Display of hospital-acquired infection data on intranet dashboard of major healthcare organization for continuous process improvement

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Presenter Disclosure

Rosemarie P. Linton, MPH

The following personal financial relationships with commercial interests relevant to this presentation existed during the past 12 months:

No relationships to disclose

Objectives

1. Define types of **infection prevention data** collected in National Healthcare Safety Network (NHSN)
2. Describe multi-hospital healthcare organization's **intranet dashboard** for display of infection outcome measures
3. Explain **statistical process control** charting methods including common cause variation and special cause variation

Infection Prevention Data collected in National Healthcare Safety Network (NHSN)

Infection Prevention Initiative

In 2012, the **Krasnoff Quality Management Institute** a division of **Northwell Health**, formerly North Shore-LIJ Health System, began displaying Hospital Acquired Infection measures from the National Healthcare Safety Network (NHSN) on an intranet dashboard, the Quality and Safety Vector of Measures.

Goal of Initiative:

- To promote transparency across health organization facilities
- To display readily accessible data monthly to
  - assess current processes,
  - identify areas for improvement, and
  - drive collaborative initiatives at both the facility and system level
- To present data at system, facility and service line Performance Improvement Coordinating Group (PICG)
- To promote best prevention strategies throughout Northwell

Northwell Health

- Largest health care provider in New York State
- Over 250,000 inpatient discharges a year
- 62,000 employees, more than 13,600 physicians and more than 15,000 RNs
- Service area of over 7 million people in Long Island, Queens, Staten Island, Manhattan and Westchester County
  - In 2016 - 14 hospitals: 5 tertiary / 9 community
- **Mission** is to improve the health and quality of life of patients by providing world-class service and patient/customer-centric care
- **Goal** is to be better tomorrow than we are today

Krasnoff Quality Management Institute supports **Northwell Health** by offering **innovative solutions** for ***defining***, ***developing*** and ***collecting*** **quality data** in order to enhance clinical care and organizational management.

Krasnoff transforms health care data into meaningful information in order **to improve hospital performance.**

National Healthcare Safety Network

The CDC's (Centers for Disease Control and Prevention) National Healthcare Safety Network (NHSN) is the most widely used healthcare-associated infection tracking system in the United States.

NHSN provides healthcare facilities and healthcare organizations with infection data needed to:

- identify areas of concern,
- measure the progress of infection prevention efforts,
- ultimately eliminate healthcare-associated infections (HAIs).

NHSN also provides data nationally, to states and regions.

National Healthcare Safety Network

Statewide Reporting	New York State Department of Health Hospital Acquired Infection Report
Federal Reporting	Centers for Medicare and Medicaid Services (CMS) Star Ratings
	CMS Value-Based Purchasing
	CMS Hospital-Acquired Conditions

CMS Hospital-Acquired Infection Measures

VBP SIR Thresholds FY 2019	CMS HAC FY 2019	CMS Star Ratings
25 % of VBP Score	85% of HAC Score	22 % of Star Rating
CLABSI SIR ≤ 0.860	CLABSI SIR	CLABSI SIR
CAUTI SIR ≤ 0.822	CAUTI SIR	CAUTI SIR
MRSA SIR ≤ 0.854	MRSA SIR	MRSA SIR
CDIFF SIR ≤ 0.924	CDIFF SIR	CDIFF SIR
Colon SSI SIR ≤ 0.783	Colon SSI SIR	Colon SSI SIR
Abdominal Hyst SSI SIR≤ 0.762	Abdominal Hyst SSI SIR	Abdominal Hyst SSI SIR
If SIR above threshold, receive 0 achievement points. Combined with AHRQ PSI 90 and PC-01 to make up Safety Domain. Calendar year 2017.	January 1, 2016-December 31, 2017 Performance Period.	Combined with AHRQ PSI 90 composite and complication following Hip/Knee Arthroplasty to make up Safety of Care Domain. Calendar year 2016.

Process of Collecting NHSN Data

Download from NHSN
- Rate Tables
- SIR, SUR, SAAR files

Upload into Oracle
- Data Staging Tables
- Processing Database

Run queries using SAP Dashboard 4.0 (Xcelsius)
- Defining landscape of dashboard

Process of Collecting NHSN Data Upload into Oracle

STAGE 1 :DATA LOADING STAGE

The data available for Northwell Health is processed through several stages.

1. **Data Auditing and Verification**: includes parsing and submission achieved through processing data through Java program. Algorithm not only verifies the accuracy of the data but also checks for outlier cases.

2. **Data Parsing with Indicator Definition**: In this step program parses data according to the definition of the Infection Prevention indicators. Indicators are calculated by numerator and denominator statements and also verified for accuracy.

3. **Data Submission in Database**: Final step is submission of database in our Oracle database which is used for further processing of data.

