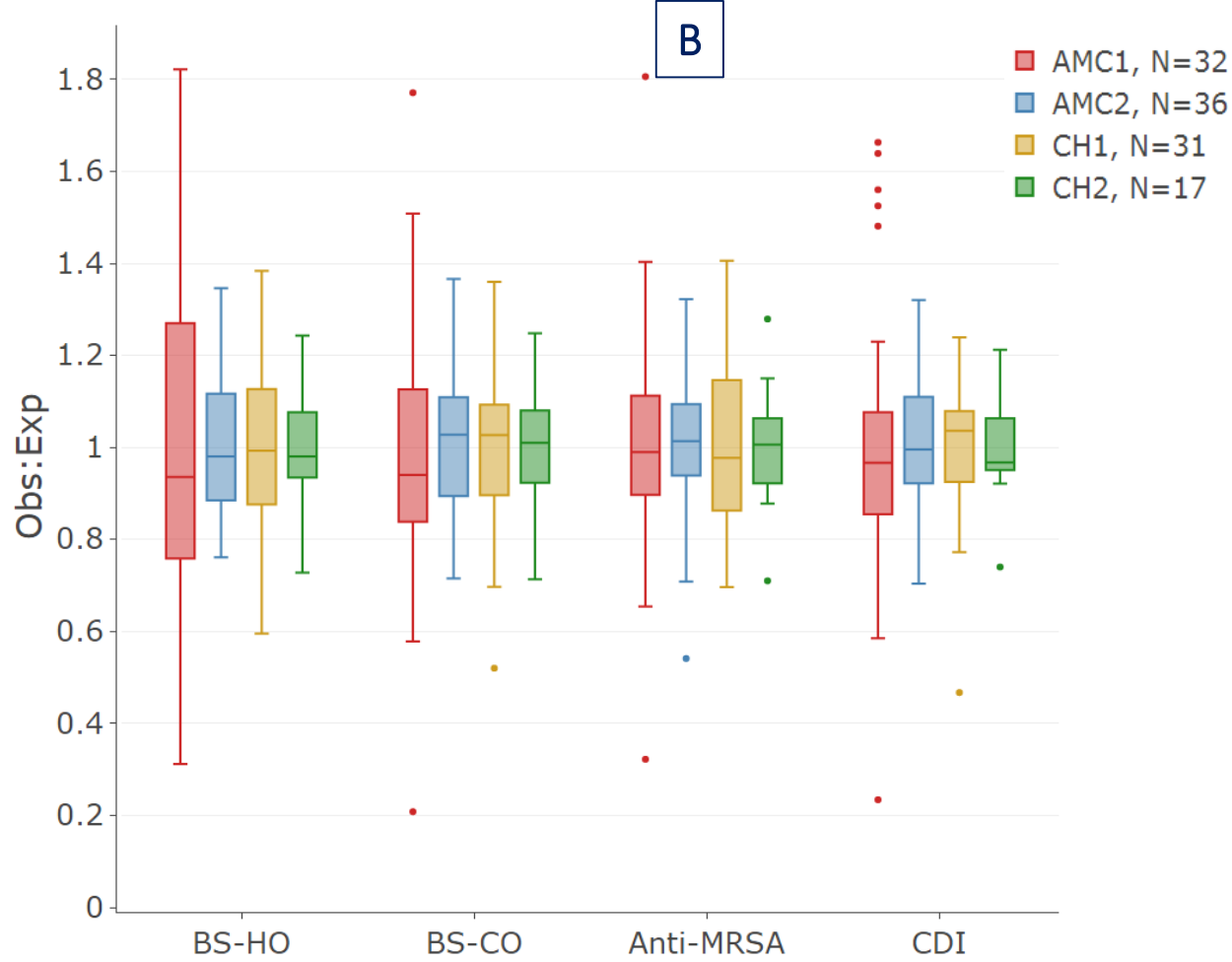
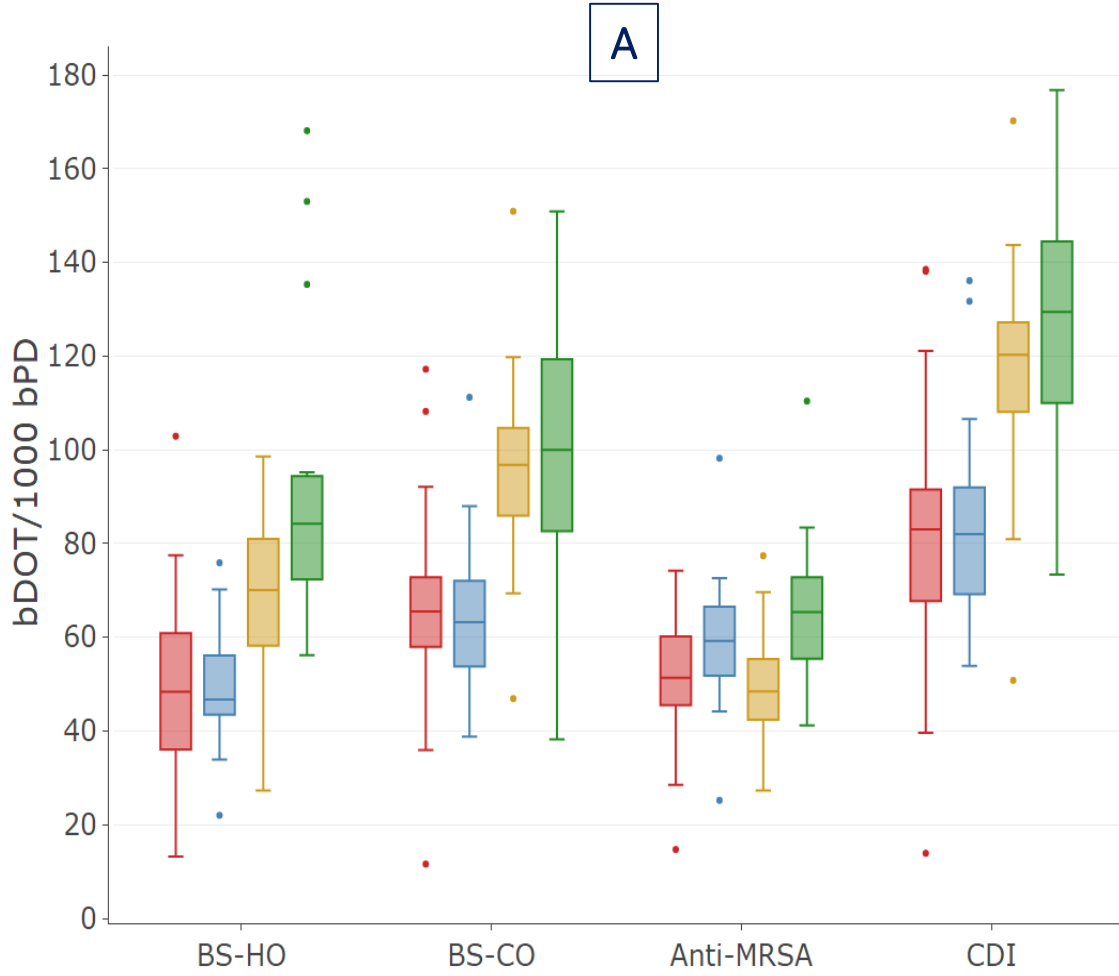


