

Practical Approaches to the Analysis of Antimicrobial Stewardship Data

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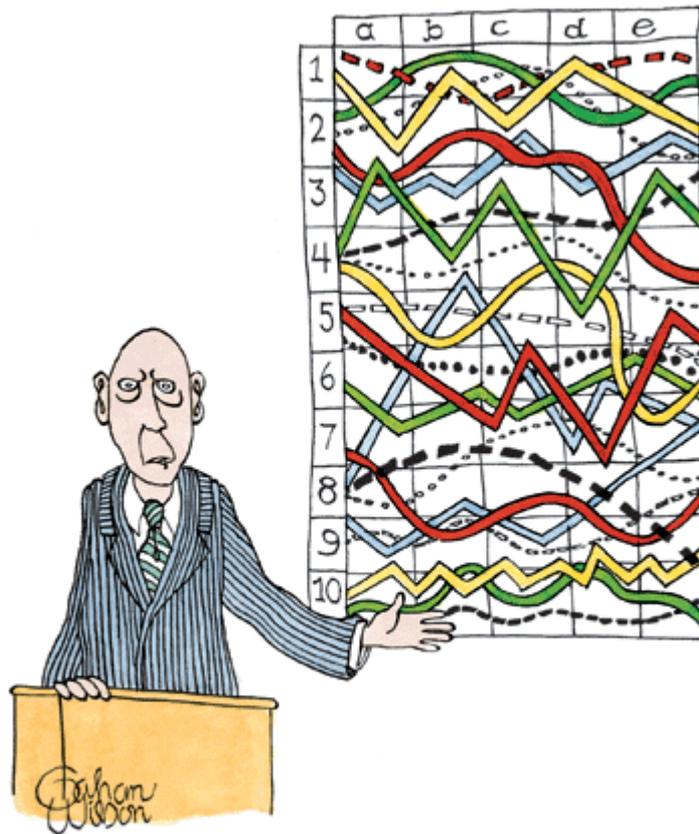
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Outline

- Why measure?
- What to measure?
- Where do we get the data?
- Key elements and pitfalls
- Implementation ideas



"I'll pause for a moment so you can let this information sink in."

Gahon Wilson. The New Yorker. 2010.

WHY MEASURE?



Why Measure?

- Identify areas for targeted intervention
- Assess response to an intervention
- Provide information/feedback to prescribers
- Justify stewardship program to administration

Institute for Healthcare Improvement (IHI) and CDC

- “**Monitor**, feedback, and make visible data regarding **antibiotic utilization**, antibiotic resistance, ...”
- “**Establish real-time monitoring and measurement systems.**”

“Antibiotic Stewardship Driver Diagram and Change Package.” Institute for Healthcare Improvement and Centers for Disease Control. July 2012. Available at: <http://www.cdc.gov/getsmart/healthcare/implementation.html>. Accessed 8/29/2014.

WHAT TO MEASURE



Measures to Consider

- Antimicrobial use
- Antimicrobial costs
- Rate of hospital-onset *Clostridium difficile* infection
- Monitoring antimicrobial resistance patterns
- Other clinical outcomes (length of stay, readmission)



Antibiotic Use Measures



- Days of therapy (DOT)
 - The aggregate sum of days for which any amount of a **specific antimicrobial agent** was administered to individual patients
- Examples
 - A patient receives both Vancomycin and Cefepime for 2 days: DOT = 4
 - A patient receives Vancomycin for 2 days and then oxacillin for 2 days: DOT = 4

Antibiotic Use Measures

- Length of therapy (LOT)
 - Number of days that a patient receives **any antimicrobial**
- Examples
 - A patient receives both Vancomycin and Cefepime for 2 days: LOT = 2
 - A patient receives Vancomycin for 2 days and then oxacillin for 2 days: LOT = 2



Antibiotic Use Measures

- Defined daily dose (DDD)
 - The DDD is the assumed average maintenance dose per day for a drug used for its main indication in adults. (WHO Provides Standards)
- Notes
 - May be easier to calculate
 - Not appropriate for children and other indications for weight-based dosing

“Core Elements of Hospital Antibiotic Stewardship Programs.” Centers for Disease Control. March 2014. Available at:

<http://www.cdc.gov/getsmart/healthcare/implementation/core-elements.html>.

