

Steps to Calculate Rates and Measurements (Joint Commission Performance Measurement Systems Only)

Introduction

Episode of care (EOC) level national hospital quality measure outcomes (category assignments and measurements) must be summarized for submission to the Joint Commission. The examples presented in this section explain how the *Measure Category Assignment* and *Measurement Value*, based on EOC-level data, are used to calculate Health Care Organization (HCO)-level rates and values for national hospital quality measures. Refer to the Data Dictionary section of this manual for an explanation of *Measure Category Assignment* and *Measurement Value*.

To calculate rates and measurements for proportion (rate-based) and continuous variable national hospital quality measures for discrete time periods, use the EOC record's *Discharge Date* to determine if the EOC record falls within the desired time period.

For additional information, please refer to the Data Dictionary section of the *ORYX[®] Technical Implementation Guide*. The two possible measure types for ORYX measures, proportion (rate based) and continuous variable are discussed. It also provides additional high-level examples of how EOC-level data are summarized.

National Hospital Quality Measure Data Elements

In addition to calculating rates and measurements, for proportion and continuous variable measures, measurement systems need to calculate five data elements related to data quality for transmission to the Joint Commission. These HCO-level ORYX transmission data elements are used to assess missing data, initial population size and to determine whether a measure is sampled.

- *Number of Cases with Missing or Invalid Population Data*
- *Number of Cases with Missing or Invalid Numerator Data*
- *Number of Cases with Missing or Invalid Risk Adjustment Data*
- *ICD Population Size*
- *Sample*

Refer to the Missing and Invalid Data section, the Sampling section and the *ORYX Technical Implementation Guide* for more information on these data elements required for national hospital quality measures.

A list of all the possible *Measure Category Assignments* for national hospital quality measures:

Category A = case contains missing or invalid data which prevents assignment to the measure population

Category B = case does not belong in the measure population

Category C = case is in the measure population, but contains missing or invalid data which prevents assignment to the numerator population

*Category D = case is in the measure population (i.e., a component of the **denominator** for measures reported as a proportion and “In measure population” for measures reported as a continuous variable)*

*Category E = case is in the **numerator** population (and is also a subset of the denominator for measures reported as a proportion)*

The following list of possible *Risk Adjustment Category Assignment* values applies only to risk adjusted measures:

Category F= case contains missing or invalid data for one or more risk factor data elements

Category G = case all required risk factor data elements

Proportion (Rate-Based) Measures

Proportion (rate-based) measures (e.g., AMI-9) are generated from count data and describe the frequency with which a clinical event has occurred in a given patient population. They are expressed in terms of a fraction or rate. The numerator is a count of the number of EOC records for patients in the measure population who experienced the event, and the denominator is a count of EOC records satisfying the measure population inclusion criteria. In other words, the numerator is a subset of the denominator. The measure algorithms in the Measure Information section identify the following:

- Numerator cases include only EOC records having a *Measure Category Assignment* of “In Numerator Population” or “Category E”
- Denominator cases include those EOC records having a *Measure Category Assignment* of “In Measure Population” (Category D) plus EOC records with a measure category Assignment of “E” (the numerator is a subset of the denominator). Numerator cases must be added to the number of EOC records with “Category D” because an EOC record can have only one *Measure Category Assignment* per national hospital quality measure (as depicted in the flowcharts (algorithm) in the Measure Information section.)

The general steps to calculate measure rates are described below:

Denominator

1. To establish the denominator population for the *Performance Measure Identifier* in question, identify and count the number of unique EOC records having a *Measure Category Assignment=D* or *Measure Category Assignment=E*.

Numerator

2. To establish the number of events for the numerator, identify and count the number of EOC records having a *Measure Category Assignment = E* from the Denominator in Step #1.

Observed Rate

3. Numerator (Step #2) / Denominator (Step #1)

Note: Where applicable, computations should retain all significant decimals and be rounded to the 6th decimal place for data submission. Rates and associated statistics submitted for ORYX require 6 decimal places.

