NHSN Analysis Training 2025

Housekeeping

- **This call will be recorded, with recording and slides posted to the State HAI website**

- **Please use the chat-box for any questions.**

Agenda

- **Updates for 2025**
  - **Antibiotic Use and Resistance (AUR) Module Ratios**
  - **Bloodstream Infection Event (CLABSI) Module Ratios**

- **Analysis Tools**
  - **Standardized Infection Ratio (SIR)**
  - **SIR Models**
  - **Standardized Utilization Ratio (SUR)**
  - **SUR Models**
  - **Cumulative Attributable Difference (CAD)**
  - **Rates**

- **NHSN Analysis Report Tree**
  - **Navigating Tree**
  - **Modifying Reports**
  - **Creating Custom Report**

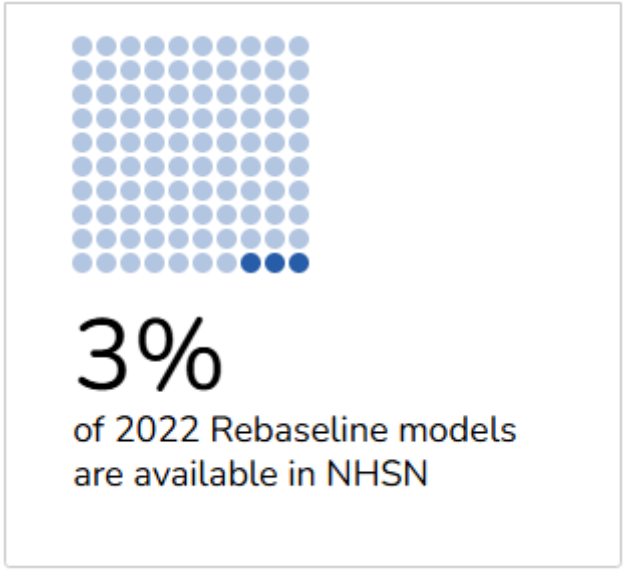
2025 Updates

2022 Re-baseline

2022 SIRs Currently Available in NHSN	2022 SIRs Under Development in NHSN
MRSA Blood LabID	CLABSI & MBI-LCBI
SSI – Complex 30-Day	CAUTI
	CDI LabID
	VAE & PedVAE
	SSI – Complex Admission/Readmission
	SSI – All SSI
	SUR models

2022 Re-baseline

- **Re-baseline: updating incidence data to create a national source for building statistical models**
- **Will be done for each SIR and SUR.**
- **Helps to continue prevention and reduction of HAIs by showing more accurate predicted infection numbers**



Analysis Tools

Standardized Infection Ratios

- **Adjusts for complexity of patients receiving care at your facility**
- **Adjusts for lab testing methods (CDI)**
- **Allows for scalability (facility-wide CLABSI SIR vs. unit-specific rates)**
- **Requires a baseline, progress can be measured**

Standardized Infection Ratio (SIR)

$$\text{SIR} = \frac{\text{Observed (O) HAIs}}{\text{Predicted (P) HAIs}}$$

- **Observed HAIs = sum of all HAIs**
- **Predicted HAIs = sum of factors from model* used**

- **SIR < 1.0 : Actual infections are LESS than predicted infections**
- **SIR > 1.0 : Actual infections are MORE than predicted infections**
- **SIR = 1.0 : Actual infections are EQUAL to predicted infections**

***Logistic Regression vs Negative Binomial Regression**

Available SIRs

HAI Type with SIRs Available in NHSN
CLABSIs
MBI-LCBIs
CAUTIs
SSIs
VAEs
LabID Events (MRSA Bacteremia & CDIs)

Standardized Infection Ratios (Models)

Healthcare-associated Infection (HAI) Type	Model Type
SSIs	★ Logistic Regression Model
CLABSIs, CAUTIs, VAEs, LabID MRSA, and LabID CDI	Negative Binomial Regression Model

Standardized Infection Ratios (Predicted SSIs)

$$logit\ (\hat{p}) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_i X_i$$

- α = Intercept
- β_i = Parameter Estimate
- X_i = Value of Risk Factor
- i = Number of Predictors

Table 1. Risk Factors for SSI HYST: Complex 30-Day Model (2015 Baseline)

Factor	Parameter Estimate	P-value	Variable Coding
Intercept	*-5.1801*	-	-
Diabetes	0.3247	<0.0001	**Yes**= 1 **No**= 0
ASA Score	0.4414	<0.0001	**1**= 1 **2**= 2 **3**= 3 **4/5**= 4
Body Mass Index (BMI)	0.1106	0.0090	**≥ 30**= 1 **< 30**= 0
Patient Age	-0.1501	<0.0001	Patient's age/10
Oncology Hospital	0.5474	0.0005	Oncology hospital= 1 Non-oncology hospital= 0

Standardized Infection Ratios (Predicted SSIs)

$$logit\,(\hat{p}) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_i X_i$$

$$logit\,(\hat{p}) = -5.1801 + 0.3247(DIABETES) + 0.4414(ASA) + 0.1106(BMI) - 0.1501(AGE) + 0.5474(ONCOLOGY\ HOSPITAL)$$

$$logit\,(\hat{p}) = -5.1801 + 0.3247(1) + 0.4414(2) + 0.1106(0) - 0.1501(3.2) + 0.5474(1) = -3.9055$$

$$\hat{p} = \frac{e^{logit(\hat{p})}}{1 + e^{logit(\hat{p})}}$$

$$\hat{p} = \frac{e^{-3.9055}}{1 + e^{-3.9055}}$$

$$\hat{p} = 0.020$$

"There is a 2% risk of SSI for Patient A undergoing this surgery."

Variable Coding
-
Yes= 1
No= 0
1= 1
2= 2
3= 3
4/5= 4
≥ 30= 1
< 30= 0
Patient's age/10
Oncology hospital= 1
Non-oncology hospital= 0

Standardized Infection Ratios (Calculating SSI SIRs)

Table 2. Risk Factors for 100 Patients Undergoing a HYST Procedure (Complex 30-Day model)

Patient	Diabetes	ASA score	BMI	Age	Oncology Hospital	SSI Identified?	Probability of SSI ($\hat{p}$)
1	Y	2	29	32	Y	1	0.020
2	N	3	35	49	Y	0	0.019
3	N	5	20	51	Y	1	0.026
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
100	N	4	27	27	Y	0	0.037
TOTAL	.	.	.	.	.	**8** (observed SSIs)	**6.750** (predicted SSIs)

$$SIR = \frac{Observed\ (O)\ HAIs}{Predicted\ (P)\ HAIs} = \frac{8}{6.750} = 1.190$$

Standardized Infection Ratios (Models)

Healthcare-associated Infection (HAI) Type	Model Type
SSIs	Logistic Regression Model
CLABSIs, CAUTIs, VAEs, LabID MRSA, and LabID CDI	★ Negative Binomial Regression Model

Standardized Infection Ratios (Predicted CDIs)

$$log\ (\lambda) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_i X_i$$

α = Intercept

β_i = Parameter Estimate

X_i = Value of Risk Factor (Categorical variables: 1 if present, 0 if not present)

i = Number of Predictors

Table 3. Risk Factors Used in the Acute Care Hospital CDI LabID Event Model

Factor	Parameter Estimate	P-value
Intercept	-8.9463	<0.0001
Inpatient community-onset (CO) admission prevalence rate	0.7339	<0.0001
CDI test type= EIA	-0.1579	<0.0001
CDI test type= NAAT	0.1307	<0.0001
# ICU beds: ≥ 43	0.7465	<0.0001
# ICU beds: 20-42	0.7145	<0.0001
# ICU beds: 10-19	0.6261	<0.0001
# ICU beds: 5-9	0.4394	<0.0001
Oncology hospital (facility type = HOSP-ONC)	1.2420	<0.0001
General acute care hospital (facility type = HOSP-GEN)	0.3740	<0.0001
Total facility bed size	0.0003	<0.0001
CDI LabID surveillance in ED or 24-hour observation location(s)	0.1119	<0.0001
Teaching facility (major, graduate, or undergraduate)	0.0331	0.0028

Standardized Infection Ratios (Predicted CDIs)

 # predicted HO CDI = Exp [-8.9463
+ 0.7339 (CO prevalence rate)
- 0.1579 (CDI test type = EIA)
+0.1307 (CDI test type = NAAT)
+ 0.7465 (ICU beds ≥ 43)
+ 0.7145 (ICU beds: 20 – 42)
+ 0.6261 (ICU beds: 10-19)
+ 0.4394 (ICU beds: 5-9)
+1.2420 (Oncology hospital)
+ 0.3740 (General hospital)
+ 0.0003 (Total facility bed size)
+ 0.1119 (Reporting from ED or 24 hr. Obs)
+ 0.0331 (Teaching hospital)] X CDI patient days

 # predicted HO CDI = Exp [-8.9463
+ 0.7339 (1.25)
- 0.1579 (0)
+0.1307 (1)
+ 0.7465 (0)
+ 0.7145 (0)
+ 0.6261 (0)
+ 0.4394 (1)
+1.2420 (0)
+ 0.3740 (0)
+ 0.0003 (100)
+ 0.1119 (1)
+ 0.0331 (0)] X 5,000 = 3.321 predicted CDI LabID events

Standardized Infection Ratios (Predicted CDIs)

 # predicted HO CDI = [-8.9463
+ 0.7339 (1.25)
- 0.1579 (0)
+0.1307 (1)
+ 0.7465 (0)
+ 0.7145 (0)
+ 0.6261 (0)
+ 0.4394 (1)
+1.2420 (0)
+ 0.3740 (0)
+ 0.0003 (100)
+ 0.1119 (1)
+ 0.0331 (0)] X 5,000 = 3.321 predicted CDI LabID events

$$SIR = \frac{5\ observed\ HO\ CDI\ LabID\ events}{3.321\ predicted\ HO\ CDI\ LabID\ events} = 1.506$$

Standardized Utilization Ratios

$$\text{SUR} = \frac{\textit{Observed } (O) \textit{ device days}}{\textit{Predicted } (P) \textit{ device days}}$$

- **Observed Device Days = sum of all Device Days**
- **Predicted Device Days = sum of factors from model**

- **SUR < 1.0 : Actual Device Days are LESS than predicted Device Days**
- **SUR > 1.0 : Actual Device Days are MORE than predicted Device Days**
- **SUR = 1.0 : Actual Device Days are EQUAL to predicted Device Days**

Available SURs

HAI Type with SURs Available in NHSN
CLABSIs
MBI-LCBIs
CAUTIs
SSIs
VAEs
LabID Events (MRSA Bacteremia & CDIs)

Standardized Utilization Ratio (Predicted NICU Central Line Days)

$$logit\,(\hat{p}) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_i X_i$$, where:

α = Intercept

β_i = Parameter Estimate

X_i = Value of Factor (Categorical variables= 1 if present, 0 if not present. Refer to "Variable Coding" column in Table 1 above.)

i = Number of Predictors

Table 1. Factors Predicting Unit Level Central Line Use; Central Line SUR, NICU (2015 Baseline)

Factor	Variable Coding	Parameter Estimate	P-value
Intercept	-	*-1.7745*	*<0.0001*
Major Teaching Hospital	Yes= 1 No= 0	0.1538	<0.0001
General Hospital	General Hospital= 1 Other hospital type= 0	-0.5650	<0.0001
Location	IN:ACUTE:CC:NURS= 1 IN:ACUTE:CC_STEP:NURS= 0	0.1781	<0.0001
Facility Bed Size	≥460 beds= 1 325-459 beds= 1 212-324 beds= 1 36-211 beds= 0	0.2783 0.1770 0.0987	<0.0001 <0.0001 0.0330
Birthweight	Birthweight Code A= 1 Birthweight Code B= 1 Birthweight Code C= 1 Birthweight Code D/E= 0	1.3932 1.0765 0.6519	<0.0001 <0.0001 <0.0001

Standardized Utilization Ratio (Predicted NICU Central Line Days)

$$logit\,(\hat{p}) = -1.7745 + 0.1538(MAJOR\ TEACHING\ HOSPITAL) - 0.5650(GENERAL\ HOSPITAL) + 0.1781(NICU) + 0.0987(BEDSIZE\ BETWEEN\ 212-324) + 1.3932(BIRTHWEIGHT\ CODE\ A)$$

$$logit\,(\hat{p}) = -1.7745 + 0.1538(1) - 0.5650(1) + 0.1781(1) + 0.0987(1) + 1.3932(1) = -0.5157$$

$$\hat{p} = \frac{e^{logit(\hat{p})}}{1+e^{logit(\hat{p})}}$$

$$\hat{p} = \frac{e^{-0.5157}}{1+e^{-0.5157}}$$

$$\hat{p} = 0.3739$$

$$number\ of\ predicted\ central\ line\ days = 0.3739\ X\ 155$$

$$number\ of\ predicted\ central\ line\ days = 57.9545$$

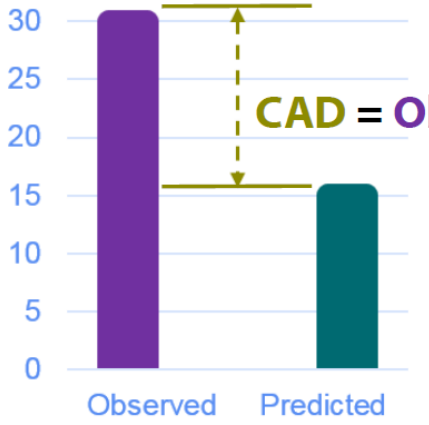
Standardized Utilization Ratio (Predicted NICU Central Line Days)

Table 2. Central Line SUR for a Level III NICU

Birthweight Code	Major Teaching Affiliation	NICU	General Hospital	Facility Bed Size	Patient Days	Probability of CL use ($\hat{p}$)	Total Predicted Device Days
A	Y	Y	Y	300	155	.3739	57.9545
B	Y	Y	Y	300	82	.3031	24.8542
C	Y	Y	Y	300	90	.2215	19.9350
D/E	Y	Y	Y	300	56	.1291	7.2296
Total							**109.9733**

$$SUR = \frac{Observed\ (O)\ CL\ Days}{Predicted\ (P)\ CL\ Days} = \frac{270}{109.9733} = 2.4551$$

Cumulative Attributable Difference



CAD = Observed # HAIs – (Predicted # HAIs x SIR goal)

CAD	Observed	Predicted	SIR goal
15	30	30	0.5

10

- **Provides the number of infections needed to prevent in order to reach reduction goal**
- **CAD is not a comparison metric like SIR**
  - **Detects burden of infection**
  - **Positive CAD = additional burden of infections than what would be predicted for the SIR goal (“excess” infections)**
  - **Negative CAD = fewer infections than what would be predicted**

SIR vs CAD

Standardized Infection Ratio SIR	Cumulative Attributable Difference CAD
• Ratio of observed to predicted infections • Summary measure used to track HAIs at a national, state, or local level over time • Risk adjusted • Used as a ***comparative*** metric	• # of infections that need to be prevented to achieve SIR goal • Summary measure to target prevention • Influenced by exposure size • Used as a ***prioritization*** metric

Hospital	Patient days	Observed	Predicted	SIR	CAD
Major Teaching	9,000	27	9	3	18
Rural	1,000	3	1	3	2

