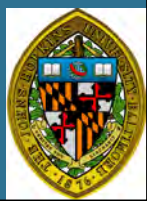
SSI surveillance: Whats new, what's next and what is over the horizon

Trish M. Perl, MD, MSc
Professor of Medicine, Pathology and Epidemiology
Johns Hopkins University
Senior Epidemiologist
Johns Hopkins Healthsystem
Tperl@jhmi.edu



Glossary of terms

- BSI-bloodstream infections
- CA-BSI-catheter associated bloodstream infections
- HAI-healthcare associated infection
- HCW-Healthcare worker
- NNIS-National nosocomial infection surveillance system
- NHSN-new NNIS or National healthcare surveillance network
- SENIC-study on the efficacy nosocomial infections
- SSI-surgical site infection
- UTI-urinary tract infection
- VAP-ventilator associated infection

Objectives

- Review basics of surveillance
- Review definition changes for NHSN
- Discuss impact of post discharge surveillance
- Identify opportunities using electronic surveillance and claims data
- Review new trends in measurement

Surveillance

- "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"

Centers for Disease Control and Prevention. Updated guidelines for evaluating public health surveillance systems. MMWR 2001;50(No.RR-13):2.

Surveillance

To watch

Implies systematic observation of the occurrence and distribution of a specific disease process

- Routine collection of data
- Utilize standardized definitions for cases
- Utilize common denominator populations
- Allows for assessment and comparison of rates
  - e.g. surgical site infection rates in patients having a procedure – SSI per 100 procedures

Purpose of surveillance

- Define background "endemic rates" of nosocomial events
- Identify increases in adverse event rates above the endemic level
- Identify specific risks for nosocomial events
- Inform hospital personnel of the risks of the care or procedures they provide

THE EFFICACY OF INFECTION SURVEILLANCE AND CONTROL PROGRAMS IN PREVENTING NOSOCOMIAL INFECTIONS IN US HOSPITALS

ROBERT W. HALEY,[1,2] DAVID H. CULVER,[1] JOHN W. WHITE,[1] W. MEADE MORGAN,[1] T. GRACE EMORI,[1] VAN P. MUNN[1] AND THOMAS M. HOOTON[1,3]

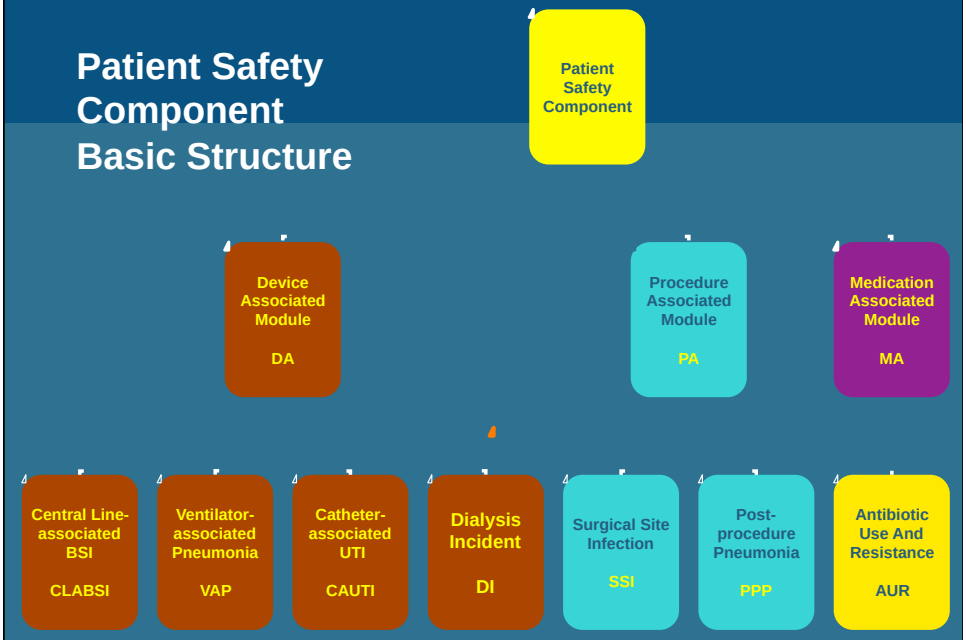
- Infection surveillance and control programs strongly associated with:
  - Reduced UTI, SSI, pneumonia, BSI
  - HAI with IC programs: ↓ 32%
  - HAI without HAI programs ↑ 18%
- Essential components of program:
  - Organized surveillance
  - 1 ICP per 250 beds
  - Trained MD
  - System to report SSI rates to surgeons

Haley RW et al Am J Epidemiol 1985;121:182-205

Is SSI surveillance efficacious?

