Technical Notes

for

Cardiac Surgery in Pennsylvania

Calendar Years 2007-2008 Data

The Pennsylvania Health Care Cost Containment Council
June 2010

Preface

The *Technical Notes for Cardiac Surgery in Pennsylvania* serves as a technical supplement to the Pennsylvania Health Care Cost Containment Council's (PHC4) report on coronary artery bypass graft (CABG) and valve surgery for combined calendar years 2007 and 2008 (January 1, 2007 to December 31, 2008) and calendar year 2008 only (January 1, 2008 to December 31, 2008). This document describes the methodology and development of the report and includes information on statewide results, cases excluded from analysis, and risk-adjustment models.

- The cardiac surgery report presents data on the outcomes associated with CABG surgery and valve surgery. The report includes two sets of outcomes for hospitals: 1) outcomes for combined 2007-2008 data, and 2) outcomes for 2008 only. The report includes one set of outcomes for surgeons based on the combined 2007-2008 data.
- The analysis included adult patients at least 30 years of age who underwent a CABG procedure, a valve procedure, or combined valve and CABG procedures in a Pennsylvania general acute care (GAC) hospital. Information is reported for each of the following four reporting groups:
    - CABG without Valve
    - Valve without CABG
    - Valve with CABG
    - Total Valve
- Risk-adjusted measures for hospitals and surgeons with at least 30 cases are reported for:
    - In-hospital mortality
    - Operative mortality (includes in-hospital and 30-day)
    - 7-day readmissions
    - 30-day readmissions
    - Post-surgical length of stay
- Average hospital charge (case-mix adjusted) is reported for hospitals with at least 13 cases in a particular reporting group.
- 2007 average Medicare payment is reported for hospitals with at least 13 cases in a particular reporting group. If the number of cases included in the payment analysis for either the Valve without CABG or the Valve with CABG reporting group is less than 13, payment data was only reported for the Total Valve reporting group.

The rigorous methodology described in this document was developed to account for the differences among individual patients that had the potential to influence the outcome of CABG and/or valve surgery.

Pennsylvania Health Care Cost Containment Council
225 Market Street, Suite 400
Harrisburg, PA 17101
Phone: (717) 232-6787
Fax: (717) 232-3821
www.phc4.org

Joseph Martin, Executive Director

TABLE OF CONTENTS

DATA COLLECTION AND VERIFICATION

The 2007 and 2008 discharge data analyzed for the Pennsylvania Health Care Cost Containment Council's (PHC4) *Cardiac Surgery in Pennsylvania* report was submitted electronically on a quarterly basis to PHC4 by Pennsylvania general acute care (GAC) hospitals. The discharge data, which was submitted via the Uniform Claims and Billing Form (UB), included demographic information, hospital charges, and diagnosis and procedure codes. The standard data verification process included extensive quality assurance and data quality checks. Error reports were generated and returned to each facility with an opportunity to correct any problems.

In addition, hospitals used the MediQual *Atlas Outcomes*™ System to abstract information from the medical record that described each patient's state of health on admission.

The 2007 Medicare payment data was provided by the Centers for Medicare and Medicaid Services (CMS).

Death certificate data was obtained to identify deaths that occurred subsequent to the hospitalization in which the CABG/valve surgery was performed. These data were supplied by the Bureau of Health Statistics and Research, Pennsylvania Department of Health, Harrisburg, Pennsylvania. The Pennsylvania Department of Health specifically disclaims responsibility for any analyses, interpretations, or conclusions.

Hospital and Cardiothoracic Surgeon Verification of Data

Discharge records for patients who underwent an open heart procedure in 2007 and/or 2008 were subjected to extensive data verification and quality assurance checks. Hospitals were requested to confirm the accuracy of discharge records, provide additional diagnoses and procedure codes as appropriate, and confirm that cases had the correct surgeon assignment. Surgeons were requested to perform a patient level review of the submitted records and then attest to the accuracy of the data and the surgeon assignment. Hospitals and/or surgeons had the opportunity to request special exclusions for cases in which the patient's outcome was most directly associated with conditions unrelated to the CABG/valve surgical episode or the care received during that hospitalization that were not accounted for through risk adjustment. The medical records were reviewed to determine whether special requests for exclusion (SRE) would be granted. In addition, because of their importance as risk factors, hospitals and surgeons had the opportunity to submit medical records for cases in which cardiogenic shock and/or acute renal failure were present at the time of or immediately prior to the surgery. These records were reviewed to verify that the criteria for pre-operative cardiogenic shock and/or pre-operative acute renal failure were met.

Hospitals were given an opportunity to verify the average Medicare payment reported for their facilities prior to the public release of the information.

STUDY POPULATION

The CABG and valve study population included those patients discharged from Pennsylvania GAC hospitals in calendar year 2007 or 2008 after undergoing CABG and/or valve surgery as identified by the presence of an appropriate ICD-9-CM (International Classification of Diseases, 9th Revision, Clinical Modification) procedure code(s) in either the principal or secondary procedure code positions of the discharge record. The population included three subgroups of patients as defined below.

1. ***CABG without Valve:*** patients who underwent at least one CABG procedure as defined below and ***no*** valve procedures.

ICD-9-CM CABG Procedure Codes

Code	Description
36.10	Aortocoronary bypass for heart revascularization, not otherwise specified
36.11	Aortocoronary bypass of one coronary artery
36.12	Aortocoronary bypass of two coronary arteries
36.13	Aortocoronary bypass of three coronary arteries
36.14	Aortocoronary bypass of four or more coronary arteries
36.15	Single internal mammary-coronary artery bypass
36.16	Double internal mammary-coronary artery bypass
36.17	Abdominal-coronary artery bypass
36.19	Other bypass anastomosis for heart revascularization

2. ***Valve without CABG:*** patients who underwent at least one valve procedure as defined below and ***no*** CABG procedures.

ICD-9-CM Valve Procedure Codes

Code	Description
35.10	Open heart valvuloplasty without replacement, unspecified valve
35.11	Open heart valvuloplasty of aortic valve without replacement
35.12	Open heart valvuloplasty of mitral valve without replacement
35.13	Open heart valvuloplasty of pulmonary valve without replacement
35.14	Open heart valvuloplasty of tricuspid valve without replacement
35.20	Replacement of unspecified heart valve
35.21	Replacement of aortic valve with tissue graft
35.22	Other replacement of aortic valve
35.23	Replacement of mitral valve with tissue graft
35.24	Other replacement of mitral valve
35.25	Replacement of pulmonary valve with tissue graft
35.26	Other replacement of pulmonary valve
35.27	Replacement of tricuspid valve with tissue graft
35.28	Other replacement of tricuspid valve
35.33	Annuloplasty
35.99	Other operations on valves of heart

3. ***Valve with CABG:*** patients who underwent at least one of the above valve procedures ***and*** at least one of the above CABG procedures during the same admission.

EXCLUSIONS FOR OUTCOME ANALYSES

Cases meeting certain criteria were excluded from the outcome analyses. Standard exclusions consisted of the following: 1) patients less than 30 years of age, 2) patients who left against medical advice, and 3) clinically complex cases (see Appendix A for definitions). Standard exclusion criteria were applied to the in-hospital mortality analysis. Standard exclusion *and* exclusion criteria particular to the measure of interest were applied to the analyses of operative mortality, 7-day and 30-day readmissions, post-surgical length of stay, and average hospital charge. Appendix B displays exclusion data for each of these outcome measures. For exclusions relevant to average Medicare payment, see the "Average Medicare Payment Analysis" section of this document.

MEASURES REPORTED

Note that two sets of outcomes are reported for hospitals: 1) outcomes for combined 2007-2008 data, and 2) outcomes for 2008 only. The report includes one set of outcomes for surgeons based on the combined 2007-2008 data.

Number of Cases

The number of cases (after standard exclusions were removed) is reported for hospitals and surgeons for each of the following reporting groups:

- ***CABG without Valve*** is the number of patients who underwent at least one CABG procedure without any valve procedures during the same admission.
- ***Valve without CABG*** is the number of patients who underwent at least one valve procedure without any CABG procedures during the same admission.
- ***Valve with CABG*** is the number of patients who underwent at least one valve procedure and at least one CABG procedure during the same admission.
- ***Total Valve*** is the number of patients who underwent at least one valve procedure with or without a CABG procedure during the same admission.

Note that the actual number of CABG/valve surgeries performed by a particular surgeon may be underreported. For example, procedures done in Veterans' hospitals and in other states were not included in this report.

In-Hospital Mortality

The in-hospital mortality rating was based on the number of deaths that occurred during the hospital admission in which the CABG/valve surgery was performed compared to the expected number of deaths. Information on whether the patient died during the hospital stay was provided by hospitals.

Operative Mortality

The operative mortality rating was based on the total number of operative deaths compared to the expected number of deaths. Operative deaths were defined as:

- The number of deaths that occurred during the hospitalization in which the CABG/valve surgery was performed, even if after 30 days, *and*
- The number of deaths that occurred after the patient was discharged from the hospital, but within 30 days of the procedure unless the death was clearly caused by unusual circumstances, such as those related to motor vehicle accidents or suicides. To determine whether a patient died within 30 days, death certificate information was obtained from the Pennsylvania Department of Health. Out-of-state residents were excluded from this analysis, because death certificate information was not available for these patients.

7-Day Readmissions

The 7-day readmissions rating was based on the number of patients who were readmitted to a GAC hospital (in Pennsylvania) within 1 to 7 days of being discharged from the hospitalization in which the CABG/valve surgery was performed compared to the expected number of readmissions within 1 to 7 days. A readmission was counted only if the patient was readmitted with a principal diagnosis that indicated a heart-related condition, or an infection or a complication that was likely related to the CABG/valve surgery hospitalization. See Appendix C for a list of diagnosis categories and their associated ICD-9-CM codes that were included in the readmissions analysis. Appendix D displays the number of readmissions for each category.

30-Day Readmissions

Similar to the 7-day readmissions rating, the 30-day readmissions rating was based on the number of patients who were readmitted to a GAC hospital within 1 to 30 days of being discharged from the hospitalization in which the CABG/valve surgery was performed compared to the expected number of readmissions within 1 to 30 days. Readmissions were counted using the same principal diagnosis criteria used for 7-day readmissions. See Appendix C for a list of diagnosis categories and their associated ICD-9-CM codes that were included in the readmissions analysis. Appendix D displays the number of readmissions for each category.

Post-Surgical Length of Stay

Post-surgical length of stay is the risk-adjusted number of days, on average, that patients stayed in the hospital following CABG/valve surgery.

Average Hospital Charge

Average hospital charge is reported for hospitals only. The average charges that appear in the report were trimmed for outliers and case-mix adjusted. The charges reported are those associated with the entire hospitalization during which the CABG/valve surgery was performed (not just the treatment associated with surgery). The charges do not include professional fees (e.g., physician fees). While charges are a standard way of reporting data, they do not reflect the actual cost of treatment, nor do they reflect the payment that the hospital may have actually received.

Average Medicare Payment

Average Medicare Payment is the mean of the Medicare fee-for-service payments as provided to PHC4 from the Centers for Medicare and Medicaid Services (CMS). Only cardiac surgery cases that could be linked to a Medicare Fee-For-Service payment were included. Average Medicare payments vary across hospitals; because, in determining what it will pay for care, Medicare takes into account differences among facilities in labor costs, physician teaching programs, and services to the poor. Average Medicare payments are only reported for 2007, because that was the most recent year of data available when analyses for the 2007-2008 cardiac surgery report were performed.

RISK ADJUSTMENT

In-hospital mortality, operative mortality, 7-day readmissions, 30-day readmissions, and post-surgical length of stay were risk adjusted, which means that the measure took into account the patient's health condition before surgery. Some patients who underwent CABG/valve surgery were more seriously ill than others. In order to report fair comparisons among hospitals and surgeons, PHC4 developed a complex mathematical formula to "risk adjust" the data, meaning that hospitals and surgeons receive "extra credit" for operating on patients who were more seriously ill or at a greater risk than others. Risk adjusting the data was important because sicker patients might be more likely to die, stay in the hospital longer, or be readmitted. Through logistic or linear regression modeling, risk factors (e.g., the age and sex of the patient and factors that indicate the illness level of the patient) were "tested" to determine which factors predicted patient outcomes (i.e., in-hospital mortality, operative mortality, 7-day and 30-day readmissions, and post-surgical length of stay). Note that a separate risk-adjustment model was built for each of these outcome measures and for each time period analyzed. The risk-adjustment models were then used to calculate the risk-adjusted ratings displayed in the report.

Each hospital and surgeon with at least 30 cases in a particular procedure group (after exclusions) received ratings for in-hospital mortality, operative mortality, 7-day readmissions, and 30-day readmissions. The ratings indicate whether the hospital or the surgeon's mortality or readmission rates were within the expected range or higher or lower than expected, taking into account the risk factors that were included in the risk-adjustment models. Rather than reporting a statistical rating for post-surgical length of stay, the risk-adjusted length of stay is reported in days. Additional detail on the methodology used to build the models and compute statistical ratings can be found in the sections titled "Risk Adjustment Methodology."

MORTALITY AND READMISSIONS ANALYSES

Risk Adjustment Methodology

Data Preparation

After cases meeting exclusion criteria were removed from the analysis, the remaining cases for each procedure group (i.e., CABG without Valve, Valve without CABG, and Valve with CABG) were randomly split into two equal-size samples for each procedure group: a development sample and a cross-validation sample. The number of relevant cases for each sample, combining the three procedure groups, is shown in Table 1a and Table 1b.

Table 1a. 2007-2008 Frequencies for Development Sample, Cross-Validation Sample, and Full Data Set

	Development Sample	Cross-Validation Sample	Full Data Set
In-Hospital Mortality			
Number of cases	15,644	15,642	31,286
Number of in-hospital deaths	392	422	814
Mortality rate (%)	2.5	2.7	2.6
Operative Mortality			
Number of cases	14,084	14,081	28,165
Number of operative deaths	464	426	890
Mortality rate (%)	3.3	3.0	3.2
7-Day Readmissions			
Number of cases	13,727	13,724	27,451
Number of readmissions within 7 days	928	917	1,845
Readmissions rate (%)	6.8	6.7	6.7
30-Day Readmissions			
Number of cases	13,727	13,724	27,451
Number of readmissions within 30 days	2,215	2,205	4,420
Readmissions rate (%)	16.1	16.1	16.1

Table 1b. 2008 Frequencies for Development Sample, Cross-Validation Sample, and Full Data Set

	Development Sample	Cross-Validation Sample	Full Data Set
In-Hospital Mortality			
Number of cases	7,815	7,816	15,631
Number of in-hospital deaths	216	205	421
Mortality rate (%)	2.8	2.6	2.7
Operative Mortality			
Number of cases	7,029	7,031	14,060
Number of operative deaths	228	214	442
Mortality rate (%)	3.2	3.0	3.1
7-Day Readmissions			
Number of cases	6,848	6,850	13,698
Number of readmissions within 7 days	469	462	931
Readmissions rate (%)	6.8	6.7	6.8
30-Day Readmissions			
Number of cases	6,848	6,850	13,698
Number of readmissions within 30 days	1,089	1,119	2,208
Readmissions rate (%)	15.9	16.3	16.1

Building the Risk-Adjustment Models

Identifying possible risk factors. The first step in building the risk-adjustment models for in-hospital mortality, operative mortality, 7-day readmissions, and 30-day readmissions was to identify possible risk factors, that is, those factors that potentially contributed to these events. In doing so, both clinical and demographic factors identified in the literature were considered, taking into account the availability and usability of the variables in the database. Also considered were factors tested in previous cardiac-related reports released by PHC4, as well as, MediQual's Key Clinical Findings (KCFs; see Appendix G). These possible risk-adjustment factors, referred to as candidate variables, were built using PHC4 data alone, MediQual data alone, or by combining the PHC4 and MediQual data (see Appendix E for definitions of variables considered). In some instances variable definitions overlapped. In these instances only one of the variables was considered for a particular model(s). For example, if "AMI Other Inferior Wall Initial Episode[C]" was considered for a model, "Acute Myocardial Infaction[P]" was not. Also, some variables were not considered for a particular model(s) because they were not applicable. For example, the calendar year in which the surgery was performed was not applicable to the single year (2008) model. Potential candidate variables were subject to univariate analysis to determine which variables should be tested for inclusion in the models. Once the candidate variables were identified, models for each outcome measure were developed using the following processes: model selection, cross-validation, and calculation of model adequacy measures.

Model selection. Binary logistic regression was used to select risk factors for the mortality and readmission models. For the mortality models, the variables in Tables 2a and 3a, which were developed primarily by MediQual for their CABG/valve in-hospital mortality model using the MediQual *Atlas Outcomes*™ System data, were entered into the models and retained, unless the analysis did not suggest that the variable would be predictive of the outcome. Note that for the readmission models, the variables developed primarily by MediQual competed equally with other potential predictors during the selection process.

The variables in Tables 2b, 3b, 4a, and 4b were entered into the models and tested for their impact in each model. Using a backward stepwise technique, candidate variables that had the least impact in the model were eliminated one at a time, until all variables remaining in the model were statistically significant. All tests of significance ($p < 0.10$) were based on the likelihood ratio. Results of the variable testing for the development model are displayed in Tables 2b, 3b, 4a, and 4b.

Cross-validation. After the development models were built for in-hospital mortality, operative mortality, 7-day readmissions, and 30-day readmissions, the models were cross-validated. The models built in the model selection process (i.e., the development models) were re-estimated using the cases in the cross-validation samples. Regression analyses were performed to determine whether the selected candidate variables would remain predictive of the relevant outcomes for the cross-validation sample. As long as the coefficient of a variable did not change from positive to negative, the variable was retained in the final model that was applied to the full data set. Note that during the cross-validation process of the mortality models, the variables developed primarily by MediQual were entered in the models but not considered for cross-validation. See Tables 2b, 3b, 4a, and 4b for the cross-validation and full data set results.

[C] This variable was based on both MediQual and PHC4 data.
[P] This variable was based on PHC4 data.

Table 2a. Candidate Variables Entered Into the Mortality Models, 2007-2008 Data

Variables retained in the model(s) are in bold text.

Demographic Variables	*Clinical Variables Other Than Lab*	
Age in Years [P]	**AMI Other Inferior Wall Initial Episode [C]**	**History of Peripheral Vascular Disease [C]**
Age # of Years > 65 [P]	**ASA Class 5 [MQ]**	**MI/AMI Other Anterior Wall [C]**
Female [P]	**ASA Emergency [MQ]**	**Mild, Moderate or Severe Altered Mental Status [MQ]**
Lab Variables	**CAD >70, 5-7 Vessels Group [MQ]**	**Other CV Procedure Group [C]**
Albumin < 3.1 g/dL [MQ]	**Current Med Immunosuppressive [MQ,**	**Percent of Left Main Stenosis [MQ]**
BUN > 40 mg/dL [MQ]	**Current Med Insulin [MQ]**	**Procedure Group [P]**
Creatinine > 1.4 mg/dL [MQ]	**Ejection Fraction [MQ]**	**PTCA/Stent/Tear Same Day CABG/Valve Surgery [C]**
Glucose > 165 mg/dL [MQ, 1]	**Heart Failure [C]**	Septal Other Anomalous Repair Heart [MQ, 1]
	History of CABG or Valve Surgery [C]	**SIRS Group [MQ]**

Table 2b. Candidate Variables Tested as Potential Predictors of Mortality, 2007-2008 Data

The results of variable testing for the 2007-2008 mortality models are displayed in the table below. The variables found to be significant predictors and their associated *p*-values are in bold text.

