Reducing Unnecessary Antibiotic Treatment for Asymptomatic Bacteriuria:
Diagnostic vs. Antibiotic Stewardship

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Disclosures: Work Supported by BCBSM, AHRQ, CDC, Gordon and Betty Moore Foundation

Background

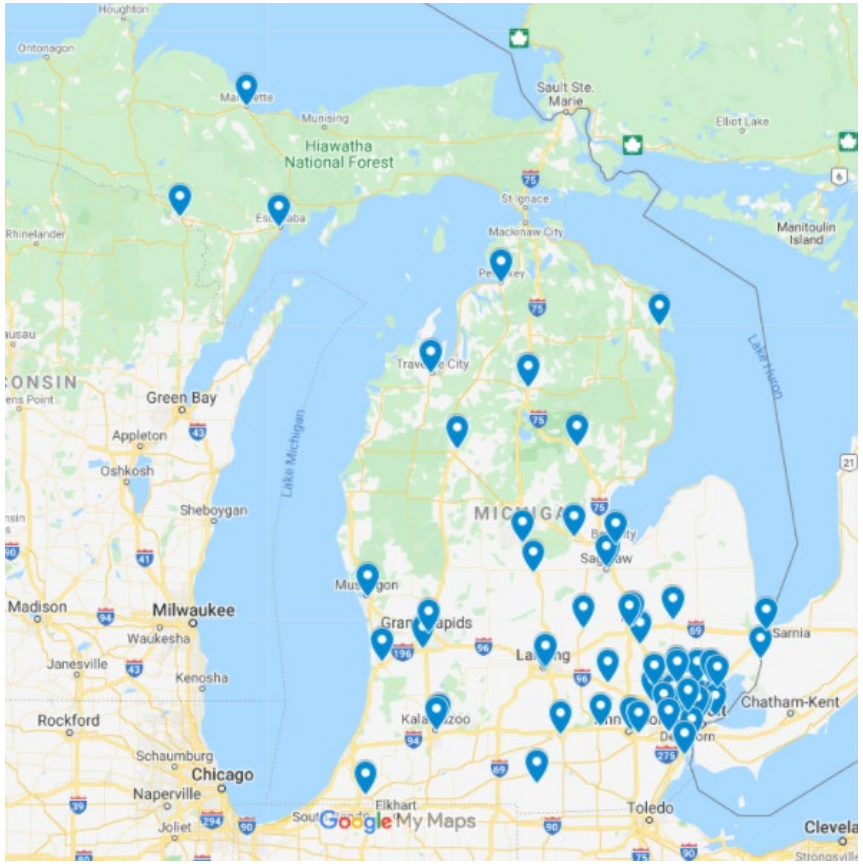
- Asymptomatic bacteriuria
  - Common in hospitalized patients
  - Antibiotic treatment does NOT improve outcomes
  - Antibiotic treatment DOES increase risk of antibiotic side effects, resistance, and for hospitalized patients→increases LOS

- Despite national guidelines recommending against treatment
  - Up to 80% of hospitalized patients with ASB receive antibiotics

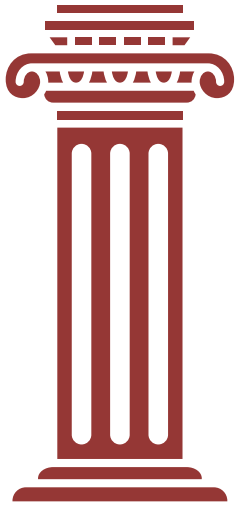
Nicolle et al. *Clin Infect Dis* 2019;
Petty et al. *JAMA IM* 2019;
Harding et al. *N Engl J Med* 2002

Michigan Hospital Medicine Safety Consortium

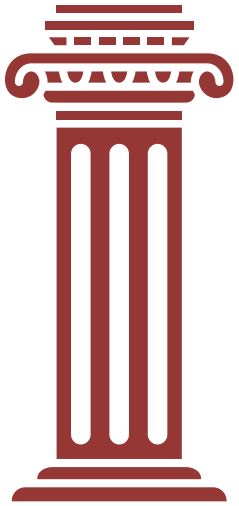
- Consortium of 69 hospitals (and growing) from around the state of Michigan
  - Our analysis based on 46 hospitals that participated from July 2017 – March 2020
- Supported by Blue Cross and Blue Shield of Michigan
  - Data abstraction (chart review)
  - Tri-annual meetings
  - Pay for performance



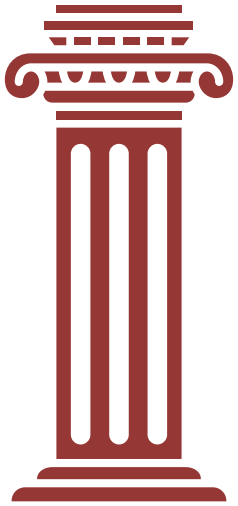
3 Pillars of Improvement



Data for Benchmarking



Sharing Best Practices



Pay-for-Performance

Vaughn et al. *Clin Infect Dis* 2022

Aims

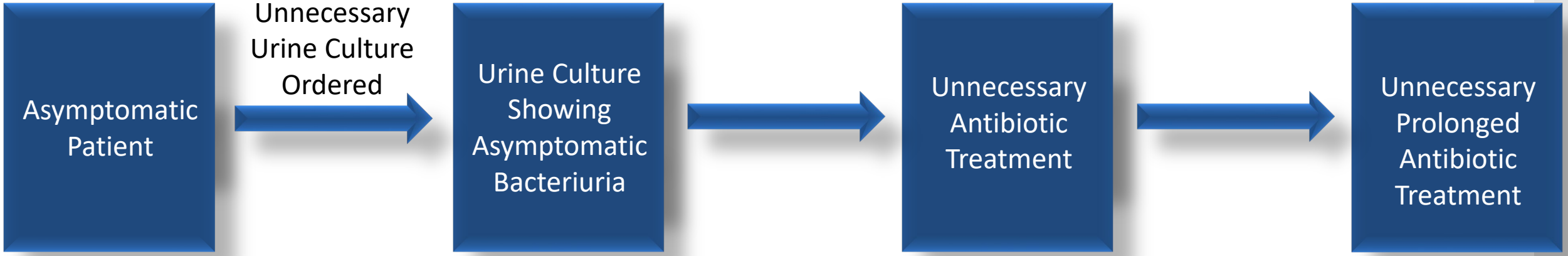
Did HMS successfully reduce ASB treatment?

- Did diagnostic vs. antibiotic stewardship result in most of the gains?

The Pathway to Antibiotic Overuse in Hospitalized Patients with ASB

Asymptomatic Patient

The Pathway to Antibiotic Overuse in Hospitalized Patients with ASB



The Pathway to Antibiotic Overuse in Hospitalized Patients with ASB

*Oversimplification as some diagnostic stewardship or antibiotic stewardship interventions target multiple steps in the pathway

Morgan et al. *JAMA* 2017
Advani et al. *Curr Infect Dis Rep* 2021

Included Patients

- Hospitalized general care, medicine patient with a positive urine culture
  - Local definition of "positive"
  - Pseudo-random selection (~16 patients/2 weeks)

- ASB
  - Asymptomatic
  - Altered mental status without systemic signs of infection

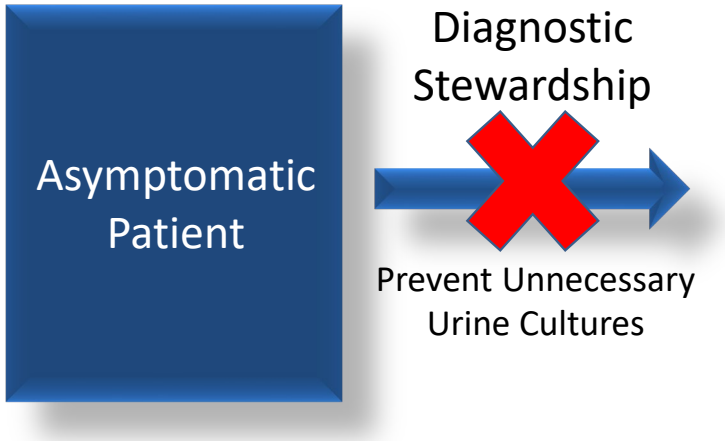
Did HMS successfully reduce ASB treatment?

