Epidemiology, Surveillance and an Introduction to the National Healthcare Safety Network (NHSN)

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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 and Surveillance:

A Deep Dive

Epidemiology

- Definition: Study of disease factors affecting populations
  - Epi = upon or around
  - Demos = people
  - Logos = study of

Clinical care: focus on the individual

vs

Epidemiology: focus on the group

CDC Principles of Epidemiology in Public Health Practice, Third Edition
(cdc.gov/csels/dsepd/ss1978/lesson1/section1.html)

Infection Prevention and Healthcare Epidemiology

- Epidemiologic research and surveillance underlie HAI prevention
  - Use data for action!
- Healthcare epidemiology answers questions such as:
  - What factors contribute to increased infection rates?
  - What populations are at higher risk for developing HAI?
  - How have HAI changed over time?

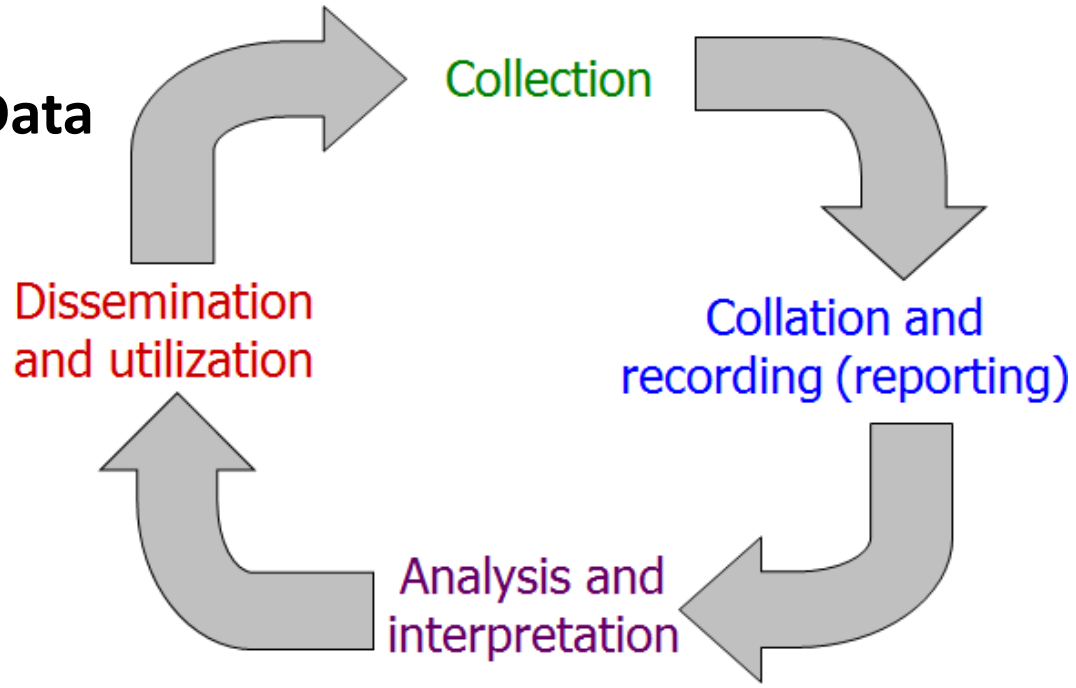
Goal is HAI prevention

Surveillance

Sur = over Veille = watch or watching watching over

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

Process and Outcome Measures

- **Process measure**: how many urinary catheters on med/surg unit B
- **Outcome measure**: UTI rate for med/surg unit B

- By the *process* of eliminating unnecessary urinary catheters, the *outcome* was a reduction in CAUTIs for med/surg unit B

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

"…align criteria and definitions and decrease subjectivity while maintaining epidemiologic standardization and clinical relevance."

(NHSN Patient Safety Module, Chapter 2, January 2022)

