

Report Overview – Risk Adjustment Supplement

STS Spring 2007 Report

I. Guide to Using STS Risk Adjustment Locally

This STS report provided to your participant by the STS contains risk-adjusted information for an entire participant over a specific time frame. Generally, a participant's report contains data for all cases submitted for that participant for the past 3 calendar years. However, a participant may want to explore their cases for a different subset of patients or for a different time period. For instance, a participant may want to look at results for a specific surgeon for the first quarter of a given calendar year – a combination they cannot obtain from the report. For these purposes, we have made it possible for a participant to calculate any number of risk-adjusted results internally. Participants can use the predicted risk scores generated by their STS certified software to calculate risk-adjustment statistics analogous to those presented in this report (See the end of this Supplement for more information on predicted risk scores).

This guide demonstrates how to locally calculate an O/E Ratio and risk-adjusted rate for a specific subgroup. The O/E Ratio is a comparison between a participant's 'expected' outcome rate and the actual 'observed' outcome rate. It reflects the participant's performance relative to the overall STS population. The risk-adjusted rate represents the outcome event percent that would be expected if the underlying patient case-mix was similar to that of the overall STS population. See section IV.d. of the Report Overview for information on the interpretation of these statistics.

NOTE: The words 'expected' and 'predicted' are generally interchangeable in discussions of STS risk-adjustment.

a. O/E Ratio:

An O/E Ratio can be calculated for any of the risk-adjusted outcomes for the allowable procedures. As noted in section IV.d. of the Report Overview, a re-calibration step is necessary to calculate O/E Ratios analogous to those presented in this report. The formula below includes that re-calibration step. The O/E Ratio is calculated by dividing the number of observed events by the 'expected' number of events and multiplying by a re-calibration multiplier:

$$\text{O/E} = (\text{no. of observed events} \div \text{'expected' no. of events}) \times \text{O/E Ratio re-calibration multiplier}$$

The number of observed events is the number of procedures for which the event occurred. The number of 'expected' events is calculated using the appropriate risk-adjustment model. STS certified software generates an expected or predicted probability of an outcome event for each patient undergoing procedure(s) for which a risk-adjustment model exists. To obtain the number of expected events for a given group of cases, sum up the expected probabilities. Note that although the number of observed events will always be a whole number, the number of expected events will not necessarily be a whole number – e.g. 5.0 and 5.6 are both valid numbers of expected events.

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An equivalent way of calculating the O/E Ratio using percents rather than number of events is as follows:

$O/E = (\text{percent observed events} \div \text{'expected' percent events}) \times \text{O/E Ratio re-calibration multiplier}$

The O/E Ratio calibration multipliers for the most recent 3 years can be found in Table 1 below. The choice of appropriate O/E multiplier depends upon the time period of the procedures for which the O/E Ratio has been calculated. For example, an O/E that has been calculated for operative mortality for a specific surgeon's isolated CAB procedures during the last half of 2004 would use the multiplier for isolated CAB operative mortality for 2004. Because the multipliers are fairly close in value from year to year, an O/E Ratio that spans 2 calendar years could simply be multiplied by either of the calendar year multipliers with similar results. If a participant would like to apply the multiplier to data from a calendar year for which a multiplier does not yet exist, the previous year's multiplier would provide a similar result.

Please contact your STS certified software vendor for any specific questions related to how your software calculates predicted risk probabilities.

Example of how to calculate an O/E Ratio: Surgeon Bob Smith wants to calculate an O/E Ratio for operative mortality on his isolated CABG cases for the first 6 months of 2004. Dr. Smith performed 70 isolated CABG procedures during that time period and 3 of the cases were operative mortalities. Dr. Smith used his STS software to calculate an 'expected' (or predicted) probability of operative mortality of each of the 70 patients. He then added those probabilities up and got 4.2. The appropriate O/E multiplier for this example would be the 2004 multiplier for isolated CAB operative mortality – 1.14,

$$O/E = (3 \div 4.2) \times 1.14 = 0.81$$

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Table 1. O/E Ratio Multiplier Table for Recalibration