Outcome

- % of patients who were treated for a UTI that actually had ASB
  - (lower is better)
- NQF endorsed metric (#3690)- https://mi-hms.org/inappropriate-diagnosis-urinary-tract-infection-uti-hospitalized-medical-patients

Diagnostic vs. Antibiotic Stewardship

Diagnostic Stewardship



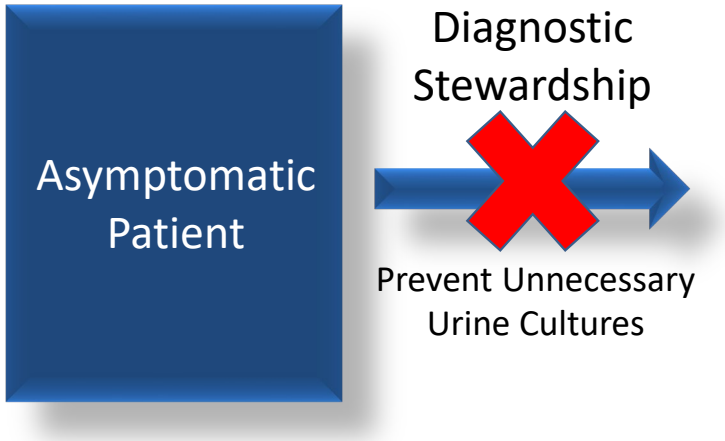
Fewer ASB cases

More UTI cases

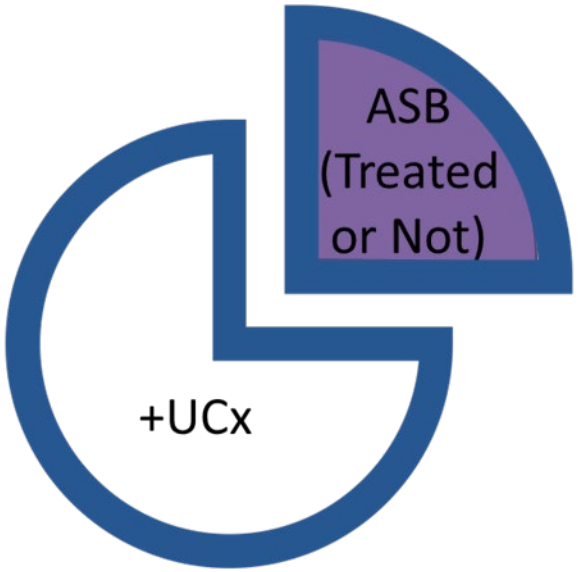
<u>ASB (Treated or Not Treated)</u>

+UCx

Diagnostic Stewardship



Fewer ASB cases
More UTI cases



Antibiotic Stewardship

Asymptomatic Patient → Urine Culture Showing Asymptomatic Bacteriuria

Antibiotic Stewardship → Prevent Antibiotic Use in Response to Unnecessary Cultures

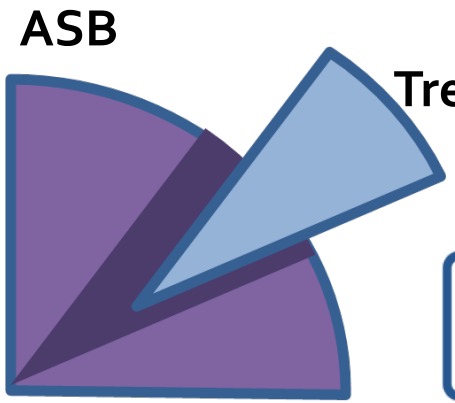
Urine Culture Showing Asymptomatic Bacteriuria → Unnecessary Antibiotic Treatment

Antibiotic Stewardship → Stop or Shorten Unnecessary Antibiotic Duration

Unnecessary Antibiotic Treatment → Unnecessary Prolonged Antibiotic Treatment

<u>ASB Treated with Antibiotics</u>
ASB

ASB Treatment Duration



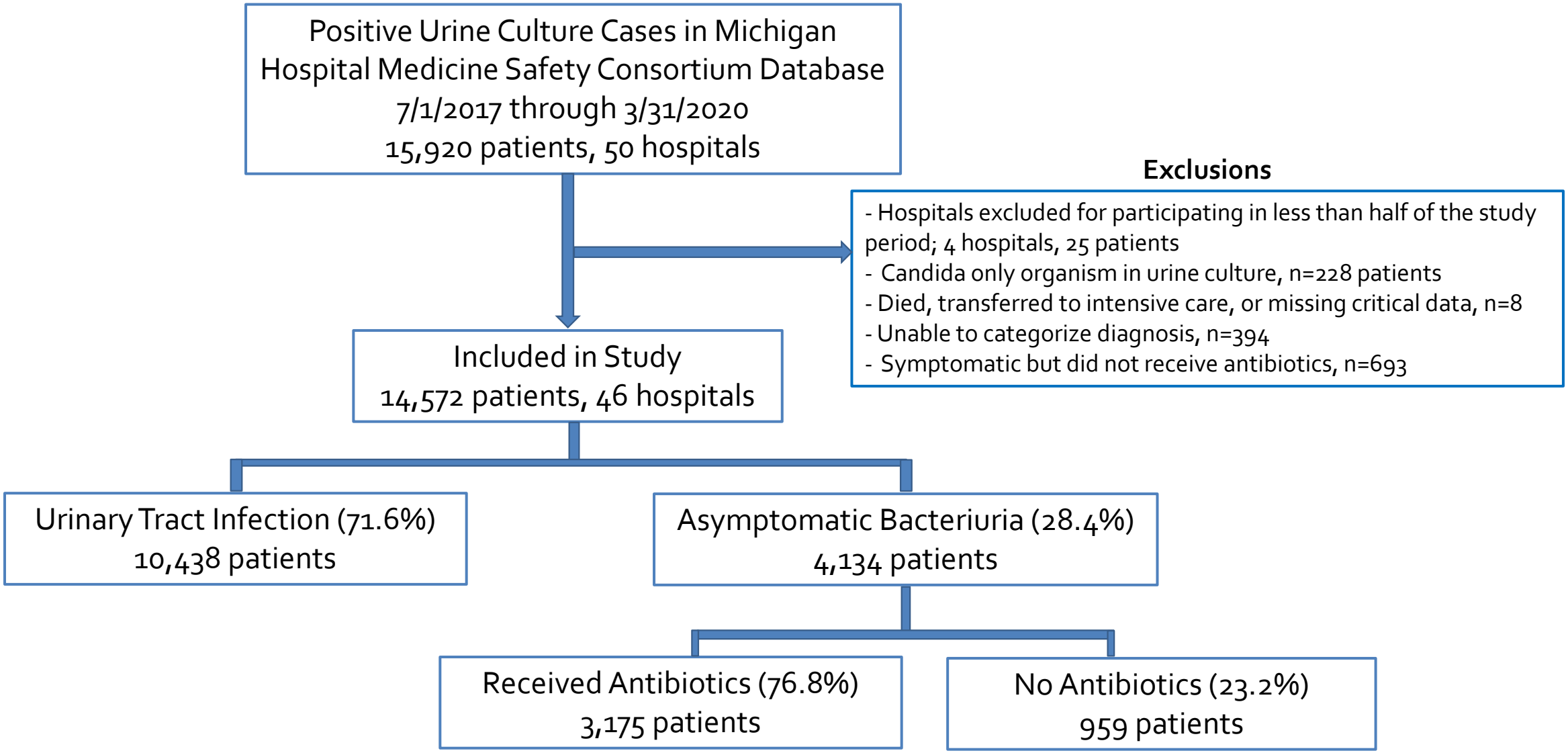
Diagnostic vs. Antibiotic Stewardship

Diagnostic Stewardship	Antibiotic Stewardship
ASB (Treated or Not Treated) +UCx	ASB Treated with Antibiotics ASB ASB Treatment Duration

