



Epidemiology and Surveillance



Basics of Infection Prevention
2-Day Mini-Course
2014

Objectives

- Discuss basic principles of epidemiology and how they apply to surveillance
- Describe surveillance process and outcome measures for infection prevention
- Review basic surveillance practices: data collection, recording, analysis, interpretation, and communication of surveillance findings

Epidemiology

- Definition: Study of disease in populations

Clinical care: focus on the individual

– VS –

Epidemiology: focus on the group

- In healthcare, answers questions such as:
 - Does care result in best outcome?
 - What % of the time?
- Allows assessment of trends over time

Infection Prevention and Hospital Epidemiology

- “The discipline concerned with preventing...healthcare-associated infection
- A practical (rather than academic) sub-discipline of [epidemiology](#)
- An essential, though often under-recognized and under-supported, part of the infrastructure of health care
- Akin to [public health](#) practice, practiced within the confines of a particular health-care delivery system rather than directed at society as a whole”

Wikipedia, 2011



Epidemiologic Surveillance

Defined as

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

Basic Terminology

- Mean, median
- Surveillance
- Lab-based surveillance
- Case finding
- Incidence vs. prevalence
- p-value, confidence interval

What do all of these terms mean???



Mean

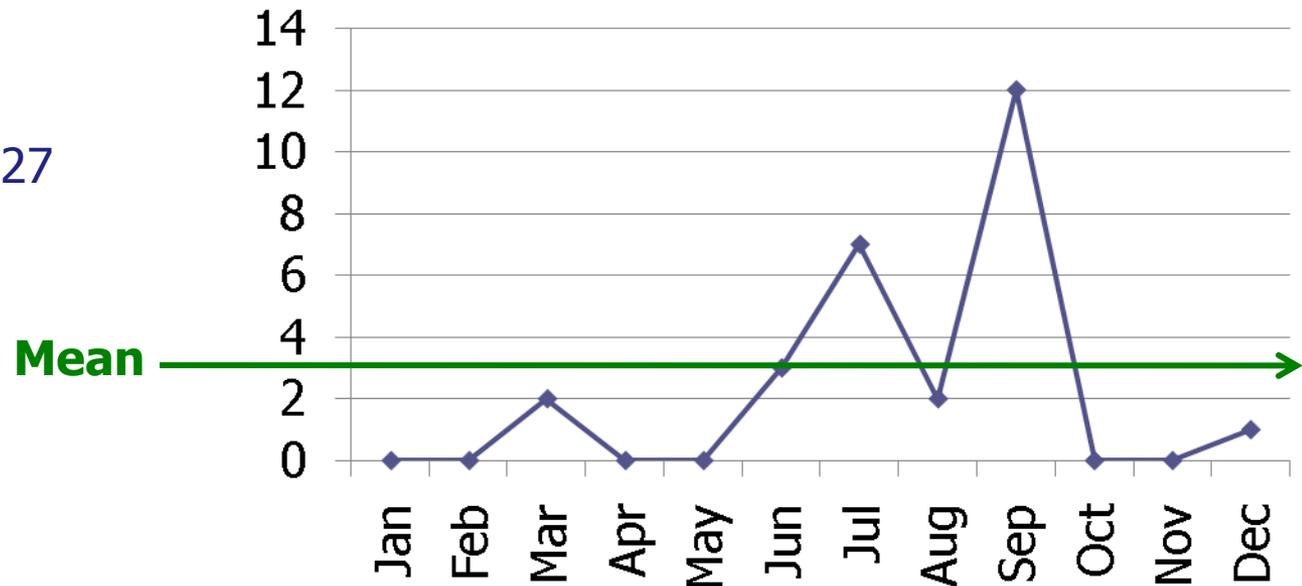
- Measure of central tendency used to describe a data set
- The average value of a set of numbers
- Most affected by outliers
- To calculate:
 - Add the values in the data set
 - Divide by total number of variables

Example:

$$0+0+2+0+0+3+7+2+12+0+0+1 = 27$$

$$27 \div 12 = \mathbf{2.25}$$

CLABSI in 2009



Median

- Another measure of central tendency used to describe a data set
- The midpoint of a distribution of values
- Same number of values above the median as below it
- To calculate:
 - Order the values in the
 - Identify middle value