	SSI Rate 1 st 6 months	2nd 6 months
Holy Cross Hospital		
clean	5.8	2.5
overall	8.4	3.9
Foothills Hospital		
clean	3.6	1.8
overall	5.7	3.3

Patient Safety Component Basic Structure



CDC. NHSN training material

Pick Your Definition: Surgical Site Infection

- Wound with purulent drainage
- Wound with culture + drainage
- Red, warm, or draining wound requiring opening by an MD
- Physician diagnosis
- Radiologic presence of abscess

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Johns Hopkins Medicine

SSI Surveillance

- CDC definition – Modified in 2012
- Defined denominator populations based on ICD-9-CM procedure codes (this will change in 2014—ICD10 procedure codes)
- Standardized, field-tested
- Utilizes:
  - Clinical data
  - Microbiologic data
  - Radiologic data

An SSI

- Event is associated with an operative procedure that is closed primarily but can include drains or other devices. The closure must include the entire length of the incision otherwise do not include in numerator or denominator.
- Categorize by depth of incision and infection.
- Risk factor information should be included
  - Gender, age, duration of procedure, emergency, anesthesia type, wound class, ASA, endoscopic procedures.
  - Procedure specific risk factors
    - C section: duration of labor, Ht, Wt or BMI
    - Spinal infusion: DM, # of levels; approach
    - TKR; THR: revision, partial

CDC NHSN SSI material: July 2013 revisions

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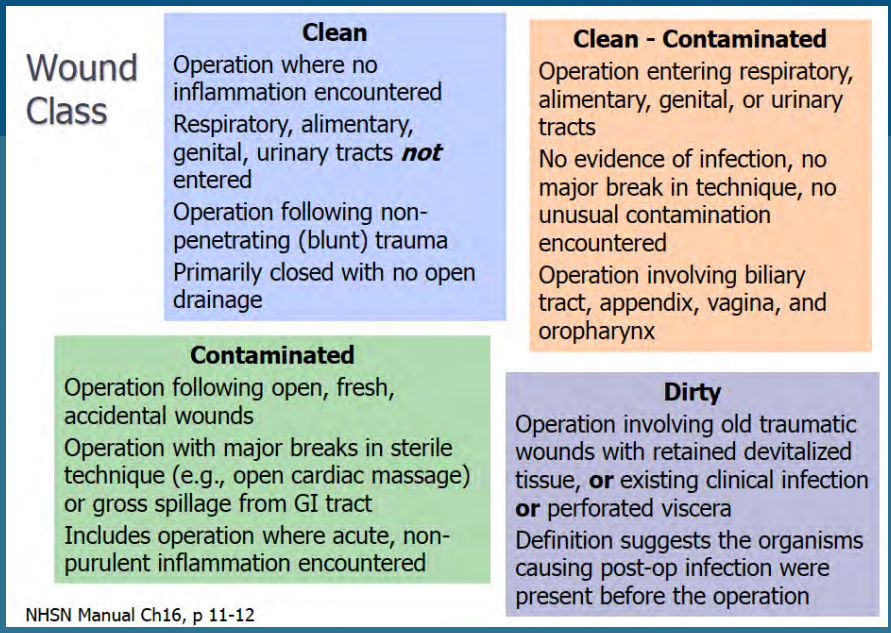
Monitoring

- 30 days post-operatively for most procedures
- 90 days monitoring for the following procedures
  - Breast
  - THR/TKR
  - CABG (B and C)
  - Ventricular Shunt
  - Laminectomy with fusion
  - Craniotomy
  - Pacemaker
  - Fx
  - Peripheral bypass graft procedures
  - herniorraphy

CDC NHSN SSI material: July 2013 revisions



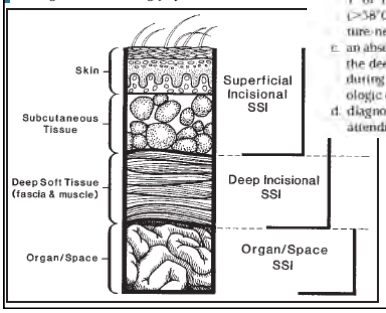
CDC NHSN SSI material: July 2013 revisions

SSI-SURGICAL SITE INFECTION

SIP/SIS-Superficial incisional surgical site infection

A superficial incisional SSI (SIP or SIS) must meet the following criterion:
Infection occurs within 30 days after the ope procedure
and
involves only skin and subcutaneous tissue o incision
and
patient has at least *1* of the following:

a. purulent drainage from the superficial incis
b. organisms isolated from an aseptically obt culture of fluid or tissue from the supe incision
c. at least *1* of the following signs or sympto infection: pain or tenderness, localized swe redness, or heat, *and* superficial incision is erately opened by surgeon and is culture po or not cultured. A culture-negative finding not meet this criterion.
d. diagnosis of superficial incisional SSI by th geon or attending physician.