Candidate Variables Variables in bold text were included in the final model.	**In-Hospital** **Model Test Results *p*-values for variables significant in the model**			**Operative** **Model Test Results *p*-values for variables significant in the model**		
	Develop-ment	Cross-Validation	Full Data Set	Develop-ment	Cross-Validation	Full Data Set
Demographic Variables						
Race/Ethnicity [P]	ns[m]	ns[m]	ns[m]	nt[m]	nt[m]	nt[m]
Clinical Variables Other Than Lab						
AMI Except Other Anterior or Other Inferior Wall [P]	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**0.048**	**<0.001**
Cachexia [P]	**<0.001**	**0.003**	**<0.001**	**<0.001**	**<0.001**	**<0.001**
Cardiac Adhesions [P]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]
Cardiogenic Shock, Pre-Operative [P]	**0.038**	**<0.001**	**<0.001**	**0.004**	**<0.001**	**<0.001**
Cardiomyopathy [P]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]
Chronic Lung Disease [P]	ns[m]	ns[m]	ns[m]	nt[m]	nt[m]	nt[m]
Chronic Pulmonary Hypertension [P]	ns[m]	ns[m]	ns[m]	ne	ne	ne
Excision of Other Lesion/Heart Tissue/LAA, Open Approach – Same Date as Valve with or without CABG [P]	ne	ne	ne	ne	ne	ne
Hypertension with Complications [P]	ne	ne	ne	ns[m]	ns[m]	ns[m]
Intra-Aortic Balloon Pump (IABP) Prior to Date of CABG/Valve Surgery [P]	**0.050**	**0.029**	**0.004**	ns[m]	ns[m]	ns[m]
Liver Disease [P]	**0.013**	**<0.001**	**<0.001**	**0.003**	**<0.001**	**<0.001**
Multiple Valve Procedures [P]	**<0.001**	**<0.001**	**<0.001**	**0.002**	**<0.001**	**<0.001**
Renal Failure/Dialysis (category) [P]	**<0.001**	**0.015**	**<0.001**	**<0.001**	**0.003**	**<0.001**

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.
[1] This variable was not retained in the in-hospital or operative mortality model because the analysis did not suggest that the variable would be predictive of the relevant outcome (i.e., the variable's coefficient was negative).
ne This variable was removed from the development model, because its coefficient was negative during the preliminary analysis of the development sample.
ns[m] Not significant. In the development model this variable was *not* a significant ($p < 0.10$) predictor of the relevant outcome; therefore, it was not tested in the cross-validation model and not included in the final model.
nt[m] Not tested. This variable was not tested in the model because the univariate analysis did not suggest that the variable would be predictive of the relevant outcome.

Table 3a. Candidate Variables Entered Into the Mortality Models, 2008 Data

The variables retained in the model(s) are in bold text.

Demographic Variables

Age in Years [P]
Age # of Years > 65 [P]
Female [P]

Lab Variables

Albumin < 3.1 g/dL [MQ, 1]
BUN > 40 mg/dL [MQ]
Creatinine > 1.4 mg/dL [MQ]
Glucose > 165 mg/dL [MQ, 2]

Clinical Variables Other Than Lab

AMI Other Inferior Wall Initial Episode [C]
ASA Class 5 [MQ]
ASA Emergency [MQ]
CAD >70, 5-7 Vessels Group [MQ]
Current Med Immunosuppressive [MQ]
Current Med Insulin [MQ]
Ejection Fraction [MQ]
Heart Failure [C]
History of CABG or Valve Surgery [C]
History of Peripheral Vascular Disease [C]
MI/AMI Other Anterior Wall [C]
Mild, Moderate or Severe Altered Mental Status [MQ,
Other CV Procedure Group [C]
Percent of Left Main Stenosis [MQ]
Procedure Group [P]
PTCA/Stent/Tear Same Day CABG/Valve Surgery [C]
Septal Other Anomalous Repair Heart [MQ, 2]
SIRS Group [MQ, 1]

Table 3b. Candidate Variables Tested as Potential Predictors of Mortality, 2008 Data

The results of variable testing for the 2008 mortality models are displayed in the table below. The variables found to be significant predictors and their associated *p*-values are in bold text.

Candidate Variables Variables in bold text were included in the final model.	**In-Hospital** **Model Test Results** ***p*-values for variables significant in the model**			**Operative** **Model Test Results** ***p*-values for variables significant in the model**		
	Develop-ment	Cross-Validation	Full Data Set	Develop-ment	Cross-Validation	Full Data Set
Clinical Variables Other Than Lab						
AMI Except Other Anterior or Other Inferior Wall [P]	**0.002**	**0.087**	**<0.001**	**0.031**	**0.092**	**0.005**
Cachexia [P]	**0.001**	**<0.001**	**<0.001**	**0.001**	**0.001**	**<0.001**
Cardiac Adhesions [P]	ns[m]	ns[m]	ns[m]	nt[m]	nt[m]	nt[m]
Cardiogenic Shock, Pre-Operative [P]	**<0.001**	**0.504**	**0.001**	**0.010**	**0.515**	**0.012**
Cardiomyopathy [P]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]
Chronic Pulmonary Hypertension [P]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]
Hypertension with Complications [P]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]
Intra-Aortic Balloon Pump (IABP) Prior to Date of CABG/Valve Surgery [P]	**0.018**	**0.500**	**0.036**	ns[m]	ns[m]	ns[m]
Liver Disease [P]	**0.055**	**0.006**	**0.001**	**0.001**	**0.217**	**0.001**
Multiple Valve Procedures [P]	**0.008**	**0.157**	**0.004**	**0.014**	**0.015**	**0.001**
Renal Failure/Dialysis (category) [P]	**0.010**	**<0.001**	**<0.001**	**<0.001**	**0.090**	**<0.001**

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.
[1] This variable was not retained in the in-hospital mortality model because the analysis did not suggest that the variable would be predictive of the relevant outcome (i.e., the variable's coefficient was negative).
[2] This variable was not retained in the in-hospital mortality or operative mortality model because the analysis did not suggest that the variable would be predictive of the relevant outcome (i.e., the variable's coefficient was negative).
ns[m] Not significant. In the development model this variable was *not* a significant ($p < 0.10$) predictor of the relevant outcome; therefore, it was not tested in the cross-validation model and not included in the final model.
nt[m] Not tested. This variable was not tested in the model because the univariate analysis did not suggest that the variable would be predictive of the relevant outcome.

Table 4a. Candidate Variables Tested as Potential Predictors of Readmission, 2007-2008 Data

The results of variable testing for the 2007-2008 readmission models are displayed in the table below. The variables found to be significant predictors and their associated *p*-values are in bold text.

Candidate Variables Variables in bold text were included in the final model.	**7-Day** **Model Test Results** ***p*-values for variables significant in the model**			**30-Day** **Model Test Results** ***p*-values for variables significant in the model**		
	Develop-ment	Cross-Validation	Full Data Set	Develop-ment	Cross-Validation	Full Data Set
Demographic Variables						
Age in Years [P]	**<0.001**	**<0.001**	**<0.001**	ns[m]	ns[m]	ns[m]
Age # of Years > 65[P]	ns[m]	ns[m]	ns[m]	**<0.001**	**<0.001**	**<0.001**
Female [P]	ns[m]	ns[m]	ns[m]	**<0.001**	**<0.001**	**<0.001**
Race [P]	**0.013**	**0.003**	**<0.001**	**0.006**	**<0.001**	**<0.001**
Clinical Variables Other Than Lab						
AMI Except Other Anterior or Other Inferior Wall [P]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]
Anemia [P]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]
Cachexia [P]	ns[m]	ns[m]	ns[m]	**0.018**	**0.346**	**0.020**
Cardiac Adhesions [P]	**0.002**	**0.557**	**0.010**	ns[m]	ns[m]	ns[m]
Cardiomyopathy [P]	ns[m]	ns[m]	ns[m]	**0.050**	**0.555**	**0.065**
Cerebrovascular Disease [P]	nt[m]	nt[m]	nt[m]	ns[m]	ns[m]	ns[m]
Chronic Lung Disease [P]	**0.002**	**0.164**	**0.001**	**0.002**	**<0.001**	**<0.001**
Chronic Pulmonary Hypertension [P]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]
Coagulopathy	nt[m]	nt[m]	nt[m]	**0.026**	**0.468**	**0.023**
Depression [P]	**0.054**	**0.107**	**0.013**	**0.008**	**0.586**	**0.023**
Diabetes (category) [P]	**0.014**	**0.139**	**0.003**	**<0.001**	**0.013**	**<0.001**
Excision of Other Lesion/Heart Tissue/LAA, Open Approach – Same Date as Valve with or without CABG [P]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]
Heart Failure [P]	**0.004**	**0.005**	**<0.001**	**0.001**	**<0.001**	**<0.001**
History of CABG or Valve Surgery [P]	ns[m]	ns[m]	ns[m]	**0.024**	**0.539**	**0.039**
History of Chronic Steroid Use [P]	nt[m]	nt[m]	nt[m]	**0.046**	**0.182**	**0.022**
History of Peripheral Vascular Disease [P]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]
Hypertension with Complications [P]	**0.003**	**0.753**	**0.017**	**<0.001**	**0.113**	**<0.001**
Liver Disease [P]	nt[m]	nt[m]	nt[m]	**<0.001**	**0.833**	**0.001**
Lupus Erythematosus, Systemic [P]	nt[m]	nt[m]	nt[m]	ns[m]	ns[m]	ns[m]
MediQual Predicted Length of Stay [MQ]	**0.027**	**0.076**	**0.005**	**<0.001**	**<0.001**	**<0.001**
Multiple Valve Procedures [P]	ns[m]	ns[m]	ns[m]	**0.001**	**0.207**	**0.001**
Obesity, Morbid [P]	**0.056**	**0.001**	**<0.001**	**0.001**	**<0.001**	**<0.001**
Other CV Procedure Group [C]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]
Procedure Group [P]	**Entered and retained in model**			**Entered and retained in model**		
Renal Failure/Dialysis (category) [P]	nt[m]	nt[m]	nt[m]	ns[m]	ns[m]	ns[m]
Renal Failure/Dialysis (binary) [P]	ns[m]	ns[m]	ns[m]	nt[m]	nt[m]	nt[m]

[P] This variable was based on PHC4 data.

[MQ] This variable was based on data obtained from MediQual.

[C] This variable was based on both MediQual and PHC4 data.

ns[m] Not significant. In the development model this variable was *not* a significant ($p < 0.10$) predictor of the relevant outcome; therefore, it was not tested in the cross-validation model and not included in the final model.

nt[m] Not tested. This variable was not tested in the model because the univariate analysis did not suggest that the variable would be predictive of the relevant outcome.

Table 4b. Candidate Variables Tested as Potential Predictors of Readmission, 2008 Data

The results of variable testing for the 2008 readmission models are displayed in the table below. The variables found to be significant predictors and their associated *p*-values are in bold text.

Candidate Variables Variables in bold text were included in the final model.	**7-Day** **Model Test Results** ***p*-values for variables significant in the model**			**30-Day** **Model Test Results** ***p*-values for variables significant in the model**		
	Develop-ment	Cross-Validation	Full Data Set	Develop-ment	Cross-Validation	Full Data Set
Demographic Variables						
Age in Years [P]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]
Age # of Years > 65[P]	**0.036**	**<0.001**	**<0.001**	**0.001**	**<0.001**	**<0.001**
Female [P]	**0.027**	**0.785**	**0.083**	**<0.001**	**0.056**	**<0.001**
Race (category) [P]	nt[m]	nt[m]	nt[m]	ns[m]	ns[m]	ns[m]
Clinical Variables Other Than Lab						
Anemia [P]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]
Cachexia [P]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]
Cancer [P]	nt[m]	nt[m]	nt[m]	ns[m]	ns[m]	ns[m]
Cardiogenic Shock, Pre-Operative [P]	nt[m]	nt[m]	nt[m]	ne	ne	ne
Cardiomyopathy [P]	nt[m]	nt[m]	nt[m]	ns[m]	ns[m]	ns[m]
Cerebrovascular Disease [P]	nt[m]	nt[m]	nt[m]	ns[m]	ns[m]	ns[m]
Chronic Lung Disease [P]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]
Chronic Pulmonary Hypertension [P]	nt[m]	nt[m]	nt[m]	ns[m]	ns[m]	ns[m]
Coagulopathy [P]	nt[m]	nt[m]	nt[m]	**0.099**	**0.064**	**0.013**
Depression [P]	ns[m]	ns[m]	ns[m]	**0.013**	**0.373**	**0.017**
Diabetes (category) [P]	nt[m]	nt[m]	nt[m]	ns[m]	ns[m]	ns[m]
Excision of Other Lesion/Heart Tissue/LAA, Open Approach – Same Dates as Valve with or without CABG [P]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]
Heart Failure [P]	ns[m]	ns[m]	ns[m]	**<0.001**	**0.001**	**<0.001**
History of CABG or Valve Surgery [P]	nt[m]	nt[m]	nt[m]	ne	ne	ne
Hypertension with Complications [P]	ns[m]	ns[m]	ns[m]	**0.041**	**0.002**	**<0.001**
Liver Disease [P]	nt[m]	nt[m]	nt[m]	**0.068**	**0.060**	**0.008**
MediQual Predicted Length of Stay [MQ]	**0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**
Multiple Valve Procedures [P]	ns[m]	ns[m]	ns[m]	**0.050**	**0.055**	**0.005**
Obesity, Morbid [P]	**0.002**	**0.285**	**0.002**	**<0.001**	**0.037**	**<0.001**
Other CV Procedure Group [C]	nt[m]	nt[m]	nt[m]	ns[m]	ns[m]	ns[m]
Other Open Heart Procedure [P]	ns[m]	ns[m]	ns[m]	nt[m]	nt[m]	nt[m]
Procedure Group [P]	**Entered and retained in model**			**Entered and retained in model**		
Renal Failure/Dialysis (binary) [P]	nt[m]	nt[m]	nt[m]	ns[m]	ns[m]	ns[m]

[P] This variable was based on PHC4 data.

[MQ] This variable was based on data obtained from MediQual.

[C] This variable was based on both MediQual and PHC4 data.

ne This variable was removed from the development model, because its coefficient was negative during the preliminary analysis of the development sample.

ns[m] Not significant. In the development model this variable was *not* a significant ($p < 0.10$) predictor of the relevant outcome; therefore, it was not tested in the cross-validation model and not included in the final model.

nt[m] Not tested. This variable was not tested in the model because the univariate analysis did not suggest that the variable would be predictive of the relevant outcome.

Measure of model adequacy. To evaluate the model performance for both the development and cross-validation samples, the estimated coefficients from the development model were applied to both samples. The coefficients from the final model were applied to the full data set. The *c* statistic was used to measure model adequacy. The *c* statistic, the measure of "goodness of fit" used to describe a logistic regression model, is a common measure for models with binary dependent variables. For binary outcomes, the *c* statistic is defined as the area under the receiver operating characteristic (ROC) curve[1]. The *c* statistic ranges between 0.5 and 1.0, with higher values associated with better discrimination, and can be expressed as a percentage ranging from 50 to 100 percent. In some respects, the *c* statistic is similar to the R^2 (Coefficient of Determination) commonly used in linear regression. Both the *c* statistic and R^2 approach 1.0 for models that perfectly discriminate. However, unlike R^2, the *c* statistic is not dependent on the frequency of the outcome. The *c* statistics for the models are listed in Table 5.

Table 5. C Statistics for Development, Cross-Validation, and Full Data Set Models

Measure	Development Model %	Cross-Validation Model %	Full Data Set Model %
2007-2008 Models			
In-Hospital Mortality	81.8	79.5	81.0
Operative Mortality	80.3	78.9	80.0
7-Day Readmissions	63.4	60.3	62.1
30-Day Readmissions	64.6	62.4	63.7
2008 Models			
In-Hospital Mortality	82.8	78.8	81.9
Operative Mortality	80.5	78.7	80.3
7-Day Readmissions	60.7	58.0	59.9
30-Day Readmissions	63.2	61.6	62.5

Coefficients and Odds Ratios

The coefficients and odds ratios for each risk factor included in the final models are listed in Tables 6a, 6b, 7a, and 7b. The entire data set was used in creating the final coefficients (i.e., the development sample and the cross-validation sample were "recombined", and the coefficients were re-estimated). For a binary variable, the odds ratio is the change in the odds for a patient with the risk factor compared to a patient without it. For example, the odds ratio for Cardiogenic Shock – Preoperative is 3.075 for the 2007-2008 in-hospital mortality model, meaning that a patient with cardiogenic shock prior to surgery was slightly more than three times as likely to die during the hospital admission as patients who did not have this risk factor. Odds ratios are not applicable for continuous variables such as age in years and MediQual Predicted Length of Stay.

[1] Hanley, J. A., & McNeil, B. J. (1982). The meaning and use of the area under a receiver operating characteristic (ROC) curve. *Radiology, 143*(1), 29-36.

Table 6a. Coefficients and Odds Ratios of Final Mortality Models, 2007-2008 Data

Predictor Variables	In-Hospital Mortality		Operative Mortality	
	Coefficient	Odds Ratio	Coefficient	Odds Ratio
Constant	-6.7822		-6.5923	
Demographic Variables				
Age in Years [P]	0.0187	NA	0.0206	NA
Age # Years > 65 [P]	0.0332	NA	0.0323	NA
Female [P]	0.4063	1.501	0.4053	1.500
Laboratory Variables				
Albumin < 3.1 g/dL [MQ]	0.1155	1.122	0.1845	1.203
BUN > 40 mg/dL [MQ]	0.6989	2.012	0.6229	1.864
Creatinine > 1.4 mg/dL [MQ]	0.2612	1.299	0.3033	1.354
Clinical Variables Other Than Laboratory Variables				
AMI Except Other Anterior or Other Inferior Wall [P]	0.5540	1.740	0.4888	1.630
AMI Other Inferior Wall Initial Episode [C]	0.7713	2.163	0.7048	2.023
ASA Class 5 [MQ]	1.0370	2.821	1.1993	3.318
ASA Emergency Flag [MQ]	0.5268	1.694	0.6503	1.916
Cachexia [P]	0.6981	2.010	0.7625	2.144
CAD > 70, 5-7 Vessels Grp [MQ]	0.0327	1.033	0.1415	1.152
Cardiogenic Shock, Preoperative [P]	1.1233	3.075	1.0501	2.858
Current Med Immunosuppresive [MQ]	0.2253	1.253	0.3388	1.403
Current Med Insulin [MQ]	0.2209	1.247	0.2023	1.224
Ejection Fraction [MQ]				
<25%	0.4194	1.521	0.5172	1.677
25-45%	0.1962	1.217	0.2305	1.259
>45%	*	*	*	*
Heart Failure [C]	0.5146	1.673	0.5296	1.698
History of CABG or Valve Surgery [C]	0.7351	2.086	0.6653	1.945
History of Peripheral Vascular Disease [C]	0.3738	1.453	0.3993	1.491
Intra-Aortic Balloon Pump (IABP) Prior to Date of CABG/Valve Surgery [P]	0.4084	1.504	ns[m]	–
Liver Disease [P]	1.2033	3.331	1.2725	3.570
MI/AMI Other Anterior Wall [C]	0.6089	1.838	0.4693	1.599
Mild, Moderate or Severe Altered Mental Status [MQ]	0.0701	1.073	0.0159	1.016
Multiple Valve Procedures [P]	0.6977	2.009	0.6864	1.987
Other CV Procedure Group [C]	0.4337	1.543	0.3416	1.407
Percent of Left Main Stenosis [MQ]	0.00395	NA	0.00250	NA
Procedure Group [P]				
CABG without Valve	*	*	*	*
Valve without CABG	0.2432	1.275	0.0786	1.082
Valve with CABG	0.6297	1.877	0.5747	1.777
PTCA/Stent/Tear Same Day as CABG/Valve Surgery [C]	0.6413	1.899	0.5042	1.656
Renal Failure Dialysis (category) [P]				
All cases not assigned to chronic and acute/dialysis categories	*	*	*	*
Chronic	0.3010	1.351	0.3129	1.367
Acute/dialysis	0.9553	2.599	0.9308	2.536
SIRS Group [MQ]	0.0351	1.036	0.0503	1.052

[P] This variable was based on PHC4 data.