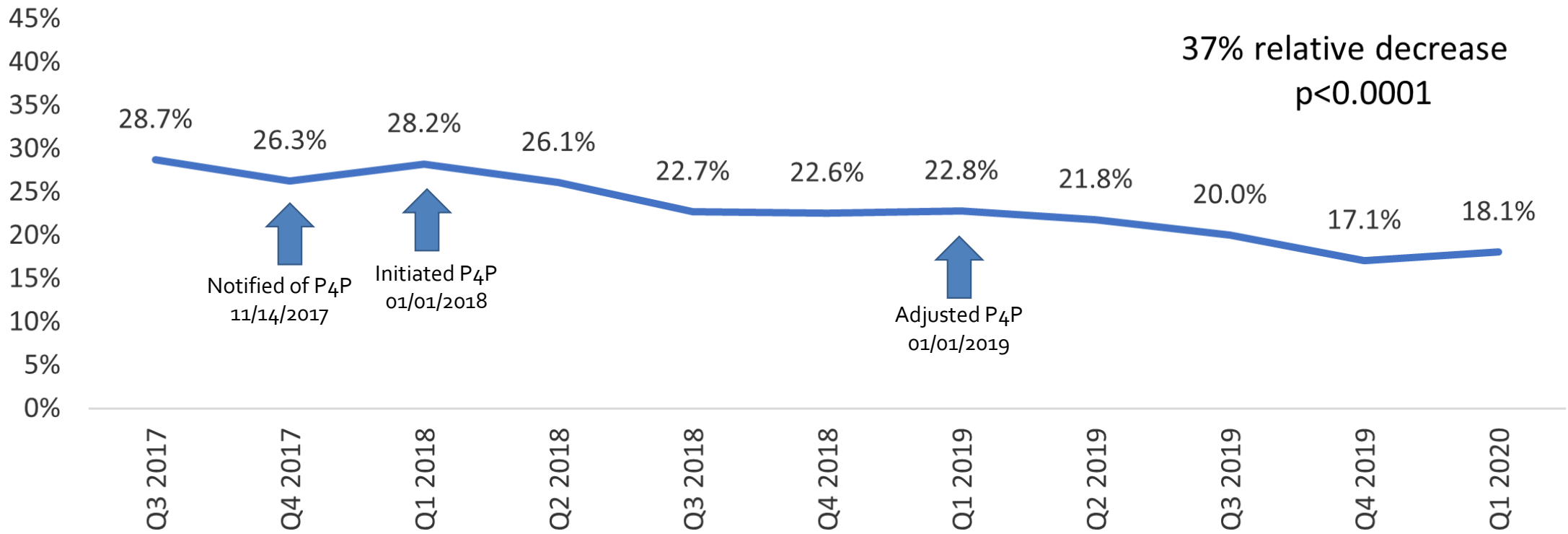
- Assessed via logistic regression (adjusted for hospital clustering)→aOR
  - Change per quarter
  - Random intercepts→baseline differences
  - Random slopes→variation in change over time
- Negative binomial model for treatment duration→aIRR