Rates

- **Fixed ratio between two things**
  - **Numerator**
  - **Denominator**

- **When there is no SIR, rates can help quantify facility progress**
  - **Not as good at adjusting for change as SIR is**
    - **Should be used only if your facility does not generate an SIR for the HAI of interest**

- **Rates are usually in the form:**

$$\frac{\text{Number of Infections (Numerator)}}{\text{Number of Device Days/Patient Days/Procedures (Denominator)}}$$

Rates

- **Not useful for comparing to other facilities**
  - **Cannot control for different patient populations or facility characteristics**
- **Can be used to compare previous time periods at same facility/location to identify spikes**
  - **Must know what is "normal" for your facility**
- **Available for:**
  - **Infection Types**
  - **Device Utilization**

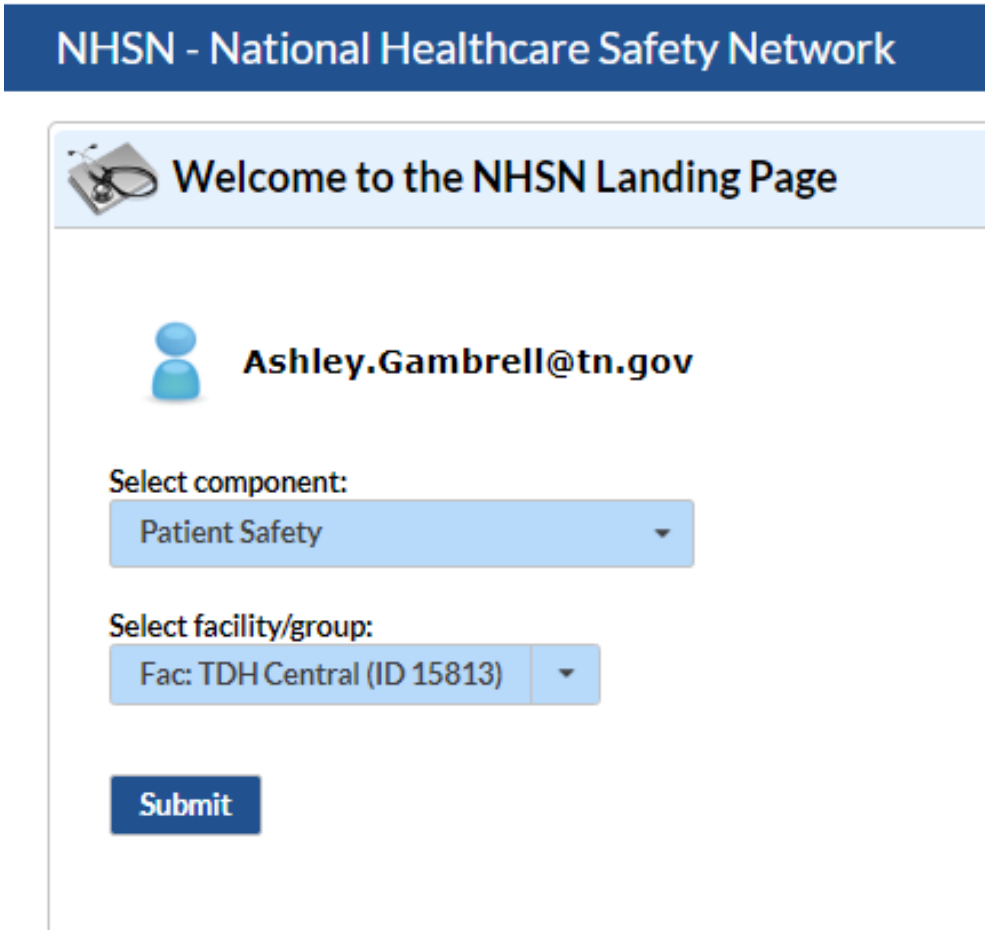
Available Rates

HAI Type with Rates Available in NHSN
CLABSIs
MBI-LCBIs
CAUTIs
PNEUs & VAPs
SSIs
VAEs
LabID Events (MRSA Bacteremia & CDIs)

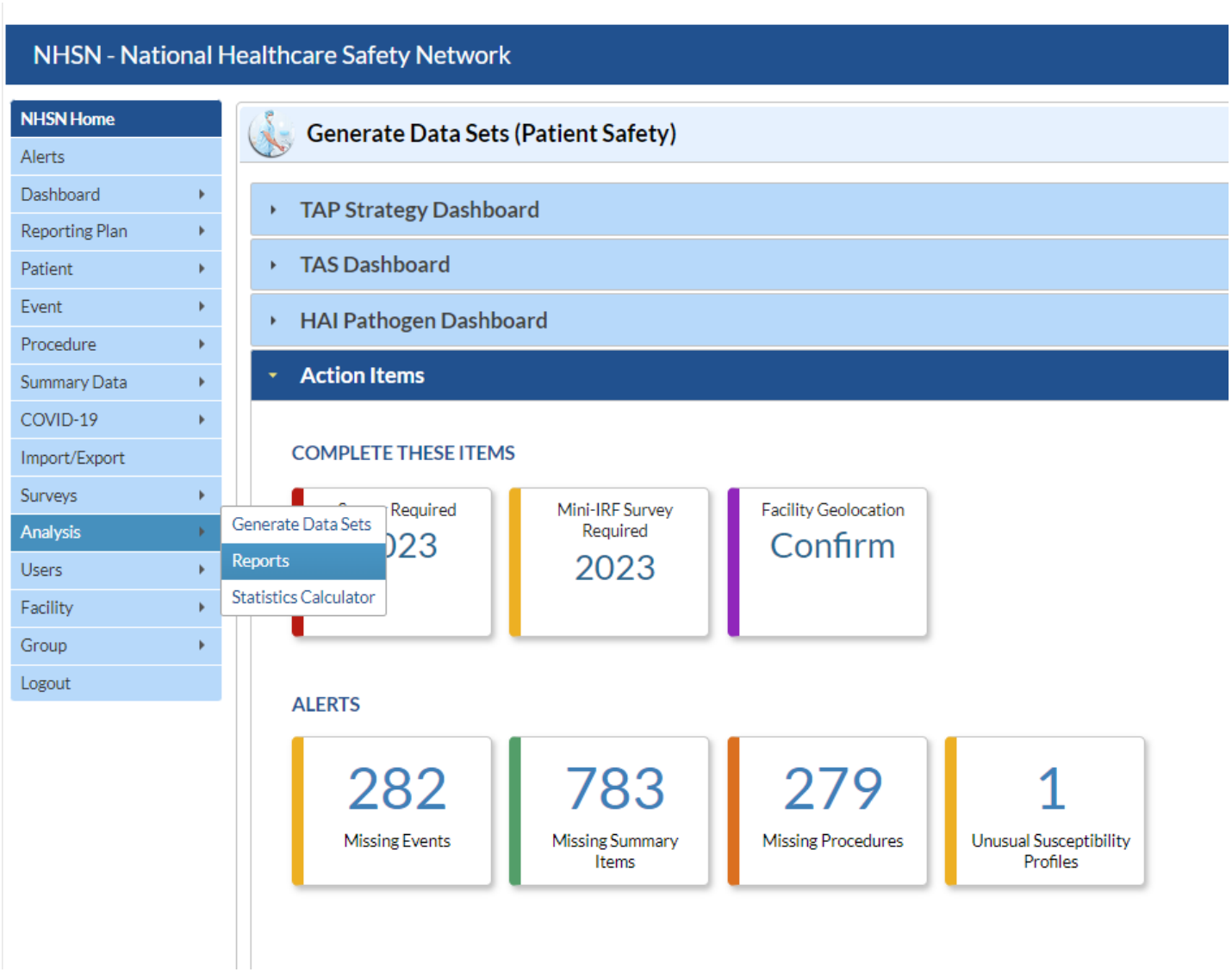
Devices/Categories with Utilization Rates in NHSN
Central Lines
Indwelling Urinary Catheters
Ventilators