[MQ] This variable was based on data obtained from MediQual.

[C] This variable was based on both MediQual and PHC4 data.

* This is the reference level for the variable.

NA Not applicable. This variable was tested as a continuous variable.

ns[m] Not significant. In the development model this variable was *not* a significant ($p < 0.10$) predictor of the relevant outcome; therefore, it was not tested in the cross-validation model and not included in the final model.

Table 6b. *Coefficients and Odds Ratios of Final Mortality Models, 2008 Data*

Predictor Variables	In-Hospital Mortality		Operative Mortality	
	Coefficient	Odds Ratio	Coefficient	Odds Ratio
Constant	-6.4533		-6.5184	
Demographic Variables				
Age in Years [P]	0.0133	NA	0.0198	NA
Age # Years > 65 [P]	0.0337	NA	0.0239	NA
Female [P]	0.4123	1.510	0.3800	1.462
Laboratory Variables				
Albumin < 3.1 g/dL [MQ]	ne	–	0.00354	1.004
BUN > 40 mg/dL [MQ]	0.9413	2.563	0.8667	2.379
Creatinine > 1.4 mg/dL [MQ]	0.1822	1.200	0.3103	1.364
Clinical Variables Other Than Laboratory Variables				
AMI Except Other Anterior or Other Inferior Wall [P]	0.5283	1.696	0.4058	1.500
AMI Other Inferior Wall Initial Episode [C]	0.5817	1.789	0.8567	2.355
ASA Class 5 [MQ]	1.1708	3.225	1.0711	2.919
ASA Emergency Flag [MQ]	0.6556	1.926	0.7273	2.069
Cachexia [P]	0.8736	2.395	0.8271	2.287
CAD > 70, 5-7 Vessels Grp [MQ]	0.0541	1.056	0.0980	1.103
Cardiogenic Shock, Preoperative [P]	1.1892	3.284	0.9143	2.495
Current Med Immunosuppresive [MQ]	0.4339	1.543	0.5778	1.782
Current Med Insulin [MQ]	0.2712	1.312	0.2121	1.236
Ejection Fraction [MQ]				
<25%	0.5673	1.763	0.6169	1.853
25-45%	0.2816	1.325	0.2933	1.341
>45%	*	*	*	*
Heart Failure [C]	0.3835	1.467	0.3797	1.462
History of CABG or Valve Surgery [C]	0.6501	1.916	0.5853	1.796
History of Peripheral Vascular Disease [C]	0.3151	1.370	0.3538	1.424
Intra-Aortic Balloon Pump (IABP) Prior to Date of CABG/Valve Surgery [P]	0.4124	1.511	ns[m]	–
Liver Disease [P]	1.2833	3.608	1.2573	3.516
MI/AMI Other Anterior Wall [C]	0.9441	2.570	0.8665	2.379
Mild Moderate or Severe AMS [MQ]	0.1606	1.174	0.1820	1.200
Multiple Valve Procedures [P]	0.5238	1.688	0.6265	1.871
Other CV Procedure Group [C]	0.4957	1.642	0.3345	1.397
Percent of Left Main Stenosis [MQ]	0.00516	NA	0.00431	NA
Procedure Group [P]				
CABG without Valve	*	*	*	*
Valve without CABG	0.3573	1.430	0.1887	1.208
Valve with CABG	0.7864	2.195	0.7766	2.174
PTCA/Stent/Tear Same Day as CABG/Valve Surgery [C]	0.4901	1.632	0.4297	1.537
Renal Failure Dialysis (category) [P]				
All cases not assigned to chronic and acute/dialysis categories	*	*	*	*
Chronic	0.5377	1.712	0.4312	1.539
Acute/dialysis	1.3410	3.823	1.2506	3.492
SIRS Group	ne	–	0.00813	1.008

[P] This variable was based on PHC4 data.

[MQ] This variable was based on data obtained from MediQual.

[C] This variable was based on both MediQual and PHC4 data.

* This is the reference level for the variable.

NA Not applicable. This variable was tested as a continuous variable.

ne This variable was removed from the development model, because its coefficient was negative during the preliminary analysis of the development sample.

ns[m] Not significant. In the development model this variable was *not* a significant ($p < 0.10$) predictor of the relevant outcome; therefore, it was not tested in the cross-validation model and not included in the final model.

Table 7a. Coefficients and Odds Ratios of Final Readmissions Models, 2007-2008 Data

Predictor Variables	7-Day Readmissions		30-Day Readmissions	
	Coefficient	**Odds Ratio**	**Coefficient**	**Odds Ratio**
Constant	-4.4379		-2.6006	
Demographic Variables				
Age in Years [P]	0.0181	NA	ns[m]	–
Age # of Years > 65 [P]	ns[m]	–	0.0223	NA
Female [P]	ns[m]	–	0.2197	1.246
Race [P]				
Black	0.4389	1.551	0.3886	1.475
Other	-0.1372	0.872	0.0634	1.065
White	*	*	*	*
Clinical Variables Other Than Laboratory Variables				
Cachexia [P]	ns[m]	–	0.2174	1.243
Cardiac Adhesions [P]	0.5253	1.691	ns[m]	–
Cardiomyopathy [P]	ns[m]	–	0.0872	1.091
Chronic Lung Disease [P]	0.1899	1.209	0.2143	1.239
Coagulopathy [P]	ns[m]	–	0.4481	1.565
Depression [P]	0.2295	1.258	0.1470	1.158
Diabetes [P]				
No Diabetes	*	*	*	*
Diabetes without Complication	0.1283	1.137	0.1410	1.151
Diabetes with Complication	0.2733	1.314	0.3213	1.379
Heart Failure [P]	0.2423	1.274	0.2266	1.254
History of CABG/Valve Surgery [P]	ns[m]	–	0.1421	1.153
History of Chronic Steroid Use [P]	ns[m]	–	0.4711	1.602
Hypertension with Complications [P]	0.1690	1.184	0.1984	1.219
Liver Disease [P]	nt[m]	–	0.5379	1.712
MediQual Predicted Length of Stay [MQ]	0.0242	NA	0.0348	NA
Multiple Valve Procedures [P]	ns[m]	–	0.2425	1.274
Obesity, Morbid [P]	0.3702	1.448	0.3864	1.472
Procedure Group [P]				
CABG without Valve	*	*	*	*
Valve without CABG	0.0919	1.096	0.0874	1.091
Valve with CABG	0.1889	1.208	0.1357	1.145

[P] This variable was based on PHC4 data.

[MQ] This variable was based on data obtained from MediQual.

* This is the reference group for the variable.

NA Not applicable. This variable was tested as a continuous variable.

ns[m] Not significant. In the development model this variable was *not* a significant ($p < 0.10$) predictor of the relevant outcome; therefore, it was not tested in the cross-validation model and not included in the final model.

nt[m] Not tested. This variable was not tested in the model because the univariate analysis did not suggest that the variable would be predictive of the relevant outcome.

Table 7b. Coefficients and Odds Ratios of Final Readmissions Models, 2008 Data

Predictor Variables	7-Day Readmissions		30-Day Readmissions	
	Coefficient	**Odds Ratio**	**Coefficient**	**Odds Ratio**
Constant	-3.3886		-2.5057	
Demographic Variables				
Age # of Years > 65[P]	0.0226	NA	0.0206	NA
Female [P]	0.1268	1.135	0.2025	1.224
Clinical Variables Other Than Laboratory Variables				
Coagulopathy [P]	ns[m]	–	0.6713	1.957
Depression [P]	ns[m]	–	0.2123	1.237
Heart Failure [P]	ns[m]	–	0.2970	1.346
Hypertension with Complications [P]	ns[m]	–	0.2508	1.285
Liver Disease [P]	ns[m]	–	0.5851	1.795
MediQual Predicted Length of Stay [MQ]	0.0524	NA	0.0445	NA
Multiple Valve Procedures [P]	ns[m]	–	0.2958	1.344
Obesity, Morbid [P]	0.4222	1.525	0.4036	1.497
Procedure Group [P]				
CABG without Valve	*	*	*	*
Valve without CABG	-0.0674	0.935	-0.0487	0.952
Valve with CABG	0.1009	1.106	0.0707	1.062

[P] This variable was based on PHC4 data.

[MQ] This variable was based on data obtained from MediQual.

* This is the reference group for the variable.

NA Not applicable. This variable was tested as a continuous variable.

ns[m] Not significant. In the development model this variable was *not* a significant ($p < 0.10$) predictor of the relevant outcome; therefore, it was not tested in the cross-validation model and not included in the final model.

Calculation of Statistical Ratings

Once the risk-adjustment models were built for each outcome measure (in-hospital mortality, operative mortality, 7-day readmissions, and 30-day readmissions), the statistical ratings were calculated. In doing so, actual rates were compared to expected rates to determine whether the difference was statistically significant.

Determining Actual (Observed) Rates

In-hospital mortality rates were determined by dividing the total number of deaths that occurred during the hospital stay by the total number of cases included in the analysis.

Operative mortality rates were determined by dividing the total number of deaths that occurred during the hospital stay *and* within 30 days of the CABG/valve surgery date by the total number of cases included in the analysis.

Seven-day and 30-day readmissions were determined by dividing the total number of cases readmitted to a general acute care hospital (for a particular principal diagnoses) within 7 or 30 days of discharge from the original hospital by the total number of cases included in the analysis.

Determining Expected Rates

The first step in calculating the expected rates was to estimate the probability of each of the relevant events occurring for each patient, that is: 1) the probability of in-hospital death, 2) the probability of death in the hospital or within 30 days of the procedure, 3) the probability of being readmitted within 7 days of discharge, and 4) the probability of being readmitted within 30 days of discharge. The probability of each of these events occurring was estimated by using the statistical technique of logistic regression. In logistic regression each category for each clinical or demographic risk factor was assigned a coefficient or "weight." A factor category's weight was higher (or lower) if patients with that factor category tended to have a higher (or lower) chance of the event occurring. These weights, determined using the statewide CABG/valve data set, were used to estimate each individual patient's probability of in-hospital death, operative death (in-hospital or within 30 days), or 7-day or 30-day readmissions given the risk factors of the patient. (Note that coefficients are displayed in Tables 6a, 6b, 7a, and 7b in the "Coefficients and Odds Ratios" section.)

The results for all patients were then summed to determine the expected number of in-hospital deaths, deaths in the hospital or within 30 days, and readmissions within 7 days or 30 days for a given hospital/surgeon. The expected rate was calculated by dividing the total number of expected events by the total number of cases in the analysis.

The following example of the in-hospital mortality analysis illustrates the calculations used in determining the statistical ratings. Similar calculations apply to operative mortality and 7-day and 30-day readmissions.

Example 1. 2008 Calculations of Statistical Ratings for In-Hospital Mortality Analysis

Total Cases: Number of hospitalizations after exclusions.

Actual Deaths: Total number of deaths (death is a discharge status equal to 20)

Rate: Total number of deaths / Total number of cases

Expected Deaths: Sum of each patient's probability of death (PD)

Rate: Total number of expected deaths / Total number of cases

To calculate a patient's probability of death:

Step 1: Calculate βX:

$\beta X = -6.4533 + 0.0133$ (Age) + 0.0337 (Age # Years > 65) + 0.4123 (Female) + 1.1708 (ASA Class 5) + 1.1892 (Cardiogenic Shock – Preoperative) + 0.3835 (Heart Failure) + coefficient (other variables in in-hospital mortality model) . . .

Step 2: Calculate the estimated probability of death (PD) using βX:

$PD = e^{\beta X} / (1 + e^{\beta X})$ where $e \approx 2.7182818285$

Test Statistic: (Actual Deaths – Expected Deaths) / Standard Deviation of Mortality

To compute Standard Deviation of Mortality:

Step 1: Compute the estimated variance of each patient's probability of death (VARPAT):

VARPAT = (PD) (1-PD)

Step 2: Calculate the Standard Deviation of Mortality

SUMVAR = sum of VARPAT across all cases

Standard Deviation of Mortality = square root of SUMVAR

***p*-value (two sided):** Calculated using test statistic as a normal z-score

Statistical Rating: If *p*-value <0.05 and test statistic > 0, then more deaths than expected (denoted as "●")
If *p*-value <0.05 and test statistic < 0, then fewer deaths than expected (denoted as "O")
Otherwise, the number of deaths were within the expected range (denoted as "⊙")

Expected Range: Lower limit = Expected Deaths – 1.960 (Standard Deviation of Mortality)
Upper limit = Expected Deaths + 1.960 (Standard Deviation of Mortality)

POST-SURGICAL LENGTH OF STAY ANALYSIS

Risk Adjustment Methodology

Data Preparation

After cases meeting the exclusion criteria were removed from the post-surgical length of stay analysis, the remaining cases for each procedure group were split into two equal-size samples by each procedure group: a development sample and a cross-validation sample. The relevant number of cases for each sample is shown in Table 8.

Table 8. Case Counts and Average Post-Surgical Length of Stay in Days

	Development Sample	Cross-Validation Sample	Full Data Set
2007-2008 Model			
Number of cases	15,095	15,094	30,189
Average post-surgical length of stay *(arithmetic)*	7.4	7.4	7.4
Average post-surgical length of stay *(geometric)*	6.5	6.4	6.5
2008 Model			
Number of cases	7,532	7,530	15,062
Average post-surgical length of stay *(arithmetic)*	7.4	7.4	7.4
Average post-surgical length of stay *(geometric)*	6.5	6.5	6.5

Building the Risk-Adjustment Model

While logistic regression was used to construct the models for in-hospital mortality, operative mortality, 7-day readmissions, and 30-day readmissions, a general linear modeling approach was used for post-surgical length of stay because it is a continuous variable. The model building steps were similar to those in the logistic regression models.

Model selection. The model was constructed using the development sample, after a natural log transformation was done to adjust for skewness in the distribution. All tests of significance ($p < 0.10$) were based on general linear model *F*-tests. The results for the development model are shown in Table 9.

Cross-validation. After the development model was built for post-surgical length of stay, the model was cross-validated. The model built in the model selection process (i.e., the development model) was re-estimated using the cases in the cross-validation sample. Regression analysis was performed to determine whether the selected candidate variables would remain predictive of the relevant outcome for the cross-validation sample. As long as the coefficient of a variable did not change from positive to negative, the variable was retained in the final model that applied to the full data set. See Table 9 for cross-validation and full data set results.

Table 9. *Case Counts and Average Post-Surgical Length of Stay in Days*

The results of variable testing for the readmission models are displayed in the table below. The variables found to be significant predictors and their associated *p*-values are in bold text.

Candidate Variables Variables in bold text were included in the final model.	**2007-2008 Data** **Model Test Results *p*-values for variables significant in the model**			**2008 Data** **Model Test Results *p*-values for variables significant in the model**		
	Develop-ment	Cross-Validation	Full Data Set	Develop-ment	Cross-Validation	Full Data Set
Demographic Variables						
Age in Years [P]	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**
Age # of Years > 65 [P]	**0.0002**	**0.0005**	**<0.0001**	**0.0131**	**0.0176**	**0.0004**
Female [P]	**<0.0001**	**0.0002**	**<0.0001**	**0.0002**	**0.1239**	**0.0003**
Race/Ethnicity [P]	**<0.0001**	**<0.0001**	**<0.0001**	nt[m]	nt[m]	nt[m]
Race [P]	nt[m]	nt[m]	nt[m]	**<0.0001**	**<0.0001**	**<0.0001**
Clinical Variables Other Than Laboratory Variables						
Acute Myocardial Infarction [P]	**0.0468**	**0.0018**	**0.0004**	ns[m]	ns[m]	ns[m]
Anemia [P]	**0.0002**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**
Cachexia [P]	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**
Cancer [P]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]
Cardiac Adhesions [P]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]
Cardiogenic Shock, Pre-Operative [P]	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**
Cardiomyopathy [P]	**0.0124**	**0.2209**	**0.0084**	ns[m]	ns[m]	ns[m]
Chronic Lung Disease [P]	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**
Chronic Pulmonary Hypertension [P]	ne	ne	ne	ns[m]	ns[m]	ns[m]
Coagulopathy [P]	**0.0078**	**0.2395**	**0.0052**	nt[m]	nt[m]	nt[m]
Diabetes with Long Term/Unspecified Complications [P]	**0.0038**	**<0.0001**	**<0.0001**	**0.0008**	**0.0046**	**<0.0001**
Excision or Other Lesion/Heart Tissue, Open Approach – Same Date as Valve with or without CABG [P]	ne	ne	ne	ne	ne	ne
Heart Failure [P]	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**
History of CABG or Valve Surgery [P]	**0.0064**	**0.0226**	**0.0004**	**0.0161**	**0.0084**	**0.0005**
History of Cerebral Vascular Accident (CVA) or Stroke [P]	nt[m]	nt[m]	nt[m]	ns[m]	ns[m]	ns[m]
History of Peripheral Vascular Disease [P]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]	ns[m]
Hypertension with Complications [P]	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**
Intra-Aortic Balloon Pump (IABP) Prior to Date of CABG/Valve Surgery [P]	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**
Liver Disease [P]	**0.0001**	**0.0031**	**<0.0001**	**0.0097**	**0.1831**	**0.0062**
MediQual Predicted Length of Stay [MQ]	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**
Multiple Valve Procedures [P]	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**
Obesity, Morbid [P]	**<0.0001**	**<0.0001**	**<0.0001**	**0.0003**	**<0.0001**	**<0.0001**
Other Open Heart Procedure [P]	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**
Procedure Group [P]	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**
PTCA/Stent Same Day as CABG/Valve Surgery [P]	**<0.0001**	**0.0003**	**<0.0001**	**0.0020**	**0.2730**	**0.0041**
Renal Failure/Dialysis (binary) [P]	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**

[P] This variable was based on PHC4 data.

[MQ] This variable was based on data obtained from MediQual.

ne This variable was removed from the development model, because its coefficient was negative during the preliminary analysis of the development sample.

ns[m] Not significant. In the development model this variable was *not* a significant ($p < 0.10$) predictor of the relevant outcome; therefore, it was not tested in the cross-validation model and not included in the final model.

nt[m] Not tested. This variable was not tested in the model because the univariate analysis did not suggest that the variable would be predictive of the relevant outcome.