Example: (AMI-9) Inpatient Mortality

Case No.	Category Assignment	Risk Adjustment Category Assignment	Predicted Value (case-level risk-adjusted rate)	Case-Level Variance
xx1	E	F	0.5	0.5 * 0.5 = 0.25
xx2	A			
xx3	D	F	0.1	0.1 * 0.9 = 0.09
xx4	B			
xx5	D	G	0.2	0.2 * 0.8 = 0.16
xx6	C			
xx7	E	G	0.4	0.4 * 0.6 = 0.24
xx8	D	G	0.3	0.3 * 0.7 = 0.21
Total			0.3 (Mean)	0.95 (Sum)

HCO-Level Data Elements

Number of Denominator Cases = 5

(3 cases with *Measure Category Assignment = D* ‘In Measure Population’
+ 2 cases with *Measure Category Assignment = E* ‘In Numerator Population’)

Number of Numerator Cases = 2

(2 cases with *Measure Category Assignment = E* ‘In Numerator Population’)

Observed Rate = 2 / 5 = 0.4

Risk-Adjusted Rate = 0.3

Standard Deviation of Risk-Adjusted Rate = SQRT (0.95) / 5 = 0.194936

Number of Cases with Missing or Invalid Population Data = 1

(1 case with *Measure Category Assignment = A*)

Number of Cases with Missing or Invalid Numerator Data = 1

(1 case with *Measure Category Assignment = C*)

Number of Cases with Missing or Invalid Risk Adjustment Data = 2

(2 cases with *Risk Adjustment Data = F*)

Number of Cases with Missing or Invalid Risk Adjustment Data = 3
(3 cases with Risk Adjustment Data = G)

ICD Population Size = 8

(case level records identified for this measure based on ICD-9-CM codes prior to filters, exclusions, and/or sampling)

Note: Episodes of care with a Measure Category Assignment of “B” are not included in the measure population, but they will be included in the ICD Population Size count.

Note: The case-level risk-adjusted rate is obtained using a risk adjustment model that considers various confounding factors.

Continuous Variable Measures

Continuous variable measures report the measurement value for a clinical process anywhere along a continuous scale. The population described in the measure statement establishes which EOC records are eligible for inclusion in the measure. The measurement is the value calculated in the measure’s algorithm for all EOC records in the measure population.

EOC records that have missing critical data needed to determine measure population inclusions or have missing data elements required to calculate the measurement are excluded. These excluded records have a *Measure Category Assignment* of “Missing or Invalid Measure Population Data” or “Category A”. When aggregating EOC records for continuous variable measures, the measurement system should calculate additional statistical data (e.g., mean, median, standard deviation, minimum, maximum, etc.), in addition to the measurement values. These statistical data are calculated to produce HCO-level data elements that are submitted to the Joint Commission. Definitions of the required HCO-level data elements appear in the *ORYX Technical Implementation Guide*. The general steps to calculate a continuous variable measure are described below.

Population (described on the Measure Information Form in the Continuous Variable Statement)

1. For the *Performance Measure Identifier* in question, identify and count the number of EOC records in the measure population or having a *Measure Category Assignment*=D.

Measurement

2. For all EOC records in Step #1, identify and calculate the sum of the *Measurement Value* (the sum will be used in the statistical calculations in the example below).

Example: (AMI-7) Mean time to Thrombolysis

Case Identifier	Measure Category Assignment	Measurement Value [Time (minutes) to Thrombolysis]	Predicted Value (case-level risk-adjusted value)	Case-Level Difference between Obs. And Pred.
1	D	30	25	30 - 25 = 5
2	A			
3	D	50	30	50 - 30 = 20
4	A			
5	D	20	25	20 - 25 = -5

6	B			
7	D	30	34	30 - 34 = -4
8	D	10	4	10 - 4 = 6
Total		28 (Mean)	23.6 (Mean)	4.4 (Sum)

Note: Example only, Performance Measure (AMI-7) is not a risk-adjusted measure.

HCO-Level Data Elements

Number of Cases = 5 (5 cases with a Measure Category Assignment of D ‘In Measure Population’)

Use the national hospital quality measure data element *Measurement Value* to calculate the following HCO-level data elements:

Mean of All Case-level Observed Values = 28

Maximum of All Case-level Observed Values = 50

Median of All Case-level Observed Values = 30

Minimum of All Case-level Observed Values = 10

Standard Deviation of All Case-level Observed Values = SQRT [{(30-28)² + (50-28)² + (20-28)² + (30-28)² + (10-28)² } / (5-1)] = 14.832397

