2019

APIC Applied Learning Conference

APIC EDUCATION

Antibiotic Stewardship: Understanding and Optimizing the Role of the IP

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APIC
Association for Professionals in Infection Control and Epidemiology

Disclosures

- David Witt: No disclosures

Antibiotic Stewardship: Optimizing the IP Role

- **Learning objectives:**
  - Be able to speak comfortably about the goals of an ABS program
  - Gain insights on when, how, and why to advocate for effective ABS
  - Identify key roles and advocate for the optimal role for an IP in ABS

Antibiotic Stewardship: Optimizing the IP Role

- Areas we will cover:
  - What is ABS?
  - Antibiotic overview
  - Antibiotic resistance
  - Possible structures for ABS
  - The optimal role for IPs
  - Data that is available from NHSN (or internally)

Antibiotic Stewardship: Optimizing the IP Role

- Opening Scenario: What would you do?
  - 42 year old man with cellulitis in his leg. Failed outpatient therapy with azithromycin. Had allergy to penicillin. Now on vancomycin x 1 day – trough 14.2. Tmax 101.2, Weight 264 lbs, erythema right lower leg. Skin intact.
    - What would you suggest?
      A. Increase the vancomycin since he is allergic to penicillin
      B. Clarify the allergy to penicillin
      C. Isolate the patient as he might have resistant S. pyogenes
      D. Nothing

Antibiotic Stewardship: Optimizing the IP Role

- Opening Scenario: What would you do?
  - Patient was changed to cefazolin 1 gram every 12 hours and continues febrile
    A. What would you suggest?
    B. Increase his cefazolin dose
    C. Change to daptomycin
    D. Isolate patient because he has resistant Streptococcus pyogenes
    E. Nothing

We Picked a Poor Name for ABS

- We have picked a poor name
  - More effective treatment
  - Decreased mortality and morbidity
  - Prevents resistance
  - Prevents patient adverse consequences
  - Avoids IVs and CVCs and associated complications
  - Shortens stays
  - Improves satisfaction with better care, shorter stay and OPAT
  - Saves costs
- We know it when we see it!

Aspects of Antibiotic Stewardship

- Better diagnosis
  - Appropriate investigations
  - Appropriate microbiology
- Optimal antibiotic choice
- Optimal antibiotic dosing
- Optimal antibiotic duration
- Tools
  - Staff education – MDs, RNs, Administrators
  - Treatment guidelines
  - Formula restriction
  - Mandatory consults for certain conditions

Aspects of Antibiotic Stewardship

- Treat known or likely site of infection
- Don’t treat contaminants or colonization
- Guide empiric treatment by antibiogram
- Target based on cultures and confirmation of infection
- Ensure timely and appropriate initial dosing
  - Pharmacokinetic/dynamic properties
  - Avoid drug interactions
  - Recognize toxicity

Aspects of Antibiotic Stewardship

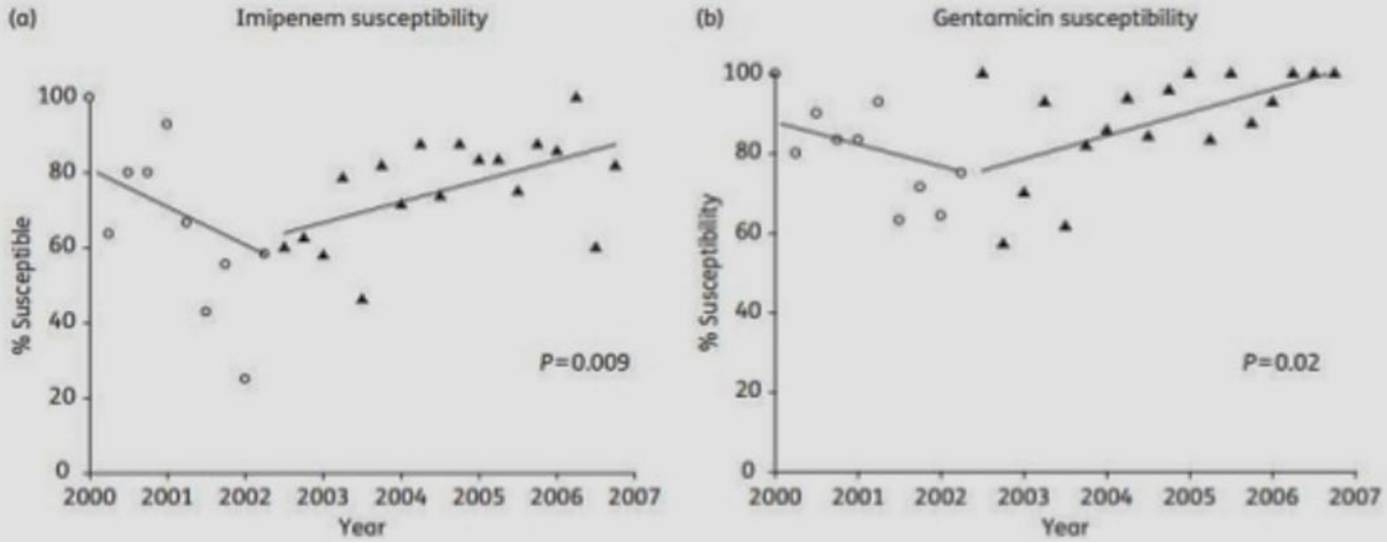
J Antimicrob Chemother 2010; **65**: 1062–1069
doi:10.1093/jac/dkq058 Advance publication 9 March 2010

Journal of Antimicrobial Chemotherapy

Improved susceptibility of Gram-negative bacteria in an intensive care unit following implementation of a computerized antibiotic decision support system

M. K. Yong[1,2*], K. L. Buising[1], A. C. Cheng[2,3] and K. A. Thursky[1]

[1]*Victorian Infectious Diseases Service, Royal Melbourne Hospital, Parkville, VIC 3050, Australia;* [2]*Infectious Diseases Department, Alfred Hospital, Prahran, VIC 3181, Australia;* [3]*Department of Epidemiology, Monash University, Melbourne, VIC, Australia*

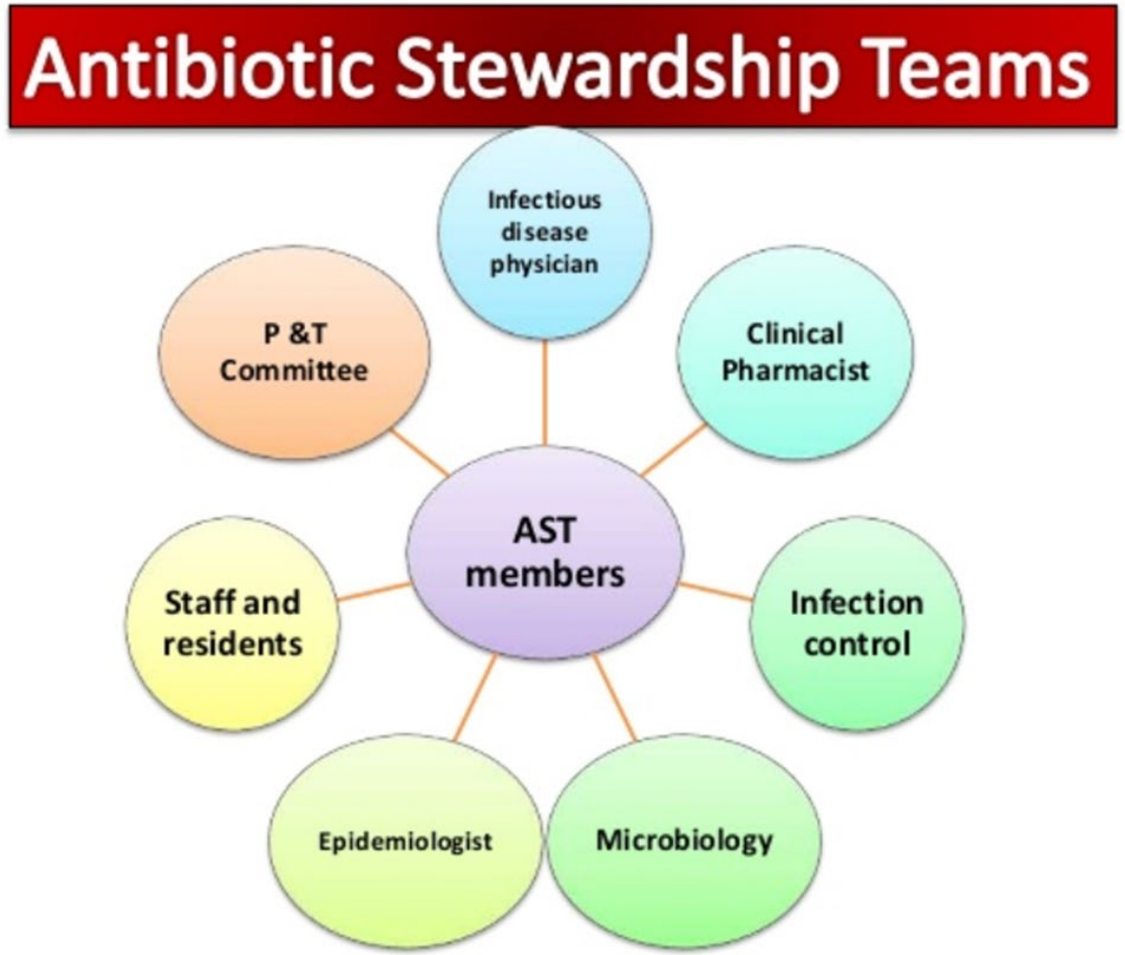


Aspects of Antibiotic Stewardship – What is the Real Team?

- ANA, CDC White Paper Redefining the Antibiotic Stewardship Team:

Recommendations from the ANA/CDC Workgroup on the Role of Registered Nurses in Hospital Antibiotic Stewardship Practices

Have we really defined the AST???



https://www.cdc.gov/antibiotic-use/healthcare/pdfs/ANA-CDC-whitepaper.pdf

Does This Reflect Your Hospital?

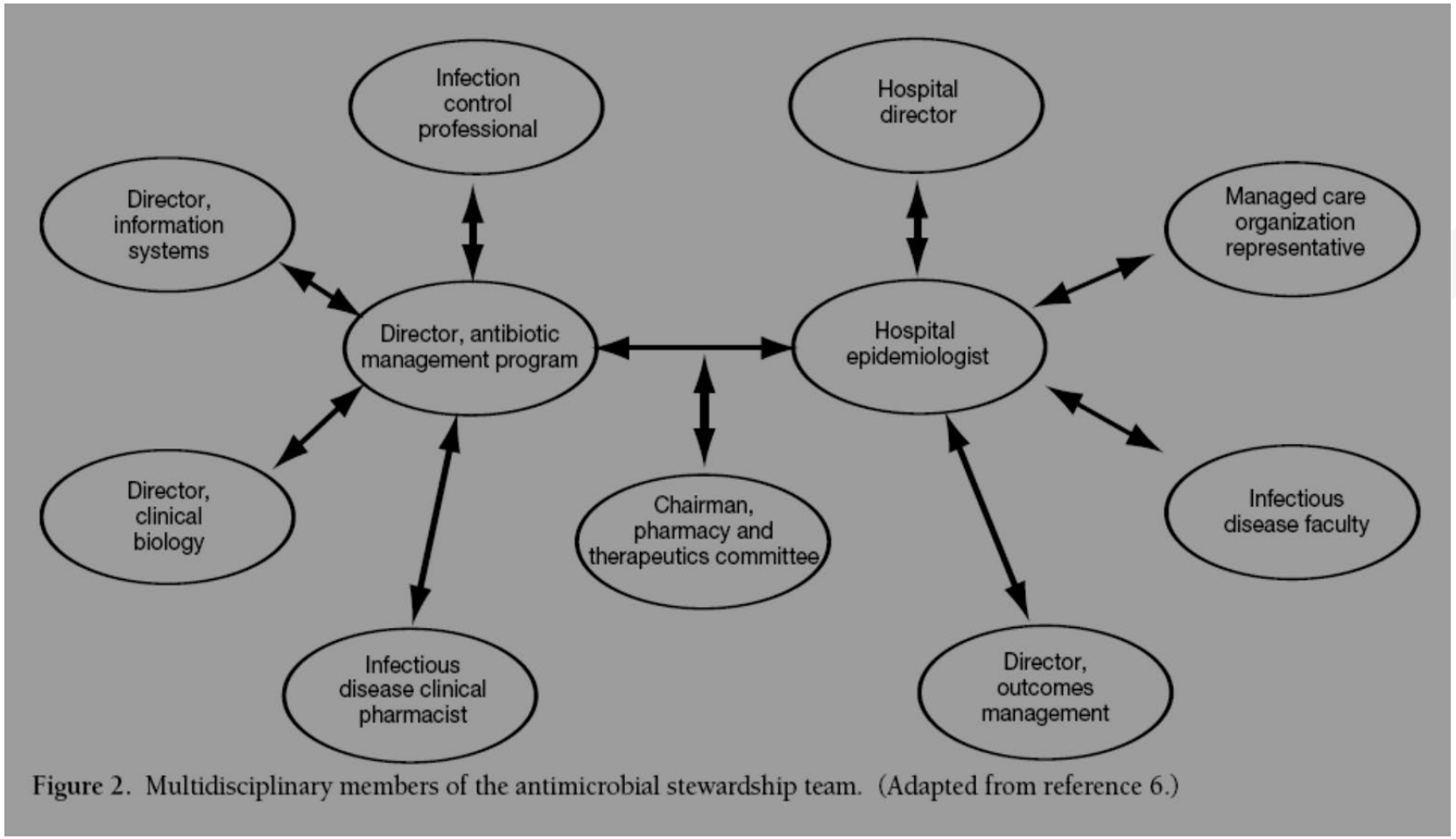


Figure 2. Multidisciplinary members of the antimicrobial stewardship team. (Adapted from reference 6.)

Rybak M. Pharmacotherapy; 27:131S

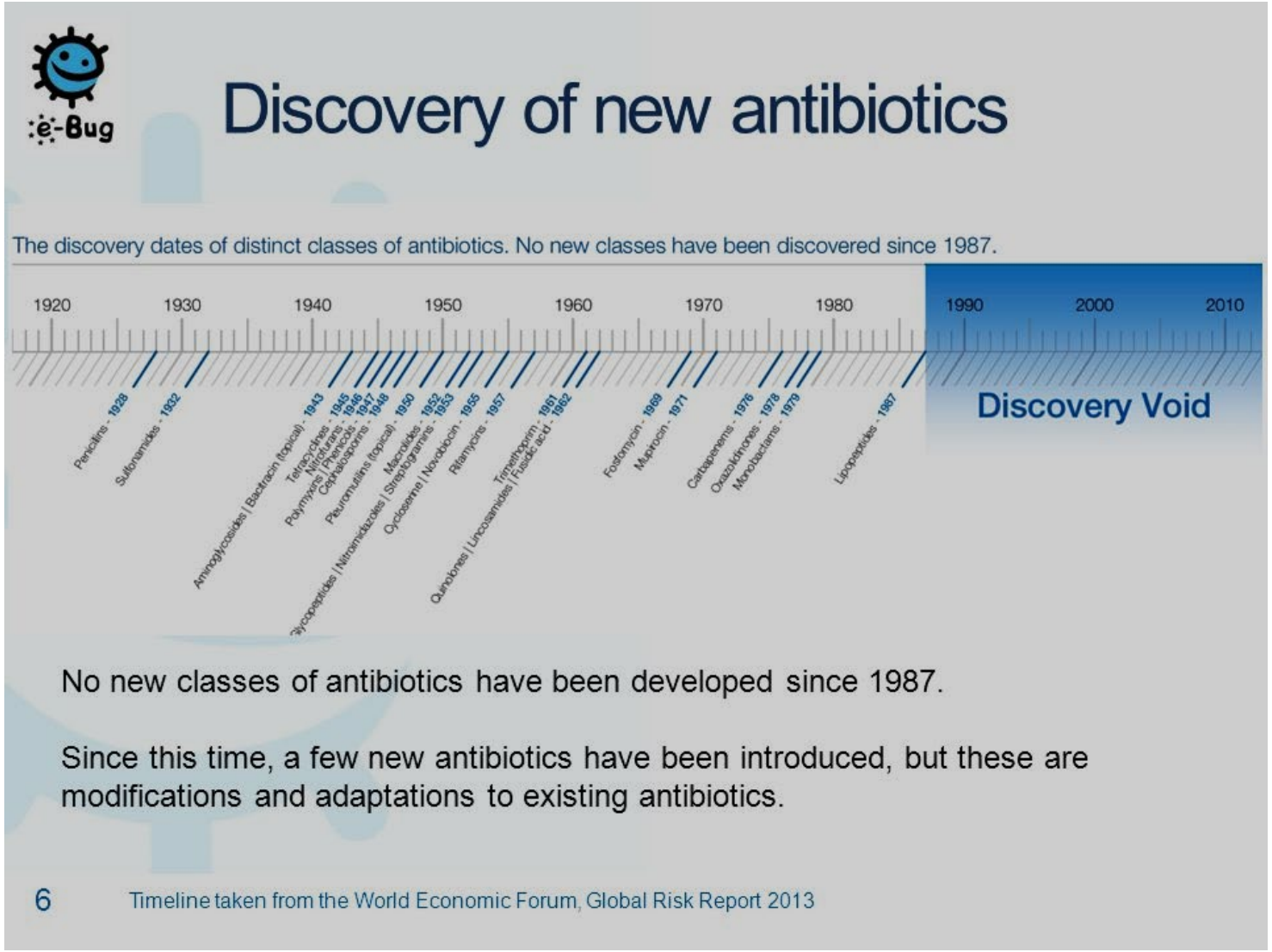
ANTIBIOTICS


BUY BONDS
PENICILLIN
CURES
GONORRHEA
IN 4 HOURS
SEE YOUR DOCTOR TODAY
HE NOW HAS PENICILLIN
FOR YOUR TREATMENT

Antibiotics

- Competitive advantage with other bacteria and fungi
  - Penicillin, for example
    - From fungal species
  - First reports missed this critical factor
    - Reported as interfering with growth on petri dishes
  - Sulfa antibiotics were designed

Discovery of New Antibiotics is Not Promising



Characteristics of Antibiotics

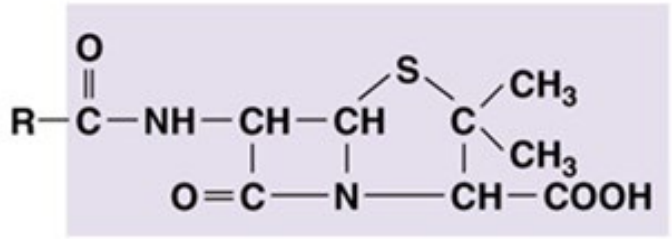
- No such thing as “powerful”
  - Often activity when others fail taken to imply more effective **FALSE!**
    - For Staph effectiveness - Penicillin > Cefazolin > Vancomycin
  - Effective for the MIC of the organism in levels achieved
- Proper dosing is required
- Longer is not better
- Too short is bad
- Oral = IV if appropriate levels are achieved
- Broad spectrum is not preferred
  - Selects for microbiome disturbance
  - Often less effective than targeted antibiotics