Measure of model adequacy. To evaluate the model performance for both the development and cross-validation samples, the estimated coefficients from the development model were applied to both samples. The coefficients from the final model were applied to the full data set. The Coefficient of Determination (R^2) was the measure considered in evaluating the models' performance. R^2 refers to the percentage of the total variability in post-surgical length of stay among the patients in the sample that can be explained by the estimated model involving the specified risk factors. R^2 values for each of the models are listed in Table 10.

Table 10. R-Squared Statistics for Development, Cross-Validation, and Full Data Set Models

Post-Surgical Length of Stay Model	Development Model %	Cross-Validation Model %	Full Data Set Model %
2007-2008 Model	31.4	30.0	30.8
2008 Model	30.3	30.5	30.6

Coefficients

Each category for each statistically significant clinical or demographic factor was assigned a coefficient or weight. These coefficients were used to compute each individual patient's expected post-surgical length of stay given the risk factors of the patient. Table 11 displays the coefficients for the variables included in the final models.

Table 11. Coefficients of Predictors in the Final Post-Surgical Length of Stay Models

Predictor Variables	2007-2008 Data	2008 Data
Intercept	1.246997709	1.161977231
Demographic Variables		
Age in Years [P]	0.004190541	0.004358886
Age # of Years > 65 [P]	0.003819398	0.003664404
Female [P]	0.033941580	0.026336997
Race/Ethnicity [P]		nt[m]
Hispanic	-0.226897177	
White (non-Hispanic)	-0.074120913	
Black (non-Hispanic)	0.065052291	
Other/Unknown	*	
Race (category) [P]	nt[m]	
Black		0.140091912
Other		0.050710639
White		*
Clinical Variables Other Than Lab		
Acute Myocardial Infarction [P]	0.024637046	ns[m]
Anemia [P]	0.040519670	0.049654867
Cachexia [P]	0.519894101	0.592763252
Cardiogenic Shock, Pre-Operative [P]	0.329775073	0.363836896
Cardiomyopathy [P]	0.018307037	ns[m]
Chronic Lung Disease [P]	0.070577928	0.062346008
Coagulopathy [P]	0.084847156	nt[m]
Diabetes with Long Term/Unspecified Complications [P]	0.048808511	0.057031474
Heart Failure [P]	0.155717331	0.148916931
History of CABG or Valve Surgery [P]	0.035611049	0.048678177
Hypertension with Complications [P]	0.082518183	0.075894741
Intra-Aortic Balloon Pump (IABP) Prior to Date of CABG/Valve Surgery [P]	0.116858919	0.121057111
Liver Disease [P]	0.117947432	0.091462600
MediQual Predicted Length of Stay [MQ]	0.019812575	0.021297579
Multiple Valve Procedures [P]	0.144838143	0.127160106
Obesity, Morbid [P]	0.093157050	0.101971958
Other Open Heart Procedure [P]	0.091365691	0.096335897
Procedure Group [P]		
CABG without Valve	*	*
Valve without CABG	0.078629624	0.066073850
Valve with CABG	0.157910761	0.144135753
PTCA/Stent Same Day as CABG/Valve Surgery [P]	0.152349710	0.104053184
Renal Failure/Dialysis (binary) [P]	0.171663430	0.151496018

[P] This variable was based on PHC4 data.

[MQ] This variable was based on data obtained from MediQual.

* This is the reference level for the variable.

ns[m] Not significant. In the development model this variable was *not* a significant ($p < 0.10$) predictor of the relevant outcome; therefore, it was not tested in the cross-validation model and not included in the final model.

nt[m] Not tested. This variable was not tested in the model because the univariate analysis did not suggest that the variable would be predictive of the relevant outcome.

Calculation of Risk-Adjusted Post-Surgical Length of Stay

Once the significant risk factors were determined, the actual post-surgical length of stay and the expected post-surgical length of stay were used to calculate the risk-adjusted post-surgical length of stay.

Actual Length of Stay

The actual post-surgical length of stay was derived by subtracting the CABG/valve procedure date from the discharge date. The average post-surgical length of stay is reported as a geometric mean[1], rather than an arithmetic mean.

Expected Length of Stay

Coefficients in the final model were summed to compute each individual patient's expected length of stay, given the risk factors of the patient. The coefficient for a category represented the estimated difference in mean (log) length of stay for the category compared to the base category of that factor. Thus, the coefficient for the base category of a factor was always zero. When dealing with categorical variables in the length of stay model there was no particular importance to the order of these categories. The constant term in the model represents the predicted value for all categorical factors at the base level. The coefficients for the other levels within a factor represent adjustments to that "baseline." No adjustment was required at the base level for any factor, because it was already accounted for in the constant. For example, a patient without heart failure had a zero or baseline coefficient; while a patient with heart failure would be adjusted upward by 0.148916931 (see Table 11). The order was not important because each ordering scheme would result in different coefficients, but the estimated difference between any pairs of levels would be the same (i.e., the difference between heart failure and no heart failure would always be 0.148916931 independent of what the specific coefficients were for each). For the quantitative factor age, there is always an adjustment because the baseline is zero.

Risk-Adjusted Post-Surgical Length of Stay

Post-surgical length of stay is reported in average days instead of a statistical rating. Unlike other measures (such as mortality where a lower number of deaths is obviously better than a higher number), it is not known whether shorter lengths of stay are "better" than longer lengths of stay or vice versa. Reporting the average length of stay in days, therefore, presents information that can be used to examine differences in lengths of stay without taking a position on what is "best."

The following example illustrates the complete calculation.

[1] Because a natural log transformation of each length of stay value was done to adjust for skewness in the distribution, it was necessary to convert the logarithm values back to days when reporting or displaying post-surgical length of stay. This process results in geometric means, rather than arithmetic means. Unlike an arithmetic mean that is derived by summing individual values and dividing by the number of observations, a geometric mean is calculated by multiplying the individual values and taking the n^{th} root of the product. Geometric means are averages and are the natural result when using the log transformation.

Example 2. 2008 Calculations Used for Post-Surgical Length of Stay Analysis

Total Cases is the number of hospitalizations after exclusions (equal to n).

Actual LOS is the number of days the patient was in the hospital post-surgery

Step 1. Calculate the actual length of stay (LOS) for each case:

LOS = Discharge date – procedure date

Natural Log (ln) is the function used in a natural log transformation (**ln** = logarithm base e).

Step 2. Perform natural log transformation across all cases to adjust for skewness in the distribution of actual length of stay values:

ln(LOS) = natural log transformation of LOS

Mean Actual LOS is the geometric mean of the actual lengths of stay (GMLOS) across all cases.

Step 3. Calculate the arithmetic mean of the natural log lengths of stay (Am**ln**(LOS)):

$$\text{Am}\mathbf{ln}(\text{LOS}) = (1/n)(\mathbf{ln}\text{LOS}_{\text{case 1}} + \mathbf{ln}\text{LOS}_{\text{case 2}} + \ldots + \mathbf{ln}\text{LOS}_{\text{case n}})$$

Step 4. Convert the arithmetic mean of the natural log lengths of stay into a value that can be expressed in days, which yields a geometric mean:

$$\text{GMLOS} = e^{\text{Am}\mathbf{ln}(\text{LOS})} \quad \text{where } e \approx 2.7182818285$$

Mean Expected LOS is the geometric mean of the *expected* lengths of stay (GM*E*LOS) across all cases

Step 5. Calculate the expected natural log lengths of stay (E*ln*LOS) for each case using the appropriate coefficients:

*E***ln**LOS = 1.161977231 + 0.004358886 (Age) + 0.003664404 (Age # Years > 65) + 0.026336997 (Female) + 0.148916931 (Heart Failure) + coefficient (other variables in post-surgical length of stay model) . . .

Step 6. Calculate the arithmetic mean of the expected natural log lengths of stay (AM*E***ln**(LOS)):

$$\text{AM}E\mathbf{ln}(\text{LOS}) = (1/n)(E\mathbf{ln}\text{LOS}_{\text{case 1}} + E\mathbf{ln}\text{LOS}_{\text{case 2}} + \ldots + E\mathbf{ln}\text{LOS}_{\text{case n}})$$

Step 7. Convert the arithmetic mean of the expected natural log lengths of stay into a value that can be expressed in days, which yields a geometric mean:

$$\text{GM}E\text{LOS} = e^{\text{AM}E\mathbf{ln}(\text{LOS})} \quad \text{where } e \approx 2.7182818285$$

Risk-Adjusted Average Post-Surgical Length of Stay for a particular hospital/surgeon

Step 8. Calculate the risk-adjusted average post-surgical length of stay (RALOS):

$$\text{RALOS} = \frac{\text{GMLOS for hospital/surgeon}}{\text{GM}E\text{LOS for hospital/surgeon}} \times \text{GMLOS for the reporting group}$$

AVERAGE HOSPITAL CHARGE ANALYSIS

Average charges were trimmed for outliers and case-mix adjusted for the three procedure groups (CABG without Valve, Valve without CABG, and Valve with CABG) and for the two years (2007 and 2008) separately. Average charge is reported for hospitals only.

Construction of Reference Database

After exclusions were applied, the charge data for each procedure group was analyzed by region and by groups based on the Diagnostic Related Group (CMS-DRG/MS-DRG) assignment.

Patients who underwent CABG without valve procedures were comprised of the following DRG groups:

DRG Group 1	CMS-DRG 106[1]	Coronary Bypass with PTCA
	MS-DRG 231[2]	Coronary Bypass with PTCA with MCC
	MS-DRG 232[2]	Coronary Bypass with PTCA without MCC
DRG Group 2	CMS-DRG 547[1]	Coronary Bypass with Cardiac Catheterization with Major Cardiovascular Diagnosis
	CMS-DRG 548[1]	Coronary Bypass with Cardiac Catheterization without Major Cardiovascular Diagnosis
	MS-DRG 233[2]	Coronary Bypass with Cardiac Catheterization with MCC
	MS-DRG 234[2]	Coronary Bypass with Cardiac Catheterization without MCC
DRG Group 3	CMS-DRG 108[1]	Other Cardiothoracic Procedures
	MS-DRG 228[2]	Other Cardiothoracic Procedures with MCC
	MS-DRG 229[2]	Other Cardiothoracic Procedures with CC
	MS-DRG 230[2]	Other Cardiothoracic Procedures without CC/MCC
DRG Group 4	CMS-DRG 549[1]	Coronary Bypass without Cardiac Catheterization with Major Cardiovascular Diagnosis
	CMS-DRG 550[1]	Coronary Bypass without Cardiac Catheterization without Major Cardiovascular Diagnosis
	MS-DRG 235[2]	Coronary Bypass without Cardiac Catheterization with MCC
	MS-DRG 236[2]	Coronary Bypass without Cardiac Catheterization without MCC

Patients who underwent valve procedures with or without CABG procedures were comprised of the following DRG groups:

DRG Group 5	CMS-DRG 104[1]	Cardiac Valve and Other Major Cardiothoracic Procedures with Cardiac Catheterization
	MS-DRG 216[2]	Cardiac Valve and Other Major Cardiothoracic Procedures with Cardiac Catheterization with MCC
	MS-DRG 217[2]	Cardiac Valve and Other Major Cardiothoracic Procedures with Cardiac Catheterization with CC
	MS-DRG 218[2]	Cardiac Valve and Other Major Cardiothoracic Procedures with Cardiac Catheterization without CC/MCC
DRG Group 6	CMS-DRG 105[1]	Cardiac Valve and Other Major Cardiothoracic Procedures without Cardiac Catheterization
	MS-DRG 219[2]	Cardiac Valve and Other Major Cardiothoracic Procedures without Cardiac Catheterization with MCC
	MS-DRG 220[2]	Cardiac Valve and Other Major Cardiothoracic Procedures without Cardiac Catheterization with CC
	MS-DRG 221[2]	Cardiac Valve and Other Major Cardiothoracic Procedures without Cardiac Catheterization without CC/MCC

[1] Quarter 1, 2007 through Q3, 2007
[2] Quarter 4, 2007 through Q4, 2008

Trim Methodology

Trimming was used to remove outlier charges from the study population. Identification of outliers eliminates extreme values that may have a significant and unrepresentative impact on the mean.

Since charges varied dramatically among regions, upper and lower trim points were calculated at the regional level for each DRG group within each procedure group for each year. Cases with charges that were below the lower trim point or above the upper trim point were excluded from further analysis.

For this analysis, upper and lower trim points were calculated using the "+/- 3.0 interquartile range" method. This non-parametric methodology was used because, historically, the distribution for charges does not follow a normal "bell-shaped" pattern.

Trim points were determined as follows:

Q1 = *the first quartile (25th percentile total charge) of all patient records from the comparative database in a particular category*

Q3 = *the third quartile (75th percentile total charge) of all patient records from the comparative database in a particular category*

IQR = *Q3 – Q1*

Lower Trim Point = *Q1 – (3.0 x IQR)*

Upper Trim Point = *Q3 + (3.0 x IQR)*

See Tables 12a through 13c for upper trim points, percent of outliers, and average charge after trimming for each DRG group within each region for each of the procedure groups.

Table 12a. *CABG without Valve: Trim Points for Average Charge, 2007*

DRG GROUP	Upper Trim Point*	Outlier %	Median Charge After Trimming	Average Charge After Trimming
Group 1 (DRG 106; MS-DRG 231, 232)				
Region 1	$359,956	6.7	$100,201	$114,312
Region 2	$465,221	0.0	$165,233	$185,606
Region 3	$199,833	7.7	$100,723	$94,719
Region 4	**	**	**	**
Region 5	$212,048	3.9	$98,869	$100,117
Region 6	$242,418	0.0	$93,795	$104,066
Region 7	$288,379	5.4	$138,695	$138,341
Region 8	$710,096	0.0	$221,280	$240,955
Region 9	$874,626	4.2	$236,957	$257,231
Group 2 (DRG 547, 548; MS-DRG 233, 234)				
Region 1	$392,866	1.6	$75,961	$101,008
Region 2	$336,477	1.5	$133,952	$140,024
Region 3	$127,882	2.6	$62,255	$64,341
Region 4	$273,481	5.1	$100,305	$104,430
Region 5	$184,145	1.2	$73,301	$79,410
Region 6	$186,128	0.8	$68,652	$74,207
Region 7	$329,426	2.0	$113,204	$132,182
Region 8	$578,790	1.4	$162,941	$177,181
Region 9	$684,856	2.2	$193,170	$219,021
Group 3 (DRG 108; MS-DRG 228, 229, 230)				
Region 1	$518,577	4.3	$202,143	$195,594
Region 2	$247,808	0.0	$114,535	$131,784
Region 3	**	**	**	**
Region 4	**	**	**	**
Region 5	**	**	**	**
Region 6	$179,780	0.0	$80,138	$85,171
Region 7	$460,083	0.0	$124,365	$143,372
Region 8	$523,820	7.7	$122,925	$142,391
Region 9	**	**	**	**
Group 4 (DRG 549, 550; MS-DRG 235, 236)				
Region 1	$335,216	1.0	$65,488	$87,016
Region 2	$188,924	3.1	$92,710	$93,892
Region 3	$103,875	1.0	$48,633	$49,830
Region 4	$196,536	3.4	$65,780	$74,400
Region 5	$125,787	1.6	$53,828	$56,821
Region 6	$131,278	1.2	$48,830	$54,086
Region 7	$236,034	7.6	$81,451	$93,047
Region 8	$395,850	1.2	$97,149	$118,867
Region 9	$681,297	1.1	$157,203	$202,784

* Charges of less than $10,000 were considered invalid. Therefore, there were no lower trim points.
** These regions under the DRG group were excluded from analysis due to low volume.

Table 12b. Valve without CABG: Trim Points for Average Charge, 2007

DRG GROUP	Upper Trim Point*	Outlier %	Median Charge After Trimming	Average Charge After Trimming
Group 5 (DRG 104; MS-DRG 216, 217, 218)				
Region 1	$668,778	2.0	$131,114	$169,419
Region 2	$737,963	0.0	$160,788	$209,649
Region 3	$252,240	0.0	$100,468	$107,590
Region 4	$696,614	0.0	$171,095	$199,739
Region 5	$290,388	2.4	$102,117	$111,824
Region 6	$238,830	1.3	$85,566	$93,780
Region 7	$339,079	3.7	$154,905	$154,098
Region 8	$714,381	1.9	$208,666	$227,239
Region 9	$739,621	4.8	$223,546	$266,567
Group 6 (DRG 105; MS-DRG 219, 220, 221)				
Region 1	$438,554	1.9	$89,245	$116,406
Region 2	$325,396	2.5	$112,714	$125,044
Region 3	$195,302	0.0	$76,938	$85,262
Region 4	$414,794	2.8	$139,694	$142,187
Region 5	$177,819	2.0	$70,624	$76,813
Region 6	$209,750	3.3	$70,569	$76,833
Region 7	$381,407	1.3	$115,377	$136,257
Region 8	$484,332	2.3	$149,541	$164,188
Region 9	$563,443	3.7	$180,632	$208,027

* Charges of less than $10,000 were considered invalid; therefore, there were no lower trim points.

Table 12c. Valve with CABG: Trim Points for Average Charge, 2007

DRG GROUP	Upper Trim Point*	Outlier %	Median Charge After Trimming	Average Charge After Trimming
Group 5 (DRG 104; MS-DRG 216, 217, 218)				
Region 1	$824,490	0.8	$148,351	$197,624
Region 2	$568,645	1.7	$197,161	$228,036
Region 3	$230,341	0.0	$105,541	$107,384
Region 4	$585,220	3.2	$191,862	$198,357
Region 5	$315,560	2.1	$114,158	$127,740
Region 6	$342,137	1.9	$112,334	$125,558
Region 7	$888,670	0.0	$189,944	$233,362
Region 8	$740,409	0.0	$211,488	$241,042
Region 9	$782,139	4.8	$257,019	$277,863
Group 6 (DRG 105; MS-DRG 219, 220, 221)				
Region 1	$568,848	0.3	$101,456	$140,920
Region 2	$401,512	3.4	$142,953	$155,632
Region 3	$188,380	0.0	$83,883	$94,492
Region 4	$606,303	0.0	$149,712	$177,093
Region 5	$215,395	4.7	$78,153	$86,050
Region 6	$193,560	4.7	$74,732	$77,890
Region 7	$495,428	1.8	$131,942	$164,580
Region 8	$416,128	5.7	$139,845	$157,677
Region 9	$676,920	1.5	$209,417	$248,167

* Charges of less than $10,000 were considered invalid. Therefore, there were no lower trim points.