NHSN Analysis Report Tree

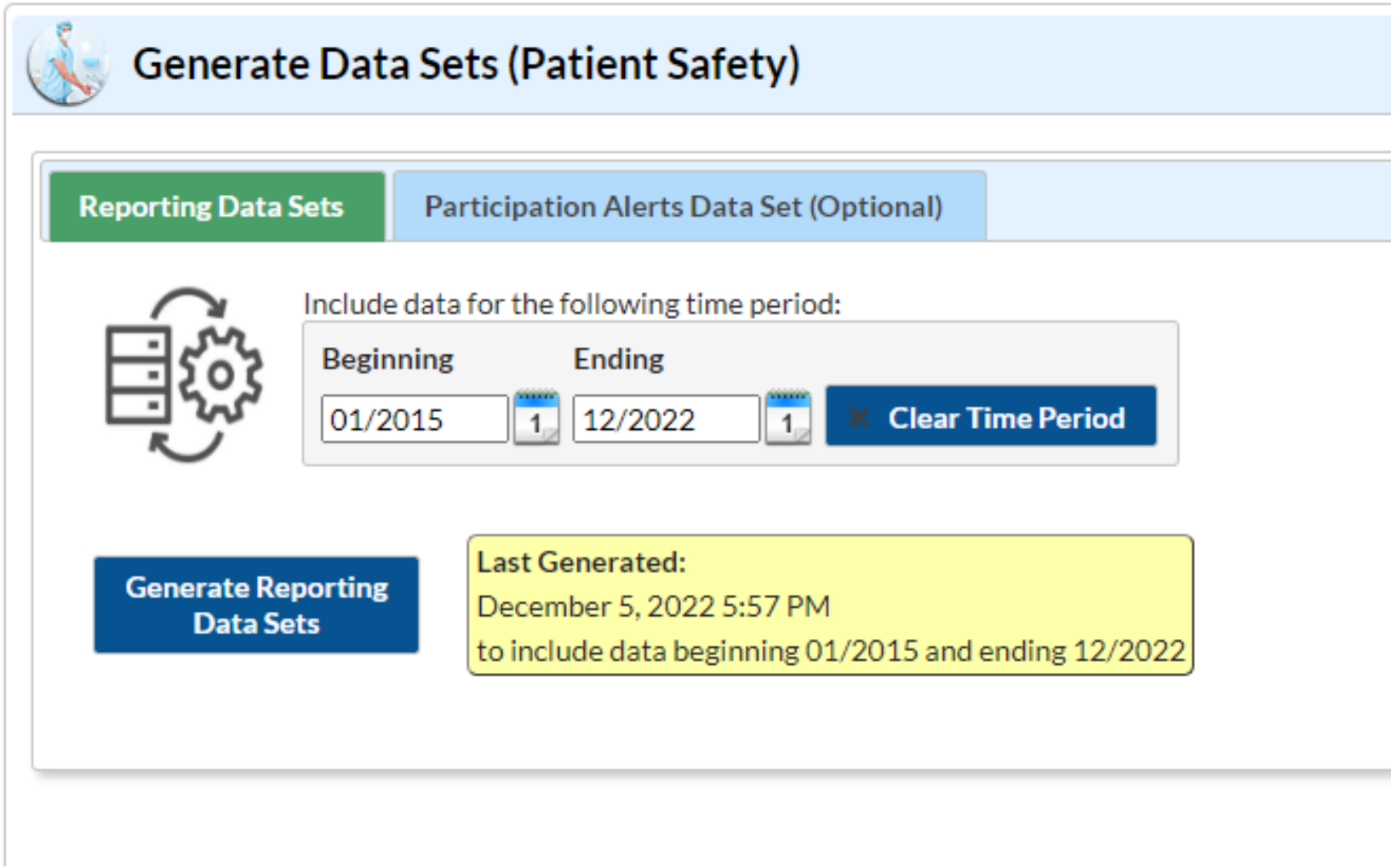
NHSN Analysis Report Tree



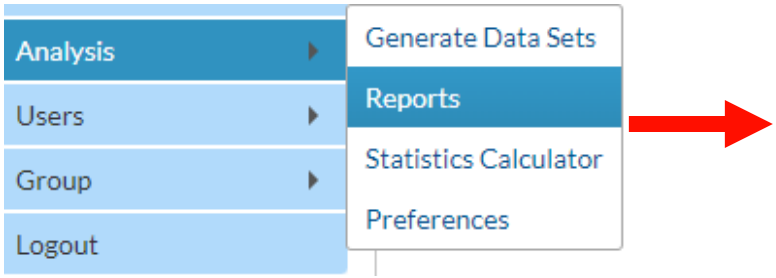
NHSN Analysis Report Tree

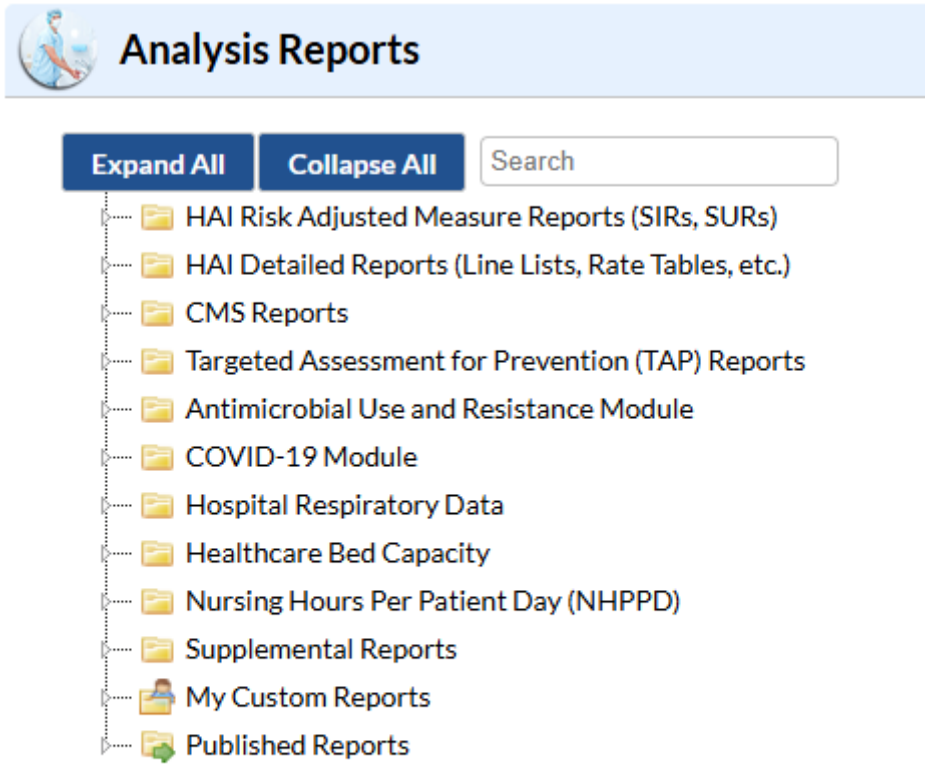


Updating Datasets



NHSN Analysis Report Tree





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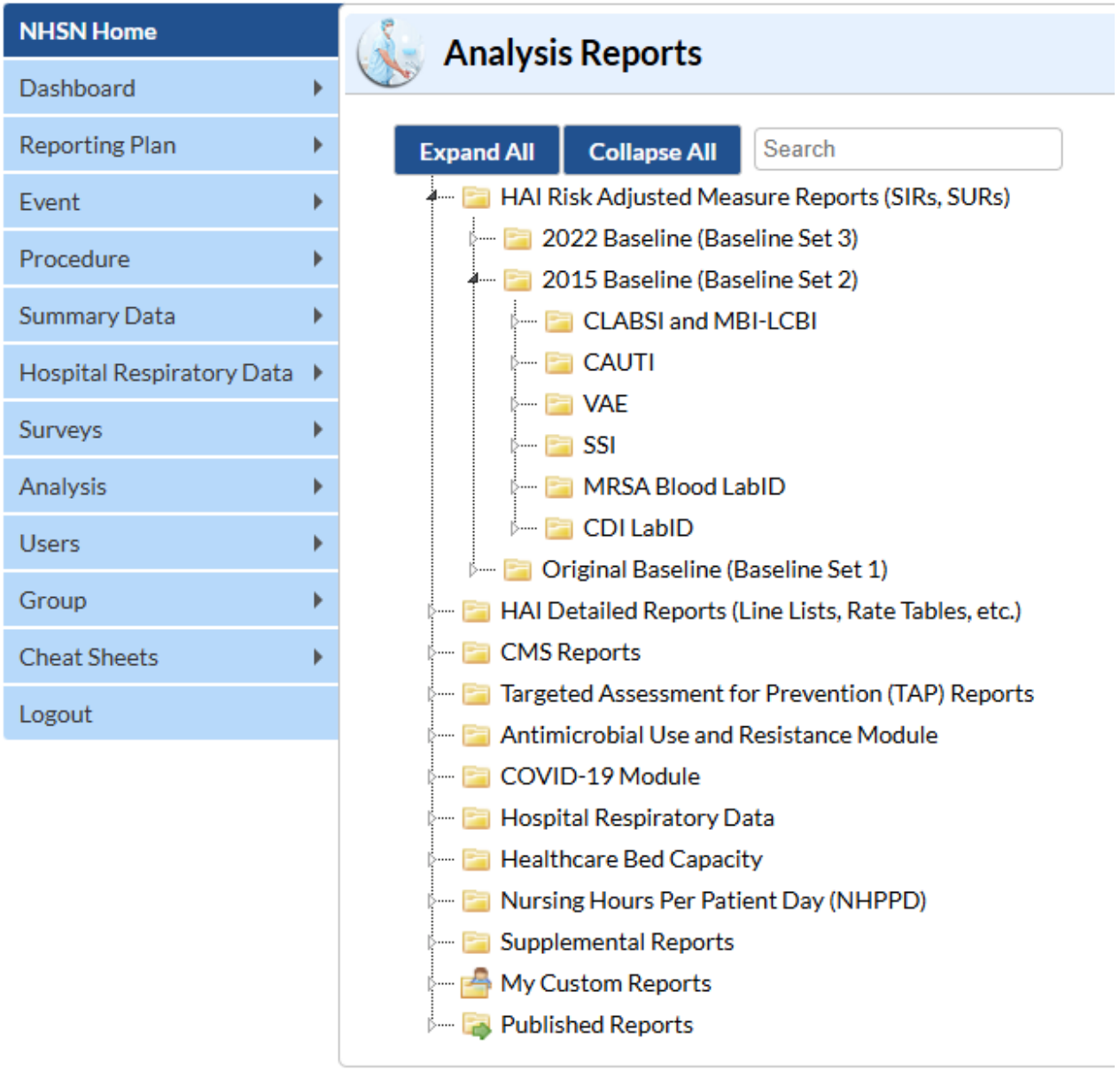

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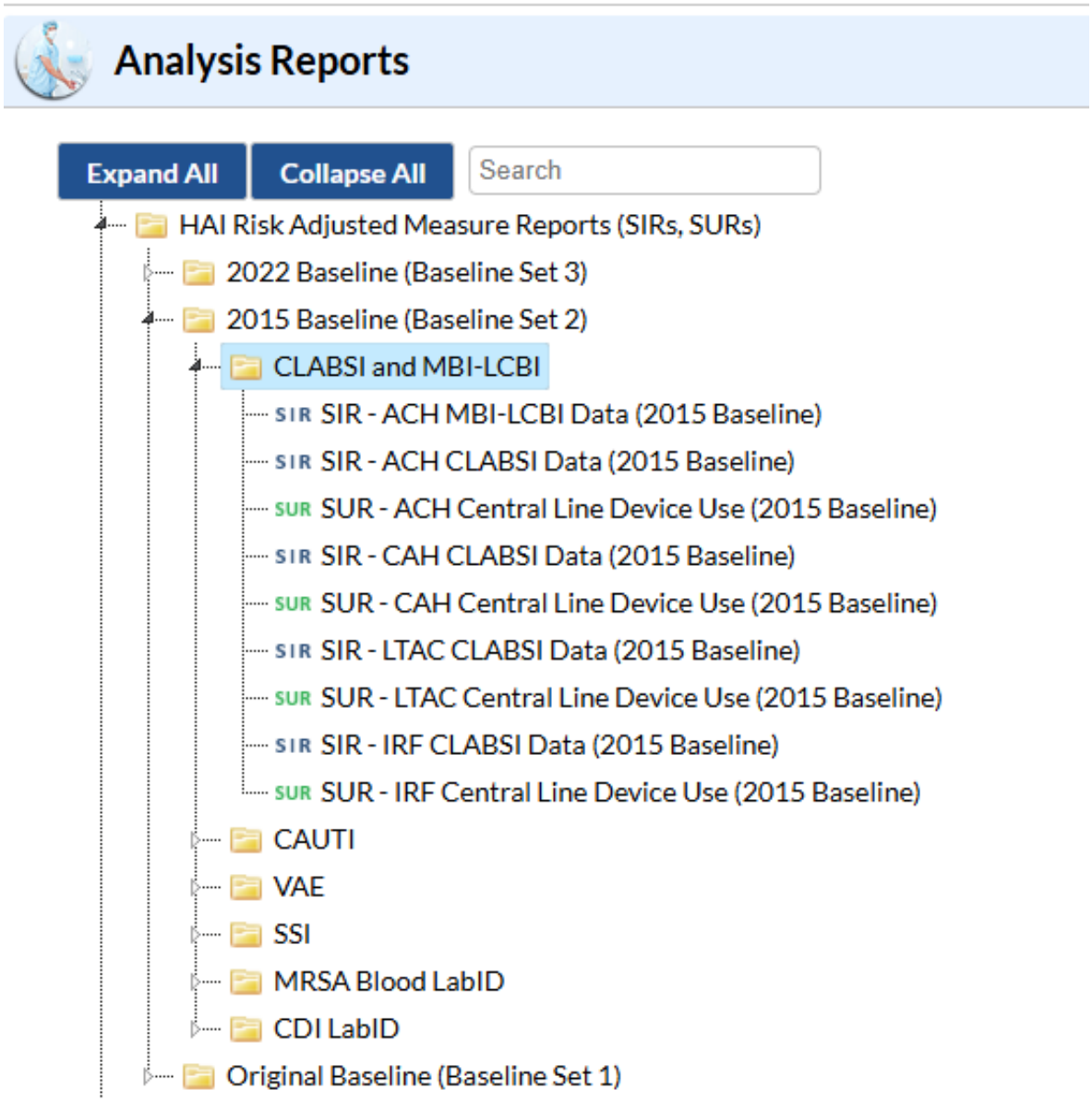

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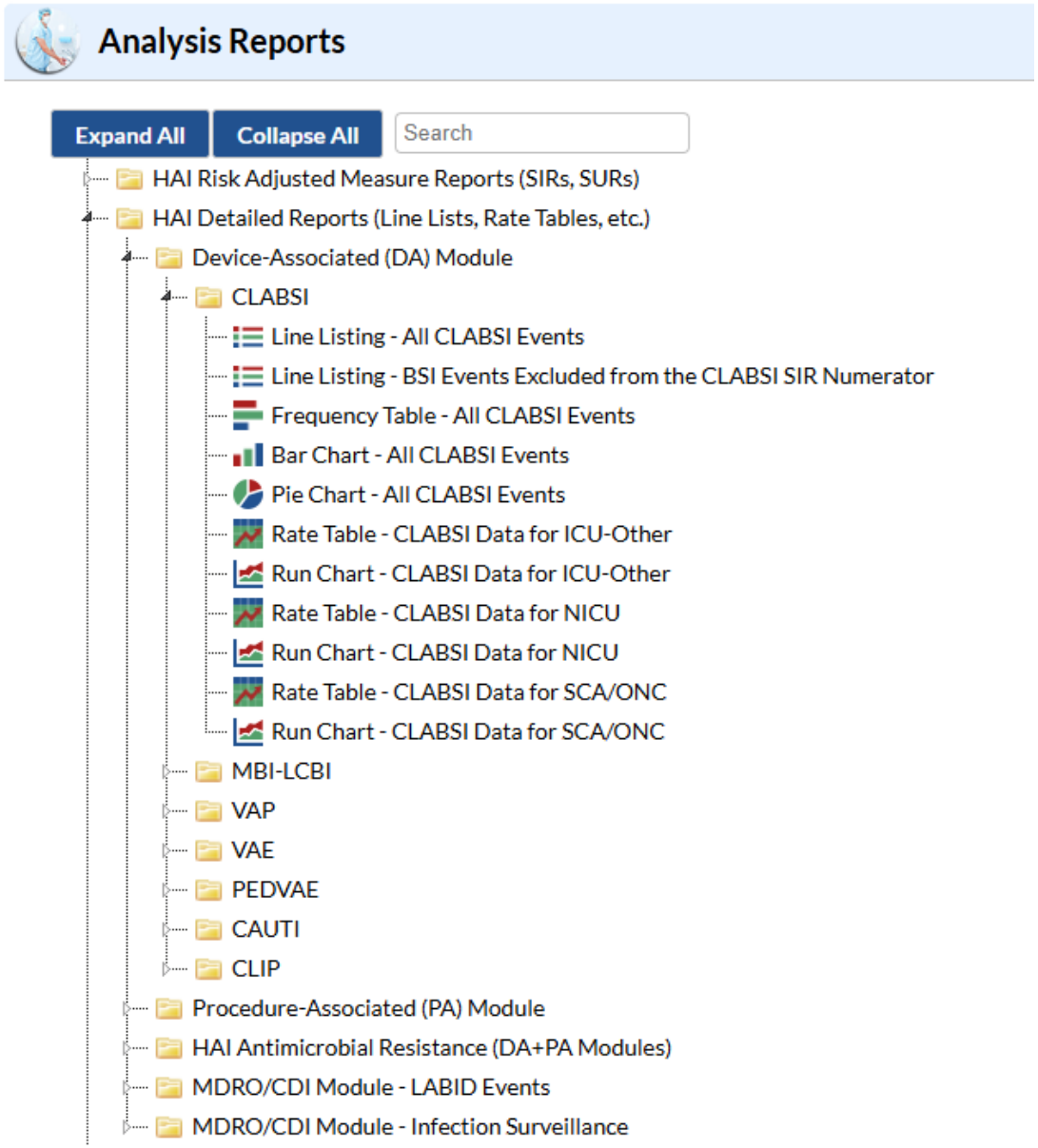

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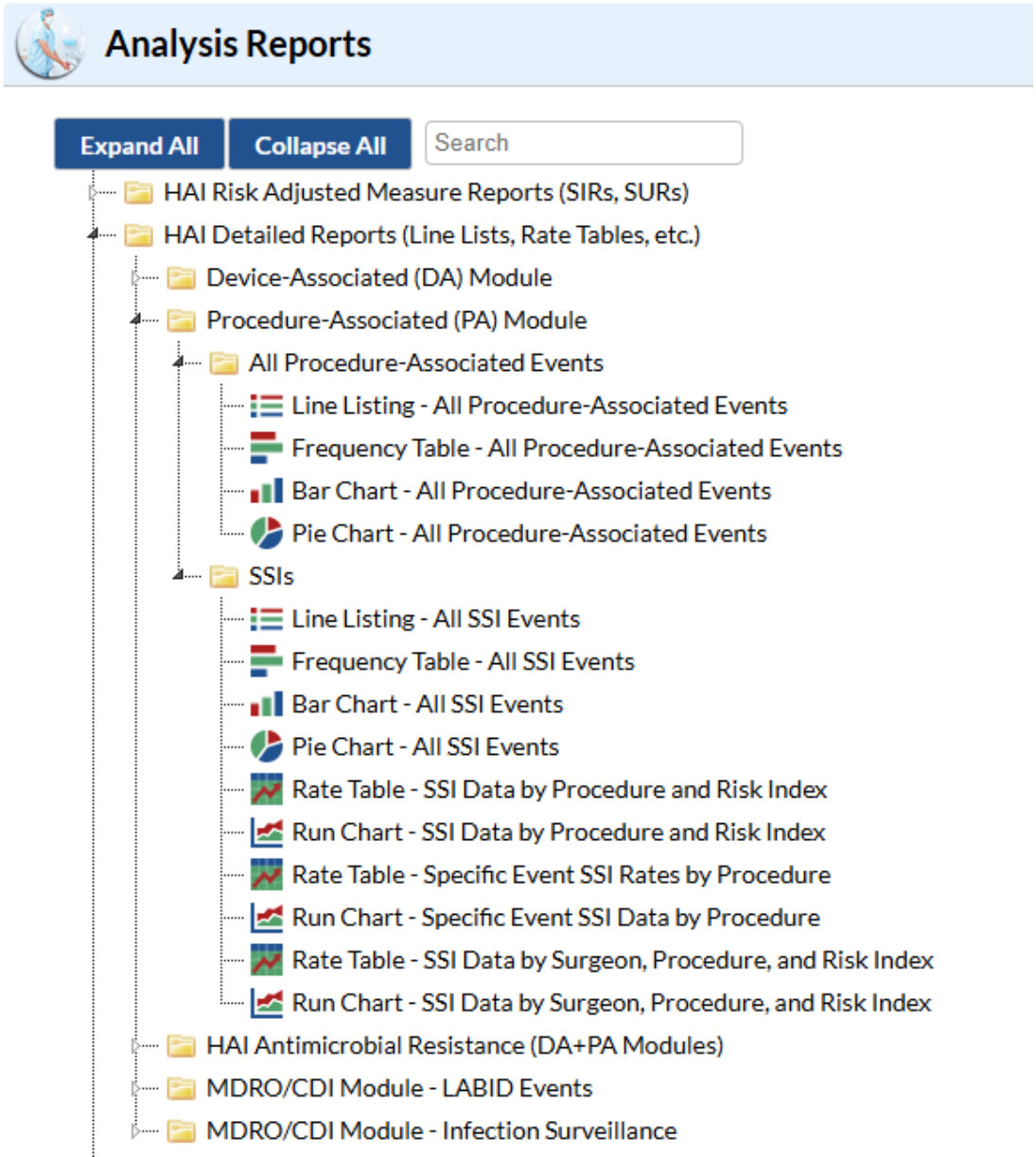

