Epidemiology and Surveillance

Last Updated 2017

Basics of Infection Prevention
Healthcare-Associated Infections Program
Center for Health Care Quality
California Department of Public Health

Objectives

- Discuss basic principles of epidemiology and how they apply to healthcare-associated infection (HAI) surveillance
- Review recommended surveillance practices
- Describe surveillance outcome and process measures for infection prevention

Epidemiology

- Definition: Study of disease factors affecting populations

  Clinical care: focus on the individual

  vs

  Epidemiology: focus on the group

- Healthcare epidemiology answers questions such as:
  - What factors contribute to increased HAI rates?
  - What populations are at higher risk for developing HAI?
  - How have HAI changed over time?
- Assessment of trends over time

Infection Prevention and Healthcare Epidemiology

- Goal is HAI prevention
- Discipline professional societies
  - Association for Professionals in Infection Control and Epidemiology (APIC)
  - Society for Healthcare Epidemiology of America (SHEA)
  - Infectious Diseases Society of America (IDSA)
- Epidemiologic research and surveillance underlies HAI prevention
  - "Data for Action"

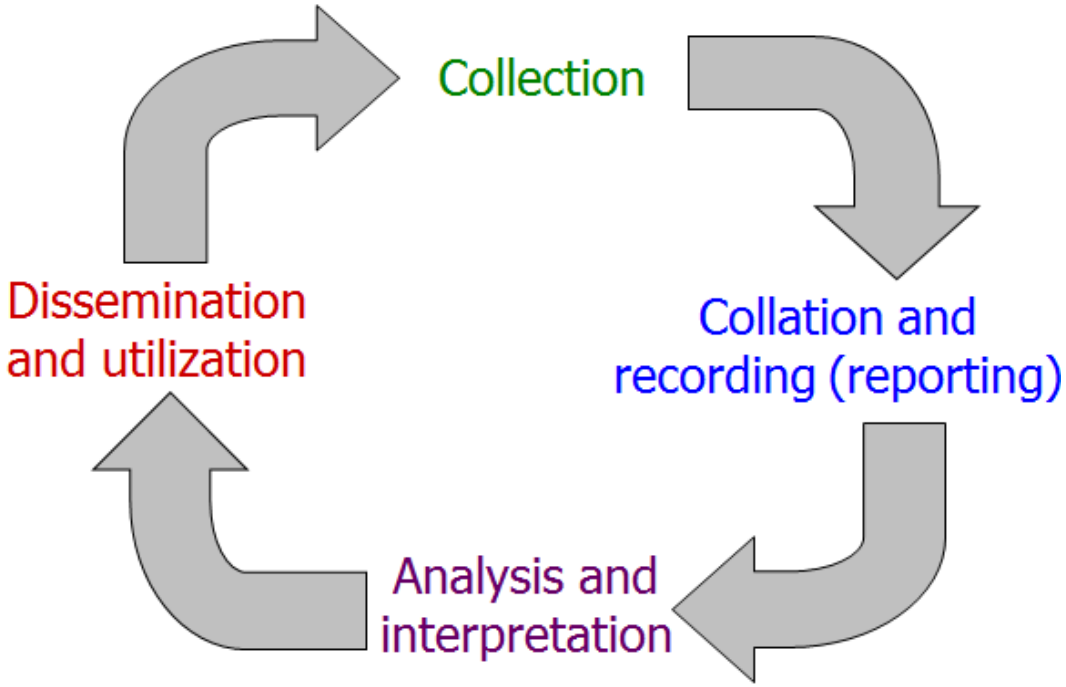
Epidemiologic Surveillance

- The ongoing, systematic collection, recording, analysis, interpretation, and dissemination of data
- Reflects rate of disease onset or current health/disease status of a community or population (e.g., healthcare patients)
- Aims to identify risk factors for disease
- Used for public health action to reduce morbidity and mortality, and to improve health

Surveillance

A surveillance system is an information loop that starts and ends with communication and action

Flow of Surveillance Data



Key Tenets of HAI Surveillance

- A written plan serves as the foundation
  - What HAI am I tracking? Why?
  - How will data be used?
  - Where are opportunities to prevent HAI in my facility?
- The intensity of surveillance efforts need to be maintained over time
- Stay consistent over time; always apply same surveillance definitions