Table 13a. CABG without Valve: Trim Points for Average Charge, 2008

DRG GROUP	Upper Trim Point*	Outlier %	Median Charge After Trimming	Average Charge After Trimming
Group 1 (DRG 106; MS-DRG 231, 232)				
Region 1	$685,560	0.0	$100,717	$152,075
Region 2	$458,611	0.0	$150,534	$151,041
Region 3	$169,880	11.1	$94,270	$88,621
Region 4	**	**	**	**
Region 5	$223,384	0.0	$104,980	$111,586
Region 6	$255,533	0.0	$108,716	$114,501
Region 7	$517,773	0.0	$166,277	$182,130
Region 8	$689,867	0.0	$256,621	$258,224
Region 9	$960,301	0.0	$264,461	$284,178
Group 2 (DRG 547, 548; MS-DRG 233, 234)				
Region 1	$413,908	1.6	$79,216	$108,090
Region 2	$313,667	1.9	$136,705	$139,248
Region 3	$153,274	1.3	$69,556	$71,445
Region 4	$291,676	2.1	$94,335	$104,540
Region 5	$177,068	3.5	$78,368	$82,502
Region 6	$178,333	1.4	$71,638	$77,332
Region 7	$404,611	2.2	$123,886	$145,336
Region 8	$572,320	1.2	$161,844	$185,604
Region 9	$695,014	2.3	$195,086	$221,755
Group 3 (DRG 108; MS-DRG 228, 229, 230)				
Region 1	$925,733	0.0	$218,179	$234,635
Region 2	$374,571	0.0	$118,115	$137,916
Region 3	$144,137	0.0	$77,922	$78,467
Region 4	**	**	**	**
Region 5	**	**	**	**
Region 6	$209,601	0.0	$87,105	$87,250
Region 7	$397,752	7.1	$124,469	$135,804
Region 8	**	**	**	**
Region 9	**	**	**	**
Group 4 (DRG 549, 550; MS-DRG 235, 236)				
Region 1	$356,163	1.3	$68,762	$93,254
Region 2	$224,734	1.9	$101,111	$102,522
Region 3	$105,593	2.7	$49,375	$52,243
Region 4	$201,261	3.4	$73,259	$80,765
Region 5	$142,310	1.5	$58,046	$61,804
Region 6	$114,710	2.6	$51,329	$53,869
Region 7	$263,666	2.8	$90,930	$101,454
Region 8	$349,634	4.0	$98,005	$119,078
Region 9	$643,945	1.8	$160,113	$196,451

* Charges of less than $10,000 were considered invalid. Therefore, with the exception of DRG Group 1 in Region 3, there were no lower trim points. The lower trim point for DRG Group 1 in Region 3 was $15,906.

** These regions under the DRG group were excluded from analysis due to low volume.

Table 13b. Valve without CABG: Trim Points for Average Charge, 2008

DRG GROUP	Upper Trim Point*	Outlier %	Median Charge After Trimming	Average Charge After Trimming
Group 5 (DRG 104; MS-DRG 216, 217, 218)				
Region 1	$687,936	0.8	$140,713	$181,403
Region 2	$656,859	0.0	$179,034	$199,672
Region 3	$251,105	0.0	$102,346	$108,784
Region 4	$639,135	6.3	$177,164	$177,183
Region 5	$281,984	7.4	$102,172	$108,746
Region 6	$341,312	0.0	$109,561	$119,402
Region 7	$577,256	5.6	$169,899	$188,772
Region 8	$699,917	0.7	$210,826	$240,044
Region 9	$748,835	2.1	$239,820	$270,035
Group 6 (DRG 105; MS-DRG 219, 220, 221)				
Region 1	$420,680	0.9	$87,730	$114,485
Region 2	$394,683	1.0	$134,847	$141,535
Region 3	$167,910	4.7	$75,730	$82,213
Region 4	$379,854	2.6	$147,383	$144,329
Region 5	$173,557	4.1	$71,705	$76,706
Region 6	$239,036	3.8	$77,933	$84,165
Region 7	$365,096	3.1	$120,572	$135,045
Region 8	$413,175	2.7	$145,867	$162,041
Region 9	$518,363	2.2	$179,383	$204,618

* Charges of less than $10,000 were considered invalid; therefore, there were no lower trim points.

Table 13c. Valve with CABG: Trim Points for Average Charge, 2008

DRG GROUP	Upper Trim Point*	Outlier %	Median Charge After Trimming	Average Charge After Trimming
Group 5 (DRG 104; MS-DRG 216, 217, 218)				
Region 1	$746,580	0.9	$130,532	$181,529
Region 2	$674,490	0.0	$205,776	$237,562
Region 3	$235,247	2.8	$112,333	$115,023
Region 4	$679,194	0.0	$178,380	$200,685
Region 5	$292,522	2.2	$118,090	$125,101
Region 6	$361,070	1.1	$121,854	$134,307
Region 7	$799,629	0.0	$206,039	$246,485
Region 8	$650,183	4.3	$207,632	$228,227
Region 9	$886,257	5.5	$267,735	$293,690
Group 6 (DRG 105; MS-DRG 219, 220, 221)				
Region 1	$657,001	0.6	$101,818	$158,664
Region 2	$389,968	2.4	$146,432	$153,792
Region 3	$206,419	0.0	$86,438	$91,189
Region 4	$352,413	5.9	$127,075	$132,311
Region 5	$225,657	2.0	$84,712	$90,918
Region 6	$215,870	2.4	$83,597	$91,983
Region 7	$482,979	1.7	$134,478	$163,435
Region 8	$567,785	7.8	$169,071	$176,800
Region 9	$783,357	2.6	$218,716	$263,773

* Charges of less than $10,000 were considered invalid. Therefore, there were no lower trim points.

Case-Mix Adjustment of Average Hospital Charge

Case-mix adjustment was used to adjust the average charge reported for hospitals after all exclusions were satisfied and outlier trimming was performed. A case-mix adjusted charge is reported separately for each reporting group for which the hospital had at least 13 cases. Charges were adjusted to account for differences in regional charges and the number of patients that a hospital had for each DRG group of patients within each procedure group.

To determine the case-mix adjusted charges at a particular hospital, first the actual charges were calculated for each reporting group. Next, expected charges were calculated for each reporting group. Expected charges were based on the average charges for each DRG group, region, procedure group, and year of discharge. The case-mix adjusted charge was calculated by dividing the mean actual charges by the mean expected charge for the hospital, and then multiplying this quantity by the average charge for the hospital's region for the relevant reporting group. The following examples illustrate how case-mix adjusted charges were computed for a hospital in Region 1 for the valve without CABG reporting group:

Example 3. Determining Case-Mixed Average Charge for a Hospital, 2007-2008 Data

Region 1: Southwestern PA
Reporting Group: Valve without CABG

Total Cases: Number of hospitalizations for a hospital after exclusions (equal to n).

Actual Charge: Mean of the charges for each hospitalization.

Expected Charge: Mean of the predicted charges for each hospitalization.

Step 1: Calculate each hospitalization's expected charge (ExpChg):

ExpChg = the expected charge for a hospitalization, which is equal to the average charge for all hospitalizations (after exclusion) in the hospital's same region, reporting group, and DRG group within the reporting group.

Region 1 - Southwestern PA, valve without CABG, DRG Group 5, 2007: $169,419
or
Region 1 - Southwestern PA, valve without CABG, DRG Group 6, 2007: $116,406
or
Region 1 - Southwestern PA, valve without CABG, DRG Group 5, 2008: $181,403
or
Region 1 - Southwestern PA, valve without CABG, DRG Group 6, 2008: $114,485

Step 2: Calculate the mean ExpChg for a hospital (expected charge):

$$\text{Mean ExpChg} = \frac{\Sigma\ \text{ExpChg}}{n}$$

Case-Mix Adjusted Charge: $\frac{\text{Mean Actual Chg}}{\text{Mean ExpChg}}$ (Mean Region 1 Actual Charge)

Example 4. *Determining Case-Mixed Average Charge for a Hospital, 2008 Data*

Region 1: Southwestern PA
Reporting Group*:* Valve without CABG

Total Cases: Number of hospitalizations for a hospital after exclusions (equal to n).

Actual Charge: Mean of the charges for each hospitalization.

Expected Charge: Mean of the predicted charges for each hospitalization.

Step 1: Calculate each hospitalization's expected charge (ExpChg):

ExpChg = the expected charge for a hospitalization, which is equal to the average charge for all hospitalizations (after exclusion) in the hospital's same region, reporting grouping, and DRG within the reporting group.

Region 1 - Southwestern PA, valve without CABG, DRG Group 5, 2008: $181,403
or
Region 1 - Southwestern PA, valve without CABG, DRG Group 6, 2008: $114,485

Step 2: Calculate the mean ExpChg for a hospital (expected charge):

$$\text{Mean ExpChg} = \frac{\Sigma\ \text{ExpChg}}{n}$$

Case-Mix Adjusted Charge: $\frac{\text{Mean Actual Chg}}{\text{Mean ExpChg}}$(Mean Region 1 Actual Charge)

AVERAGE MEDICARE PAYMENT ANALYSIS

The Medicare payment data for 2007 was provided to PHC4 by the Centers for Medicare and Medicaid Services (CMS) and then matched by PHC4 to the cases included in the cardiac surgery analysis. Only cases with Medicare Fee-For-Service as the primary payer were included in the average payment calculations. Cases were included when the Medicare FFS payment was greater than zero and payment from a different primary payer (e.g., Medicare HMO) was less than or equal to zero.

There were 5,850 cardiac cases matched to Medicare FFS payments. Cases were then excluded for hospitals that are no longer open and to comply with CMS confidentiality restrictions. The CMS confidentiality restrictions require that each average Medicare payment calculation include 13 or more cases. For example, the average Medicare payment for a hospital's CABG without Valve reporting group had to include at least 13 cases. If there were less than 13 cases, the cases were excluded from the analysis. After exclusions, 5,668 cases remained in the average Medicare payment analysis.

The average Medicare payment was calculated using the dollar amount that CMS provided for the Medicare Part A hospital insurance fund payment. Patient liabilities (e.g., coinsurance and deductible dollar amounts) were not included. The average payment was calculated by summing the Medicare payment amounts for the cases in a particular reporting group and dividing the sum by the number of cases in that reporting group.

The average Medicare payment is reported for each reporting group (CABG without Valve, Valve without CABG, Valve with CABG and Total Valve) with 13 or more cases cases, with one exception: if the number of cases included in the payment analysis for either the Valve without CABG or the Valve with CABG reporting group is less than 13, payment data for both of these reporting groups will not be reported.

Hospitals were given an opportunity to verify the average Medicare payment reported for their facilities prior to the public release of the information.

.

APPENDICES

APPENDIX A: EXCLUSION DEFINTIONS

Table A. Exclusions: Organ Transplants (ICD-9-CM Codes)

Code	Description
33.50	Lung transplantation, not otherwise specified
33.51	Unilateral lung transplantation
33.52	Bilateral lung transplantation
33.6	Combined heart and lung transplant
37.51	Heart transplantation
37.52	Implantation of total internal biventricular heart replacement device
37.53	Replacement or repair of thoracic unit of total replacement heart system
41.00	Autologous bone marrow transplant without purging
41.02	Allogeneic bone marrow transplant with purging
41.03	Allogeneic bone marrow transplant without purging
41.09	Autologous bone marrow transplant with purging
41.94	Transplantation of spleen
46.97	Transplant of intestine
50.51	Auxiliary liver transplant
50.59	Other transplant of liver
52.80	Pancreatic transplant, not otherwise specified
52.82	Homotransplant of pancreas
52.83	Heterotransplant of pancreas
55.61	Renal autotransplantation
55.69	Other kidney transplantation

Table B1. Exclusions: CABG *without* Valve (ICD-9-CM Clinical Complexity Codes)

Key to abbreviations: px = procedure code; dx = diagnosis code

Code Type	Code Position	ICD-9-CM Code	and Description
px	Any	32.22	Lung volume reduction surgery **performed at the same time as CABG surgery**
px	Any	35.31	Operations on papillary muscle
px	Any	35.32	Operations on chordae tendineae
px	Any	35.34	Infundibulectomy
px	Any	35.35	Operations on trabeculae carneae cordis
px	Any	35.39	Operations on other structures adjacent to valves of heart
px	Any	35.42	Creation of septal defect in heart
px	Any	35.50	Repair of unspecified septal defect of heart with prosthesis
px	Any	35.51	Repair of atrial septal defect with prosthesis, open technique
px	Any	35.53	Repair of ventricular septal defect with prosthesis, open technique
px	Any	35.54	Repair of endocardial cushion defect with prosthesis
px	Any	35.60	Repair of unspecified septal defect of heart with tissue graft
px	Any	35.61	Repair of atrial septal defect with tissue graft
px	Any	35.62	Repair of ventricular septal defect with tissue graft
px	Any	35.63	Repair of endocardial cushion defect with tissue graft
px	Any	35.70	Other and unspecified repair of unspecified septal defect of heart
px	Any	35.71	Other and unspecified repair of atrial septal defect
px	Any	35.72	Other and unspecified repair of ventricular septal defect
px	Any	35.73	Other and unspecified repair of endocardial cushion defect
px	Any	35.81	Total repair of Tetralogy of Fallot

APPENDIX A: EXCLUSION DEFINTIONS *continued*

Table B1. Exclusions: CABG *without* Valve (ICD-9-CM Clinical Complexity Codes)

Key to abbreviations: px = procedure code; dx = diagnosis code

Code Type	Code Position	ICD-9-CM Code and Description	
px	Any	35.82	Total repair of total anomalous pulmonary venous connection
px	Any	35.83	Total repair of truncus arteriosus
px	Any	35.84	Total correction of transposition of great vessels, not elsewhere classified
px	Any	35.91	Intratrial transposition of venous return
px	Any	35.92	Creation of conduit between right ventricle and pulmonary artery
px	Any	35.93	Creation of conduit between left ventricle and aorta
px	Any	35.94	Creation of conduit between atrium and pulmonary artery
px	Any	35.95	Revision of corrective procedure on heart
px	Any	35.98	Other operations on septa of heart
px	Any	36.91	Repair of aneurysm of coronary vessel
px	Any	37.32	Excision of aneurysm of heart
px	Any	37.33	Excision or destruction of other lesion or tissue of heart, open approach
px	Any	37.35	Partial ventriculectomy
px	Any	37.36‡‡	Excision or destruction of left atrial appendage (LAA)
px	Any	38.12	Carotid endarterectomy
px	Any	38.34	Resection of aorta with anastomosis
px	Any	38.35	Resection of other thoracic vessel with anastomosis
px	Any	38.36	Resection of abdominal arteries with anastomosis
px	Any	38.44	Resection of abdominal aorta with replacement
px	Any	38.45	Resection of other thoracic vessel with replacement
px	Any	38.46	Resection of abdominal arteries with replacement
px	Any	39.51	Clipping of aneurysm
px	Any	39.52	Other repair of aneurysm
px	Any	39.71	Endovascular implantation of graft in abdominal aorta
px	Any	39.73	Endovascular implantation of graft in thoracic aorta
dx/px	Any	423.2/37.31	Diagnosis of constrictive pericarditis and undergoing pericardiectomy
dx	Any	441.00	Dissection of aorta, unspecified site
dx	Any	441.01	Dissection of aorta, thoracic
dx	Any	996.81	Complications of transplanted kidney
dx	Any	996.82	Complications of transplanted liver
dx	Any	996.83	Complications of transplanted heart
dx	Any	996.84	Complications of transplanted lung
dx	Any	996.85	Complications of transplanted bone marrow
dx	Any	996.86	Complications of transplanted pancreas
dx	Any	996.87	Complications of transplanted intestine
dx	Any	V42.0	History of kidney transplant
dx	Any	V42.1	History of heart transplant
dx	Any	V42.6	History of lung transplant
dx	Any	V42.7	History of liver transplant
dx	Any	V42.81	Bone marrow replaced by transplant
dx	Any	V42.83	Pancreas replaced by transplant
dx	Any	V42.84	Intestine replaced by transplant

‡‡ Effective 10/01/2008

APPENDIX A: EXCLUSION DEFINTIONS *continued*

Table B2. Exclusions: Valve *without* CABG (ICD-9-CM Clinical Complexity Codes)

Key to abbreviations: px = procedure code; dx = diagnosis code; pdx = principal diagnosis code

Code Type	Code Position	ICD-9-CM Code and Description	
pdx	Principal	038.x, 038.xx*	Septicemia
px	Any	32.22	Lung volume reduction surgery **performed at the same time as valve surgery**
px	Any	35.42	Creation of septal defect in heart
px	Any	35.50	Repair of unspecified septal defect of heart with prosthesis
px	Any	35.51	Repair of atrial septal defect with prosthesis, open technique
px	Any	35.53	Repair of ventricular septal defect with prosthesis, open technique
px	Any	35.54	Repair of endocardial cushion defect with prosthesis
px	Any	35.60	Repair of unspecified septal defect of heart with tissue graft
px	Any	35.61	Repair of atrial septal defect with tissue graft
px	Any	35.62	Repair of ventricular septal defect with tissue graft
px	Any	35.63	Repair of endocardial cushion defect with tissue graft
px	Any	35.70	Other and unspecified repair of unspecified septal defect of heart
px	Any	35.72	Other and unspecified repair of ventricular septal defect
px	Any	35.73	Other and unspecified repair of endocardial cushion defect
px	Any	35.81	Total repair of Tetralogy of Fallot
px	Any	35.82	Total repair of total anomalous pulmonary venous connection
px	Any	35.83	Total repair of truncus arteriosus
px	Any	35.84	Total correction of transposition of great vessels, not elsewhere classified
px	Any	35.91	Intratrial transposition of venous return
px	Any	35.92	Creation of conduit between right ventricle and pulmonary artery
px	Any	35.93	Creation of conduit between left ventricle and aorta
px	Any	35.94	Creation of conduit between atrium and pulmonary artery
px	Any	37.32	Excision of aneurysm of heart
px	Any	37.35	Partial ventriculectomy
px	Any	38.12	Carotid endarterectomy
px	Any	38.34	Resection of aorta with anastomosis
px	Any	38.35	Resection of other thoracic vessel with anastomosis
px	Any	38.36	Resection of abdominal arteries with anastomosis
px	Any	38.44	Resection of abdominal aorta with replacement
px	Any	38.45	Resection of other thoracic vessel with replacement
px	Any	38.46	Resection of abdominal arteries with replacement
px	Any	39.51	Clipping of aneurysm
px	Any	39.52	Other repair of aneurysm
px	Any	39.71	Endovascular implantation of graft in abdominal aorta
px	Any	39.73	Endovascular implantation of graft in thoracic aorta
dx	Any	277.30/425.7	Amyloidosis, unspecified plus nutritional & metabolic cardiomyopathy
dx	Any	277.39/425.7	Other amyloidosis plus nutritional & metabolic cardiomyopathy
dx	Any	414.10	Aneurysm of heart (wall)
dx	Any	414.19	Other aneurysm of heart
pdx	Principal	421.0	Acute and subacute bacterial endocarditis
pdx	Principal	421.1	Acute and subacute infective endocarditis in diseases classified elsewhere

* Codes ending in .xx refer only to 5-digit codes (do not include 4-digit codes). Codes ending in .x refer only to 4 digit codes (do not include 5-digit codes).