Results

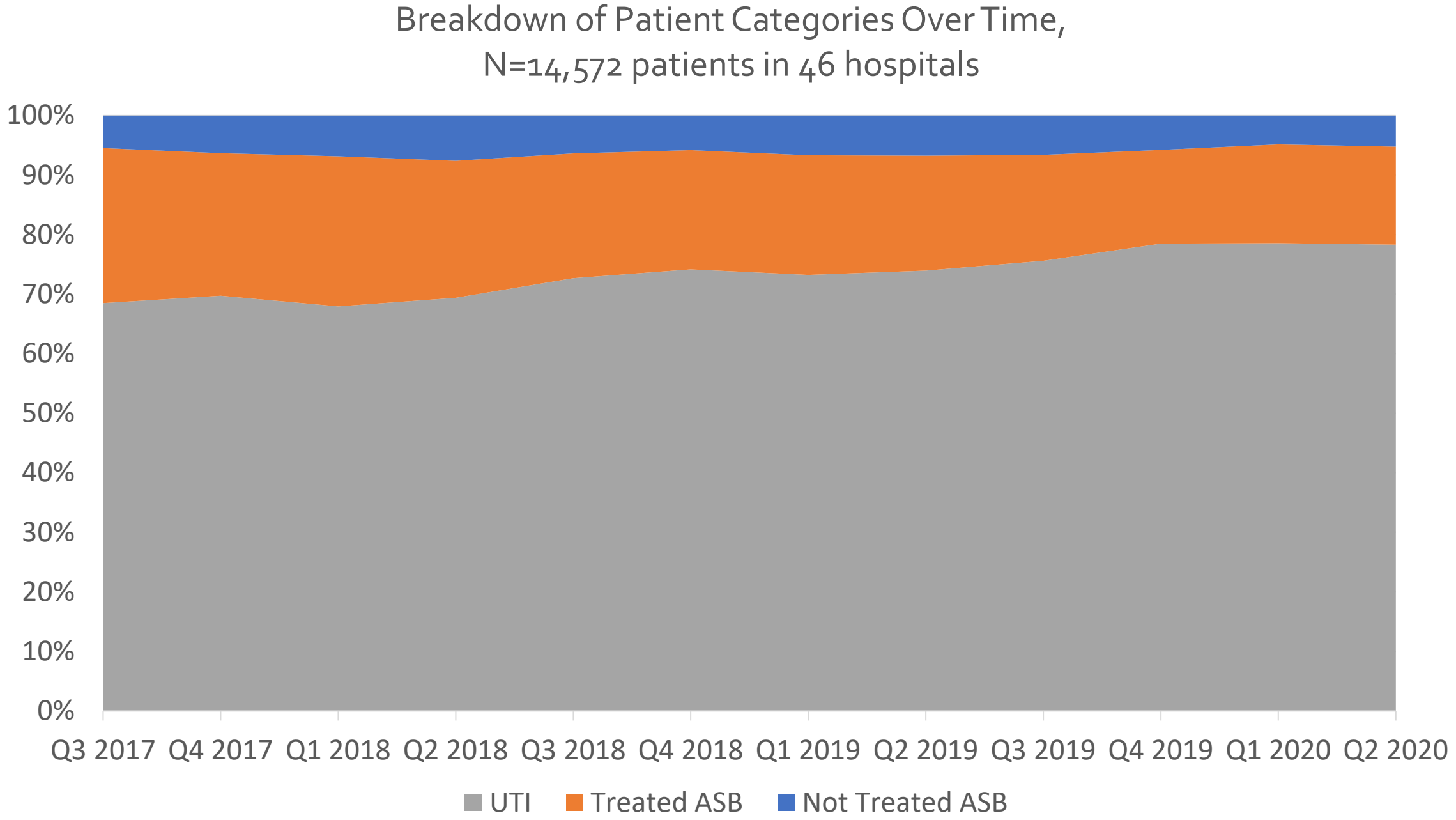
Study Flow Diagram



Percentage of patients treated for a UTI who actually had ASB, over time

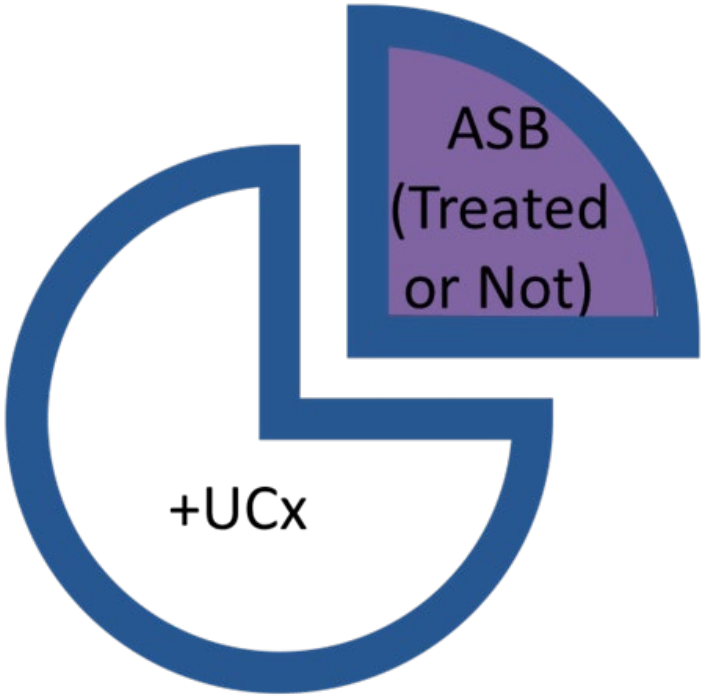


NQF endorsed metric (#3690)- https://mi-hms.org/inappropriate-diagnosis-urinary-tract-infection-uti-hospitalized-medical-patients

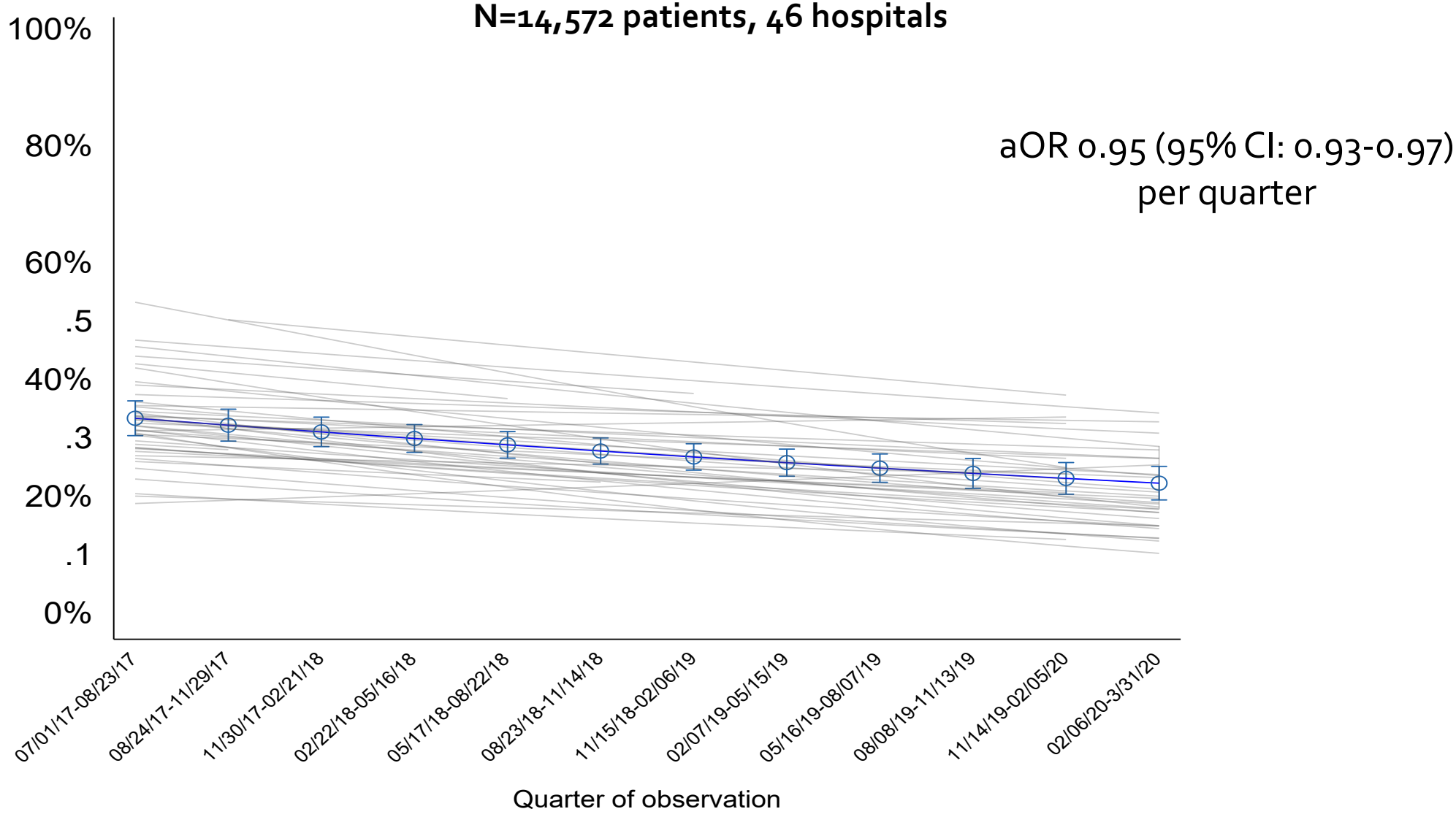

Breakdown of Patient Categories Over Time,
N=14,572 patients in 46 hospitals
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Q3 2017
Q4 2017
Q1 2018
Q2 2018
Q3 2018
Q4 2018
Q1 2019
Q2 2019
Q3 2019
Q4 2019
Q1 2020
Q2 2020
UTI
Treated ASB
Not Treated ASB

Diagnostic vs. Antibiotic Stewardship

Diagnostic Stewardship



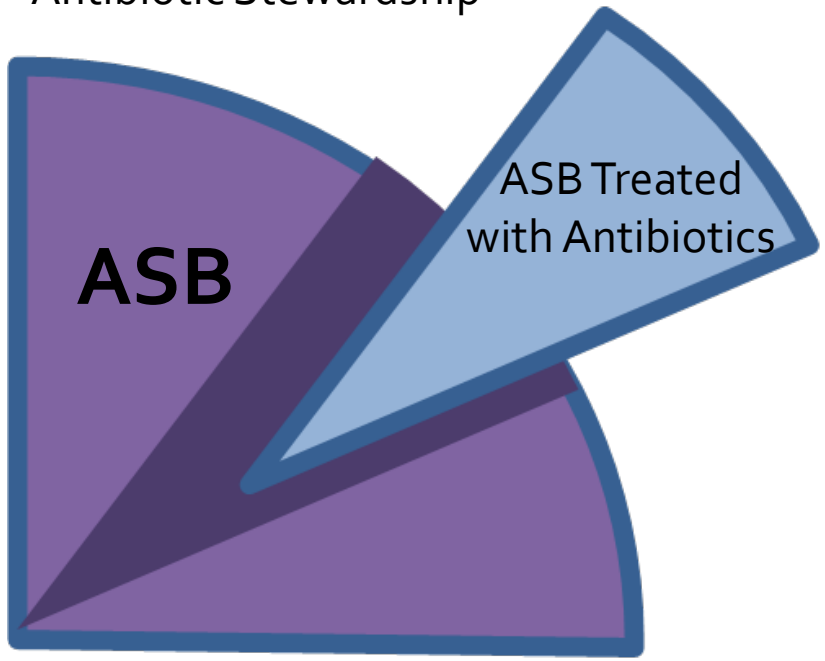
Percent of Patients with a Positive Urine Culture who Had ASB Over Time (Predicted Probability Over Time)
N=14,572 patients, 46 hospitals