Process of Collecting NHSN Data Upload into Oracle

STAGE 2 : PROCESSING DATABASE

Once the data is loaded in the oracle database. First step is to merge data from disparate tables (example CDIFF, SSI, MRSA, ECOLI, etc.).

Merging process includes summing numerators and denominators by a predefined time period (quarterly or monthly) and unit type where applicable.

There are appropriate procedures written in database that handles the post-processing of the data which are source for reports used by Crystal Reports and dashboard reporting.

Infection Prevention data collected in NHSN

Types of Hospital-Acquired Infections

- Catheter Associated Urinary Tract Infections (CAUTI)
- Central Line-Associated Bloodstream Infections (CLABSI)
- Ventilator Associated Events (VAE)
- Methicillin-resistant Staphyloccus aureus Bacteremia (MRSA)
- Clostridium difficile Laboratory events (CDIFF)
- Carbapenem-resistant Escherichia coli (E.Coli)
- Carbapenem-resistant Klebsiella species (Klebsiella)
- Carbapenem-resistant Enterobacteriaceae (Enterobacter)
- Surgical Site Infections (SSIs)

Infection Prevention data collected in NHSN

Calculation of Device Index

$$\frac{\text{Infection Count}}{\text{\# of Device Days}} \times 1{,}000$$

20 indices

Calculation of MDRO* Index

*Multidrug-resistant organism

$$\frac{\text{Infection Count}}{\text{Patient Care Days}} \times 1{,}000$$

4 indices

Calculation of SSI Rates

$$\frac{\text{Infection Count}}{\text{Total \# Patients Underwent Procedure}} \times 100$$

12 SSI Rates

Calculation of Device Utilization

$$\frac{\text{Device Days}}{\text{Patient Care Days}} \times 100$$

8 device utilization indicators

Infection Prevention data collected in NHSN

Calculation of a SIR

$$\frac{\text{Observed Infection Count}}{\text{Predicted Infection Count}}$$

36 SIRs

Calculation of a SUR

$$\frac{\text{Device Days}}{\text{Predicted Device Days}}$$

9 SURs

Calculation of a SAAR

$$\frac{\text{\# of Days on Antimicrobials}}{\text{Predicted Days on Antimicrobials}}$$

10 SAARs

Statistical Process Control Charting Methods

Statistical Process Charting

Control Chart

- Line graph plotted in time order with mean line, and upper and lower limits that define statistical control.
- A quality tool developed in 1920s by William Shewhart to monitor variation from standards in industry.
- Help professionals monitor when process is out of control and variation from acceptable norms
- Once norm established, can be used to monitor excessive or unacceptable deviation from defined standard of care

Run Chart

- Line graph that displays data values in time sequential order.
- Can be useful for identifying special cause variation by examining shifts, trends, runs and astronomical points.

Statistical Process Control Charting

Special Cause Variation

A non-random event leading to unexpected change in process output

Rule 1: A single data point beyond the 3SD upper or lower control limit

Rule 2: A run of 8 points above or below the mean

Rule 3: 2 out of 3 consecutive points beyond the 2SD upper or lower warning limit

Rule 4: a run of 6+ points ascending or descending

Statistical Process Control Charting

Common Cause Variation

Natural or expected variation in process. Fluctuation caused by unknown factors resulting in a random distribution of output around the mean of the data points

A measure of how well the process can perform after special cause variation has been removed

Statistical Process Run Charting

Special Cause Variation

A non-random event leading to unexpected change in process output

Rule 1- An astronomical point: an extremely high or low point in the process

Rule 2 - A shift: a run of 6 points or more above or below the mean

Rule 3 - A run: too few or too many crossings of mean line

Rule 4 - A trend: five consecutive data points in same direction

Statistical Process Run Charting
Special Cause Variation

Table for Checking for Too Many or Too Few Runs on a Run Chart

Total number of data points on the run chart *that do not fall on the median*	Lower limit for the number of runs (< than this number of runs is "too few")	Upper limit for the number of runs (> than this number of runs is "too many")
10	3	9
11	3	10
12	3	11
13	4	11
14	4	12
15	5	12
16	5	13
17	5	13
18	6	14
19	6	15
20	6	16
21	7	16
22	7	17
23	7	17
24	8	18
25	8	18

Table is based on about a 5% risk of failing the run test for random patterns of data.
Adapted from Swed, Feda S. and Eisenhart, C. (1943). "Tables for Testing Randomness of Grouping in a Sequence of Alternatives. Annals of Mathematical Statistics. Vol. XIV, pp. 66 and 87, Tables II and III.

