Tracking Antimicrobial Use in Healthcare Institutions

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- ***What (I assume) you know about this topic…***
  - Principles of antimicrobial stewardship
- ***What we will discuss…***
  - Why measure antimicrobial use?
  - How is antimicrobial use measured?
  - How to put antimicrobial use data into context
- ***What you should be able to do (learning objectives)…***
  - Describe two initiatives that will lead to required antimicrobial use measurement/reporting
  - Describe two primary metrics for quantifying aggregate antimicrobial use
  - Describe two approaches to contextualize aggregate use data

Why Measure?

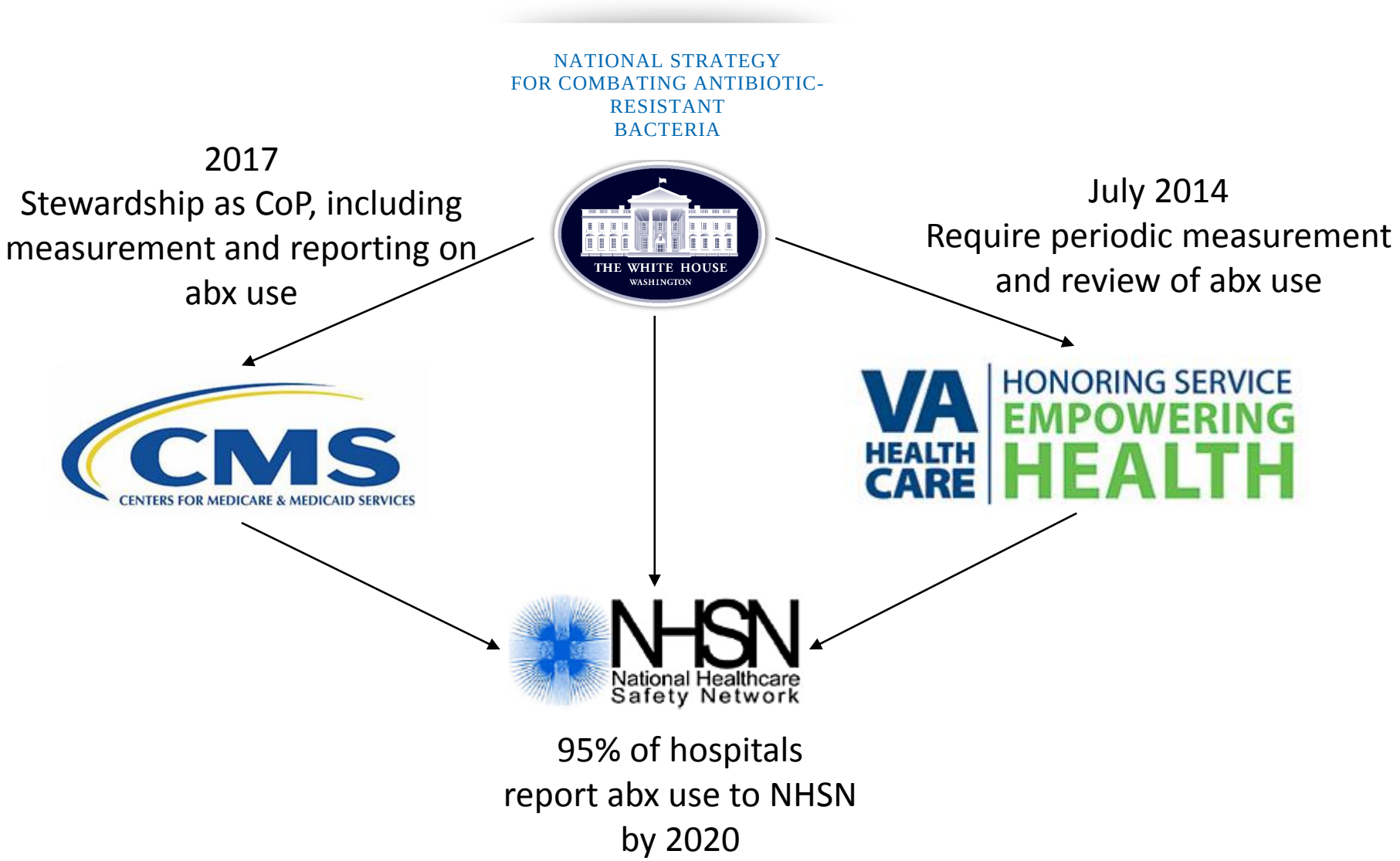
NATIONAL STRATEGY FOR COMBATING ANTIBIOTIC-RESISTANT BACTERIA

THE WHITE HOUSE
WASHINGTON

Vision: *The United States will work domestically and internationally to prevent, detect, and control illness and death related to infections caused by antibiotic- resistant bacteria by implementing measures to mitigate the emergence and spread of antibiotic resistance and ensuring the continued availability of therapeutics for the treatment of bacterial infections.*

September 2014

Why measure antimicrobial use?



California Department of Public Health

- 2008: Senate Bill (SB) 739
  - "…all general acute care hospitals develop processes for **evaluating the judicious use of antibiotics and monitor results** using appropriate quality improvement committees"
  - No enforcement provisions or funding
- 2010: SB 739 Enforcement
  - Medical lead for ASP hired, development of ASP programs
  - Evaluation of SB 739 compliance – without consequences
- 2014: SB 1311
  - Adopt and implement ASP policy, identify MD and PharmD leads, ensure formal ASP training, report activities to hospital quality
  - "…violation…constitutes a misdemeanor punishable by a fine not to exceed $1,000, by **imprisonment in a county jail**, or by both that fine and imprisonment."

Trivedi K, Rosenberg J. *Infect Control Hosp Epidemiol* 2013;34:379-384
http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140SB1311

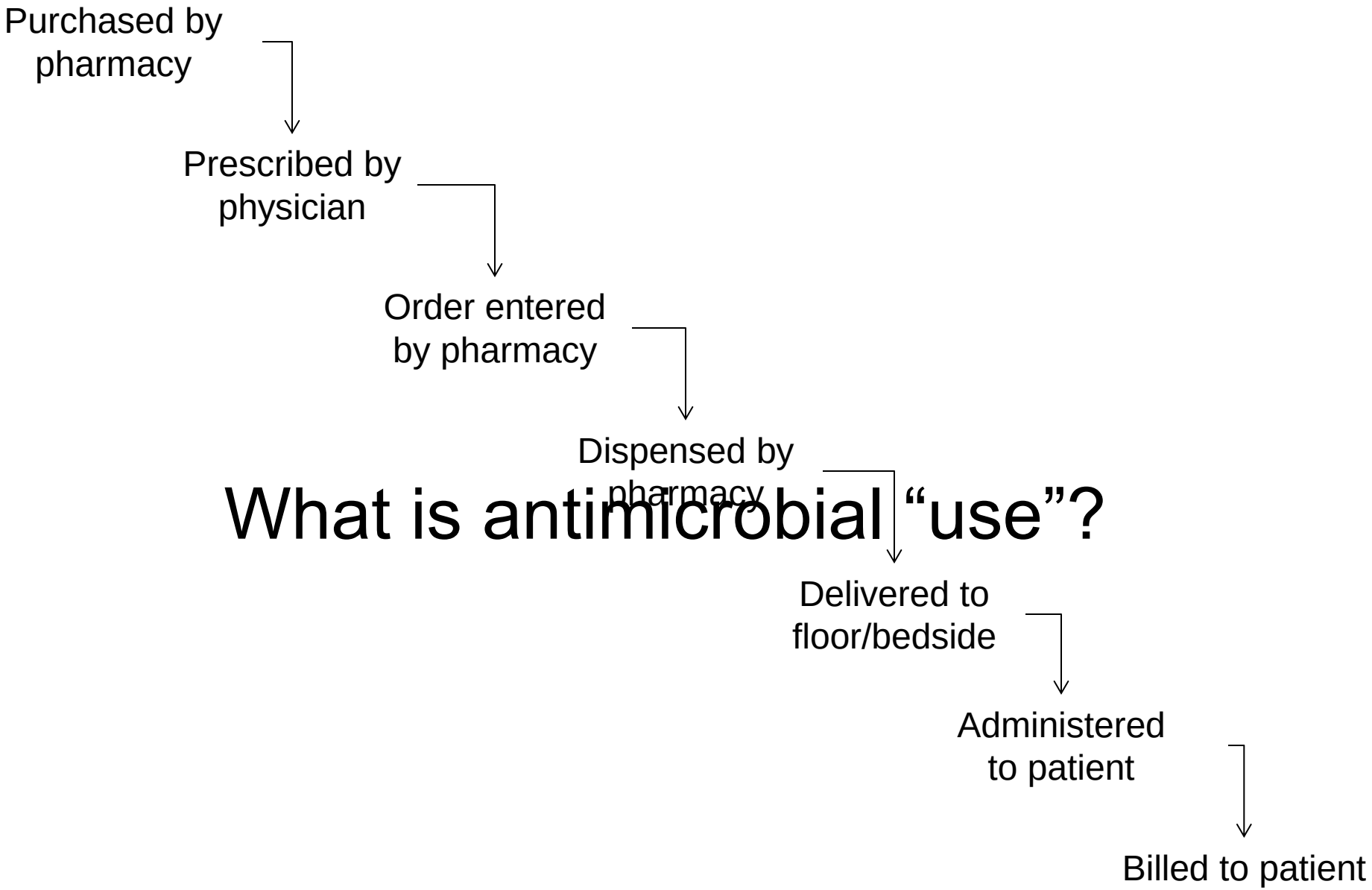
What and How to Measure

ASP Metrics: What to Collect/Report

	Morris et al 2012[1]	CDPH 2013[2]	IDSA 2015[3]
Aggregate Antimicrobial Use	DOT/1000 PD	DDD or DOT/1000PD	DOT > DDD
Aggregate Antimicrobial Susceptibility	# of patients with specific drug-resistant organisms	Annual antibiogram per CLSI methodology	Resistance in selected pathogens
Disease-specific	-Avoidable DOT for CAP, SSTI, BSI		-CAP, UTI, SSTI
Others	-Resistant-organism-related mortality		-Rate of *C. difficile* -Length of stay on abx -Excess IV abx days

[1]Morris AM, et al. *ICHE* 2012;33:500-506
[2] http://www.cdph.ca.gov/programs/hai/Pages/AntimicrobialStewardshipProgramInitiative.aspx
[3]IDSA; in preparation

What is antimicrobial "use"?



Level	Data Source	Advantages	Disadvantages
Purchased by pharmacy	-Pharmacy purchasing -Wholesaler data	-Easiest to obtain aggregate data	-”Farthest” from actual use -Time trends irregular
Prescribed by physician	-Chart orders	-Measures intent	-Impracticable if no CPOE
Order entered by pharmacy	-Pharmacy system	-Measures intent	-Can be difficult to query
Dispensed by pharmacy	-Pharmacy system	-Approximates administration	-Can be difficult to query
Administered to patient	-MAR	-Most accurate	-Impracticable if no BCMA
Billed to patient	-Hospital billing records -Group data	-Sometimes easier to obtain -Benchmarking	-Over- or under-estimate -Delay

How do I measure antibiotic use?