aOR 0.95 (95% CI: 0.93-0.97) per quarter

Diagnostic vs. Antibiotic Stewardship

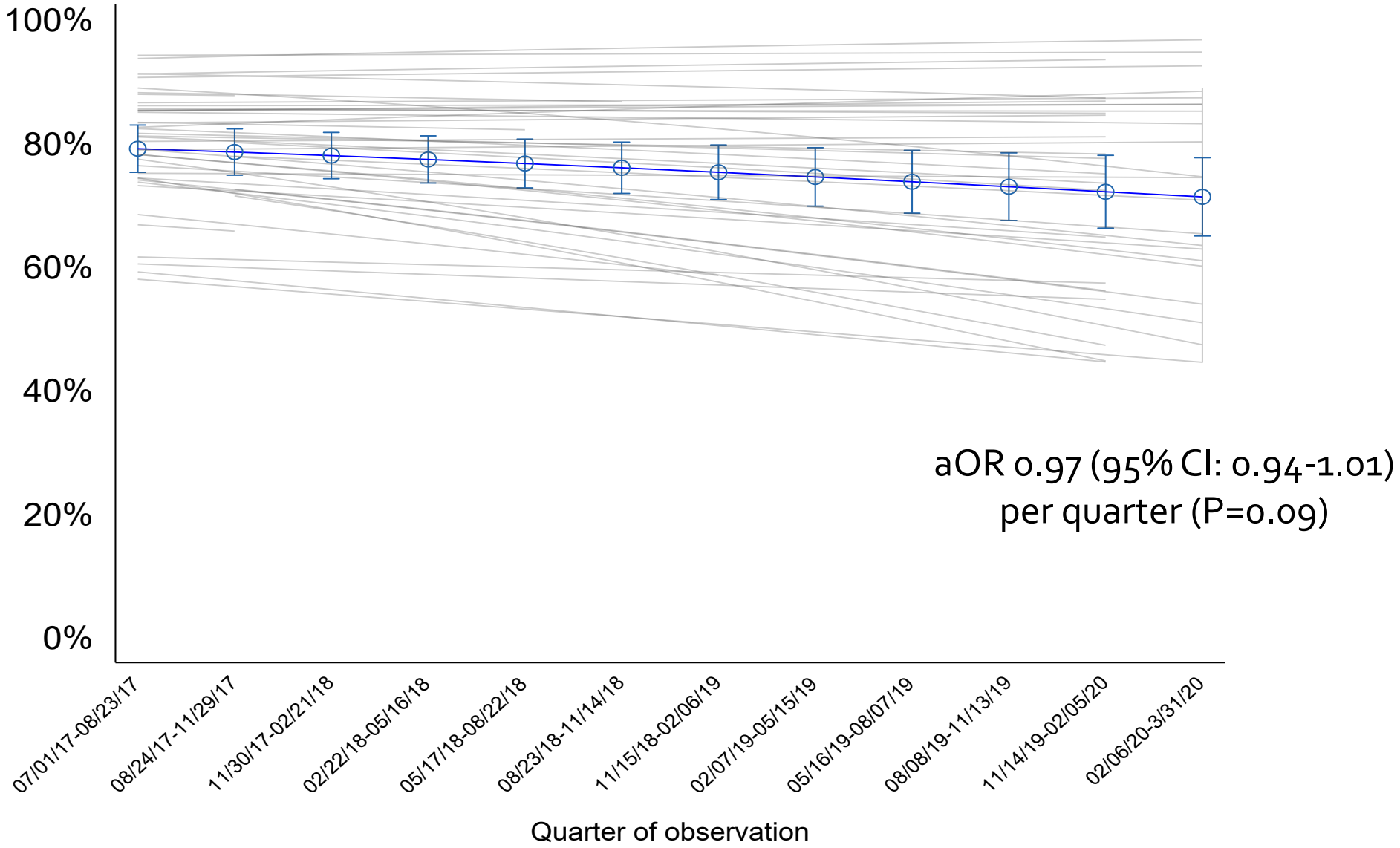
Antibiotic Stewardship



AND

ASB Treatment Duration

Percent of Patients with ASB who were Treated with Antibiotics (Predicted Probability Over Time)



aOR 0.97 (95% CI: 0.94-1.01) per quarter (P=0.09)

ASB Treatment Duration

- In patients with ASB who received antibiotic therapy
  - Median (IQR) duration of therapy was 6 (4-8) days
    - Median at discharge: 2 (0-5) days
  - 84.3% received ≥3 days
- After adjusting for hospital clustering
  - Mean duration decreased only slightly—if at all
    - 6.38 days (95% CI: 6.00,6.78) to 5.93 (95% CI: 5.54,6.35)
  - aIRR 0.99 per quarter (95% CI: 0.99-1.00, P=0.045)

Summary

- Over time, HMS resulted in reduced treatment of ASB
  - Percent of patients treated for a UTI that actually had ASB (NQF Metric) decreased by ~ 1/3
- Reduction driven by diagnostic stewardship
  - % of + urine cultures that were ASB significantly decreased
    - aOR 0.95 (95% CI: 0.93-0.97)
  - % of ASB that was treated with antibiotics did NOT decrease
  - ASB duration marginally decreased (<0.5 days/3 years)

Limitations

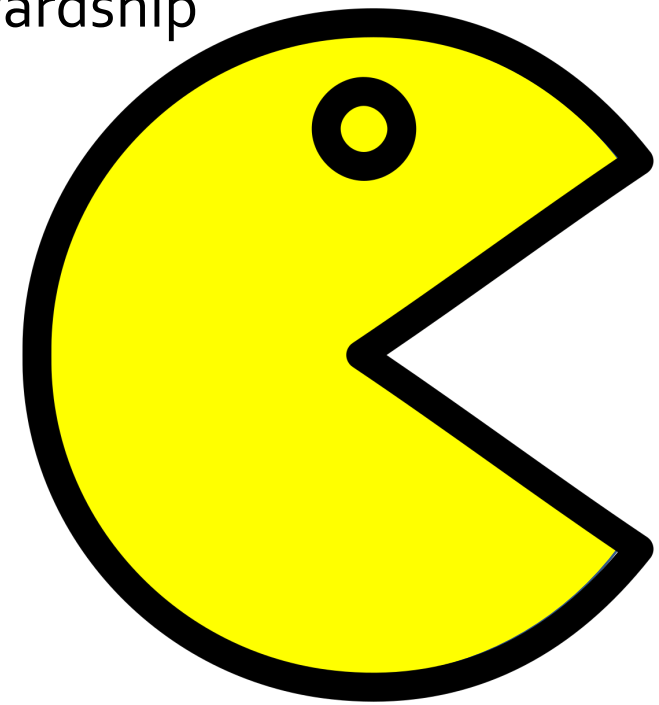
- Do not have data on urine cultures over time
  - Saw reductions in urine cultures in HMS-wide 2-week point prevalence survey in 2018 vs. 2019
  - Internal data from academic healthcare systems in HMS confirms reduction in urine cultures per 1000 patient-days
- Do not have data on patients where urine cultures were avoided
  - Some many have received antibiotic therapy anyway
- Relied on medical record data
  - Did not see evidence of changes in documentation (objective signs remained stable over time)

Other thoughts

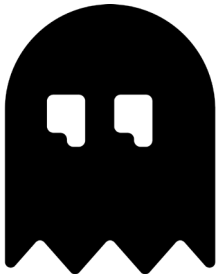
- Antibiotic stewardship and diagnostic stewardship are often not dichotomous, separate interventions
  - Bundled interventions
  - Overlapping/same teams
  - Diagnostic stewardship often included within antibiotic stewardship activities (e.g., education, audit and feedback)
  - Though the average hospital did not see a reduction in the % of patients with ASB who were treated with antibiotics… some did!