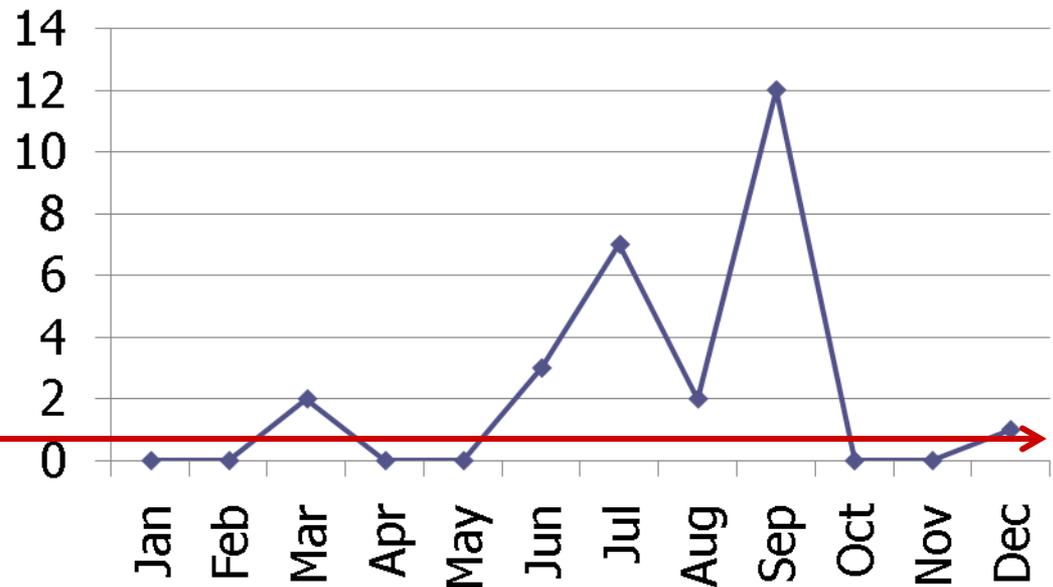
Example:

0,0,0,0,0,0,1,2,2,3,7,12

0.5

Median

CLABSI in 2009



Surveillance Terms

- **Case definition (also called surveillance definition)**
 - the clinical and laboratory characteristics that a patient must have to be counted as a case for surveillance purposes
- **Universal case reporting**
 - a surveillance system in which all cases of a disease are supposed to be reported
- **Laboratory-based reporting**
 - a surveillance method in which the reports of cases come from clinical laboratory data (forgoing case review)



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**

Infection Rates

Incidence rate =

of new cases of disease in a population
of people at risk for getting the disease

Example: $\frac{10 \text{ HCWs out sick with influenza}}{100 \text{ unvaccinated HCWs}} = 10\%$

Prevalence rate =

of existing cases of disease in a population
of people in the population

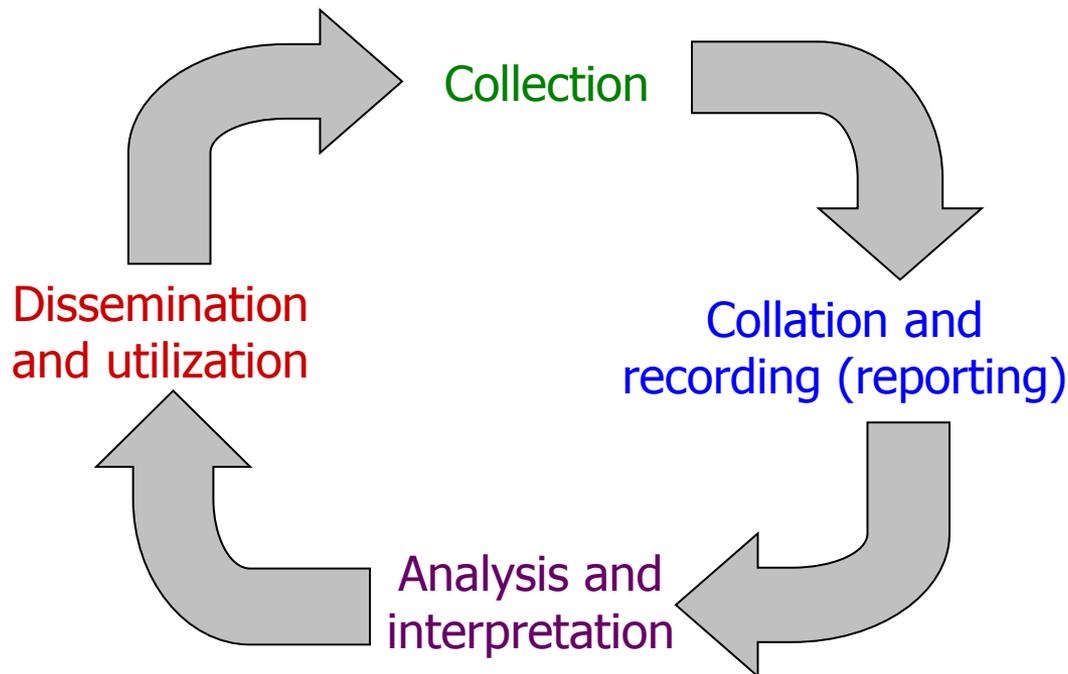
Example: $\frac{17 \text{ SNF pts TB skin test+ on admission}}{100 \text{ SNF patients}} = 17\%$



Surveillance

- A surveillance system is an **information** loop or cycle
- Starts and ends with communication and action