Collect Surveillance Data

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

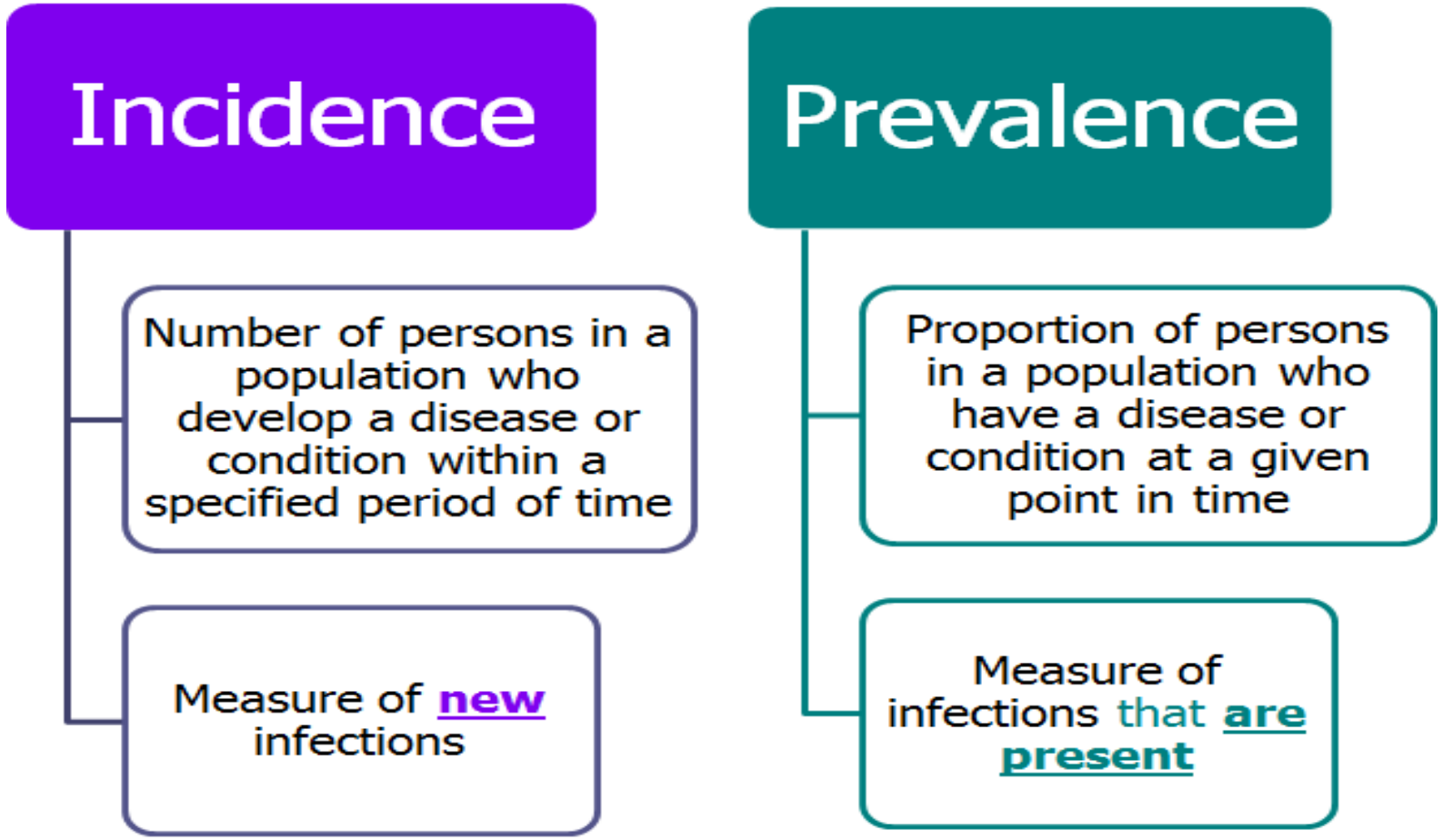
Numerator Data

- 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: 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 days
  - Patient visits

Measuring Infections



Prospective Surveillance

- Initiated when patient is still under 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
- Administrative (billing, coding) data alone **cannot accurately identify HAI**
  - May be useful for identifying **possible HAI**

Laboratory-based surveillance

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

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:

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

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

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

Risk Adjustment and Risk Factor Data

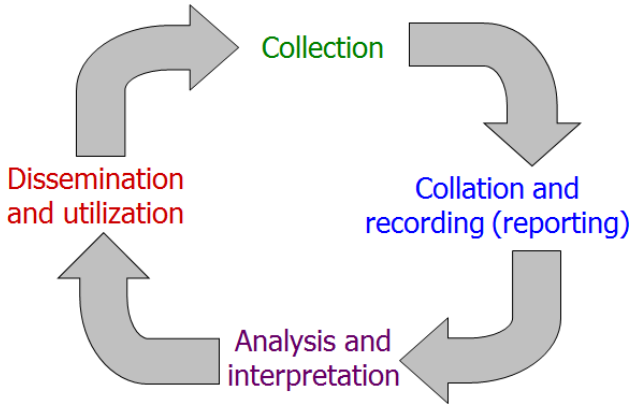
- Factors that increase a patient's risk for HAI include:
  - Patient characteristics and co-morbidities
  - Facility characteristics
    - Level I trauma
    - Level III NICU
    - Critical access hospital
  - Unit / ward type
    - Med/surg
    - Telemetry
    - ICU
  - Community disease prevalence
  - Invasive device use and duration
    - Central lines
    - Indwelling urinary catheters
    - Ventilator use
  - Surgical procedure types, duration, approach
    - Use of robotics
    - Use of laparoscope versus open procedure

Data collection includes risk factor data necessary for risk adjustment

Standardized Infection Ratio (SIR)

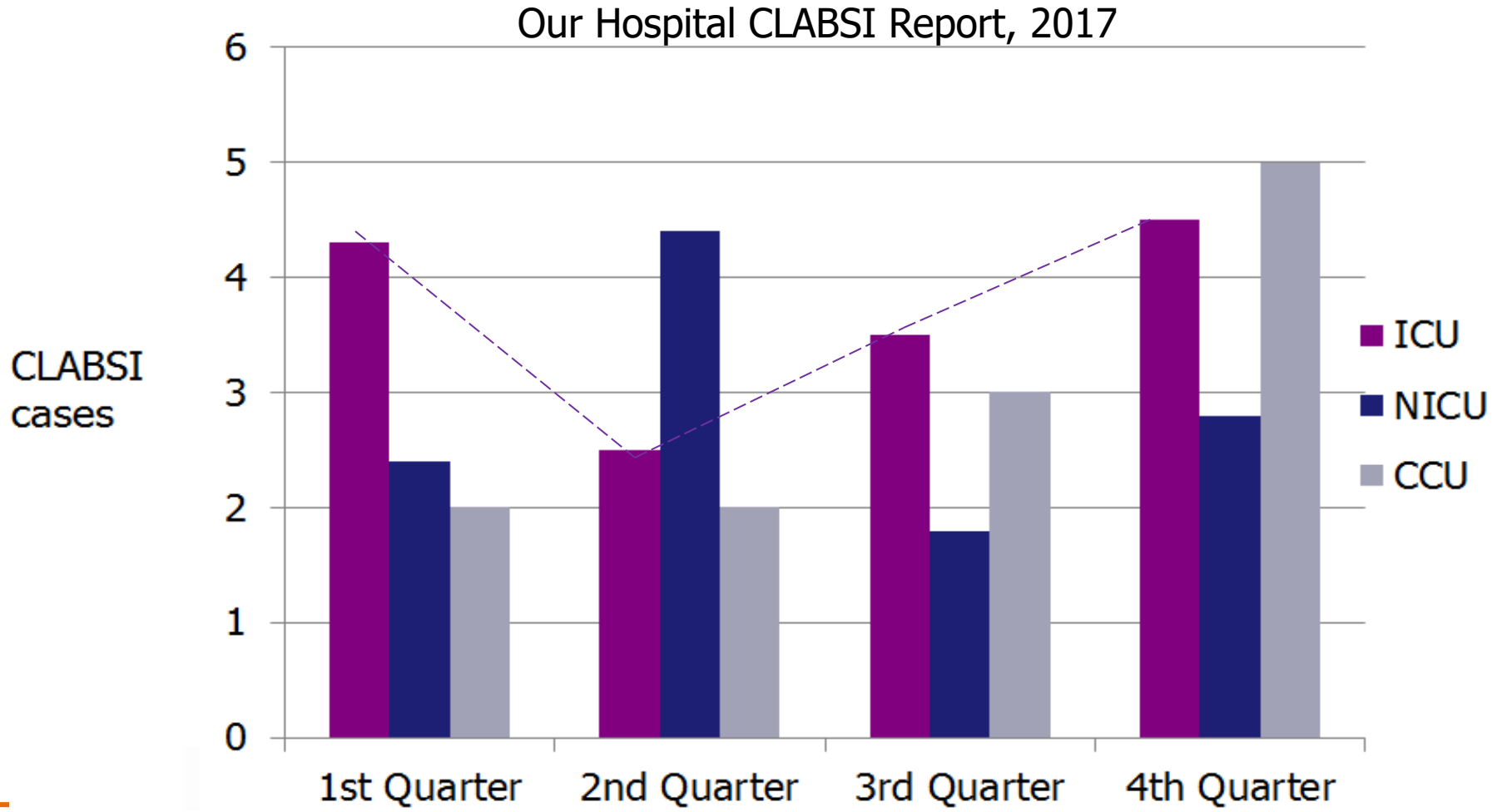
- Summary measure used to track HAI incidence
- Allows for tracking over time
- Compares the actual number of HAI reported to what would be predicted using 2015 baseline data
- Adjusted for risk factors significantly associated with HAI