Conclusion

Diagnostic Stewardship



Antibiotic Stewardship



Thanks…

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Tejal Gandhi, MD

Questions?

Keep In Touch!

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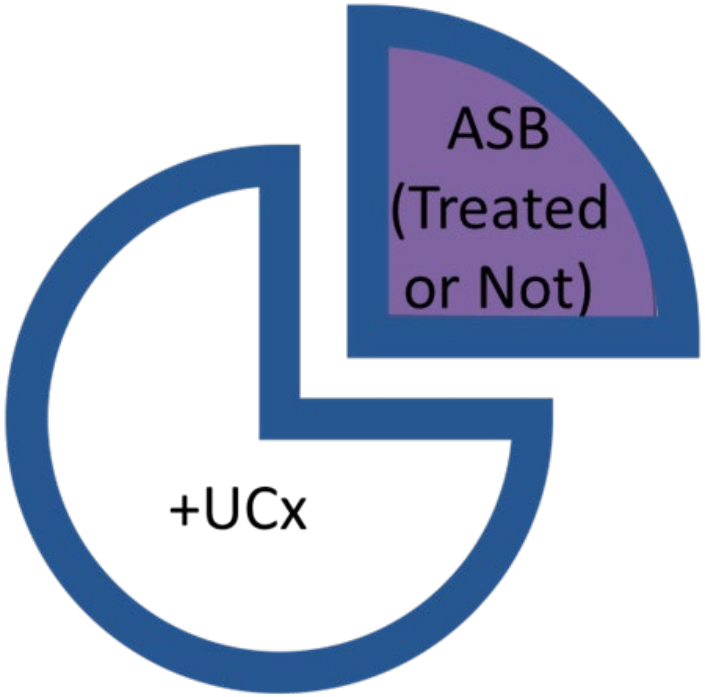
Diagnostic Stewardship



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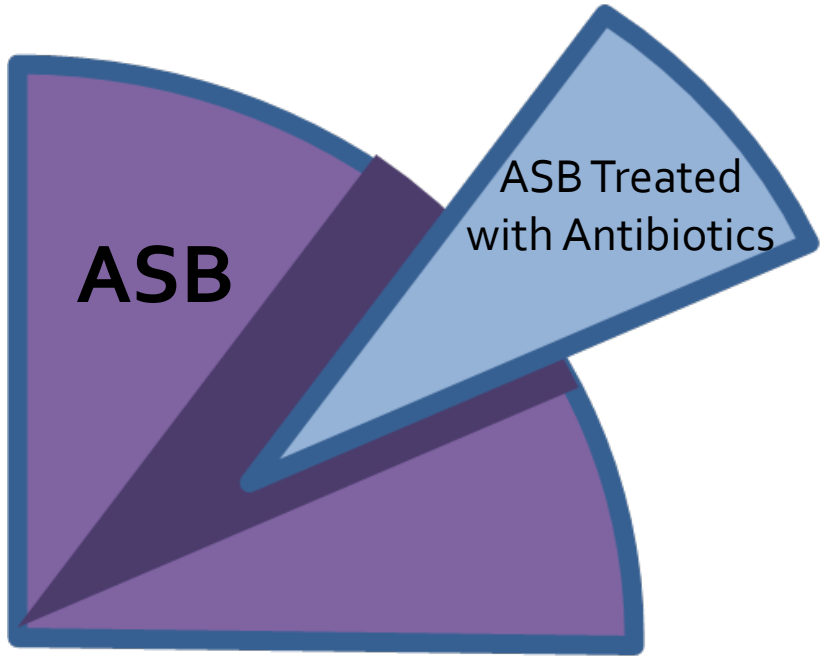
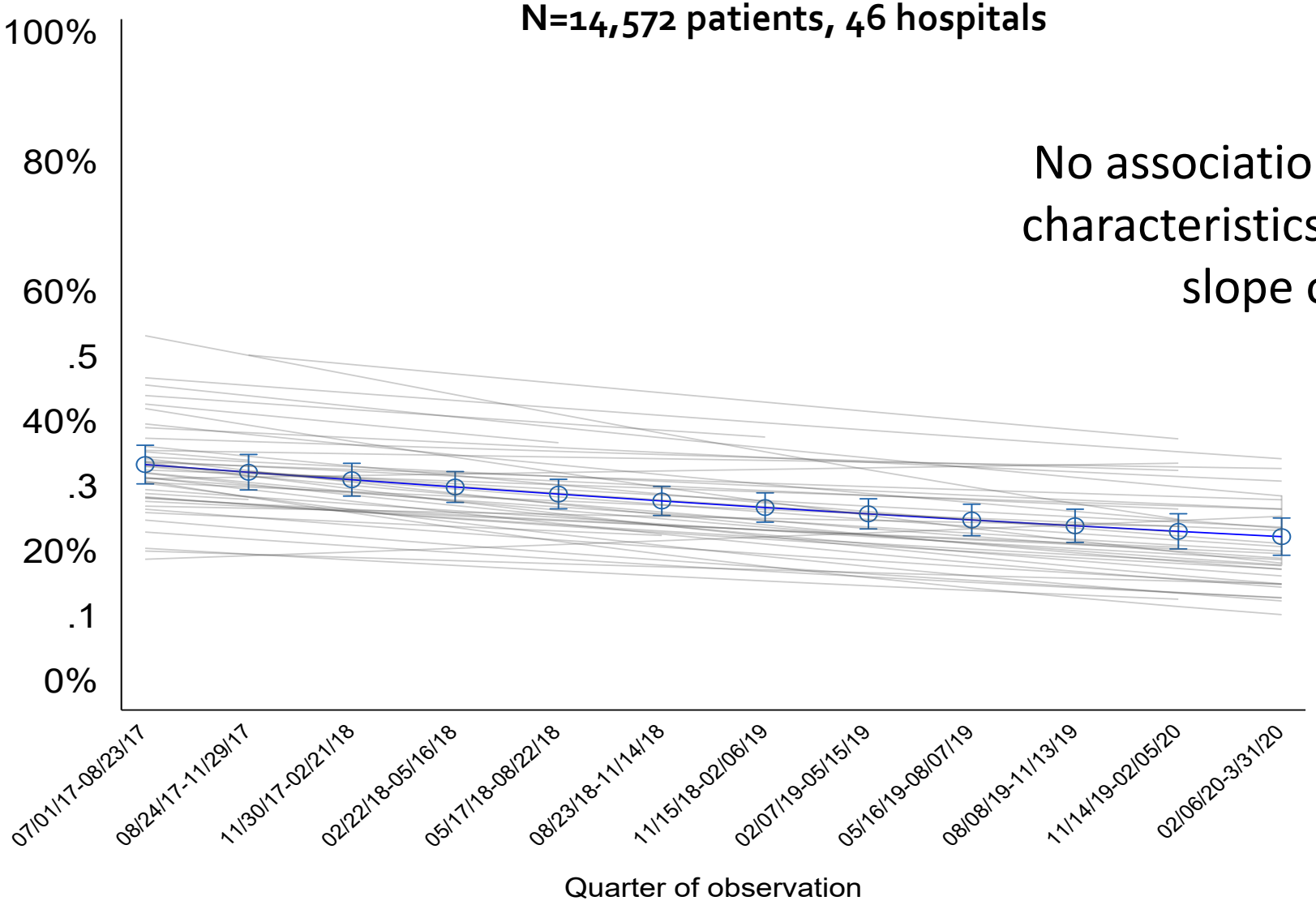