DIP/DIS-Deep incisional surgical site infection

A deep incisional SSI (DIP or DIS) must meet the following criterion:
Infection occurs within 30 days after the operative procedure if no implant[1] is left in place or within 1 year if implant is in place and the infection appears to be related to the operative procedure
and
involves deep soft tissues (eg, fascial and muscle layers) of the incision
and
patient has at least *1* of the following:

a. purulent drainage from the deep incision but not from the organ/space component of the surgical site
b. a deep incision spontaneously dehisces or is deliberately opened by a surgeon and is culture-positive or not cultured when the patient has at least *1* of the following signs or symptoms: fever (>38°C), or localized pain or tenderness. A culture-negative finding does not meet this criterion.
c. an abscess or other evidence of infection involving the deep incision is found on direct examination, during reoperation, or by histopathologic or radiologic examination
d. diagnosis of a deep incisional SSI by a surgeon or attending physician.

Organ/space-Organ/space surgical site infection

An organ/space SSI involves any part of the body, excluding the skin incision, fascia, or muscle layers, that is opened or manipulated during the operative procedure. Specific sites are assigned to organ/space SSI to identify further the location of the infection. Listed below in reporting instructions are the specific sites that must be used to differentiate organ/space SSI. An example is appendectomy with subsequent subdiaphragmatic abscess, which would be reported as an organ/space SSI at the intraabdominal specific site (SSI-IAB).

An organ/space SSI must meet the following criterion:
Infection occurs within 30 days after the operative procedure if no implant[1] is left in place or within 1 year if implant is in place and the infection appears to be related to the operative procedure
and
infection involves any part of the body, excluding the skin incision, fascia, or muscle layers, that is opened or manipulated during the operative procedure
and
patient has at least *1* of the following:

a. purulent drainage from a drain that is placed through a stab wound into the organ/space
b. organisms isolated from an aseptically obtained culture of fluid or tissue in the organ/space
c. an abscess or other evidence of infection involving the organ/space that is found on direct examination, during reoperation, or by histopathologic or radiologic examination
d. diagnosis of an organ/space SSI by a surgeon or attending physician.

Superficial Incisional SSI

- Events occurs within 30 days after the surgical procedure AND
- Involves only skin and subcutaneous tissue of incision AND
- At least one of the following
  - Purulent drainage from the superficial incision
  - Organisms isolated from an aseptically obtained culture of fluid or tissue from the superficial incision
  - At least 1 of the following signs or symptoms of infection: pain or tenderness, localized swelling, redness, or heat, AND superficial incision is deliberately opened by surgeon and is culture-positive or not cultured.
  - Diagnosis of a superficial incisional SSI by the surgeon or attending physician

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Deep Incisional SSI

- Events occurs within 30 days (or 90 days) after the surgical procedure AND
- Involves deep tissues of incision (ie fascial and muscle layers) AND
  - Purulent drainage from deep incision
  - Spontaneously dehisces or opened by surgeon and organisms isolated or not cultured AND
    - fever (>38°C)
    - Localized pain or tenderness
    - An abscess or other evidence of infection; direct examination, during reoperation, or by histopathologic or radiologic examination
- Diagnosis made by surgeon or attending physician

Organ Space SSI

- Events occurs within 30 days (or 90 days) after the surgical procedure AND
- Involves parts of the body manipulated during the procedure but not fascia and incision AND
  - Purulent drainage from deep incision
  - organisms isolated from tissue/fluids in organ space
  - An abscess or other evidence of infection; direct examination, during reoperation, or by histopathologic or radiologic examination
  - Diagnosis made by surgeon or attending physician
- Meets criteria for specific organ space infections (Table 4 of NHSN manual, 9-14)

Surveillance: Changes

- Healthcare associated infections
- Problem pathogens: MDROs, influenza, *C. difficile*, RSV etc….
- Process measures: compliance with influenza vaccine, hand hygiene, isolation, surgical prophylaxis recommendations
- Syndromes that are epidemiologically significant
- Epidemiologically significant events in healthcare workers (HCW)

How valid are definitions: lessons from SSI

	Gold std.(n=)	Nurses (%)	CI_{95} (%)
General surgery	50	94	83-98
Trauma surgery	50	82	71-93
Overall	100	88	82-94
Run in period	16	63	36-85
Post intervention	34	91	76-98