Gram Positive Agents

- Beta-lactams – damage cell wall formation
  - Penicillins
  - Cephalosporins
  - “Carbapenems”
  - Combination beta-lactam and beta-lactamase inhibitors
- Vancomycin - damage cell wall formation
- Daptomycin – multiple disruption of membrane function
- Linezolid – Protein synthesis inhibitor
- Clindamycin (kind of) – Protein synthesis inhibitor

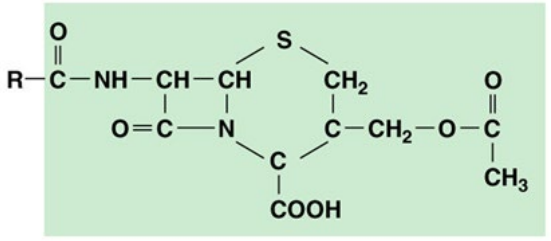
Penicillins

- Penicillins
  - Pen VK
  - IV Penicillin
  - Benzathine Penicillin
- Aminopenicillins
  - Amoxicillin/ampicillin
- Extended-spectrum penicillins
  - Piperacillin
- Penicillins + β-lactamase inhibitors
  - Amoxicillin + clavulanic acid
  - Ampicillin + sulbactam
  - Piperacillin + tazobactam
- Penicillinase-resistant penicillins
    - Carbapenems: very broad spectrum
    - Monobactam: Gram negative



Penicillin nucleus

Cephalosporins - Examples



Cephalosporin nucleus

- 1st Cefazolin
  - Primarily Gram positive and some Gram negative
- 2nd Cefotetan
  - Some added Gram negative and anaerobes
- 3rd Ceftriaxone, Ceftazidime
  - Better Gram-negative and some Gram-positive species, especially streptococci
- 4th Cefepime, cefpirome
  - Can have enhanced activity vs both Gram positive and Gram negative
- 5th Ceftaroline (MRSA activity), Ceftobiprole (coming – broad PA, ECOC, MRSA)
- Combination with beta-lactamase inhibitor
  - Ceftazidime + Avibactam
  - Ceftolozane + Tazobactam

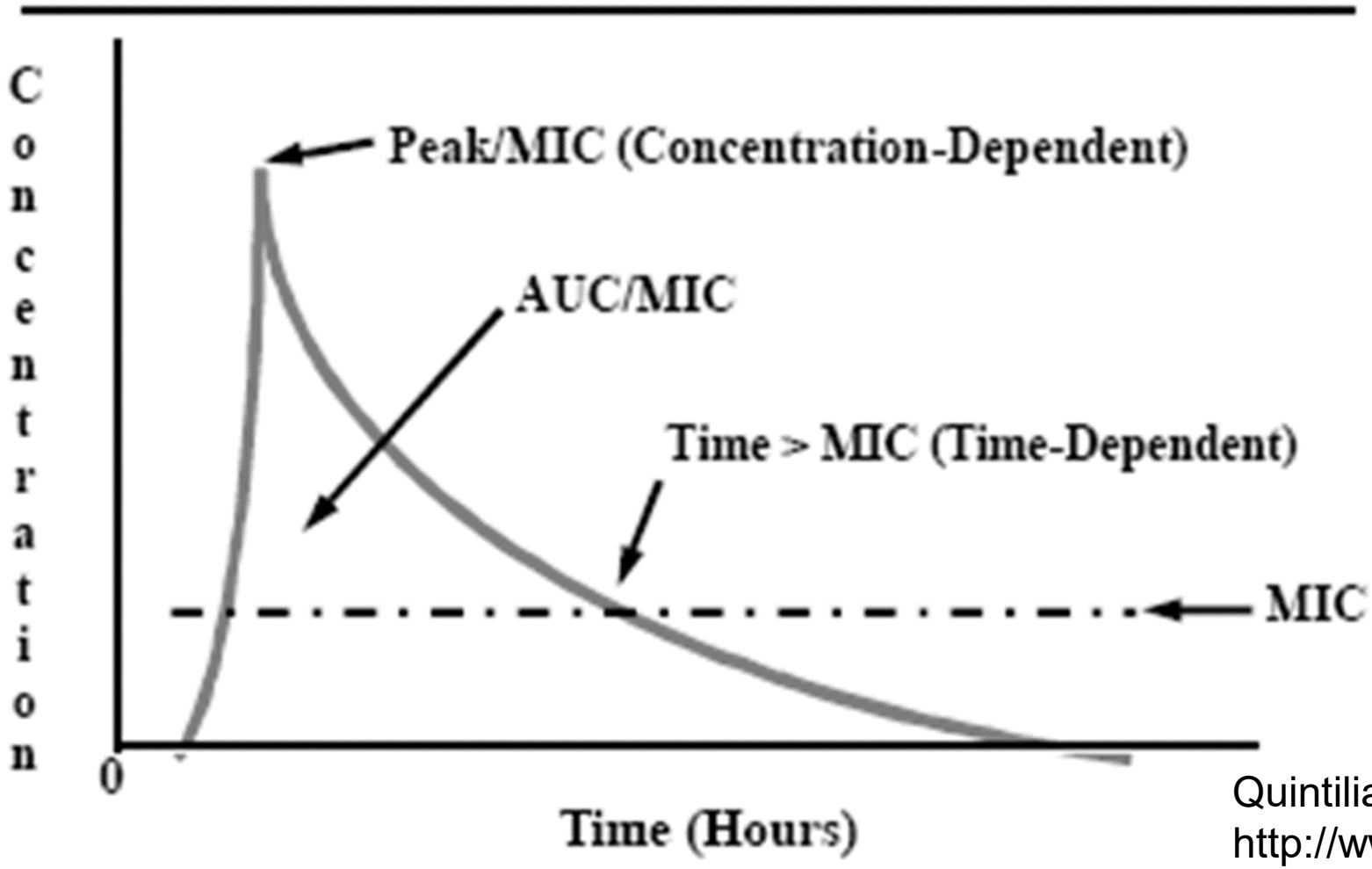
Other Antibiotics

- Quinolones – inhibit DNA synthesis
  - Broad Gram negative coverage
  - Some have Gram positive
  - Moxifloxacin has anerobic coverage
  - Ciprofloxacin, levofloxacin
- Rifampin – inhibits RNA synthesis
- Linezolid - inhibits RNA synthesis
- Polymyxin/colistin – inhibit membrane
- Sulfas (TMP/SMX) – competes for folate

Other Antibiotics

- Aminoglycosides:
  - Pure Gram negative activity
  - Inhibits protein synthesis
  - Gentamicin, tobramycin, amikacin, streptomycin, neomycin
- Tetracyclines – broad activity
  - Inhibits protein synthesis
- Macrolides:
  - Inhibits protein synthesis
  - Erythromycin, azithromycin

How to View Antibiotic Dosing



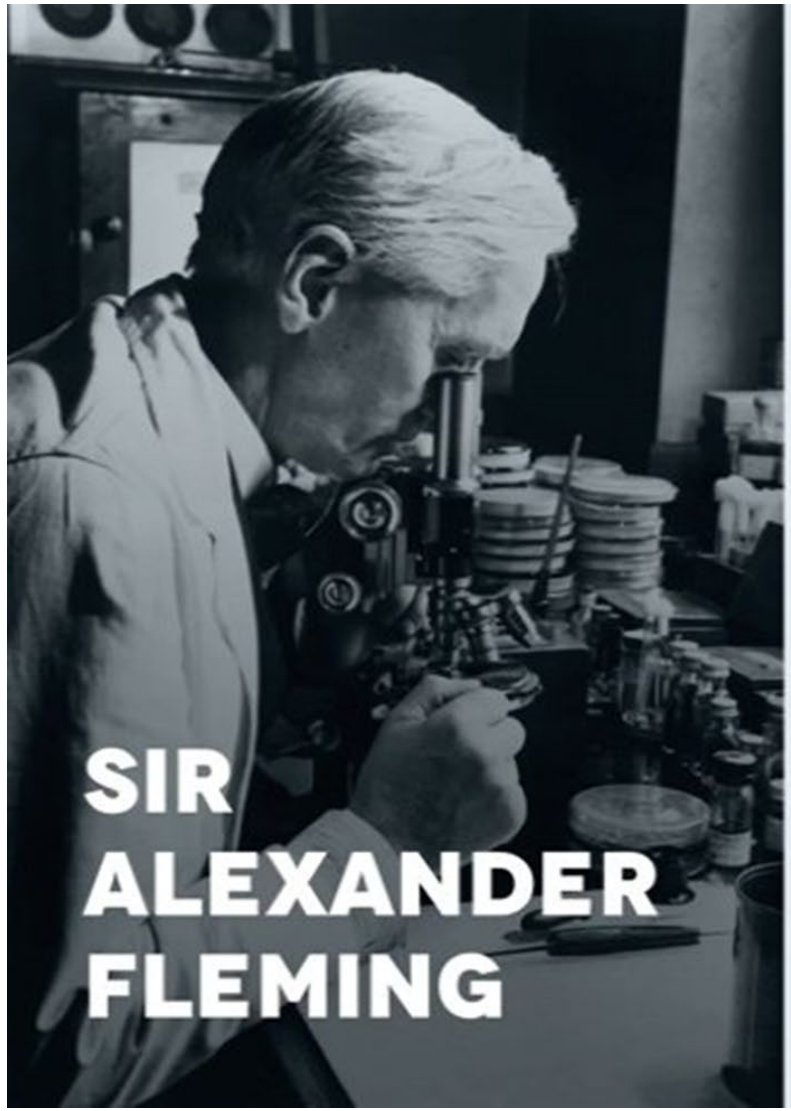
Quintiliani, R.
http://www.antimicrobe.org/h04c.files/history/PK-PD%20Quint.asp

Factors in Antibiotic Selection

- Target the infection – empiric vs directed
- Narrow spectrum as possible
- Efficacy
- Toxicity
- Disruption to normal flora
  - Can vary by hospital – inducers, *C. difficile* risk
- Planning for home
- Cost/formulary

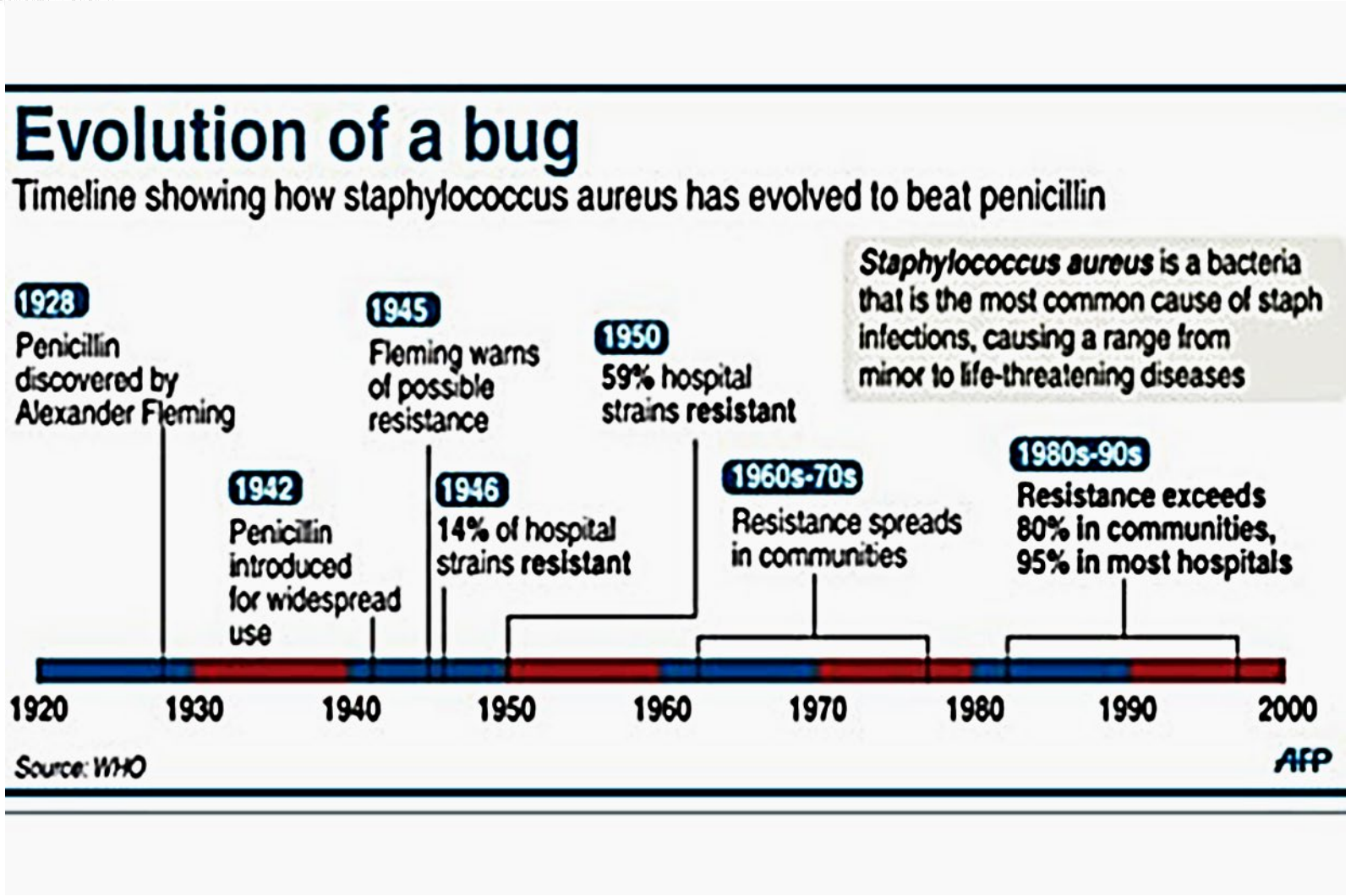
RESISTANCE

Resistance was Not Unexpected



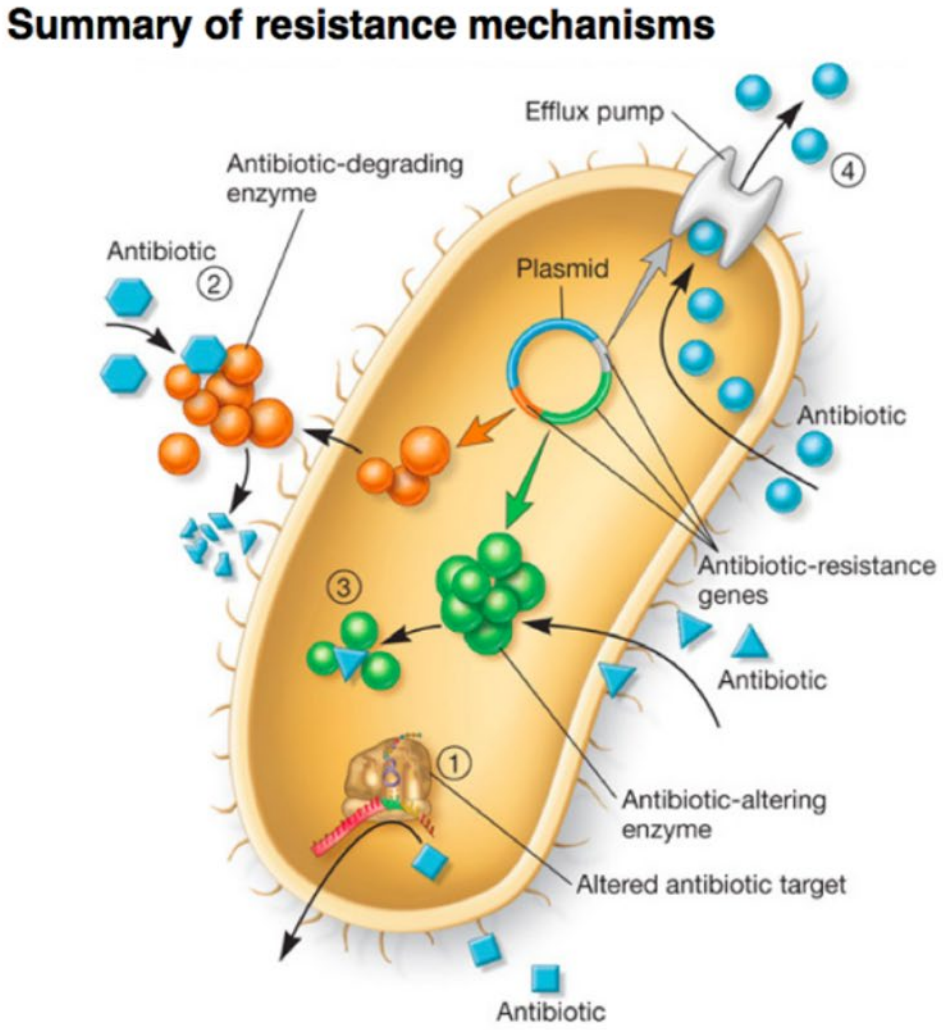
The thoughtless person playing with penicillin treatment is morally responsible for the death of the man who succumbs to infection with the penicillin-resistant organism.

The Original Resistance



cdc.gov/drugresistance

Many Potential Resistance Mechanisms



1) Altered target
2) Inactivation
3) Bypass
4) Efflux
5) Impermeability

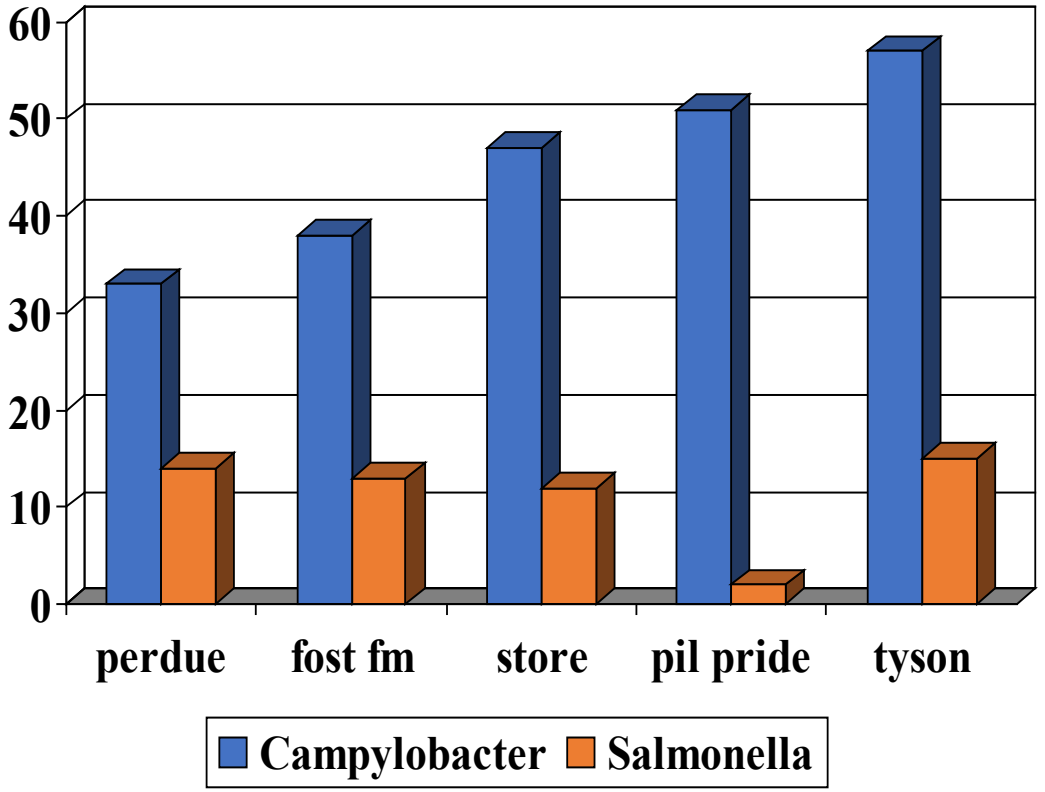
Why are Bacteria Becoming Resistant?