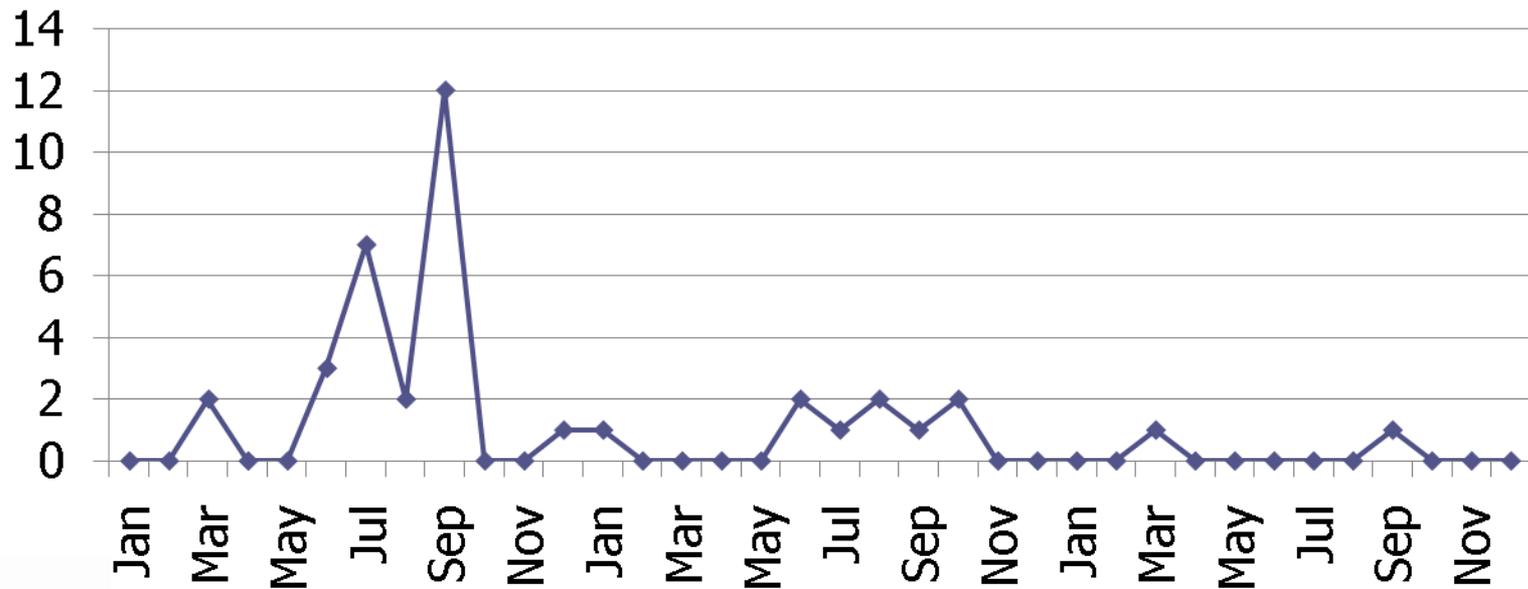
Flow of Surveillance Data



Endpoint of HAI Surveillance?

Data that demonstrate progress in **HAI Prevention!**

CLABSI, 2009-2011



AJIC major articles

Recommended practices for surveillance: Association for Professionals in Infection Control and Epidemiology (APIC), Inc.

Terrie B. Lee, RN, MS, MPH, CIC, Ona G. Montgomery, RN, MSHA, CIC, James Marx, RN, MS, CIC, Russell N. Olmsted, MPH, CIC, and William E. Scheckler, MD

A good reference to start!

Surveillance in public health is defined as “the ongoing systematic collection, analysis, interpretation, and dissemination of data regarding a health-related event for use in public health action to reduce morbidity and mortality and to improve health.” Infection control professionals apply this definition to both reduce and prevent health care-associated infections (HAIs) and enhance patient safety. Surveillance, as part of infection prevention and control programs in health care facilities, contributes to meeting the pro-

the frequency of adverse events such as infection or injury. Although the goal of contemporary infection prevention and control programs is to eliminate HAIs, epidemiologic surveillance is still required for accurate quantification of events and demonstration of performance improvement.

Although there is no single or “right” method of surveillance design or implementation, sound epidemiologic principles must form the foundation of effective systems and be understood by key participants in the

Am J Infect Control 2007;35:427-40.

Quality HAI Surveillance

Key tenets

- A written plan should serve as the foundation
 - What HAIs am I tracking? Why?
 - How will data be used?
 - If only to meet mandates, how **can** data be used?
 - Where are opportunities to prevent HAI in **MY** facility?
- The intensity of surveillance needs to be maintained over time
- Stay consistent over time; apply same surveillance definitions

Recommended Practices for Surveillance

- I. Assess the population
- II. Select the outcome or process for surveillance
- III. Use surveillance definitions
- IV. Collect surveillance data
- V. Calculate and analyze infection rates
- VI. Apply risk stratification methodology
- VII. Report and use surveillance information



AJIC Am J Infect Control 1998; 26:277-88

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

Recommended Practices for Surveillance

I. Assess the population



Patient Population at Risk for Infection

Do you know...

- What infections occur most commonly?
- What infections are likely to occur?
- Where are greatest opportunities to prevent infections?
- What are our most frequently performed surgical or procedures?
- What types of patients increase liability and/or costs for our facility?