Intranet Dashboard display of Infection Prevention Indicators

Quality and Safety Vector of Measures

Landing/Overview page with goals for select indicators

- Performance Details of 100 plus indicators displayed as Control chart or Run chart
  - Numerators and Denominators supplementary page
  - Data Definitions (PDF)
  - Performance by Hospital Report (PDF)
  - Performance by Indicator Report (PDF)
  - Performance by Region (PDF)
  - System Performance Report (PDF)

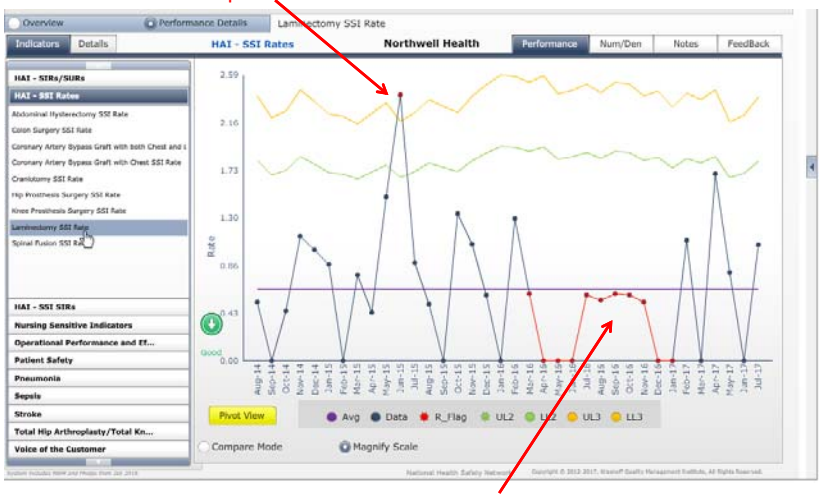
Interactive Dashboard

- Tabs for each **hospital** of Northwell Health
- Tabs for each of 4 **regions** of Northwell Health
- Tab for **Northwell Health** in aggregate
- Buttons for each **indicator** of dashboard placed into sections such as HAI – Indices, HAI - SIRs
- **Pivot feature** of each graphic allows calculation of performance before and after pivot date