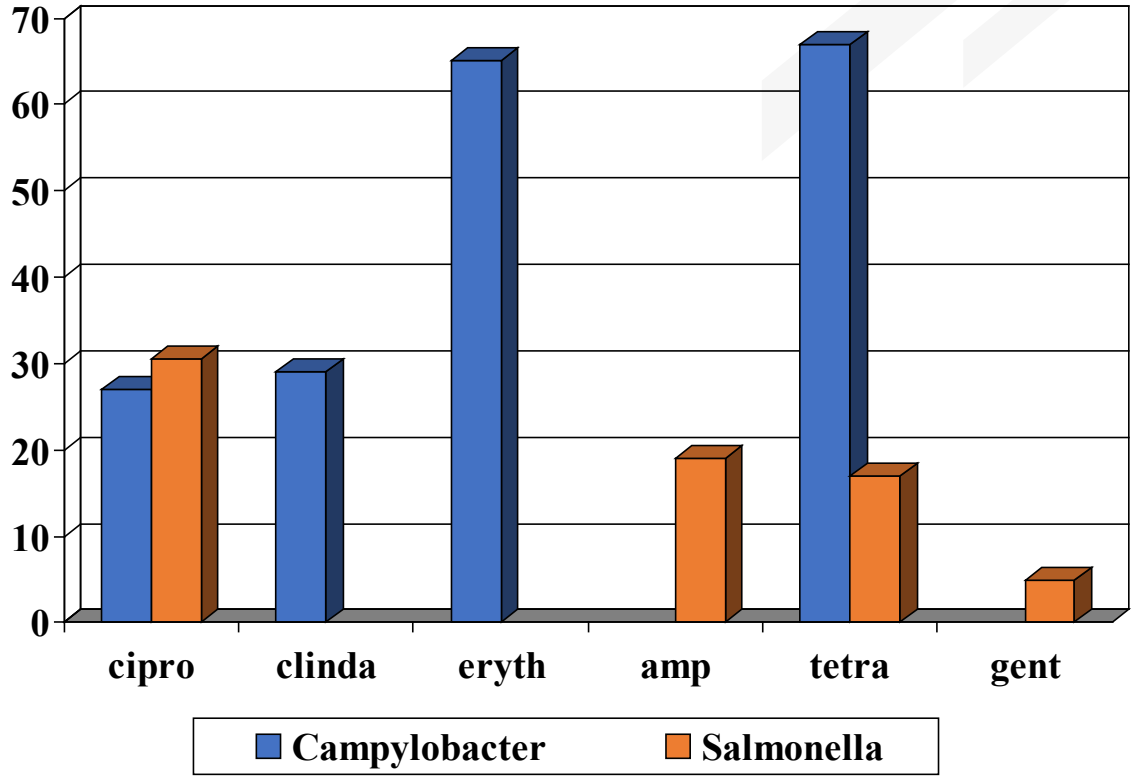
- Antimicrobial use in the community and hospitals
- In veterinary medicine and agriculture
  - 8 million kg used for animals annually
  - 22,000 kg used for fruit trees annually in the U.S.
- In 1954, two million pounds of antibiotics were produced in the US. Today > 50 million pounds.
- > 100 million courses of antibiotics in the US annually.
- Increase in empiric antibiotics
- Prolonged and broad-spectrum antibiotic courses
- Repeated antibiotic courses

Why do we Use Antibiotics in Animals?

- For treatment of disease.
- For metaprophylaxis.
- For growth enhancement. Usually antibiotics not used in humans
  - In cattle: bacitracin, tetracyclines, lasalocid, monensin
  - In swine: asanilic acid, bambermycin, erythromycin, penicillin, tiamulin, virginiamcin

Resistant Pathogens From Commercial Chickens





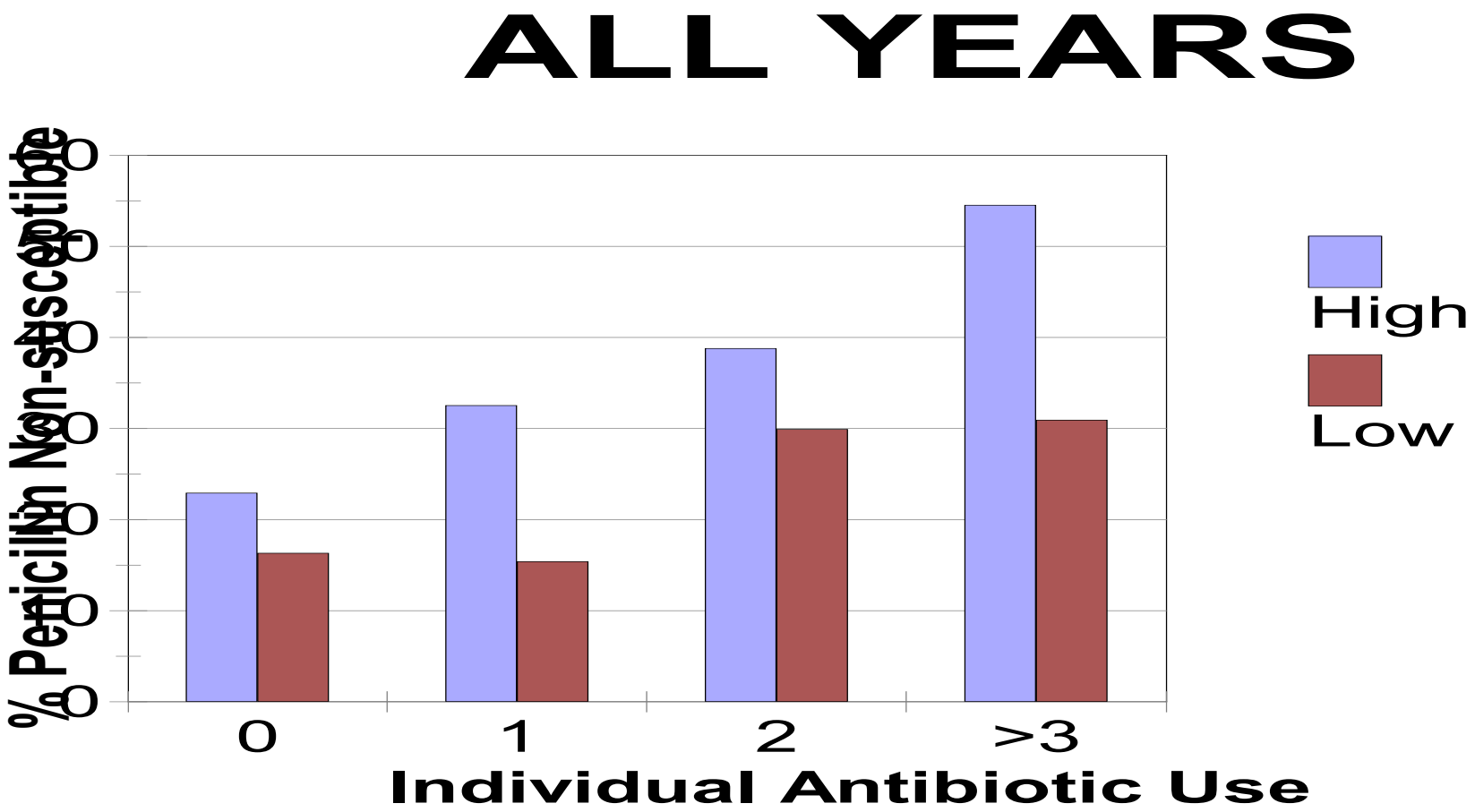
Consumer Reports 1-03

Antibiotic Overuse in U.S. Hospitals

CDC (2010 – 183 hospitals/50,000 discharges)

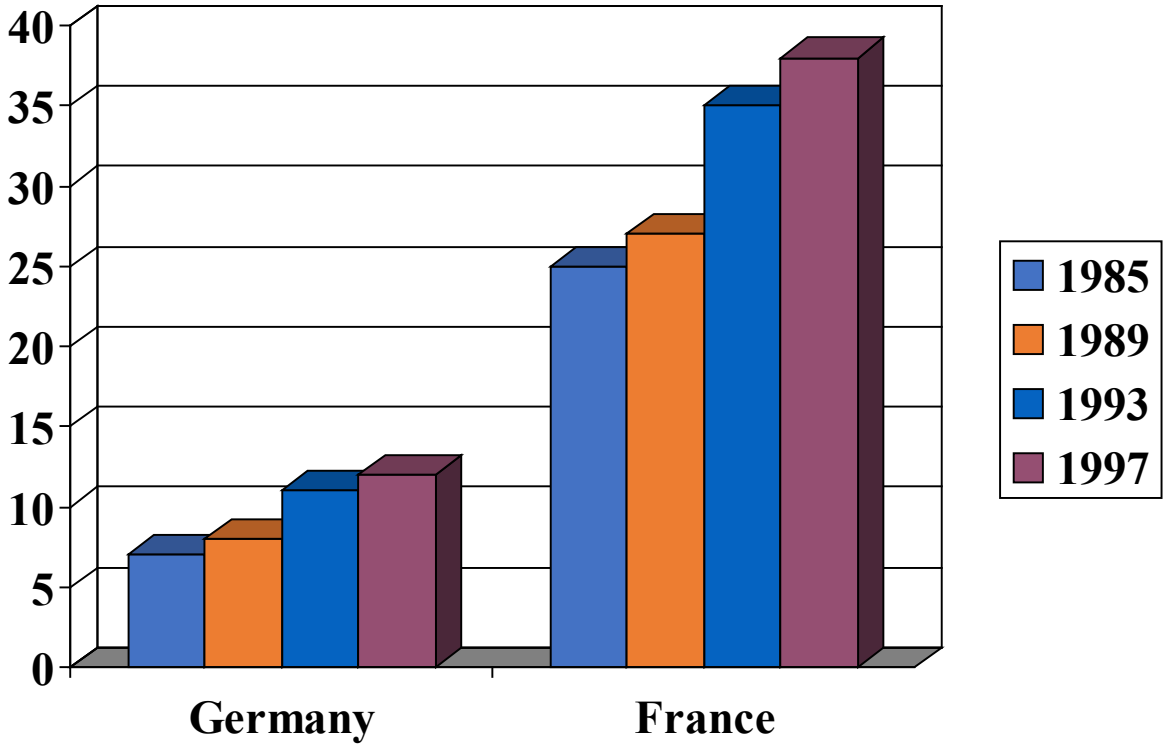
- > 50% hospitalized inpatients receive antibiotic Rx
- > 37% of this use unnecessary or inappropriate
- Did not address duration
- Did not address spectrum

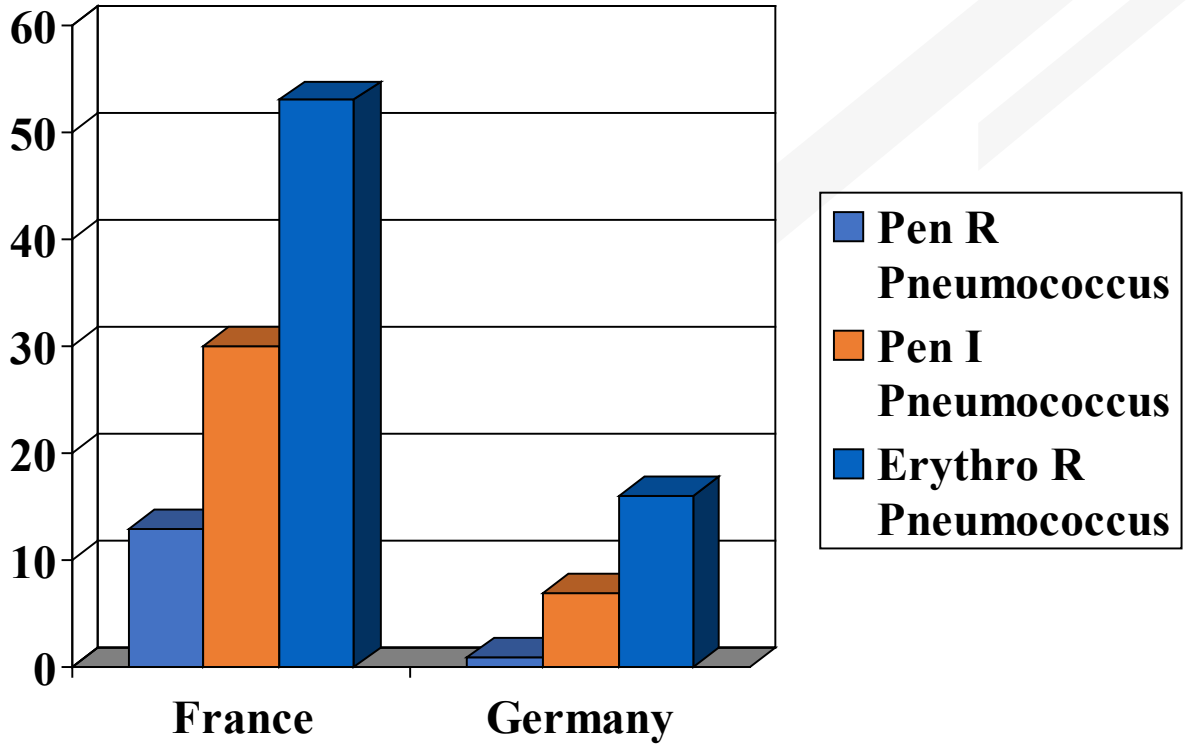
Antibiotic Resistance is a Community Issue



(Hennessy T. ISPPD 2002)

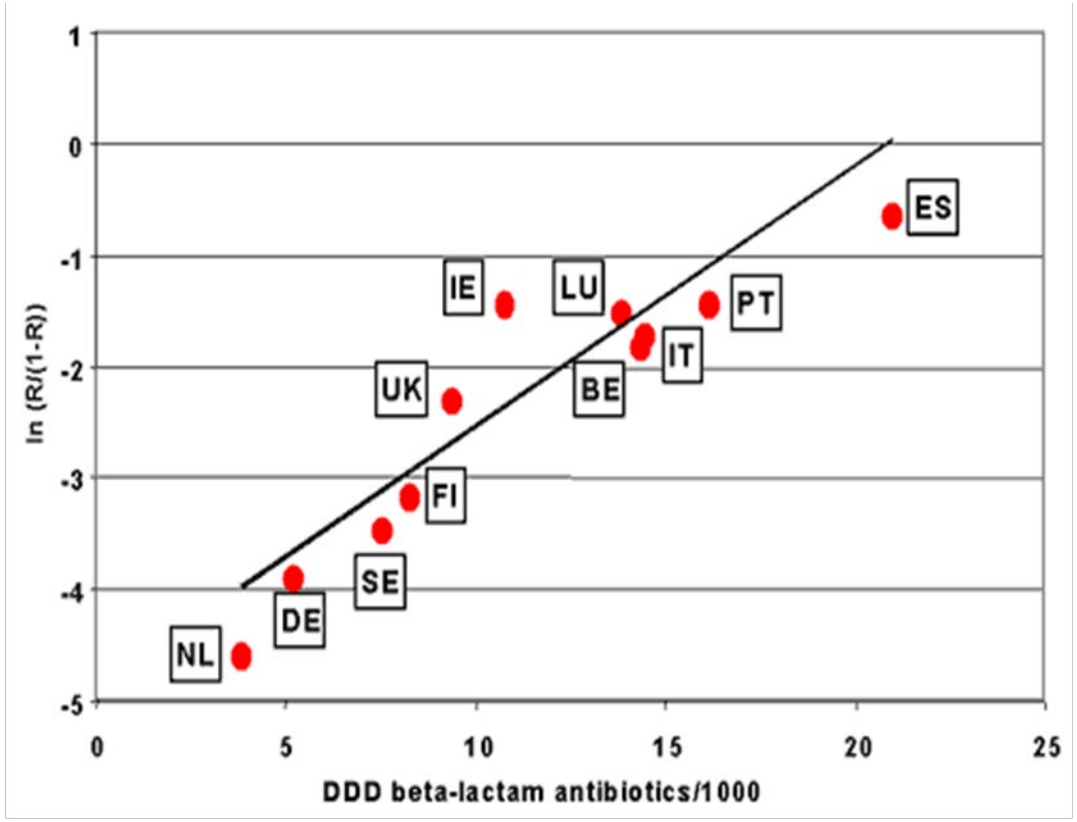
Outpatient Antibiotic Use and Resistance





Harbarth, Emerg Infect Dis 2002;8:1460.

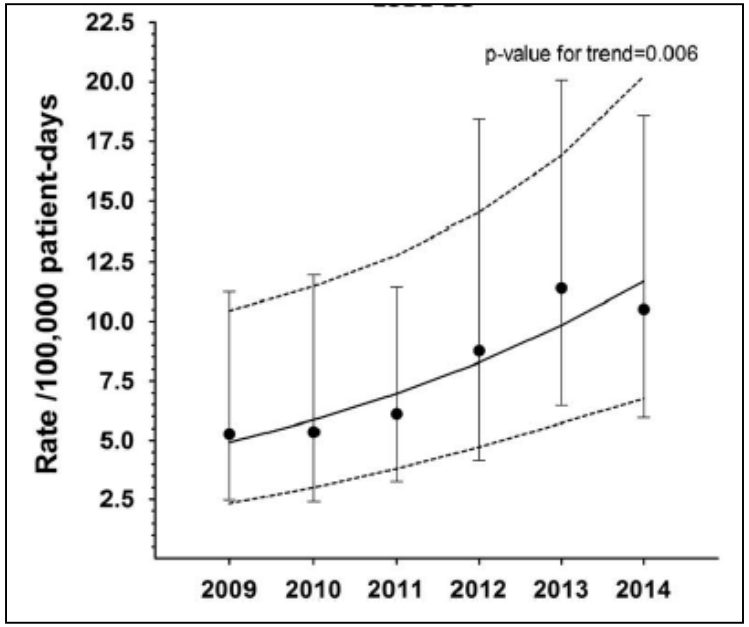
Outpatient Antibiotic Use and Resistance

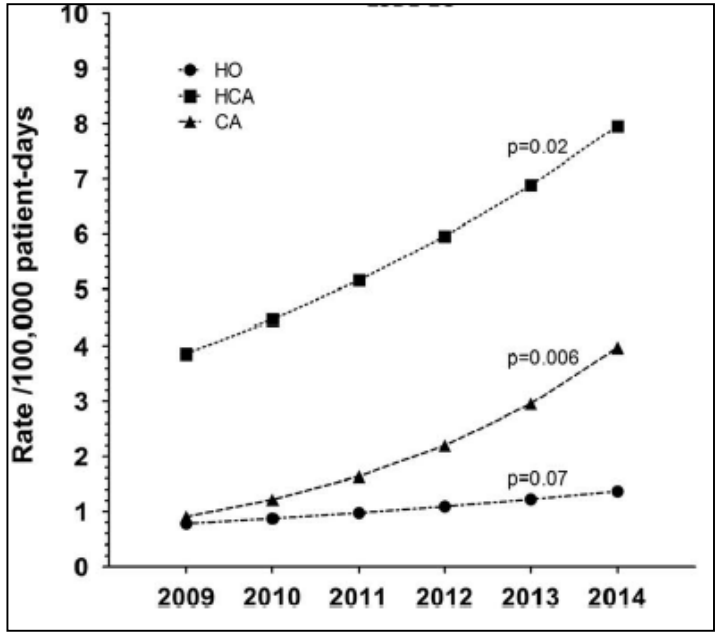


(Bronzwaer et al. Emerging Infectious Diseases 2002)

Epidemiology of ESBL

- ESBL-producing *E coli* infections are **increasing** in the US
  - In the southeastern US, the incidence increased 50% between 2009 and 2014.
- Both hospital and community acquired





Is This the Future??