Accessed 8/29/2014.

WHERE DO WE GET THIS DATA?



Where to get antibiotic use data?

- Two key elements:
 - Numerator: DOT
 - Denominator:
 - Number of admissions
 - Number of patient days

Numerator Data Sources

- DOT
- Depending on hospital setup, may need to work with:
 - Pharmacy
 - Information services
 - Electronic medical record administrators
 - Registry/administrative data
- Know the type of data you are getting
 - Dispensed from pharmacy
 - Billed to patient
 - Administered to patient (MAR)

Numerator - Processing Pharmacy Data

- IV to PO Conversions
 - Day of conversion, patient might receive both IV ampicillin-sulbactam and PO amoxicillin-clavulanate
 - Administrations will have different medication names and routes, but want to count toward 1 DOT

Denominator

- E.g. number of patient days “at risk”
- Similar sources as numerator data
- But, depending on hospital setup – may be different source than numerator data
 - Important to match cohort
 - Need a way to link data

Denominator

- Most important – **this should include all patients, not just those who received an antimicrobial**
- Clearly define “at-risk” population
 - General hospital – should patients in well-baby nursery be included?



Key Point

- **Data quality and reliability is essential**
- Unreliable data -> unreliable decisions ->
 - ?patient harm
 - ?provider mistrust