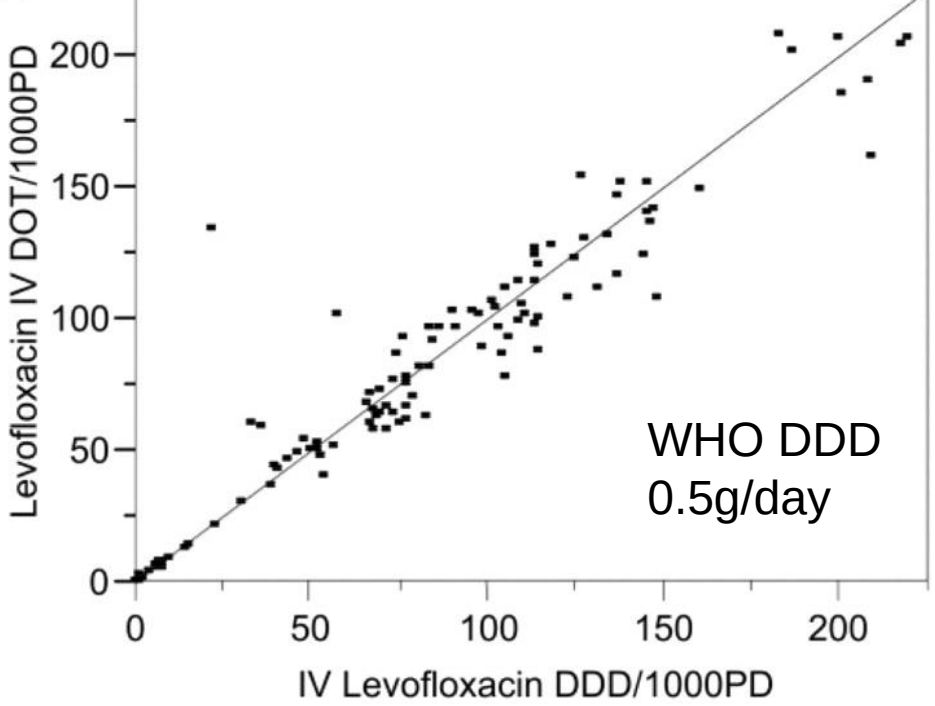
I want to know…	Measurement	Examples
…how often patients are getting antibiotics	Point (period) prevalence	% of CAP patients receiving atypical coverage
…how long patients are getting antibiotics for	Mean or median duration	Duration of antibiotic therapy for VAP
…the overall amount of antibiotics received adjusted for patient time at risk	Incidence density rate	Defined daily doses or days of therapy/1000 patient-days

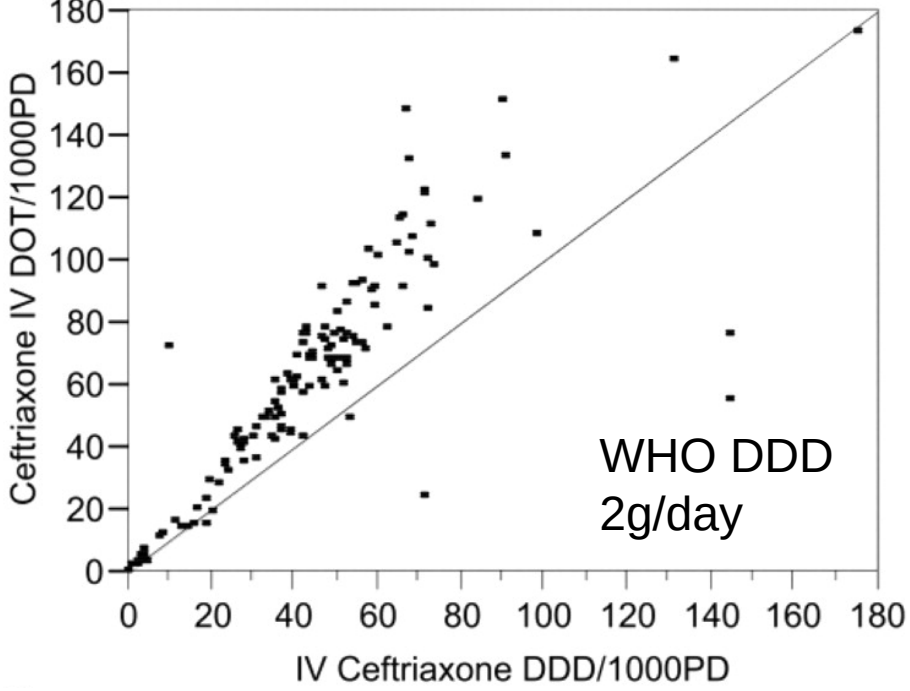
Comparison	Defined Daily Doses (DDD)	Days of Therapy (DOT)
Procedure	Count total grams of drug, sum, and divide by the "standard" (defined) daily dose	Count total days any drug is used and sum
Standard measure	World Health Organization	CDC NHSN Antimicrobial Utilization Module
Data source	Purchasing, delivery, dispensing, aggregated patient-level	Aggregated patient-level
Sensitivity to actual prescribed dosage	High; influences: -WHO DDD -mix of pediatrics -renal dysfunction -mg/kg dosing -secular dose trends	No
Compare to actual doses	Under-, equal, or over-estimate	Equal or overestimate
Best measure for	Drug exposure?	Prescribing intent?

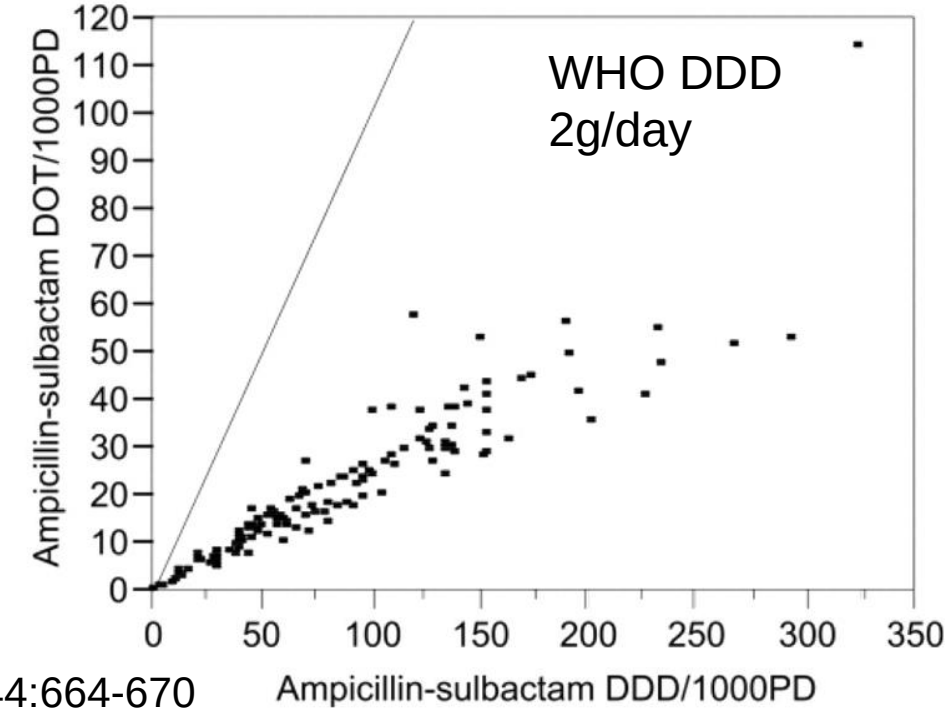
Drug	Regimen	Total grams	WHO defined daily dose	Defined Daily Doses (DDD)	Days of Therapy (DOT)
cefazolin	1g IV x1	1g	3g		
vancomycin	1g IV q12h x3 days	6g	2g		
ampicillin/ sulbactam	3g IV q6h x3 days	36g	2g		
moxifloxacin	400mg po qd x4 days	1.6g	0.4g		
Total					

Drug	Admits	Patient-days	Patients receiving	% Patients	Total grams	defined daily dose	Defined Daily Doses (DDD)	DDD/1000 patient-days
cefazolin	24007	145242	6481	26.9%	26489	3g	26489/3= 8829	8829/145= 60.8
vancomycin	24007	145242	5715	21.6%	47992	2g	47992/2= 23996	23996/145= 165.2
ampicillin/sulbactam	24007	145242	111	0.46%	2974	2g	2974/2= 1487	1487/145 10.23
moxifloxacin	24007	145242	723	3.0%	1804	0.4g	1804/0.4= 4510	1804/145 31.0
Total	24007	145242						267.23

Drug	Admits	Patient-days	Patients receiving	% Patients	Mean duration	Days of Therapy (DOT)	DOT/1000 patient-days
cefazolin	24007	145242	6481	26.9%	1.8	6481*1.8 = 11665	11665/145= 80.3
vancomycin	24007	145242	5715	21.6%	4.8	5715 *4.8 =27432	27432/145= 188.8
ampicillin/ sulbactam	24007	145242	111	0.46%	3.3	111 * 3.3 = 366	366/145= 2.5
moxifloxacin	24007	145242	723	3.0%	6.3	723 * 6.3 = 4554	4554/145= 31.4
Total	24007	145242					303