ORG		KPNE !
Susceptibility (ATTENTION: Important ANTIBIOTIC information c		
	Klebsiella pneumoniae MBINT	
Ampicillin	>32	RESISTANT
Ampicillin+Sulbactam	>=32/16	RESISTANT
Aztreonam	>=64	RESISTANT
Cefazolin	>=64	RESISTANT
Cefepime	>=64	RESISTANT
Ceftazidime	>=64	RESISTANT
Ceftriaxone	>=64	RESISTANT
Ciprofloxacin	>=4	RESISTANT
Ertapenem	Pending	.
Gentamicin	<=1	SUSCEPTIBLE
Levofloxacin	>=8	RESISTANT
Meropenem	4	RESISTANT
Piperacillin+Tazobactam	>=128/4	RESISTANT
Trimethoprim+Sulfamethoxazole	>=16/304	RESISTANT

What are the elements of antibiotic stewardship and how should infection preventionists participate?

CDC. Core Elements of Hospital Antibiotic Stewardship Programs. 2014.

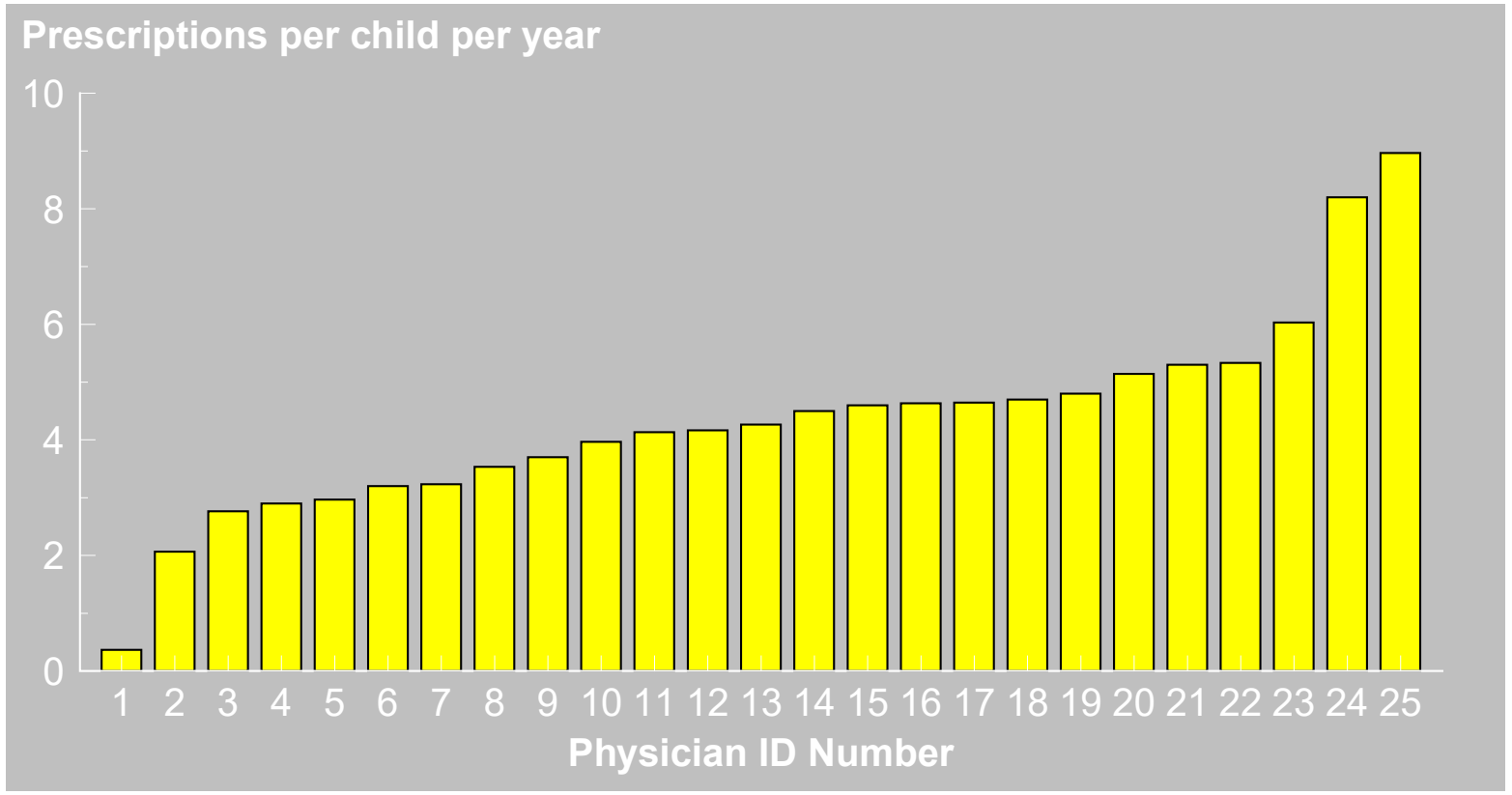
- Formal statements that the facility supports efforts to improve and monitor antibiotic use
- Include stewardship-related duties in job descriptions and annual performance reviews
- Ensure staff from relevant departments are given sufficient time
- Support training and education
- Ensure participation from the groups that can support stewardship

What are the issues for IPs in view of this?

Physician Issues with Antibiotic Prescribing

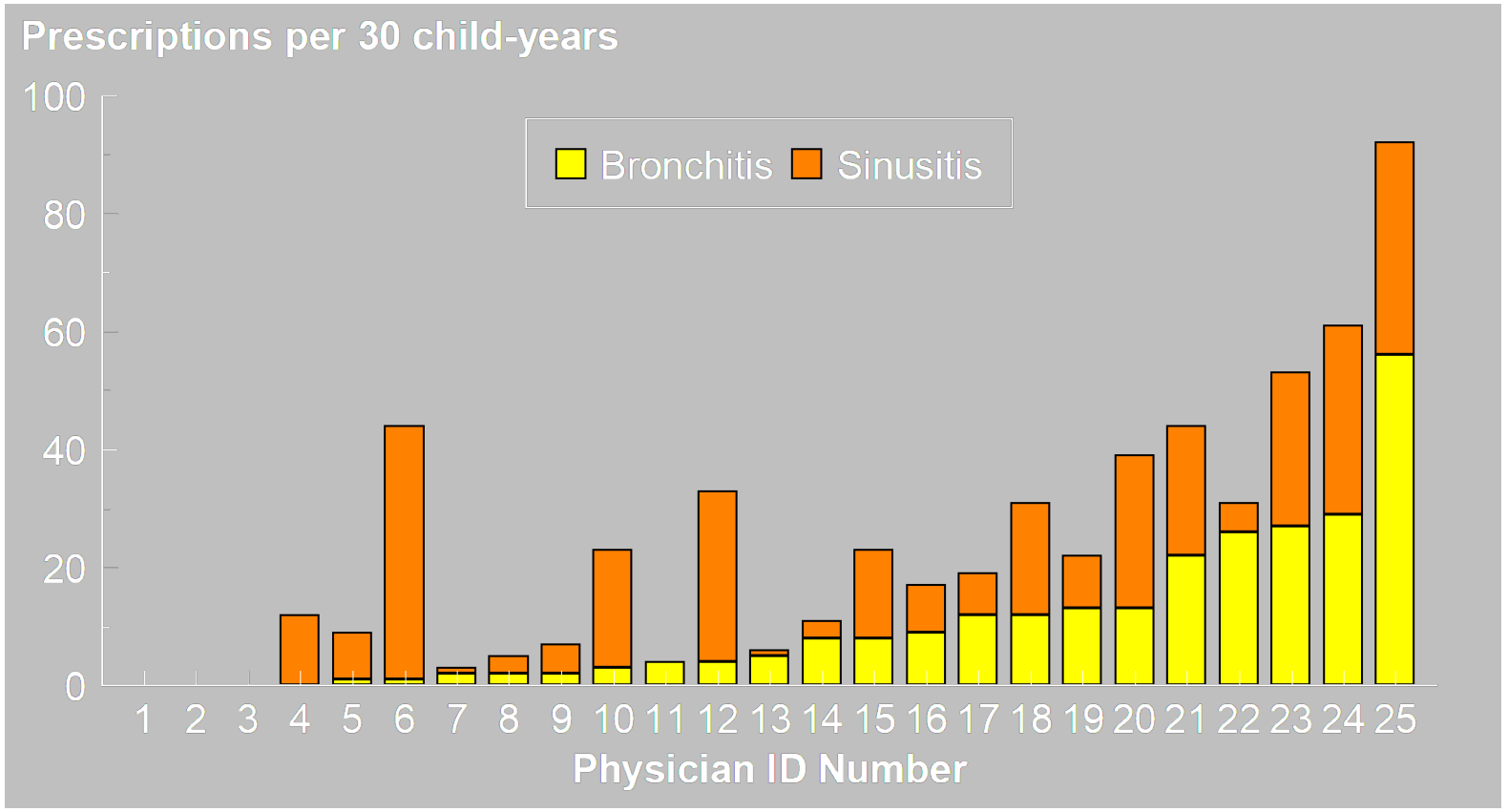
Can the IP address these?

Antibiotic Prescribing by 25 Atlanta Office-Based Pediatricians



Dowell,ARI abstract 1997;W2B:77

Antibiotic Prescribing for Bronchitis and Sinusitis by 25 Atlanta Office-Based Pediatricians



Dowell,ARI abstract 1997;W2B:77

It Takes More Than Physician Education to Change

Partner: Kaiser, Denver

Approach

- controlled trial: full, partial, or no intervention

Full Intervention

- clinician education: opinion leader model, practice profiling, detailing/practice tips
- household education: brochures, magnets
- office education: posters for office, fact sheets

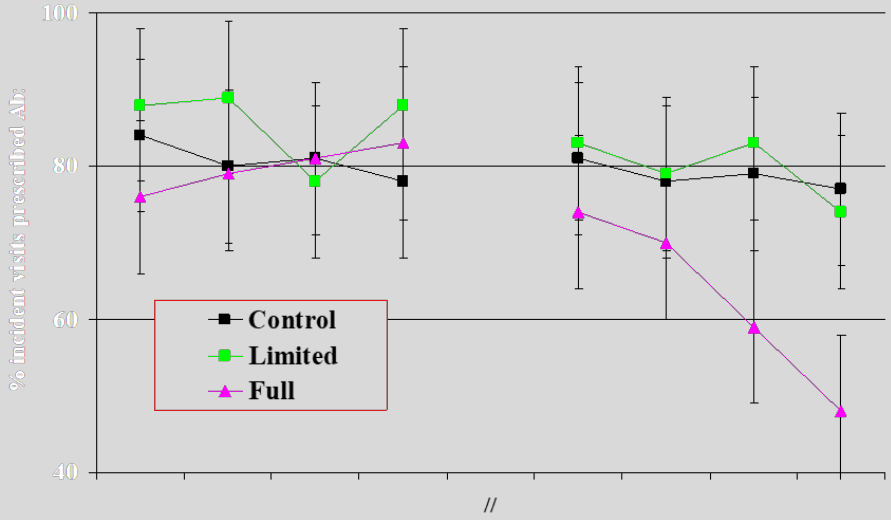
Partial Intervention

- office education only

Gonzales, JAMA 1999;281:1512-19

It Takes More Than Physician Education to Change

Intervention to Reduce Antibiotic Use, Denver, 1997-1998



baseline **study**

Gonzales et al. JAMA 1999; 281:1512-9

Physician Barriers

- Physician accountability and acceptance of need for stewardship
- Misperceptions
  - “Powerful” antibiotics
  - Liability
  - Can cover “everything”
- Misalignment of incentives
- Ignorance
- Lack of definition of appropriate use of antimicrobial agents
- Lack of standardized, risk-adjusted measures
- Adaptive/behavioral changes needed to change prescribing practices

Changing Prescriber Behavior

- IPs can identify critical results
- IPs can be interface with staff RNs
- Engagement of senior physician leadership (clinical and administrative) is critical
- Address stewardship message to the clinical leadership within existing clinical groups (rather than just the trainees or the ID doctors) – need a physician champion to work with.
- ID should not be excluded from stewardship process
- Understand local culture and patient population
- Behavior science suggests additional models

The Approach to the Problem Prescriber

- Carefully plan your approach:
  - Pick your battles
  - Timing is important
  - Avoid heat of the moment confrontations (generate light not heat)
- Do your homework – Recruit your physician ally
  - Gather as much data as possible
    - DUE: Service and physician specific for several drugs
    - Interview Clinical PharmDs and discretely other MDs
    - Discuss with Department Chief/Chief of staff
  - Understand the MD's Practice and Patient Population
  - Look into the MD's own professional literature

How should IPs participate in antibiotic stewardship?

Take five minutes at your table and come up with your recommendations.

How Should IPs Participate in Stewardship?

- Stewardship *definition:* the conducting, supervising, or managing of something; *especially,* ***the careful and responsible management of something entrusted to one's care.***
  - What is our role?
  - Use our strengths
  - Not waste our time
- Suggestions?

So – How DO IPs Participate in Effective Stewardship? Scenario:

64 year old man with onset of sepsis on his 12th day of hospitalization for perforated colon secondary to adenocarcinoma of the colon. His creatinine had been deteriorating since admission, presumptively due to imaging contrast, now 3.6. He had progressive respiratory distress requiring intubation and new pulmonary infiltrates on CXR. He was placed on Vancomycin 1 gm q 12 h, meropenem 1 gm q 8 h, ciprofloxacin 400 mg q 12 h and azithromycin 500 mg qd. He had one loose BM overnight. Blood and urine cultures from his Foley catheter were obtained.

What should the IP do in this setting?

A. Recommend antibiotic dosing changes?
B. Encourage removal of the catheter?
C. Recommend *C. difficile* testing?
D. Other actions?

So – How DO IPs Participate in Effective Stewardship? Scenario from above:

64 year old man with onset of sepsis on his 12th day of hospitalization for perforated colon secondary to adenocarcinoma of the colon. His creatinine was now 3.6. He had progressive respiratory distress requiring intubation and new pulmonary infiltrates on CXR. He was placed on Vancomycin 1 gm q 12 h, meropenem 1 gm q 8 h, ciprofloxacin 400 mg q 12 h and azithromycin 500 mg qd. He had one loose BM overnight. Blood and urine cultures from his Foley catheter were obtained.

Sputum cultures grew K. pneumoniae resistant to meropenem, ciprofloxacin and all others agents on routine panel of testing.

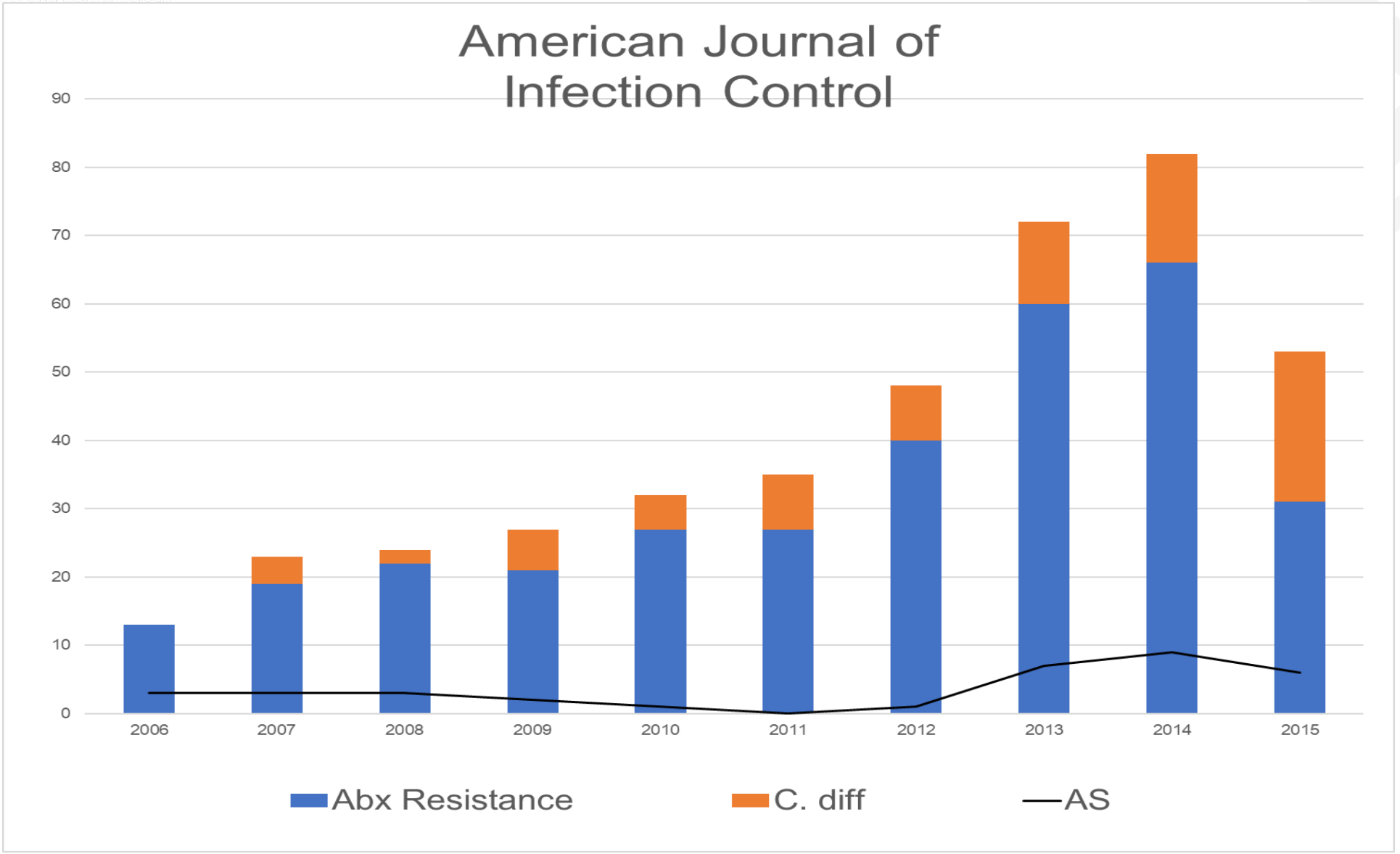
What should the IP do in this setting?