Mean of All Case-level Risk-Adjusted Values = 23.6

Maximum of All Case-level Risk-Adjusted Values = 34

Median of All Case-level Risk-Adjusted Values = 25

Minimum of All Case-level Risk-Adjusted Values = 4

Standard Deviation of All Case-level Risk-Adjusted Values = SQRT [{(25-23.6)² + (30-23.6)² + (25-23.6)² + (34-23.6)² + (4-23.6)² } / (5-1)] = 11.588788

Standard Deviation of All Case-level Differences Between the Observed and Risk-Adjusted Values = SQRT [{5 - 4.4)² + (20 - 4.4)² + (-5 - 4.4)² + (-4 - 4.4)² + (6 - 4.4)² } / (5-1)] = 10.064790

Number of Cases with Missing or Invalid Population Data = 2

(2 cases with Measure Category Assignment = A ‘Missing or Invalid Population Data’)

ICD Population Size = 8

(case-level records identified for this measure based on ICD-9-CM codes prior to filters, exclusions, and/or sampling).

Stratified National Hospital Quality Measures

Stratified measures differ from non-stratified measures in that there is an overall rate and individual rates for each strata or subgroup. The overall rate is calculated using all cases that fall into the measure population. Strata or subcategory rates are calculated using only those cases that meet the discrete criteria for that subcategory. The overall rate and each stratified rate have a unique *Performance Measure Identifier* to facilitate ORYX reporting.

Example: SIP-2 Prophylactic Antibiotic Selection for Surgical Patients

Set Measure ID #	Transmission ID #	Strata	Measure Category Assignment	RA Category Assignment
SIP-2a	14666	Overall rate – all surgical procedures	Must be assigned for all records	Not applicable to SIP-2 (not a risk adjusted measure)
SIP-2b	14667	CABG		
SIP-2c	14668	Cardiac Surgery		
SIP-2d	14669	Hip Arthroplasty		
SIP-2e	14670	Knee Arthroplasty		
SIP-2f	14671	Colon Surgery		
SIP-2g	14672	Hysterectomy		
SIP-2h	14673	Vascular Surgery		

SIP-2, Prophylactic Antibiotic Selection for Surgical Patients, has an overall rate (SIP-2a) that includes all surgical patients with no evidence of prior infection. Strata or subcategory rates are calculated by reporting the prophylactic antibiotic selection rates subcategorized by discrete surgical procedures (SIP-2b through SIP-2h). To calculate rates for measures SIP-2b through SIP-2h, only cases with a *Type of Surgery* allowable value corresponding to the unique strata are included. Please refer to the Data Dictionary for more details on *Type of Surgery* and the list of allowable values.

Example: SIP-2 Prophylactic Antibiotic Selection for Surgical Patients (continued)
 SIP-2 data for a hospital with 40 surgical procedures during a specific month

Case No.	Type of Surgery	Measure Cat. Assign. for SIP-2a (Overall Rate)	Measure Category Assignment (Strata)						
			SIP-2b Type of Surgery = 1	SIP-2c Type of Surgery = 2	SIP-2d Type of Surgery = 3	SIP-2e Type of Surgery = 4	SIP-2f Type of Surgery = 5	SIP-2g Type of Surgery = 6	SIP-2h Type of Surgery = 7
1	2	E	B	E	B	B	B	B	B
2	6	E	B	B	B	B	B	E	B
3	4	E	B	B	B	E	B	B	B
4	1	E	E	B	B	B	B	B	B
5	1	D	D	B	B	B	B	B	B
6	1	E	E	B	B	B	B	B	B
7	2	E	B	E	B	B	B	B	B
8	7	E	B	B	B	B	B	B	E
9	1	E	E	B	B	B	B	B	B
10	4	B	B	B	B	B	B	B	B
11	6	E	B	B	B	B	B	E	B
12		A	B	B	B	B	B	B	B
13	2	B	B	B	B	B	B	B	B
14	4	E	B	B	B	E	B	B	B
15	3	E	B	B	E	B	B	B	B
16	1	D	D	B	B	B	B	B	B
17	3	E	B	B	E	B	B	B	B
18	5	E	B	B	B	B	E	B	B
19	5	E	B	B	B	B	E	B	B
20	1	C	B	B	B	B	B	B	B
21	5	E	B	B	B	B	E	B	B
22	4	E	B	B	B	E	B	B	B
23	5	D	B	B	B	B	D	B	B
24	2	B	B	B	B	B	B	B	B
25	2	E	B	E	B	B	B	B	B
26	1	D	D	B	B	B	B	B	B
27	5	E	B	B	B	B	E	B	B
28		B	B	B	B	B	B	B	B
29		B	B	B	B	B	B	B	B
30	7	E	B	B	B	B	B	B	E
31	3	E	B	B	E	B	B	B	B
32	2	E	B	E	B	B	B	B	B
33	2	E	B	E	B	B	B	B	B
34	5	E	B	B	B	B	E	B	B
35	6	E	B	B	B	B	B	E	B
36	4	B	B	B	B	B	B	B	B
37	5	B	B	B	B	B	B	B	B
38	3	B	B	B	B	B	B	B	B
39	7	E	B	B	B	B	B	B	E
40	5	E	B	B	B	B	E	B	B
Total D + E		30	6	5	3	3	7	3	3
Total E		26	3	5	3	3	6	3	3
Rate		0.866667	0.5	1.0	1.0	1.0	0.857143	1.0	1.0
Total A		1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total C		1	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Assigning Stratified Measure Category Assignments

