

1b.2. Provide performance scores on the measure as specified (current and over time) at the specified level of analysis.

The STS Congenital Heart Surgery Database currently represents >90% of all US centers performing congenital heart surgery. Pre-operative, operative and outcomes data are collected on all patients undergoing pediatric and congenital heart surgery at participating centers. Coding is performed by clinicians and trained data managers using the International Pediatric and Congenital Cardiac Code. Data quality and reliability are evaluated through intrinsic verification of data (e.g. identification and correction of missing/out of range values and inconsistencies in values across fields), and a formal process of site visits and data audits at ~10% of participating institutions annually. The Duke Clinical Research Institute serves as the data warehouse and analysis center for all of the STS National Databases.

The model's target population includes patients of all ages undergoing a congenital cardiac operation with or without cardiopulmonary bypass. Both pediatric and adult patients are included in order to allow assessing outcomes across each institution's entire case mix. The analysis is limited to procedure types that have been assigned to a STAT Mortality Category and only the first (index) cardiac operation of each hospital admission is analyzed. Participating sites are excluded if they have >10% missing data for key covariates (preoperative factors, non-cardiac abnormalities, genetic syndromes, prior cardiothoracic operations, prematurity) or have >10% missing or unknown operative mortality status. In addition, participating sites must have ≤10% missing mortality data for operations performed in 2015, ≤5% missing mortality data for operations performed in 2016, and ≤2% missing mortality data for operations performed in 2017 or later. At the patient level, the analysis excludes operations on infants <2.5 kg undergoing isolated ductus arteriosus ligation, patients with missing or invalid data for key variables (operative mortality, age, sex, or weight), records collected under an obsolete data collection form prior to STS version 3.0.

For the current NQF update, we used STS data from two 4-year time periods:

- Time Period #1. January 1, 2010 – December 31, 2013 (4 years)
 - N = 52,224 operations
 - N = 86 participants
- Time Period #2. July 1, 2014 – June 30, 2018 (4 years)
 - N = 89,677 operations
 - N = 105 participants

Note: Results for Time Period #1 are from our prior submission of this measure in 2015.

Each participant's expected mortality rate was obtained by averaging the predicted probability of death according to the model across all patients at the participant who met the measure's inclusion and exclusion criteria. The O/E ratio was then calculated as $O/E = (\text{actual observed mortality rate}) / (\text{expected mortality rate})$. A 95% confidence interval CI for the O/E ratio was calculated by treating the observed number of deaths as a binomial random variable and treating the expected number of deaths as constant. An O/E ratio > 1.0 implies that the participant had more deaths than was expected in light of the participant's case mix whereas an O/E ratio < 1.0 implies that the number of deaths was fewer than expected in light of the participant's case mix.

Distribution of Participant-Specific Observed-to-Expected (O/E) Ratios

Time Period #1. Jan 2010 – Dec 2013

	# of		Std.	Range		Inter-Quartile Range	
	sites	Mean	Dev.	Min	Max	25%	75%
All sites	86	1.13	0.58	0.00	3.70	0.79	1.36
Sites with ≥ 100 eligible records	78	1.17	0.55	0.25	3.70	0.79	1.35
Sites with ≥ 200 eligible records	64	1.08	0.35	0.51	1.98	0.79	1.3

	Percentiles								
	10%	20%	30%	40%	50%	60%	70%	80%	90%
All sites	0.65	0.73	0.84	0.95	1.05	1.18	1.3	1.44	1.73
Sites with ≥ 100 eligible records	0.68	0.76	0.85	0.96	1.07	1.18	1.3	1.42	1.75
Sites with ≥ 200 eligible records	0.68	0.76	0.84	0.95	1.04	1.12	1.26	1.34	1.58

Time Period #2. Jul 2014 – Jun 2018

	# of		Std.	Range		Inter-Quartile Range	
	sites	Mean	Dev.	Min	Max	25%	75%
All sites	105	1.1	0.44	0	2.28	0.76	1.34
Sites with ≥ 100 eligible records	99	1.1	0.43	0.25	2.28	0.76	1.33
Sites with ≥ 200 eligible records	94	1.1	0.44	0.25	2.28	0.76	1.33

	Percentiles								
	10%	20%	30%	40%	50%	60%	70%	80%	90%
All sites	0.59	0.74	0.85	0.94	1.08	1.21	1.31	1.44	1.71
Sites with ≥ 100 eligible records	0.59	0.74	0.85	0.94	1.07	1.2	1.29	1.4	1.71
Sites with ≥ 200 eligible records	0.59	0.74	0.85	0.94	1.08	1.22	1.29	1.4	1.71

1b.4. Provide disparities data from the measure as specified (current and over time) by population group, e.g., by race/ethnicity, gender, age, insurance status, socioeconomic status, and/or disability. (This is required for endorsement maintenance. Describe the data source including number of measured entities; number of patients; dates of data; if a sample, characteristics of the entities include.) This information also will be used to address the subcriterion on improvement (4b.1) under Usability and Use.