A. Recommend colistin?
B. Point out that these antibiotics are ineffective?
C. Initiate isolation?
D. Notify Public Health?
E. B,C, and E and Other actions?

The Role of IPs in ABS

- It is not yet well-defined
  - Various organizations have their views
- It will vary by type of facility
- It will vary by departmental interest in ABS
- It requires making leadership understand what it is
- It requires a willingness to participate on IP's part

Literature in Infection Prevention is Limited*



*So far!

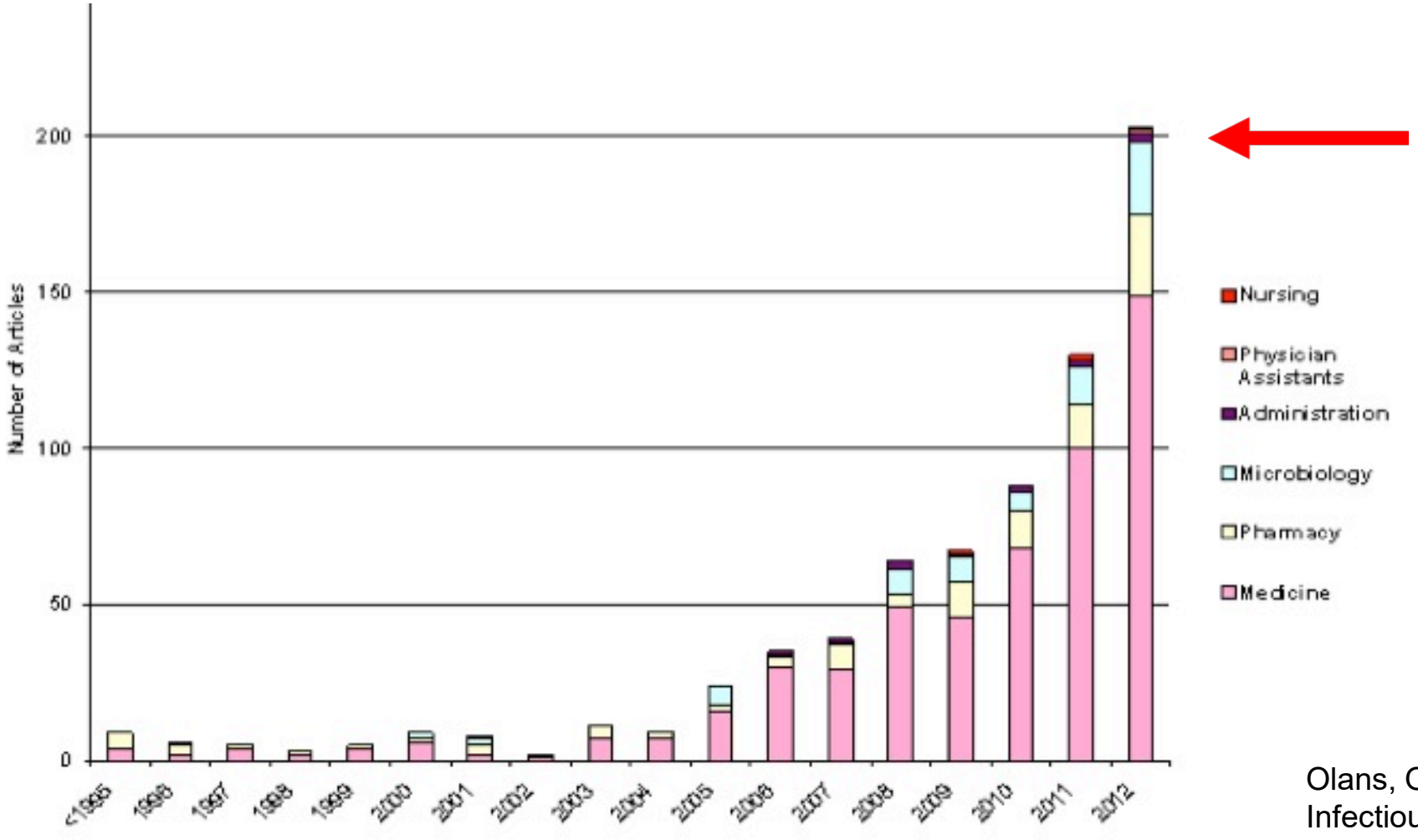
How Does ABS Interface With IPs?

"MRDO infections are more difficult to treat, incur greater treatment costs, and have greater morbidity and mortality than infections caused by organisms susceptible to antibiotics….

Antibiotic misuse and overuse facilitates the development of MDROs, as well as CDI infections – an antibiotic-associated adverse drug event – making AS an important synergistic HAI prevention and control strategy"

Manning, ML,et al, Antimicrobial stewardship and infection prevention—leveraging the synergy: A position paper update AJIC 46;2018:364-8

Articles in the Literature on ABS



Olans, Olans, DeMaria, Clinical Infectious Diseases® 2016;62(1):84–9

Issues For IPs in Antibiotic Stewardship

- Infection – identify causative organisms (true positive)
- Contamination – false positive due to contaminate
  - Time to culture positivity
  - Number of positive blood bottles
  - Consider what sites should normally be sterile
  - Consider common causes of culture contamination
  - Question polymicrobial culture results
  - Promote correct antiseptic technique when obtaining cultures
- In essence support “diagnostic stewardship”

What are Contaminants?

Microorganism (No. of Isolates)	No. (%) of Isolates per Indicated Category		
	True Pathogen	Contaminent	Unknown
Staphylococcus aureus (204)	178 (87.2)	13 (6.4)	13 (6.4)
Coagulase-negative staphylococcus (703)	87 (12.4)	575 (81.9)	41 (5.8)
Streptococcus pneumoniae (34)	34 (100)	0	0
Viridans streptococci (71)	27 (38.0)	35 (49.3)	9 (12.7)
Other streptococci (31)	21 (67.7)	6 (19.4)	4 (12.9)
Enterococcus spp. (93)	65 (69.9)	15 (16.1)	13 (14.0)
Corynebacterium spp. (53)	1 (1.9)	51 (96.2)	1 (1.9)
Bacillus spp. (12)	1 (8.3)	11 (91.7)	0
Escherichia coli (143)	142 (99.3)	0	1 (0.7)
Klebsiella pneumoniae (65)	65 (100)	0	0
Other enteric gram-negative bacteria (108)	104 (96.3)	1 (0.9)	3 (2.8)
Pseudomonas aeruginosa (55)	53 (96.4)	1 (1.8)	1 (1.8)
Propionibacterium acnes (48)	0	48 (100)	0
Other Gram-positive anaerobes including *Clostridium* spp. (35)	19 (54.3)	15 (42.8)	1 (2.9)
Bacteroides fragilis group (18)	16 (88.9)	0	2 (11.1)
Other Gram-negative anaerobes (5)	2 (40)	2 (40)	1 (20)
Candida spp. (60)	56 (93.3)	0	4 (6.7)
Cryptococcus neoformans (8)	8 (100)	0	0

Clin Infect Dis. 1997;24:584-602.

Key Interventions: De-escalation of Therapy

- Advantages
  - Allows initial use of broad-spectrum therapy
  - Narrows therapy when appropriate
  - May influence future prescribing behavior
  - Decreases inappropriate use of antimicrobials
  - Reduces adverse events
  - May save money overall
- Disadvantages
  - Still alters flora
  - Prescribers may be reluctant to change therapy if the patient is doing well
  - If not done correctly, may narrow therapy "inappropriately"

Antibiotic Resistance – Risk of Spread

- Spread of organisms by staff members.
- Rate of transfer = $\frac{\text{Number of contacts X Risk per event}}{[1-q]}$
- q is unique exposures.
- RNs have many more contacts, but few patients.
- MDs have few contacts with many patients!

IPs are the Interface with Nursing Staff

Table 1. Inpatient Admission: Antimicrobial Stewardship Tasks and Functions Performed by Nurses[18]

Activity/Task	Person Responsible	Functions the Nurse Performs
Appropriate triage and isolation	Infection preventionist	Assesses the source of infection and appropriate precautions. An infection preventionist may subsequently be called for a consultation.
Accurate antibiotic allergy history	Pharmacist	Gathers information about the patient's allergy history, performs medication reconciliation, and records this in the medical record.
Early and appropriate cultures	Hospitalist, microbiologist	Obtains cultures before starting antibiotics and sends these to the microbiology laboratory. Monitors culture results and reports these to the physician.
Timely antibiotic initiation	Hospitalist, infectious disease specialist, pharmacist	Receives the orders, reviews the dose and timing of dose schedule for accuracy, checks for history of allergy, and administers antibiotics and documents administration.

Olans, RD, Olans, RN, Witt, DJ. Good Nursing Is Good Antibiotic Stewardship
Am J Nur 2017; 117(8):58-63

IPs are the Interface with Nursing Staff

Table 2. Inpatient Stay: Antimicrobial Stewardship Tasks and Functions Performed by Nurses[18]

Activity/Task	Person Responsible	Functions the Nurse Performs
Progress reporting	Hospitalist, infectious disease specialist	Cares for the patient 24 hours a day, 7 days a week; monitors and communicates daily patient progress.
Antibiotic adjustment based on microbiology reports	Hospitalist, infectious disease specialist, microbiologist	Typically receives laboratory and radiology reports first; coordinates results and communicates them to the treating physicians.
Antibiotic dosing, culture and sensitivity reporting, and deescalation	Infectious disease specialist, microbiologist, pharmacist	Updates clinical and laboratory renal function results, drug levels, and preliminary and final microbiology results.
Adverse events	Hospitalist, pharmacist	Monitors and reports to the physician and pharmacist any adverse events, including diarrhea.
Antibiotic orders	Hospitalist, infectious disease specialist	Reviews patient's clinical status and changes in medications.
Antibiotic resistance	Infectious disease specialist, hospitalist, microbiologist	Reviews culture and sensitivity results and reports "bug–drug" mismatches. Time outs and antibiotic deescalation are used to reassess the patient's clinical status.
Superinfection and resistant infection	Infectious disease specialist, infection preventionist, microbiologist	Monitors patient response and initiates appropriate changes in isolation precautions.

Olans, RD, Olans, RN, Witt, DJ. Good Nursing Is Good Antibiotic Stewardship Am J Nur 2017; 117(8):58-63

IPs are the Interface with Nursing Staff

Table 3. Inpatient Discharge: Antimicrobial Stewardship Tasks and Functions Performed by Nurses[18]

Activity/Task	Person Responsible	Functions the Nurse Performs
Transition patients from IV to oral antibiotics and to outpatient antibiotic therapy	Case manager, infectious disease specialist, pharmacist	Monitors patient's clinical progress and capacity to take oral medications.
Length of stay: monitors patient's progress 24 hours a day, 7 days a week	Administrator, case manager, infectious disease specialist	Reviews patient's response to therapy and capacity for discharge to home and rehabilitation needs.
Patient education and medication reconciliation	Hospitalist, infectious disease specialist, pharmacist	Educates patient and family and performs discharge teaching.
Manages transition to outpatient visiting nurse service, skilled nursing facility, or long-term care facility as well as readmission to the hospital	Administrator, case manager, infection preventionist	Communicates patient's diagnosis, management, and medications to the nurse at the visiting nurse service, skilled nursing facility, or long-term care facility.

Olans, RD, Olans, RN, Witt, DJ. Good Nursing Is Good Antibiotic Stewardship
Am J Nur 2017; 117(8):58-63

How Does ABS Interface With IPs?

"They (IPs) do engage a diverse range of clinical disciplines across practice settings in HAI prevention. IPs have substantial contact with bedside nurses, often together reviewing patients who develop HAIs as part of routine daily activities…..

They can leverage these strong collegial relationships to influence and facilitate nursing's supporting role in initiating antibiotic timeouts, performing antibiotic reconciliation during patient transitions of care, and educating patients and families about safe and appropriate antibiotic use."

Manning, ML,et al, Antimicrobial stewardship and infection prevention—leveraging the synergy: A position paper update AJIC 46;2018:364-8

How Does ABS Interface With IPs - Results?

"Creating educational strategies to address each discipline's clinical interests and make the case for why IPC and AS is of value to them and their patients is essential….

A logical area for IPC education participation is to ensure that front-line physicians and nurses are aware of the indications for testing as well as the risks associated with inappropriate testing.

Some specific examples include indications for obtaining and appropriate collection of urine cultures, indications for obtaining culture from endotracheal tubes, and indications for testing for CDI infections."

Manning, ML, et al. Antimicrobial stewardship and infection prevention—leveraging the synergy: A position paper update AJIC 46;2018:364-8

How Does ABS Interface With IPs - Results?

- Benefits of appropriate culturing:
  - Appropriate cultures improve the chances of identifying the offending microorganism
  - Administration of antimicrobials before culture collection may decrease culture yields
  - More difficult to deescalate therapy without cultures
- Potential role for IP:
  - Educate RNs on obtaining accurate allergy histories
  - Train in getting cultures expeditiously and correctly
  - Encourage appropriate culturing
  - Discourage inappropriate culturing

How Does ABS Interface With IPs - Results?

Antibiotic stewardship programs reduced the incidence of infections and colonization:

- MDRO Gram-negative (51% reduction (95% CI 0·35–0·68; p<0·0001)
- ESBL (48%; 0·27–0·98; p=0·0428)
- MRSA 37%; 0·63, 0·45–0·88; p=0·0065

C difficile infection reduction (32%; 0·68, 0·53–0·88; p=0·0029).

- Antibiotic stewardship programs were more effective when implemented with:
- Infection control measures (IR 0·69, 0·54–0·88; p=0·0030),
- Hand-hygiene interventions (0·34, 0·21–0·54; p<0·0001)

Bauer, Cochrane Rev Lancet Infect Dis 2017; 17: 990–1001

IPs Unique capabilities for ABS

- You appreciate the importance of antibiotic resistance
- You are used to multi-disciplinary linkages
- You are a recognized source for information and education
- You know your hospitals
- You are experienced at operationalizing critical interventions (CAUTI, CLABSI)
- You *won't* wash your hands of this critical problem

What are the Most Important Processes for IPs to do in ABS?

A. Round every day with ABS team?
B. Review all antibiotics daily?
C. Review MRDO alerts and ensure appropriate isolation?
D. Review MRDO alerts and ensure and target patient's team?
E. Review MRDO alerts and ensure appropriate antibiotics?
F. Educate staff regarding MDROs identified?
G. Ensure appropriate cultures are obtained
H. Nursing education

- How to measure antibiotic appropriateness?

What Data do You Want to Measure?

- What are your sources?
- What categories of information do you need?
- Who will you present it to?

Measures of Antibiotic Use

- DDDs (defined daily dose)

$$\frac{\text{total usage/ average prescribed dose}}{\text{patient days}}$$

- DOTs (days of therapy) Number of days an antibiotic was prescribed on
- What are the advantages of each?

Measures of Antibiotic Use

- What other factors modify analysis of antibiotic use metrics?

Potential Factors That Affect Antibiotic Usage

Yu, K, et al. CID
2018;67(11):1677–85

Table 1. Proportion of Total Patient-Days and Factors Considered for Risk Adjustment in Predicting Expected Days of Therapy Among 2 680 580 Admissions

Characteristic	Total Patient-Days = 8 585 300
Facility factor	
Hospital teaching status	
Teaching	74%
Nonteaching	26%
Unit type	
Medical/surgical	48.8%
Maternity	13.1%
Stepdown	9.7%
Critical care	8.1%
Perioperative	16.9%
Pediatric medical/surgical	2.8%
Pediatric critical care unit	0.6%
Administrative factor	
Age on date of admission, y	
Mean ± SD	57.4 ± 22.4
Sex	
Female	58%
Male	42%
Admission type	
Urgent	61.4%
Emergency	25.2%
Elective	13.4%
Admission source	
Home	90.9%
Residential care/long-term care	1.9%
Hospital transfer	9.1%
Other	6.3%
Admitted through emergency department	
Yes	49.8%
No	50.2%
Transfer from skilled nursing facility	
Yes	2%
No	98%
Patient class	
Inpatient	76%
Outpatient medical	14%
Outpatient surgery	10%
Time spent in observation	
Yes	21.5%
No	78.5%
DRG, present or not	
Yes	76%
No (day surgery and/or short observations stays)	24%
Infection diagnosis present on admission	
Yes	30.5%
No	69.5%
% of days in ICU location (days at risk in ICU / total days at risk for hospital stay)	
0% days in ICU	84%
1%–49% days in ICU	6.4%
50%–99% days in ICU	6.4%
100% days in ICU	3.2%
Case mix index	
Mean ± SD	1.6 ± 2.2
Surgical DRG indicator	
Yes	30.4%
No	69.6%
Clinical factor	
First WBC count result within 24 h of admission	
Mean ± SD	11.2 ± 8.6
First creatinine result within 24 h of admission	
Mean ± SD	1.4 ± 1.7
Charlson score	
Mean ± SD	4.2 ± 4.5
DxCG risk score[a]	
Missing for 2.6% of days	
Mean ± SD	11.6 ± 22.6
Emergency department visits in prior 7 d (count)	
0	89.2%
1	9.6%
≥2	1.2%
Outpatient office visits in prior 7 d (count)	
0	90.8%
1	7.5%
2	1.4%
≥3	0.3%
Outpatient antibiotics in past 7 d	
Yes	6.3%
No	93.7%
History of MRSA[b]	
Yes	3.2%
No	96.8%
History of ESBL[c]	
Yes	3.1%
No	96.9%
History of drug-resistant Enterobacteriaceae[d]	
Yes	9.4%
No	90.6%
History of drug-resistant gram-positive species[e]	
Yes	3.9%
No	96.1%

Abbreviations: DRG, diagnosis-related group; ESBL, extended-spectrum β-lactamase; ICU, intensive care unit; MRSA, methicillin-resistant *Staphylococcus aureus*; SD, standard deviation; WBC, white blood cell.

[a]Verisk Health risk score predicting clinic cost during the current year based on age, gender, and diagnosis data from past 12 months. Medicare model used for Medicare patients, commercial model for all others.

[b]Laboratory culture result that is positive for MRSA within 12 months prior to admission.

[c]ESBL laboratory culture result indicating Enterobacteriaceae with resistance to any of ceftazidime, cefepime, cefotaxime, or ceftriaxone.

[d]Laboratory culture result indicating Enterobacteriaceae with resistance to any of cefazolin, ciprofloxacin, penicillin, or trimethoprim-sulfamethoxazole.