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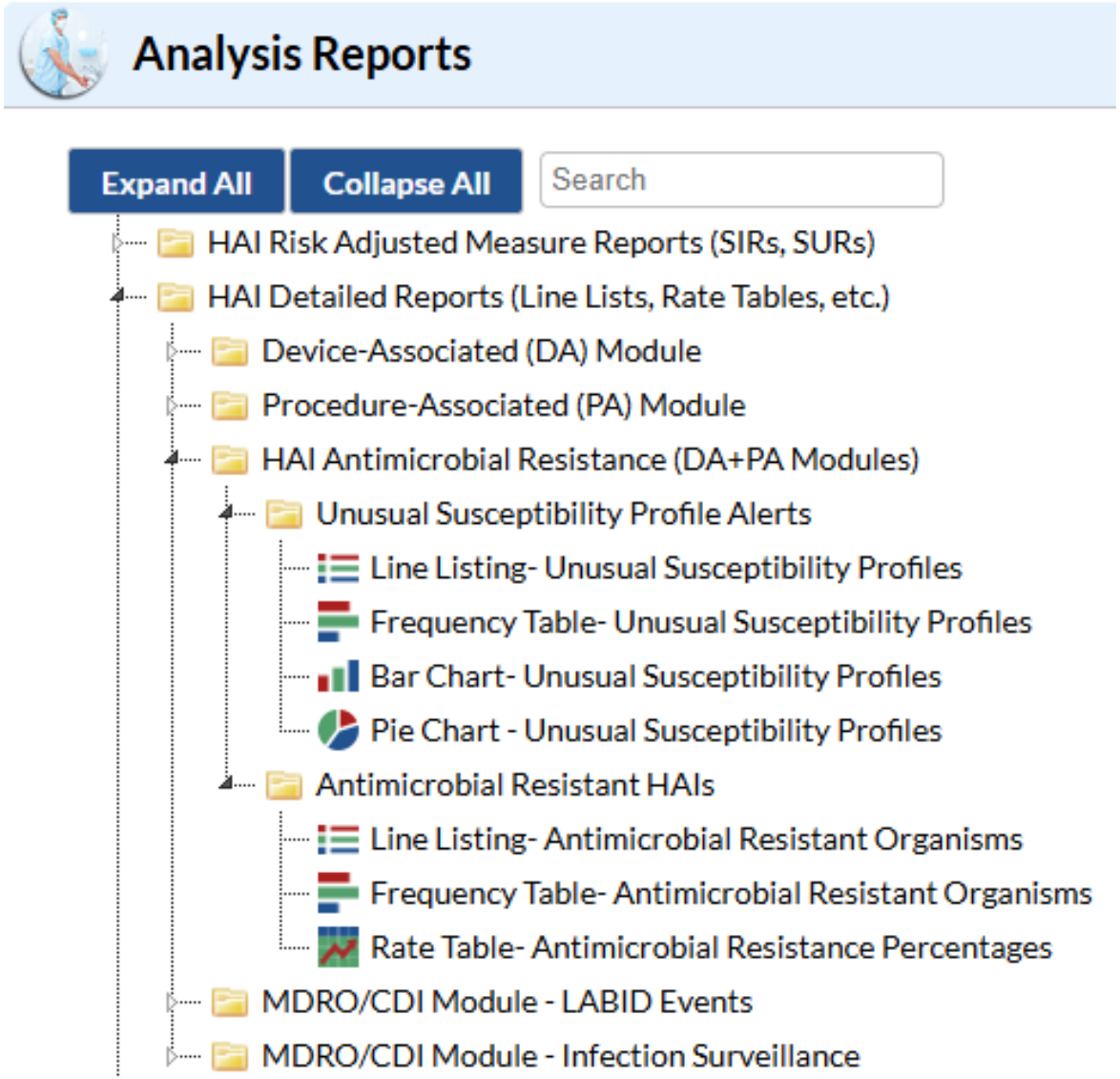

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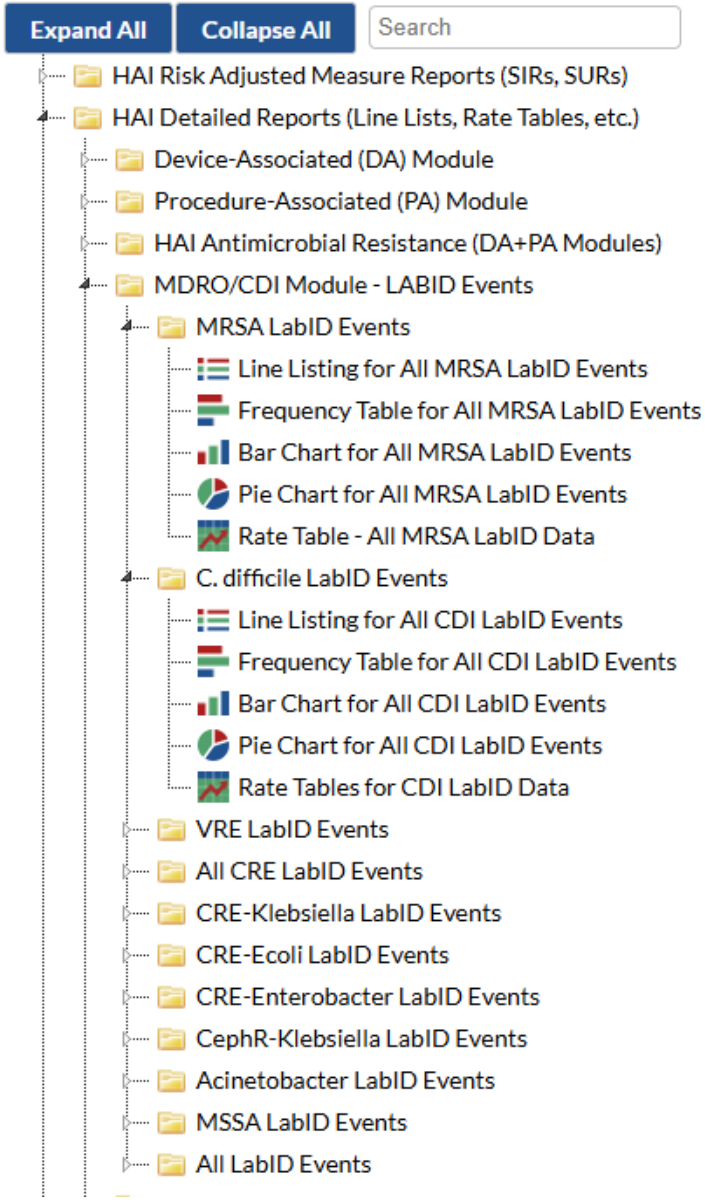

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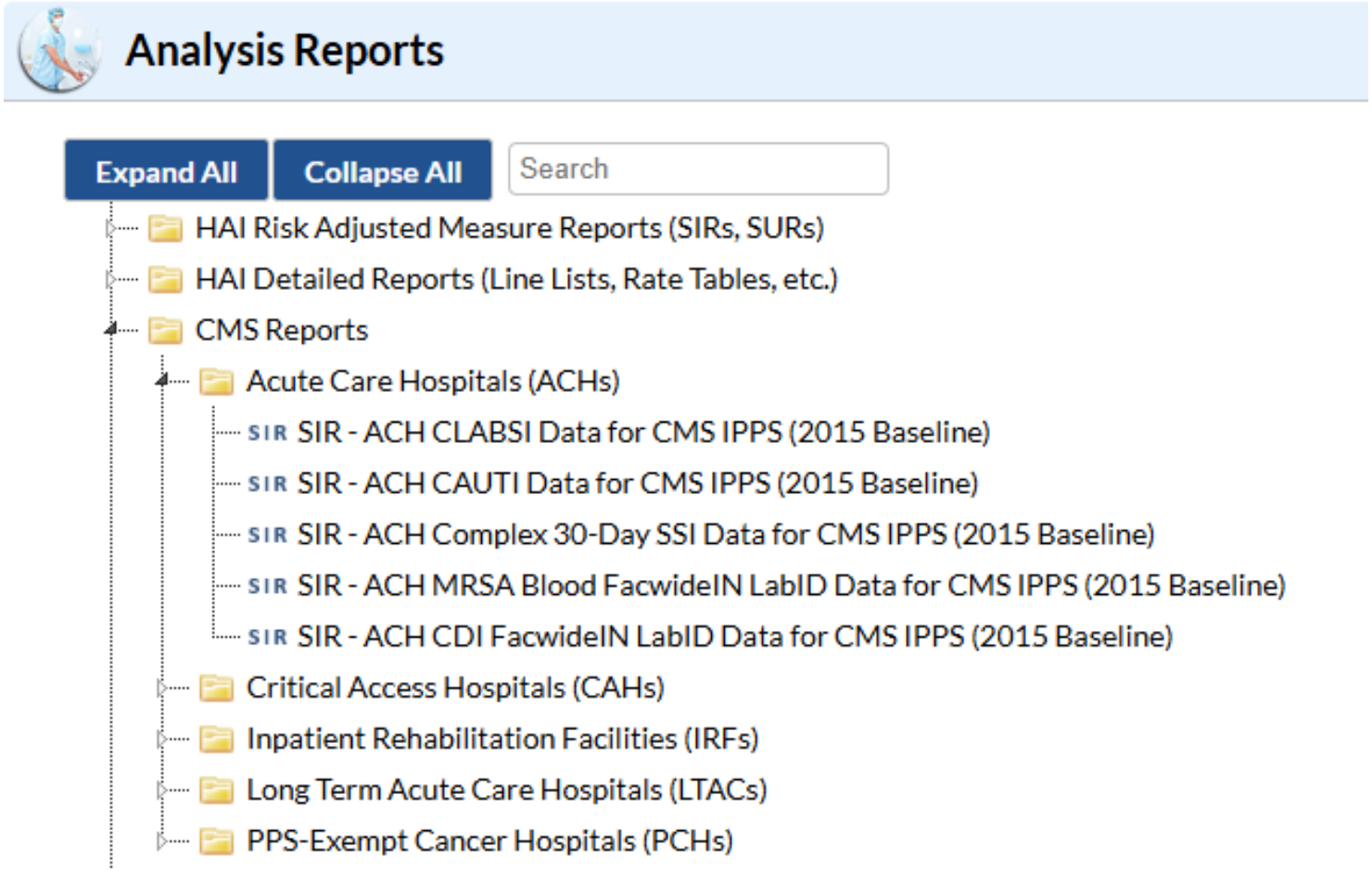

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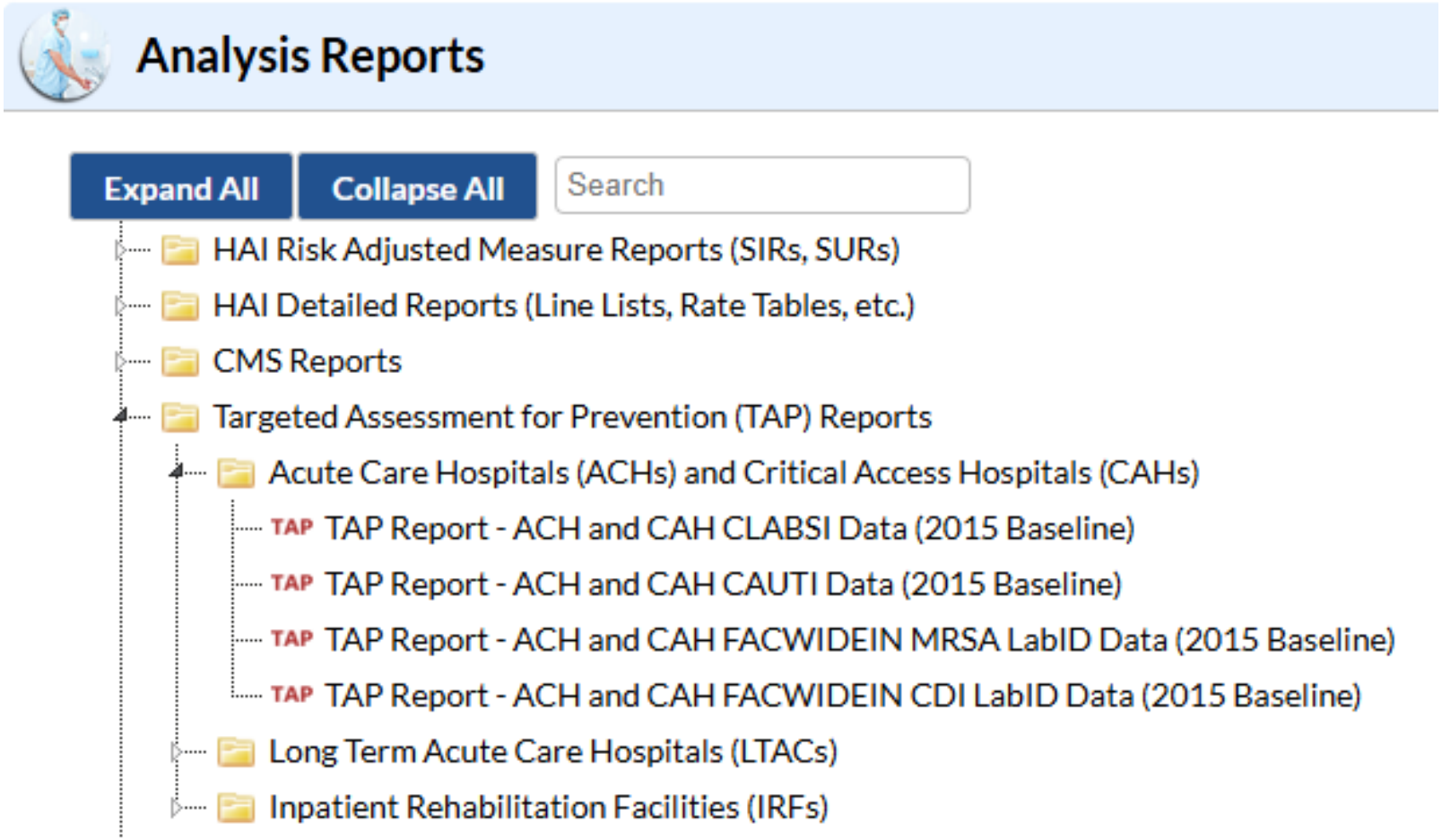