ANALYSIS APPROACHES AND PITFALLS



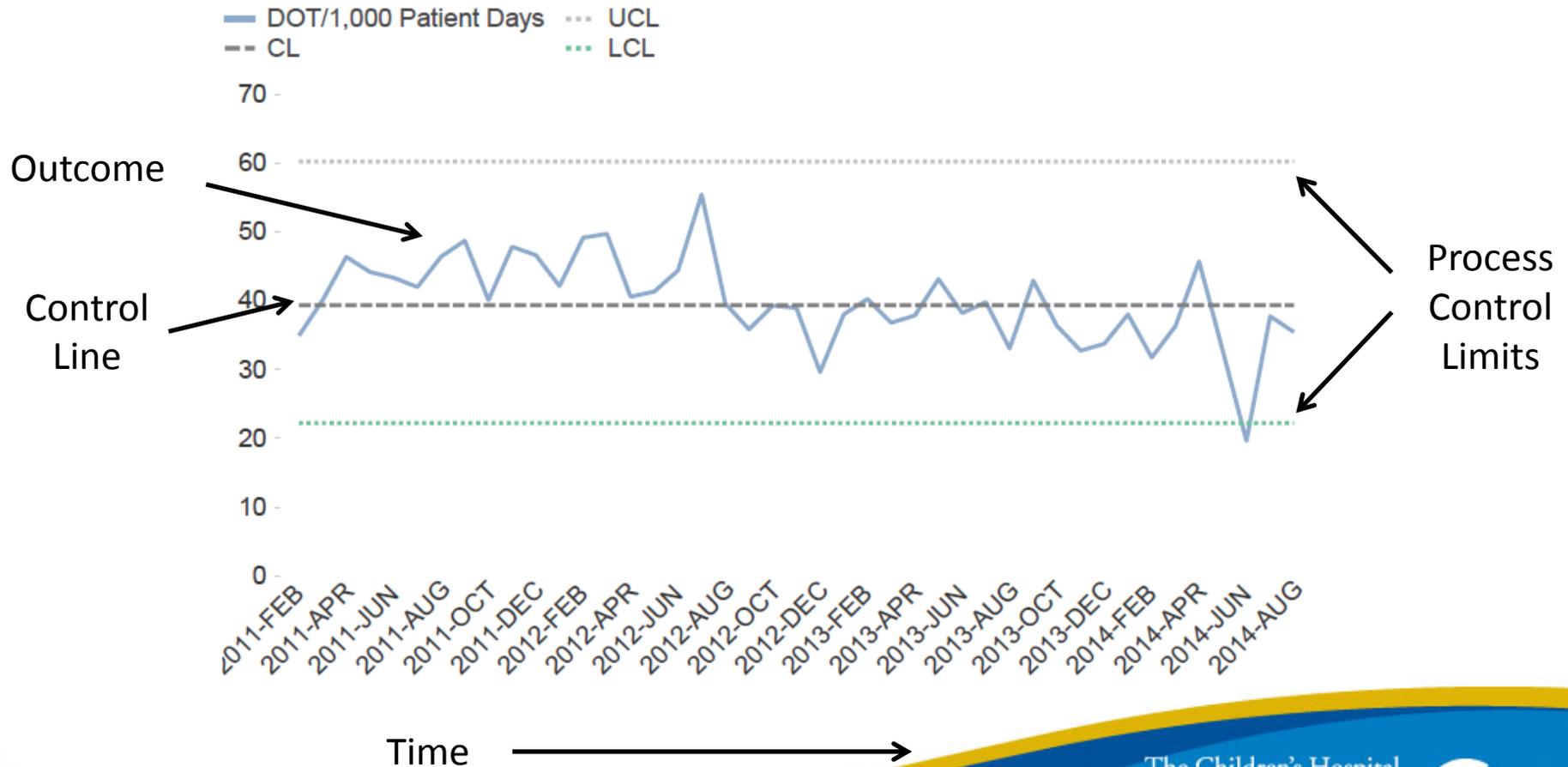
ANALYSIS APPROACHES AND PITFALLS

- **Process Control Charts**
- Seasonality
- Compare Similar Groups

Process Control Charts

- Plot outcome (i.e. DOT/1000 Patient Days) over time
- Include center line, upper control limit, and lower control limit