Quality and Safety Vector of Measures

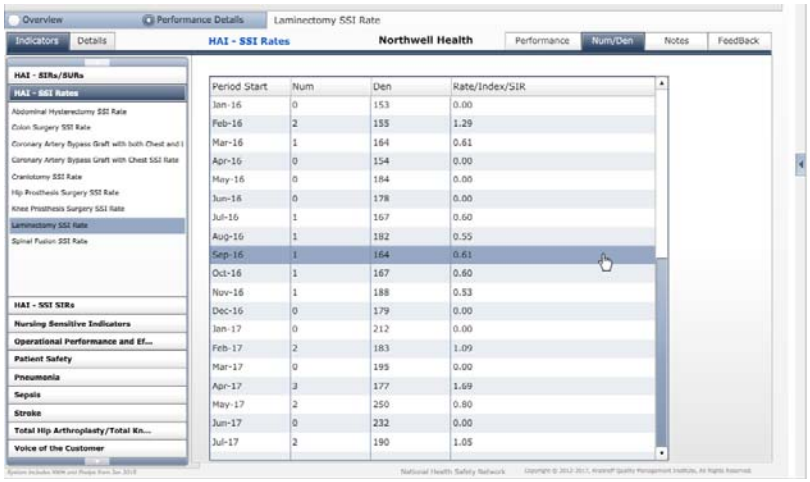
Performance Page

Rule 1 – June 2015 -1 point above 3 SD



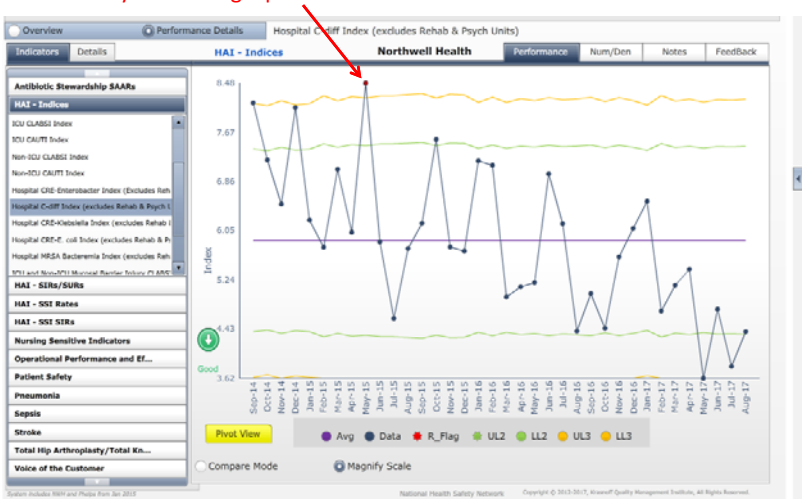
Rule 2 – run of 8 points below mean

Quality and Safety Vector of Measures
Numerator/Denominator Page



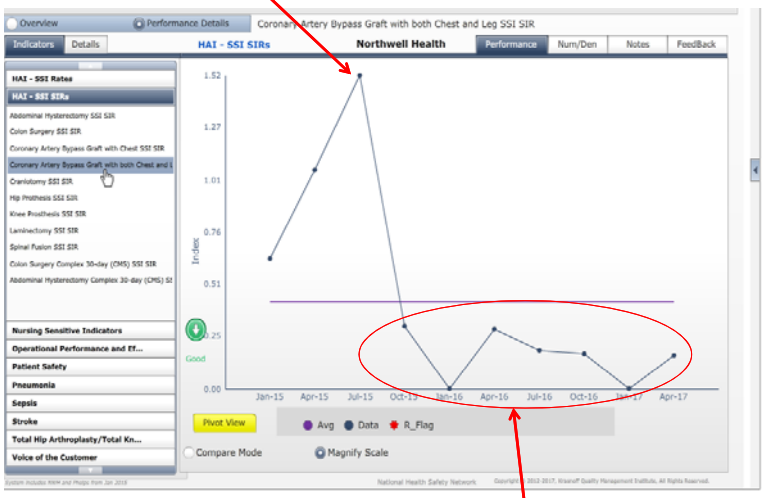
Dashboard – Control Chart – C-Diff Index

Rule 1 – May 2015 - single point above 3 SD control limit



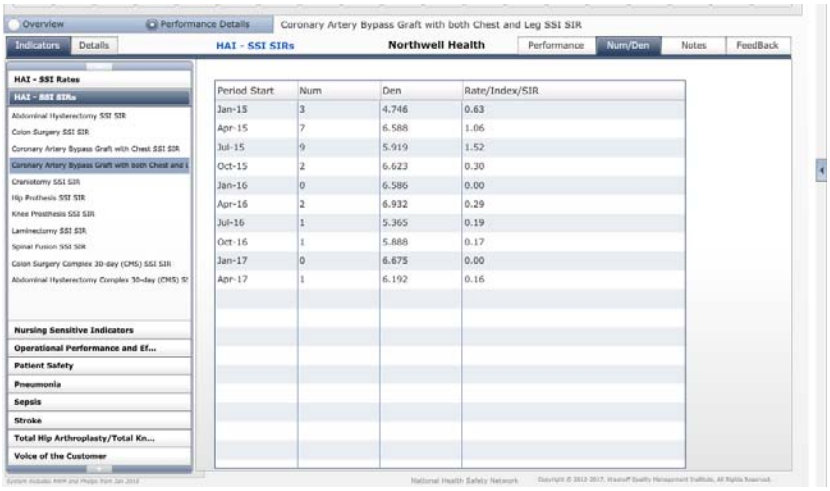
Dashboard – Run Chart of CABG with both Chest and Leg SSI SIR

Astronomical point



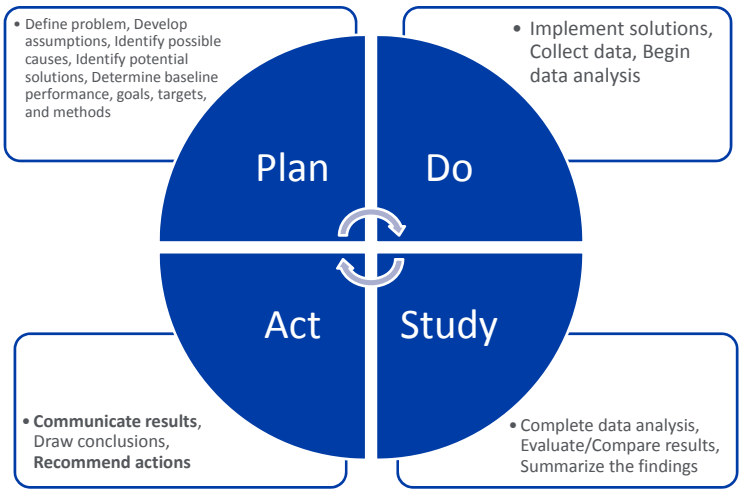
A shift: a run of 6 points or more below the mean

Dashboard – Numerators/Denominators of CABG with both Chest and Leg SSI SIR



Period Start	Num	Den	Rate/Index/SIR
Jan-15	3	4.746	0.63
Apr-15	7	6.588	1.06
Jul-15	9	5.919	1.52
Oct-15	2	6.623	0.30
Jan-16	0	6.586	0.00
Apr-16	2	6.932	0.29
Jul-16	1	5.365	0.19
Oct-16	1	5.888	0.17
Jan-17	0	6.675	0.00
Apr-17	1	6.192	0.16