Cardo, ICHE 1993

Agreement among IP's: Europe

CI_{95} (%)

Intra specialty agreement for SSI diagnosis: 0.04 (0.00-0.62)-0.65 (0.45-0.82)
Intra specialty agreement for depth: 0.05 (0.00-0.10)-0.5 (0.45-0.55)

Intra specialty agreement among surgeons: 0.24 (0.14-0.42)
Intra specialty agreement among IPs: 0.41 (0.28-0.61)

After reading SSI definitions
Intra specialty agreement among surgeons: 0.09
Intra specialty agreement among IPs: 0.57
Depth no change

Birgand etal Plos One 2013:8;1-9

An apparent excess of SSI: analyses to evaluate false-positive diagnoses

- The infection preventionist at a 200-bed general community hospital reported that a neurosurgeon's SSI rate was excessive
- When the surgeon proposed to terminate his practice, the hospital administrator asked consultants to perform an independent investigation
- False-positive diagnoses
  - Serous, serosanguineous, or bloody wound drainage, or hematoma at the wound site; wound separation or mild wound erythema or, in two instances, simply the recovery of staphylococcal species from a wound swab culture

Ehrenkranz NJ. ICHE 1995

TABLE 1
HOST ATTRIBUTES AT OPERATION

Patient Characteristics, Preoperative Status, and Preparation	Controls	Documented OSI	Presumptive OSI
Total number	18	6	12
Male sex	10	2	4
Caucasian	18	5	11
Medicare payment	12	6	8
Private insurance	16	6	9
Remote site infection	3	0	3
Serum albumin <3.5G/dL	3	0	0
Body mass index:lbs weight/(in height)^2≥0.04	6	2	4
Concurrent systemic corticosteroid Rx	1	2	3
≥1 Significant medical condition*	2	3	2
Operation indication:			
Spinal stenosis	9	3	7
Disk disease	8	3	4
Progressive paralysis	1	0	1
Repeat operation	4	2	1
Clean classification	18	5	12
Skin hair shaved	1	0	1
Antimicrobial shower/bath	11	5	6
Myelogram before operation	3	1	1
Current nonsteroidal ant-inflammatory drugs	0	0	1
Current anticoagulant drug	0	0	0
Abnormal skin near planned incision	1	1	0
Antibiotic prophylaxis with 2 hrs of incision	4	1	4
ASA ≥3†	11	3	6

* Significant medical condition = diabetes mellitus, bleeding diathesis, current cancer, current cancer therapy, current alcoholism, current severe liver disease, paraplegia.
Abbreviations: †ASA, American Society of Anesthesiologists preoperative assessment score.

Ehrenkranz NJ. ICHE 1995

TABLE 3
THERAPEUTIC CONSEQUENCES OF OSI DIAGNOSES: DURATION OF HOSPITALIZATION AND USE OF INTRAVENOUS ANTIMICROBIALS

Median Duration	Controls	Documented OSI	Presumptive OSI	Documented OSI Versus Controls	Presumptive OSI Versus Controls	Documented OSI Versus Presumptive OSI
Days of hospitalization (range)	7 (3-9)	27 (10-31)	9.5 (4-17)	*P*<.001	*P*=.04	*P*=.01
Days of administration of intravenous antimicrobial (range)	0 (0-4)	9 (1-45)	1.5 (0-9)	*P*<.001	*P*=.005	*P*=.1

Ehrenkranz NJ. ICHE 1995

Case Finding

- Follow cases as identified systematically—ICD-9 or ICD-10 codes
- Reporting mechanisms
  - Surgeons and OR Staff
  - Surgical units and rounds
  - ID consults
- Microbiology reports
- Readmissions/Re-operations
- Pharmacy records for ABX use
- Post-discharge surveillance

Surveillance Methods

- 100% Chart Review and Wound Examination
- 100% Chart Review
- Targeted SSI Surveillance: 100% Chart Review for Selected Procedures
- Targeted SSI Surveillance: 100% Chart Review of Patients at High Risk
- Selective Chart Review
- Postdischarge Surveillance
- Electronic Data Surveillance

Challenges

- 100% Chart Review and Wound Examination
  - Includes daily wound examination
  - Not practical & feasible in large hospitals
- 100% Chart Review
  - The ICP identified 84% of SSIs noted by the hospital epidemiologist
  - Quality depends on completeness of medical records & on the reviewer's experience

Targeted SSI Surveillance: 100% Chart Review for Selected Procedures

- Target only clean operative procedures
  - Approximately 70% of operative procedures and relatively low SSI risk
  - the SENIC project; SSI surveillance of contaminated or dirty procedures reduced SSI rates as effectively as did SSI surveillance of clean or clean-contaminated procedures
- Target surveillance to high-volume procedures at an institution
- Target surveillance to high-risk of morbidity and mortality procedures
  - Craniotomy or coronary artery bypass procedures vs. hernia repair
- Target surveillance to high-risk of infection rates