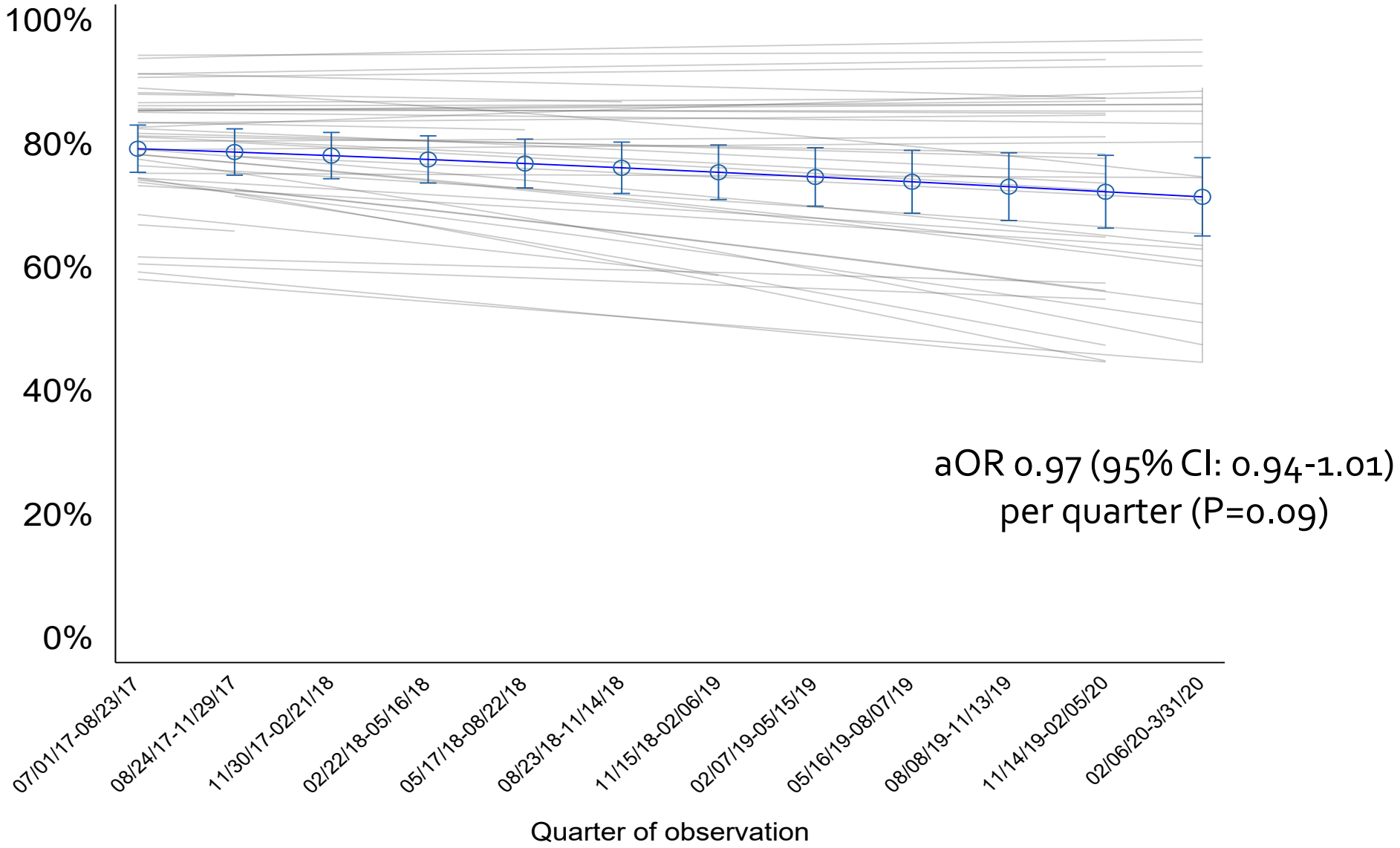
Did ASB Treatment Differ by Hospital Characteristics?

Percent of Patients with a Positive Urine Culture who Had ASB Over Time (Predicted Probability Over Time)
N=14,572 patients, 46 hospitals



No association of any hospital characteristics with baseline or slope of change

Percent of Patients with ASB who were Treated with Antibiotics (Predicted Probability Over Time)



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Did ASB Treatment Differ by Hospital Characteristics?

Association of Hospital Characteristics with Baseline Rate and Change in the Percentage of Hospitalized Patients with ASB Who Were Treated for a UTI; N=46 hospitals with 4,134 Patients

Hospital Characteristic	N (%) of hospitals, N=46 Hospitals	Interaction Effect with Baseline Treatment	Interaction Effect with Change Over Time
Antibiotic Stewardship Team Leader			
ID Physician and ID Pharmacist	18 (46.2%)	REF	REF
ID Physician or ID Pharmacist	16 (41.0%)	1.28 (0.72-2.27)	1.04 (0.97-1.12)
Non-ID trained	5 (12.8%)	0.75 (0.30-1.89)	1.11 (0.99-1.25)
Academic Hospital	38 (82.6%)	0.94 (0.46-1.91)	1.03 (0.93-1.15)
Rurality (RUCC Score)	2 (1-3)	0.95 (0.83-1.10)	1.00 (0.98-1.02)
1-3 (non-rural)	37 (80.4%)	REF	REF
4-9 (rural)	5 (10.9%)	1.35 (0.49-3.73)	0.92 (0.75-1.11)
7-9 (very rural)	4 (8.7%)	0.68 (0.28-1.66)	1.06 (0.93-1.20)
Bed Size; median (IQR)	308 (186-443)	0.96 (0.86-1.06)	1.00 (0.98-1.01)

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Bed Size; median (IQR)	308 (186-443)	0.96 (0.86-1.06)	1.00 (0.98-1.01)
Profit Type[c]			
Non-profit	39 (84.8%)	REF	REF
For profit	5 (10.9%)	0.74 (0.34-1.63)	**1.12 (1.01-1.23)***
System			
Independent	4 (8.7%)	**3.69 (1.14-11.89)***	**0.75 (0.64-0.88)***
State	19 (41.3%)	0.74 (0.44-1.25)	**0.93 (0.88-0.99)***
National	23 (50.0%)	REF	REF

Table 1. Characteristics of Included Patients with UTI or ASB, by Receipt of Antibiotic Therapy
N=14,572 patients across 46 hospitals

Patient Characteristic	UTI Treated with Antibiotics N=10,438	ASB Treated with Antibiotics N=3,175	ASB Not Treated with Antibiotics, N=959
Gender; n (%)			
Male	3250 (31.1%)	780 (24.6%)	262 (27.3%)
Female	7184 (68.8%)	2394 (75.4%)	697 (72.7%)
Race; n (%)			
White	7767 (74.4%)	2357 (74.2%)	749 (78.1%)
Black	2209 (21.2%)	687 (21.6%)	177 (18.5%)
Asian	64 (0.6%)	10 (0.3%)	4 (0.4%)
American Indian	25 (0.2%)	11 (0.3%)	2 (0.2%)
Native Islander	17 (0.2%)	4 (0.1%)	4 (0.4%)
Other	181 (1.7%)	41 (1.3%)	15 (1.6%)
Unknown	175 (1.7%)	65 (2.0%)	8 (0.8%)
Age (years); median (IQR)	75.0 (63.1-84.5)	78.8 (68.0-86.9)	74.7 (63.2-84.3)
≥65 years; n (%)	7501 (71.9%)	2558 (80.6%)	686 (71.5%)
≥80 years; n (%)	3882 (37.2%)	1480 (46.6%)	337 (35.1%)
Insurance Status; n (%)			
Private	1425 (13.7%)	305 (9.6%)	134 (14.0%)
Medicare	7488 (71.7%)	2550 (80.3%)	687 (71.6%)
Medicaid	998 (9.6%)	195 (6.1%)	86 (9.0%)
Uninsured	105 (1.0%)	9 (0.3%)	10 (1.0%)
Missing	422 (4.0%)	116 (3.7%)	42 (4.4%)