Procedure/Outcome	2004	2005	2006
Isolated CAB			
In-hospital Mortality	1.27	1.34	1.46
Operative Mortality	1.14	1.19	1.27
Morbidity: Any Reoperation	1.10	1.09	1.10
Morbidity: Permanent Stroke	1.38	1.40	1.53
Morbidity: Renal Failure	1.13	1.09	1.17
Morbidity: Deep Sternal Wound Infection	1.66	1.83	2.12
Morbidity: Prolonged Ventilation	0.78	0.77	0.75
Combined Morbidity/Mortality Outcomes*	1.01	1.00	1.00
Short Length of Stay: PLOS < 6 days	0.97	0.97	1.00
Long Length of Stay: PLOS > 14 days	1.03	0.99	0.99
Isolated AV Replacement			
In-hospital Mortality	1.47	1.83	1.67
Operative Mortality	1.34	1.58	1.45
Isolated MV Replacement			
In-hospital Mortality	1.22	1.42	1.38
Operative Mortality	1.16	1.31	1.26
AV Replacement + CAB			
In-hospital Mortality	1.42	1.58	1.46
Operative Mortality	1.28	1.45	1.33
MV Replacement + CAB			
In-hospital Mortality	1.26	1.19	1.41
Operative Mortality	1.21	1.15	1.31

* includes any of the 5 morbidities above and/or operative mortality

b. Risk-adjusted rates:

A risk-adjusted rate can be calculated for any of the risk-adjusted outcomes for the allowable procedures. The risk-adjusted rate is calculated by multiplying the O/E Ratio (calculated using the re-calibration multiplier) by the STS observed event percent:

Risk-adjusted rate = O/E Ratio x STS observed event percent

The O/E Ratio and the STS observed event percent should all be from the same time period. The STS observed event rates for the most recent 3 calendar years can be obtained in Table 2 below.

Example of how to calculate a risk-adjusted rate: To continue with the example of Dr. Smith from above, we would like to calculate his risk-adjusted rate for his isolated CAB operative mortality for the last 6 months of 2004. His O/E Ratio is 0.81 and the STS event rate for 2004 is 2.34.

The risk-adjusted rate would be $0.81 \times 2.34 = 1.90$

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Table 2. STS Event Percents

Procedure/Outcome	2004	2005	2006
Major Procedures			
Operative Mortality	2.84	2.68	2.61
In-hospital Mortality	2.57	2.40	2.30
Isolated CAB			
Operative Mortality	2.34	2.25	2.08
In-hospital Mortality	2.10	2.00	1.82
Morbidity: Any Reoperation	5.06	5.17	5.11
Morbidity: Permanent Stroke	1.33	1.32	1.21
Morbidity: Renal Failure	3.66	3.85	3.62
Morbidity: Deep Sternal Wound Infx	0.44	0.41	0.36
Morbidity: Prolonged Ventilation	8.39	8.60	8.86
Combined Morbidity/Mortality Outcomes*	14.30	14.59	14.67
Short Length of Stay: PLOS < 6 days	52.23	51.92	50.65
Long Length of Stay: PLOS > 14 days	5.42	5.67	5.65
Isolated AV Replacement			
In-hospital Mortality	3.00	2.45	2.74
Operative Mortality	3.29	2.83	3.15
Isolated MV Replacement			
In-hospital Mortality	5.64	4.81	5.10
Operative Mortality	5.97	5.18	5.58
AV Replacement + CAB			
In-hospital Mortality	5.06	4.54	4.89
Operative Mortality	5.60	4.97	5.34
MV Replacement + CAB			
In-hospital Mortality	10.67	11.16	9.48
Operative Mortality	11.07	11.56	10.18

* Includes any of the 5 morbidities above and/or operative mortality

c. Odds Ratio:

The Odds Ratio supplied in the STS participant report cannot be calculated by participants. The Odds Ratio is calculated using a hierarchical analysis technique (See section IV.c of the Report Overview for more information), that utilizes data on all STS participants. For this reason, the participant report generated by the DCRI is the only resource containing the Odds Ratio.