When the *Measure Category Assignment* for the overall rate (SIP-2a) = ‘D’ (in measure population) or ‘E’ (in numerator population), the appropriate strata measure (SIP-2b through SIP-2h) is assigned the same *Measure Category Assignment* as the overall rate. The remaining strata measure’s are assigned a *Measure Category Assignment* = ‘B’ (not in measure population).

When the *Measure Category Assignment* for the overall rate (SIP-2a) = ‘B’ (not in measure population), all of the strata measures are assigned a ‘B’ (not in measure population) *Measure Category Assignment*.

Missing/Invalid data counts are only performed for the overall measure rate. Therefore, when the *Measure Category Assignment* for the overall rate (SIP-2a) = ‘A’ (missing measure population data) or ‘C’ (missing numerator data), all of the strata measures are assigned a ‘B’ (not in measure population) *Measure Category Assignment*.

Note: For risk adjusted measures, the *Risk Adjustment Category Assignment* is also calculated, when the *Measure Category Assignment* for the overall rate measure = ‘D’ or ‘E’. The *Risk Adjustment Category Assignment* is the same for the overall rate and each strata measure. The *Risk Adjustment Category Assignment* is not calculated for risk adjusted measures when the measure’s *Measure Category Assignment* = ‘A’, ‘B’, or ‘C’.

Examples

Case # 1 –

Measure Category Assignment for SIP-2a = ‘E’
Measure Category Assignment for SIP-2c = ‘E’ because
Type of Surgery = 2 (Cardiac Surgery)

Measure Category Assignment for SIP-2b, SIP-2d, SIP-2e, SIP-2f, SIP-2g
and SIP-2h = ‘B’ (not in measure population)

Risk Adjustment Category Assignment: Not applicable

Case # 5 –

Measure Category Assignment for SIP-2a = ‘D’
Measure Category Assignment for SIP-2b = ‘D’ because
Type of Surgery = 1 (CABG)

Measure Category Assignment for SIP-2c, SIP-2d, SIP-2e, SIP-2f, SIP-2g
and SIP-2h = ‘B’ (not in measure population)

Risk Adjustment Category Assignment: Not applicable

Case # 10 –

Measure Category Assignment for SIP-2a = ‘B’
Measure Category Assignment for SIP-2b, SIP-2c, SIP-2d, SIP-2e, SIP-2f,
SIP-2g and SIP-2h = ‘B’ (not in measure population)

Risk Adjustment Category Assignment: Not applicable

Case # 12 – *Measure Category Assignment* for SIP-2a = ‘A’
Measure Category Assignment for SIP-2b, SIP-2c, SIP-2d, SIP-2e, SIP-2f,
SIP-2g and SIP-2h = ‘B’ (not in measure population)

Risk Adjustment Category Assignment: Not applicable

Note: When the *Measure Category Assignment* for the overall rate = ‘A’, ‘B’, or ‘C’, data collection tool skip logic may preclude the need to collect additional data elements, including *Type of Surgery*.

Data Integrity Prior to Algorithm Calculation

Refer to the Missing and Invalid Data section for information regarding how episodes of care with missing and/or invalid data should be handled.

Quarterly Comparison Analysis

The Joint Commission conducts quarterly comparison analysis for both national hospital quality measures and ORYX measure data. This is done by aggregating monthly data points submitted by measurement systems into quarterly data points. Measurement systems are expected to implement similar process as described below.