Recommended Practices for Surveillance

1. Assess the population
2. Select the outcome or process for surveillance
   - Comply with State and federal requirements
3. Use surveillance definitions
4. Collect surveillance data
5. Calculate and analyze infection rates
6. Apply risk stratification methodology
7. Report and use surveillance information

AJIC *Am J Infect Control,* 26:277-88, 1998

AJIC *Am J Infect Control,* 35:427-40, 2007

Outcome Measure Examples

- CLABSI, CDI, and SSI Standardized Infection Ratio (SIR)
- MRSA and VRE BSI rate per 10,000 patient days

Process Measure Examples

- CAUTI prevention: percent urinary catheters with appropriate indication
- CLABSI prevention: percent adherence to CLIP bundle (all or none)
- CDI prevention: thoroughness of environmental cleaning
- HAI prevention: percent adherence to hand hygiene

Measuring Infections

Incidence

- Number of persons in a population who develop a disease or condition within a specified period of time
- Measure of **new** infections

Prevalence

- Proportion of persons in a population who have a disease or condition at a given point in time
- Measure of infections that **are present**

Incidence

Incidence measures the frequency of **disease onset** (i.e., rate).
Answers: 'What is the risk of X occurring?'

$$\text{Incidence} = \frac{\text{(\# of new cases) during a specified time period}}{\text{(size of a specific population)}}$$

Example:

$$\frac{\text{5 SSI}}{\text{97 Kidney Surgeries}} = \text{0.05 new infections per kidney surgery, During the time period of Jan-Dec 2017}$$

Prevalence

Prevalence measures disease status in a population at a particular time. Answers: 'How common is X?'

$$\text{Prevalence} = \frac{\text{(\# of existing cases) during a specified time period}}{\text{(size of a specific population)}}$$

Examples:

$$\frac{\text{30 employees got flu shot}}{\text{100 employees}} = 0.3 = \text{30\% of employees had flu shot as of Mar 31, 2012}$$

$$\frac{\text{2 patients colonized with MRSA}}{\text{10 patients admitted Mar 31, 2017}} = 0.2 = \text{20\% of patients admitted on Mar 31, 2017 are colonized}$$

Incidence Density Rate

Incidence density accounts for variation in the time each person is at risk for the event.

Incidence density rate =

$$\frac{\text{(\# of new cases)}}{\text{(person-time at risk)}}$$ during a specified time period

Example:

$$\frac{\text{\# hospital onset CDI}}{\text{\# of patient days}}$$

Clinical vs Surveillance Definitions

- Clinical
  - Patient centered
  - Used for therapeutic decisions

- Surveillance
  - Population based
  - Applied exactly the same way each time

HAI Surveillance Definitions

- Case definition (surveillance definition)
  - Clinical and laboratory characteristics that a patient must have to be counted as an event or case for surveillance purposes
  - **Time, place, & person** (e.g., age, sex)
  - Universal case reporting
  - A surveillance system in which all cases of a disease are to be reported

Laboratory-based surveillance

A surveillance method in which the reports of cases come from clinical laboratory data only (forgoing case review/symptomatology)

Applying Surveillance Definitions

- Always refer to written definitions to ensure accuracy of applying case definitions
  - Use standardized, published, validated definitions where available
- For accurate and valid comparisons, use the same definitions
  - If definitions change, the comparability of rates over time will be compromised

Collect Surveillance Data

- Include IP, staff, and others with responsibility or interest
- Limit collection to only what is needed
- Be involved in efforts when creating or revising the electronic health records to enable HAI data collection

Prospective Surveillance

- Initiated when patient is still under the care
- Advantages
  - Ability to capture information in real time
  - Can interview caregivers
  - Can gather findings not recorded in patient record
  - Easier to demonstrate temporality (e.g., before and after observations) and therefore make causal inferences

Retrospective Surveillance

- Closed record review after patient has been discharged
- Advantages:
  - Allows for comprehensive review of sequential events
  - Efficient
- Disadvantage:
  - Does not allow for prompt intervention
  - Important/relevant information my be missing
- Avoid sole reliance administrative data (i.e., abstracted billing)
  - May be useful for identifying possible HAI
  - Not reliable or valid for HAI surveillance on its own