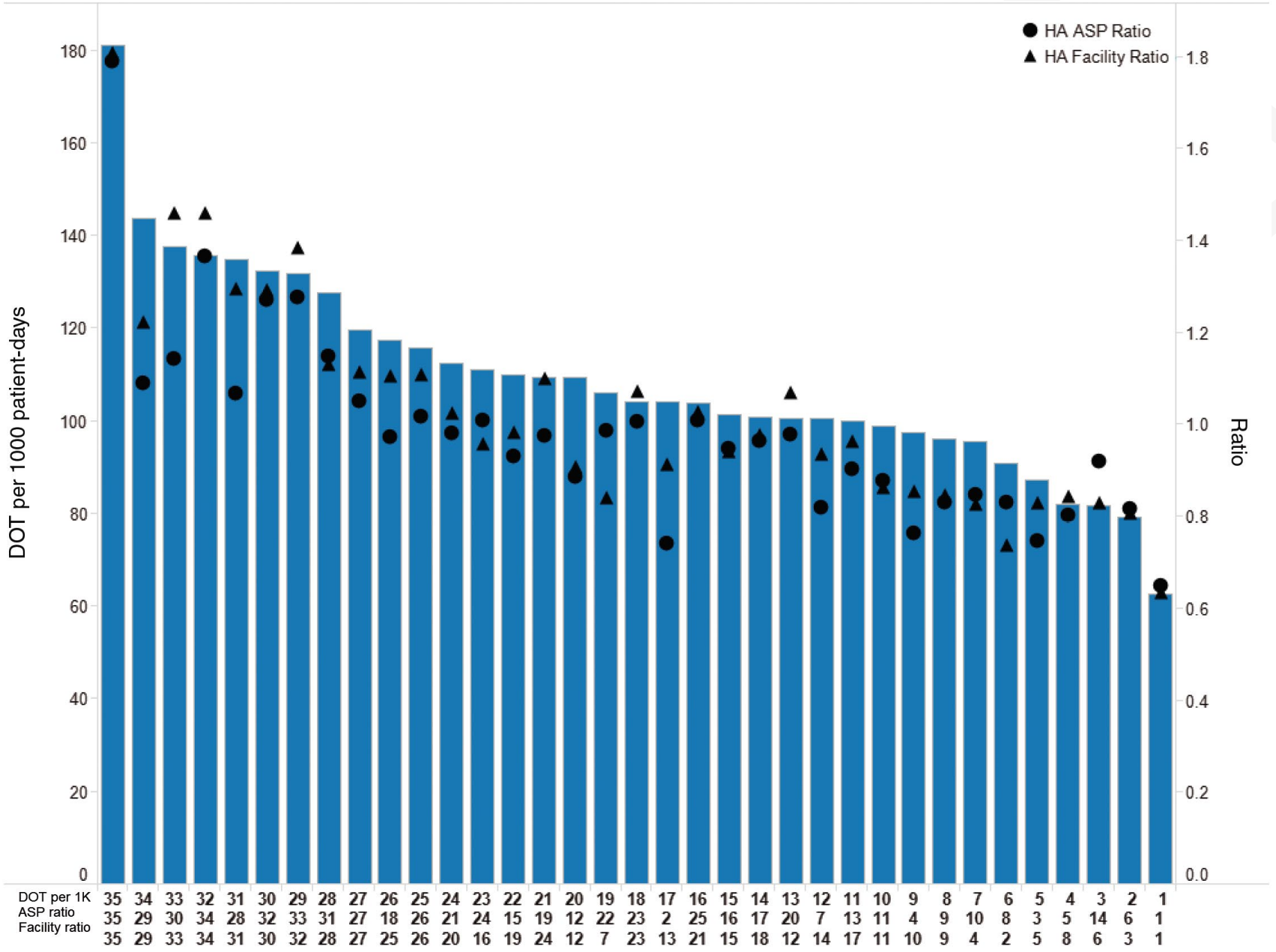
[e]Laboratory culture result in the past year indicating MRSA or vancomycin-resistant *Enterococcus*.

Methodology for Assessing Results

We were interested in 3 primary evaluations concerning the models:

1. What were the most contributing variables from the complex model to help inform the construction of a simplified ASP model?

Different Risk Adjustment Models Lead to Erroneous Analysis



Yu, K, et al. CID
2018;67(11):1677–85

Data Options

- You may have internal pharmacy data
- NHSN Antibiotic Module
- P&T can request data
- You may have data mining available

NHSN Antibiotic Module

- Standardized Antimicrobial Administration Ratio
- (SAAR) = $\frac{\text{Observed (O) Antimicrobial Use}}{\text{Predicted (P) Antimicrobial Use}}$
- The predicted antimicrobial use is calculated using predictive models developed by CDC and applied to nationally aggregated 2017 AU data reported to NHSN from the same group of patient care location types.

NHSN Antibiotic Module

AU Line List

Note: This example uses fictitious data for illustrative purposes only.

National Healthcare Safety Network
Line Listing - All Submitted AU Data by Location

As of: December 3, 2018 at 3:09 PM
Date Range: SUMMARYAU summaryYQ 2017Q3 to 2017Q3
if (((location = 4MICU)))

Location=4MICU

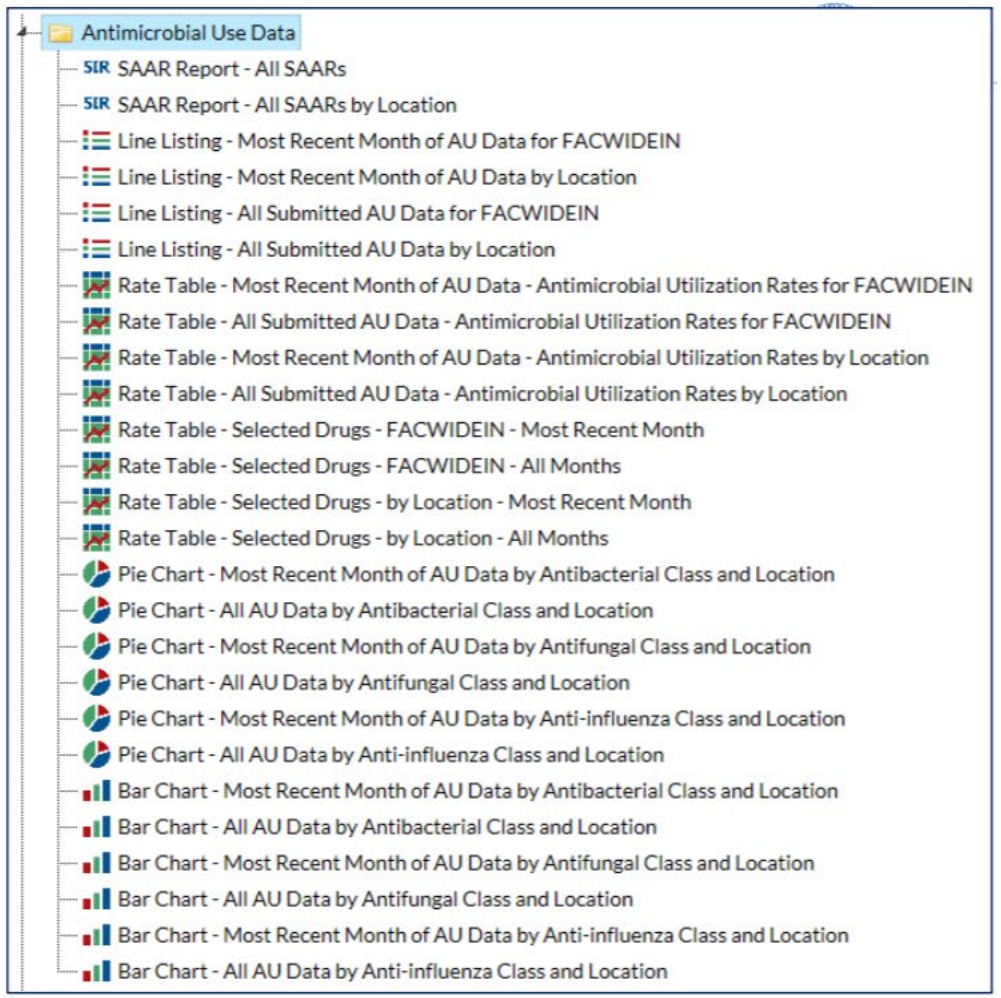
Summary Year/Month	Antimicrobial Agent Description	Antimicrobial Days	Days Present	Admissions	Route: IM	Route: IV	Route: Digestive	Route: Respiratory	Location
2017M07	AMAN - Amantadine	0	500	.	0	0	0	0	4MICU
2017M08	AMAN - Amantadine	0	482	.	0	0	0	0	4MICU
2017M07	AMK - Amikacin	0	500	.	0	0	0	0	4MICU
2017M08	AMK - Amikacin	0	482	.	0	0	0	0	4MICU
2017M07	AMOX - Amoxicillin	0	500	.	0	0	0	0	4MICU
1 2017M08	AMOX - Amoxicillin	2	482	.	0	0	2	0	4MICU
2017M07	AMOXWC - Amoxicillin with Clavulanate	2	500	.	0	0	2	0	4MICU
2017M08	AMOXWC - Amoxicillin with Clavulanate	2	482	.	0	0	2	0	4MICU
2017M07	AMP - Ampicillin	0	500	.	0	0	0	0	4MICU
2 2017M08	AMP - Ampicillin	6	482	.	0	6	0	0	4MICU
2017M07	AMPH - Amphotericin B	0	500	.	0	0	0	0	4MICU
2017M08	AMPH - Amphotericin B	0	482	.	0	0	0	0	4MICU
2017M07	AMPHOT- Amphotericin B Liposomal	0	500	.	0	0	0	0	4MICU

1. In August 2017, there were two Amoxicillin antimicrobial days in the 4MICU. Both of these antimicrobial days were administered via the digestive route.
2. In August 2017, there were six total Ampicillin antimicrobial days in the 4MICU. All of these antimicrobial days were administered via the IV route.

https://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/aur/au-qrg-linelist.pdf

AU Option – NHSN Analysis Reports

- Basic analysis reports available
  - Line lists
  - Rate tables
  - Pie charts
  - Bar charts
  - SAARs (Standardized Antimicrobial Administration Ratio)



Antibacterial Agent Categories Used for SAAR Calculations*

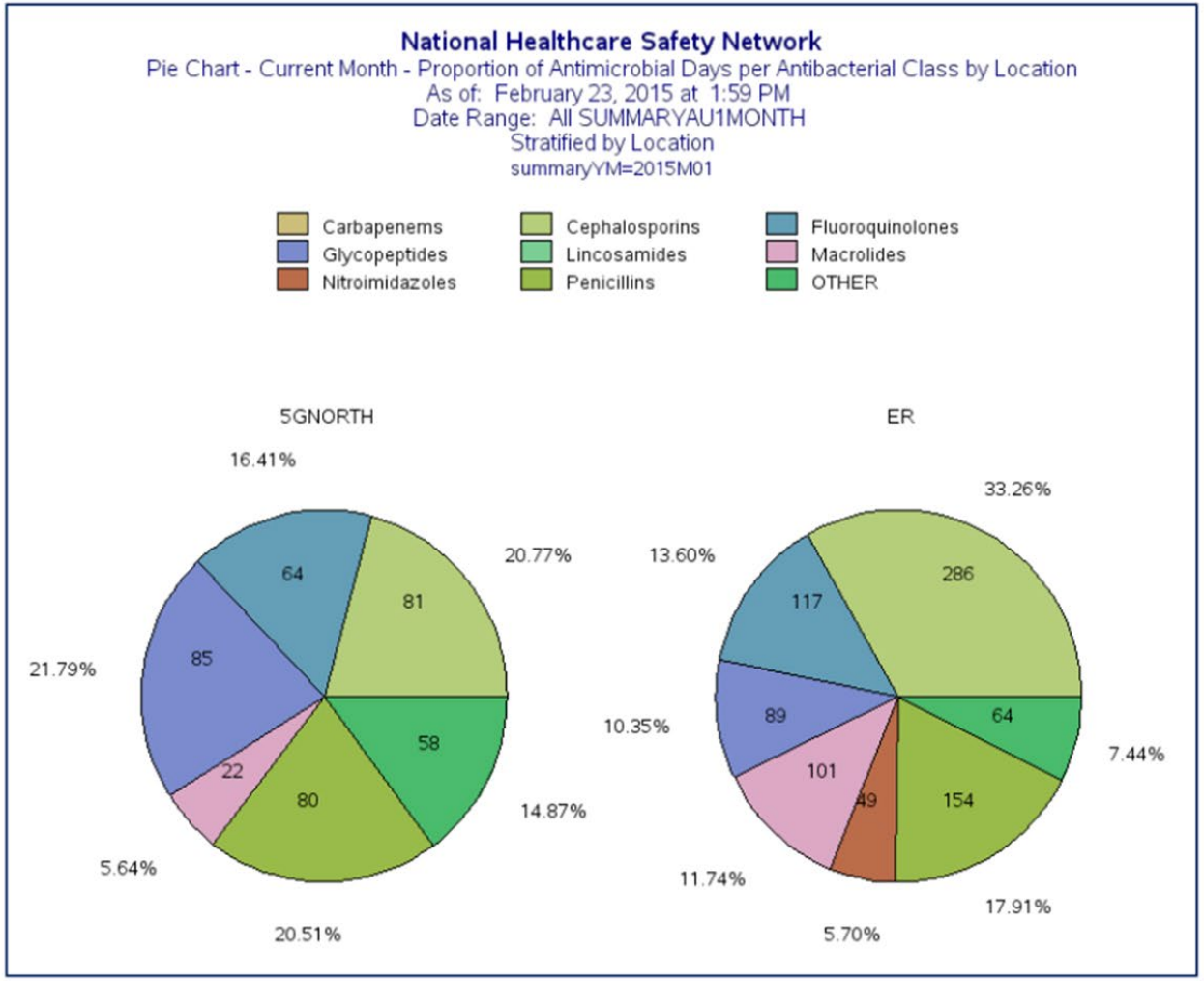
- High value targets for antimicrobial stewardship programs:
  1. Broad spectrum agents predominantly used for hospital-onset/multi-drug resistant bacteria – aminoglycosides, carbapenems (except ertapenem), 4th and 5th gen. cephalosporins, penicillin B-lactam/b-lactamase inhibitor combinations, and other agents
  2. Broad spectrum agents predominantly used for community-acquired infection – Ertapenem, some cephalosporins, and some fluroquinolones
  3. Anti-MRSA agents – Ceftaroline, Dalbavancin, Daptomycin, Linezolid, Oritavancin, Quinupristin/Dalfopristin, Tedizolid, Telavancin, and Vancomycin (IV only)
  4. Agents predominantly used for surgical site infection prophylaxis (IV only) – Cefazolin, Cefotetan, Cefoxitin, Cefuroxime, and Cephalexin
- High level indicators for antimicrobial stewardship programs:
  5. All antibacterial agents – All antibacterial agents included in NHSN AUR protocol

NHSN Antibiotic Module – By Location

AU Option – Pie Chart

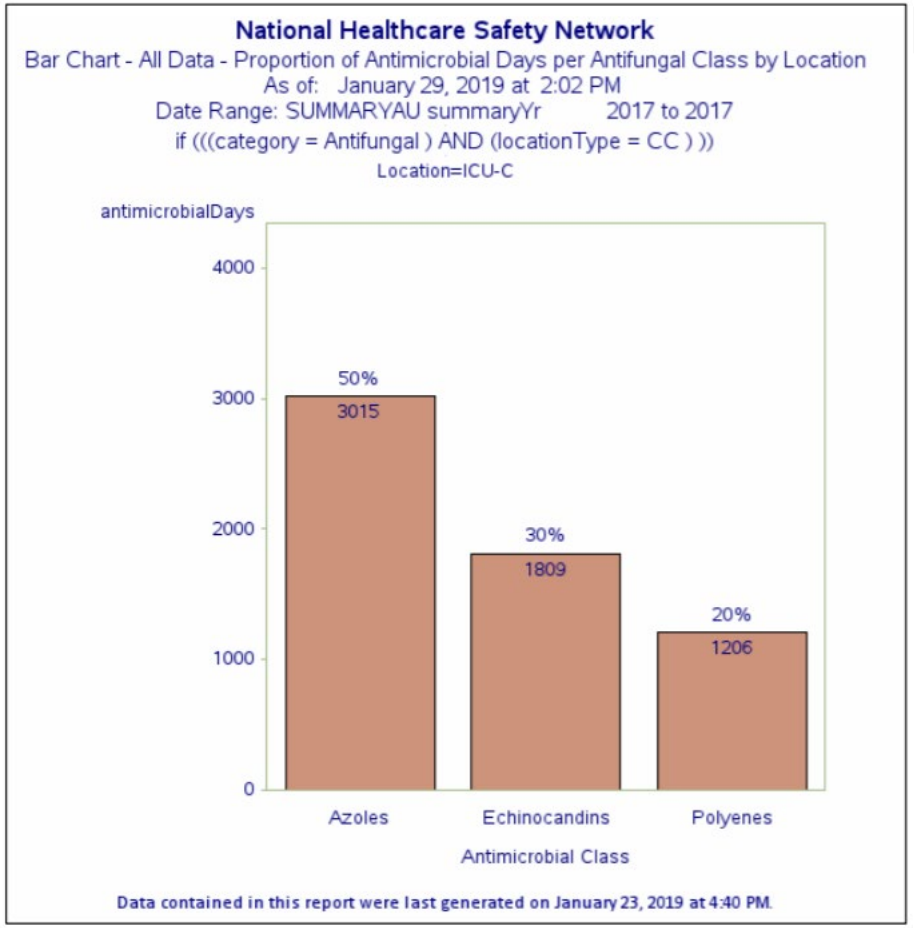
- Shows proportion of antimicrobial days per class
- Modified to show proportions by:
  - Category
  - Drug
  - Time period
  - Location