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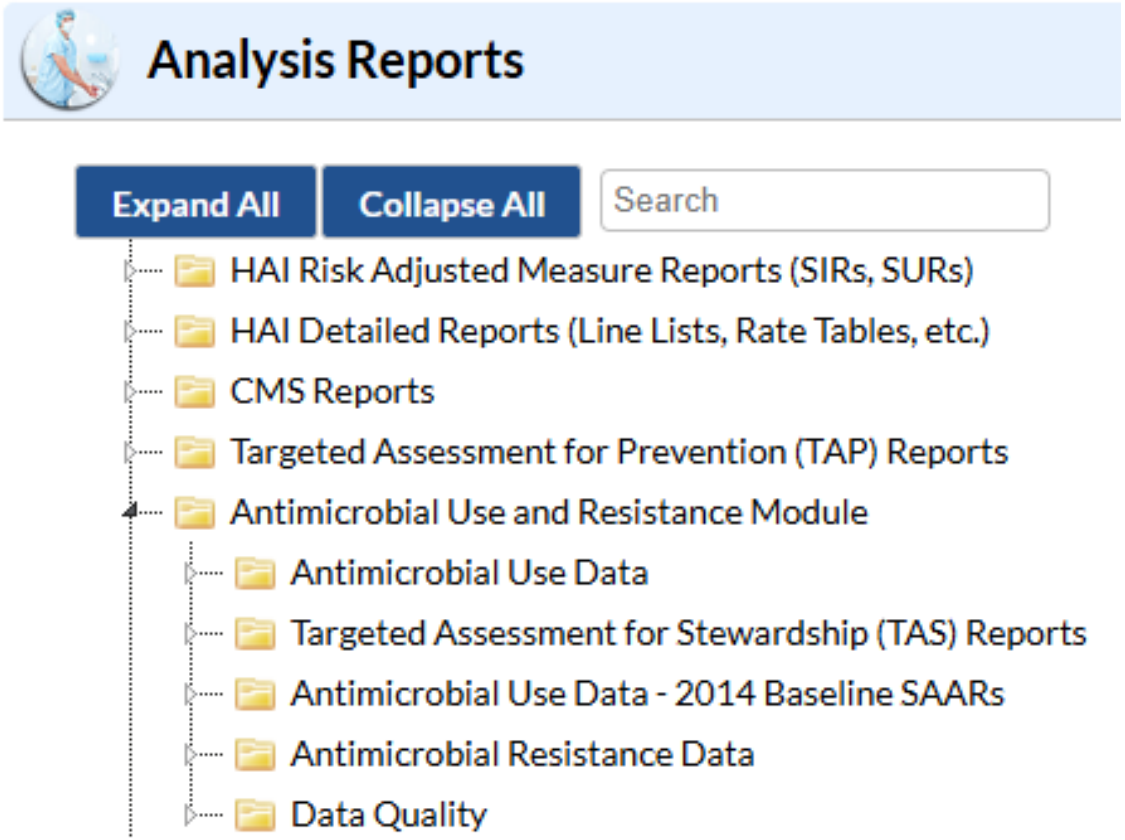

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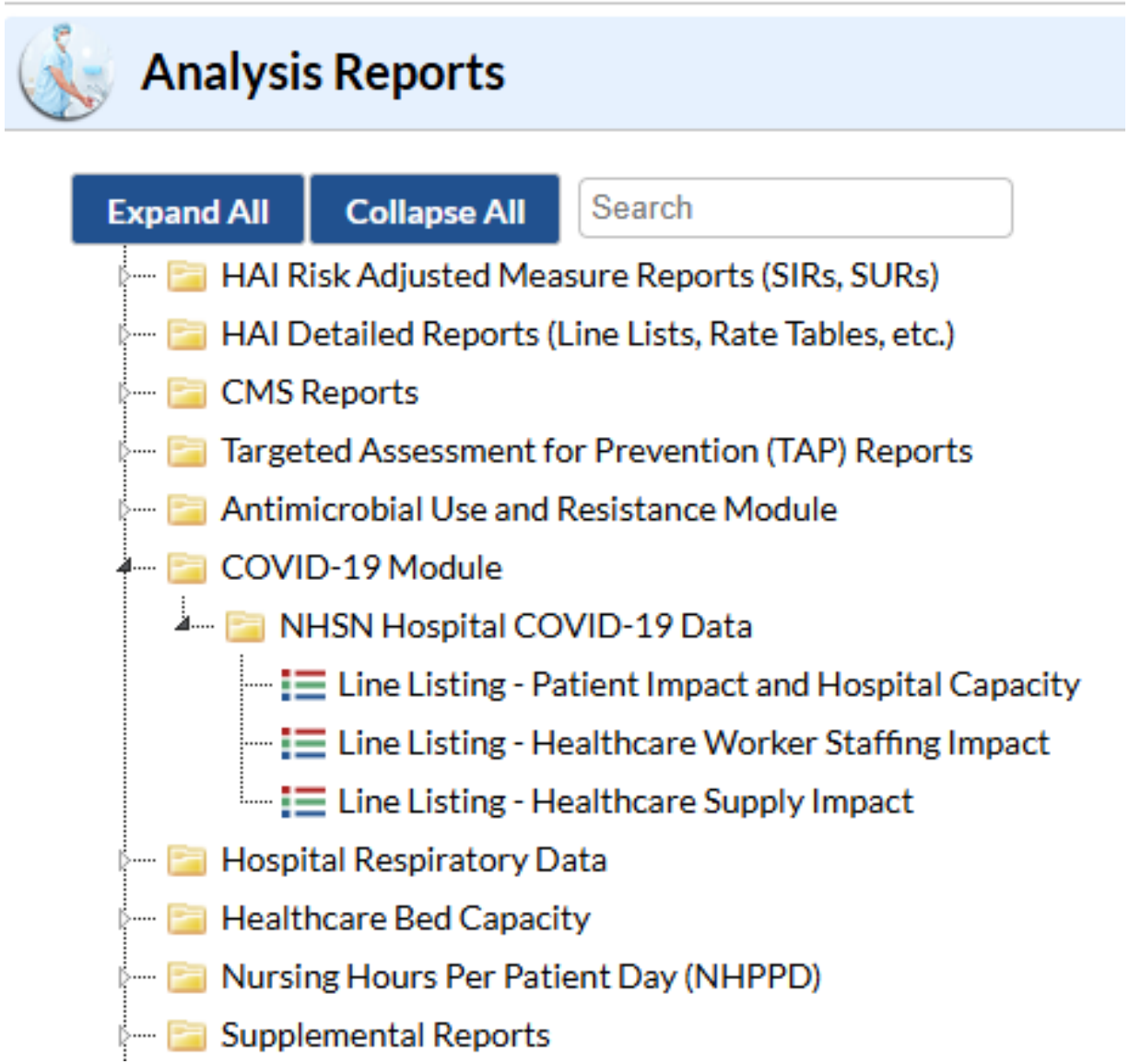

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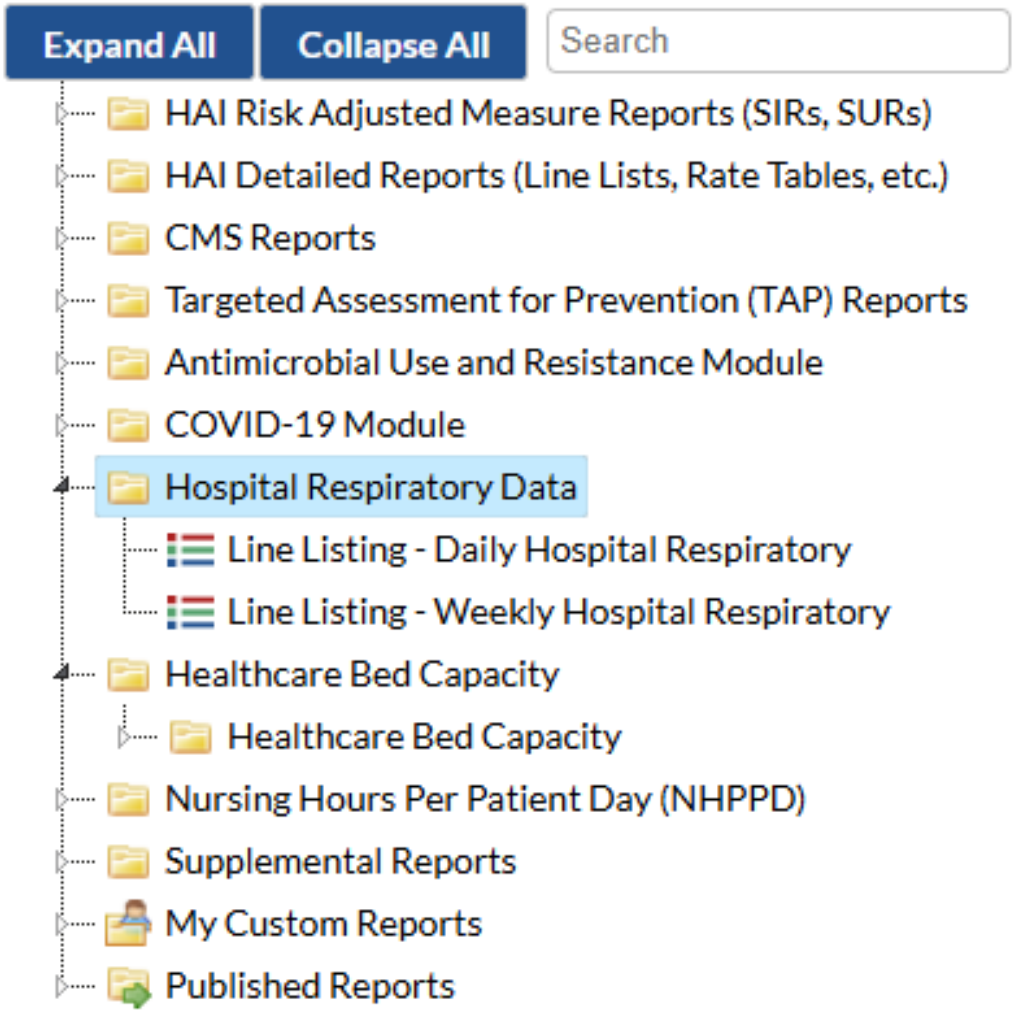

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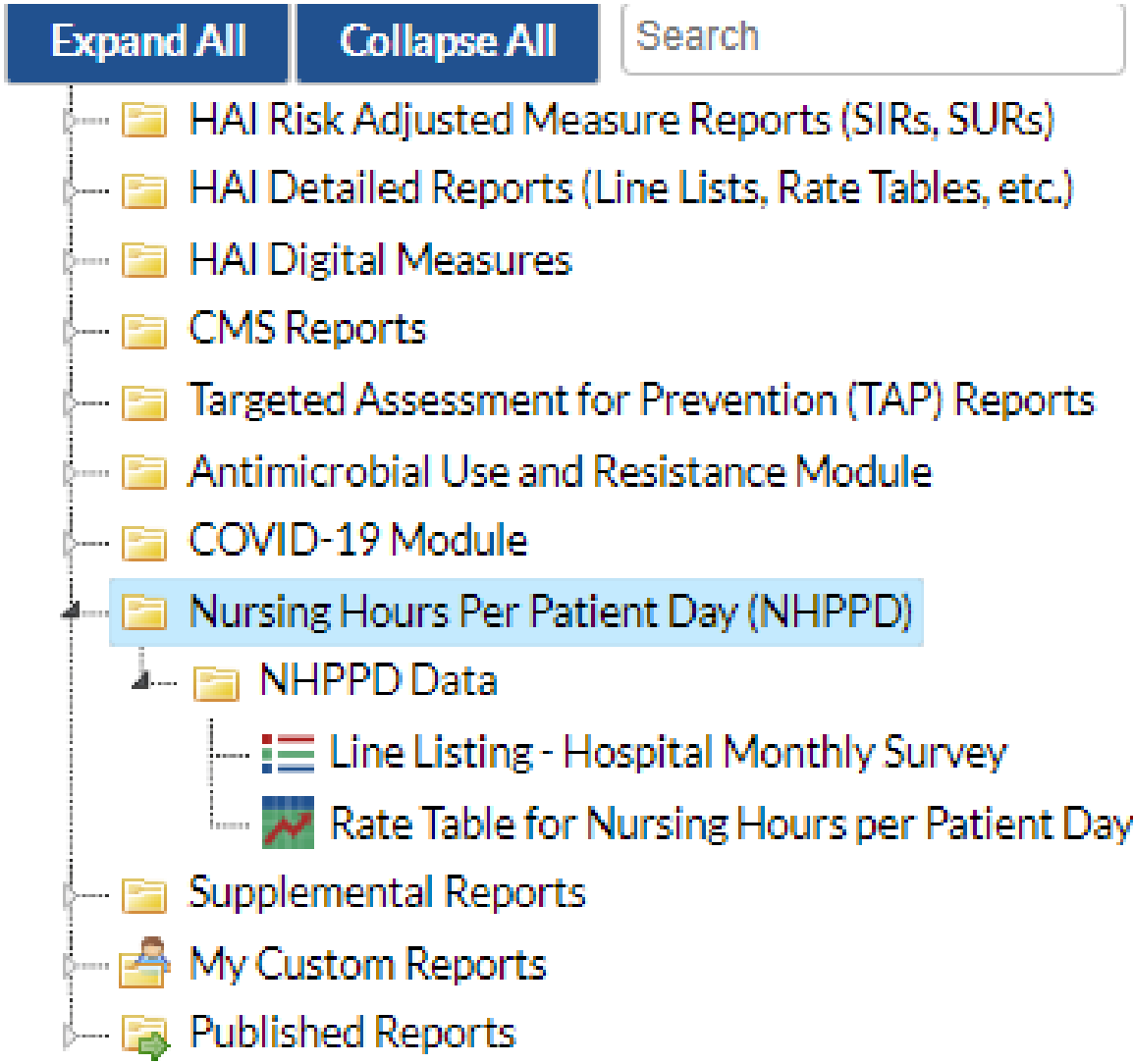