Numerator Data

- Numerator = number of instances of the "event" being measured
- Examples:
  - HAI identified through **active** surveillance: CLABSI, CAUTI, SSI, VAP
  - HAIs identified by **laboratory** finding alone: CDI, MRSA BSI, VRE BSI
  - Care **practices, processes**, observations: CLIP, hand hygiene compliance
- Record point in time or time period

Denominator Data

- Denominator = number of patients or procedures being followed, the population size, or person-time at risk (patient or line days)
- Examples: procedures, patient census, patient encounters, or number of patient days

$$\frac{\text{5 SSI}}{\text{300 APPY Procedures}} = 0.67$$

$$\frac{\text{2 CLABSI}}{\text{1500 line days}} = 1.33$$

$$\frac{\text{90 CLIP w/100\% adherence}}{\text{100 line insertions}} = .90 \text{ or } 90\%$$

Risk Factor Data

Data collection may involve collection of risk factor data necessary for risk adjustment

HAI	Factors in Risk Adjustment
CDI	Test type, community onset prevalence, facility bed size*,facility medical school affiliation*, number of ICU beds*, facility type*,reporting from ED or 24-hr observation unit
CLABSI	ICU vs ward, medical school affiliation*, facility bed size*, facility type* average length of stay* (LTACH), birth weight (NICU)
MBI-LCBI	Acute care hospitals only; ICU vs ward, facility bed size*, medical school affiliation*
MRSA BSI	Community onset prevalence, average length of stay*, medical school affiliation*, facility type*, number of ICU beds*
SSI	Age, ASA score, wound class (contaminated or dirty), procedure duration, general anesthesia, emergency procedure, gender, BMI, diabetes, trauma, endoscope, procedure type (primary, revision), approach, spine level, closure, duration of labor, oncology, facility bed size*, medical school affiliation*
	* Data from NHSN Annual Survey

Calculate and Analyze Infection Rates

Calculate rates and ratios by denominator type

- Total population at risk, or time at risk
- Used to calculate raw rate or incidence density rate:

Examples:

$$\frac{5 \text{ SSI}}{300 \text{ APPY Procedures}} \times 100 = 0.67$$

$$\frac{2 \text{ CLABSI}}{1500 \text{ line days}} \times 1000 = 1.33$$

$$\frac{218 \text{ patient days with central line}}{360 \text{ patient days}} = 0.61$$

Apply Risk Adjustment Methodology

- **CLABSI and CAUTI:** Infection risk takes into account patient location
- **SSI:** Probability of infection calculated for each surgical patient; varies by surgery
- **CDI & MDRO (LabID):** Infection risk accounts for disease burden (community prevalence), testing method (for CDI), and facility characteristics

Standardized Infection Ratio (SIR)

- Summary measure used to track HAI
- Allows for tracking over time
- Compares the actual number of HAI reported to what would be predicted using 2015 baseline data
- Adjusted for risk factors significantly associated with HAI

Calculating Standardized Infection Ratio (SIR)

- Standardized infection ratio

$$SIR = \frac{\text{Observed HAI}}{\text{Predicted HAI}}$$

Example:
Hospital A has 4 MRSA BSI over 23,500 patient days. National data predicted 2.5 MRSA BSI.

$$SIR = \frac{4}{2.5} = 1.6$$

NHSN: A Guide to the SIR

- How to interpret SIR
- How SIR is calculated
- Risk adjustment factors for specific HAI

NHSN: A Guide to the SIR
https://www.cdc.gov/nhsn/pdfs/ps-analysis-resources/nhsn-sir-guide.pdf