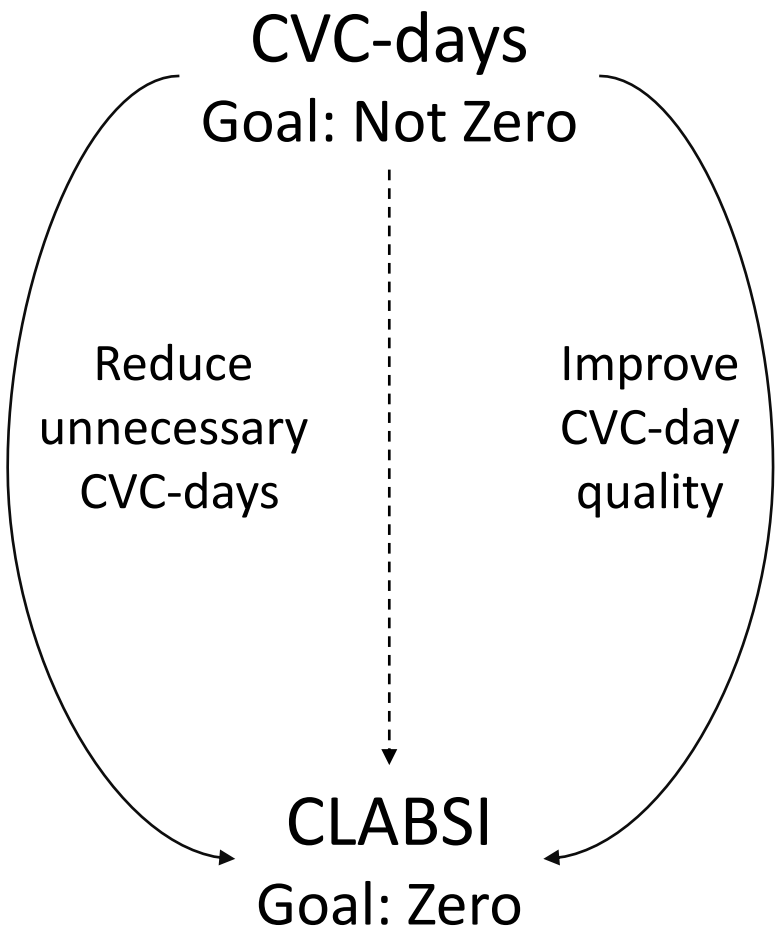


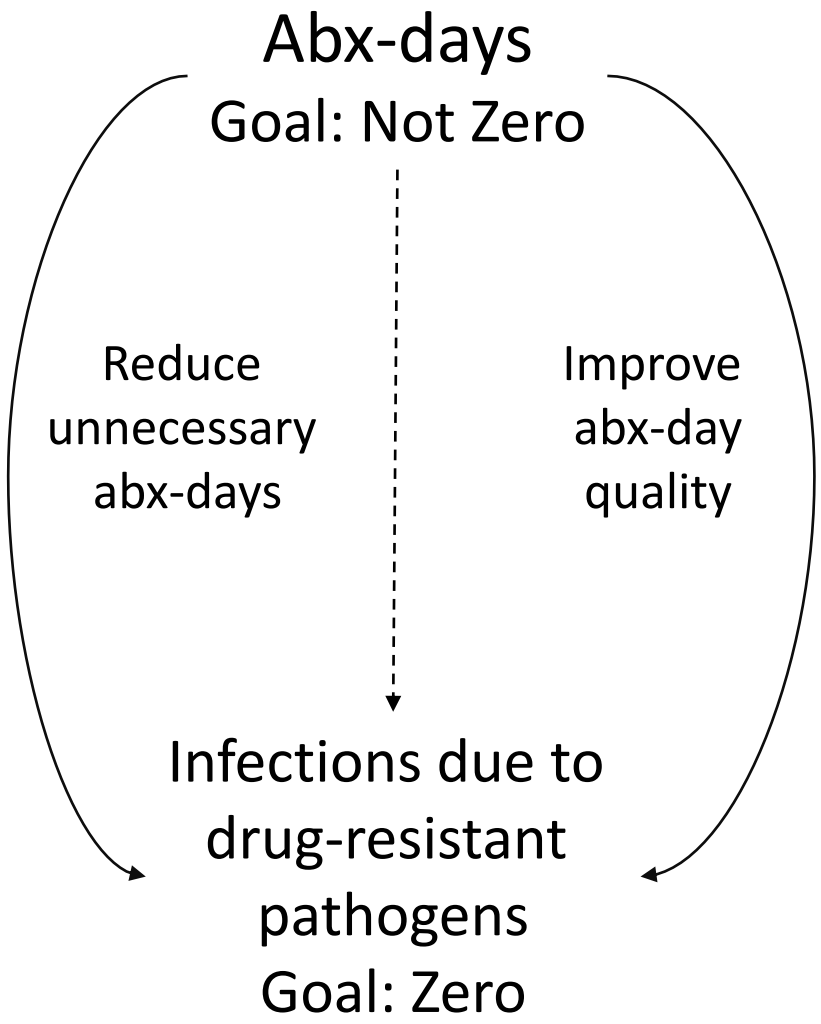


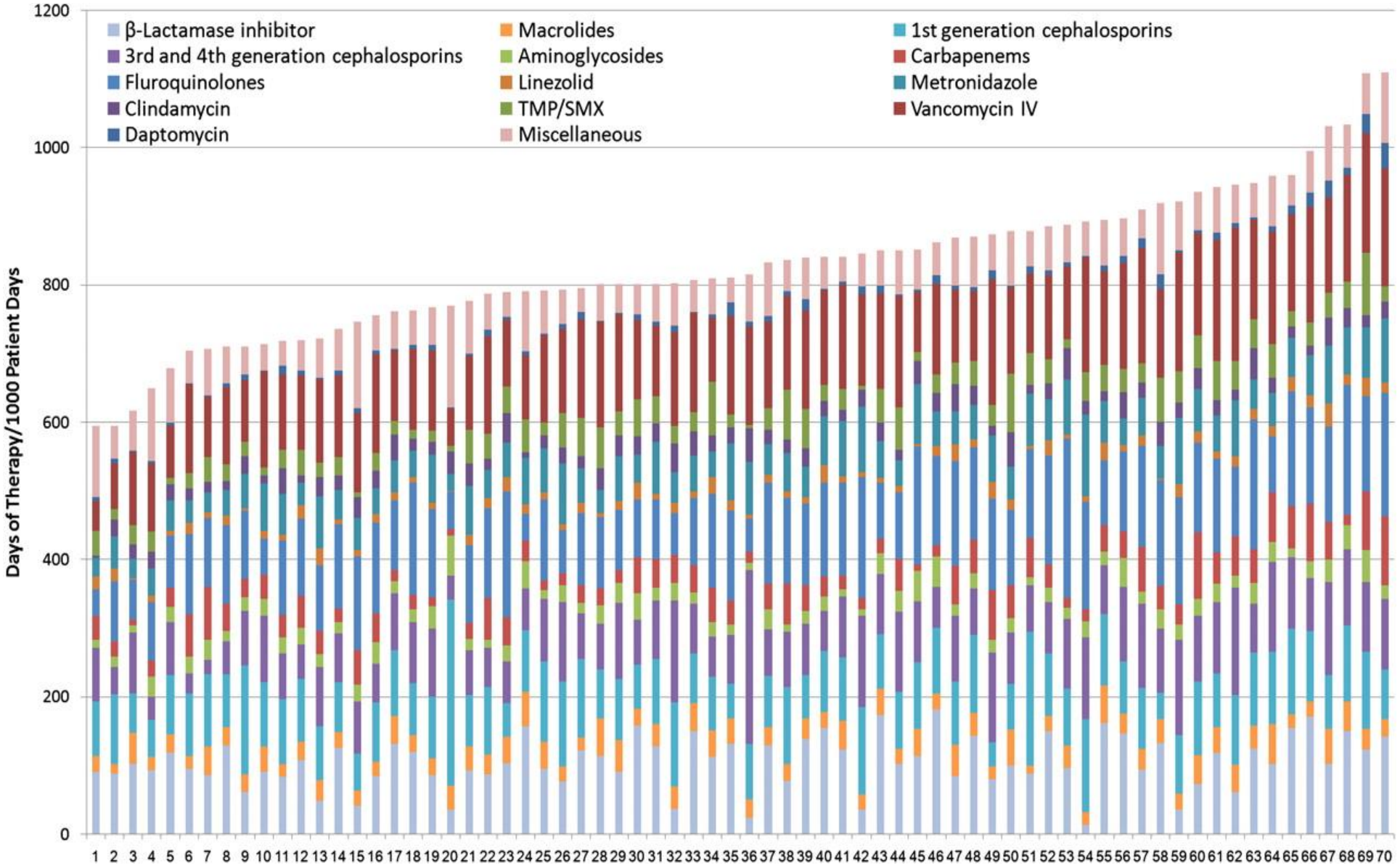
Polk RE, et al. *Clin Infect Dis* 2007;44:664-670

How to Contextualize Usage Data

What is our target?







Polk RE, et al. Clinical Infectious Diseases 2011;53(11):1100–10

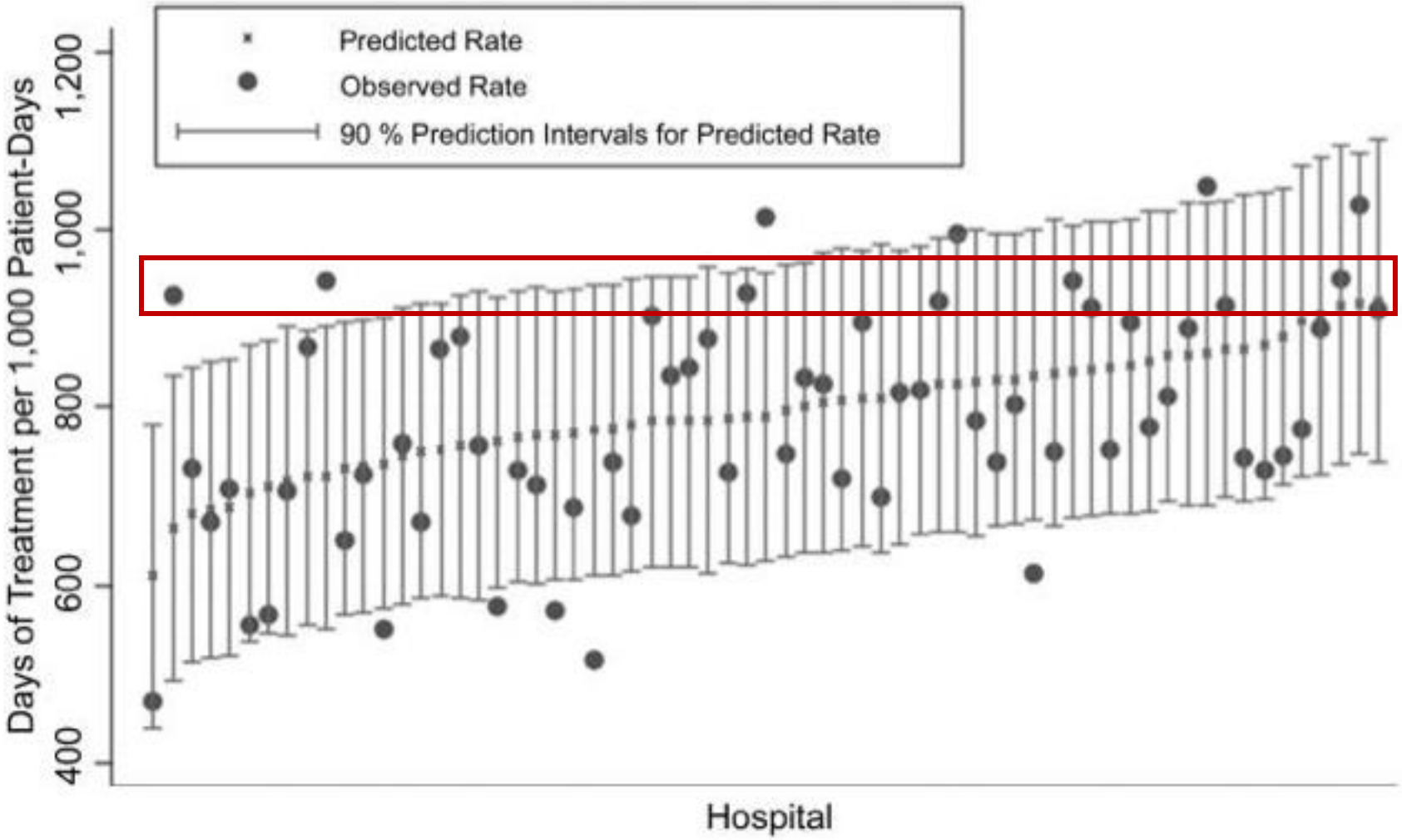


FIGURE. Comparison of observed and predicted total rates of antibacterial use among hospitals in the validation data set. The model used to calculate the predicted rate was as follows: predicted rate of antibacterial use = 0.09(no. of beds) + 0.74(no. of intensive care unit days per 1,000 patient-days) + 0.43(no. of surgeries per 1,000 discharges) + 3.30(no. of cases of pneumonia per 1,000 discharges) + 6.89(no. of cases of bacteremia per 1,000 discharges) + 1.68(no. of cases of urinary tract infection per 1,000 discharges) + 237.08.