APPENDIX A: EXCLUSION DEFINTIONS *continued*

Table B2. Exclusions: Valve *without* CABG (ICD-9-CM Clinical Complexity Codes)

Key to abbreviations: px = procedure code; dx = diagnosis code; pdx = principal diagnosis code

Code Type	Code Position	ICD-9-CM Code and Description	
pdx	Principal	421.9	Acute endocarditis, unspecified
dx/px	Any	423.2/37.31	Diagnosis of constrictive pericarditis and undergoing pericardiectomy
pdx	Principal	424.90	Endocarditis, valve unspecified, unspecified cause
pdx	Principal	424.91	Endocarditis in diseases classified elsewhere
pdx	Principal	424.99	Other endocarditis, valve unspecified
dx	Any	441.00	Dissection of aorta, unspecified site
dx	Any	441.01	Dissection of aorta, thoracic
pdx	Principal	996.02	Mechanical complication of cardiac device, implant, and graft due to heart valve prosthesis
pdx	Principal	996.61	Infection and inflammatory reaction due to cardiac device, implant, and graft
pdx	Principal	996.71	Other complication of internal prosthetic device due to heart valve prosthesis
dx	Any	996.81	Complications of transplanted kidney
dx	Any	996.82	Complications of transplanted liver
dx	Any	996.83	Complications of transplanted heart
dx	Any	996.84	Complications of transplanted lung
dx	Any	996.85	Complications of transplanted bone marrow
dx	Any	996.86	Complications of transplanted pancreas
dx	Any	996.87	Complications of transplanted intestine
dx	Any	V42.0	History of kidney transplant
dx	Any	V42.1	History of heart transplant
dx	Any	V42.6	History of lung transplant
dx	Any	V42.7	History of liver transplant
dx	Any	V42.81	Bone marrow replaced by transplant
dx	Any	V42.83	Pancreas replaced by transplant
dx	Any	V42.84	Intestine replaced by transplant

EXCLUSIONS CONTINUED ON NEXT PAGE

APPENDIX A: EXCLUSION DEFINTIONS *continued*

Table B3. Exclusions: Valve *with* CABG (ICD-9-CM Clinical Complexity Codes)

Key to abbreviations: px = procedure code; dx = diagnosis code; pdx = principal diagnosis code

Code Type	Code Position	ICD-9-CM Code and Description	
pdx	Principal	038.x, 038.xx*	Septicemia
px	Any	32.22	Lung volume reduction surgery **performed at the same time as valve with CABG surgery**
px	Any	35.42	Creation of septal defect in heart
px	Any	35.50	Repair of unspecified septal defect of heart with prosthesis
px	Any	35.51	Repair of atrial septal defect with prosthesis, open technique
px	Any	35.53	Repair of ventricular septal defect with prosthesis, open technique
px	Any	35.54	Repair of endocardial cushion defect with prosthesis
px	Any	35.60	Repair of unspecified septal defect of heart with tissue graft
px	Any	35.61	Repair of atrial septal defect with tissue graft
px	Any	35.62	Repair of ventricular septal defect with tissue graft
px	Any	35.63	Repair of endocardial cushion defect with tissue graft
px	Any	35.70	Other and unspecified repair of unspecified septal defect of heart
px	Any	35.72	Other and unspecified repair of ventricular septal defect
px	Any	35.73	Other and unspecified repair of endocardial cushion defect
px	Any	35.81	Total repair of Tetralogy of Fallot
px	Any	35.82	Total repair of total anomalous pulmonary venous connection
px	Any	35.83	Total repair of truncus arteriosus
px	Any	35.84	Total correction of transposition of great vessels, not elsewhere classified
px	Any	35.91	Intratrial transposition of venous return
px	Any	35.92	Creation of conduit between right ventricle and pulmonary artery
px	Any	35.93	Creation of conduit between left ventricle and aorta
px	Any	35.94	Creation of conduit between atrium and pulmonary artery
px	Any	35.95	Revision of corrective procedure on heart
px	Any	35.98	Other operations on septa of heart
px	Any	36.91	Repair of aneurysm of coronary vessel
px	Any	37.32	Excision of aneurysm of heart
px	Any	37.35	Partial ventriculectomy
px	Any	38.12	Carotid endarterectomy
px	Any	38.34	Resection of aorta with anastomosis
px	Any	38.35	Resection of other thoracic vessel with anastomosis
px	Any	38.36	Resection of abdominal arteries with anastomosis
px	Any	38.44	Resection of abdominal aorta with replacement
px	Any	38.45	Resection of other thoracic vessel with replacement
px	Any	38.46	Abdominal arteries with replacement
px	Any	39.51	Clipping of aneurysm
px	Any	39.52	Other repair of aneurysm
px	Any	39.71	Endovascular implantation of graft in abdominal aorta
px	Any	39.73	Endovascular implantation of graft in thoracic aorta
dx	Any	277.30 /425.7	Amyloidosis, unspecified plus nutritional & metabolic cardiomyopathy
dx	Any	277.39 /425.7	Other amyloidosis plus nutritional & metabolic cardiomyopathy

* Codes ending in .xx refer only to 5-digit codes (do not include 4-digit codes). Codes ending in .x refer only to 4 digit codes (do not include 5-digit codes).

APPENDIX A: EXCLUSION DEFINTIONS *continued*

Table B3. Exclusions: Valve *with* CABG (ICD-9-CM Clinical Complexity Codes)

Key to abbreviations: px = procedure code; dx = diagnosis code; pdx = principal diagnosis code

Code Type	Code Position	ICD-9-CM Code and Description	
dx	Any	414.10	Aneurysm of heart (wall)
dx	Any	414.19	Other aneurysm of heart
pdx	Principal	421.0	Acute and subacute bacterial endocarditis
pdx	Principal	421.1	Acute and subacute infective endocarditis in diseases classified elsewhere
pdx	Principal	421.9	Acute endocarditis, unspecified
dx/px	Any	423.2/37.31	Diagnosis of constrictive pericarditis and undergoing pericardiectomy
pdx	Principal	424.90	Endocarditis, valve unspecified, unspecified cause
pdx	Principal	424.91	Endocarditis in diseases classified elsewhere
pdx	Principal	424.99	Other endocarditis, valve unspecified
dx	Any	441.00	Dissection of aorta, unspecified site
dx	Any	441.01	Dissection of aorta, thoracic
pdx	Principal	996.02	Mechanical complication of cardiac device, implant, and graft due to heart valve prosthesis
pdx	Principal	996.61	Infection and inflammatory reaction due to cardiac device, implant, and graft
pdx	Principal	996.71	Other complication of internal prosthetic device due to heart valve prosthesis
dx	Any	996.81	Complications of transplanted kidney
dx	Any	996.82	Complications of transplanted liver
dx	Any	996.83	Complications of transplanted heart
dx	Any	996.84	Complications of transplanted lung
dx	Any	996.85	Complications of transplanted bone marrow
dx	Any	996.86	Complications of transplanted pancreas
dx	Any	996.87	Complications of transplanted intestine
dx	Any	V42.0	History of kidney transplant
dx	Any	V42.1	History of heart transplant
dx	Any	V42.6	History of lung transplant
dx	Any	V42.7	History of liver transplant
dx	Any	V42.81	Bone marrow replaced by transplant
dx	Any	V42.83	Pancreas replaced by transplant
dx	Any	V42.84	Intestine replaced by transplant

DRG CRITERIA ON NEXT PAGE

APPENDIX A: EXCLUSION DEFINTIONS *continued*

Table C1. DRG Criteria for Study Population Definition (Quarter 1, 2007 – Quarter 3, 2007)

DRGs *Not* Excluded from the Study: CABG without Valve	
DRG 103	Heart Transplant or Implant of Heart Assist System
DRG 104	Cardiac Valve Procedures and Other Major Cardiothoracic Procedures with Cardiac Catheterization
DRG 105	Cardiac Valve Procedures and Other Major Cardiothoracic Procedures without Cardiac Catheterization
DRG 106	Coronary Bypass with PTCA
DRG 108	Other Cardiothoracic Procedures
DRG 515	Cardiac Defibrillator Implant without Cardiac Catheterization
DRG 525	Other Heart Assist System Implant
DRG 535	Cardiac Defibrillator Implant with Cardiac Catheterization with Acute Myocardial Infarction, Heart Failure, or Shock
DRG 536	Cardiac Defibrillator Implant with Cardiac Catheterization without Acute Myocardial Infarction, Heart Failure, or Shock
DRG 541 and MDC 5[1]	ECMO or tracheostomy with Mechanical Ventilation 96+ Hours or Principal Diagnosis Except Face, Mouth, Neck with Major O.R. Procedures
DRG 547	Coronary Bypass with Cardiac Catheterization with Major Cardiovascular Diagnosis
DRG 548	Coronary Bypass with Cardiac Catheterization without Major Cardiovascular Diagnosis
DRG 549	Coronary Bypass without Cardiac Catheterization with Major Cardiovascular Diagnosis
DRG 550	Coronary Bypass without Cardiac Catheterization without Major Cardiovascular Diagnosis
DRGs *Not* Excluded from the Study: Valve without CABG	
DRG 103	Heart Transplant or Implant of Heart Assist System
DRG 104	Cardiac Valve Procedures and Other Major Cardiothoracic Procedures with Cardiac Catheterization
DRG 105	Cardiac Valve Procedures and Other Major Cardiothoracic Procedures without Cardiac Catheterization
DRG 108	Other Cardiothoracic Procedures
DRG 515	Cardiac Defibrillator Implant without Cardiac Catheterization
DRG 525	Other Heart Assist System Implant
DRG 535	Cardiac Defibrillator Implant with Cardiac Catheterization with Acute Myocardial Infarction, Heart Failure, or Shock
DRG 536	Cardiac Defibrillator Implant with Cardiac Catheterization without Acute Myocardial Infarction, Heart Failure, or Shock
DRG 541 and MDC 5[1]	ECMO or tracheostomy with Mechanical Ventilation 96+ Hours or Principal Diagnosis Except Face, Mouth, Neck with Major O.R. Procedures
DRGs *Not* Excluded from the Study: Valve *with* CABG	
DRG 103	Heart Transplant or Implant of Heart Assist System
DRG 104	Cardiac Valve Procedures and Other Major Cardiothoracic Procedures with Cardiac Catheterization
DRG 105	Cardiac Valve Procedures and Other Major Cardiothoracic Procedures without Cardiac Catheterization
DRG 108	Other Cardiothoracic Procedures
DRG 515	Cardiac Defibrillator Implant without Cardiac Catheterization
DRG 525	Other Heart Assist System Implant
DRG 535	Cardiac Defibrillator Implant with Cardiac Catheterization with Acute Myocardial Infarction, Heart Failure, or Shock
DRG 536	Cardiac Defibrillator Implant with Cardiac Catheterization without Acute Myocardial Infarction, Heart Failure, or Shock
DRG 541 and MDC 5[1]	ECMO or tracheostomy with Mechanical Ventilation 96+ Hours or Principal Diagnosis Except Face, Mouth, Neck with Major O.R. Procedures

DRG CRITERIA CONTINUED ON NEXT PAGE

[1] Major Diagnostic Category (MDC) 5: Diseases and Disorders of the Circulatory System

APPENDIX A: EXCLUSION DEFINTIONS *continued*

Table C2. DRG Criteria for Study Population Definition (Quarter 4, 2007 – Quarter 4, 2008)

MS-DRGs *Not* Excluded from the Study: CABG without Valve	
MS-DRG 001	Heart Transplant or Implant of Heart Assist System with MCC
MS-DRG 002	Heart Transplant or Implant of Heart Assist System without MCC
MS-DRG 003 and MDC 5[1]	ECMO or tracheostomy with Mechanical Ventilation 96+ Hours or Principal Diagnosis Except Face, Mouth, Neck with Major O.R. Procedures
MS-DRG 215	Other Heart Assist System Implant
MS-DRG 216	Cardiac Valve and Other Major Cardiothoracic Procedures with Cardiac Catheterization with MCC
MS-DRG 217	Cardiac Valve and Other Major Cardiothoracic Procedures with Cardiac Catheterization with CC
MS-DRG 218	Cardiac Valve and Other Major Cardiothoracic Procedures with Cardiac Catheterization without CC/MCC
MS-DRG 219	Cardiac Valve and Other Major Cardiothoracic Procedures without Cardiac Catheterization with MCC
MS-DRG 220	Cardiac Valve and Other Major Cardiothoracic Procedures without Cardiac Catheterization with CC
MS-DRG 221	Cardiac Valve and Other Major Cardiothoracic Procedures without Cardiac Catheterization without CC/MCC
MS-DRG 222	Cardiac Defibrillator Implant with Cardiac Catheterization with Acute MI/Heart Failure/Shock with MCC
MS-DRG 223	Cardiac Defibrillator Implant with Cardiac Catheterization with Acute MI/Heart Failure/Shock without MCC
MS-DRG 224	Cardiac Defibrillator Implant with Cardiac Catheterization without Acute MI/Heart Failure/Shock with MCC
MS-DRG 225	Cardiac Defibrillator Implant with Cardiac Catheterization without Acute MI/Heart Failure/Shock without MCC
MS-DRG 226	Cardiac Defibrillator Implant without Cardiac Catheterization with MCC
MS-DRG 227	Cardiac Defibrillator Implant without Cardiac Catheterization without MCC
MS-DRG 228	Other Cardiothoracic Procedures with MCC
MS-DRG 229	Other Cardiothoracic Procedures with CC
MS-DRG 230	Other Cardiothoracic Procedures without CC/MCC
MS-DRG 231	Coronary Bypass with PTCA with MCC
MS-DRG 232	Coronary Bypass with PTCA without MCC
MS-DRG 233	Coronary Bypass with Cardiac Catheterization with MCC
MS-DRG 234	Coronary Bypass with Cardiac Catheterization without MCC
MS-DRG 235	Coronary Bypass without Cardiac Catheterization with MCC
MS-DRG 236	Coronary Bypass without Cardiac Catheterization without MCC
DRGs *Not* Excluded from the Study: Valve without CABG	
MS-DRG 001	Heart Transplant or Implant of Heart Assist System with MCC
MS-DRG 002	Heart Transplant or Implant of Heart Assist System without MCC
MS-DRG 003 and MDC 5[1]	ECMO or tracheostomy with Mechanical Ventilation 96+ Hours or Principal Diagnosis Except Face, Mouth, Neck with Major O.R. Procedures
MS-DRG 215	Other Heart Assist System Implant
MS-DRG 216	Cardiac Valve and Other Major Cardiothoracic Procedures with Cardiac Catheterization with MCC
MS-DRG 217	Cardiac Valve and Other Major Cardiothoracic Procedures with Cardiac Catheterization with CC
MS-DRG 218	Cardiac Valve and Other Major Cardiothoracic Procedures with Cardiac Catheterization without CC/MCC
MS-DRG 219	Cardiac Valve and Other Major Cardiothoracic Procedures without Cardiac Catheterization with MCC
MS-DRG 220	Cardiac Valve and Other Major Cardiothoracic Procedures without Cardiac Catheterization with CC
MS-DRG 221	Cardiac Valve and Other Major Cardiothoracic Procedures without Cardiac Catheterization without CC/MCC
MS-DRG 222	Cardiac Defibrillator Implant with Cardiac Catheterization with Acute MI/Heart Failure/Shock with MCC
MS-DRG 223	Cardiac Defibrillator Implant with Cardiac Catheterization with Acute MI/Heart Failure/Shock without MCC
MS-DRG 224	Cardiac Defibrillator Implant with Cardiac Catheterization without Acute MI/Heart Failure/Shock with MCC
MS-DRG 225	Cardiac Defibrillator Implant with Cardiac Catheterization without Acute MI/Heart Failure/Shock without MCC
MS-DRG 226	Cardiac Defibrillator Implant without Cardiac Catheterization with MCC
MS-DRG 227	Cardiac Defibrillator Implant without Cardiac Catheterization without MCC
MS-DRG 228	Other Cardiothoracic Procedures with MCC
MS-DRG 229	Other Cardiothoracic Procedures with CC
MS-DRG 230	Other Cardiothoracic Procedures without CC/MCC

[1] Major Diagnostic Category (MDC) 5: Diseases and Disorders of the Circulatory System

APPENDIX A: EXCLUSION DEFINTIONS *continued*

Table C2. DRG Criteria for Study Population Definition (Quarter 4, 2007 – Quarter 4, 2008)

DRGs *Not* Excluded from the Study: Valve *with* CABG	
MS-DRG 001	Heart Transplant or Implant of Heart Assist System with MCC
MS-DRG 002	Heart Transplant or Implant of Heart Assist System without MCC
MS-DRG 003 and MDC 5[1]	ECMO or tracheostomy with Mechanical Ventilation 96+ Hours or Principal Diagnosis Except Face, Mouth, Neck with Major O.R. Procedures
MS-DRG 215	Other Heart Assist System Implant
MS-DRG 216	Cardiac Valve and Other Major Cardiothoracic Procedures with Cardiac Catheterization with MCC
MS-DRG 217	Cardiac Valve and Other Major Cardiothoracic Procedures with Cardiac Catheterization with CC
MS-DRG 218	Cardiac Valve and Other Major Cardiothoracic Procedures with Cardiac Catheterization without CC/MCC
MS-DRG 219	Cardiac Valve and Other Major Cardiothoracic Procedures without Cardiac Catheterization with MCC
MS-DRG 220	Cardiac Valve and Other Major Cardiothoracic Procedures without Cardiac Catheterization with CC
MS-DRG 221	Cardiac Valve and Other Major Cardiothoracic Procedures without Cardiac Catheterization without CC/MCC
MS-DRG 222	Cardiac Defibrillator Implant with Cardiac Catheterization with Acute MI/Heart Failure/Shock with MCC
MS-DRG 223	Cardiac Defibrillator Implant with Cardiac Catheterization with Acute MI/Heart Failure/Shock without MCC
MS-DRG 224	Cardiac Defibrillator Implant with Cardiac Catheterization without Acute MI/Heart Failure/Shock with MCC
MS-DRG 225	Cardiac Defibrillator Implant with Cardiac Catheterization without Acute MI/Heart Failure/Shock without MCC
MS-DRG 226	Cardiac Defibrillator Implant without Cardiac Catheterization with MCC
MS-DRG 227	Cardiac Defibrillator Implant without Cardiac Catheterization without MCC
MS-DRG 228	Other Cardiothoracic Procedures with MCC
MS-DRG 229	Other Cardiothoracic Procedures with CC
MS-DRG 230	Other Cardiothoracic Procedures without CC/MCC

[1] Major Diagnostic Category (MDC) 5: Diseases and Disorders of the Circulatory System

APPENDIX B: EXCLUSION DATA

Specific cases were excluded from the analysis. Exclusion criteria that were relevant to all outcome measures (i.e., standard exclusions) were first applied to the in-hospital mortality analysis (see Table A below). For the other outcome measures in the report, additional exclusion criteria were applied as appropriate.

Table A. Exclusions for In-Hospital Mortality Analysis

	Cases		In-Hospital Mortality	
	#	%	#	%
2007-2008 Data				
Total cases prior to in-hospital mortality exclusions	*35,321*	*100.0*	*1,159*	*3.3*
Exclusions:				
• Patients < 30 years of age	265	0.8	8	3.0
• Patients who left against medical advice	11	< 0.1	0	0.0
• Clinically complex cases[1]	3,759	10.6	337	9.0
Total exclusions	4,035	11.4	345	8.6
Total cases remaining in analysis	***31,286***	***88.6***	***814***	***2.6***
2008 Data				
Total cases prior to in-hospital mortality exclusions	*17,674*	*100.0*	*574*	*3.2*
Exclusions:				
• Patients < 30 years of age	132	0.7	3	2.3
• Patients who left against medical advice	6	< 0.1	0	0.0
• Clinically complex cases[1]	1,905	10.8	150	7.9
Total exclusions	2,043	11.6	153	7.5
Total cases remaining in analysis	***15,631***	***88.4***	***421***	***2.7***

[1] Clinically complex cases included organ transplant cases (see Appendix A: Table A), clinically complex cases based on ICD-9-CM codes (see Appendix A: Tables B1, B2, and B3), cases *not* in the study DRGs (See Appendix A: Tables C1 and C2 for DRGs included in the study), and cases granted special request for exclusion (SRE).