Continuous Process Improvement

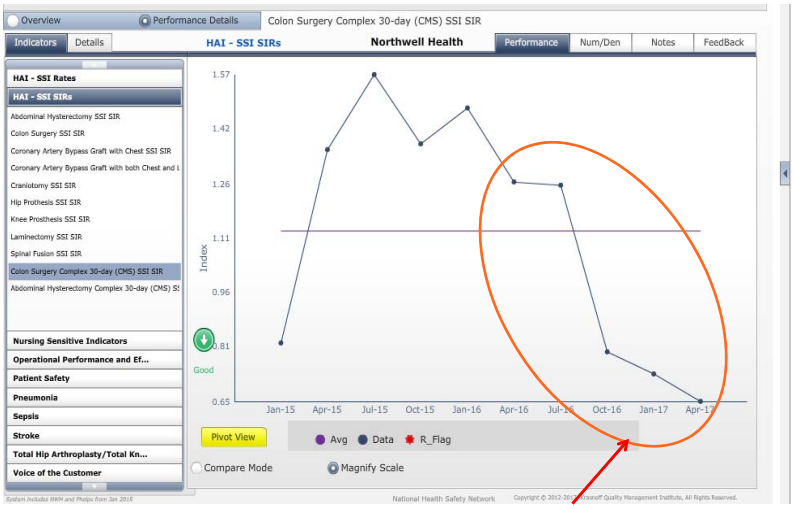


Continuous Process Improvement
CMS Colon SSI SIR

- **Plan**: Define problem - Upward trends and astronomical points always examined with root cause analysis
- **Do**: Collect data, begin data analysis - Dashboard also promotes executive buy-in
- **Study**: Leadership reviews data published monthly - Once leadership on board, can enlist physicians to get involved as with Colon SSI
- **Act**: Communicate results, recommend actions - Due to buy-in nurses working with surgeons on colorectal care bundle under leadership of top colorectal surgeon

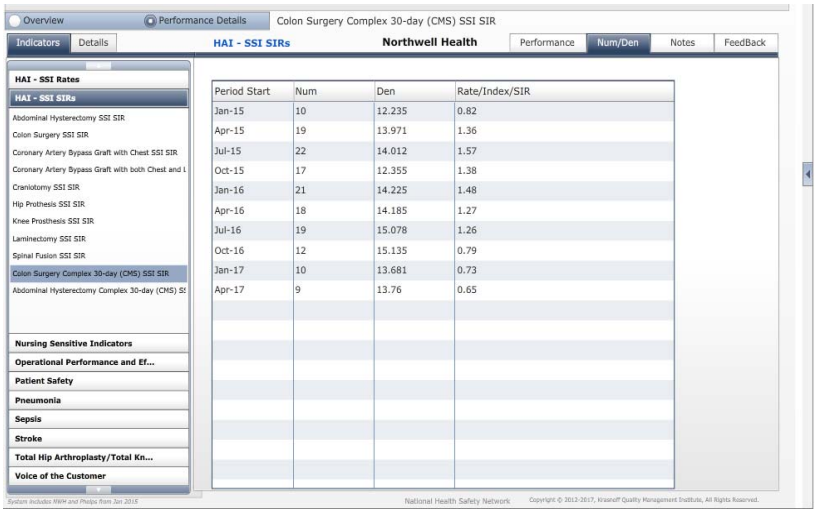
Result of clinicians awareness combined with leadership buy-in is significant improvement in Colon SSI SIRs from 2015 to 2017

Dashboard – Run Chart of CMS Colon SSI SIR (Threshold 0.783)



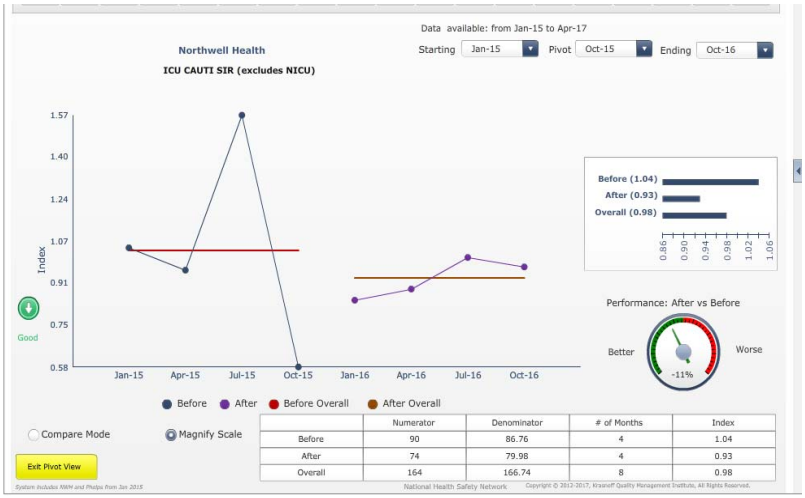
Trend: 5 consecutive points descending

Dashboard – CMS Colon SSI SIR (Threshold 0.783)