MacDougall C, Polk RE.
Infect Control Hosp Epidemiol
2008;29:203-211

Reporting ASP Data: CDC Antimicrobial Use (AU) Module

- Component of National Healthcare Safety Network (NHSN)
- Electronic transfer of data to NHSN
  - Aggregated as DOT per 1000 days present
- Most EMR/CPOE vendors committed
  - Currently 60 hospitals contributing data
- Institutional & aggregated comparator data available

http://www.cdc.gov/nhsn/acute-care-hospital/aur/

Example Use of Data for a Hospital
(AU Analysis Output Options):
Risk-adjusted Benchmarking of Antimicrobial Use To Guide Stewardship

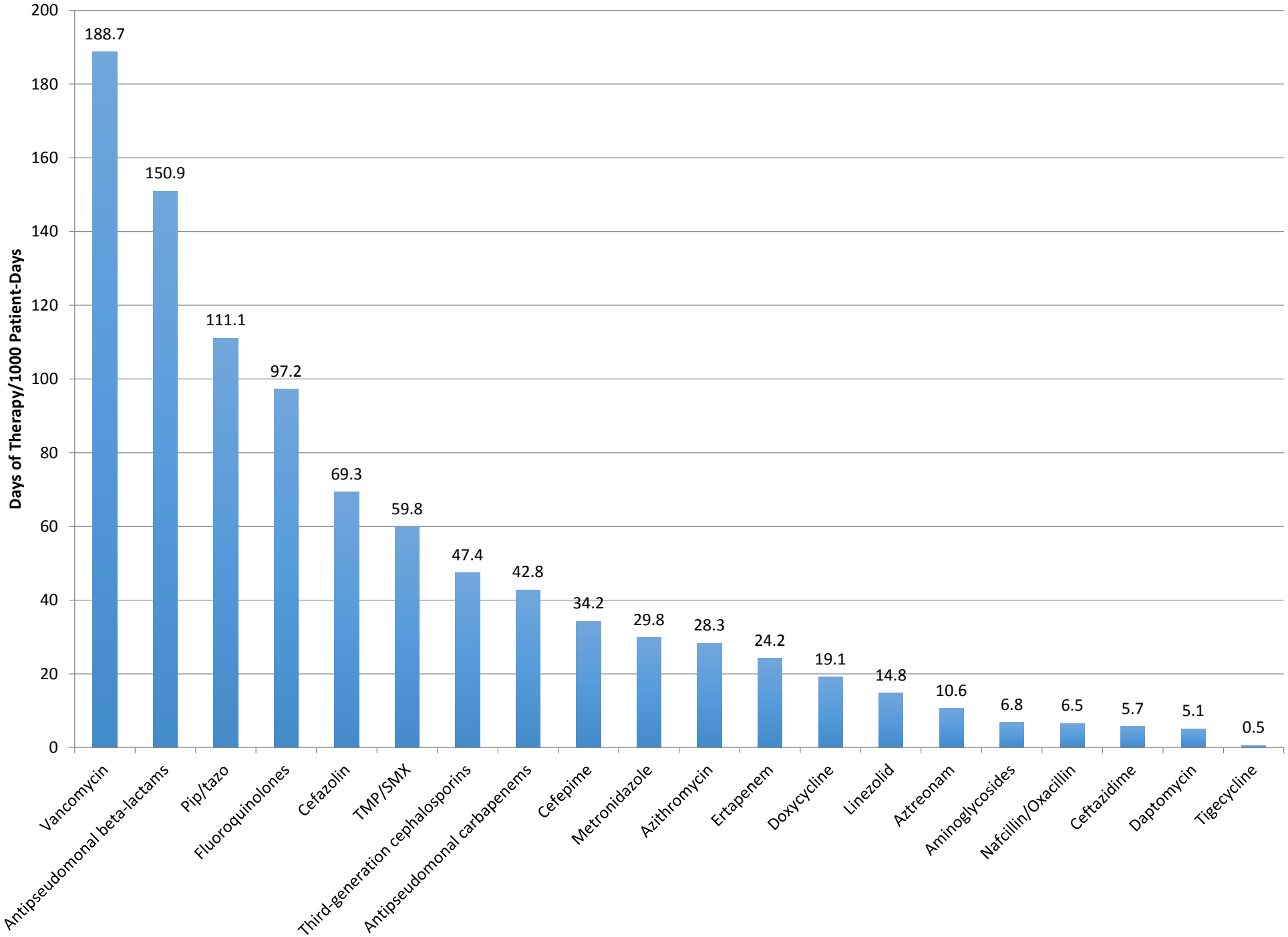
Antimicrobial Class-Specific Usage Rates and Standardized Utilization Ratios (SURs)				
Anti-MRSA Intravenous				
	ABX Days			
	Observed	Predicted	SUR	Interpretation
MICU	4000	1000	4.0	Excessive
SICU	2000	2000	1.0	Consistent
Medical Ward	3000	4000	0.75	Lower Use
Surgical Ward	1000	3000	0.33	Much Lower
Hospital	170,250	171,000	0.99	Consistent

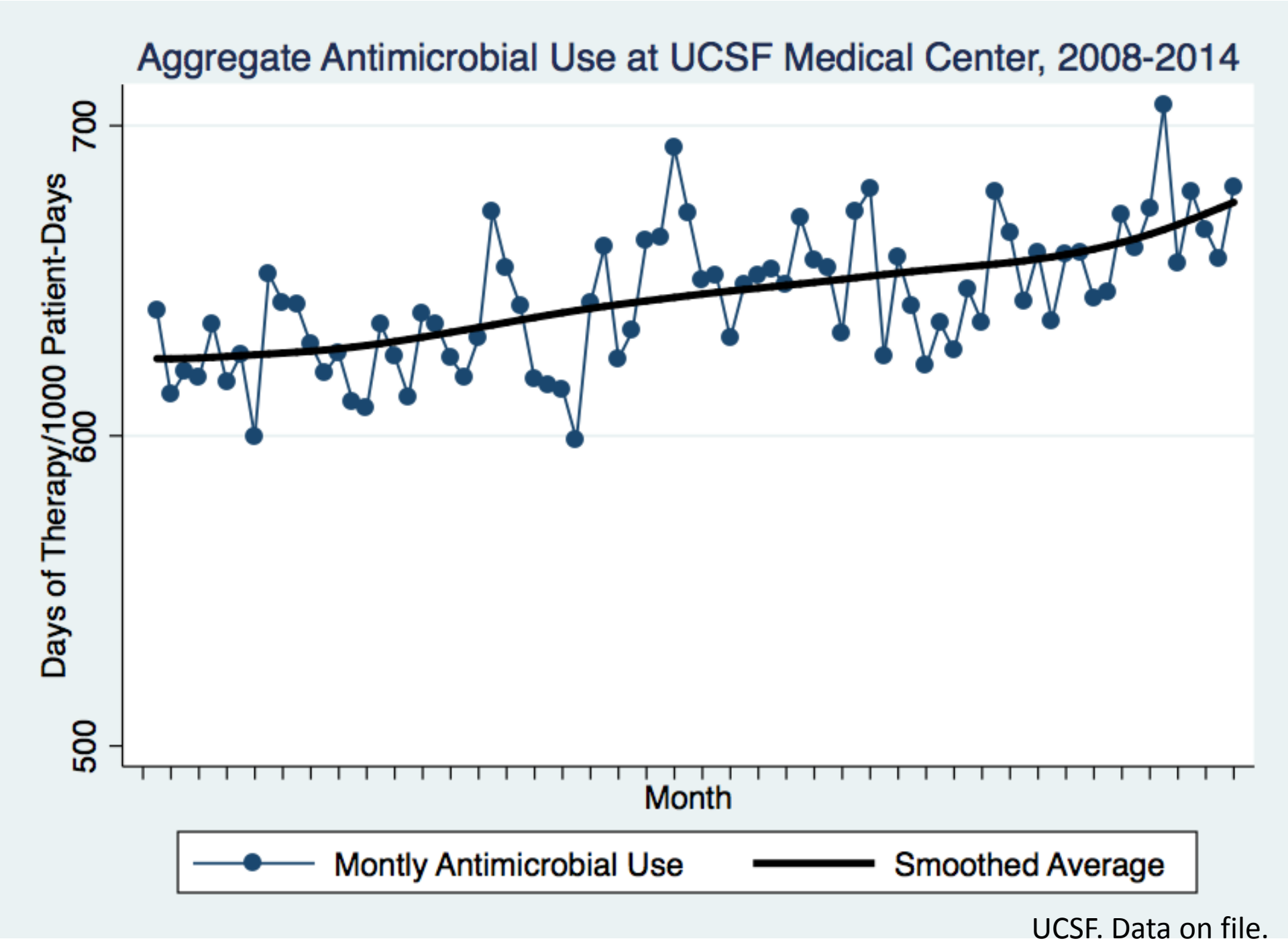
Example Data Only; SUR is a ratio of actual usage patterns compared to expected patterns given the patient population defined by the location (e.g., MICU , SICU, etc)

Slide courtesy Arjun Srinivasan, MD

Great, but what do I do ***now***?