Analysis and Interpretation

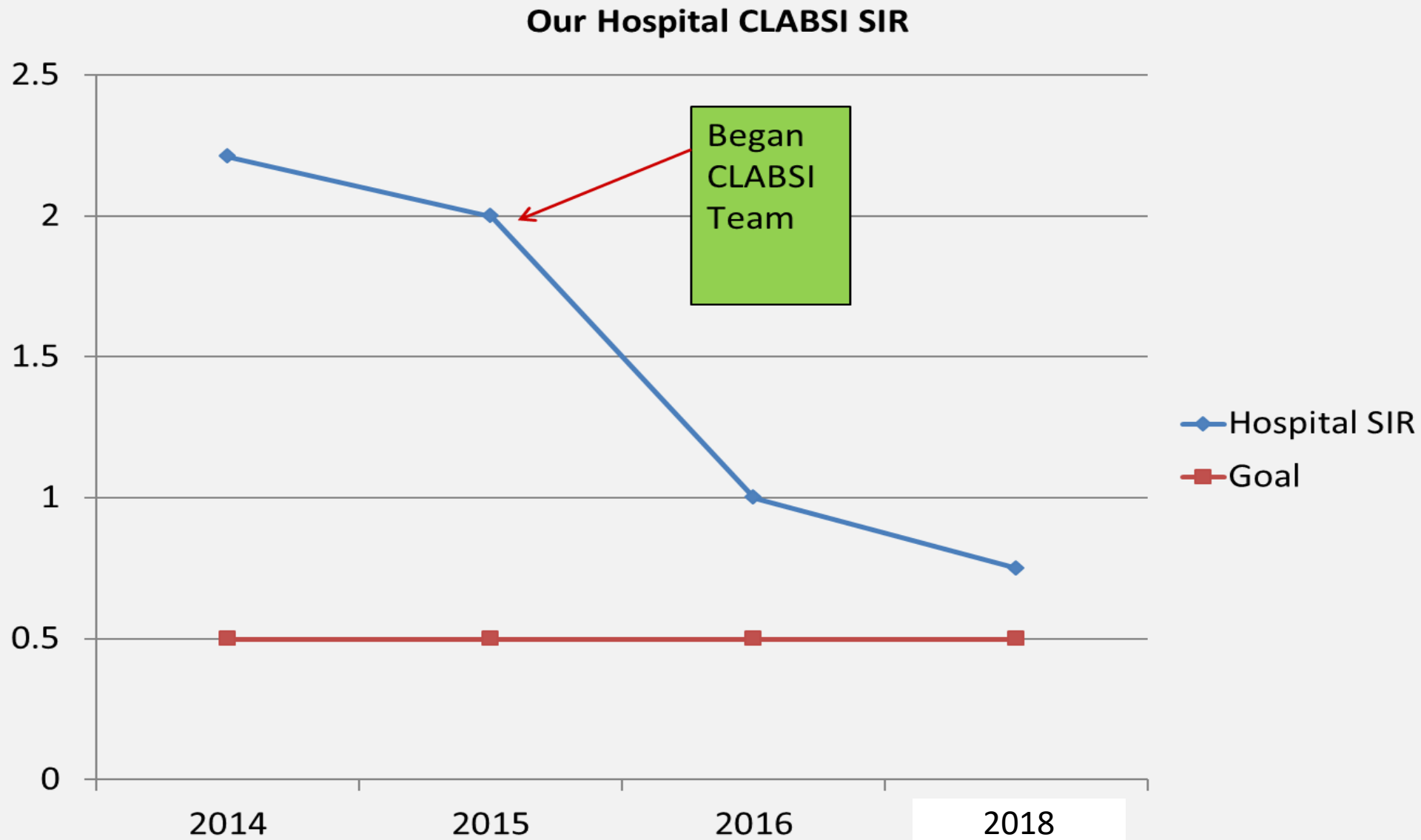


- What story did the data tell you?
  - Are things better?
    - Did the changes made make the difference in the results, or was there other things going on (called 'noise' or variables)
  - Are things worse?
    - Did the changes make things worse, or was there a failure to make the changes?
      - If so, why?

Sample Bar Charts

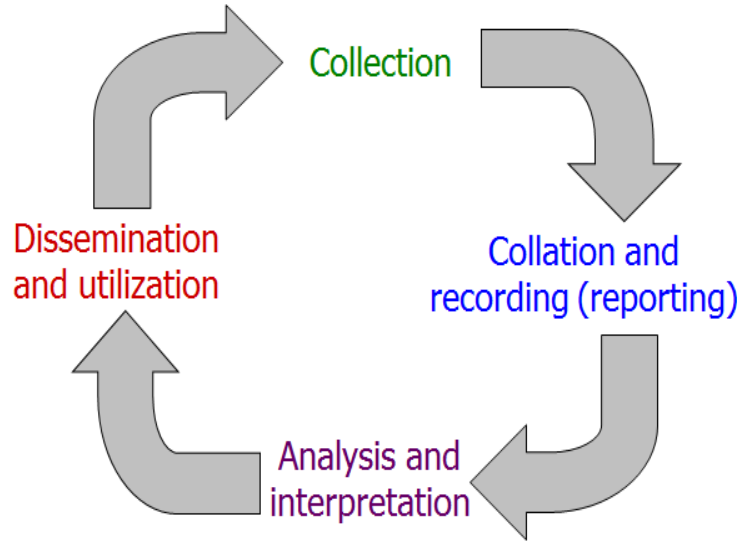


Sample Line Graphs and Histograms - 3



Report and Use Surveillance Data

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



Professional societies

- Association for Professionals in Infection Control and Epidemiology (APIC)
- Society for Healthcare Epidemiology of America (SHEA)
- Infectious Diseases Society of America (IDSA)

  – Guidance documents for definitions, white papers, and evidence-based protocols

Summary

"Infection surveillance, once the primary task of infection preventionists (IPs), has transitioned over time to assume a more limited place in a massively expanded scope of IP responsibilities. Infection surveillance data is used to measure success of infection prevention and control programs, to identify areas for improvement, and to meet public reporting mandates and pay for performance goals."