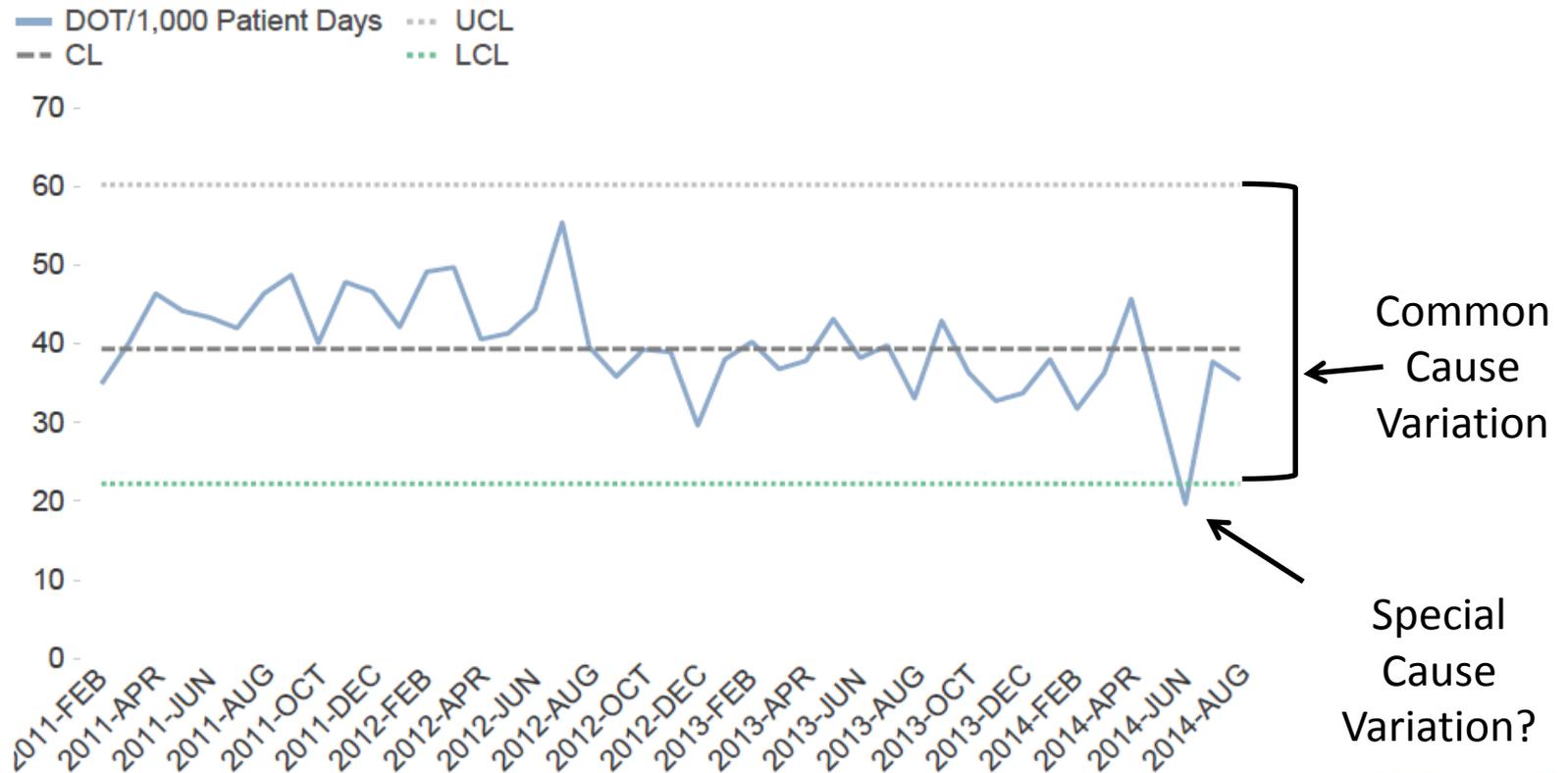
Process Control Charts – Metronidazole Use



Process Control Charts

- Control limits typically set with ± 3 standard deviations
 - Within control limits – “common cause variation”
 - Outside of control limits – “special cause variation”

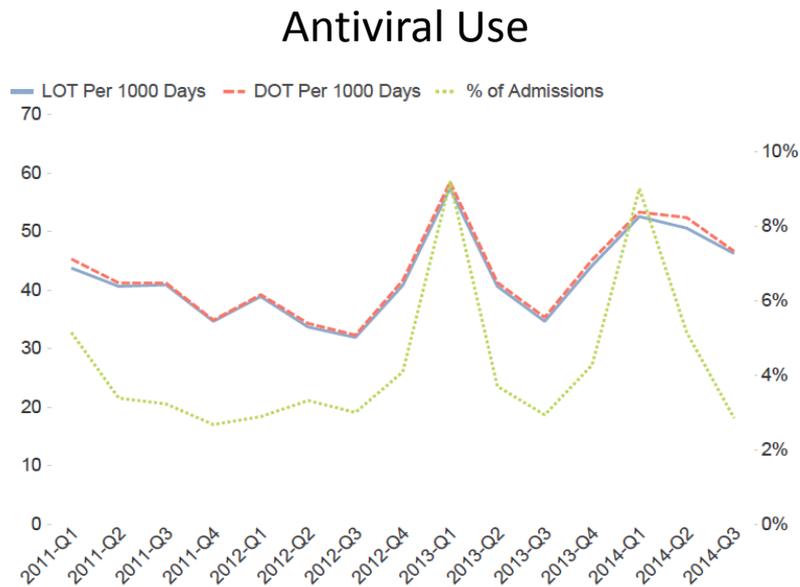
Process Control Charts



ANALYSIS APPROACHES AND PITFALLS

- Process Control Charts
- **Seasonality**
- Compare Similar Groups

Remember That Antimicrobial Use Can Be Seasonal



- Does the seasonality make sense for the medication and patient population?
- Has the seasonal trend occurred in the past?
- Standard control charts may not be appropriate