Level 1: If you lack comparator data


Days of Therapy/1000 Patient-Days
200
180
160
140
120
100
80
60
40
20
0
188.7
150.9
111.1
97.2
69.3
59.8
47.4
42.8
34.2
29.8
28.3
24.2
19.1
14.8
10.6
6.8
6.5
5.7
5.1
0.5
Vancomycin
Antipseudomonal beta-lactams
Pip/tazo
Fluoroquinolones
Cefazolin
TMP/SMX
Third-generation cephalosporins
Antipseudomonal carbapenems
Cefepime
Metronidazole
Azithromycin
Ertapenem
Doxycycline
Linezolid
Aztreonam
Aminoglycosides
Nafcillin/Oxacillin
Ceftazidime
Daptomycin
Tigecycline



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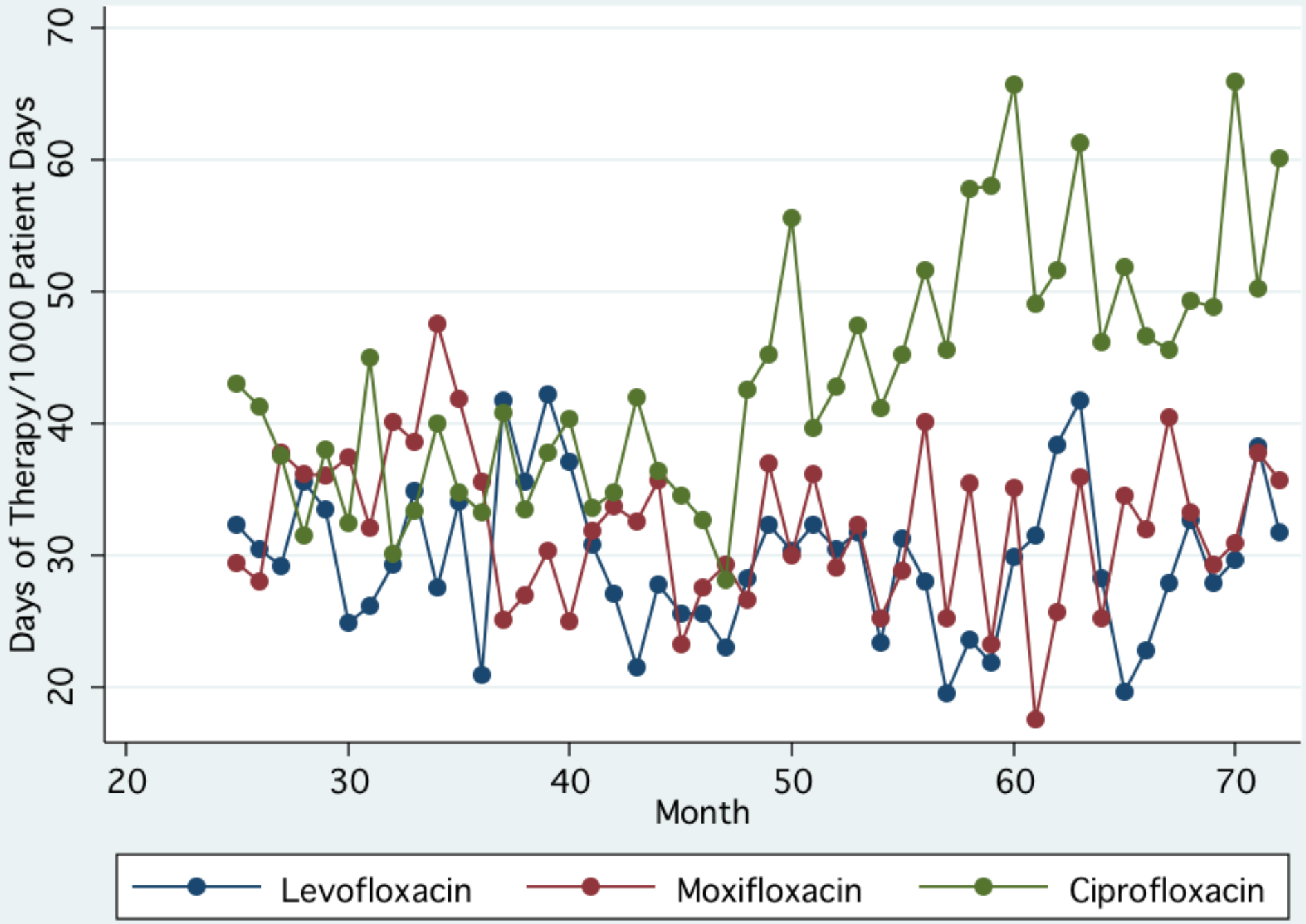
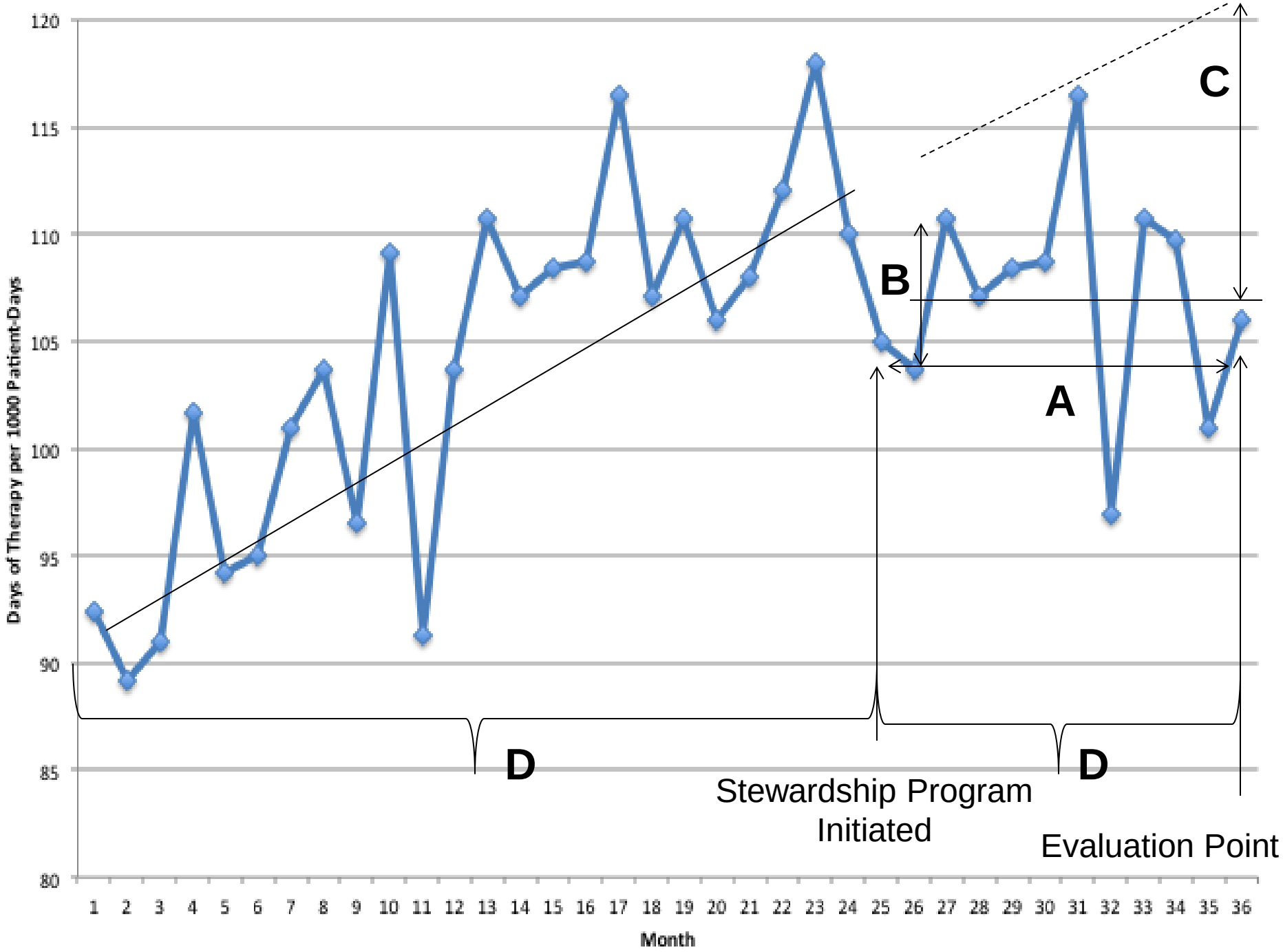
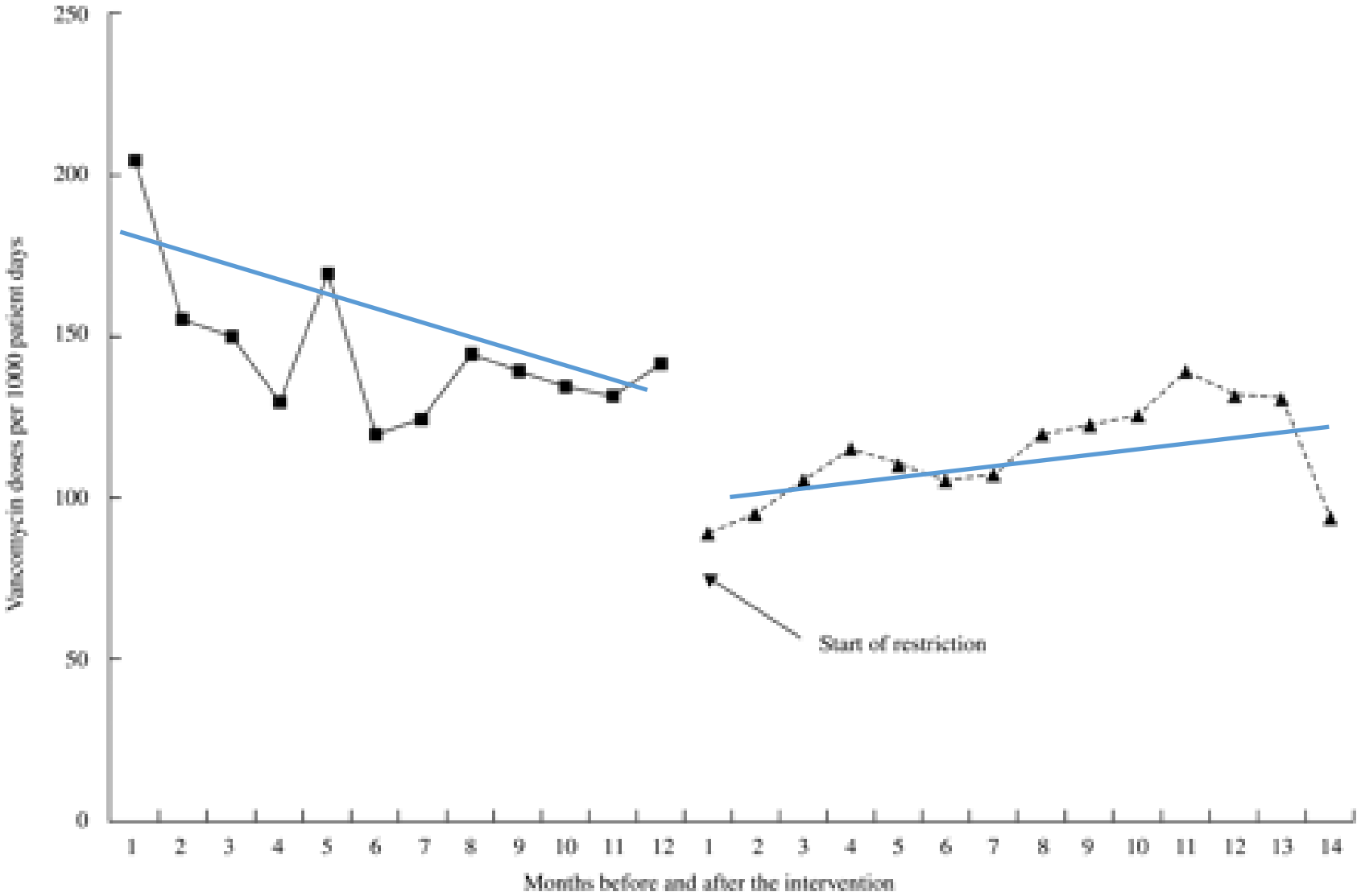
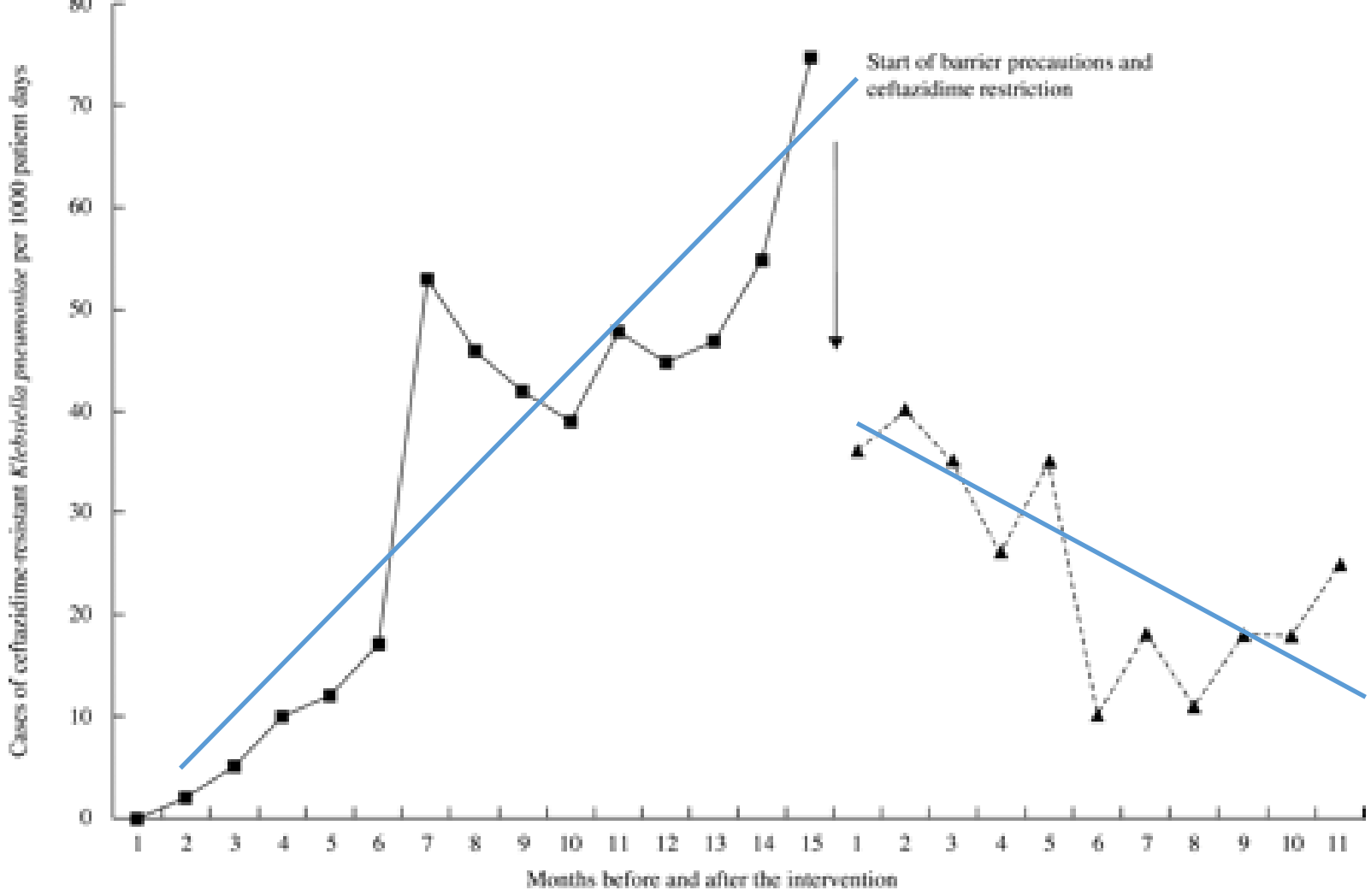