Surveillance by microbiology reports

- Not all infections are cultured
- Not all cultures are handled properly
- Certain etiologic agents are difficult to culture, i.e. viruses
- The presence of microbial agents is not equivalent to an infection

Post Discharge Surveillance

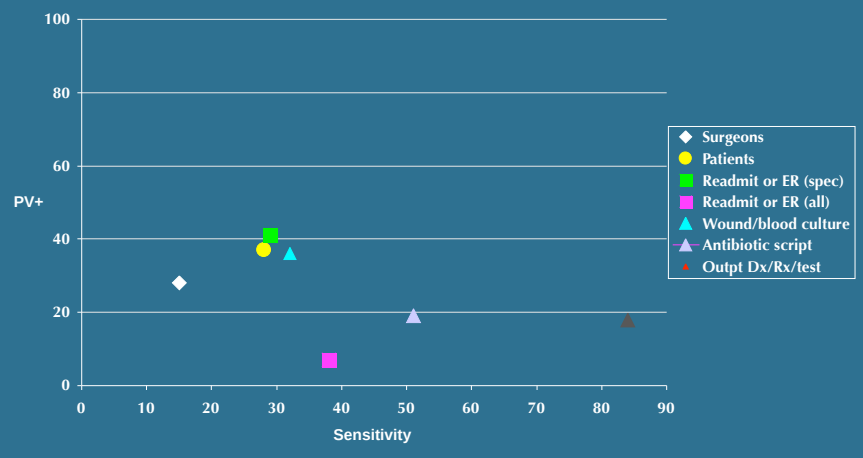
- Majority of SSIs occurs in the outpatient setting
  - 45–72% of SSIs were detected after discharge from the hospital
- Post discharge SSI
  - More outpatient visits, readmissions, emergency department visits, and use of home health services, increased costs ($5,155 for the 8 weeks after discharge, vs $1,773 for in-hospital SSI)
- The cost and time required to perform post discharge surveillance may discourage many infection prevention and control programs from instituting such systems
- Integrated electronic medical records will likely to identify SSIs after hospital discharge

Methods to perform post-discharge SSI surveillance

- 501 randomly selected surgeries
- 38% contacted by telephone
- 89% reported no complications
- 1% reported no complications and had documented SSI while in hospital
- 9.5% had symptoms: pus, pain, fever
- 89% of patients with symptoms had seen an MD and no MDs reported an SSI
- Required 15 minutes per patient

Manian ICHE 1993

Finding SSIs: post-discharge



Sands, JID 1996

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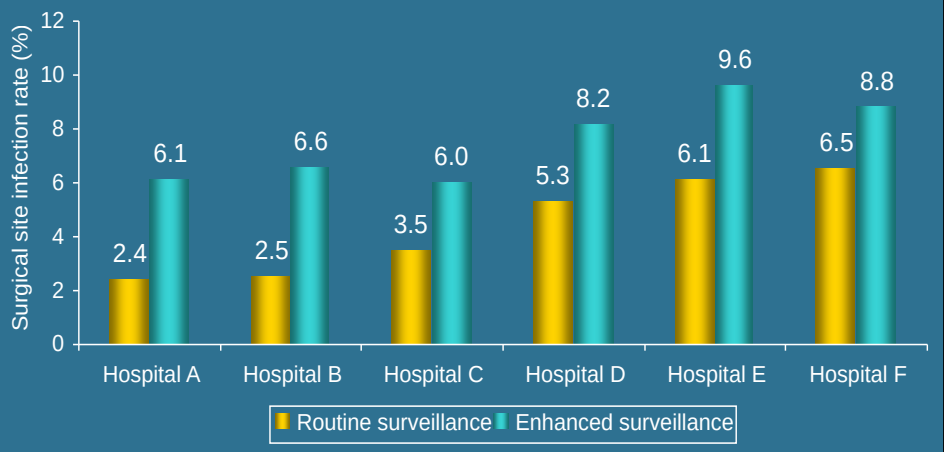
Why use electronic data?