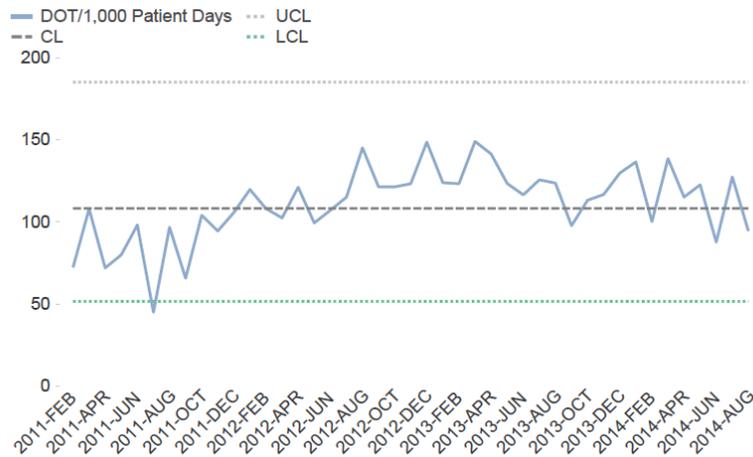
ANALYSIS APPROACHES AND PITFALLS

- Process Control Charts
- Seasonality
- **Compare Similar Groups**

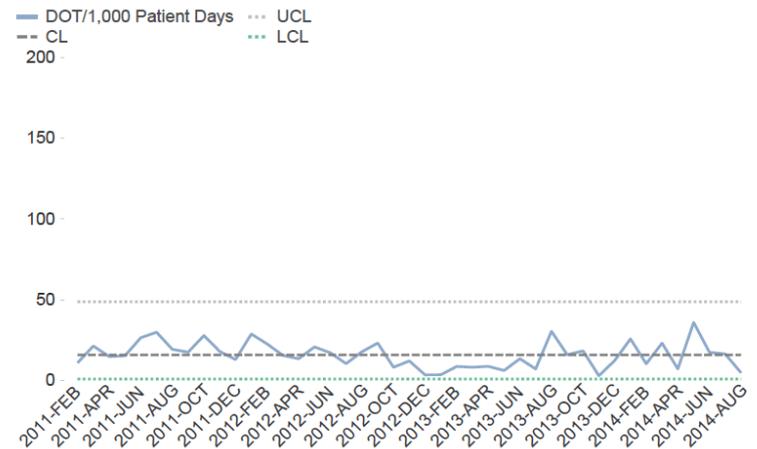
Compare “Like with Like”

- Expectations are different for distinct patient populations

Cefepime – Critical Care



Cefepime – General Pediatrics



- Consider longitudinal comparisons

What if Other Things are Changing?