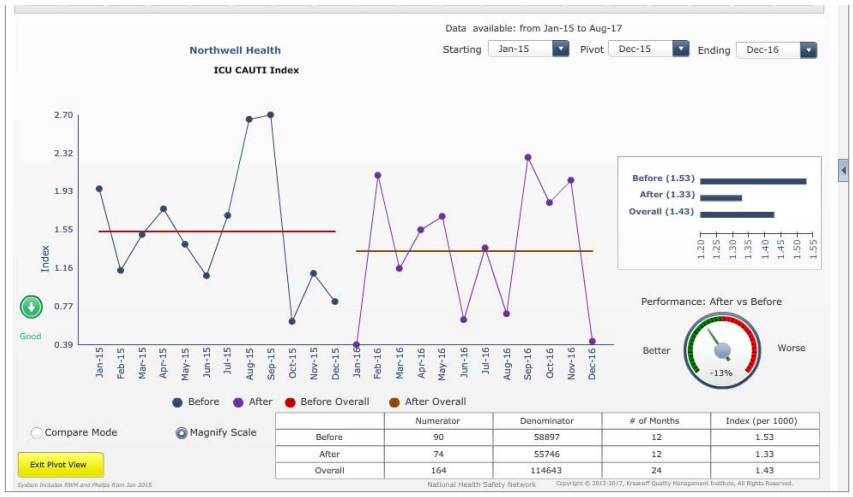


Period Start	Num	Den	Rate/Index/SIR
Jan-15	10	12.235	0.82
Apr-15	19	13.971	1.36
Jul-15	22	14.012	1.57
Oct-15	17	12.355	1.38
Jan-16	21	14.225	1.48
Apr-16	18	14.185	1.27
Jul-16	19	15.078	1.26
Oct-16	12	15.135	0.79
Jan-17	10	13.681	0.73
Apr-17	9	13.76	0.65

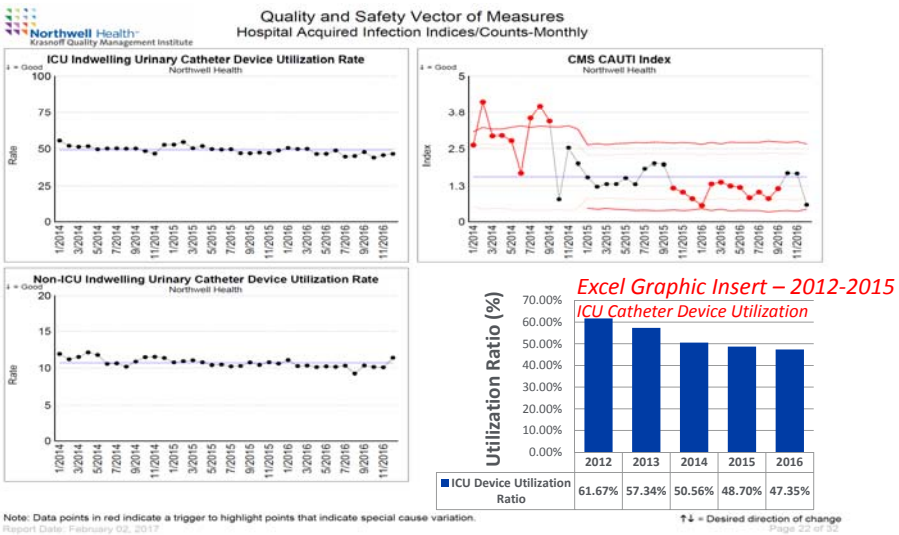
Dashboard – Run Chart of ICU CAUTI SIR with pivot 2015 vs. 2016



Dashboard – Run Chart of ICU CAUTI Index with pivot 2015 vs. 2016



Dashboard – PDF – Catheter Device Utilization



ICU CAUTI Index and Non-ICU CAUTI Index Performance 2012-2016

Northwell Health

ICU Catheter Associated Urinary Tract Infection (CAUTI) Index

(January 2012 - December 2016)

	2012	2013	2014	2015*	2016**	% Decrease from 2012
Index	3.81	3.49	2.87	1.53	1.30	-66%
Numerator	282	234	169	90	73	
Denominator	74,081	67,078	58,831	58,897	56,185	

ICU Catheter Associated Urinary Tract Infection (CAUTI) Index is calculated as:

$$\frac{\text{ICU patients who developed a hospital associated indwelling urinary catheter infection}}{\text{Indwelling urinary catheter days in ICU}} \times 1000$$

Northwell Health

Non-ICU Catheter Associated Urinary Tract Infection (CAUTI) Index

(January 2012 - December 2016)

	2012	2013	2014	2015*	2016**	% Decrease from 2012
Index	2.43	1.84	2.07	1.37	1.11	-54%
Numerator	296	200	204	139	114	
Denominator	121,721	108,873	98,430	101,159	102,796	

Non-ICU Catheter Associated Urinary Tract Infection (CAUTI) Index is calculated as:

$$\frac{\text{Non-ICU patients who developed a hospital associated indwelling urinary catheter infection}}{\text{Indwelling urinary catheter days in Non-ICU}} \times 1000$$

*2015 data includes Northern Westchester and Phelps Memorial. **2016 data includes Northern Westchester, Phelps Memorial, and Peconic Bay.