- Measurement systems may create quarterly data points using patient-level data or by aggregating the monthly HCO-level aggregate data they submitted to the Joint Commission. Tables 1 and 2 describe aggregation rules for key data elements and their aggregation examples.
- After quarterly data are obtained, comparison analysis should be performed using the approach described in the Appendix B of the *Mining ORYX Data 2000*. The data elements listed in Tables 1 and 2 are those used in the comparison analysis.
- If some monthly data are missing for a quarter, systems should use available data to create quarterly data. For example, if January data point is missing, February and March data should be used to create the first quarter data. If both January and February data are missing, systems should use March data as the first quarter data.
- Control charts will still depict monthly data points. Measurement systems must continue to submit monthly data points to the Joint Commission.

Analysis of Time-to-Event National Hospital Quality Measures

There are three time-to-event measures in the initial set of national hospital quality measures. They include mean time to Thrombolysis (AMI-7), mean time to PCI (AMI-8) and antibiotic timing (mean) (PN-5). The analysis of time to event measures (control chart and comparison analysis) will be performed based on mean and standard deviation as described in the *Mining ORYX Data 2000*.

**Table 1. HCO-Level Data Elements
(For National Hospital Quality and other ORYX Measures)**

Data Element	Aggregation Rule	Example	
		Monthly Data	Quarterly Data
Number of Denominator Cases (ZR201)	Sum of denominator cases (or denominator component for ratio)	5, 10, 15	$5+10+15=30$
Number of Numerator Cases (ZR202)	Sum of numerator cases (or numerator component for ratio)	2, 4, 9	$2+4+9=15$
Observed Rate (ZR203)	Sum of numerator cases divided by sum of denominator cases (or weighted average of observed rates, where the weight is the number of denominator cases)	0.4, 0.4, 0.6	$(2+4+9)/(5+10+15) = 0.5$ or $(0.4*5+0.4*10+0.6*15)/(5+10+15)=0.5$
Risk Adjusted Rate (ZR205)	Weighted average of risk adjusted rates, where the weight is the number of denominator cases	0.6, 0.3, 0.4	$(0.6*5+0.3*10+0.4*15)/(5+10+15)=0.4$
Number of Cases (ZC201)	Sum of number of cases	15, 10, 5	$15+10+5=30$
Mean of All Case-Level Observed Values (ZC202)	Weighted average of mean observed values, where the weight is the number of cases	50, 55, 40	$(50*15+55*10+40*5)/(15+10+5)=50$
Standard Deviation of All Case-Level Observed Values (ZC206)	Square root of [sum of {(number of cases minus 1) times (standard deviation squared)} divided by {(sum of number of cases) minus (number of non-missing monthly data points)}]	20, 20, 20	$\text{SQRT}[\{(15-1)*20^2+(10-1)*20^2+(5-1)*20^2\}/\{(15+10+5)-3\}]=20$
Mean of All Case-Level Risk-Adjusted Values (ZC207)	Weighted average of mean risk adjusted values, where the weight is the number of cases	40, 45, 30	$(40*15+45*10+30*5)/(15+10+5)=40$

**Table 2. Comparison Group-Level Data Elements
(For ORYX Measures that are not National Hospital Quality Measures)**

Data Element	Aggregation Rule	Example	
		monthly data	quarterly data
Total Number of Denominator Cases (ZR101)	Sum of total denominator cases (or total denominator component for ratio)	50, 100, 150	$50+100+150=300$
Total Number of Numerator Cases (ZR106)	Sum of total numerator cases (or total numerator component for ratio)	20, 40, 90	$20+40+90=150$
Overall Observed Rate (ZR115)	Sum of total numerator cases divided by sum of total denominator cases (or weighted average of overall observed rates, where the weight is the total number of denominator cases)	0.4, 0.4, 0.6	$(20+40+90)/(50+100+150) = 0.5$ or $(0.4*50+0.4*100+0.6*150)/(50+100+150)=0.5$
Total Number of Cases (ZC101)	Sum of total number of cases	150, 100, 50	$150+100+50=300$
Overall Mean Observed Value (ZC110)	Weighted average of overall mean observed values, where the weight is the total number of cases	50, 55, 40	$(50*150+55*100+40*50)/(150+100+50)=50$