Predictive Models of Prescribing by NHSN Category - AMC1

		Parameters								Model Fit		
Facility	ABX Group	Age ≥ 65	UTI	Sepsis	PNEU	ESRD	CCM > 2	Malignancy	Neuro	Adjusted R ²	F-Statistic	p-value
AMC1	BS-HO	+								0.014	1.45	0.24
	BS-CO		+	+			-			0.28	5.06	0.006
	Anti-MRSA	+		+	-					0.15	2.78	0.06
	CDI	+	+	+			-			0.26	3.76	0.01

+ = positive parameter estimate; - = negative parameter estimate; blank = not included in model

Variation in Hospitalist-Specific Crude Antibiotic Prescribing Rate, (A) and Adjusted O:E (B), by NHSN Category and Hospital



Summary

- By attributing all DOT on a bPD to an individual hospitalist, we derived an inpatient hospitalist-specific prescribing rate
- Rates were risk-adjusted by patient-mix
- Adjusting for patient-mix significantly reduced much of the variation in hospitalist-specific prescribing rate, particularly in the community hospitals
- Patient-mix did not appear to be a primary driver of antibiotic use at AMC1



Limitations

- Model fit at AMC1 was relatively poor for all antibiotic categories
 - Unmeasured patient-mix factors
 - Severity of illness
 - Other comorbidities
 - Unmeasured factors not attributed to patient-mix
 - Experience
 - Use of ID consults
- Reliance on administrative coding to capture comorbidities and diagnoses
- Outlier O:Es have not been reviewed to determine degree of unnecessary antibiotic use



Conclusions and Implications

- A risk adjusted hospitalist-specific prescribing metric can be derived from electronic data sources for peer comparisons
- Variations in hospitalist prescribing rates are reduced greatly with risk adjustment, but not uniformly across different hospital types
- Pursuit of more universally relevant risk adjustment/co-founders is needed
- Validation of adjusted metric would increase clinical credibility and is a next step



Thank You!