Days of Therapy/1000 Patient Days
20
30
40
50
60
70
Month
Levofloxacin
Moxifloxacin
Ciprofloxacin


Days of Therapy per 1000 Patient-Days
120
115
110
105
100
95
90
85
80
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36
Month
A
B
C
D
D
Stewardship Program Initiated
Evaluation Point



Change (post-intervention minus pre-intervention) in vancomycin doses per 1000 patient days		*P* value
Change in mean	Decrease by 31 doses	<0.001
Change in level	Decrease by 23 doses	0.05
Change in slope	Increase by 6 doses	<0.001

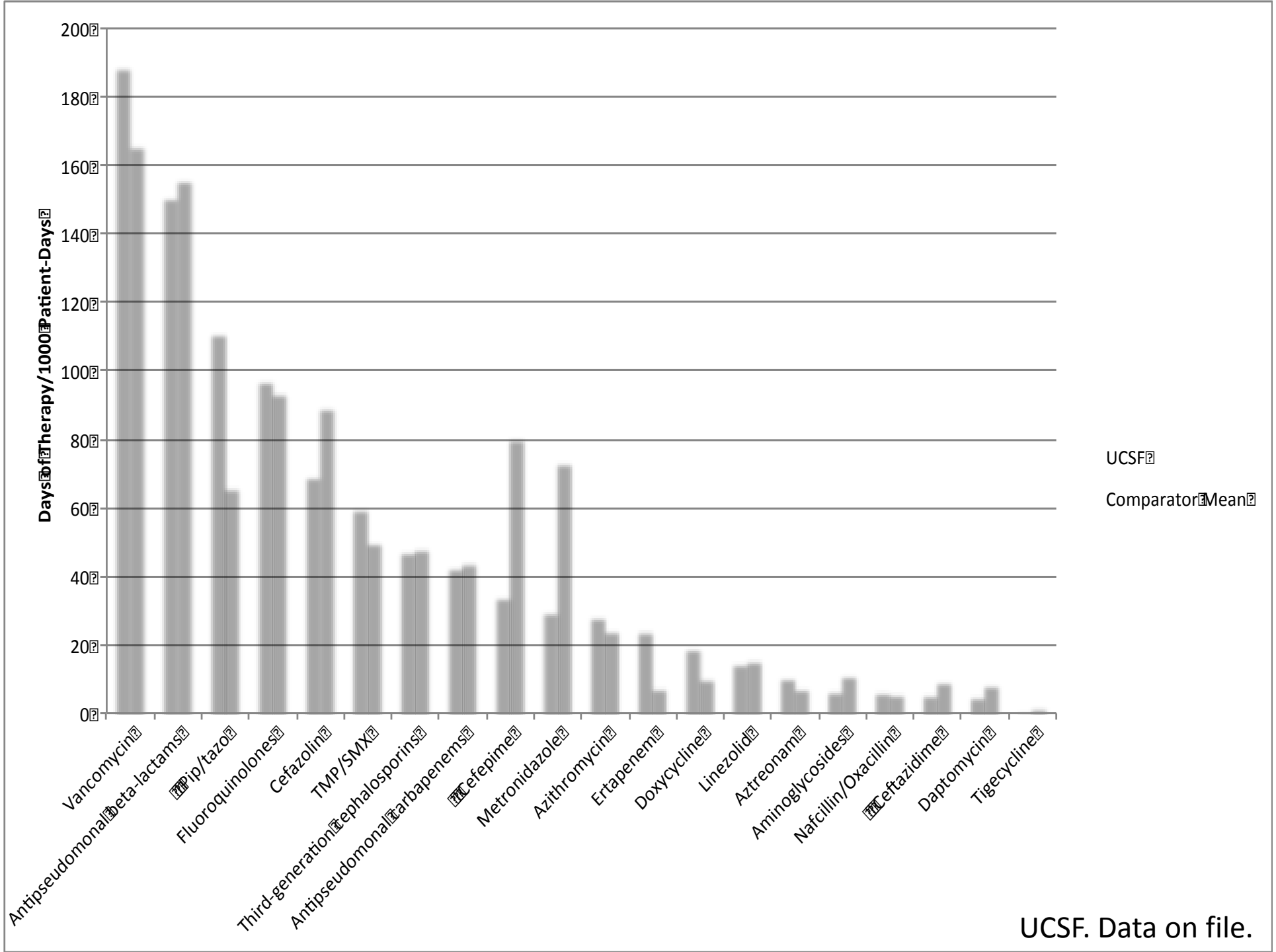
Ramsay C, et al. *J Antimicrob Chemother* 2003;52:764-771



Change (post-intervention minus pre-intervention) in cases of ceftazidime resistant *Klebsiella pneumoniae* per 1000 patient days		*P* value
Change in mean	Decrease by 11.7 cases	0.1
Change in level	Decrease by 38.6 cases	<0.001
Change in slope	Decrease by 6.7 cases	<0.001