Procedure-associated Risk

- Infection risk varies by type of procedure

Table 22. SSI rates* by operative procedure and risk index category, PA module, 2006 through 2007

SSI rate-inpatient procedures						
Procedure code	Operative procedure description	Duration cut point (min)	Risk index category	No. of procedures	No. of SSI	Pooled mean
AAA	Abdominal aortic aneurysm repair	225	0,1	881	16	1.82
AAA	Abdominal aortic aneurysm repair	225	2,3	288	15	5.21
APPY	Appendix surgery	81	0,1	2691	40	1.49
APPY	Appendix surgery	81	2,3	372	13	3.49
AVSD	Arteriovenostomy for renal dialysis	111	0,1,2,3	606	6	0.99
BILI	Bile duct, liver or pancreatic surgery	330	0,1	422	37	8.77
BILI	Bile duct, liver or pancreatic surgery	330	2,3	202	33	16.34
BRST	Breast surgery	202	0	997	8	0.80
BRST	Breast surgery	202	1	914	25	2.74
CARD	Cardiac surgery	300	0,1	10,382	121	1.17
CARD	Cardiac surgery	300	2,3	3,396	58	1.71
CBGB	Coronary bypass w/chest and donor incision	300	0	1,003	3	0.30
CBGB	Coronary bypass w/chest and donor incision	300	1	47,296	1,399	2.96
CBGB	Coronary bypass w/chest and donor incision	300	2,3	15,706	767	4.88
CBGC	Coronary bypass graft with chest incision	285	0,1	3,495	57	1.63
CBGC	Coronary bypass graft with chest incision	285	2,3	1,147	33	2.88
CEA	Carotid endarterectomy	133	0,1,2,3	2,615	11	0.42
CHOL	Gallbladder surgery	121	0,1,2,3	3,337	23	0.69
CHOL	Gallbladder surgery	121	0	6,530	300	4.10

Device-associated Risk

- Infection risk increases with use of invasive devices
 - Higher risk with longer duration



Incidence Density Rate

- Rate calculation that accounts for variation in time of exposure
- For HAI surveillance: days of exposure

Incidence density rate =

$$\frac{\text{\# of new cases of infection or disease in population}}{\text{\# of exposure periods (e.g. patient days or line days)}}$$

Examples:
$$\frac{\text{\# hospital onset CDI}}{\text{\# of patient days}} \quad \frac{\text{\#CLABSI}}{\text{\# central line days}}$$

Patient- or Care-level Risk

- Infection risk varies by patient-specific risk factors
- Infection rates vary by patient care unit

Central line-associated BSI rate*				
Type of Location	No. of Locations+	No. of CLABSI	Central line-days	Pooled mean
Critical Care Units				
Burn	33	193	36,355	5.3
Medical Major teaching	135 (134)	740	335,840	2.2
Medical All other	191 (183)	461	293,177	1.6
Medical Cardiac	252 (246)	556	330,123	1.7
Medical/Surgical Major teaching	192	760	446,751	1.7
Medical/Surgical All other <= 15 beds	837 (771)	982	693,747	1.4
Medical/Surgical All other > 15 beds	324 (323)	1,111	871,750	1.3
Neurologic	23	67	36,414	1.8
Neurosurgical	79 (78)	194	129,732	1.5
Pediatric Cardiothoracic	21	161	65,419	2.5
Pediatric Medical	15 (13)	36	13,823	2.6
Pediatric Medical/Surgical	142 (135)	504	228,206	2.2

NHSN 2009 Data Summary,
published 2011



Recommended Practices for Surveillance

II. Select the outcome or process for surveillance



Outcomes vs. Process Measures

- Outcome - the result of care or performance
 - Infection
 - Length of stay
 - Patient satisfaction
- Process - series of steps that result in an outcome; adherence to polices and recommended practices
 - Immunization
 - Central line insertion practices
 - Hand hygiene

Outcome Measures

Examples:

- CAUTI per 1000 Foley catheter days (or patient days-?)
- CLABSI per 1000 central line days
- VAP per 1000 ventilator days
- CDI per 10,000 patient days
 - Hospital Onset (HO) cases for incidence of CDI
 - Community Onset (CO) cases for prevalence of CDI

Process Measures

Examples:

- **CAUTI prevention:** % foley catheters with appropriate indication
- **CLABSI prevention:** % adherence to CLIP bundle (all or none)
- **CDI prevention:** thoroughness of environmental cleaning

Recommended Practices for Surveillance

III. Use surveillance definitions



Surveillance Definitions

- Always refer to written definitions to ensure accuracy of applying case definitions
 - Use standardized, published, validated definitions where available
 - Where not available, prepare written definitions to ensure intra-facility standardization
- For accurate and valid comparisons, use the same definitions
 - If definitions change, the comparability of rates over time will be compromised

NHSN Infection Surveillance Definitions

AJIC major articles

CDC/NHSN surveillance definition of health care–associated infection and criteria for specific types of infections in the acute care setting

Teresa C. Horan, MPH, Mary Andrus, RN, BA, CIC, and Margaret A. Dudeck, MPH
Atlanta, Georgia