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Appendix Slides



This page contains provider-specific information on prescribing rates and Obs/Exp values for BS-HO agents

Obs/Exp (yellow dot) < 1: indicates observed prescribing rate is lower than expected

Obs/Exp (yellow dot) > 1: indicates observed prescribing rate is higher than expected

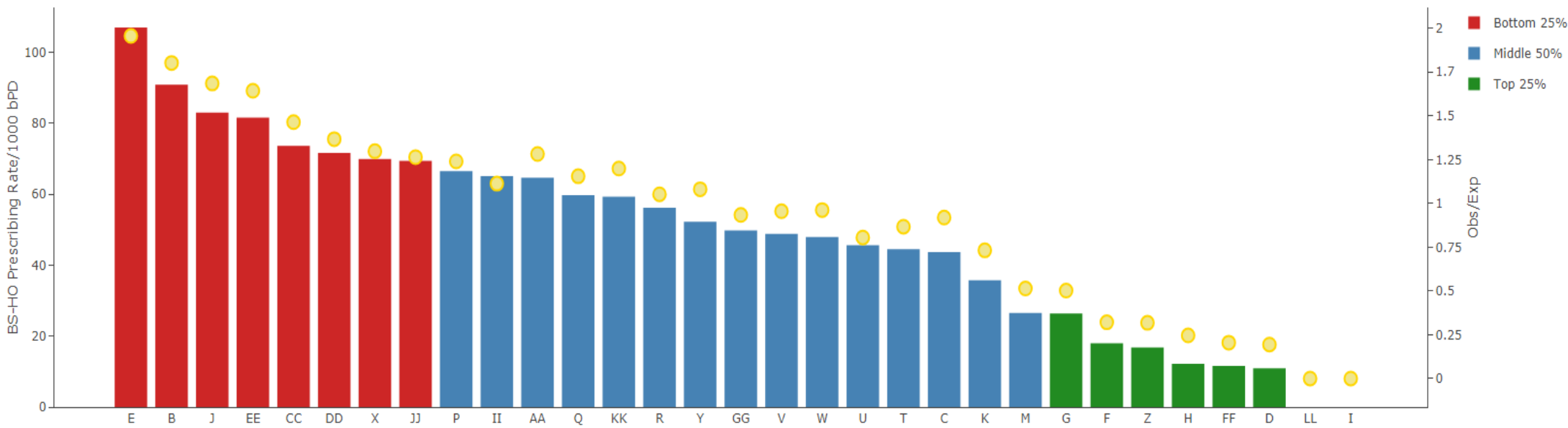
BS-HO Agents: gentamicin (IV only), tobramycin (IV only), amikacin (IV only), piperacillin-tazobactam, ceftazidime, cefepime, imipenem/cilastatin, meropenem, aztreonam (IV only), doripenem