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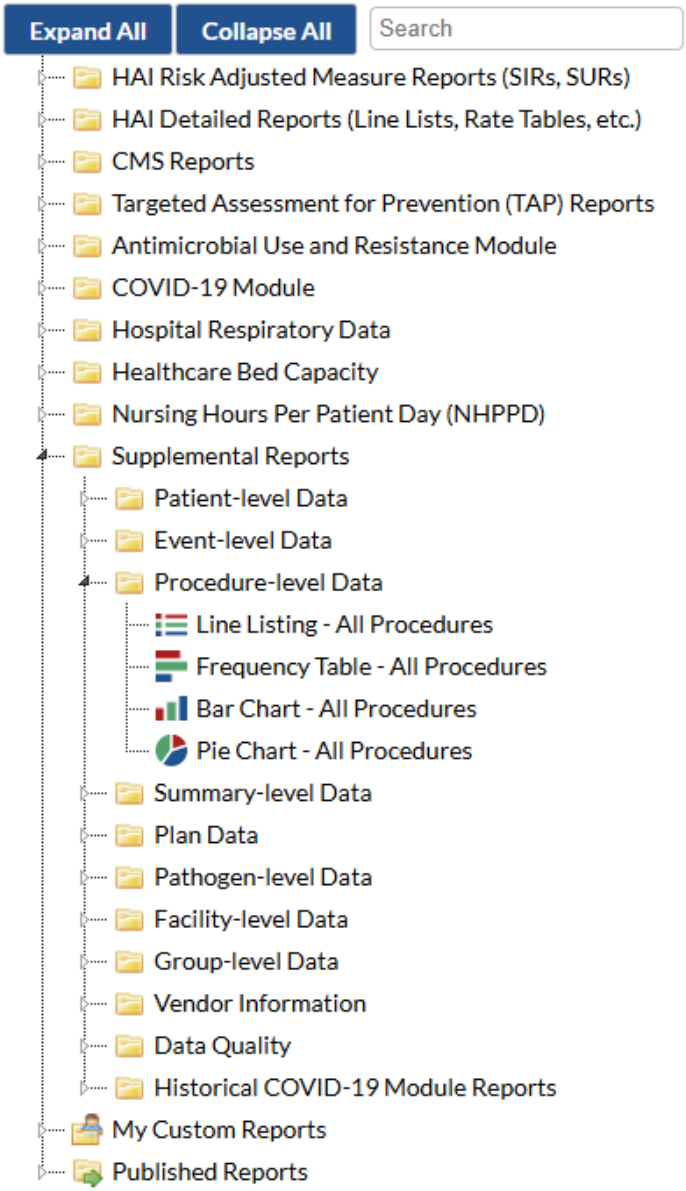
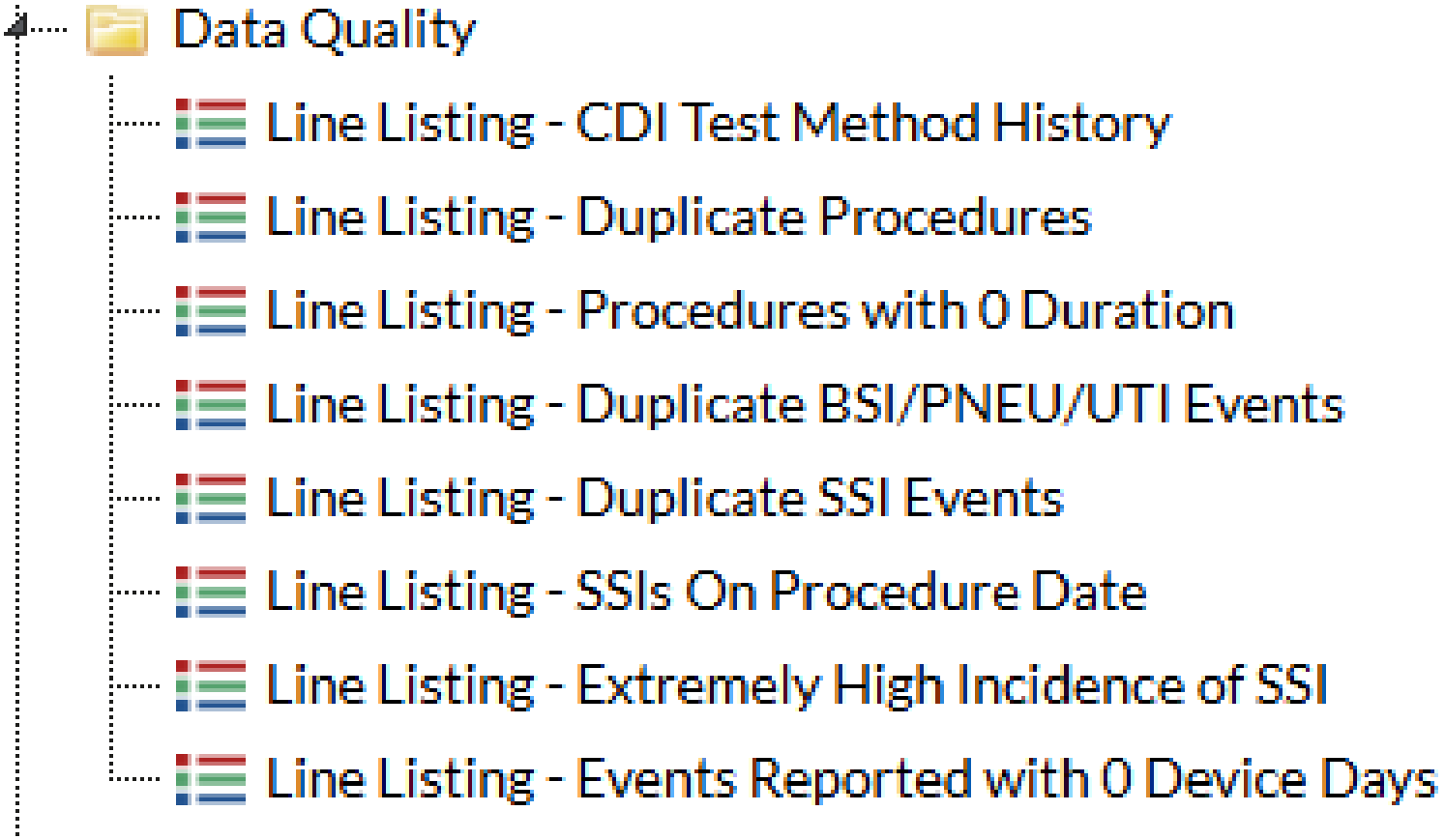
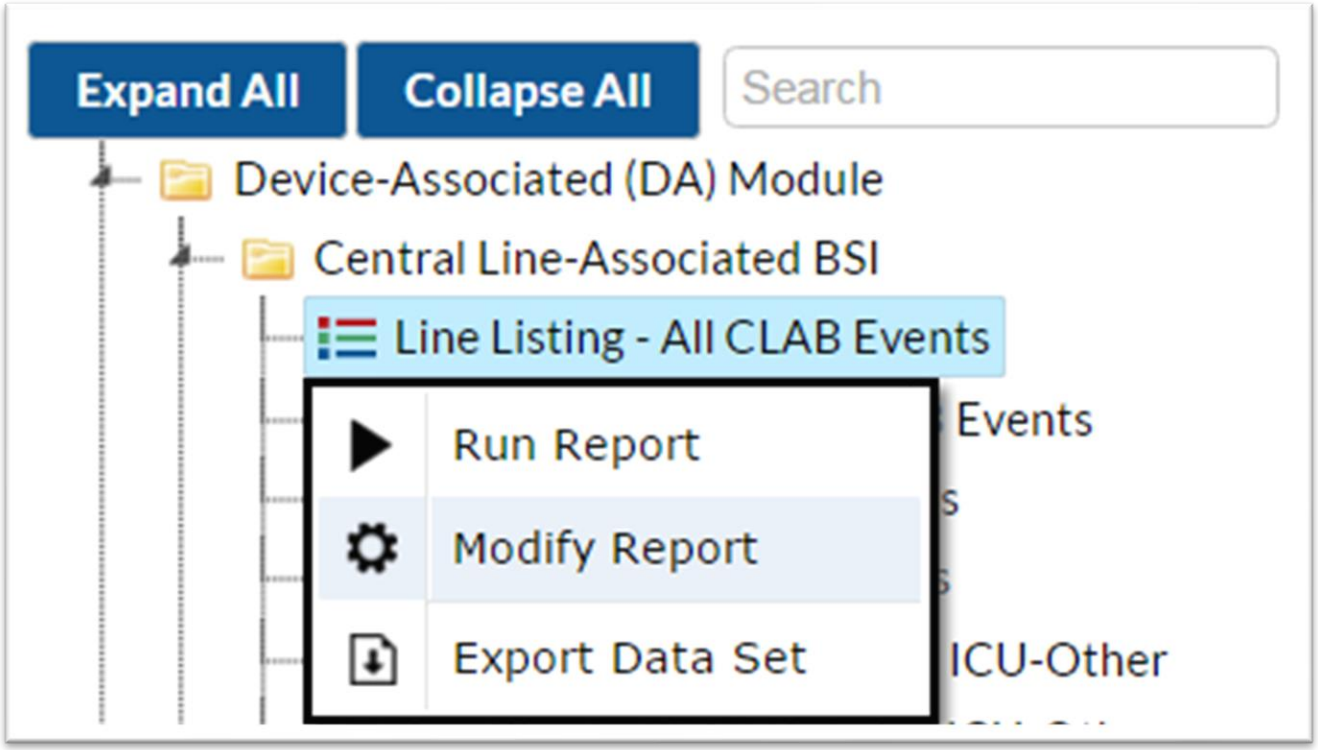


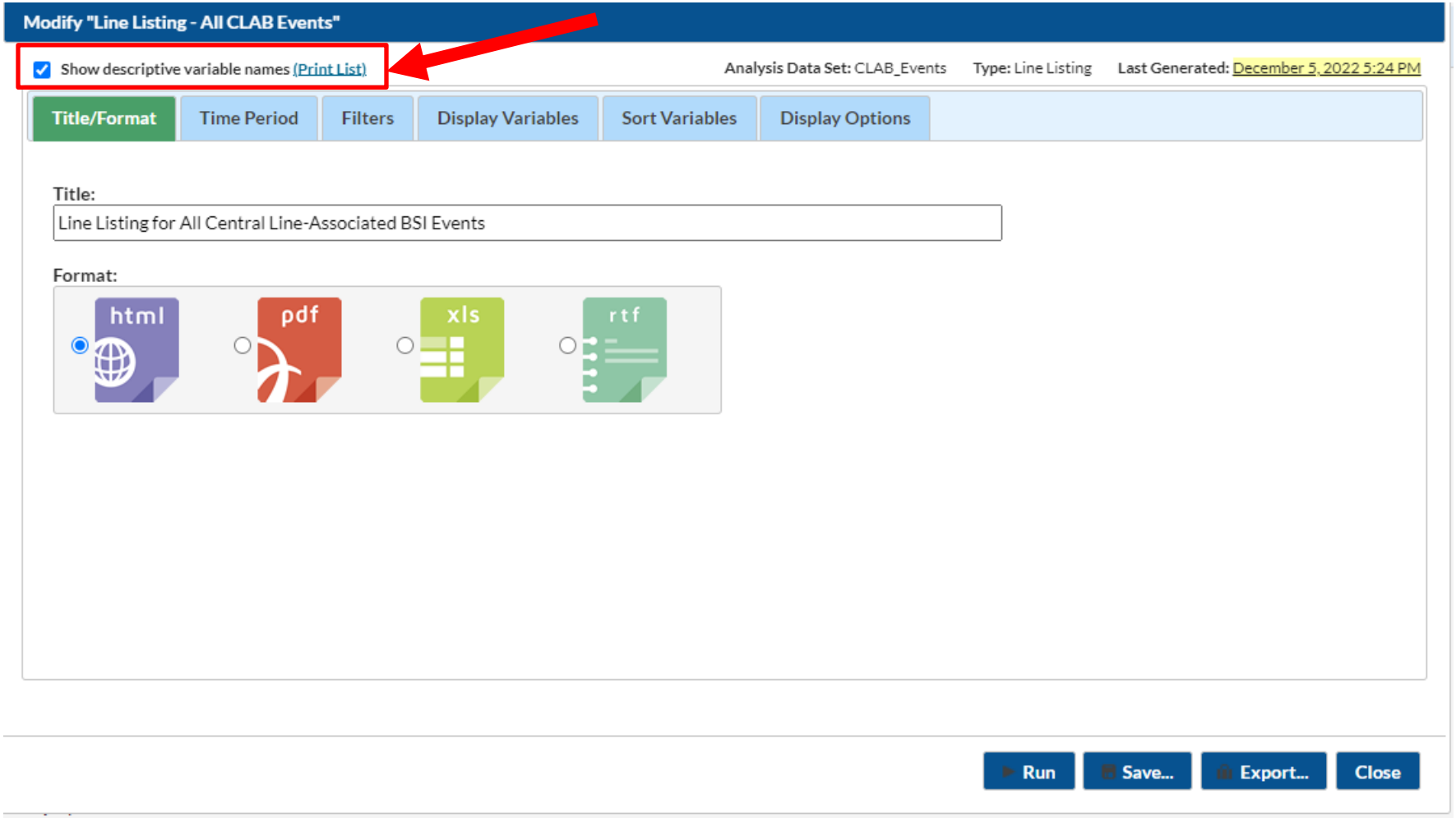
Specialized Reports (Data Quality)



Modifying Report (Line Listing)



Modifying Report (Line Listing)



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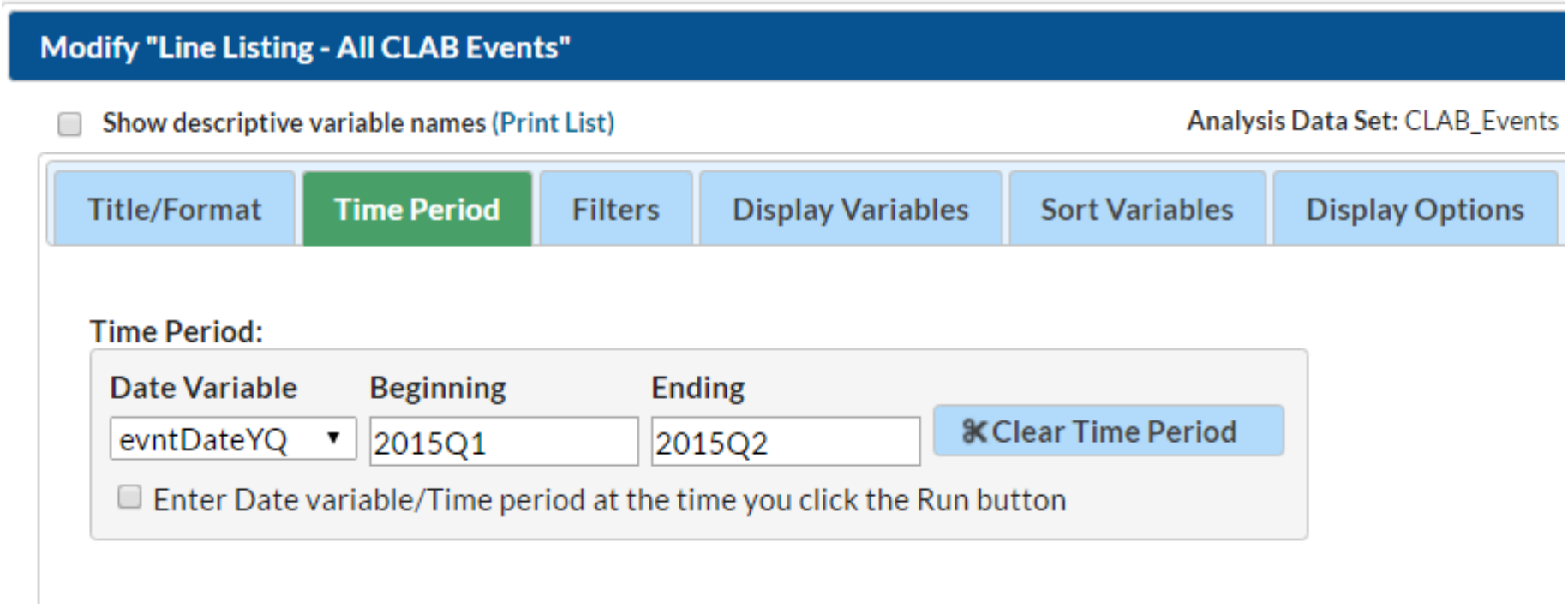