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d. STS Certified Software Package Predicted Risk Scores

To illustrate some of the mechanics of the risk-adjustment information available to you in your STS Vendor Software, we have created a sample set of cases. The sample set consists of 10 cases. For the purposes of illustration it does not matter which procedure and/or outcome is being discussed. The STS vendor software provides a risk probability for each case. A probability is a number expressing the likelihood that a specific event will occur. Probabilities range from 0-1 with 1 being the highest likelihood. The risk probability can be multiplied by 100 to obtain a risk percentage. The risk probabilities for any group of cases can be summed and the risk percentages averaged. Please note that the terminology and presentation of risk-adjustment information may vary by software vendor. The table below outlines the 10 test cases and is followed by some definitions for the various statistics. Note that, for the purposes of illustration, the probabilities in this table are likely higher than those you would see in with actual data.

Table 3. 10-case Sample of STS Software Risk Probabilities

Patient	Risk probability		Risk percentage
1	0.23467	$\times 100 =$	23.47%
2	0.35653	$\times 100 =$	35.65%
3	0.09889	$\times 100 =$	9.89%
4	0.07932	$\times 100 =$	7.93%
5	0.91217	$\times 100 =$	91.22%
6	0.05894	$\times 100 =$	5.89%
7	0.09700	$\times 100 =$	9.70%
8	0.07556	$\times 100 =$	7.56%
9	0.03239	$\times 100 =$	3.24%
10	0.50161	$\times 100 =$	50.16%
Group	Sum of probabilities		Average risk percentage
	2.44708		24.47%

Definitions:

Risk probability = the probability of the outcome in that patient given that patient's set of risk factors.

Risk percentage = the percent chance of the outcome for that patient given that patient's set of risk factors.

Sum of the probabilities = the expected/predicted number of outcome events in the given group of patients.

Average risk percentage = the expected/predicted percent of outcome events in the given group of patients.

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It's important to note that risk scores should not be used for predicting a single patient's outcomes. The risk scores are computed for the purpose of aggregate risk adjustment. However, an individual patient's predicted risk score might be useful as a participant reviews its cases retrospectively. For instance, to investigate a particular patient's negative outcome, a participant could look to the patient's predicted risk score to understand if that outcome was 'expected' based on the variables known to be related to that outcome. However, just looking at a predicted risk score out of context could be misleading since many of the predicted risk values appear to be low.

The table that follows shows the predicted risk score quartiles for all STS 2005 CABG procedures and provides a context in which to view a patient's predicted risk value. The 25th percentile value is the predicted risk value under which the 25% *lowest* risk patients are located. The 50th percentile value is the median predicted risk value – half of the patients have a lower value and half of the patients have a higher value. The median predicted risk value could be considered that for *normal* risk patients. Finally, the 75th percentile value is the predicted risk value above which the 25% *highest* risk patients are located.

With this table it's possible to see that a patient with only a 1.0% predicted risk value of deep sternal wound infection is actually among the STS patients at highest risk of having an infection.

Table 4. Predicted Risk Percentage Distribution – 2006 Isolated CABG

<i>Predicted risk percentage</i>	25th percentile	50th percentile	75th percentile
Mortality	0.8%	1.4%	2.7%
Renal Failure	1.6%	2.7%	4.7%
Reoperation	3.6%	4.7%	6.6%
Deep Sternal Wound Infection	0.4%	0.6%	0.9%
Prolonged ventilation	2.7%	4.3%	7.5%
Permanent stroke	0.7%	1.3%	2.3%
Morbidity or mortality	7.6%	11.3%	17.7%
Short length of stay	37.8%	51.6%	64.6%
Long length of stay	2.2%	3.8%	6.6%

Note, although it is possible that some software products will produce a predicted risk score for a patient before all variables are entered, this score may differ from the final predicted risk score based on all available data. The final risk score is the most reliable one.