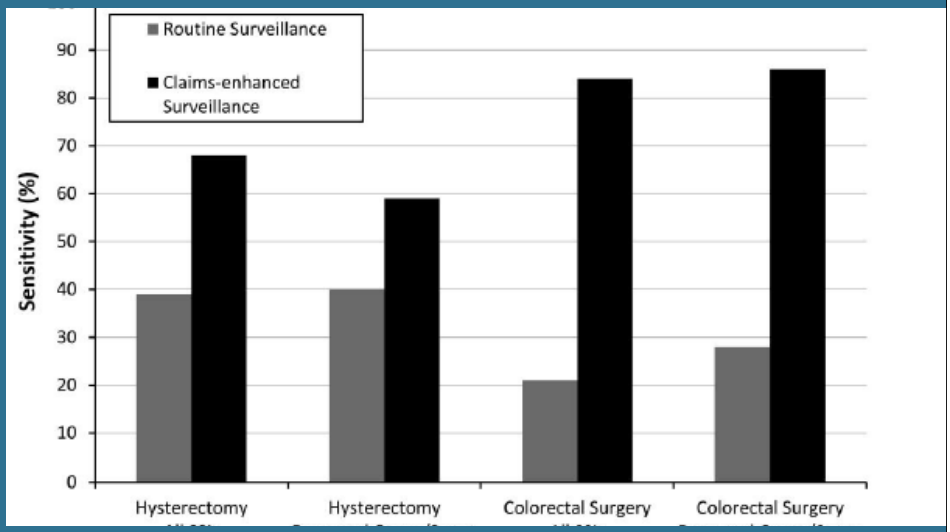
- Potential advantages
  - ↑ accuracy/objectivity/consistency/timeliness
  - Broaden scope of surveillance
  - ↓ burden of data collection, more time for prevention
- Data: numerator (events), denominator (risk adjustment)

SSI rates routine vs enhanced surveillance



Yokoe. Emerg Infect Dis 2004;10:1924-30.

SSI detection: Claims data



LeTourneau etal. ICHE 2013;34:1321-3.

SSI detection: Can you just look in one hospital?

- Retrospective cohort 1/1/2006-31/12/2009
- 91,121 THR and 121,640 TKR were identified with SSI rates of 2.3% (2214) and 2.0% (2465), respectively
- 17% of SSI missed is surveillance was limited to one hospital
- Hospital ranking affected in 61% of cases

Yokoe. CID 2013;34:1282-8.

SSI detection: Can you just look in one hospital?

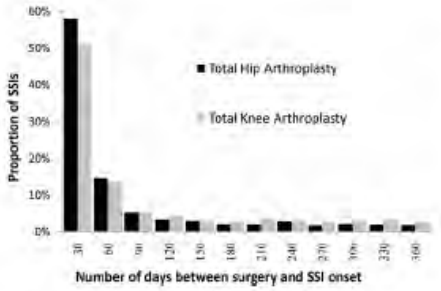


Figure 1. Distribution of the number of days between total hip or knee arthroplasty procedures and surgical site infection diagnosis during the 365 days following surgery. Abbreviation: SSI, surgical site infection.

Figure 2. Distribution of the proportion of surgical site infections detected at nonoperative hospitals during the 365 days following surgery. Abbreviation: SSI, surgical site infection.

Yokoe. CID 2013;34:1282-8.

Reporting the Results

- Make comparisons (external or internal) only when
  - surveillance intensity, collection methods, definitions and populations are the same or similar
- User-friendly
  - accurate and interpretable and short
  - use graphs whenever possible
- Stimulate performance improvement
  - give recommendations

Equations

- SSI rate

$$\text{SSI Rate} = \frac{\text{No. SSI in patients during specified time*}}{\text{No. operations during specified time}} \times 100$$

- For NHSN surveillance, the denominator needs to include the procedures with the International Classification of Diseases, Ninth Edition (ICD-9) procedure codes
- Various SSI rates
  - Service-specific incidence (i.e. neurosurgery)
  - Surgeon-specific incidence
  - Procedure-specific incidence (i.e. cholecystectomy)
  - Risk-specific incidence
- The surgeon-specific incidence and procedure-specific incidence more closely reflect the true SSI incidence

TABLE 3. Comparison of Surgical Site Infection (SSI) Rates in the Hospitals of the International Nosocomial Infection Control Consortium (INICC) and the US Centers for Disease Control and Prevention National Healthcare Safety Network (CDC-NHSN)