– Sue Barnes, 2017, Infection Control Today

Introduction to the National Healthcare Safety Network (NHSN)

Objectives

- Review mandatory HAI surveillance and reporting requirements
- Describe National Healthcare Safety Network (NHSN) and key terms
- Demonstrate how to use NHSN
- Review how to interpret NHSN reports

National Healthcare Safety Network

- Centers for Disease Control and Prevention (CDC) surveillance system for HAI reporting from hospitals, long term care facilities, outpatient settings, inpatient rehabilitation, inpatient psychiatric, and hemodialysis facilities
  - Provides standardization
  - Data used for HAI public reporting and pay for performance programs
- **Required by CDPH for facilities to report required HAI data**
- Accessed through a secure, web-based interface; open to all U.S. healthcare facilities at no charge

Figure 1: NHSN Components

https://www.cdc.gov/nhsn/pdfs/pscmanual/pcsmanual_current.pdf

California HAI Reporting Requirements for Hospitals

Report data monthly per NHSN protocol

CDPH reporting deadline: 30 days after end of each quarter

- Central line associated bloodstream infections **(CLABSI)**
- MRSA bloodstream infections **(MRSA BSI)**
- VRE bloodstream infections (**VRE BSI)**
- *C. difficile* infections (**CDI)**
- Surgical site infections for 28 procedures **(SSI)**
- Influenza vaccination of healthcare practitioners (HCP)

x Central Line Insertion Practices (CLIP) and preoperative antimicrobial administration reporting are **no longer required**

AFL 21-18:GACH Reporting Requirements of HAI I CDPH
(cdph.ca.gov/Programs/CHCQ/LCP/Pages/AFL-21-18.aspx)

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Additional HAI Reporting Requirements for Facilities Participating in CMS Quality Improvement Programs

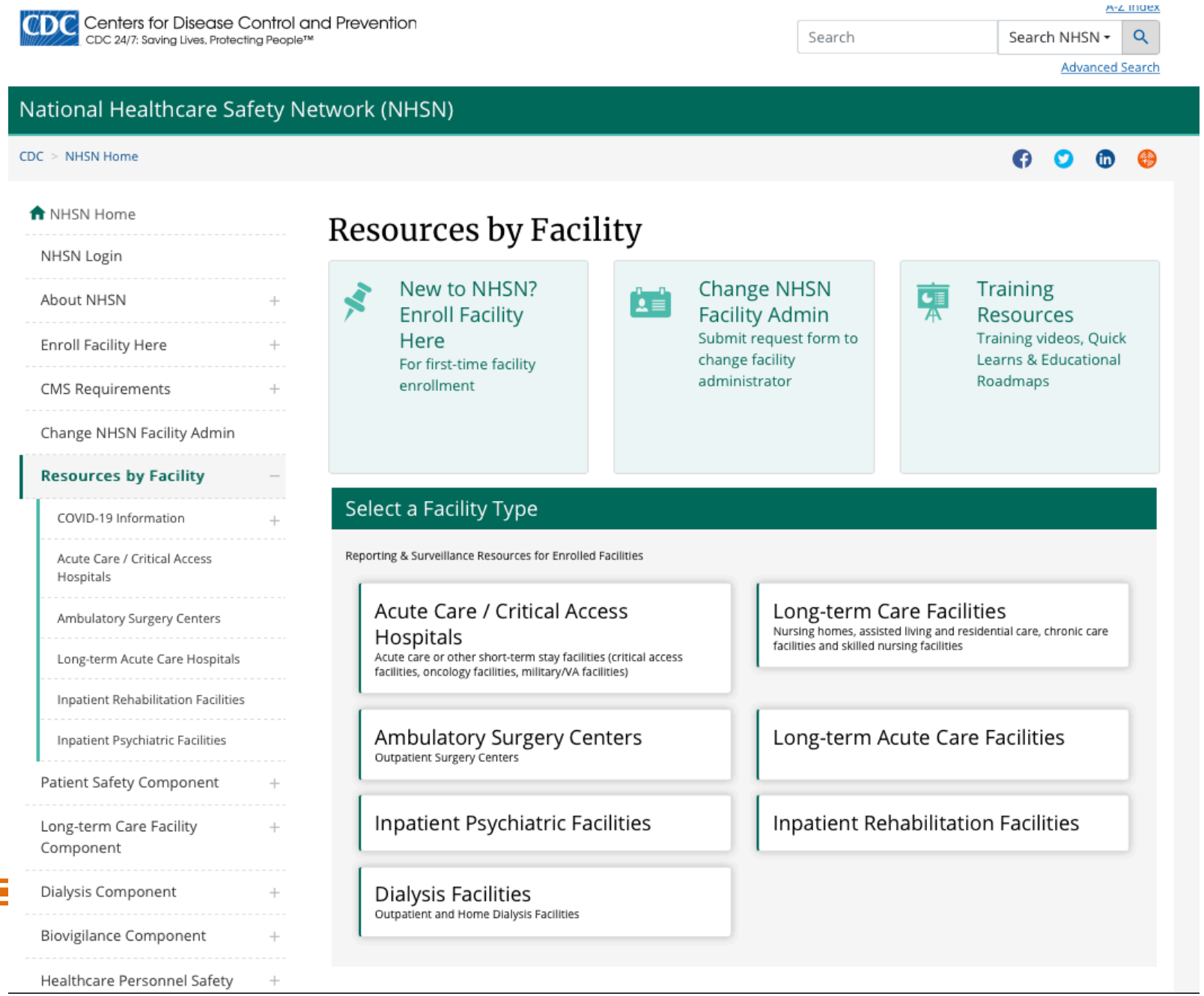
- Catheter-associated urinary tract infections (CAUTI)
- Ventilator-associated events (VAE) - **LTAC hospitals only**