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N=14,572 patients across 46 hospitals

Patient Characteristic	UTI Treated with Antibiotics N=10,438	ASB Treated with Antibiotics N=3,175	ASB Not Treated with Antibiotics, N=959
Comorbidities; n (%)			
Presence of indwelling urinary catheter at time of urine culture	1383 (13.3%)	446 (14.1%)	82 (8.6%)
Charlson Comorbidity Index; Median (IQR)	3 (1-5)	3 (1-5)	3 (1-5)
Renal disease	4228 (40.5%)	1325 (41.7%)	398 (41.5%)
Hemodialysis	156 (1.5%)	47 (1.5%)	17 (1.8%)
Liver disease	626 (6.0%)	172 (5.4%)	68 (7.1%)
Congestive heart failure	2356 (22.6%)	829 (26.1%)	311 (32.4%)
COPD	1854 (17.8%)	612 (19.3%)	190 (19.8%)
History of Cancer	2107 (20.2%)	631 (19.9%)	217 (22.6%)
Immune compromise[ł]	363 (3.5%)	99 (3.1%)	35 (3.7%)
Dementia	2090 (20.0%)	832 (26.2%)	127 (13.2%)
Diabetes mellitus	4014 (38.5%)	1208 (38.1%)	387 (40.4%)
Sepsis; n (%)			
≥2 SIRS Criteria	6138 (58.8%)	643 (20.3%)	237 (24.7%)
Severe Sepsis^	2412 (23.1%)	0 (0%)	0 (0%)

ł Defined as chemotherapy administered within 30 days, human immunodeficiency virus positive with a CD4 count greater than 200 cells/mm3, prednisone dose of 10mg/d or more for at least 30 days (or equivalent corticosteroid dose), receiving biologic agents, or congenital or acquired immunodeficiency.

^ Patients with severe sepsis (i.e., ≥2 SIRS criteria plus evidence of end organ damage) who were treated for a UTI were considered, by definition, to have a UTI. Patients were considered to have ASB if, based on chart review, they did not have signs or symptoms of a UTI as defined by national guidelines. Antibiotic therapy was defined as any antibiotic therapy for a UTI regardless of duration (patients with concomitant infections were excluded).

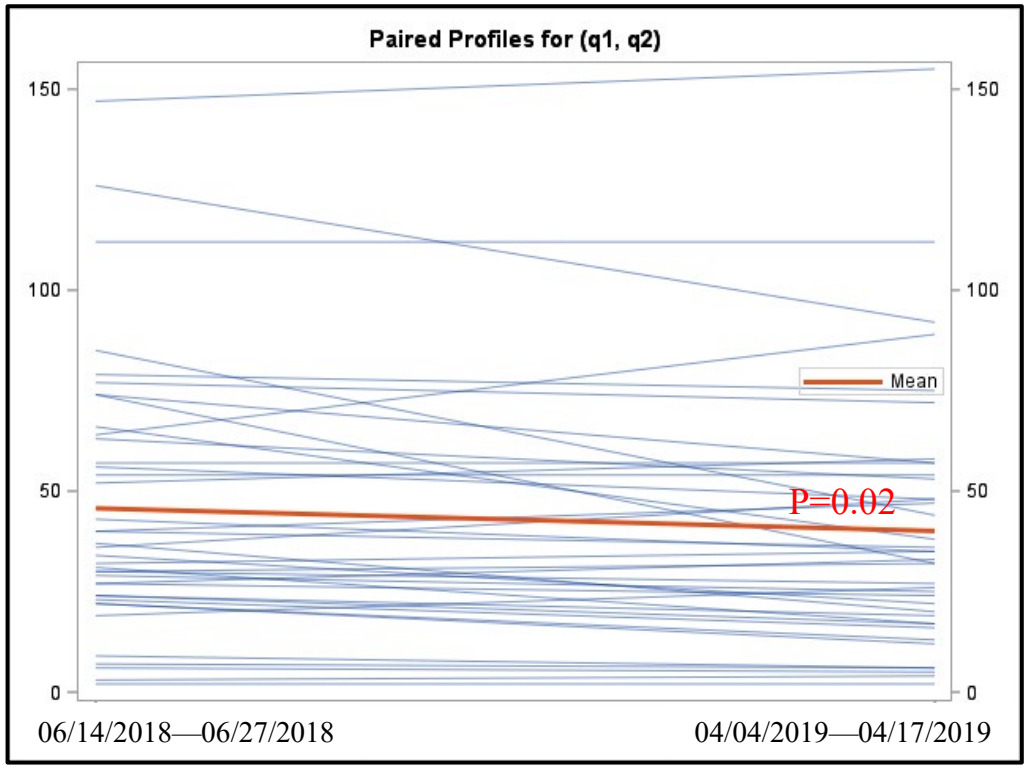
eTable 1. Antibiotic Treatment and Outcomes of Patients with UTI or ASB who were Treated with Antibiotics
N=13,613 patients across 46 hospitals

Characteristic	UTI treated with Antibiotics N=10,438	ASB treated with Antibiotics N=3,175
Duration of Therapy		
Days; Median (IQR)	8 (5-11)	6 (4-8)
≥3 Days; n (%)	9470 (93.3%)	2675 (84.3%)
Empiric Antibiotics; n (%)		
Ceftriaxone	7542 (72.3%)	2233 (70.3%)
Fluoroquinolone^	1037 (9.9%)	336 (10.6%)
Cephalosporin (1st or 2nd generation)	937 (9.0%)	242 (7.6%)
Piperacillin/tazobactam	473 (4.5%)	55 (1.7%)
Trimethoprim/sulfamethoxazole	173 (1.7%)	81 (2.6%)
Fosfomycin	118 (1.1%)	59 (1.9%)
Nitrofurantoin	130 (1.2%)	64 (2.0%)
Ampicillin/sulbactam	62 (0.6%)	11 (0.3%)
Other	1409 (13.5%)	252 (7.9%)
Missing antibiotic name	114 (1.1%)	77 (2.4%)
Antibiotics at Discharge; n (%)	7405 (70.9%)	1799 (56.7%)
Cephalosporin (1st , 2nd, or 3rd generation)	2813 (38.0%)	693 (38.5%)
Fluoroquinolone^	2364 (31.9%)	546 (30.4%)
Trimethoprim/sulfamethoxazole	832 (11.2%)	181 (10.1%)
Nitrofurantoin	393 (5.3%)	120 (6.7%)
Fosfomycin	76 (1.0%)	19 (1.1%)
Other	1118 (15.1%)	264 (14.7%)
Ordering Provider; n (%)		
Ordered urine culture*		
EM provider	6632/8510 (77.9%)	1686/2447 (68.9%)
Other	1878/8510 (22.1%)	761/2447 (31.1%)
Ordered antibiotic*		
EM provider	5981/8501 (70.4%)	1349/2410 (56.0%)
Other	2520/8501 (29.6%)	1061/2410 (44.0%)

^ Includes ciprofloxacin, levofloxacin, or moxifloxacin.

* Only a subset of patients had these data collected.

Urine Cultures Populated, by Hospital



Pneumonia Cases Populated, by Hospital