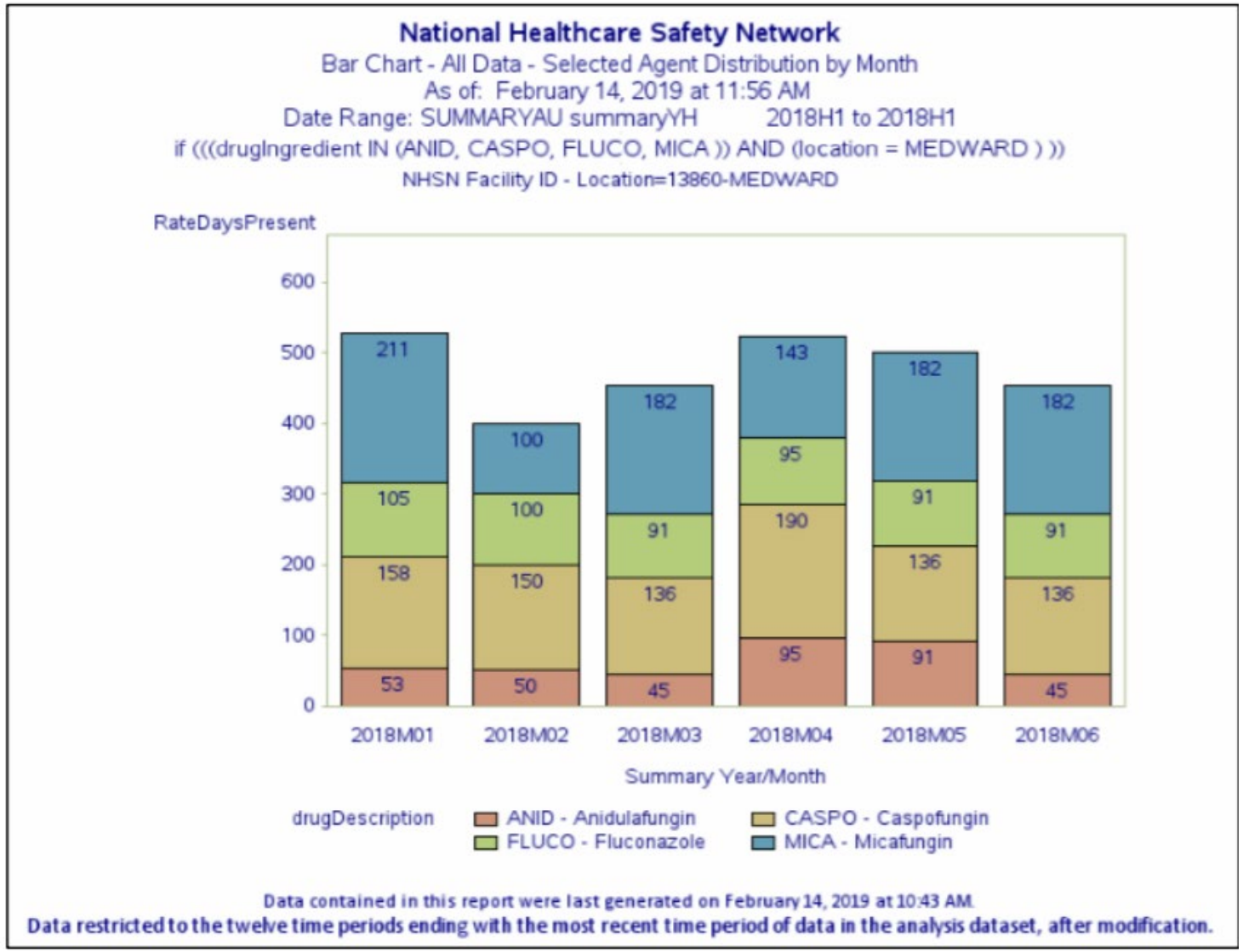
*Data for example only



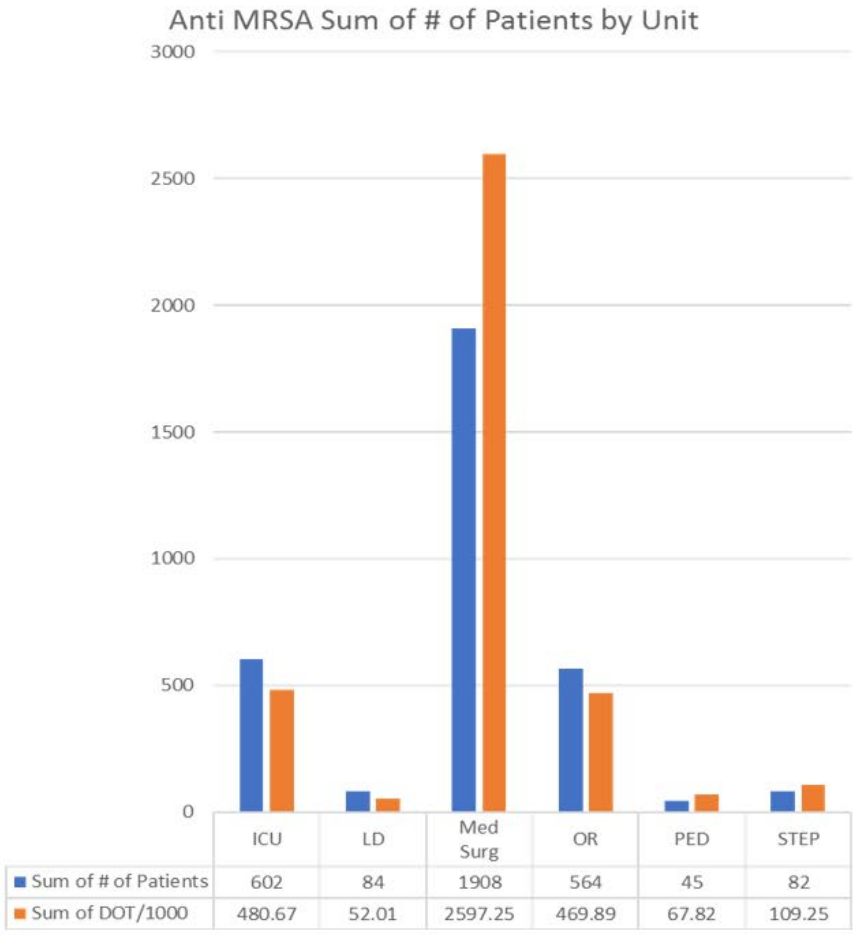
NHSN Antibiotic Module

- Bar Chart
  - Shows antibiotic use by location
  - Shows proportion of each drug by location
  - Can filter by:
    - Location
    - Time period
    - Antibiotic
    - Antibiotic category

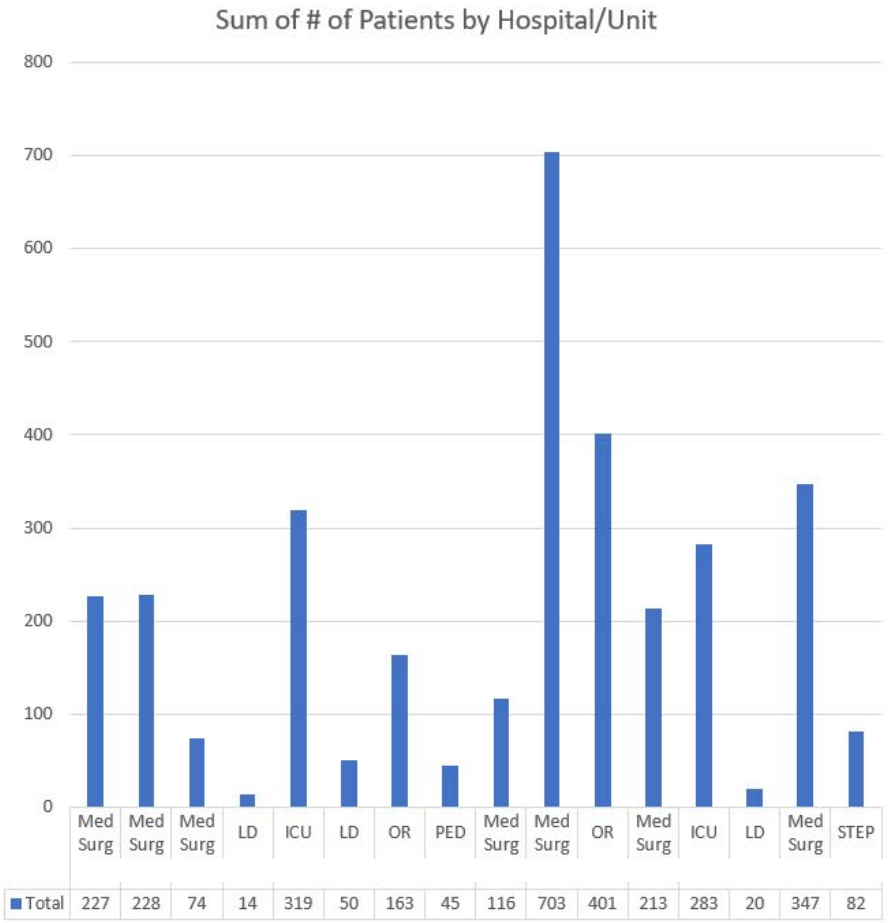



National Healthcare Safety Network
Bar Chart - All Data - Selected Agent Distribution by Month
As of: February 14, 2019 at 11:56 AM
Date Range: SUMMARYAU summaryYH 2018H1 to 2018H1
if (((drugIngredient IN (ANID, CASPO, FLUCO, MICA)) AND (location = MEDWARD)))
NHSN Facility ID - Location=13860-MEDWARD
RateDaysPresent
600
500
400
300
200
100
0
211
105
158
53
100
100
150
50
182
91
136
45
143
95
190
95
182
91
136
91
182
91
136
45
2018M01
2018M02
2018M03
2018M04
2018M05
2018M06
Summary Year/Month
drugDescription
ANID - Anidulafungin
CASPO - Caspofungin
FLUCO - Fluconazole
MICA - Micafungin
Data contained in this report were last generated on February 14, 2019 at 10:43 AM.
Data restricted to the twelve time periods ending with the most recent time period of data in the analysis dataset, after modification.

Anti-MRSA Category Breakdown

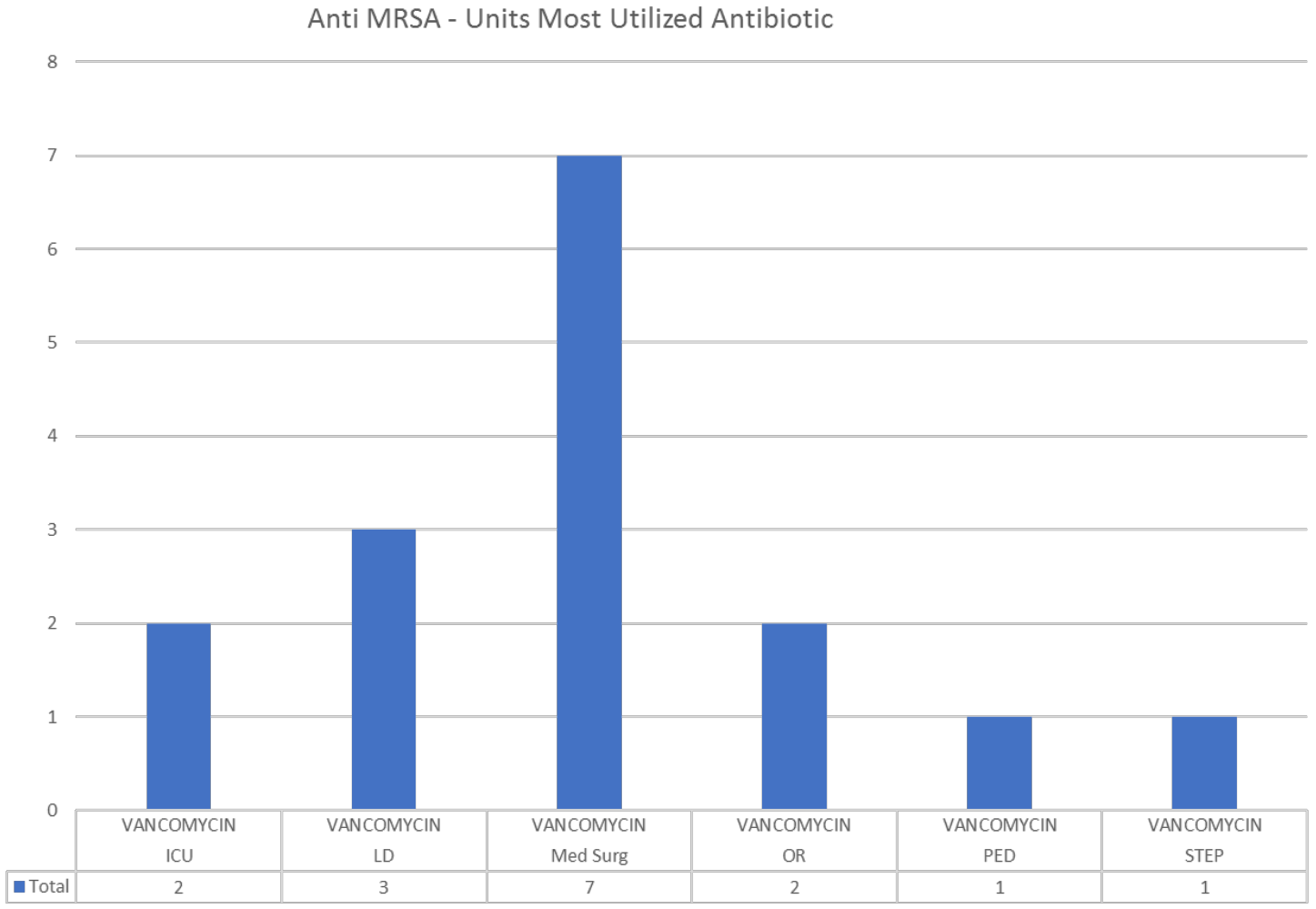


	ICU	LD	Med Surg	OR	PED	STEP
Sum of # of Patients	602	84	1908	564	45	82
Sum of DOT/1000	480.67	52.01	2597.25	469.89	67.82	109.25

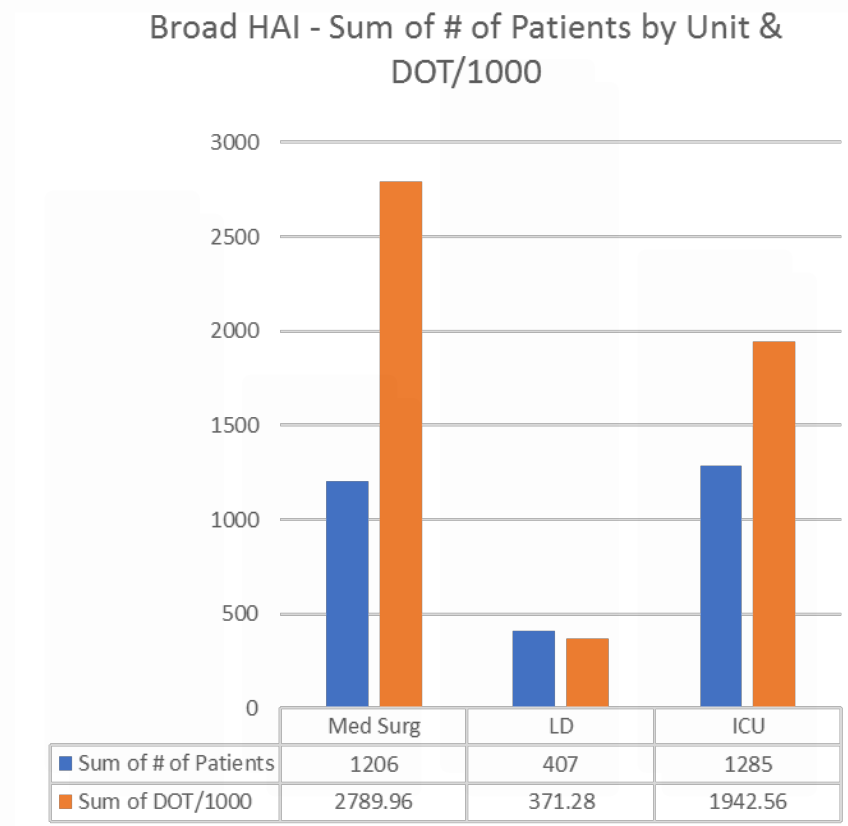


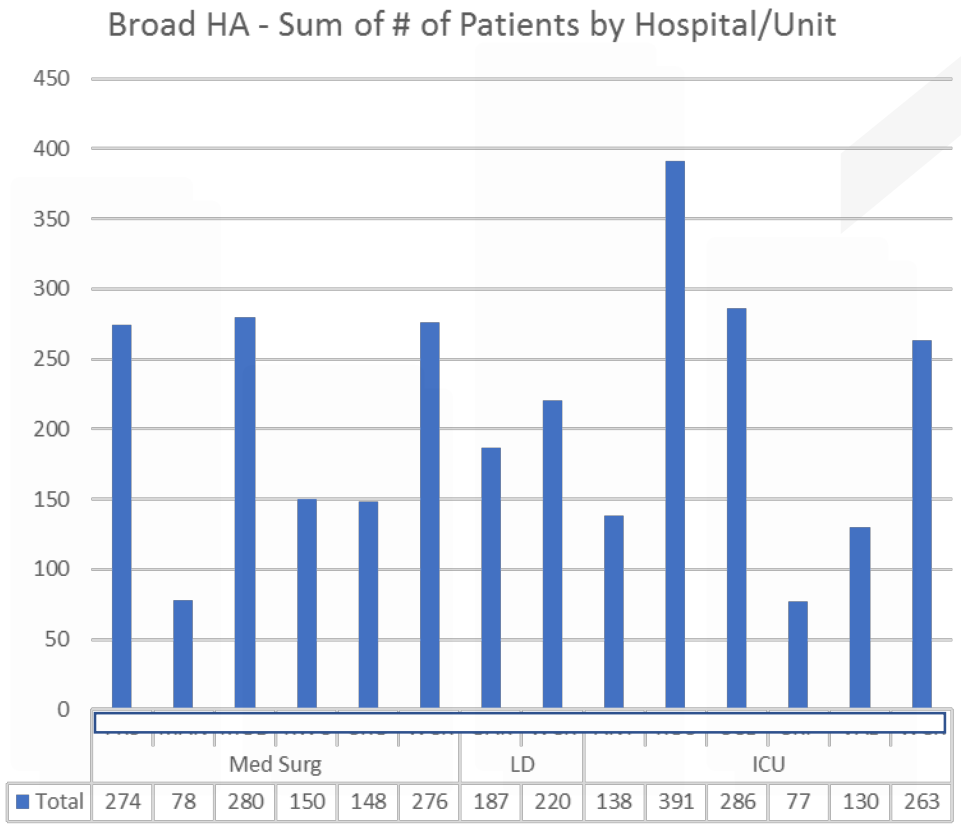
Total	227	228	74	14	319	50	163	45	116	703	401	213	283	20	347	82

Anti-MRSA Category Breakdown



Broad HAI Category Breakdown





Standardized Antimicrobial Administration Ratio (SAAR)

- Observed-to-Predicted Ratio for antibiotic use.
- SAAR allows facilities to compare their AU to the AU of a standard referent population (i.e., NHSN baseline)
- Observed AU: antimicrobial days of therapy reported by a hospital for a specified group of antimicrobial agents used in a specified patient care location or group of locations
- Predicted AU: antimicrobial days of therapy predicted for a hospital for a specified group of antimicrobial agents used in a specified patient care location or group of locations on the basis of negative binomial regression modeling applied to nationally aggregated AU data

Standardized Antimicrobial Administration Ratio (SAAR)

- **Interpreting SAAR values**
- A SAAR value <1 may indicate underuse of antimicrobials
- A SAAR value=1 indicates observed AU is equivalent to predicted AU
- A SAAR value >1 may indicate overuse of antimicrobials

- **Note**: A SAAR alone is not a definitive measure of the appropriateness or judiciousness of antimicrobial use, and any SAAR may warrant further investigation. For example, a SAAR above 1.0 that does not achieve statistical significance may be associated with meaningful excess of antimicrobial use and further investigation may be needed. Also, a SAAR that is statistically different from 1.0 does not mean that further investigation will be productive.