BS-HO Prescribing Predictors: Age >= 65

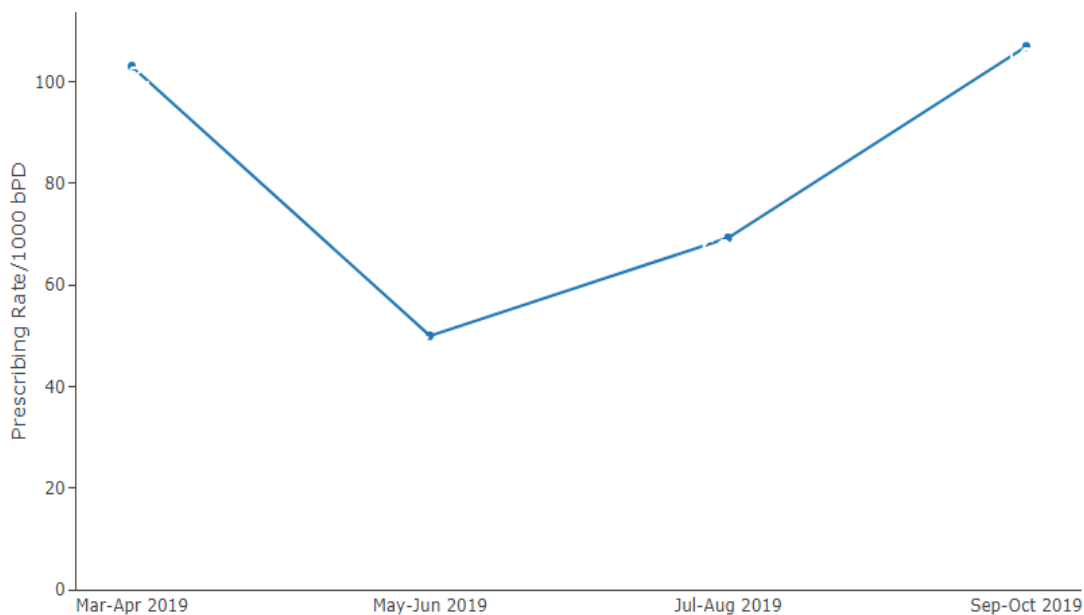
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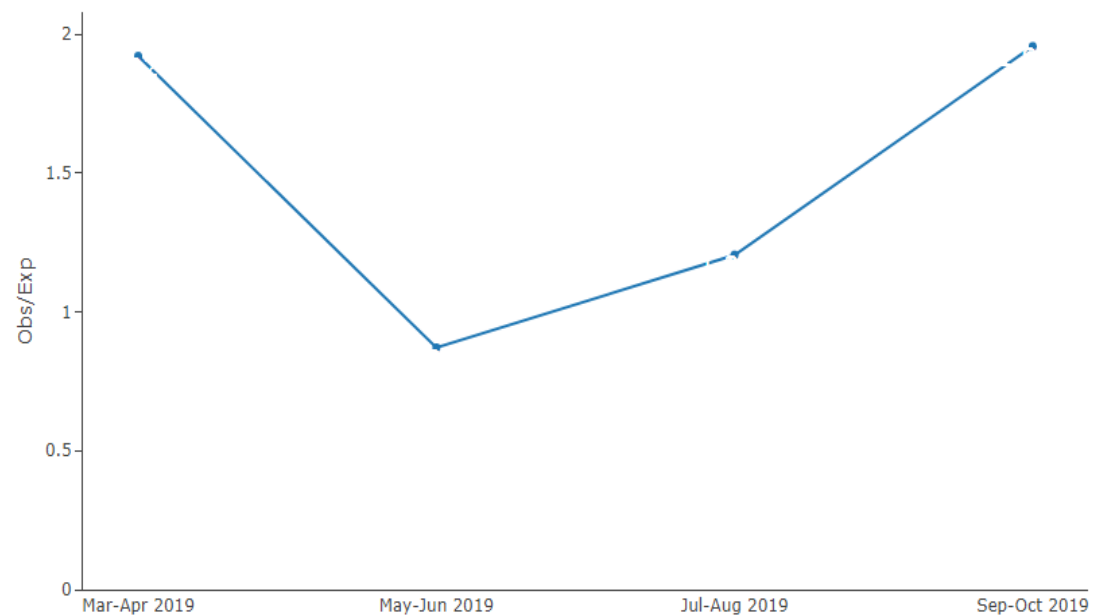
BS-HO Prescribing Rate and Obs/Exp by Provider, Sep-Oct 2019