ICU CLABSI Index and Non-ICU CLABSI Index Performance 2012-2016

Northwell Health

ICU Central Line-Associated BSI Index

(January 2011 - December 2016)

	2012	2013	2014	2015*	2016**	% Decrease from 2012
Index	0.90	0.68	0.54	0.57	0.80	-12%
Numerator	49	34	25	26	34	
Denominator	54,155	50,268	46,565	46,006	42,247	

ICU Central Line-Associated BSI Index is calculated as:

$$\frac{\text{ICU patients with a bacteremia associated with a central line, PICC, mediport, broviac, or Hickman}}{\text{Line days in ICU}} \times 1000$$

Northwell Health

Non-ICU Central Line-Associated BSI Index

(January 2011 - December 2016)

	2012	2013	2014	2015*	2016**	% Decrease from 2012
Index	0.98	0.60	0.63	0.91	0.90	-8%
Numerator	90	51	50	72	68	
Denominator	91,875	84,910	78,999	79,103	75,278	

Non-ICU Central Line-Associated BSI Index is calculated as:

$$\frac{\text{Non-ICU patients with a bacteremia associated with a central line, PICC, mediport, broviac or Hickman}}{\text{Line days in Non-ICU}} \times 1000$$

*2015 data includes Northern Westchester and Phelps Memorial. **2016 data includes Northern Westchester, Phelps Memorial, and Peconic Bay.

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Formulas for Select Indicators

Infection Prevention data collected in NHSN
CAUTI Index Calculations

CAUTI Indices

- By ICU, Non-ICU, or combined ICU and Non-ICU units
- ICU defined as any Critical Care unit in hospital
- Rate multiplied by 1000

ICU CAUTI Index calculated as:

$$\frac{\text{ICU patients who developed a hospital associated indwelling urinary catheter infection}}{\text{Indwelling urinary catheter days in ICU}} * 1000$$

Non-ICU CAUTI Index calculated as:

$$\frac{\text{Non-ICU patients who developed a hospital associated indwelling urinary catheter infection}}{\text{Indwelling urinary catheter days in Non-ICU units}} * 1000$$

ICU and Non-ICU CAUTI Index calculated as:

$$\frac{\text{ICU and Non-ICU patients who developed a hospital associated indwelling urinary catheter infection}}{\text{Indwelling urinary catheter days in ICU and Non-ICU units}} *1000$$

Infection Prevention data collected in NHSN
CAUTI SIR Calculations

CAUTI SIRs

- By ICU, Non-ICU, or combined ICU and Non-ICU units
- ICU defined as any Critical Care unit in hospital

ICU CAUTI SIR calculated as:

$$\frac{\text{Hospital associated indwelling urinary catheter infections in ICU patient population}}{\text{Expected number of hospital associated indwelling catheter infections in ICU patient population}}$$

Non-ICU CAUTI SIR calculated as:

$$\frac{\text{Hospital associated indwelling urinary catheter infections in Non-ICU patient population}}{\text{Expected number of hospital associated indwelling catheter infections in Non-ICU patient population}}$$

ICU and Non-ICU CAUTI SIR calculated as:

$$\frac{\text{Hospital associated indwelling urinary catheter infections in ICU and Non-ICU patient population}}{\text{Expected number of hospital associated indwelling catheter infections in ICU and Non-ICU patient population}}$$

Infection Prevention data collected in NHSN
Indwelling Urinary Catheter Device Utilization Calculations

Indwelling Urinary Catheter Device Utilization

- By ICU, Non-ICU, or combined ICU and Non-ICU units
- ICU defined as any Critical Care unit in hospital
- Rate multiplied by 100

ICU Indwelling Urinary Catheter Device Utilization Rate calculated as:

$$\frac{\text{Indwelling urinary catheter days in ICU}}{\text{Total number of patient days in ICU}} * 100$$

Non-ICU Indwelling Urinary Catheter Device Utilization Rate calculated as:

$$\frac{\text{Indwelling urinary catheter days in Non-ICU}}{\text{Total number of patient days in Non-ICU}} * 100$$

ICU and Non-ICU Indwelling Urinary Catheter Device Utilization Rate calculated as:

$$\frac{\text{Indwelling urinary catheter days in ICU and Non-ICU}}{\text{Total number of patient days in ICU and Non-ICU}} * 100$$