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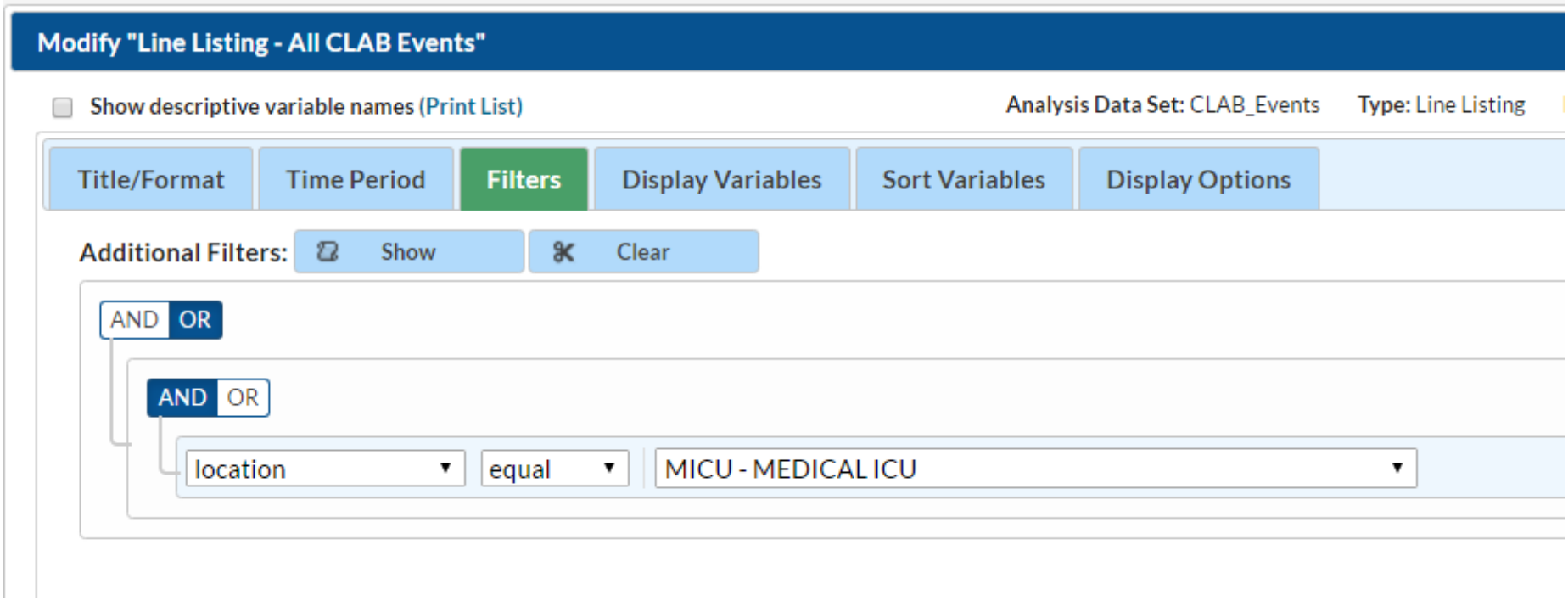

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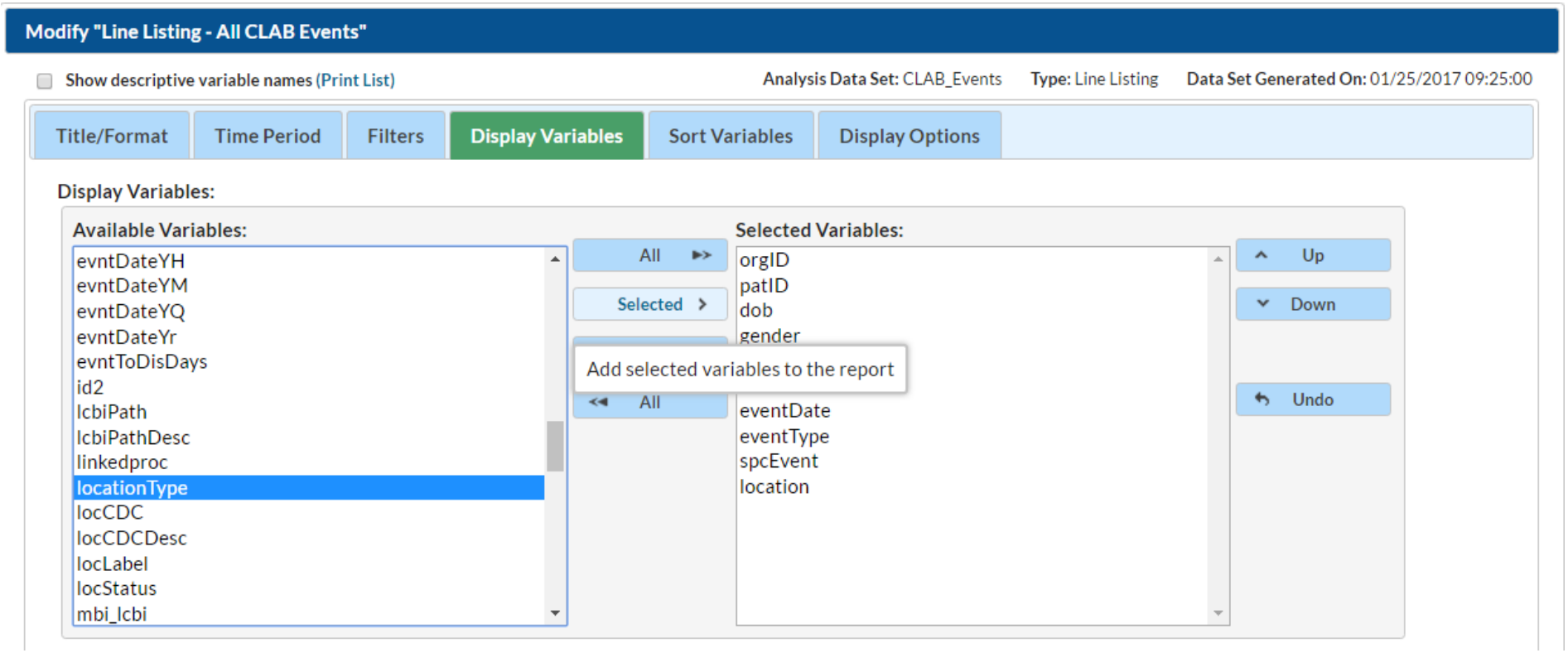

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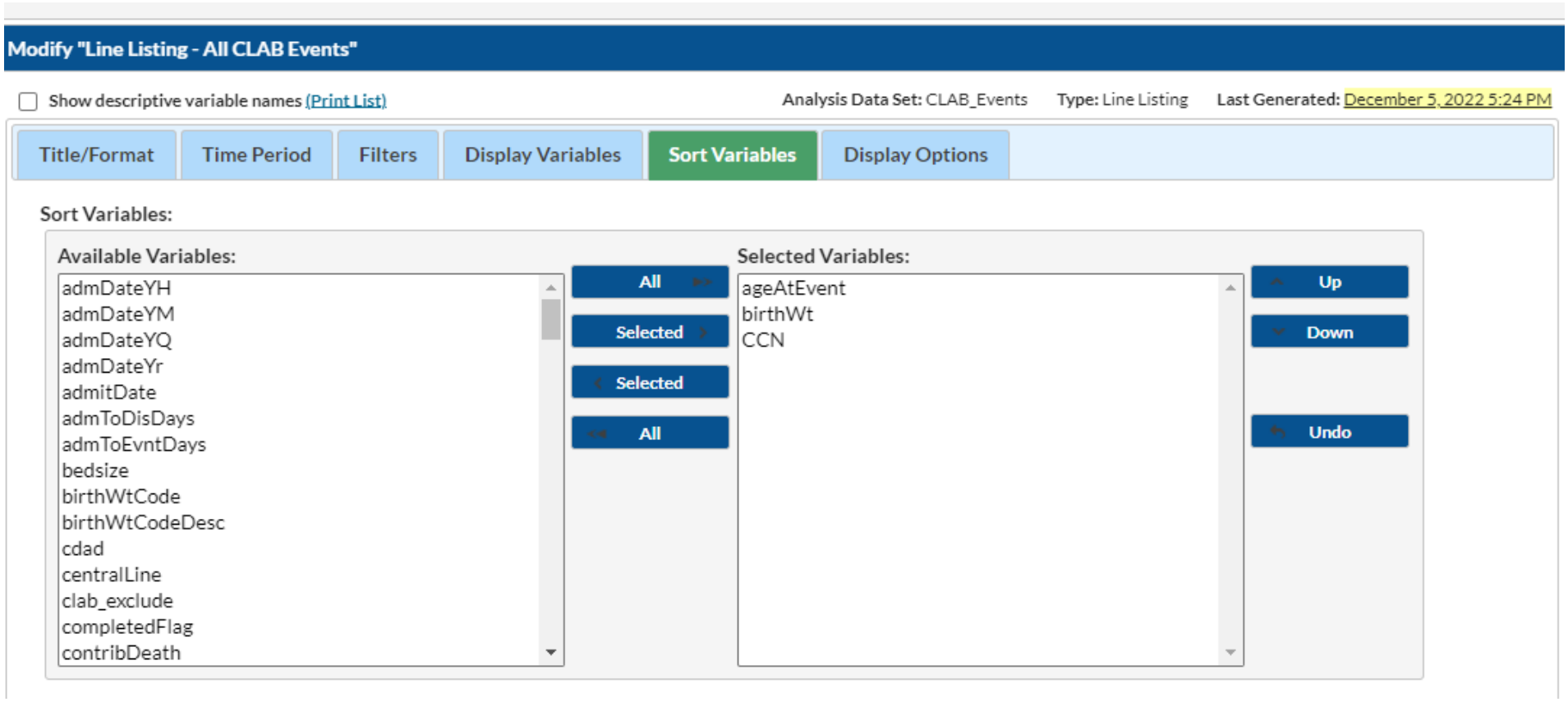
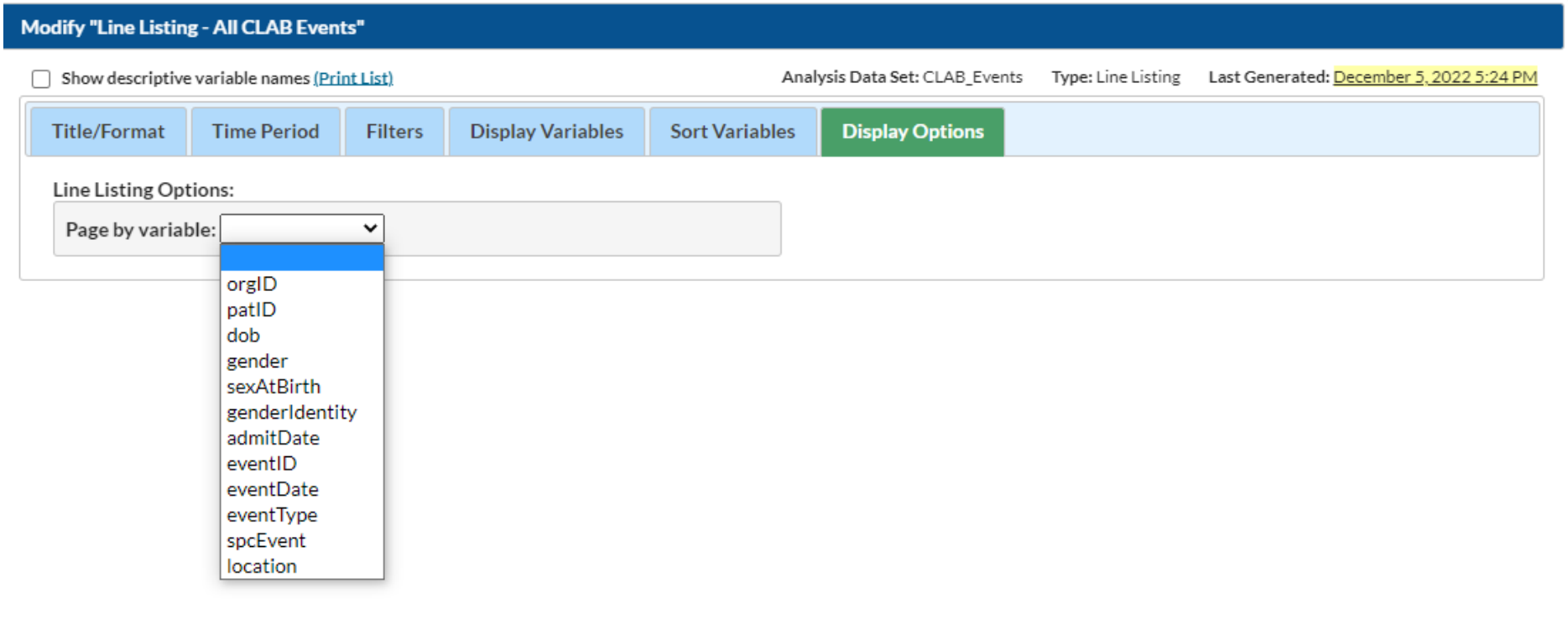
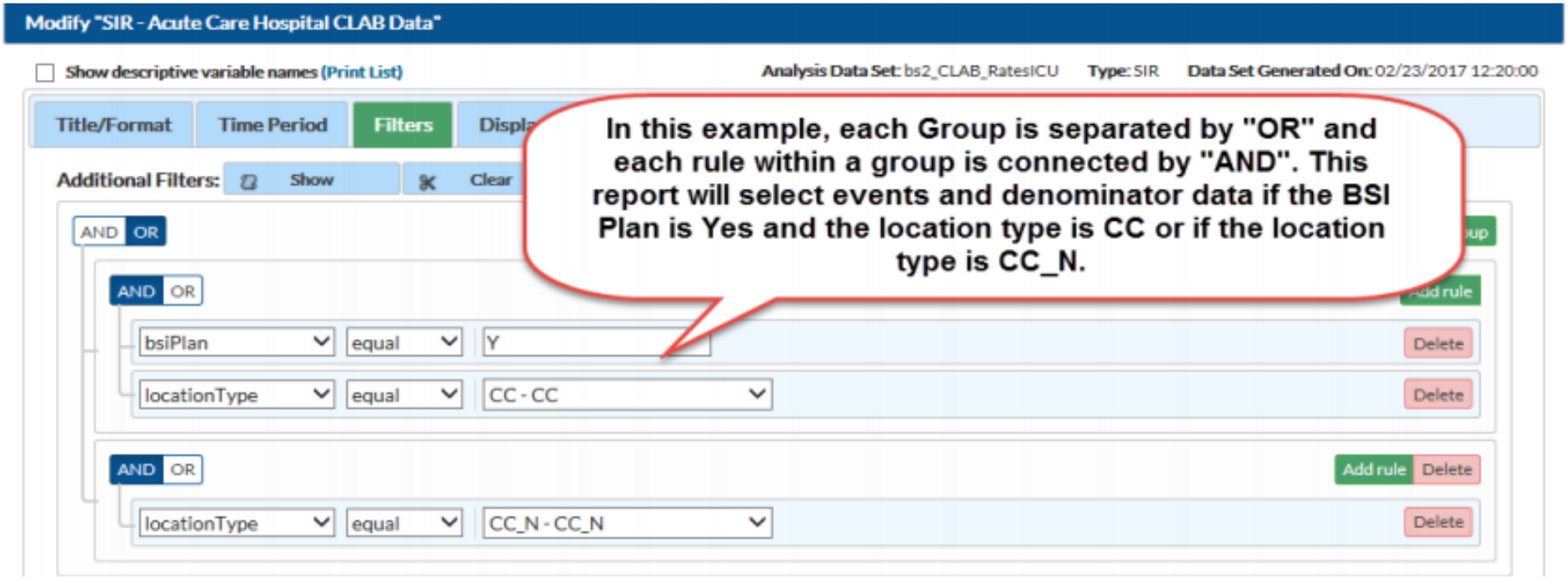