Table B. Exclusions for Operative Mortality Analysis

	Cases		Operative Mortality	
	#	%	#	%
2007-2008 Data				
Total cases after in-hospital mortality exclusions	*31,286*	*100.0*	–	–
Additional Exclusions:				
• Cases with invalid/inconsistent data[1]	290	0.9	–	–
• Out-of state residents[2]	2,831	9.0	–	–
Total exclusions	3,121	10.0	–	–
Total cases remaining in analysis	***28,165***	***90.0***	***890***	***3.2***
2008 Data				
Total cases after in-hospital mortality exclusions	*15,631*	*100.0*	–	–
Additional Exclusions:				
• Cases with invalid/inconsistent data[1]	103	0.7	–	–
• Out-of state residents[2]	1,468	9.4	–	–
Total exclusions	1,571	10.1	–	–
Total cases remaining in analysis	***14,060***	***89.9***	***442***	***3.1***

[1] Cases with invalid/inconsistent data (i.e., social security number, date of birth, or sex) could not be linked to death certificate information.

[2] Out-of-state residents were excluded because death certificate data was not available for these patients.

APPENDIX B: EXCLUSION DATA *continued*

Table C. *Exclusions for 7-Day and 30-Day Readmissions Analysis*

	Cases		7-Day Readmissions		30-Day Readmissions	
	#	%	#	%	#	%
2007-2008 Data						
Total cases after in-hospital mortality exclusions	*31,286*	*100.0*	–	–	–	–
Additional exclusions:						
• Patients who died during hospitalization in which surgery was performed	814	2.6	–	–	–	–
• Cases with invalid data[1]	279	0.9	–	–	–	–
• Out-of state residents[2]	2,742	8.8	–	–	–	–
Total exclusions	3,835	12.3	–	–	–	–
Total cases remaining in analysis	***27,451***	***87.7***	***1,845***	***6.7***	***4,420***	***16.1***
2008 Data						
Total cases after in-hospital mortality exclusions	*15,631*	*100.0*	–	–	–	–
Additional exclusions:						
• Patients who died during hospitalization in which surgery was performed	421	2.7	–	–	–	–
• Cases with invalid/inconsistent data[1]	95	0.6	–	–	–	–
• Out-of state residents[2]	1,417	9.1	–	–	–	–
Total exclusions	1,933	12.4	–	–	–	–
Total cases remaining in analysis	***13,698***	***87.6***	***931***	***6.8***	***2,208***	***16.1***

[1] Cases with invalid data (i.e., social security number, date of birth, or sex) could not be linked to subsequent hospitalizations.

[2] Out-of-state residents were excluded because such patients could undergo a CABG and/or valve surgery in a Pennsylvania hospital, return to their state of residence and be readmitted to a hospital in their home state. Therefore, readmission data would not be available for these patients.

Table D. *Exclusions for Post-Surgical Length of Stay (LOS) Analysis*

	Cases		Average Post-Surgical LOS in Days
	#	%	
2007-2008 Data			
Total cases after in-hospital mortality exclusions	*31,286*	*100.0*	*7.9*
Additional exclusions:			
• Patients who died during hospitalization in which surgery was performed	814	2.6	12.7
• Cases that were length of stay outliers[1]	283	0.9	46.1
Total exclusions	1,097	3.5	21.3
Total cases remaining in analysis	***30,189***	***96.5***	***7.4***
2008 Data			
Total cases after in-hospital mortality exclusions	*15,631*	*100.0*	*7.9*
Additional exclusions:			
• Patients who died during hospitalization in which surgery was performed	421	2.7	13.3
• Cases that were length of stay outliers[1]	148	0.9	44.0
Total exclusions	569	3.6	21.3
Total cases remaining in analysis	***15,062***	***96.4***	***7.4***

[1] Length of stay outliers include those cases with post-surgical lengths of stay as follows: CABG without Valve – less than two days or greater than 30 days; Valve without CABG – less than three days or greater than 50 days; Valve with CABG – less than three days or greater than 50 days.

APPENDIX B: EXCLUSION DATA *continued*

Table E. *Exclusions for Average Hospital Charge Analysis*

	Cases		Average Charge
	#	%	
2007-2008 Data			
Total cases after in-hospital mortality exclusions	*31,286*	*100.0*	*$153,891*
Additional exclusions:			
• Patients with invalid or missing charges[1]	2	< 0.1	$7,304
• Case in tracheostomy DRGs[2]	718	2.3	$584,553
• Cases in low volume DRGs[3]	310	1.0	$408,690
• Cases that were charge outliers[4]	599	1.9	$529,932
Total exclusions	1,629	5.2	
Total cases remaining in analysis	***29,657***	***94.8***	***$133,216***
2007 Data			
Total cases after in-hospital mortality exclusions	*15,655*	*100.0*	*$150,597*
Additional exclusions:			
• Patients with invalid or missing charges[1]	1	< 0.1	$5,502
• Case in tracheostomy DRGs[2]	337	2.2	$573,302
• Cases in low volume DRGs[3]	130	0.8	$409,352
• Cases that were charge outliers[4]	294	1.9	$529,326
Total exclusions	762	4.9	
Total cases remaining in analysis	***14,893***	***95.1***	***$131,307***
2008 Data			
Total cases after in-hospital mortality exclusions	*15,631*	*100.0*	*$157,190*
Additional exclusions:			
• Patients with invalid or missing charges[1]	1	< 0.1	$9,105
• Case in tracheostomy DRGs[2]	381	2.4	$594,504
• Cases in low volume DRGs[3]	180	1.2	$408,212
• Cases that were charge outliers[4]	305	2.0	$530,517
Total exclusions	867	5.5	
Total cases remaining in analysis	***14,764***	***94.5***	***$135,142***

[1] Invalid/missing charges included cases with charges that were less than $10,000.

[2] Tracheostomy cases were assigned to DRG 541 and MDC 5 for Q1-2007 through Q3-2007 and MS-DRG 003 and MDC 5 effective Q4-2007.

[3] DRGs with low volume and DRGs when a particular combination of region, procedure type, and DRG had less than 10 cases.

[4] Charge outliers were determined using the "+/- 3.0 interquartile range" method—after accounting for differences in charges by DRG group, region, and procedure type.

APPENDIX C: REASONS FOR READMISSION DEFINITIONS

A readmission was counted only if the patient was readmitted with a principal diagnosis (i.e., the reason for the readmission) that indicated a heart-related condition, or an infection or a complication that was likely related to the CABG/valve surgery hospitalization. The following list of categories shows the ICD-9-CM codes that were counted as readmissions if the code was located in the principal diagnosis position.

CIRCULATORY SYSTEM

Cardiac Dysrhythmias

Heart Block

426.0, 426.10, 426.11, 426.12, 426.13, 426.2, 426.3, 426.4, 426.50, 426.51, 426.52, 426.53, 426.54, 426.6, 426.7, 426.81, 426.82, 426.89, 426.9

Paroxysmal Tachycardia

427.0, 427.1, 427.2

Atrial Fibrillation and Atrial Flutter

427.31, 427.32

Ventricular Fibrillation and Ventricular Flutter

427.41, 427.42, 427.5

Premature Heart Beats

427.60, 427.61, 427.69

Other Cardiac Dysrhythmias

427.81, 427.89, 427.9

Heart Failure

398.91, 428.0, 428.1, 428.20, 428.21, 428.22, 428.23, 428.30, 428.31, 428.32, 428.33, 428.40, 428.41, 428.42, 428.43, 428.9

Functional Disturbances Follow Cardiac Surgery (Postcardiotomy Syndrome)

429.4

Hypertension and Hypotension

Essential Hypertension

401.0, 401.1, 401.9

Hypertensive Heart Disease

402.00, 402.01, 402.10, 402.11, 402.90, 402.91

Hypertensive Chronic Kidney Disease

403.00, 403.01, 403.10, 403.11, 403.90, 403.91

Hypertensive Heart and Chronic Kidney Disease

404.00, 404.01, 404.02, 404.03, 404.10, 404.11, 404.12, 404.13, 404.90, 404.91, 404.92, 404.93

Secondary Hypertension

405.01, 405.09, 405.11, 405.19, 405.91, 405.99

Hypotension

458.0, 458.1, 458.21, 458.29, 458.8, 458.9, 796.3

Myocardial Infarction and Ischemia

Acute Myocardial Infarction, Initial Episode

410.01, 410.11, 410.21, 410.31, 410.41, 410.51, 410.61, 410.71, 410.81, 410.91

Acute Myocardial Infarction, Unspecified or Subsequent Episode

410.00, 410.02, 410.10, 410.12, 410.20, 410.22, 410.30, 410.32, 410.40, 410.42, 410.50, 410.52, 410.60, 410.62, 410.70, 410.72, 410.80, 410.82, 410.90, 410.92

Other Forms of Myocardial Ischemia

411.0, 411.81, 411.89, 429.79

APPENDIX C: REASONS FOR READMISSION DEFINITIONS *continued*

Angina Pectoris and Chest Pain

411.1, 413.0, 413.1, 413.9, 786.50, 786.51, 786.59

Atherosclerosis

Coronary Atherosclerosis

414.00, 414.01, 414.02, 414.03, 414.04, 414.05, 414.06, 414.07, 414.2‡, 414.3‡‡

Other Atherosclerosis

429.2, 440.0, 440.1, 440.20, 440.21, 440.22, 440.23, 440.24, 440.29, 440.30, 440.31, 440.32, 440.8, 440.9

Heart Aneurysm and Dissection

414.10, 414.11, 414.12, 414.19

Pericarditis, Endocarditis and Myocarditis

397.9, 398.0, 420.90, 420.91, 420.99, 421.0, 421.9, 422.90, 422.91, 422.92, 422.93, 422.99, 423.1, 423.2, 423.3‡, 423.8, 423.9, 424.90, 424.99, 429.0, 429.1

Heart Valve Disease

Mitral Valve Disease

394.0, 394.1, 394.2, 394.9, 424.0

Aortic Valve Disease

395.0, 395.1, 395.2, 395.9, 424.1

Tricuspid Valve Disease

397.0, 424.2

Pulmonary Valve Disease

397.1, 424.3

Multiple Valve Disease

396.0, 396.1, 396.2, 396.3, 396.8, 396.9

Other Endocardial Structure Disease

429.5, 429.6, 429.71, 429.81

Cardiomyopathies

425.0, 425.1, 425.3, 425.4, 425.9

Other Aneurysm and Dissection

Aortic Aneurysm and Dissection

441.00, 441.01, 441.02, 441.03, 441.1, 441.2, 441.3, 441.4, 441.5, 441.6, 441.7, 441.9

Other Arterial Aneurysm

442.0, 442.1, 442.2, 442.3, 442.81, 442.82, 442.83, 442.84, 442.89, 442.9

Other Arterial Dissection

443.21, 443.22, 443.23, 443.24, 443.29

Arterial Embolism and Thrombosis

Abdominal and Thoracic Aorta

444.0, 444.1

Arteries of the Extremities

444.21, 444.22, 445.01, 445.02

‡ Effective 10/1/2007
‡‡ Effective 10/1/2008

APPENDIX C: REASONS FOR READMISSION DEFINITIONS *continued*

Other Arteries Excluding Precerebral and Cerebral Arteries

444.81, 444.89, 444.9, 445.81, 445.89, 449[‡], 593.81

Venous Embolism and Thrombosis

Lower Extremity Venous Embolism and Thrombosis

453.40, 453.41, 453.42

Renal Vein Embolism and Thrombosis

453.3

Other Venous Embolism and Thrombosis

453.8, 453.9

Phlebitis and Thrombophlebitis

Lower Extremity Phlebitis and Thrombophlebitis

451.0, 451.11, 451.19, 451.2

Upper Extremity Phlebitis and Thrombophlebitis

451.82, 451.83, 451.84

Other Vessel Phlebitis and Thrombophlebitis

451.81, 451.89, 451.9

Occlusion and Stenosis

Precerebral Artery Occlusion and Stenosis

433.00, 433.20, 433.30, 433.80, 433.90

Cerebral Artery Occlusion and Stenosis

433.10, 434.00, 434.10, 434.90

Retinal Artery Occlusion and Visual Loss

362.30, 362.31, 362.32, 362.33, 362.34, 362.35, 362.36, 362.37, 368.11, 368.12, 368.40

Other Diseases and Symptoms of the Circulatory System

398.90, 398.99, 414.8, 414.9, 423.0, 429.3, 429.82, 429.89, 429.9, V533.1, V533.2, V533.9

RESPIRATORY SYSTEM

Pulmonary Embolism and Infarction

Pulmonary Embolism and Infarction

415.0, 415.12[‡], 415.19

Postoperative Pulmonary Embolism and Infarction

415.11

Pleural Effusion and Atelectasis

511.0, 511.8[††], 511.89[‡‡], 511.9, 518.0

Pneumothorax

Pneumothorax

512.0, 512.8

Postoperative Pneumothorax

512.1

[‡] Effective 10/1/2007
[††] Invalid 10/1/2008
[‡‡] Effective 10/1/2008

APPENDIX C: REASONS FOR READMISSION DEFINITIONS *continued*

Pulmonary Edema

514, 518.4, 518.5

Acute Respiratory Failure

518.81, 518.82, 518.84, 799.1

Other Diseases and Symptoms of the Respiratory System

518.1, 519.19, 519.2, 733.6, 786.00, 786.02, 786.04, 786.05, 786.06, 786.09, 786.3, 786.52, 786.6, 786.7, 786.8, 786.9, 998.81

NERVOUS SYSTEM

Stroke

Ischemic Stroke

433.01, 433.11, 433.21, 433.31, 433.81, 433.91, 434.01, 434.11, 434.91

Hemorrhagic Stroke

430, 431, 432.0, 432.1, 432.9

Transient Cerebral Ischemia

435.0, 435.1, 435.2, 435.3, 435.8, 435.9

Postoperative Stroke

997.02

Encephalopathies

348.30, 348.31, 348.39, 349.82, 437.2

Cerebral Edema and Brain Compression

348.4, 348.5

Anoxic Brain Damage

348.1

Coma and Stupor

780.01, 780.03, 780.09

Postoperative Pain

338.12, 338.18

Other Diseases and Symptoms of the Nervous System

336.1, 436, 780.2, 780.4, 780.97

DIGESTIVE SYSTEM

Ischemic Bowel and Vascular Insufficiency of the Intestine

557.0, 557.9

Intestinal Obstruction and Ileus

560.1, 560.81, 560.89, 560.9

Ulceration, Bleeding and Perforation of the Digestive System

528.00, 528.02, 528.09, 530.10, 530.12, 530.20, 530.21, 530.82, 531.00, 531.01, 531.10, 531.11, 531.20, 531.21, 531.30, 531.31, 531.40, 531.41, 531.50, 531.51, 531.60, 531.61, 531.70, 531.71, 531.90, 531.91, 532.00, 532.01, 532.10, 532.11, 532.20, 532.21, 532.30, 532.31, 532.40, 532.41, 532.50, 532.51, 532.60, 532.61, 532.70, 532.71, 532.90, 532.91, 533.00, 533.01, 533.10, 533.11, 533.20, 533.21, 533.30, 533.31, 533.40, 533.41, 533.50, 533.51, 533.60, 533.61, 533.70, 533.71, 533.90, 533.91, 534.00, 534.01, 534.10, 534.11, 534.20, 534.21, 534.30, 534.31, 534.40, 534.41, 534.50, 534.51, 534.60, 534.61, 534.70, 534.71, 534.90, 534.91, 535.00, 535.01, 535.40, 535.41, 535.50, 535.51, 535.60, 535.61, 569.3, 569.82, 569.83, 578.9

Acute Liver Failure

570, 572.2

Other Diseases and Symptoms of the Digestive System

560.30, 560.39, 568.81, 577.0, 578.0, 578.1

APPENDIX C: REASONS FOR READMISSION DEFINITIONS *continued*

URINARY SYSTEM

Acute Glomerulonephritis and Pyelonephritis

580.0, 580.4, 580.89, 580.9, 590.10, 590.11, 590.80

Nephrotic Syndrome

581.0, 581.1, 581.2, 581.3, 581.89, 581.9

Acute Renal Failure

584.5, 584.6, 584.7, 584.8, 584.9

Other Diseases and Symptoms of the Urinary System

593.9, 599.7[††], 599.70[‡‡], 599.71[‡‡], 599.72[‡‡], 788.20, 788.29

COMPLICATIONS OF SURGICAL AND MEDICAL CARE

Mechanical Complication of Cardiac Device, Implant and Graft

Mechanical Complication of Cardiac Pacemaker and AICD

996.00, 996.01, 996.04

Mechanical Complication of Heart Valve Prosthesis

996.02

Mechanical Complication of Coronary Artery Bypass Graft

996.03

Other and Unspecified Mechanical Complication

996.09, 996.1, 996.59

Other Complication of Internal Prosthetic Device, Implant and Graft

Other Complication of Heart Valve Prosthesis

996.71

Other Complication of Other Cardiac Device, Implant and Graft

996.72

Other Complicaton of Vascular Device, Implant and Graft

996.74

Shock

Postoperative Shock

998.0

Cardiogenic Shock

785.51

Other Shock

785.50, 785.59

Hemorrhage and Hematoma Complicating a Procedure

459.0, 998.11, 998.12, 998.13

Foreign Body Accidentally Left or Accidental Laceration During a Procedure

998.2, 998.4, 998.7

Dehiscence and Rupture of Operation Wound

998.31, 998.32, 998.6, 998.83

[††] Invalid 10/1/2008
[‡‡] Effective 10/1/2008

APPENDIX C: REASONS FOR READMISSION DEFINITIONS *continued*

Other Complications of Surgical and Medical Care

Nervous System Complication

997.00, 997.01, 997.09

Circulatory System Complication

997.1, 997.2, 997.71, 997.72, 997.79, 999.1, 999.2

Respiratory System Complication

519.00, 519.02, 519.09, 997.3[††], 997.39[‡‡]

Digestive System Complication

536.40, 536.42, 536.49, 997.4

Urinary System Complication

997.5

Other Complications

998.89, 998.9, 999.8[††], 999.89[‡‡]

INFECTIONS

Postoperative Infections

997.31[‡‡], 998.51, 998.59, 99.3[†], 999.31[‡], 999.39[‡]

Sepsis and Bacteremia

038.0, 038.10, 038.11, 038.12[‡‡], 038.19, 038.2, 038.3, 038.40, 038.41, 038.42, 038.43, 038.44, 038.49, 038.8, 038.9, 785.52, 790.7, 995.90, 995.91, 995.92

Pneumonia

Pneumonia

481, 482.0, 482.1, 482.2, 482.30, 482.31, 482.32, 482.39, 482.40, 482.41, 482.42[‡‡], 482.49, 482.81, 482.82, 482.83, 482.84, 482.89, 482.9, 485, 486, 511.1

Aspiration Pneumonia

507.0

Empyema and Abscess of Lung

510.0, 510.9, 513.0, 513.1

Infection due to Device, Implant and Graft

Cardiac Device, Implant and Graft

996.61

Vascular Device, Implant and Graft

996.62

Other and Unspecified Infections due to Device, Implant and Graft

519.01, 536.41

Urinary Tract Infection

590.3, 590.9, 595.0, 599.0, 996.64

Cellulitis

681.00, 681.01, 681.02, 681.10, 681.11, 681.9, 682.0, 682.1, 682.2, 682.3, 682.4, 682.5, 682.6, 682.7, 682.8, 682.9

