VSURG Report Dictionary – Risk Models

Risk adjusted number of outcomes are provided for each hospital. The risk adjusted number is expected number of outcomes for a hospital considering their patient's characteristics. The adjustment is done using a statistical modeling technique (logistic regression) with various pre-procedural variables. As a summary measure for each hospital (a scale-free comparison), we use ratio of the observed number to its expected one (OE Ratio), i.e. Observed/Expected. Interpretation of the OE ratio is as the following:

    i.   OE Ratio = 1: the hospital observed the same number of outcomes as expected

    ii.   OE Ratio > 1: the hospital had more outcomes than expected

    iii.   OE Ratio < 1: the hospital had less outcome than expected

The Details of the Risk Adjustment Analysis

Total number used to build model and exclusion criteria

The number of cases used to build the model are different from the total procedures in the main report. We excluded cases that may add noise to the model. Exclusion criteria are as the following:

1. BMI > 80 or BMI < 10

2. Age < 18 or Age > 200

3. Any missing values in the variables used in the model

4. A case with multiple hospitalization (except the earliest procedure)

5. Emergent procedures

Outcome	Total Number of Observations
Transfusion	7289
Readmission	7289
SSI	7289
MI	7289
TIA/Stroke	7289
Mortality	7289

Included variables and their significance

We used pre-procedural variables such as patient history, medications, indication, arterial location, and procedure status in the model. All the variables listed in Table 1 are included, and we mark "X" for the variables whose coefficient was significant at the 5% significance level.

Table 1
Included Variables in the Risk Models

Variable	Transfusion	Readmission	SSI	MI	TIA/Stroke	Death
Female	X	X	X			X
Age						
Race = Black	X					
Race = Other						
Low BMI	X		X			
High BMI	X	X	X			
Former Smoker						
Current Smoker						
Pre-Anemia	X	X				X
Family History of Premature CAD						
History of Hyperlipidemia						
History of Hypertension						
History of Diabetes			X			X
History of Coronary Heart Failure		X		X		
History of Significant Valve Disease	X					
History of COPD						X
History of CVD/TIA					X	
History of Coronary Artery Disease	X		X	X		
PCI in Last 6 Months						
MI in Last 6 Months	X					
History of Atrial Fibrillations						
Taking Aspirin at Admission						
Taking Plavix at Admission						X
Taking Ace Inhibitors at Admission						
Indication = Claudication	X					
Indication = Limb Ischemia						
Renal	X	X			X	
Aorto-Iliac			X			
Femoral-Popliteal	X				X	
Below Knee	X		X			
Open AAA	X	X	X	X	X	
Open Bypass	X	X	X	X		
Urgent Procedure	X	X	X		X	

Estimated coefficients and model assessment measure

Table 2 shows estimated odds ratios and p-values for the significant variables in the transfusion model. An odds ratio of greater than 1 means that the variable is positively related to having a transfusion. For example, the odds ratio of 2.22 for "Female" means that female patients have 2.22 times higher odds than male patients to receive a transfusion.

We also provide model assessment measures. If the model has decent prediction or discrimination ability, we would see Hosmer-Lemeshow p-value over 0.05 and high Area under the ROC curve (AUC), at least over 0.5.

Table 2
Estimated Coefficients for Transfusion Risk Model

Variable	Odds Ratio [95% CI]	P Value
Female	2.22 [1.9, 2.6]	< 0.001
Age		
Race = Black	1.73 [1.41, 2.12]	< 0.001
Race = Other		
Low BMI	1.61 [1.09, 2.35]	0.015
High BMI	0.83 [0.7, 0.98]	0.029
Former Smoker		
Current Smoker		
Pre-Anemia	3.8 [3.23, 4.49]	< 0.001
Family History of Premature CAD		
History of Hyperlipidemia		
History of Hypertension		
History of Diabetes		
History of Coronary Heart Failure		
History of Significant Valve Disease	1.3 [1, 1.68]	0.049
History of COPD		
History of CVD/TIA		
History of Coronary Artery Disease	1.29 [1.09, 1.52]	0.003
PCI in Last 6 Months		
MI in Last 6 Months	2.27 [1.48, 3.46]	< 0.001
History of Atrial Fibrillations		
Taking Aspirin at Admission		
Taking Plavix at Admission		
Taking Ace Inhibitors at Admission		
Indication = Claudication	0.79 [0.66, 0.94]	0.009
Indication = Limb Ischemia		
Renal	3.27 [1.59, 6.3]	< 0.001
Aorto-Iliac		
Femoral-Popliteal	1.26 [1.04, 1.53]	0.017
Below Knee	1.57 [1.03, 2.36]	0.034
Open AAA	13.03 [9.2, 18.49]	< 0.001
Open Bypass	6.43 [4.88, 8.54]	< 0.001
Urgent Procedure	1.24 [1, 1.52]	0.046
Model Assessment		
Hosmer-Lemeshow P-Value	0.457	
Area Under the ROC Curve (AUC)	0.818	