Provider-Specific Prescribing Rate by Time Period



Provider-Specific Obs/Exp by Time Period



Clinical Data Warehouse Subject Areas

Information	Description	Source	Status
Patient and Provider	Patient, Provider and Location	EeMR, Healthquest , Centricity, IDX	From Sep 1995
	Hospital Visits, Readmissions, Providers, Locations, ADTs	EeMR, Healthquest	From Sep 1998
	Clinic Visits, Providers, Locations	Centricity, IDX	From Sep 1995
Diagnoses, Procedures	Billing Diagnoses and Procedures, (ICD, and CPT)	Healthquest, Centricity, IDX , Meta, HDM	From Sep 1998
	Problem List	EeMR	From Sep 2009
Patient Financial Data	Hospital and Clinic Billings, Payments, Payers, RVUs	Healthquest, Centricity, IDX	From Sep 1998
Laboratory	Chemistry, Microbiology	Pathnet	From Jan 2001
	Anatomic Pathology	Pathnet, CoPath	From Mar 2005
Medications	Prescriptions, Inpatient Orders, EMAR, Inpatient dispensing, Immunizations	EeMR	From Feb 2005
Scheduling	Outpatient Appointment and Resource Scheduling	Centricity, IDX	From Sep 1995
	Capacity Management	Centricity, IDX	From Nov 2008
Emergency Data	Emergency Department Visits, Procedures, Events, Timing	EeMR	From Aug 2002
Clinical Documentation	Powerforms Structured Documents	EeMR, Powerworks	From Aug 2002
	Direct Charting, IView, Medication Reconciliation	EeMR, Powerworks	From Sep 2010
	Powernotes Physician Notes	EeMR	From Feb 2007
	Allergies	EeMR	From May 2005
Orders Management	On-line Orders	EeMR	From Feb 2005
	Detailed Turnaround Timing	EeMR	From Sep 2007
Radiology	Radiology Reports, Room Utilization	EeMR	From Jan 2007



NHSN-Defined Antibiotic Categories

Adult Broad spectrum antibacterial agents predominantly used for hospital-onset infections

- AMIKACIN (IV only)
- AZTREONAM (IV only)
- CEFEPIME
- CEFTAZIDIME
- DORIPENEM
- GENTAMICIN (IV only)
- IMPENEM/CILASTATIN
- MEROPENEM
- PIPERACILLIN/TAZOBACTAM
- TOBRAMYCIN (IV only)

Adult Broad spectrum antibacterial agents predominantly used for community-acquired infections

- CEFACTOR
- CEFDINIR
- CEFIXIME
- CEFOTAXIME
- CEFPODOXIME
- CEFPROZIL
- CEFTRIAXONE
- CIPROFLOXACIN
- CEFUROXIME
- ERTAPENEM
- GEMIFLOXACIN
- LEVOFLOXACIN
- MOXIFLOXACIN

Adult Antibacterial agents predominantly used for resistant Gram-positive infections (e.g., MRSA)

- CEFTAROLINE
- DALBAVANCIN
- DAPTOMYCIN
- LINEZOLID
- ORITAVANCIN
- QUINUPRISTIN/DALFOPRISTIN
- TEDIZOLID
- TELAVANCIN
- VANCOMYCIN (IV only)

Adult Antibacterial agents posing the highest risk for CDI

This category contains antimicrobials that are part of other SAAR categories.

- CEFDINIR
- CEFEPIME
- CEFIXIME
- CEFOTAXIME
- CEFPODOXIME
- CEFTAZIDIME
- CEFTRIAXONE
- CIPROFLOXACIN
- CLINDAMYCIN
- GEMIFLOXACIN
- LEVOFLOXACIN
- MOXIFLOXACIN

(1) Appendix E: Antimicrobial Groupings for SAAR and Rate Table Calculations. Antimicrobial Use and Resistance (AUR) Module, Centers for Disease Control, <https://www.cdc.gov/nhsn/PDFs/pscManual/11pscAURcurrent.pdf>. Updated January 2020.



ABX Group	Hospital	No. Hospitalists	Total bPD	Total DOT	Hospitalist-Specific Unadjusted Prescribing Rate (DOT/1000 bPD)	
					Median	Range
BS-HO	AMC1	32	119,202	6,180	48.4	13.2 - 102.9
	AMC2	36	153,484	7,666	46.7	22 - 75.9
	CH1	17	58,510	5,605	84.2	56.2 - 168.1
	CH2	31	105,557	7,868	70.1	27.3 - 98.6
BS-CO	AMC1	32	119,202	7,693	65.5	11.6 - 117.2
	AMC2	36	153,484	9,569	63.3	38.8 - 111.2
	CH1	17	58,510	6,509	100	38.2 - 150.9
	CH2	31	105,557	10,455	96.8	46.9 - 150.9
Anti-MRSA	AMC1	32	119,202	6,245	51.4	14.7 - 74.2
	AMC2	36	153,484	9,022	59.3	25.2-98.2
	CH1	17	58,510	4,389	65.4	41.2 - 110.4
	CH2	31	105,557	5,361	48.4	27.3 - 77.4
CDI	AMC1	32	119,202	9,483	83	13.9 - 135.5
	AMC2	36	153,484	12,114	82	53.9 - 136.1
	CH1	17	58,510	7,730	129.4	73.4 - 176.8
	CH2	31	105,557	12,873	120.3	50.8 - 170.2