CODE	Procedure name	INICC 2005–2010, SSI rate, %	CDC-NHSN 2006–2008 SSI rate (pooled risk categories), %	RR	95% CI	*P*
AAA	Abdominal aortic aneurysm repair	7.7	3.2	2.41	0.33–17.40	.3668
AMP	Limb amputation	2.7	2.3	1.18	0.80–1.74	.4099
APPY	Appendix surgery	2.9	1.4	2.05	1.61–2.59	.0001
BILI	Bile duct, liver or pancreatic surgery	9.2	9.9	0.93	0.70–1.22	.5945
BRST	Breast surgery	1.7	2.3	0.77	0.55–1.06	.1111
CBGB	Coronary bypass with chest and donor incision	4.5	2.9	1.52	1.44–1.61	.0001
CARD	Cardiac surgery	5.6	1.3	4.32	3.81–4.88	.0001
CHOL	Gallbladder surgery	2.5	0.6	3.94	3.10–5.01	.0001
COLO	Colon surgery	9.4	5.6	1.69	1.52–1.87	.0001
CRAN	Craniotomy	4.4	2.6	1.69	1.46–1.96	.0001
CSEC	Cesarean section	0.7	1.8	0.39	0.34–0.43	.0001
FUSN	Spinal fusion	3.2	1.5	2.10	1.48–3.00	.0001
FX	Open reduction of fracture	4.2	1.7	2.44	2.02–2.93	.0001
GAST	Gastric surgery	5.5	2.3	2.41	1.82–3.19	.0001
HER	Herniorrhaphy	1.8	2.3	0.78	0.63–0.96	.0197
HPRO	Hip prosthesis	2.6	1.3	2.06	1.80–2.37	.0001
HYST	Abdominal hysterectomy	2.7	1.6	1.66	1.36–2.03	.0001
KPRO	Knee prosthesis	1.6	0.9	1.84	1.56–2.18	.0001
LAM	Laminectomy	1.7	1.0	1.67	1.33–2.09	.0001
NECK	Neck surgery	3.7	3.5	1.07	0.60–1.91	.8116
NEPH	Kidney surgery	3.1	1.5	2.12	1.07–4.18	.0267
PRST	Prostate surgery	2.1	1.2	1.82	0.97–3.43	.0598
PVBY	Peripheral vascular bypass surgery	2.5	6.7	0.37	0.28–0.49	.0001
REC	Rectal surgery	2.3	7.4	0.32	0.16–0.63	.0005
SB	Small bowel surgery	5.5	6.1	0.91	0.72–1.14	.3937
SPLE	Spleen surgery	5.6	2.3	2.39	0.93–6.10	.0606
THOR	Thoracic surgery	6.1	1.1	5.50	3.59–8.44	.0001
THYR	Thyroid and/or parathyroid surgery	0.3	0.3	1.27	0.13–12.19	.8366
VHYS	Vaginal hysterectomy	2.0	0.9	2.24	1.52–3.28	.0002
VSHN	Ventricular shunt	12.9	5.6	2.30	1.96–2.69	.0001
XLAP	Exploratory abdominal surgery	4.1	2.0	2.05	1.64–2.55	.0001
All		2.9	2.0	1.45	...	...

NOTE. CI, confidence interval; RR, relative risk.

Rosenthal et al ICHE 2013;43:597-604.

SIR

- SIR is a ratio of observed events divided by the number of expected events. SIR = O/E
- Similar to other standardized ratios such as the standardized mortality ratio (SMR).
- Expected values calculated from local, national or international benchmarks.
- The SIR "standardizes" values across units, procedures, hospitals, etc in order to compare performance.
- SIR provides not only direction of performance but also magnitude. It does not give your relation to "0".

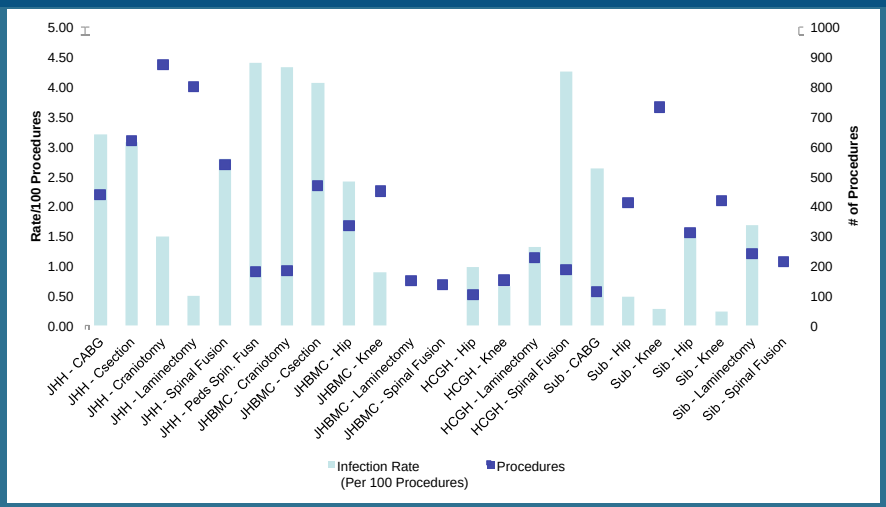
Basics: General SIR Interpretation

- SIR < 1 means performance was better than expected based on benchmark.
- SIR = 1 means performance was the same as expected based on benchmark.
- SIR > 1 means performance was worse than expected based on benchmark.