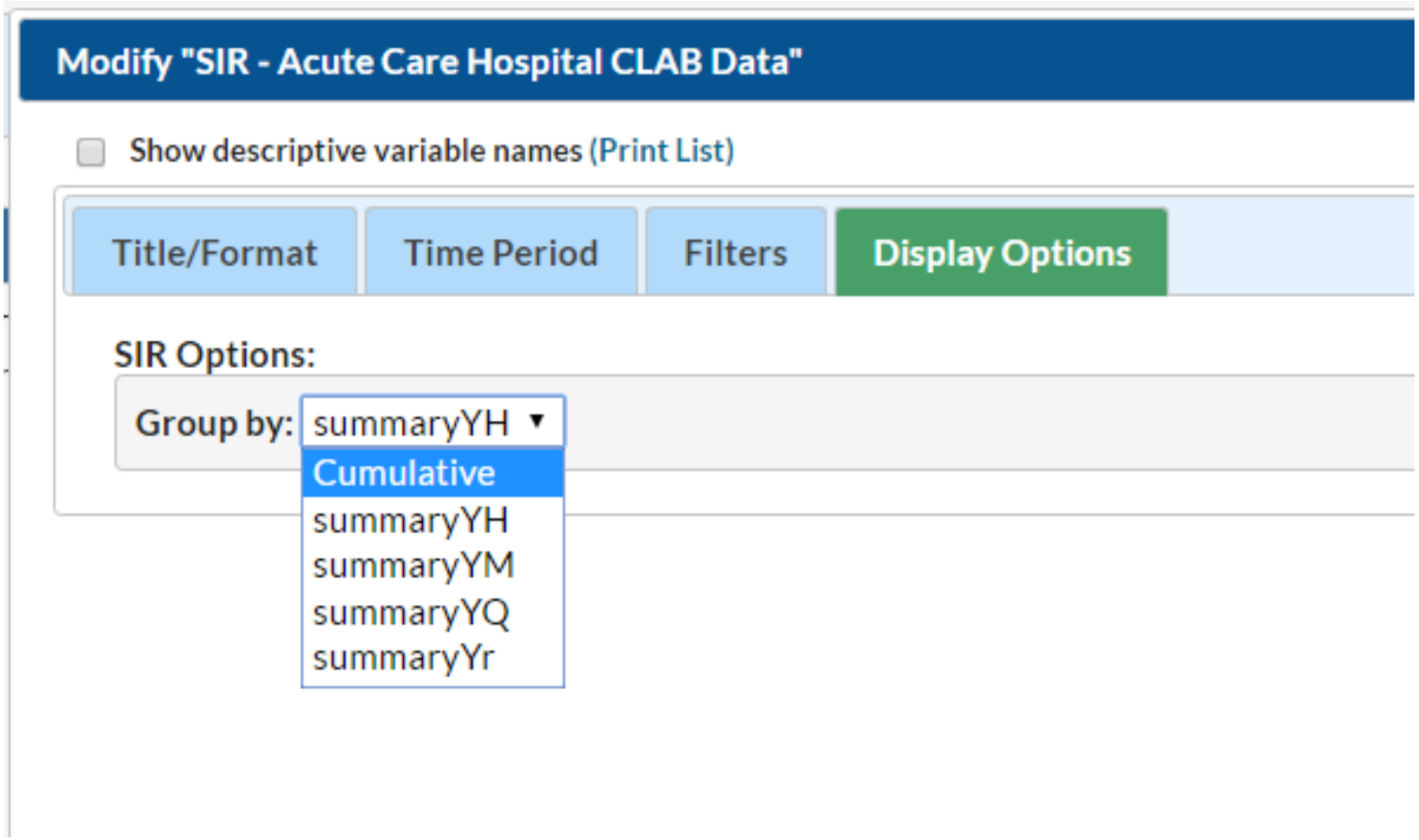
Modifying Report (Line Listing)



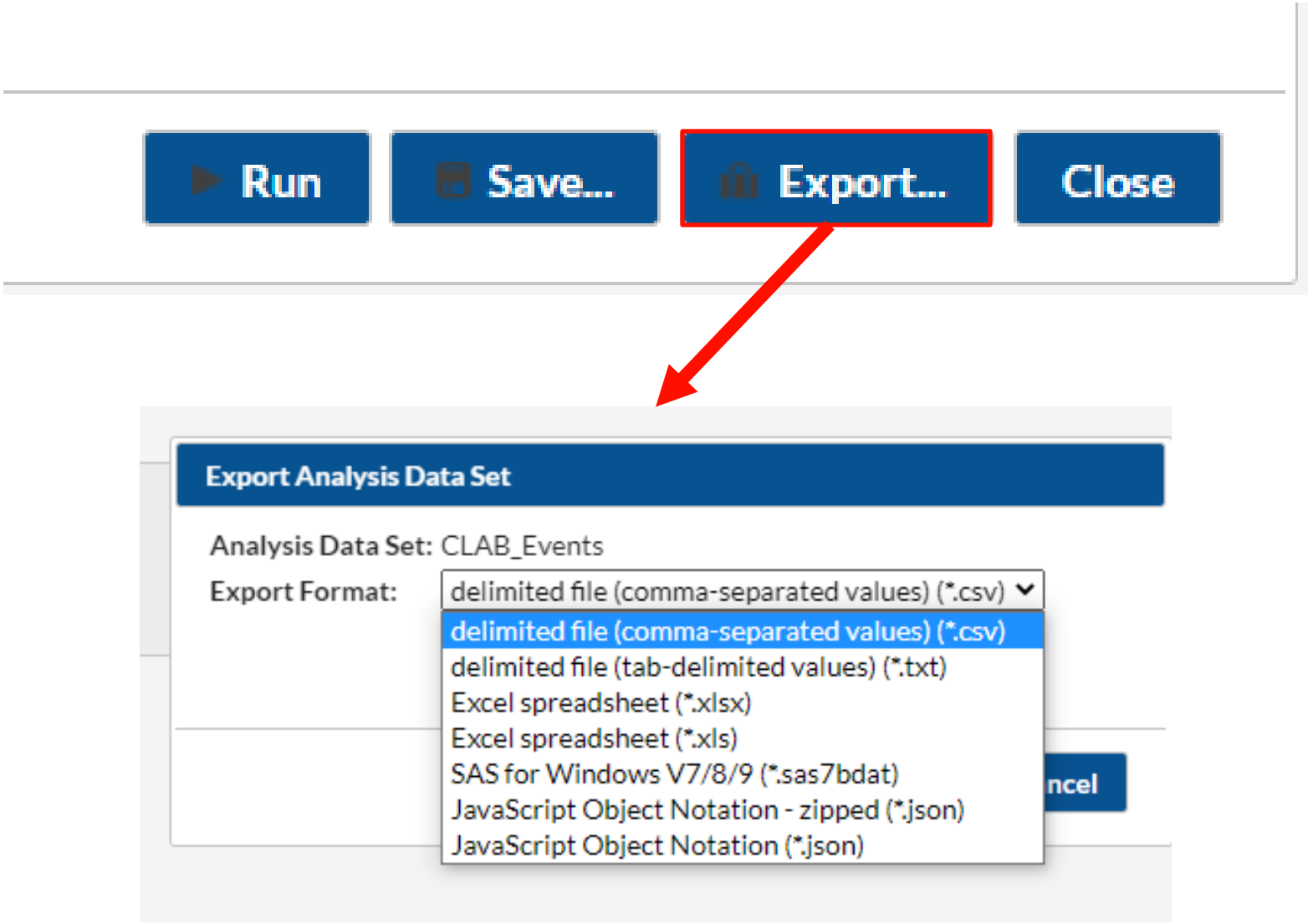
Modifying Report (SIR Report)



Modifying Report (SIR Report)



Viewing Report



Interpreting Report (SIR Report – Option "Run")

National Healthcare Safety Network

SIR for Central Line-Associated BSI Data for Acute Care Hospitals (2015 baseline) - By OrgID

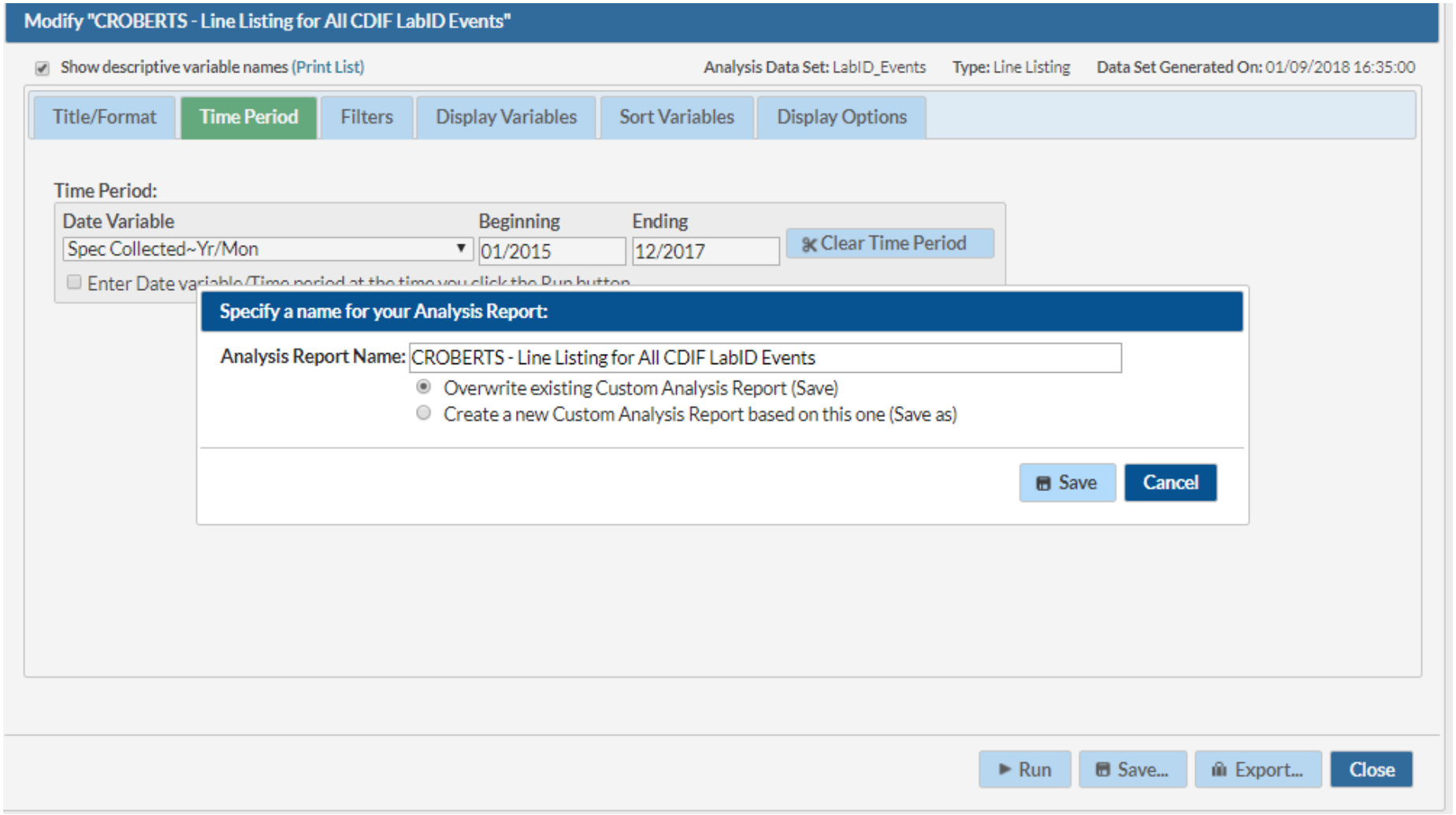
As of: March 10, 2017 at 9:58 AM

Date Range: BS2_CLAB_RATESALL summaryYr 2015 to 2015

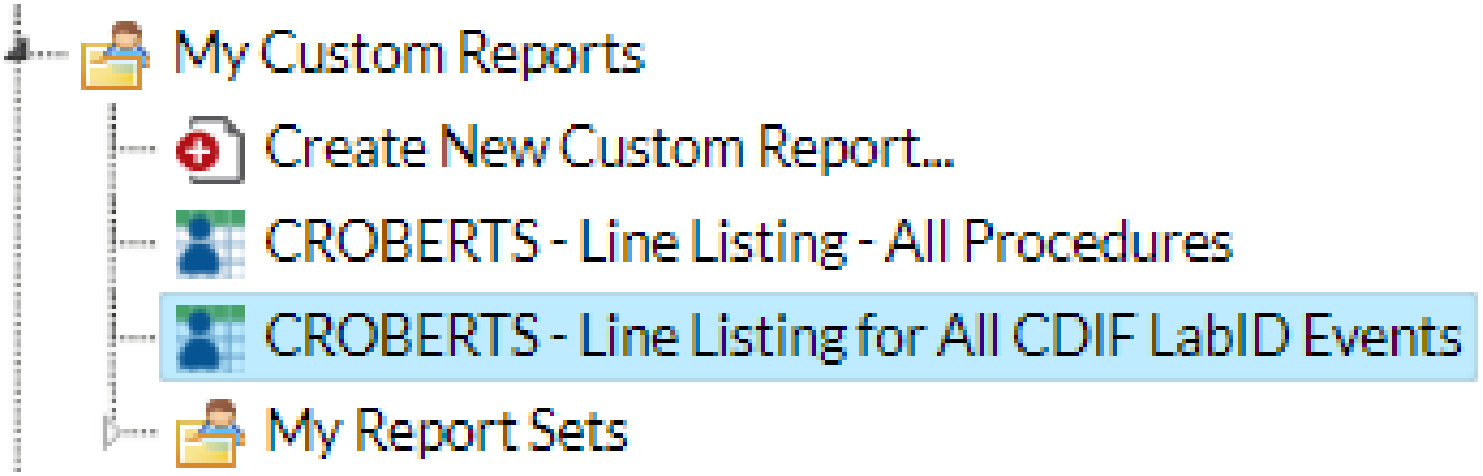
orgID=10000 CCN=32M22222 medType=M

orgID	summaryYQ	infCount	numPred	numcldays	SIR	SIR_pval	sir95ci
10000	2015Q1	4	1.903	1917	2.102	0.1701	0.668, 5.070
10000	2015Q2	4	2.310	2018	1.731	0.2878	0.550, 4.176
10000	2015Q3	0	0.026	32	.	.	
10000	2015Q4	0	0.042	49	.	.	

Creating a Custom Report



Creating a Custom Report



NHSN Resources

Analysis Tools

- A Guide to the Standardized Infection Ratio
- A Guide to the Standardized Utilization Ratio
- AR Option Standardized Resistant Infection Ratio Guide
- AR Option Pathogen-specific Standardized Infection Ratio Guide
- NHSN Patient Safety Component Analysis Quick References Guides

General Tools

- 2025 Patient Safety Component Manual
- Charting the Course: 2022 NHSN HAI Rebaseline
- CDC's Rebaseline Project FAQ

Contact

- **NHSN Related**
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  - Vicky.Lindsey@tn.gov
- **Infection Prevention**
  - HAI.Health@tn.gov