BACKGROUND

Since 1988, the Centers for Disease Control and Prevention (CDC) has published 2 articles in which nosocomial infection and criteria for specific types of nosocomial infection for surveillance purposes for use in acute care settings have been defined.^{1,2} This document

population for which clinical sepsis is used has been restricted to patients ≤ 1 year old. Another example is that incisional SSI descriptions have been expanded to specify whether an SSI affects the primary or a secondary incision following operative procedures in which more than 1 incision is made. For additional information about how these criteria are used for NHSN surveillance, refer

Look for updates to definitions at

www.cdc.gov/nhsn



Alternative Surveillance Definitions

Surveillance definitions also exist for settings that may not yet be covered by NHSN definitions

- Home care
- Clinics
- Dental offices

The screenshot shows a web browser window displaying the APIC (Association for Professionals in Infection Control and Epidemiology) website. The browser's address bar shows the URL: http://www.apic.org/AM/Template.cfm?Section=Surveillance_D. The search bar contains the text "apic surveillance definitions". The website header includes the APIC logo and the tagline "Spreading knowledge. Preventing infection.™". Navigation links include "About APIC", "Member Services", "Education & Certification", "Research", "Guidelines & Standards", "Public Policy", "Resources/Information Services", and "Emergency Preparedness". A sidebar on the left lists various categories under "GUIDELINES & STANDARDS", including "Construction Issues", "Definitions & Surveillance", "Environmental Services", "Guidelines & Standards", "HAI Compendium", "Healthcare Workers & Infection Prevention", "Multi Drug Resistance Organisms", "Targeting Zero", "APIC Elimination Guides", "Topics", "Surveillance Technology Resources", "National Patient Safety Goals", "Hand Hygiene", and "Position Statements". The main content area is titled "Surveillance Definitions, Reports and Recommendations" and features several articles, including one from August 23, 2004, regarding FDA donor eligibility criteria, and another from 2007 regarding recommended practices for surveillance. The bottom of the browser window shows a Windows taskbar with various application icons and a system clock indicating 3:36 PM on 10/21/2011.

See www.apic.org/AM or google "APIC surveillance definitions"

Recommended Practices for Surveillance

IV. Collect surveillance data



Collecting Surveillance Data

- Data collectors should include IP staff **and others** with responsibility or interest
- Limit collection to only what is needed
- Be involved in efforts that advance the electronic health record

Prospective vs. Retrospective

Concurrent or prospective surveillance

- Initiated when patient is still under the care
- Advantages
 - ability to capture information in real time
 - interview caregivers
 - observe findings not recorded in patient record

Prospective vs. Retrospective

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
- Avoid reliance administrative data, i.e. abstracted billing
 - may be useful for identifying possible HAIs
 - not reliable or valid for HAI surveillance

Numerator Data Collection

Numerator = the “Event” being measured

Examples:

- HAIs 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

Denominator Data

- Denominator = Population at risk or total of all possible events
- Denominator data collection may involve collection of risk factor data necessary for risk adjustment
 - e.g. age, birthweight, ASA score

Recommended Practices for Surveillance

- V. Calculate and analyze infection rates
- VI. Apply risk stratification methodology



Calculating Rates/Ratios by Denominator Type

- Total population at risk
 - Used to calculate a raw rate or incidence density rate
 - Examples:

$$\frac{5 \text{ SSI} \quad \times 100}{300 \text{ APPY procedures}} = 1.67$$

$$\frac{2 \text{ CLABSI} \quad \times 1000}{1500 \text{ line days}} = 1.33$$
- Total number of events possible
 - Used to calculate a ratio or proportion (a comparison of two numbers)
 - Examples:

$$\frac{90 \text{ CLIPs w/100\%-adherence}}{100 \text{ line insertions}} = 0.9 \text{ or } 90\%$$

$$\frac{31 \text{ hand hygiene (HH) observations}}{50 \text{ opportunities for HH}} = 0.62$$

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

NHSN published data can help you interpret **Your** HAI Data

AJIC major articles

National Healthcare Safety Network (NHSN) report: Data summary for 2006 through 2008, issued December 2009

Jonathan R. Edwards, MStat, Kelly D. Peterson, BBA, Yi Mu, PhD, Shailendra Banerjee, PhD, Katherine Allen-Bridson, RN, BSN, CIC, Gloria Morrell, RN, MS, MSN, CIC, Margaret A. Dudeck, MPH, Daniel A. Pollock, MD, and Teresa C. Horan, MPH
Atlanta, Georgia

*Published by the Association for Professionals in Infection Control and Epidemiology, Inc.
(Am J Infect Control 2009;37:783-805.)*

This report is a summary of Device-Associated (DA) and Procedure-Associated (PA) module data collected and reported by hospitals and ambulatory surgical centers participating in the National Healthcare Safety Network (NHSN) from January 2006 through December 2008 as reported to the Centers for Disease Control and Prevention (CDC) by July 6, 2009. This report updates previously pub-

- Estimation of the magnitude of HAIs
- Monitoring of HAI trends
- Facilitation of interfacility and intrafacility comparisons with risk-adjusted data that can be used for local quality improvement activities
- Assistance to facilities in developing surveillance and analysis methods that permit timely recognition of

NHSN 2006-2008 Summary Data
(referent period), published Dec 2009



National Healthcare Safety Network (NHSN) Report, Data Summary for 2009, Device-associated Module

Dudeck MA, Horan TC, Peterson KD, Bridson KA, Morrell GC, Pollock DA, Edwards JR

This report is public domain and can be copied freely.