Infection Prevention data collected in NHSN
Indwelling Urinary Catheter Device Standardized Utilization Ratio (SUR) Calculations

Indwelling Urinary Device SUR

- By ICU, Non-ICU, or combined ICU and Non-ICU units
- ICU defined as any Critical Care unit in hospital

ICU Indwelling Urinary Catheter Device SUR calculated as:

$$\frac{\text{Indwelling urinary catheter days in ICU}}{\text{Number of predicted indwelling urinary catheter days in ICU}}$$

Non-ICU Indwelling Urinary Catheter Device SUR calculated as:

$$\frac{\text{Indwelling urinary catheter days in Non-ICU}}{\text{Number of predicted indwelling urinary catheter days in Non-ICU}}$$

ICU and Non-ICU Indwelling Urinary Catheter Device SUR calculated as:

$$\frac{\text{Indwelling urinary catheter days in ICU and Non-ICU}}{\text{Number of predicted indwelling urinary catheter days in ICU and Non-ICU}}$$

Infection Prevention data collected in NHSN
CLABSI Index Calculations

CLABSI Indices

- By ICU, Non-ICU, or combined ICU and Non-ICU units
- ICU defined as any Critical Care unit in hospital
- Rate multiplied by 1000

ICU CLABSI Index calculated as:

$$\frac{\text{ICU patients with a bacteremia associated with a central line, PICC, mediport, broviac, or Hickman}}{\text{Line days in ICU}} * 1000$$

Non-ICU CLABSI Index calculated as:

$$\frac{\text{Non-ICU patients with a bacteremia associated with a central line, PICC, mediport, broviac, or Hickman}}{\text{Line days in Non-ICU}} * 1000$$

ICU and Non-ICU CLABSI Index calculated as:

$$\frac{\text{ICU and Non-ICU patients with a bacteremia associated with a central line, PICC, mediport, broviac, or Hickman}}{\text{Line days in ICU and Non-ICU}} * 1000$$

Infection Prevention data collected in NHSN
CLABSI SIR Calculations

CLABSI SIRs

- By ICU, Non-ICU, or combined ICU and Non-ICU units
- ICU defined as any Critical Care unit in hospital

ICU CLABSI SIR calculated as:

$$\frac{\text{Bacteremias associated with a central line, PICC, mediport, broviac, or Hickman for ICU patient population}}{\text{Expected number of bacteremias associated with a central line, PICC, mediport, broviac, or Hickman for ICU patient population}}$$

Non-ICU CLABSI SIR calculated as:

$$\frac{\text{Bacteremias associated with a central line, PICC, mediport, broviac, or Hickman for Non-ICU patient population}}{\text{Expected number of bacteremias associated with a central line, PICC, mediport, broviac, or Hickman for Non-ICU patient population}}$$

ICU and Non-ICU CLABSI SIR calculated as:

$$\frac{\text{Bacteremias associated with a central line, PICC, mediport, broviac, or Hickman for ICU and Non-ICU patient population}}{\text{Expected number of bacteremias associated with a central line, PICC, mediport, broviac, or Hickman for ICU and Non-ICU patient population}}$$

Infection Prevention data collected in NHSN
Central Line Device Utilization Calculations

Central Line Device Utilization Rates

- By ICU, Non-ICU, or combined ICU and Non-ICU units
- ICU defined as any Critical Care unit in hospital
- Rate multiplied by 100

ICU Central Line Device Utilization Rate calculated as:

$$\frac{\text{Central Line days in ICU}}{\text{Total number of patient days in ICU}} * 100$$

Non-ICU Central Line Device Utilization Rate calculated as:

$$\frac{\text{Central Line days in Non-ICU}}{\text{Total number of patient days in Non-ICU}} * 100$$

ICU and Non-ICU Central Line Device Utilization Rate calculated as:

$$\frac{\text{Central Line days in ICU and Non-ICU}}{\text{Total number of patient days in ICU and Non-ICU}} * 100$$

Infection Prevention data collected in NHSN
Central Line Device Standardized Utilization Ratio (SUR) Calculations

Central Line Device SURs

- By ICU, Non-ICU, or combined ICU and Non-ICU units
- ICU defined as any Critical Care unit in hospital

ICU Central Line Device Standardized Utilization Ratio calculated as:

$$\frac{\text{Central line days in ICU}}{\text{Number of predicted central line days in ICU}}$$

Non-ICU Central Line Device Standardized Utilization Ratio calculated as:

$$\frac{\text{Central line days in Non-ICU}}{\text{Number of predicted central line days in Non-ICU}}$$

ICU and Non-ICU Central Line Device Standardized Utilization Ratio calculated as:

$$\frac{\text{Central line days in ICU and Non-ICU}}{\text{Number of predicted central line days in ICU and Non-ICU}}$$