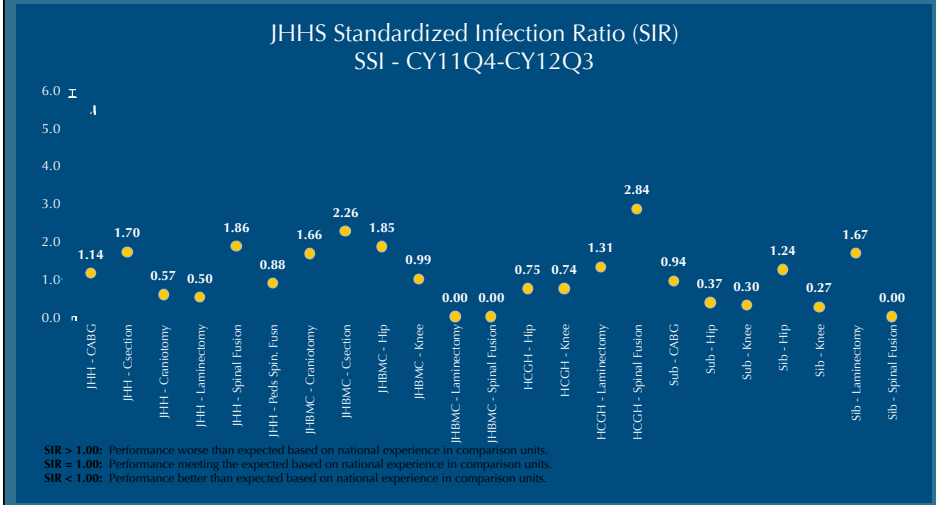
Basics: Significance

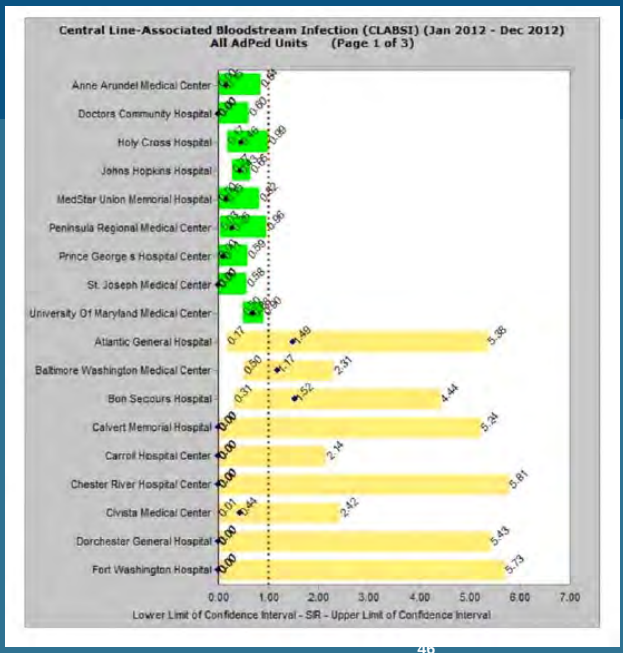
- SIR allows you to calculate statistical significance to see if your performance is "significantly" better or worse. Since SIR = 1 is rare, numbers close to one are often adjudicated using statistics to see if there was a more significant difference than expected.
- Obtained by confidence intervals or p-value.

Challenges in a HealthSystem



Challenges in a HealthSystem





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In Practice: JHM Mission Objectives Scoring

Stretch Target	Target	Threshold	Did Not Meet
SIR = < 0.75	SIR = 0.75 – 0.99	SIR = 1.00 – 1.25	SIR > 1.25
3 pts	2pts	1pt	0pts

JHM Scoring matches with scoring for other indicators (Core measures, Hand Hygiene, Patient Satisfaction, etc).

Conclusions

- Although methods of case-finding are hard to choose, the infection control team should focus on patients or procedures at high risk of infection, if their resources are limited
- Collecting data and calculating rates are useless if epidemiology and surgical staff do not use the data to prevent SSI
- Infection prevention and control personnel must collaborate closely with surgical teams and utilize available guidelines and recommendations to implement, monitor, and improve compliance with SSI prevention measures

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- As healthcare delivery shifts to the outpatient setting, numerous aspects of SSI surveillance must change, because many factors that influence the risk of SSI also will change
- Surveillance methods that worked well in the past and were supported by well-designed studies may no longer be efficacious