Healthcare Facility HAI Reporting Requirements to CMS via NHSN (PDF)
(https://www.cdc.gov/nhsn/PDFs/CMS/CMS-Reporting-Requirements.pdf)

NHSN Protocol Updates

- **NHSN Nurse Staffing Hours Indicator for ACH (optional)**
  - Critical care units only
  - Staffing hours worked for RN, LPN/LVN, and UAP
  - Assess nursing staffing trends and correlation to patient safety
- **Hospital Respiratory Data required by 11/1/2024 (CMS):** Hospital Respiratory Data | NHSN | CDC
  - COVID-19, Influenza, RSV
- **2022 HAI Rebaseline**
  - HAI and device utilization incidence data to be compared to 2022 NHSN data as the newest baseline year
  - These 2022 NHSN incidence data serve as the national source used to build models, estimate predicted events, and calculate NHSN's SIRs and SURs

What is Rebaselining and Why is it Important? (cdc.gov)



https://www.cdc.gov/NHSN

Surveillance protocols, forms, analysis resources, FAQ, training, CMS requirements, newsletters

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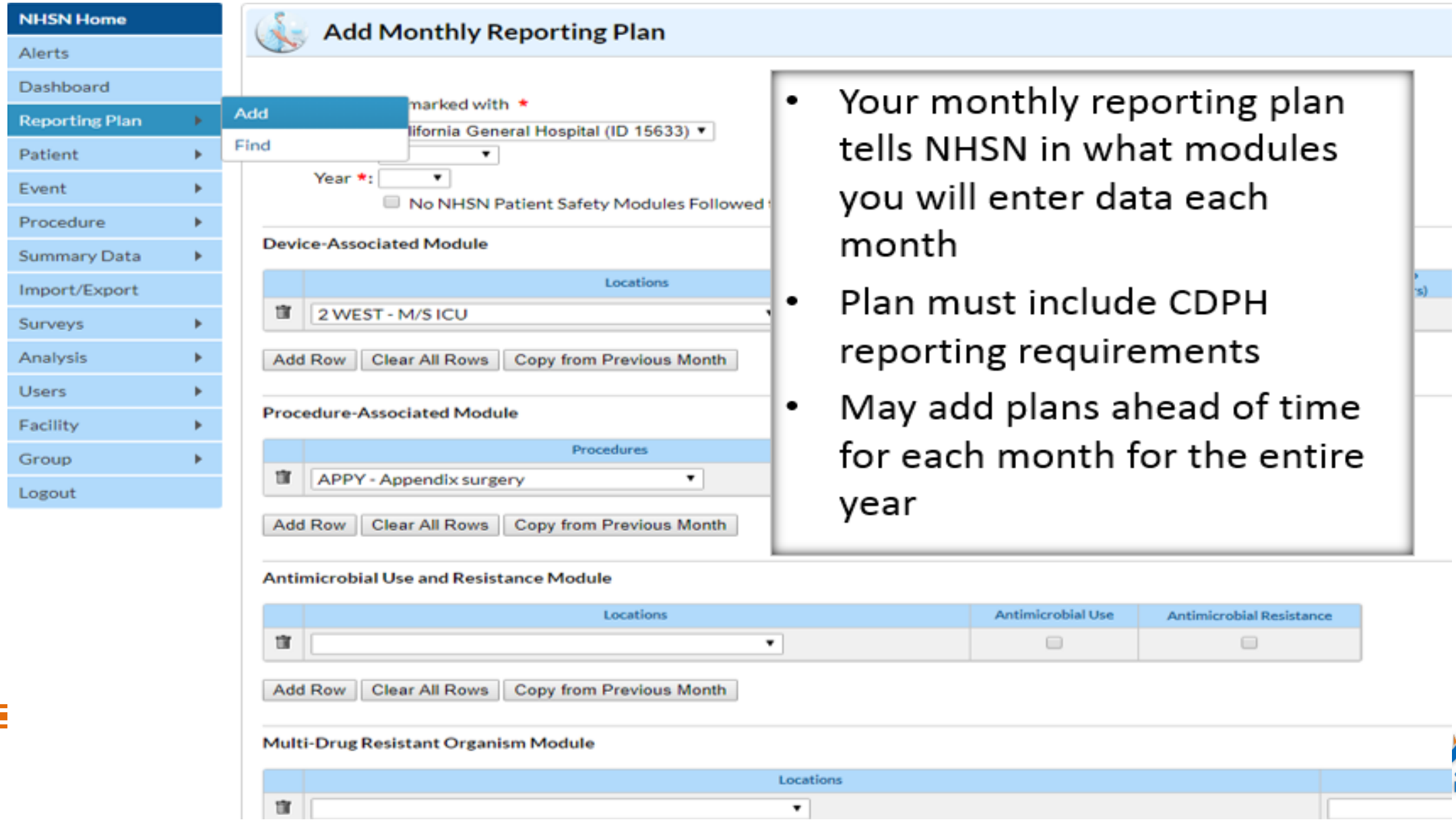
Map NHSN Locations

- Each NHSN patient care area is defined by the type of patients receiving care in that location
- Define (or redefine) a patient care location:
  - Step 1: Determine the acuity level (e.g., critical care, ward)
  - Step 2: Determine the type of service (e.g., burn, surgical, cardiac)
- Hospital designates each location type
- Important to review location mapping **yearly** to ensure correct risk adjustments applied for each location