Table 3 shows estimated odds ratios and p-values for the significant variables in the readmission model. An odds ratio of greater than 1 means that the variable is positively related to being readmitted. For example, the odds ratio of 1.46 for "Female" means that female patients have 1.46 times higher odds than male patients to be readmitted.

Table 3
Estimated Coefficients for Readmission Risk Model

Variable	Odds Ratio [95% CI]	P Value
Female	1.46 [1.23, 1.74]	< 0.001
Age		
Race = Black		
Race = Other		
Low BMI		
High BMI	1.28 [1.07, 1.52]	0.006
Former Smoker		
Current Smoker		
Pre-Anemia	1.42 [1.19, 1.7]	< 0.001
Family History of Premature CAD		
History of Hyperlipidemia		
History of Hypertension		
History of Diabetes		
History of Coronary Heart Failure	1.37 [1.1, 1.71]	0.004
History of Significant Valve Disease		
History of COPD		
History of CVD/TIA		
History of Coronary Artery Disease		
PCI in Last 6 Months		
MI in Last 6 Months		
History of Atrial Fibrillations		
Taking Aspirin at Admission		
Taking Plavix at Admission		
Taking Ace Inhibitors at Admission		
Indication = Claudication		
Indication = Limb Ischemia		
Renal	2.06 [0.98, 3.91]	0.039
Aorto-Iliac		
Femoral-Popliteal		
Below Knee		
Open AAA	1.63 [1.01, 2.54]	0.038
Open Bypass	2.82 [2.15, 3.7]	< 0.001
Urgent Procedure	1.31 [1.03, 1.65]	0.024
Model Assessment		
Hosmer-Lemeshow P-Value	0.465	
Area Under the ROC Curve (AUC)	0.688	

Table 4 shows estimated odds ratios and p-values for the significant variables in the SSI model. An odds ratio of greater than 1 means that the variable is positively related to having an SSI. For example, the odds ratio of 1.55 for "Female" means that female patients have 1.55 times higher odds than male patients to have an SSI.

Table 4
Estimated Coefficients for SSI Risk Model

Variable	Odds Ratio [95% CI]	P Value
Female	1.55 [1.2, 1.98]	< 0.001
Age		
Race = Black		
Race = Other		
Low BMI	0.24 [0.04, 0.77]	0.048
High BMI	1.78 [1.39, 2.29]	< 0.001
Former Smoker		
Current Smoker		
Pre-Anemia		
Family History of Premature CAD		
History of Hyperlipidemia		
History of Hypertension		
History of Diabetes	1.3 [1, 1.67]	0.046
History of Coronary Heart Failure		
History of Significant Valve Disease		
History of COPD		
History of CVD/TIA		
History of Coronary Artery Disease	1.51 [1.15, 1.98]	0.003
PCI in Last 6 Months		
MI in Last 6 Months		
History of Atrial Fibrillations		
Taking Aspirin at Admission		
Taking Plavix at Admission		
Taking Ace Inhibitors at Admission		
Indication = Claudication		
Indication = Limb Ischemia		
Renal		
Aorto-Iliac	1.78 [1.24, 2.5]	0.001
Femoral-Popliteal		
Below Knee	2.18 [1.22, 3.68]	0.005
Open AAA	3.88 [1.56, 8.88]	0.002
Open Bypass	9.66 [5.71, 17.28]	< 0.001
Urgent Procedure	1.59 [1.16, 2.17]	0.003
Model Assessment		
Hosmer-Lemeshow P-Value	0.172	
Area Under the ROC Curve (AUC)	0.771	

Table 5 shows estimated odds ratios and p-values for the significant variables in the MI model. An odds ratio of greater than 1 means that the variable is positively related to having MI. For example, the odds ratio of 1.87 for "History of Coronary Heart Failure" means that patients with a history of CHF have 1.87 times higher odds to have MI than patients without a history of CHF.