Disparities by race and ethnicity were analyzed using data from two 4-year time periods (Time Period #1: January 2010 – December 2013 and Time Period #2: July 2014 – Jun 3018). For a description of the data source please see Section 1b.2. Disparities by insurance status were analyzed using the subset of records from Time Period #2 that were collected under version 3.3 of the STS data collection form (surgery dates January 1, 2016 – June 30, 2018; N = 55,604 records; N = 103 participants).

Differences in risk-adjusted mortality by race and ethnicity were assessed in each time period by adding indicator variables for race and ethnicity to the risk adjustment model.

Differences in risk adjusted mortality across categories of primary payor (none/self-pay, Medicaid, other) were analyzed by re-estimating the risk-adjustment model after adding indicator variables for primary payer using the subset of data collected under Version 3.3 of the data collection form.

Multivariable odds ratios for race, Hispanic ethnicity, and insurance type are summarized below. These variables were not considered for inclusion in the regression model due to NQF's policy at the time of developing the model.

Disparities by Race/Ethnicity: Time Period #1 (Jan 2010 – Dec 2013)

Population Group	Odds Ratio (95% CI)	P-value
Asian	1.06 (0.82, 1.37)	0.65
Black	1.46 (1.28, 1.66)	<.0001
Native American	0.73 (0.44, 1.21)	0.23
Native pacific / Hawaiian	1.40 (0.82, 2.36)	0.21
Other race	1.03 (0.88, 1.21)	0.73
Hispanic ethnicity	0.98 (0.85, 1.13)	0.78

Disparities by Race/Ethnicity: Time Period #2 (Jul 2014 – Jun 2018)

Population Group	Odds Ratio (95% CI)	P-value
Asian	1.19 (0.97, 1.47)	0.10
Black	1.32 (1.18, 1.49)	<.0001
Native American	1.49 (1.03, 2.15)	0.03
Native pacific / Hawaiian	0.81 (0.46, 1.41)	0.45
Other race	1.12 (0.98, 1.28)	0.11
Hispanic ethnicity	1.13 (1.01, 1.27)	0.03

Disparities by Insurance Status: Time Period #2 (Jul 2014 – Jun 2018) Subset of Records Collected Under Data Version 3.3.

Insurance Status	Odds Ratio (95% CI)	P-value
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None / Self-Pay (versus commercial/government/other)	1.52 (1.07, 2.15)	0.02
Medicaid (versus commercial/government other)	1.09 (0.97, 1.23)	0.13

Note: Comparisons of unadjusted mortality are not presented as these are confounded by differences case mix including the types of lesions and associated procedures.

4b.1. Progress on Improvement. (Not required for initial endorsement unless available) – Performance results on this measure (current and over time) should be provided in 1b.2 and 1b.4. Discuss:

- Progress (trends in performance results, number and percentage of people receiving high-quality healthcare)
- Geographic area and number and percentage of accountable entities and patients included

To explore improvement over time, we examined the aggregated outcomes of all hospitals combined within each of the following 1-year time intervals:

- Year 1: July 1, 2014 – June 30, 2015
- Year 2: July 1, 2015 – June 30, 2016
- Year 3: July 1, 2016 – June 30, 2017
- Year 4: July 1, 2017 – June 30, 2018

As shown in the table, the observed mortality rate decreased from 3.01% in Year 1 to 2.55% in Year 4 whereas the expected mortality rate increased from 2.71% in Year 1 to 2.86% in Year 4. The fact that expected mortality rate increased over time suggests that the improvement in observed mortality over time was not explained by a lower-risk case mix. The aggregate O/E ratio decreased from 1.11 (95% CI 1.03 to 1.19) in Year 1 to 0.89 (95% CI 0.82 to 0.96) in Year 4. The non-overlapping confidence intervals indicates that the difference was unlikely to be explained by chance variation.

Time Period	# of participants	# of records	Mortality		
			Observed (O)	Expected (E)	O/E (95% CI)
Year 1: 7/2014-6/2015	103	22562	3.01%	2.71%	1.11 (1.03, 1.19)
Year2: 7/2015-6/2016	102	22802	3.09%	2.85%	1.08 (1.00, 1.16)
Year 3: 7/2016-6/2017	103	22711	2.76%	2.87%	0.96 (0.89, 1.04)
Year 4: 7/2017-6/2018	102	21602	2.55%	2.86%	0.89 (0.82, 0.96)