NHSN Patient Safety Manual: Chapter 15

Monthly Reporting Plan



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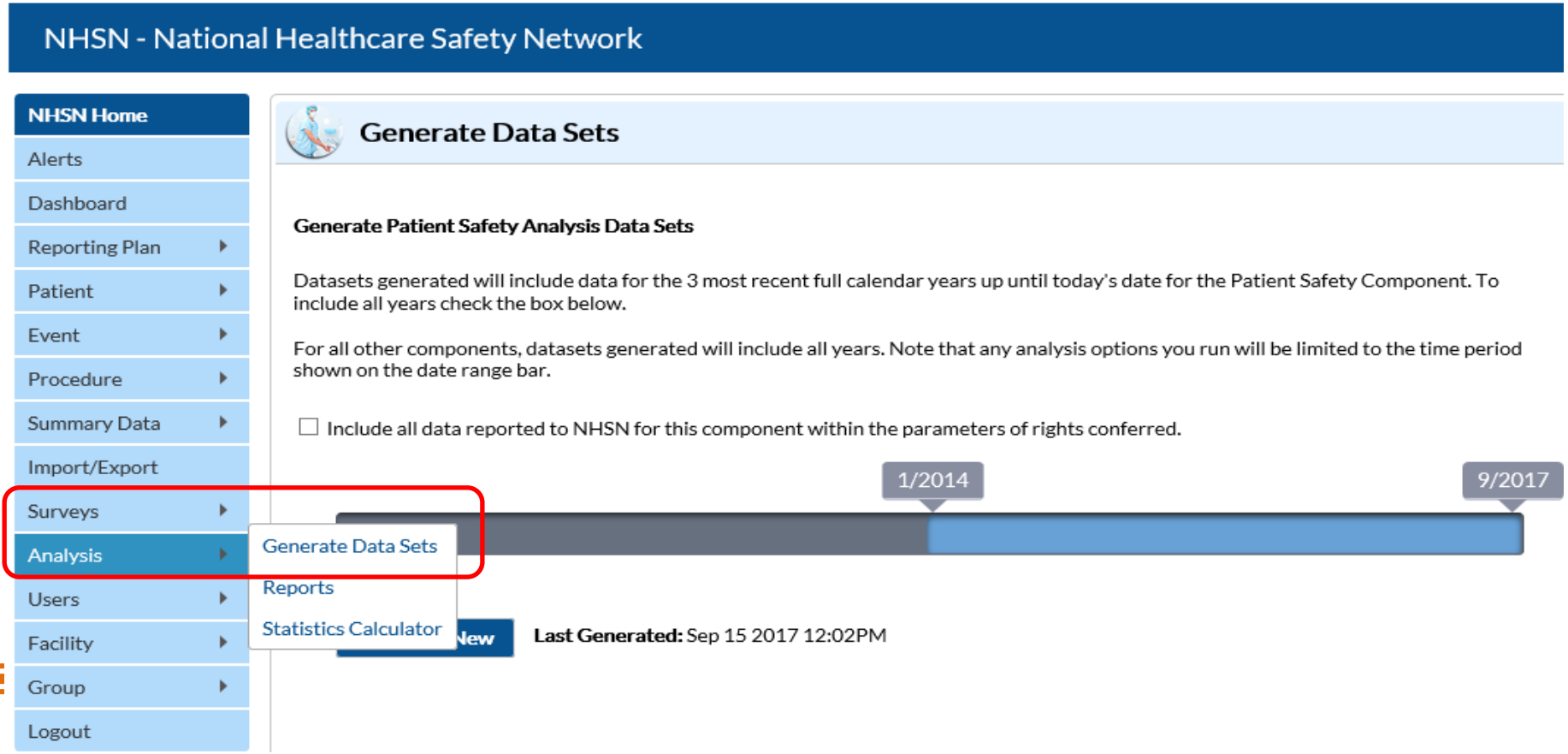
Alerts and Resolving Alerts

- Automatic checks
- Alerts must be cleared before analysis
- If applicable, check the Report No Events box
- Events or no events must be entered if uni is included in reporting plan

Use Your NHSN Data

- Generate data sets
- Data sets are specific to each NHSN user



NHSN Analysis Options and Reports

- Analysis Reports are available only if you generate a data set
- Multiple report options available

Sample Rate Table

- Review your rate tables routinely to verify that infections and denominator data are reported each month

National Healthcare Safety Network
Rate Table for Central Line-Associated BSI Data for ICU-Ot
As of: September 23, 2017 at 6:20 PM
Date Range: BS2_CLAB_RATESICU summaryYM 2016M01 to 2016M12

loccdc=IN:ACUTE:CC:CT CCN= 99999 facType=HO

location	summaryYM	CLABCount	numCLDays	CLABRate	numPatDays
CCU	2016M01	0	187	0.000	410
CCU	2016M02	1	226	4.425	392
CCU	2016M03	0	242	0.000	383
CCU	2016M04	0	165	0.000	388
CCU	2016M05	0	217	0.000	341
CCU	2016M06	1	197	5.076	353
CCU	2016M07	0	207	0.000	386
CCU	2016M08	0	164	0.000	289
CCU	2016M09	0	180	0.000	342
CCU	2016M10	0	176	0.000	356
CCU	2016M11	0	53	0.000	469
CCU	2016M12	0	197	0.000	398

NHSN Standardized Infection Ratio (SIR)

- Used by NHSN to report infection incidence
  - SIR instead of infection rate
- Driven by need for a single summary measure of infection incidence that adjusts for differences in infection risk
- SIR compares the number of HAI reported by your hospital with a predicted number of HAI calculated by NHSN

NHSN Risk Adjustment

NHSN applies risk adjustment to determine the predicted number of HAI for your hospital based on 2015 referent data

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

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.

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

What is *p* Value?

As far as the SIR goes…

The **p-value** is a statistical measure that tells us whether the number of observed infections is statistically significantly different than the number of predicted infections (i.e., whether the SIR is significantly different from 1.0).

If the **p-value ≤ 0.05**, we can conclude that the number of observed infections is statistically significantly different than the number of predicted infections.

If the **p-value > 0.05**, we conclude that the number of observed infections is **not** statistically significantly different than the number of predicted infections.

What is *Confidence Interval*?

And how about that 95% Confidence Interval (CI)?

The 95% CI is a statistical range of values for which we have a high degree of confidence that the true SIR lies within that range.

If the **CI does not include 1**, then the SIR is significantly different than 1.0 (i.e., the number of observed infections is significantly different than the number predicted).
Example: 95% CI= (0.85, 0.92)

If the **CI includes the value of 1**, then the SIR is **not** significantly different than 1.0 (i.e., the number of observed infections is not significantly different than the number predicted).
Example: 95% CI= (0.85, 1.24)

If the **SIR is 0.000** (i.e., the infection count is 0 and the number of predicted infections is ≥ 1.0), the lower bound of the 95% CI will **not** be calculated.