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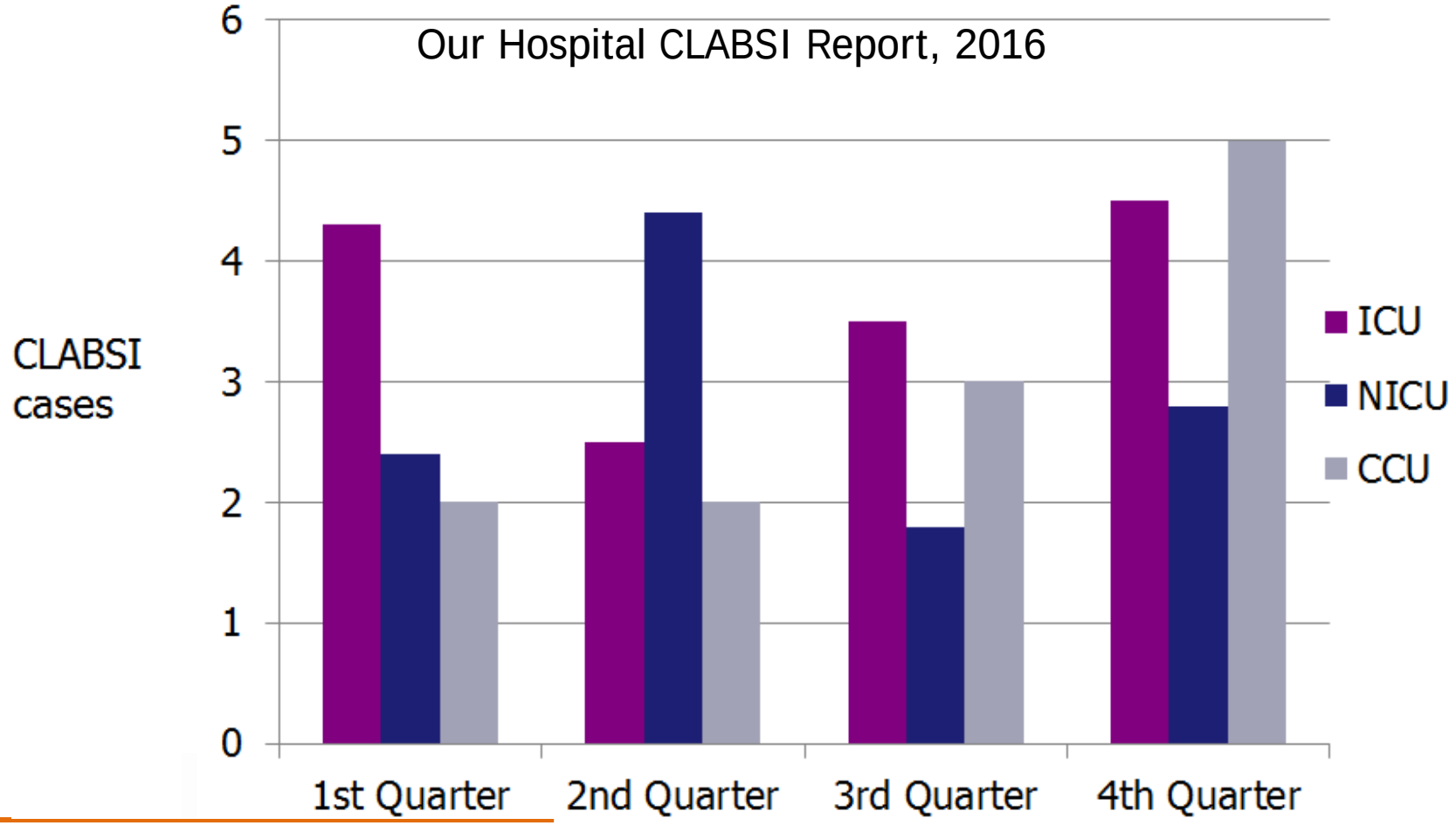
Report and Use Surveillance Data

"The demonstrable power of surveillance is in sharing findings with those who need to know and who can act on the findings to improve patient safety."