National Center for Emerging and Zoonotic Infectious Diseases
Division of Healthcare Quality Promotion



NHSN 2009 Summary Data, published 2011

Applying Risk Adjustment Methods

CLABSI & CAUTI

- Infection risk specific to location

SSI

- Probability of infection calculated for each patient
- Varies by surgery

CDI & MDRO (LabID)

- Infection risk accounts for disease burden (prevalence), testing method (for CDI), & facility characteristics



INFECTION CONTROL AND HOSPITAL EPIDEMIOLOGY OCTOBER 2011, VOL. 32, NO. 10

ORIGINAL ARTICLE

Improving Risk-Adjusted Measures of Surgical Site Infection for the National Healthcare Safety Network

Yi Mu, PhD;¹ Jonathan R. Edwards, MStat;¹ Teresa C. Horan, MPH;² Sandra I. Berrios-Torres, MD;¹ Scott K. Fridkin, MD¹

(See the commentary by Moehring et al, on pages 987–989.)

BACKGROUND. The National Healthcare Safety Network (NHSN) has provided simple risk adjustment of surgical site infection (SSI) rates to participating hospitals to facilitate quality improvement activities; improved risk models were developed and evaluated.

METHODS. Data reported to the NHSN for all operative procedures performed from January 1, 2006, through December 31, 2008, were analyzed. Only SSIs related to the primary incision site were included. A common set of patient- and hospital-specific variables were evaluated as potential SSI risk factors by univariate analysis. Some ifc variables were available for inclusion. Stepwise logistic regression was used to develop the specific risk models by procedure category. Bootstrap resampling was used to validate the models, and the c-index was used to compare the predictive power of new procedure-specific risk models with that of the models with the NHSN risk index as the only variable (NHSN risk index model).

RESULTS. From January 1, 2006, through December 31, 2008, 847 hospitals in 43 states reported a total of 849,659 procedures and 16,147 primary incisional SSIs (risk, 1.90%) among 39 operative procedure categories. Overall, the median c-index of the new procedure-specific risk was greater (0.67 [range, 0.59–0.85]) than the median c-index of the NHSN risk index models (0.60 [range, 0.51–0.77]); for 33 of 39 procedures, the new procedure-specific models yielded a higher c-index than did the NHSN risk index models.

CONCLUSIONS. A set of new risk models developed using existing data elements collected through the NHSN improves predictive performance, compared with the traditional NHSN risk index stratification.

Infect Control Hosp Epidemiol 2011;32(10):970–986

Surgical site infection (SSI) is one of the most common healthcare-associated infections (HAIs) and is a major cause of increased length of hospital stay and mortality.^{1–3} SSI surveillance is integral to hospital infection control and quality improvement programs, with feedback of SSI rates being an important component of SSI reduction strategies.^{4,5} However, hospitals with surgeons who treat patients with multiple non-modifiable risk factors would expect higher SSI rates. Therefore, risk adjustment that accounts for differences in patient case mix is critical to allow for more meaningful comparisons between surgeons or between hospitals, especially when using SSI summary data as a quality improvement performance metric.^{6,7}

Controversies exist regarding several aspects of such risk adjustment. One is the inclusion of intraoperative or post-operative variables in any risk adjustment strategy, because these variables may reflect surgical technique more than patient case mix, and adjustment for surgical technique may inappropriately allow for adjusting rates down among sur-

geons with poor technique. Another is the inclusion of SSIs detected through SSI surveillance after discharge from the hospital, which is a setting with great variation in case-finding intensity. In addition, including more procedure-specific variables to generate improved procedure-specific models adds to the data collection burden.

These controversies are relevant to the National Healthcare Safety Network (NHSN), a secure Web-based system used by the Centers for Disease Control and Prevention (CDC) and its healthcare and public health partners for surveillance of HAIs, other adverse events in health care, and adherence to prevention practices in hospitals and other reporting facilities. Traditionally, SSI rates calculated by the CDC and other NHSN data users from data reported to the NHSN have been risk stratified using a risk index of 3 equally weighted factors: the American Society of Anesthesiologists (ASA) score, wound classification, and procedure duration.^{8,9} However, for some procedures, these variables are not associated with SSI risk, are not equally important in the risk they confer, and

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Recommended Practices for Surveillance

VII. Report and use surveillance information



Reporting and Using 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 2007; 35:427-40

- 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
 - charts, graphs, tables, or other graphics data