SIR Interpretation

Summary Yr	Infection Count	Number Expected	Central Line Days	SIR	SIR p-value	95% Confidence Interval
2016	9	7.191	3786	1.25	0.2962	0.653, 2.184

1. 9 HAI CLABSI in 2016, only 7.2 were expected. The SIR is 1.25 or 25% higher than what would be predicted from national data
2. The difference is not significantly different than **that predicted by** the national hospital data because our estimate is not very precise
3. The SIR varies from 35% below to more than double the predicted value (.65 – 2.2)
4. Continue to monitor CLABSI rates over time. More data will help us better understand how we compare to other similar hospitals

SIR Interpretation - 2

Summary Yr/Half	InfCount	Number Expected	Central Line Days	SIR	SIR p-value	95% Confidence Interval
2016H1	74	26.606	10065	2.78	0.0000	2.184, 3.492

This report indicates the following:

1. 74 HAI CLABSI per 10,065 line days, 26.6 were predicted
2. The SIR is 2.78, nearly 3 times higher than what would be predicted
3. The precision of this estimate shows that the hospital is between 2 and 3 ½ times higher than predicted (C.I. 2.2 – 3.5)
4. This facility needs to implement a CLABSI prevention program immediately

Sample Standardized Infection Ratio (SIR) Table for One Year – by Location

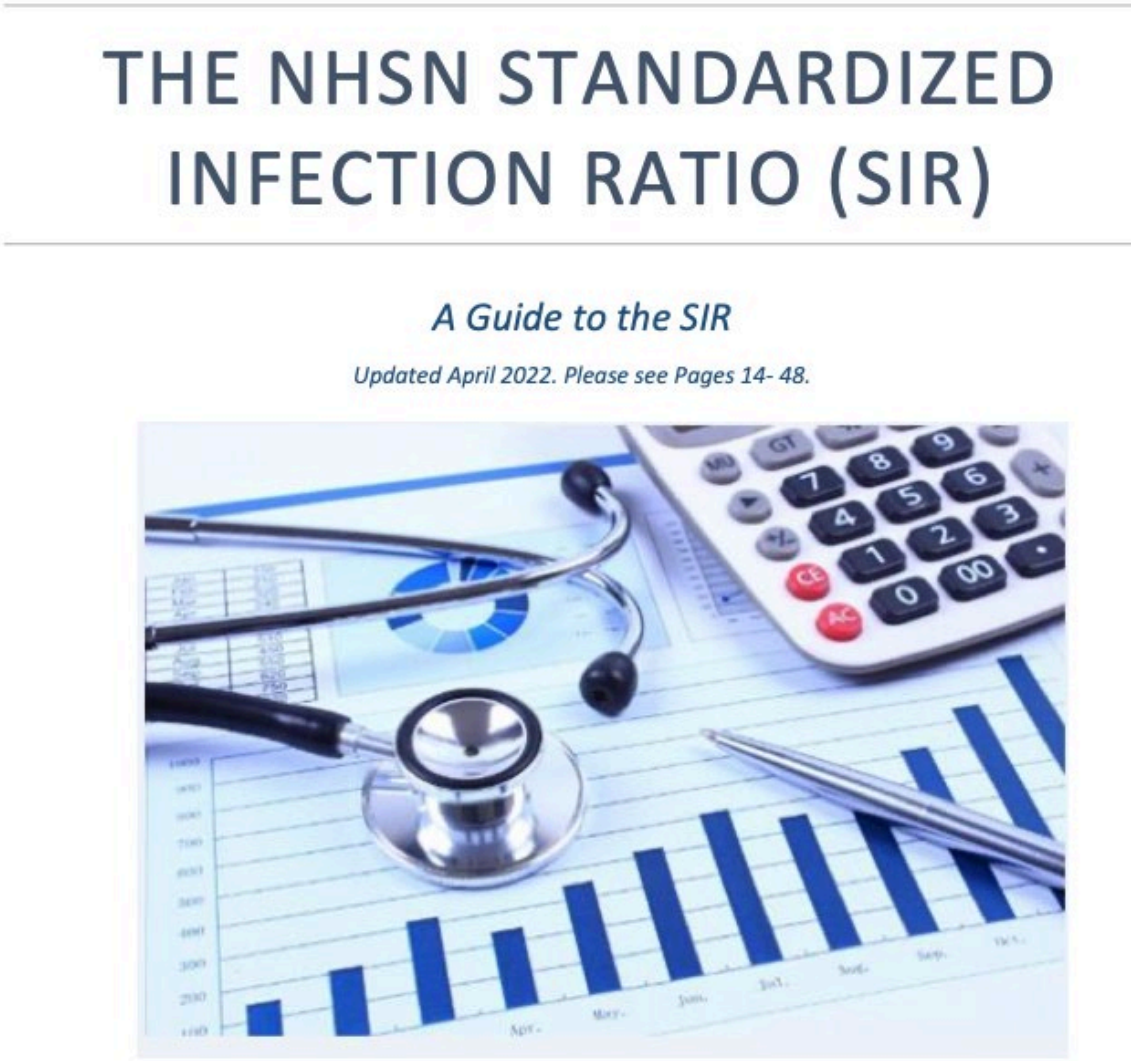
Shows each location's predicted number of CLABSI

Shows each locations SIR and p-value indicating if the SIR is significantly lower or higher than predicted

location	summaryYr	months	infcount	numPred	numcldays	SIR	SIR_pval	SIR95CI
4 M/S	2016	12	1	2.862	3288	0.349	0.2778	0.017, 1.723
5 MED	2016	12	3	4.237	4867	0.708	0.5940	0.180, 1.927
6E ONC	2016	12	5	4.406	4158	1.135	0.7309	0.416, 2.516
6S 6W	2016	12	1	2.330	2676	0.429	0.4214	0.021, 2.117
CCU	2016	12	2	2.227	2211	0.898	0.9634	0.151, 2.967
CMU NEW	2016	12	1	1.905	2188	0.525	0.5813	0.026, 2.589
ICCU	2016	12	2	1.333	1477	1.501	0.5352	0.252, 4.958
ICU	2016	12	11	4.463	4430	2.465	0.0085	1.296, 4.284