Table 5
Estimated Coefficients for MI Risk Model

Variable	Odds Ratio [95% CI]	P Value
Female		
Age		
Race = Black		
Race = Other		
Low BMI		
High BMI		
Former Smoker		
Current Smoker		
Pre-Anemia		
Family History of Premature CAD		
History of Hyperlipidemia		
History of Hypertension		
History of Diabetes		
History of Coronary Heart Failure	1.87 [1.15, 3]	0.01
History of Significant Valve Disease		
History of COPD		
History of CVD/TIA		
History of Coronary Artery Disease	1.9 [1.19, 3.07]	0.008
PCI in Last 6 Months		
MI in Last 6 Months		
History of Atrial Fibrillations		
Taking Aspirin at Admission		
Taking Plavix at Admission		
Taking Ace Inhibitors at Admission		
Indication = Claudication		
Indication = Limb Ischemia		
Renal		
Aorto-Iliac		
Femoral-Popliteal		
Below Knee		
Open AAA	3.57 [1.43, 8.13]	0.004
Open Bypass	2.37 [1.24, 4.61]	0.01
Urgent Procedure		
Model Assessment		
Hosmer-Lemeshow P-Value	0.183	
Area Under the ROC Curve (AUC)	0.753	

Table 6 shows estimated odds ratios and p-values for the significant variables in the TIA/Stroke model. An odds ratio of greater than 1 means that the variable is positively related to having a TIA/Stroke. For example, the odds ratio of 4.44 for "History of CVD/TIA" means that patients with a history of CVD/TIA have 4.44 times higher odds to have a TIA/Stroke than patients without a history of CVD/TIA.

Table 6
Estimated Coefficients for TIA/Stroke Risk Model

Variable	Odds Ratio [95% CI]	P Value
Female		
Age		
Race = Black		
Race = Other		
Low BMI		
High BMI		
Former Smoker		
Current Smoker		
Pre-Anemia		
Family History of Premature CAD		
History of Hyperlipidemia		
History of Hypertension		
History of Diabetes		
History of Coronary Heart Failure		
History of Significant Valve Disease		
History of COPD		
History of CVD/TIA	4.44 [2.44, 8.25]	< 0.001
History of Coronary Artery Disease		
PCI in Last 6 Months		
MI in Last 6 Months		
History of Atrial Fibrillations		
Taking Aspirin at Admission		
Taking Plavix at Admission		
Taking Ace Inhibitors at Admission		
Indication = Claudication		
Indication = Limb Ischemia		
Renal	8.57 [1.59, 33.89]	0.005
Aorto-Iliac		
Femoral-Popliteal	2.25 [1.11, 4.4]	0.02
Below Knee		
Open AAA	7.47 [2.51, 22.81]	< 0.001
Open Bypass		
Urgent Procedure	3.56 [1.71, 7.1]	< 0.001
Model Assessment		
Hosmer-Lemeshow P-Value	0.319	
Area Under the ROC Curve (AUC)	0.829	

Table 7 shows estimated odds ratios and p-values for the significant variables in the mortality model. An odds ratio of greater than 1 means that the variable is positively related to death. For example, the odds ratio of 2.31 for "Female" means that female patients have 2.31 times higher odds to die than male patients.

Table 7
Estimated Coefficients for Mortality Risk Model

Variable	Odds Ratio [95% CI]	P Value
Female	2.31 [1.1, 4.82]	0.025
Age		
Race = Black		
Race = Other		
Low BMI		
High BMI		
Former Smoker		
Current Smoker		
Pre-Anemia	4.29 [1.89, 10.71]	< 0.001
Family History of Premature CAD		
History of Hyperlipidemia		
History of Hypertension		
History of Diabetes	2.19 [1.02, 4.76]	0.044
History of Coronary Heart Failure		
History of Significant Valve Disease		
History of COPD	2.84 [1.31, 6.59]	0.011
History of CVD/TIA		
History of Coronary Artery Disease		
PCI in Last 6 Months		
MI in Last 6 Months		
History of Atrial Fibrillations		
Taking Aspirin at Admission		
Taking Plavix at Admission	0.13 [0.03, 0.73]	0.009
Taking Ace Inhibitors at Admission		
Indication = Claudication		
Indication = Limb Ischemia		
Renal		
Aorto-Iliac		
Femoral-Popliteal		
Below Knee		
Open AAA		
Open Bypass		
Urgent Procedure		
Model Assessment		
Hosmer-Lemeshow P-Value	0.39	
Area Under the ROC Curve (AUC)	0.853	