Tables and Line Lists

National Healthcare Safety Network

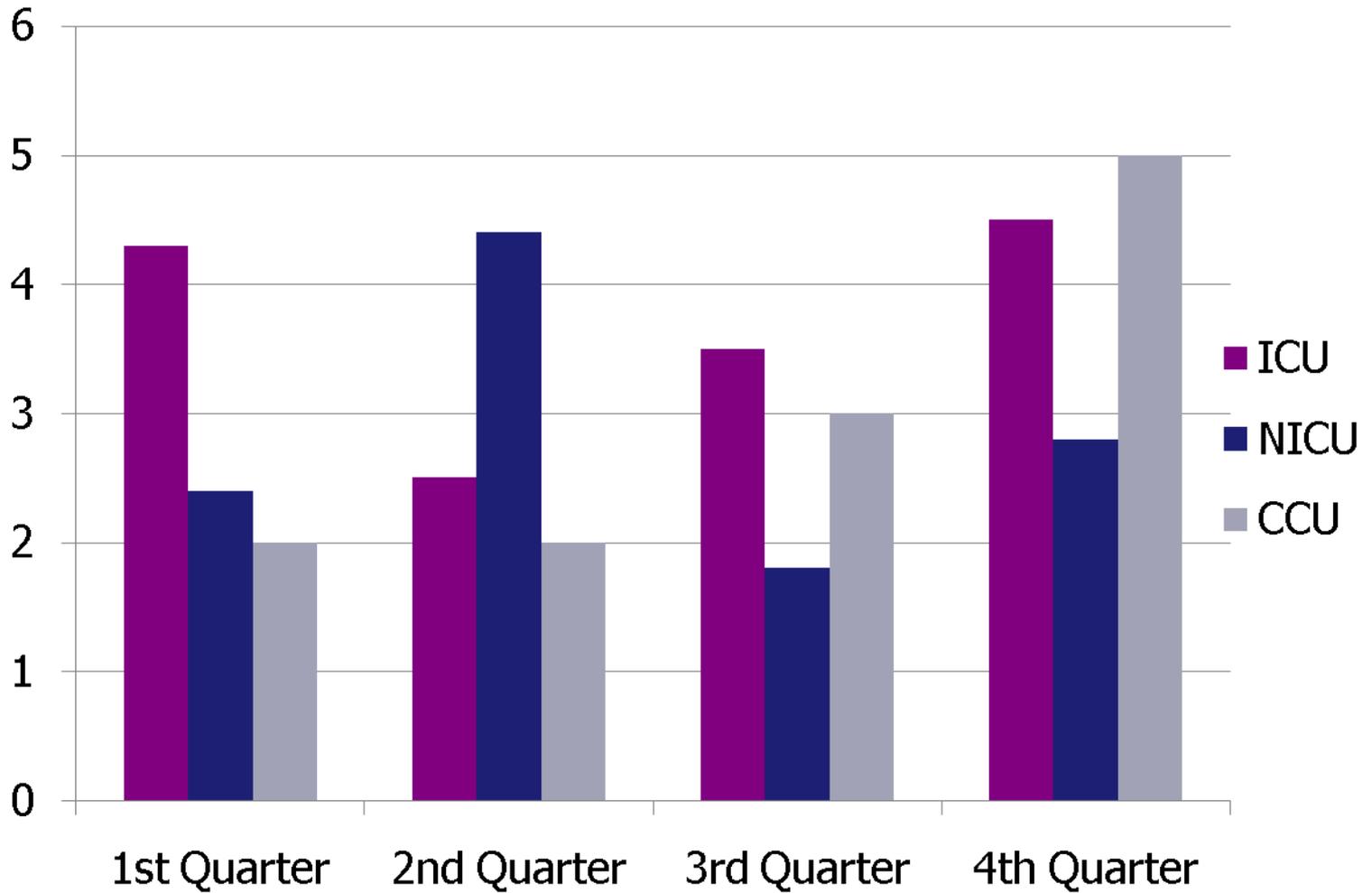
Line Listing for All Central Line-Associated BSI Events