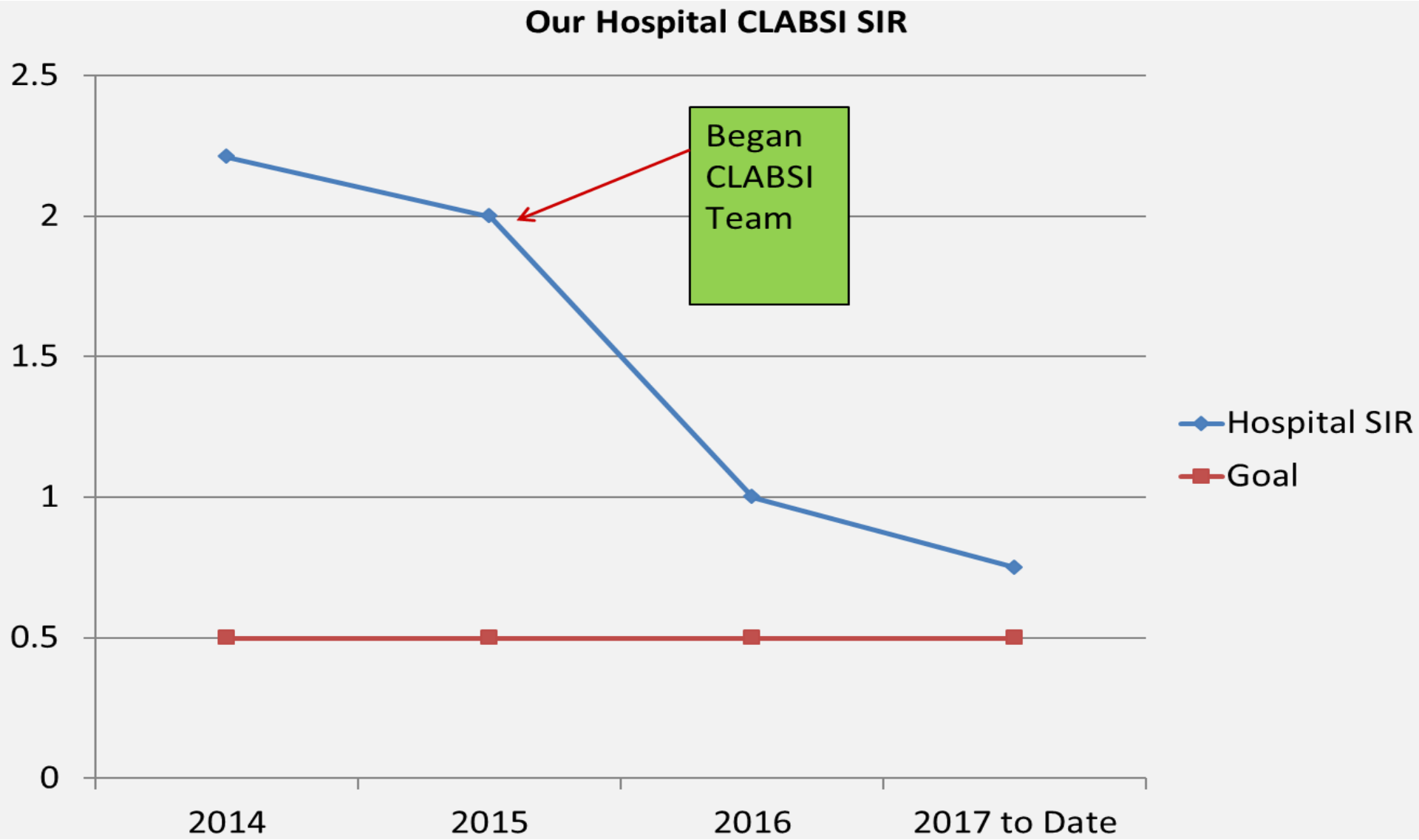
AJIC Am J Infect Control, 35:427-40, 2007

- Plan for distribution of findings
- Report to health care providers most able to impact patient care
- Report in a manner to stimulate process improvement
- Use visual displays of data (e.g., charts, graphs, tables)

Sample Bar Charts



Sample Line Graphs and Histograms - 3



Summary

- The IP must understand the basic principles of epidemiology and apply them to HAI surveillance
- Accurate and consistent data collection, recording, analysis, interpretation, and communication of findings is an essential part of the infection prevention and surveillance plan
- Surveillance of process measures helps focus prevention activities to improve outcomes

References

Ebbing Lautenbach, K. F. Woeltje, and P.N. Malani., Practical Healthcare Epidemiology, 3rd Edition, 2010.

Horan, T.C., Andrus, M., and Dudeck, M.A. CDC/NHSN surveillance definition of health care-associated infection and criteria for specific types of infections in the acute care setting. Am J Infection Control 36: 309-332, 2008.

Lee, T.B., Marx, J., Olmsted, R.N., and Scheckler, W.E., Recommended practices for surveillance: Association for Professionals in Infection Control and Epidemiology (APIC), Inc. Am J Infect Control 35:427-440, 2007.

Yi, M., Edwards, M., Horan, T., Berrios-Torres, S., Fridkin, S., *Improving risk-adjusted measures of surgical site infection for the National Health Safety Network.* Infect Control and Hospital Epidemiology. 32(10), 2011.

Questions?

For more information,
please contact any
HAI Program member.

Or email
HAIProgram@cdph.ca.gov