NHSN: A Guide to the SIR

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



cdc.gov/nhsn/pdfs/ps-analysis-resources/nhsn-sir-guide.pdf

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Standardized Utilization Ratio (SUR)

National Healthcare Safety Network

SUR for Central Line Device Use for Acute Care Hospitals (2015 baseline) - By OrgID

As of: July 8, 2021 at 10:51 AM

Date Range: All B 82_CLAB_RATE BALL

orgID=10018 medType=G

orgID	ccn	summaryYH	numCLDays	numPatDays	numPredDDays	SUR	SUR_pval	SUR95CI	SUR_pctl
10018	66666	2019H1	2974	3530	776.379	3.831	0.0000	3.696, 3.970	100
10018	66666	2019H2	961	1529	284.308	3.380	0.0000	3.172, 3.599	100

1. This report includes central line utilization data from acute care hospitals for 2015 and forward.
2. The SUR is only calculated if number of predicted device days (numPredDDays) is >= 1. Lower bound of 95% Confidence Interval only calculated when number of observed device days > 0.
3. The predicted device utilization days is calculated based on national aggregate NHSN data from 2015. It is risk adjusted for CDC location, hospital beds, medical school affiliation type, and facility type.

The number of central line days/the number of predicted central line days = SUR*

*Calculated SUR is also available for CAUTI surveillance

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THE NHSN STANDARDIZED UTILIZATION RATIO (SUR)

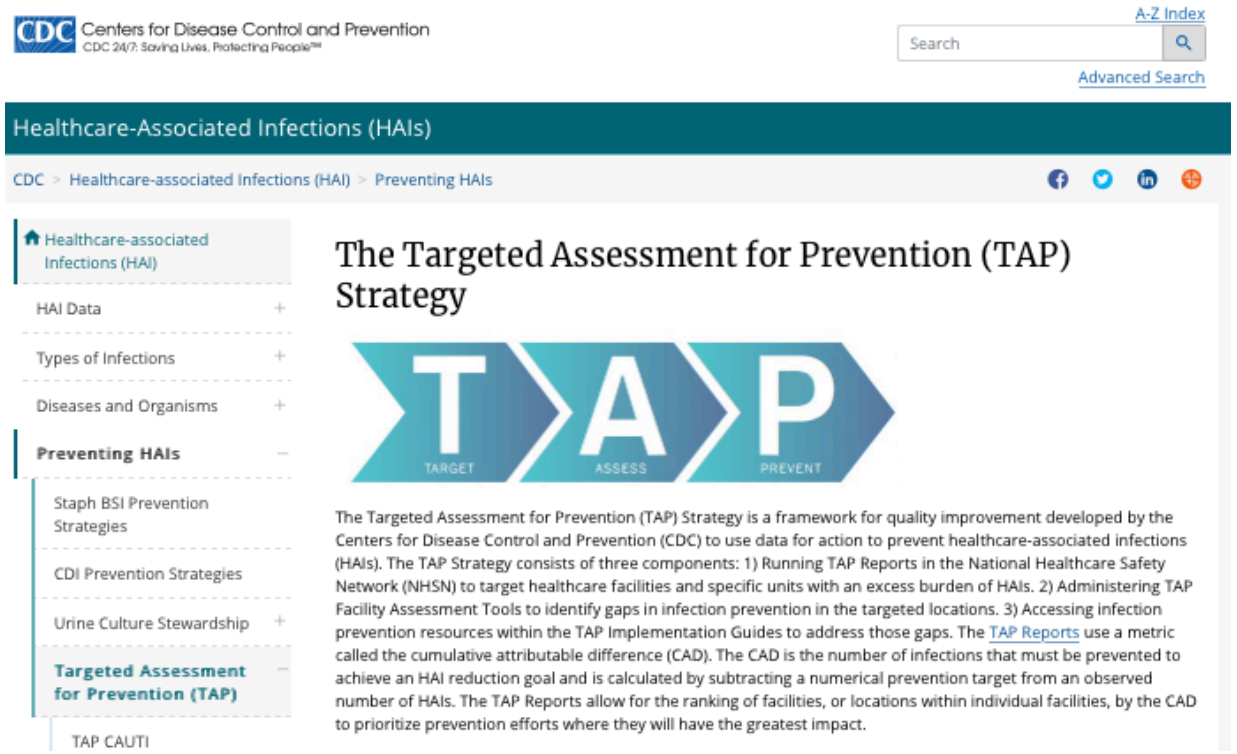
A Guide to the SUR

Updated April 2022

[CDC NHSN Standardized Utilization Ration (SUR) Guide](cdc.gov/nhsn/pdfs/ps-analysis-resources/nhsn-sur-guide-508.pdf) (PDF)
cdc.gov/nhsn/pdfs/ps-analysis-resources/nhsn-sur-guide-508.pdf

Targeted Assessment for Prevention (TAP) Reports

- **Available for CDI, CLABSI, CAUTI**
- Identifies **number of infections that need to be prevented** to reach targeted goal
  - Called the cumulative attributable difference (CAD) in NHSN
  - Lists results by location for CLABSI and CAUTI
- Assists in deciding where to focus infection prevention efforts



cdc.gov/hai/prevent/tap.html

Using the Cumulative Attributable Difference (CDA) to Explain Rates

- Eliminates statistical terms when explaining results
- "If our medical ICU had eliminated _(#) CLABSIs, we would have met our goal"
- In this example, eliminating 23 C. difficile HAI cases out of 61 would have met the facility goal

Number of Beds	Patient Days	COHCFA Prevalence	CDIF Facility Incident HO LabID Event Count	CDIF Facility Incident HO LabID Number Expected	Facility CAD	SIR
354	60059	0.14	61	55.034	22.48	1.108

NHSN Help

- Use NHSN website www.cdc.gov/nhsn
- Email NHSN questions to nhsn@cdc.gov

- For technical questions about CDPH NHSN requirements, email HAI_Data@cdph.ca.gov

Summary

- NHSN is a surveillance system used for recording data which meets the regulatory reporting requirements for CDPH and CMS
- NHSN has many analysis features to assist users in interpreting and presenting their data
- Resources are available for interpretation and analysis of NHSN data from:
  - CDC (cdc.gov/nhsn)
  - CDPH (cdph.ca.gov/HAI)

Questions?

For more information,

please contact

HAIProgram@cdph.ca.gov