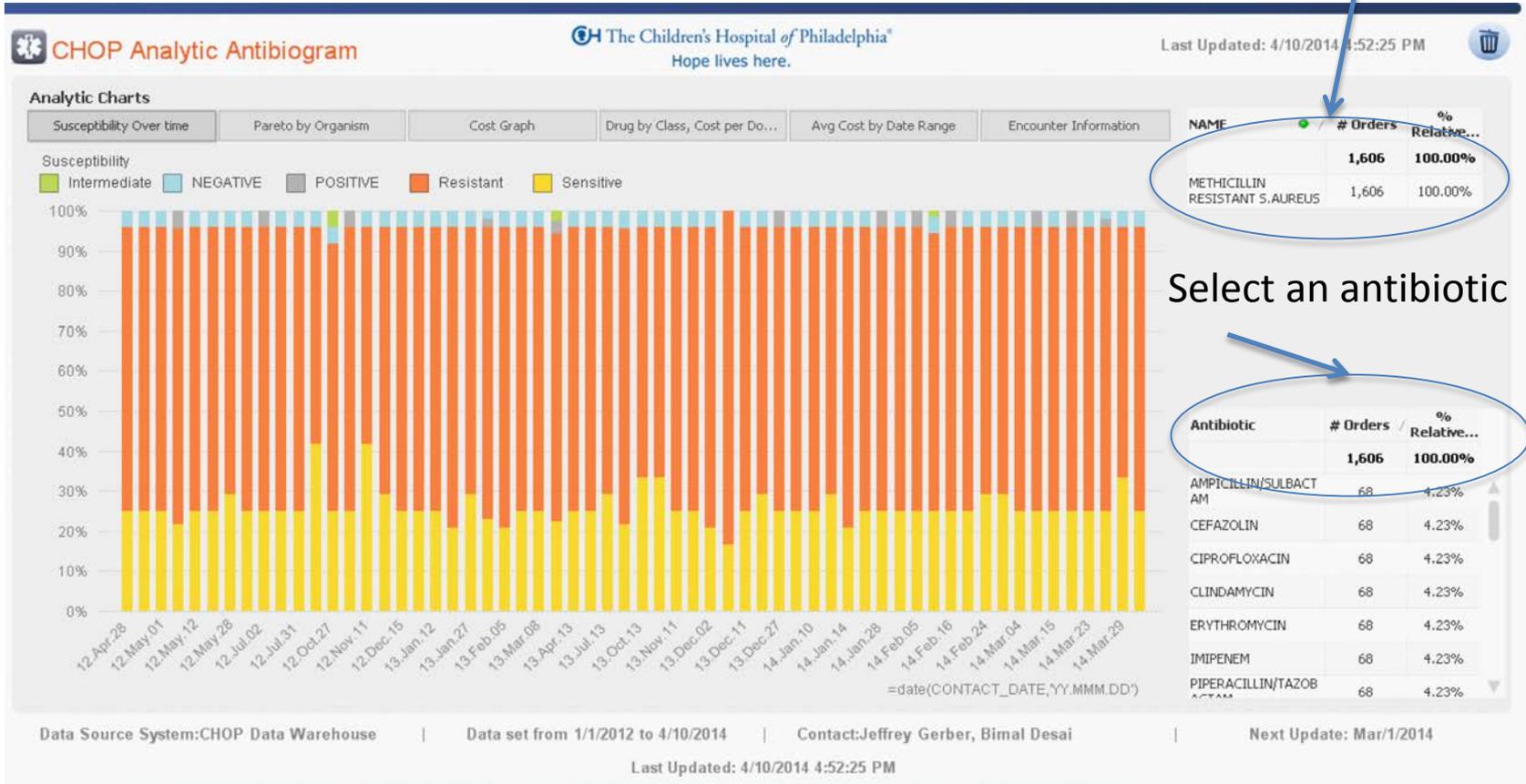
- Factors that might impact antimicrobial use
 - Implementation of EMR
 - Differences in patient insurance
 - Differences in acuity of patients
- Consider adjustment/regression modeling
- If considering adjustment, consult statistician, epidemiologist, or other professional familiar with methods

EXAMPLES FROM CHOP



The Future: Monitoring Resistance Over Time

Select an organism



Slide Courtesy Bimal Desai, MD (CHOP)



Real-Time Monitoring

- QlikView
- CHOP Interactive Antimicrobial Use Application

Thanks

- Questions?
- Contact Information:
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ADDITIONAL INFORMATION



CDC

- **“Sharing facility-specific information on antibiotic use** is a tool to motivate improved prescribing, particularly if wide variations in the patterns of use exist among similar patient care locations.”
- **“Perform periodic assessments of the use of antibiotics** or the treatment of infections to determine the quality of antibiotic use.”

“Core Elements of Hospital Antibiotic Stewardship Programs.” Centers for Disease Control. March 2014. Available at:

<http://www.cdc.gov/getsmart/healthcare/implementation/core-elements.html>.

Accessed 8/29/2014.