As of: November 3, 2009 at 9:04 AM

Date Range: All CLAB_EVENTS

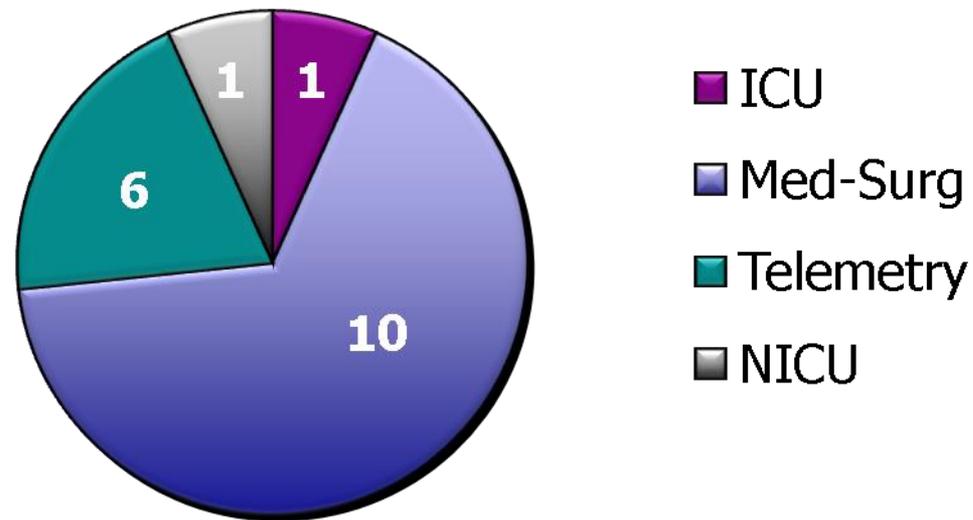
orgID	patID	dob	gender	admitDate	eventID	eventDate	eventType	spcEvent	location
10018	7425	09/22/1961	M	06/06/2005	1676	06/11/2005	BSI	LCBI	BMT
10018	MD-4937	09/19/1922	F	05/30/2005	1678	06/21/2005	BSI	LCBI	BMT
10018	85613	04/18/1951	M	07/08/2005	1685	07/13/2005	BSI	LCBI	S-ICU
10018	10222	01/04/1978	F	08/01/2005	1927	08/08/2005	BSI	LCBI	MICU
10018	01-88-145	10/07/1939	M	03/17/2006	3321	03/21/2006	BSI	LCBI	S-ICU
10018	122-501	02/29/1952	M	02/21/2006	4265	02/23/2006	BSI	LCBI	S-ICU
10018	34-22-100	03/22/1940	M	03/12/2006	4789	03/20/2006	BSI	LCBI	MICU
10018	86-990-01	12/12/1926	M	03/10/2006	4798	03/14/2006	BSI	LCBI	S-ICU
10018	26-22-678	03/28/2006	M	03/28/2006	4800	03/31/2006	BSI	LCBI	NICU
10018	32-54-731	02/21/1959	M	03/06/2006	4820	03/09/2006	BSI	LCBI	S-ICU
10018	13-19	04/18/1934	F	03/07/2006	4821	03/16/2006	BSI	LCBI	MICU
10018	44-18-004	08/16/1944	F	02/11/2006	4824	02/21/2006	BSI	LCBI	MICU

Bar Charts



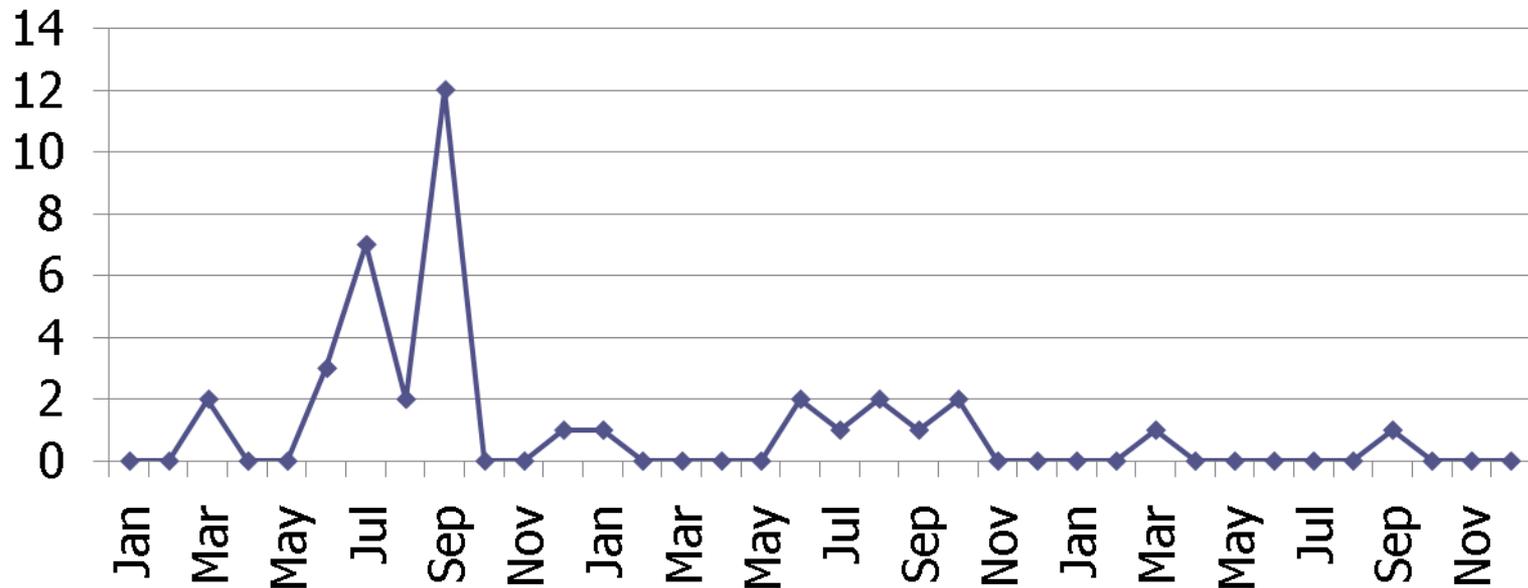
Pie Charts

Missing Line Day Counts by Unit
(# months missing)



Line Graphs or Histograms

CLABSI, 2009-2011



**Make sure to demonstrate
"surveillance to prevention!"**

Questions?