Presentation of SAAR (NHSN)

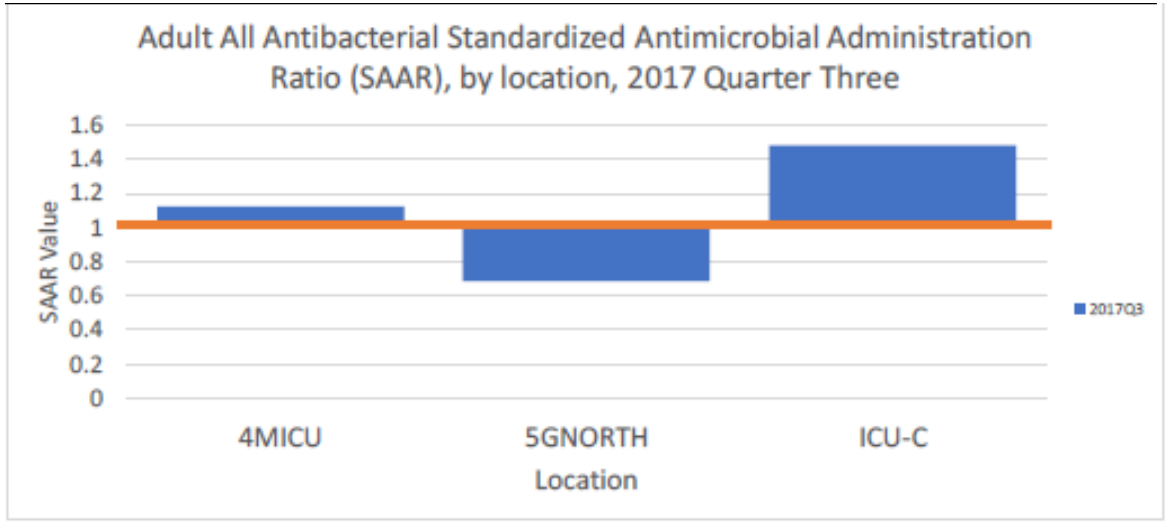


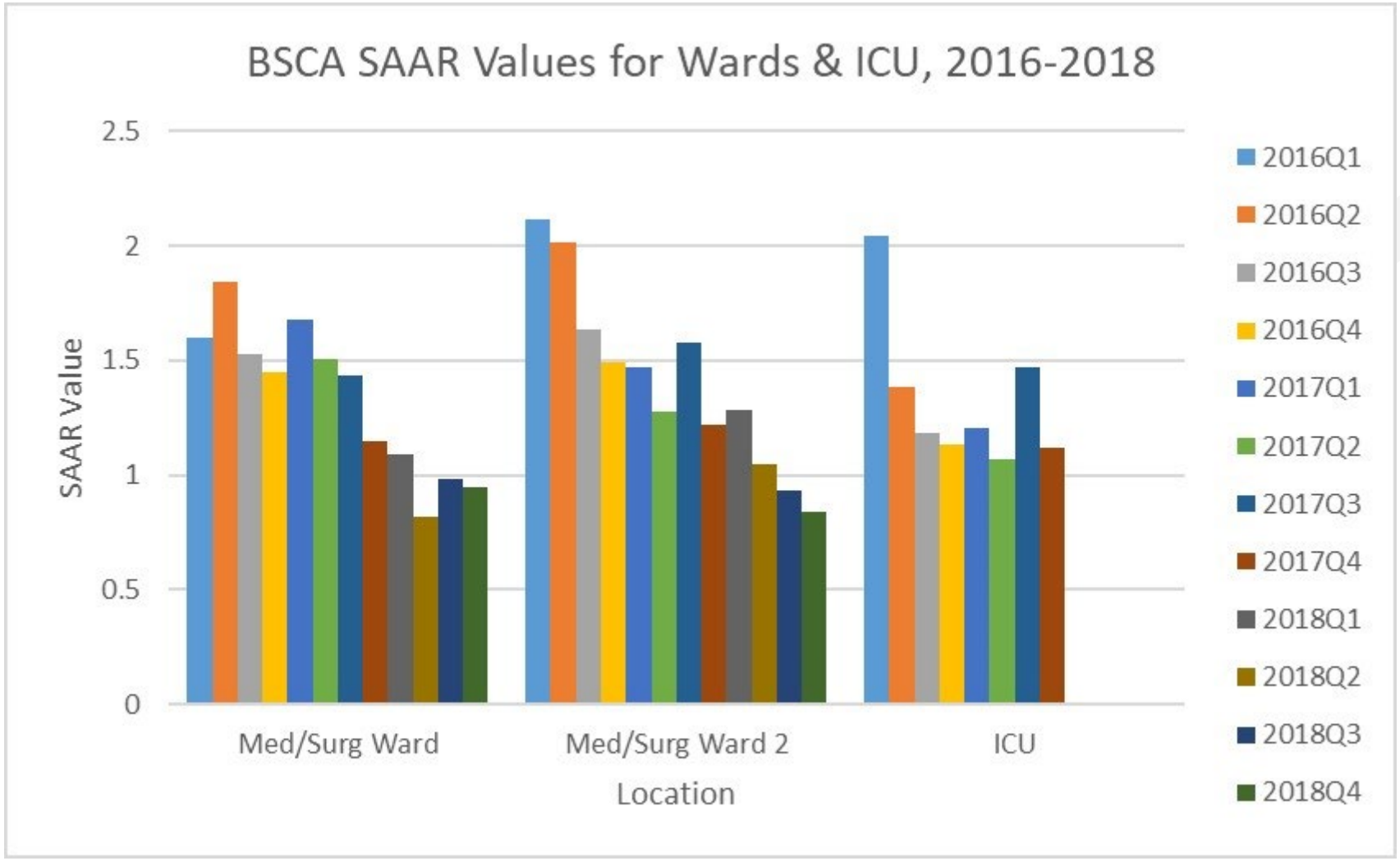
Figure 8

Table 1

All Antibacterial SAAR (2017 Baseline) by Location, Facility XYZ - Q3 2017				
location	Antimicrobial Days	AU Days Predicted	SAAR	SAAR 95% CI
4MICU	522	465.23	1.122	1.076, 1.172
5GNORTH	493	718.65	0.686	0.622, 0.742
ICU-C	400	270.12	1.482	1.185, 1.783

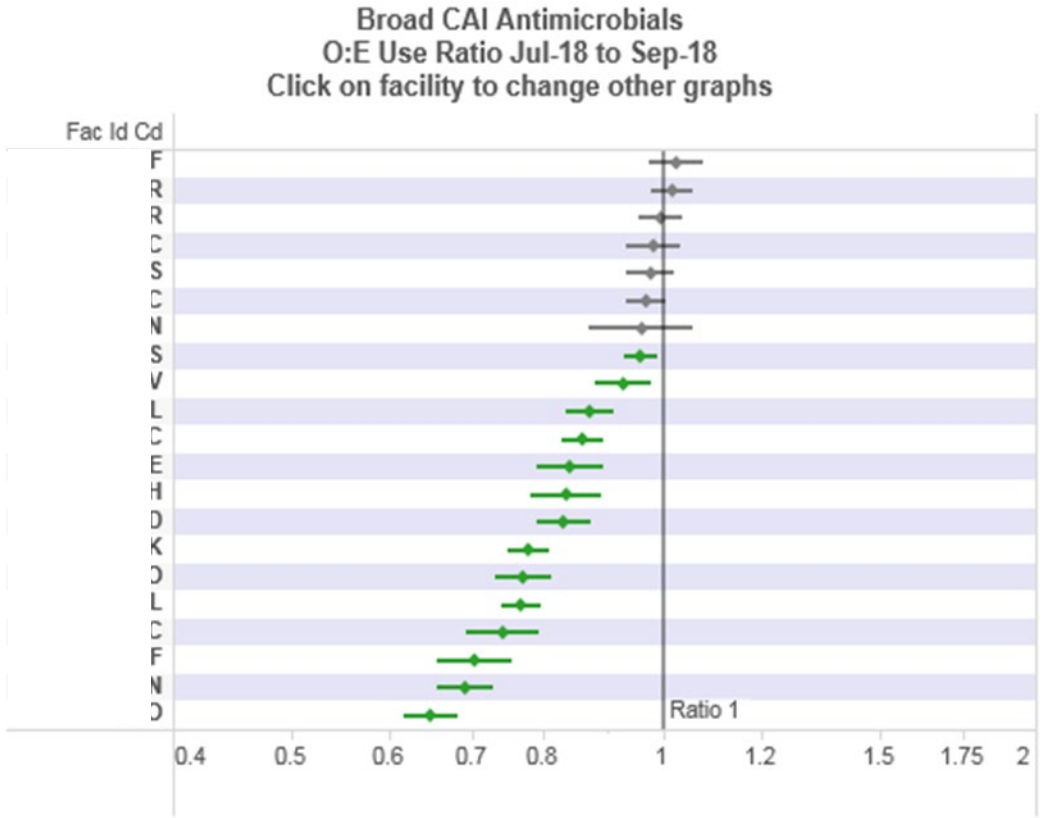
https://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/aur/au-qrg-saar-bartable-location-508.pdf

Presentation of SAAR (NHSN) - Fluoroquinolones



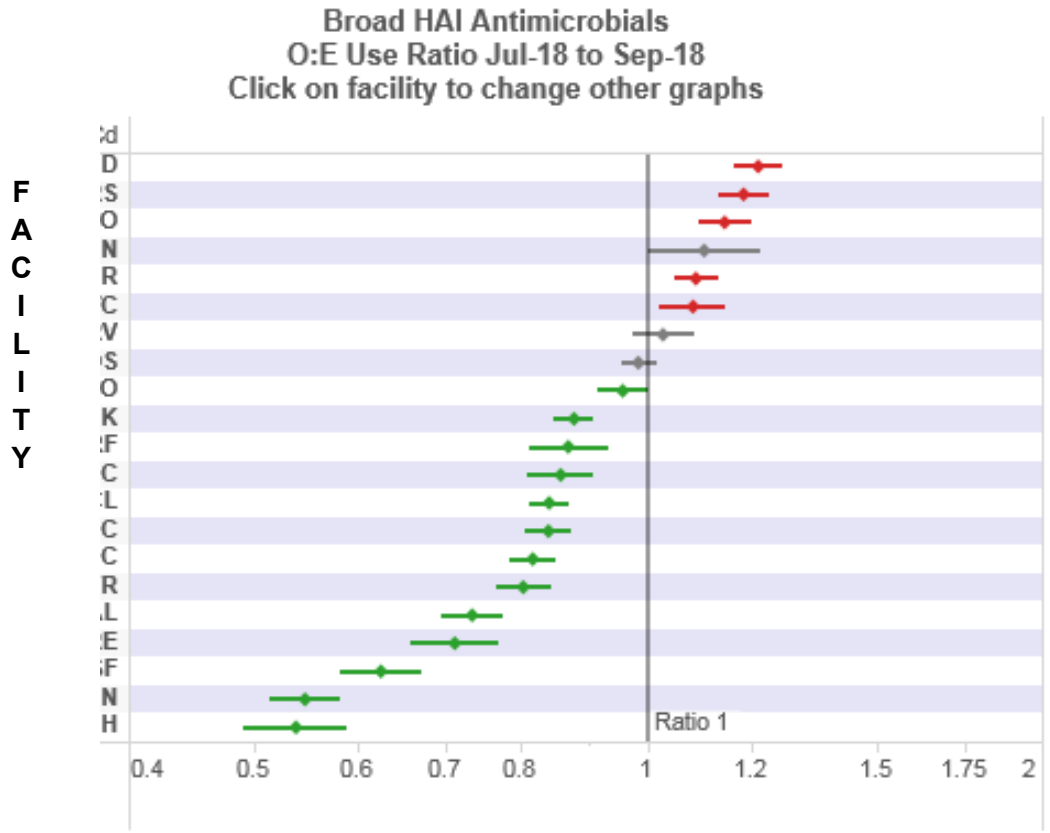
https://www.cdc.gov/nhsn/au-case-examples/reduce-fluoroquinolone-use.html

Broad CAI Category Breakdown



- **6 / 21 Hospitals with O/E > 1**
- Ceftriaxone driving utilization
- Unit with the most instances: OR (3)
- Other Units: LD (2), ICU (1), PED (1), PICU (1)

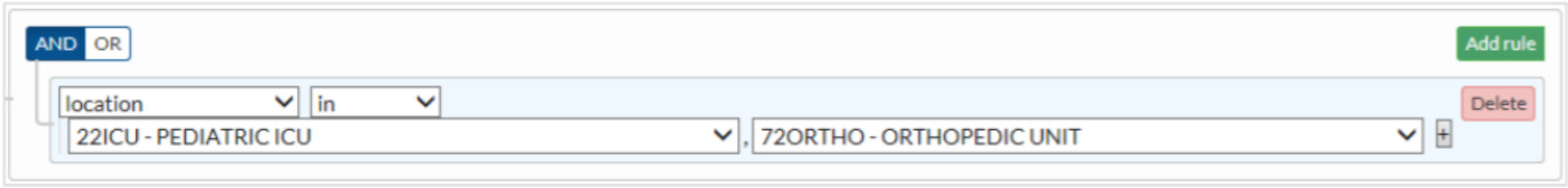
Broad HAI Category Breakdown



- **12/21 Hospitals with O/E > 1**
- Piperacillin-Tazobactam driving utilization
- Unit with the most instances: Med Surg (6) and ICU (6)
- Other Units: LD (2)
- Other antibiotics: Gentamicin (LD)

Creation of Custom Reports NHSN Antibiotic Module

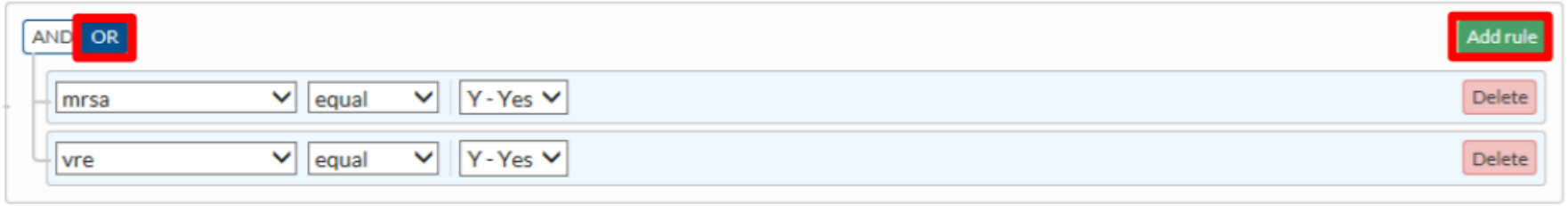
Tip: *Use the "in" operator to select multiple values of a variable. For example, location in (22ICU, 72ORTHO) would include all records where the location is either 22ICU or 72ORTHO. Many variables, such as location, supply drop-down menus for selection; other variables, such as "CLABCount", allow a free text field for entry of values.*



Example 1

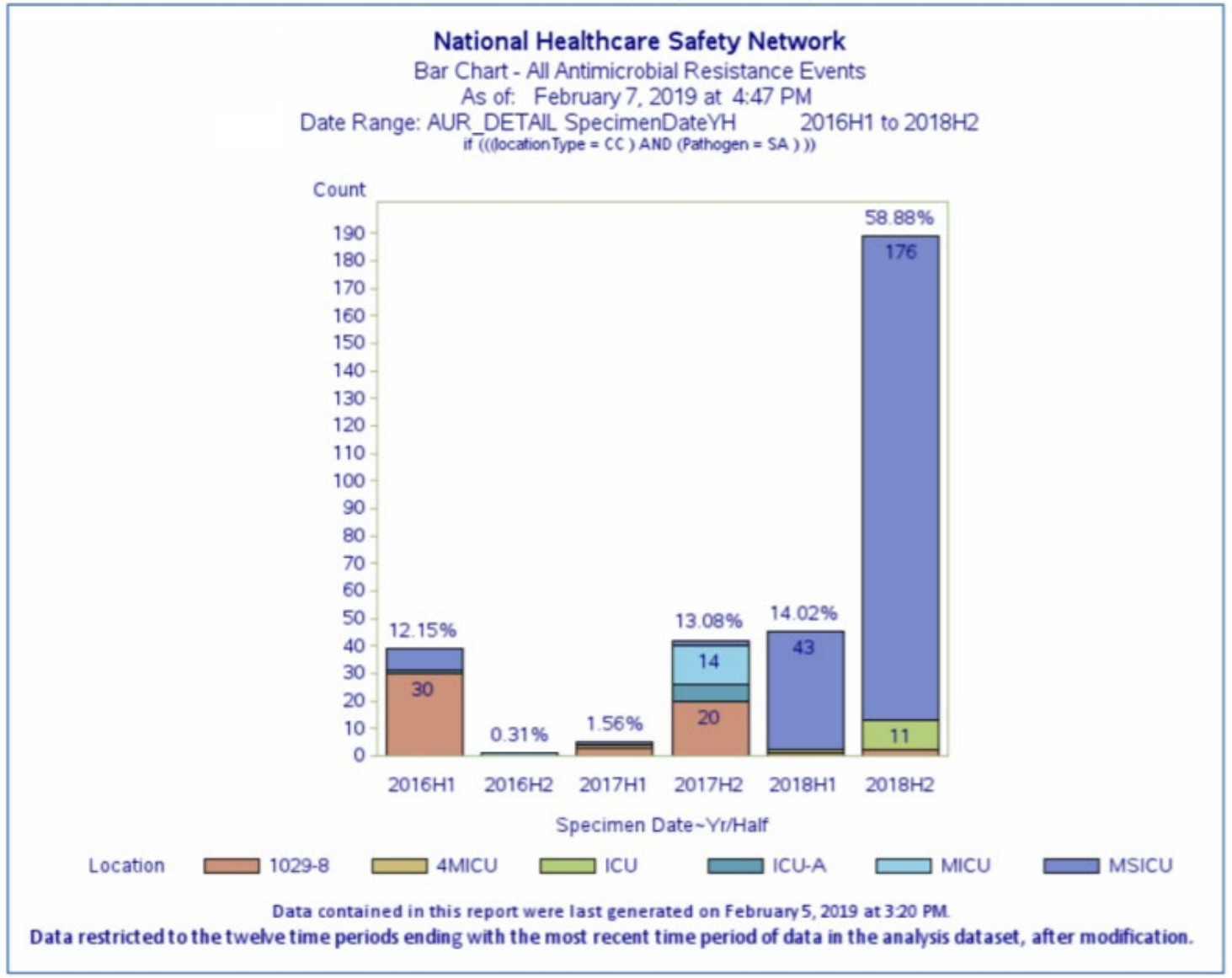
Suppose you wish to view a line list of CAUTIs in which MRSA or VRE were identified.

- Because we wish to restrict the report to specific multi-drug resistant organisms (MDRO), select from the drop-down menu for each MDRO by selecting the "add rule" box.



- Consider each row (addition of a rule) in the selection criteria grid its own equation/filter. Therefore, in this example, MRS A = Y and VRE = Y are on two separate rows/rules.

NHSN Antibiotic Resistance Module



Summary – IP Role in Antibiotic Stewardship

- Advocate for a role consistent with your capabilities
- Protect from wasted time
- Evaluate early in your facility
- IPs have unique skills
  - Relations with multiple disciplines – particularly nursing
  - Are educators and recognized as resource for information in resistant organisms
  - Generally have early awareness of problem pathogens
  - Can augment efforts to prevent transmission using ABS
  - Often aware of critical cases before ID
  - Background with NHSN

QUESTIONS?