Ramsay C, et al. *J Antimicrob Chemother* 2003;52:764-771

Level 2: If you have comparator data



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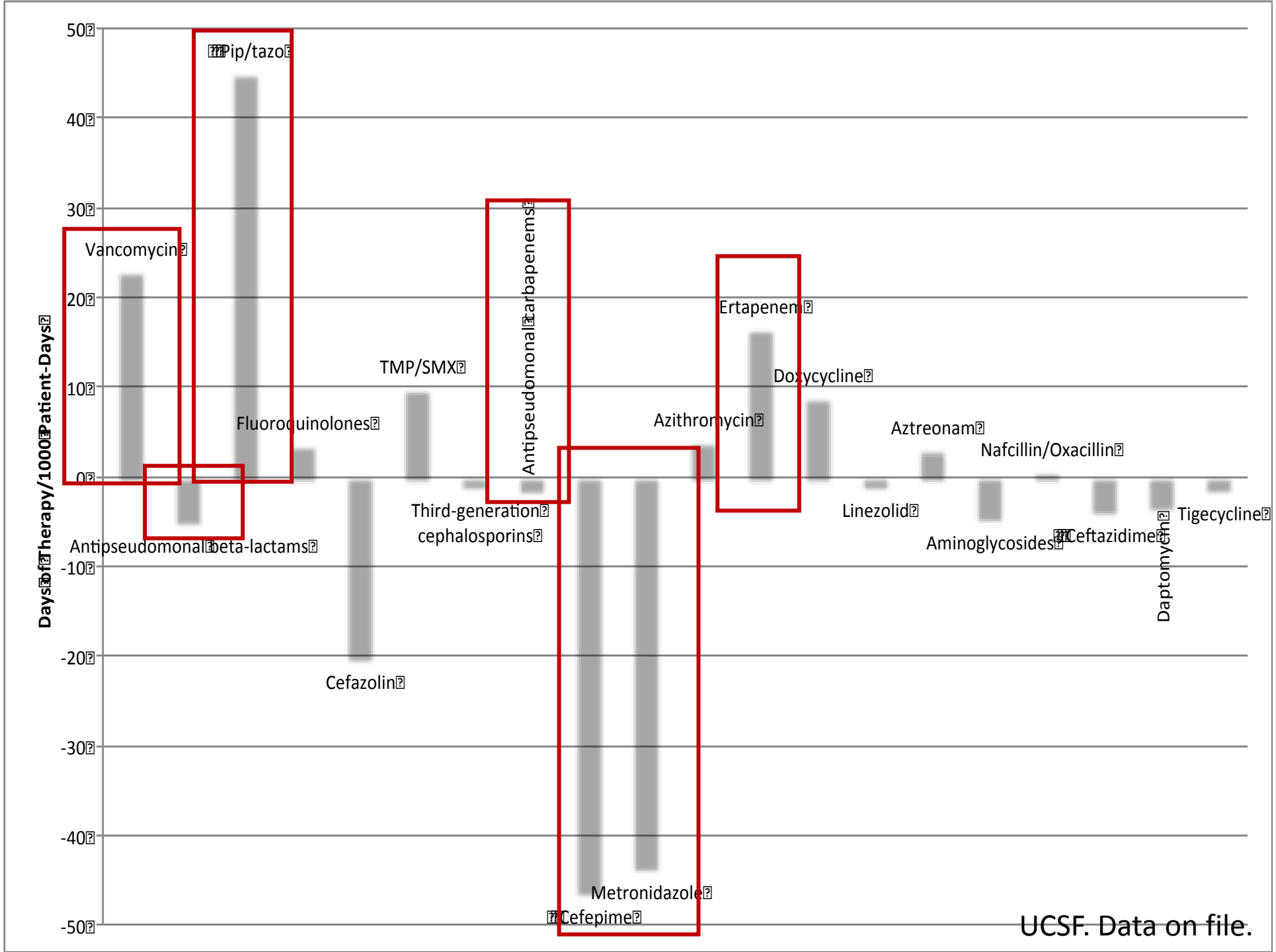
Days of Therapy/1000 Patient-Days
50
40
30
20
10
0
-10
-20
-30
-40
-50
Vancomycin
Pip/tazo
Antipseudomonal beta-lactams
Fluoroquinolones
Cefazolin
TMP/SMX
Third-generation cephalosporins
Antipseudomonal carbapenems
Metronidazole
Cefepime
Azithromycin
Ertapenem
Doxycycline
Linezolid
Aztreonam
Aminoglycosides
Nafcillin/Oxacillin
Ceftazidime
Daptomycin
Tigecycline
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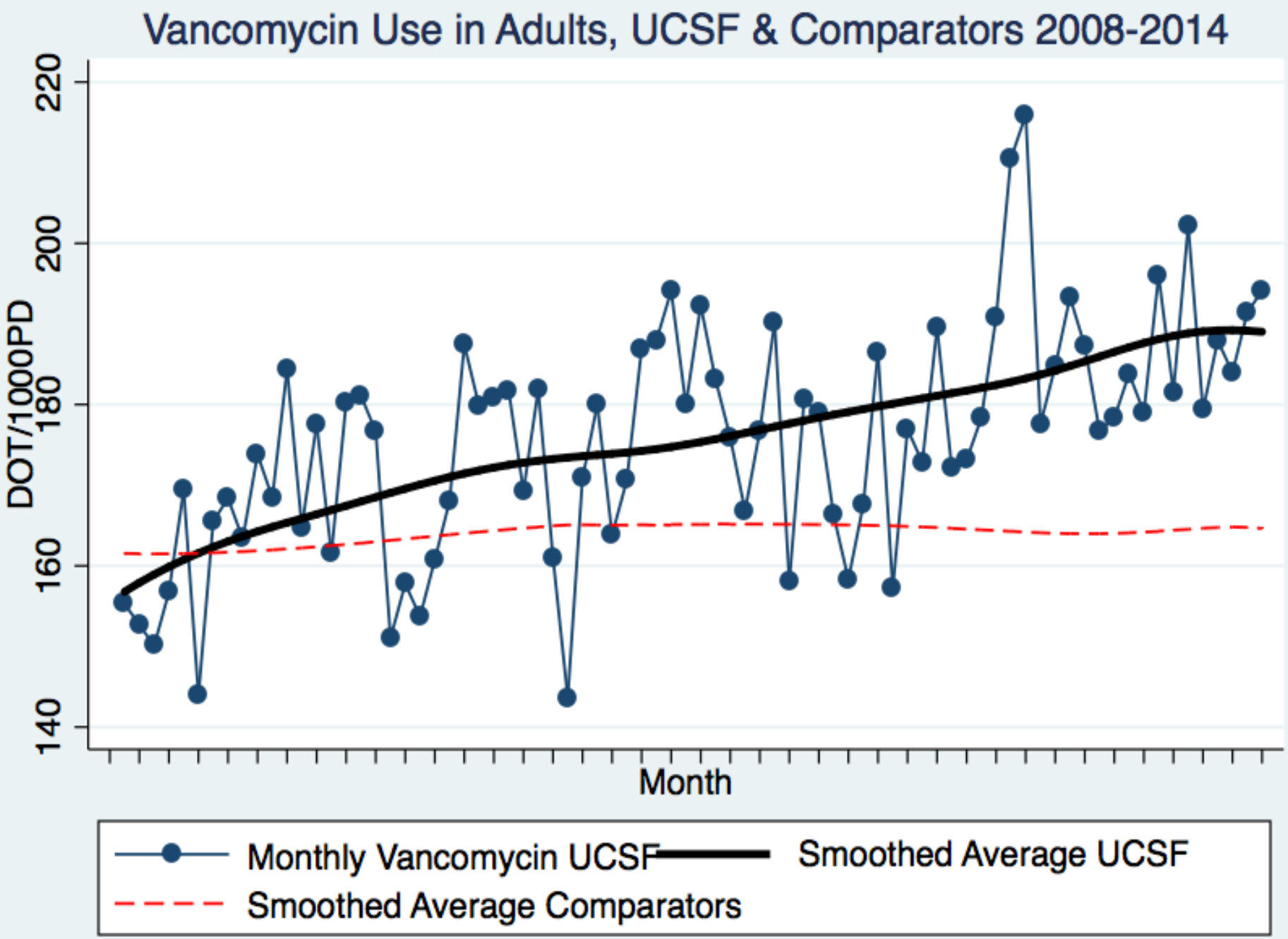

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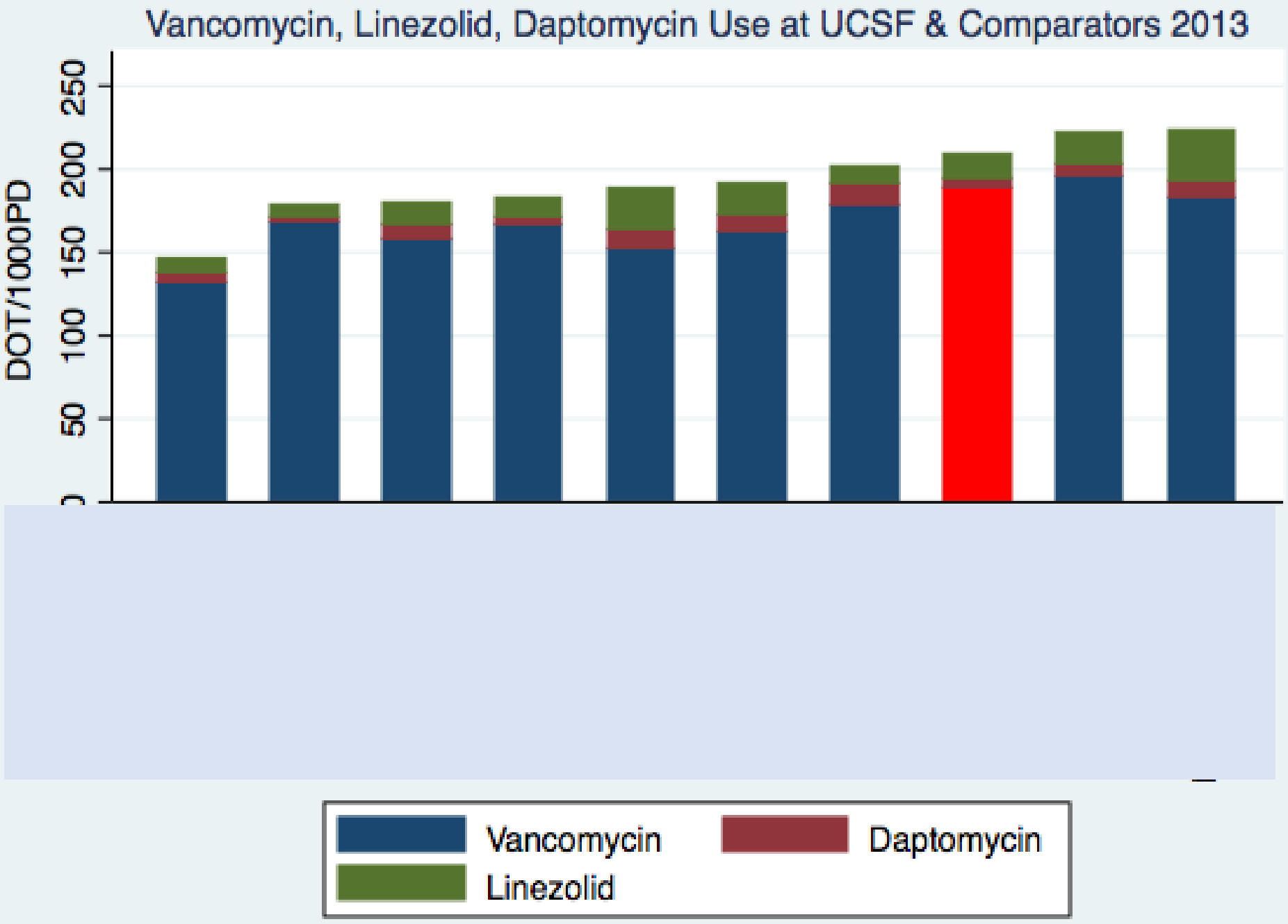
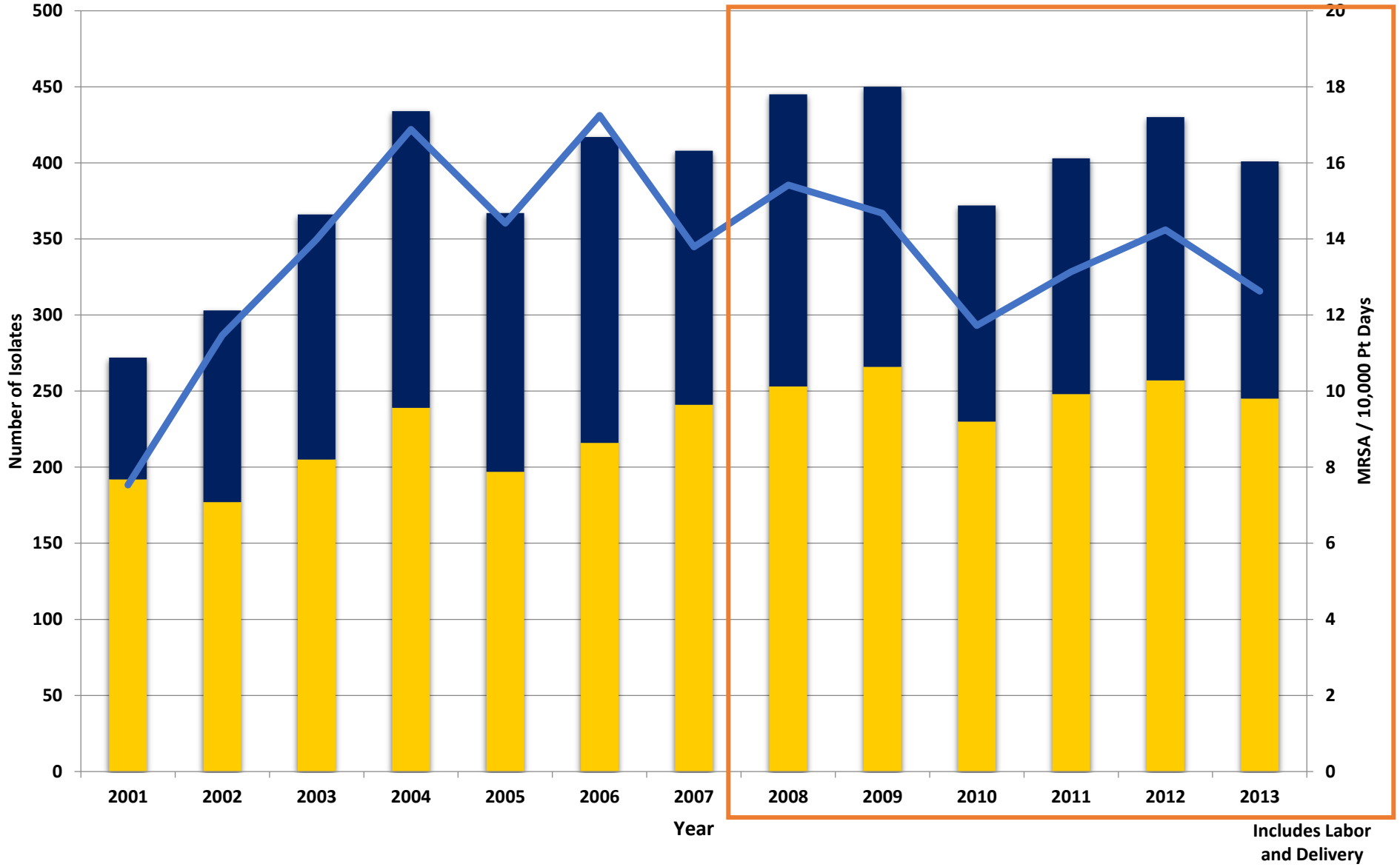