IDSA

- “In conjunction with developing local strategies for improving antimicrobial stewardship, **programs must establish process and outcome measures** to determine the impact of antimicrobial stewardship on antimicrobial use and resistance patterns.”

Dellit, et al. “Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America Guidelines for Developing an Institutional Program to Enhance Antimicrobial Stewardship.” *Clinical Infectious Diseases* 2007;44:159-177.

Numerator - DOT

- Important to think about level of aggregation
 - Patient-day, patient-admission
 - Hospital-day, month, quarter
 - Hospital unit, service
 - Specific diagnoses

Process Control Charts

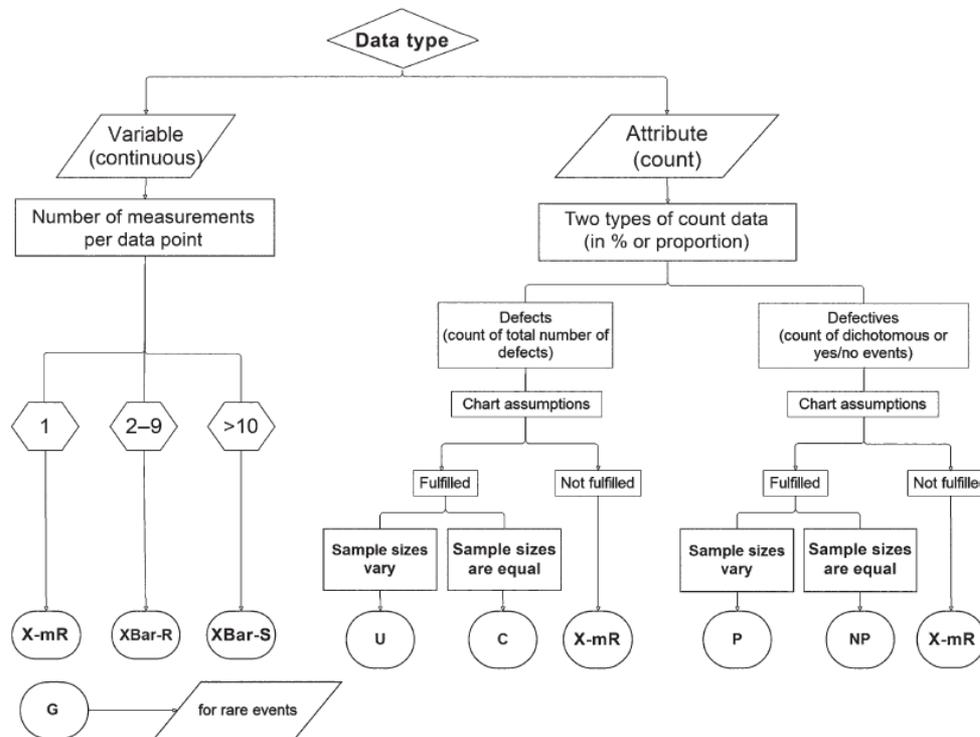
- Control limits typically set with ± 3 standard deviations
- Deciding on how to measure variation can be difficult for medication-use data
 - SD of Measure (least preferable)
 - Poisson distribution
 - Negative binomial approximations

Benneyan, J. “Statistical quality control methods in infection control and hospital epidemiology, part I: Introduction and basic theory.” *Infection Control and Hospital Epidemiology* 1998;19:194-214.

Process Control Chart – Data Requirements

- Most experts recommend at least 20-25 time points to establish baseline
 - By month – 2 years of data
 - By quarter – 5-6 years of data

Lots of Charts for Different Types of Measures



Cheung, Y, et. al. "Quality initiatives: statistical control charts: simplifying the analysis of data for quality improvement." Radiographics 2012;32:2113-26.

Basic Regression Methods

- Continuous outcomes – linear, log-gamma, quantile regression
- Count outcomes (including DOT) – Poisson, negative-binomial regression
- Binary (yes/no) outcomes – logistic regression