UCSF. Data on file.

Methicillin-Resistant *Staphylococcus aureus* (MRSA)
MRSA in Adults at Moffitt/Long Hospitals, New Patients by Year
Specimens Collected from Adult In-Patient Locations, 2001 – 2013



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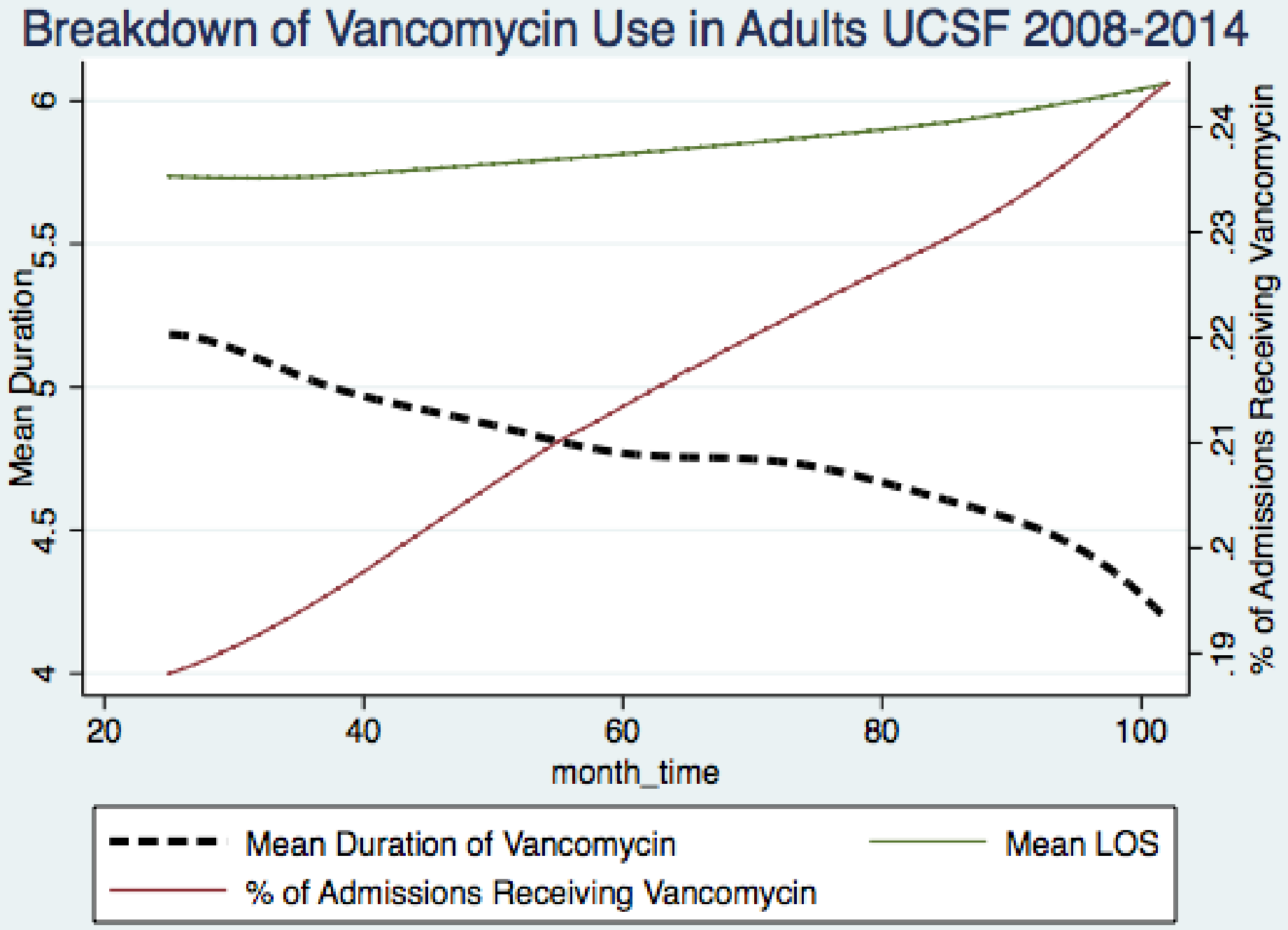

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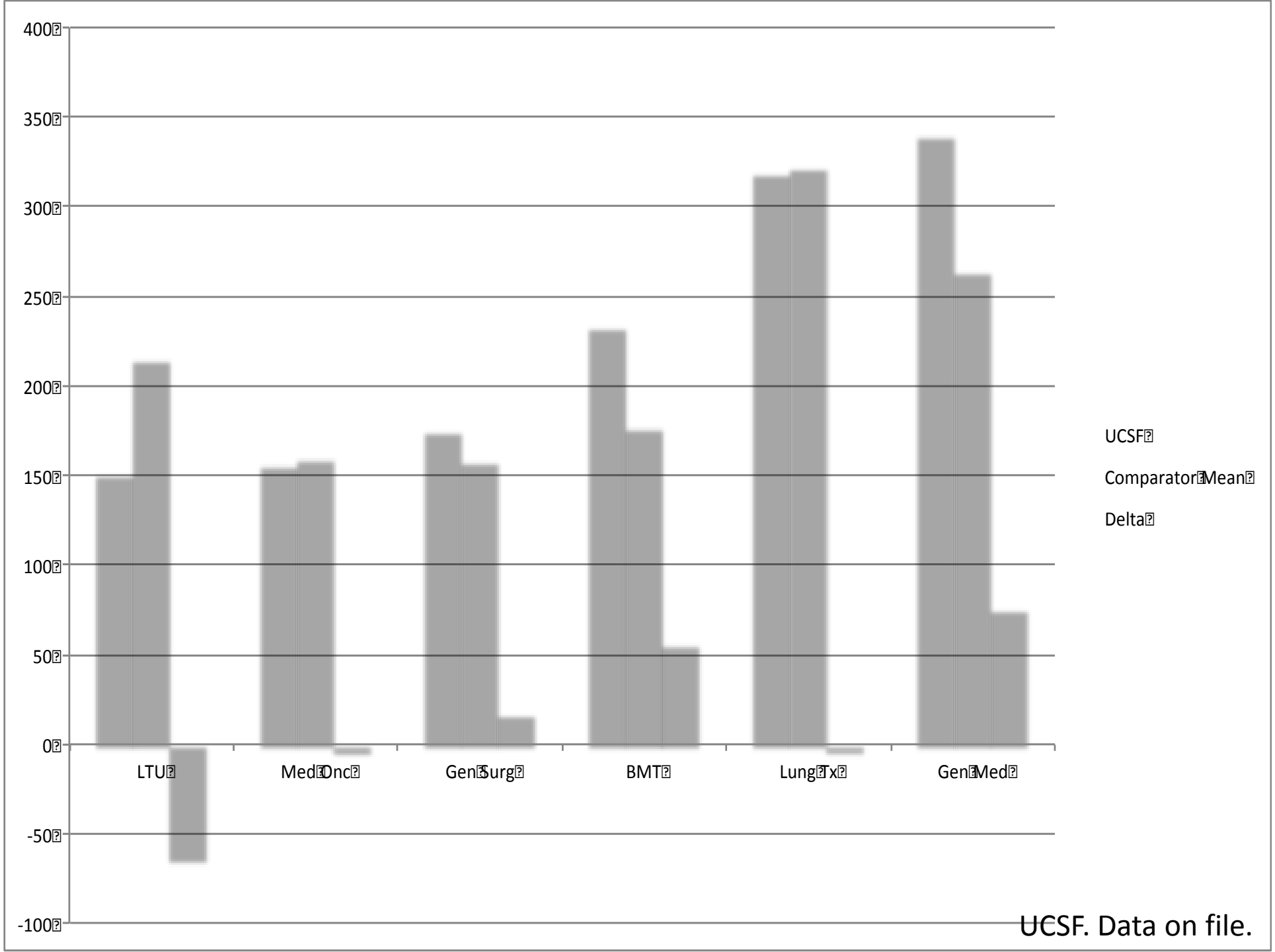

UCSF. Data on file.

Questions/Discussion