[††] Invalid 10/1/2008
[‡‡] Effective 10/1/2008
[†] Invalid 10/1/2007
[‡] Effective 10/1/2007

APPENDIX C: REASONS FOR READMISSION DEFINITIONS *continued*

Osteomyelitis

730.03, 730.06, 730.07, 730.08, 730.09

Intestinal Infection due to Clostridium difficile

008.45

Other Infection Related Conditions and Symptoms

567.21, 567.29, 567.9, 590.2, 780.6[††], 780.60[‡‡], 780.61[‡‡], 780.62[‡‡]

FLUID AND ELECTROLYTE IMBALANCE

Hyperosmolality and Hyposmolality

276.0, 276.1

Acidosis and Alkalosis

276.2, 276.3, 276.4

Dehydration and Hypovolemia

276.50, 276.51, 276.52

Fluid Overload

276.6

Hyperpotassemia and Hypopotassemia

276.7, 276.8

Other Electrolyte and Fluid Disorders

276.9

ANEMIA AND COAGULATION DEFECTS

Anemia

Acute Posthemorrhagic Anemia

285.1

Anemia

280.0, 285.8, 285.9

Coagulation Defects

Hemorrhagic Disorders due to Anticoagulants

286.5

Thrombocytopenia

287.4, 287.5, 289.84[‡‡], 446.6

Other Coagulation Defects

286.6, 286.7, 286.9, 289.82, 790.92

[††] Invalid 10/1/2008
[‡‡] Effective 10/1/2008

APPENDIX D: READMISSIONS DATA

2007 – 2008 Data	7-Day N = 1,845 (6.7%) #	7-Day N = 1,845 (6.7%) %	30-Day N = 4,420 (16.1%) #	30-Day N = 4,420 (16.1%) %
CIRCULATORY SYSTEM	**907**	**49.2**	**2,154**	**48.7**
Cardiac Dysrhythmias	166	9.0	392	8.9
Heart Block	4	0.2	12	0.3
Paroxysmal Tachycardia	9	0.5	21	0.5
Atrial Fibrillation and Atrial Flutter	129	7.0	294	6.7
Ventricular Fibrillation and Ventricular Flutter	2	0.1	5	0.1
Premature Heart Beats	0	0.0	1	0.0
Other Cardiac Dysrhythmias	22	1.2	59	1.3
Heart Failure	298	16.2	613	13.9
Functional Disturbances Follow Cardiac Surgery (Postcardiotomy Syndrome)	73	4.0	167	3.8
Hypertension and Hypotension	35	1.9	96	2.2
Essential Hypertension	2	0.1	4	0.1
Hypertensive Heart Disease	7	0.4	15	0.3
Hypertensive Chronic Kidney Disease	1	0.1	2	0.0
Hypertensive Heart and Chronic Kidney Disease	1	0.1	3	0.1
Secondary Hypertension	0	0.0	0	0.0
Hypotension	24	1.3	72	1.6
Myocardial Infarction and Ischemia	22	1.2	77	1.7
Acute Myocardial Infarction, Initial Episode	13	0.7	60	1.4
Acute Myocardial Infarction, Unspecified or Subsequent Episode	2	0.1	3	0.1
Other Forms of Myocardial Ischemia	7	0.4	14	0.3
Angina Pectoris and Chest Pain	241	13.1	595	13.5
Atherosclerosis	12	0.7	61	1.4
Coronary Atherosclerosis	12	0.7	53	1.2
Other Atherosclerosis	0	0.0	8	0.2
Heart Aneurysm and Dissection	0	0.0	0	0.0
Pericarditis, Endocarditis and Myocarditis	26	1.4	72	1.6
Heart Valve Disease	1	0.1	5	0.1
Mitral Valve Disease	1	0.1	3	0.1
Aortic Valve Disease	0	0.0	0	0.0
Tricuspid Valve Disease	0	0.0	0	0.0
Pulmonary Valve Disease	0	0.0	0	0.0
Multiple Valve Disease	0	0.0	1	0.0
Other Endocardial Structure Disease	0	0.0	1	0.0
Cardiomyopathies	1	0.1	2	0.0

APPENDIX D: READMISSIONS DATA *continued*

2007 – 2008 Data	7-Day N = 1,845 (6.7%) #	%	30-Day N = 4,420 (16.1%) #	%
Other Aneurysm and Dissection	2	0.1	7	0.2
Aortic Aneurysm and Dissection	1	0.1	4	0.1
Other Arterial Aneurysm	1	0.1	3	0.1
Other Arterial Dissection	0	0.0	0	0.0
Arterial Embolism and Thrombosis	5	0.3	8	0.2
Abdominal and Thoracic Aorta	0	0.0	1	0.0
Arteries of the Extremities	5	0.3	6	0.1
Other Arteries Excluding Precerebral and Cerebral Arteries	0	0.0	1	0.0
Venous Embolism and Thrombosis	13	0.7	33	0.7
Lower Extremity Venous Embolism and Thrombosis	11	0.6	28	0.6
Renal Vein Embolism and Thrombosis	0	0.0	0	0.0
Other Venous Embolism and Thrombosis	2	0.1	5	0.1
Phlebitis and Thrombophlebitis	3	0.2	4	0.1
Lower Extremity Phlebitis and Thrombophlebitis	3	0.2	4	0.1
Upper Extremity Phlebitis and Thrombophlebitis	0	0.0	0	0.0
Other Vessel Phlebitis and Thrombophlebitis	0	0.0	0	0.0
Occlusion and Stenosis	4	0.2	11	0.2
Precerebral Artery Occlusion and Stenosis	2	0.1	2	0.0
Cerebral Artery Occlusion and Stenosis	1	0.1	8	0.2
Retinal Artery Occlusion and Visual Loss	1	0.1	1	0.0
Other Diseases and Symptoms of the Circulatory System	5	0.3	11	0.2
RESPIRATORY SYSTEM	**196**	**10.6**	**437**	**9.9**
Pulmonary Embolism and Infarction	52	2.8	111	2.5
Pulmonary Embolism and Infarction	33	1.8	72	1.6
Postoperative Pulmonary Embolism and Infarction	19	1.0	39	0.9
Pleural Effusion and Atelectasis	72	3.9	188	4.3
Pneumothorax	12	0.7	15	0.3
Pneumothorax	5	0.3	6	0.1
Postoperative Pneumothorax	7	0.4	9	0.2
Pulmonary Edema	2	0.1	6	0.1
Acute Respiratory Failure	37	2.0	73	1.7
Other Diseases and Symptoms of the Respiratory System	21	1.1	44	1.0
NERVOUS SYSTEM	**133**	**7.2**	**304**	**6.9**
Stroke	97	5.3	224	5.1
Ischemic Stroke	18	1.0	44	1.0
Hemorrhagic Stroke	2	0.1	10	0.2
Transient Cerebral Ischemia	74	4.0	167	3.8
Postoperative Stroke	3	0.2	3	0.1

APPENDIX D: READMISSIONS DATA *continued*

2007 – 2008 Data	7-Day N = 1,845 (6.7%) #	%	30-Day N = 4,420 (16.1%) #	%
Encephalopathies	1	0.1	3	0.1
Cerebral Edema and Brain Compression	0	0.0	0	0.0
Anoxic Brain Damage	0	0.0	0	0.0
Coma and Stupor	2	0.1	2	0.0
Postoperative Pain	6	0.3	8	0.2
Other Diseases and Symptoms of the Nervous System	27	1.5	67	1.5
DIGESTIVE SYSTEM	**59**	**3.2**	**133**	**3.0**
Ischemic Bowel and Vascular Insufficiency of the Intestine	5	0.3	9	0.2
Intestinal Obstruction and Ileus	6	0.3	9	0.2
Ulceration, Bleeding and Perforation of the Digestive System	35	1.9	88	2.0
Acute Liver Failure	0	0.0	1	0.0
Other Diseases and Symptoms of the Digestive System	13	0.7	26	0.6
URINARY SYSTEM	**28**	**1.5**	**85**	**1.9**
Acute Glomerulonephritis and Pyelonephritis	0	0.0	2	0.0
Nephrotic Syndrome	0	0.0	1	0.0
Acute Renal Failure	24	1.3	73	1.7
Other Diseases and Symptoms of the Urinary System	4	0.2	9	0.2
COMPLICATIONS OF SURGICAL AND MEDICAL CARE	**208**	**11.3**	**438**	**9.9**
Mechanical Complication of Cardiac Device, Implant and Graft	7	0.4	13	0.3
Mechanical Complication of Cardiac Pacemaker and AICD	2	0.1	4	0.1
Mechanical Complication of Heart Valve Prosthesis	1	0.1	3	0.1
Mechanical Complication of Coronary Artery Bypass Graft	1	0.1	2	0.0
Other and Unspecified Mechanical Complication	3	0.2	4	0.1
Other Complication of Internal Prosthetic Device, Implant and Graft	16	0.9	37	0.8
Other Complication of Heart Valve Prosthesis	3	0.2	8	0.2
Other Complication of Other Cardiac Device, Implant and Graft	9	0.5	21	0.5
Other Complicaton of Vascular Device, Implant and Graft	4	0.2	8	0.2
Shock	0	0.0	0	0.0
Postoperative Shock	0	0.0	0	0.0
Cardiogenic Shock	0	0.0	0	0.0
Other Shock	0	0.0	0	0.0
Hemorrhage and Hematoma Complicating a Procedure	10	0.5	31	0.7
Foreign Body Accidentally Left or Accidental Laceration During a Procedure	1	0.1	1	0.0
Dehiscence and Rupture of Operation Wound	22	1.2	66	1.5
Other Complications of Surgical and Medical Care	152	8.2	290	6.6
Nervous System Complication	0	0.0	2	0.0
Circulatory System Complication	92	5.0	163	3.7

APPENDIX D: READMISSIONS DATA *continued*

2007 – 2008 Data	7-Day N = 1,845 (6.7%) #	%	30-Day N = 4,420 (16.1%) #	%
Respiratory System Complication	50	2.7	103	2.3
Digestive System Complication	4	0.2	9	0.2
Urinary System Complication	1	0.1	2	0.0
Other Complications	5	0.3	11	0.2
INFECTIONS	**265**	**14.4**	**746**	**16.9**
Postoperative Infections	116	6.3	363	8.2
Sepsis and Bacteremia	52	2.8	104	2.4
Pneumonia	54	2.9	126	2.9
Pneumonia	49	2.7	109	2.5
Aspiration Pneumonia	5	0.3	17	0.4
Empyema and Abscess of Lung	2	0.1	3	0.1
Infection due to Device, Implant and Graft	5	0.3	15	0.3
Cardiac Device, Implant and Graft	2	0.1	8	0.2
Vascular Device, Implant and Graft	3	0.2	7	0.2
Other and Unspecified Infections due to Device, Implant and Graft	0	0.0	0	0.0
Urinary Tract Infection	13	0.7	38	0.9
Cellulitis	8	0.4	36	0.8
Osteomyelitis	0	0.0	0	0.0
Intestinal Infection due to Clostridium difficile	11	0.6	51	1.2
Other Infection Related Conditions and Symptoms	4	0.2	10	0.2
FLUID AND ELECTROLYTE IMBALANCE	**25**	**1.4**	**69**	**1.6**
Hyperosmolality and Hyposmolality	3	0.2	6	0.1
Acidosis and Alkalosis	1	0.1	1	0.0
Dehydration and Hypovolemia	14	0.8	45	1.0
Fluid Overload	3	0.2	7	0.2
Hyperpotassemia and Hypopotassemia	4	0.2	10	0.2
Other Electrolyte and Fluid Disorders	0	0.0	0	0.0
ANEMIA AND COAGULATION DEFECTS	**24**	**1.3**	**54**	**1.2**
Anemia	15	0.8	30	0.7
Acute Posthemorrhagic Anemia	4	0.2	7	0.2
Anemia	11	0.6	23	0.5
Coagulation Defects	9	0.5	24	0.5
Hemorrhagic Disorders due to Anticoagulants	0	0.0	0	0.0
Thrombocytopenia	2	0.1	5	0.1
Other Coagulation Defects	7	0.4	19	0.4

APPENDIX D: READMISSIONS DATA *continued*

2008 Data	7-Day N = 931 (6.8%) #	7-Day N = 931 (6.8%) %	30-Day N = 2,208 (16.1%) #	30-Day N = 2,208 (16.1%) %
CIRCULATORY SYSTEM	**500**	**53.7**	**1,201**	**54.4**
Cardiac Dysrhythmias	68	7.3	159	7.2
Heart Block	2	0.2	4	0.2
Paroxysmal Tachycardia	9	1.0	15	0.7
Atrial Fibrillation and Atrial Flutter	47	5.0	115	5.2
Ventricular Fibrillation and Ventricular Flutter	2	0.2	2	0.1
Premature Heart Beats	0	0.0	0	0.0
Other Cardiac Dysrhythmias	8	0.9	23	1.0
Heart Failure	133	14.3	274	12.4
Functional Disturbances Follow Cardiac Surgery (Postcardiotomy Syndrome)	30	3.2	71	3.2
Hypertension and Hypotension	16	1.7	39	1.8
Essential Hypertension	1	0.1	2	0.1
Hypertensive Heart Disease	4	0.4	6	0.3
Hypertensive Chronic Kidney Disease	1	0.1	2	0.1
Hypertensive Heart and Chronic Kidney Disease	0	0.0	0	0.0
Secondary Hypertension	0	0.0	0	0.0
Hypotension	10	1.1	29	1.3
Myocardial Infarction and Ischemia	8	0.9	37	1.7
Acute Myocardial Infarction, Initial Episode	5	0.5	27	1.2
Acute Myocardial Infarction, Unspecified or Subsequent Episode	1	0.1	2	0.1
Other Forms of Myocardial Ischemia	2	0.2	8	0.4
Angina Pectoris and Chest Pain	221	23.7	533	24.1
Atherosclerosis	3	0.3	25	1.1
Coronary Atherosclerosis	3	0.3	22	1.0
Other Atherosclerosis	0	0.0	3	0.1
Heart Aneurysm and Dissection	0	0.0	0	0.0
Pericarditis, Endocarditis and Myocarditis	6	0.6	21	1.0
Heart Valve Disease	0	0.0	4	0.2
Mitral Valve Disease	0	0.0	2	0.1
Aortic Valve Disease	0	0.0	0	0.0
Tricuspid Valve Disease	0	0.0	0	0.0
Pulmonary Valve Disease	0	0.0	0	0.0
Multiple Valve Disease	0	0.0	1	0.0
Other Endocardial Structure Disease	0	0.0	1	0.0
Cardiomyopathies	1	0.1	1	0.0

APPENDIX D: READMISSIONS DATA *continued*

2008 Data	7-Day N = 931 (6.8%) #	7-Day N = 931 (6.8%) %	30-Day N = 2,208 (16.1%) #	30-Day N = 2,208 (16.1%) %
Other Aneurysm and Dissection	1	0.1	2	0.1
Aortic Aneurysm and Dissection	0	0.0	0	0.0
Other Arterial Aneurysm	1	0.1	2	0.1
Other Arterial Dissection	0	0.0	0	0.0
Arterial Embolism and Thrombosis	2	0.2	4	0.2
Abdominal and Thoracic Aorta	0	0.0	0	0.0
Arteries of the Extremities	2	0.2	3	0.1
Other Arteries Excluding Precerebral and Cerebral Arteries	0	0.0	1	0.0
Venous Embolism and Thrombosis	7	0.8	17	0.8
Lower Extremity Venous Embolism and Thrombosis	7	0.8	14	0.6
Renal Vein Embolism and Thrombosis	0	0.0	0	0.0
Other Venous Embolism and Thrombosis	0	0.0	3	0.1
Phlebitis and Thrombophlebitis	1	0.1	1	0.0
Lower Extremity Phlebitis and Thrombophlebitis	1	0.1	1	0.0
Upper Extremity Phlebitis and Thrombophlebitis	0	0.0	0	0.0
Other Vessel Phlebitis and Thrombophlebitis	0	0.0	0	0.0
Occlusion and Stenosis	1	0.1	6	0.3
Precerebral Artery Occlusion and Stenosis	0	0.0	0	0.0
Cerebral Artery Occlusion and Stenosis	1	0.1	6	0.3
Retinal Artery Occlusion and Visual Loss	0	0.0	0	0.0
Other Diseases and Symptoms of the Circulatory System	2	0.2	7	0.3
RESPIRATORY SYSTEM	**89**	**9.6**	**189**	**8.6**
Pulmonary Embolism and Infarction	18	1.9	43	1.9
Pulmonary Embolism and Infarction	11	1.2	25	1.1
Postoperative Pulmonary Embolism and Infarction	7	0.8	18	0.8
Pleural Effusion and Atelectasis	40	4.3	85	3.8
Pneumothorax	5	0.5	5	0.2
Pneumothorax	1	0.1	1	0.0
Postoperative Pneumothorax	4	0.4	4	0.2
Pulmonary Edema	1	0.1	4	0.2
Acute Respiratory Failure	13	1.4	30	1.4
Other Diseases and Symptoms of the Respiratory System	12	1.3	22	1.0
NERVOUS SYSTEM	**94**	**10.1**	**204**	**9.2**
Stroke	81	8.7	175	7.9
Ischemic Stroke	8	0.9	14	0.6
Hemorrhagic Stroke	2	0.2	4	0.2
Transient Cerebral Ischemia	70	7.5	156	7.1
Postoperative Stroke	1	0.1	1	0.0

APPENDIX D: READMISSIONS DATA *continued*

2008 Data	7-Day N = 931 (6.8%) #	%	30-Day N = 2,208 (16.1%) #	%
Encephalopathies	1	0.1	1	0.0
Cerebral Edema and Brain Compression	0	0.0	0	0.0
Anoxic Brain Damage	0	0.0	0	0.0
Coma and Stupor	0	0.0	0	0.0
Postoperative Pain	2	0.2	3	0.1
Other Diseases and Symptoms of the Nervous System	10	1.1	25	1.1
DIGESTIVE SYSTEM	**28**	**3.0**	**57**	**2.6**
Ischemic Bowel and Vascular Insufficiency of the Intestine	3	0.3	4	0.2
Intestinal Obstruction and Ileus	4	0.4	5	0.2
Ulceration, Bleeding and Perforation of the Digestive System	16	1.7	34	1.5
Acute Liver Failure	0	0.0	1	0.0
Other Diseases and Symptoms of the Digestive System	5	0.5	13	0.6
URINARY SYSTEM	**13**	**1.4**	**39**	**1.8**
Acute Glomerulonephritis and Pyelonephritis	0	0.0	1	0.0
Nephrotic Syndrome	0	0.0	0	0.0
Acute Renal Failure	10	1.1	32	1.4
Other Diseases and Symptoms of the Urinary System	3	0.3	6	0.3
COMPLICATIONS OF SURGICAL AND MEDICAL CARE	**84**	**9.0**	**166**	**7.5**
Mechanical Complication of Cardiac Device, Implant and Graft	2	0.2	4	0.2
Mechanical Complication of Cardiac Pacemaker and AICD	1	0.1	3	0.1
Mechanical Complication of Heart Valve Prosthesis	0	0.0	0	0.0
Mechanical Complication of Coronary Artery Bypass Graft	1	0.1	1	0.0
Other and Unspecified Mechanical Complication	0	0.0	0	0.0
Other Complication of Internal Prosthetic Device, Implant and Graft	7	0.8	13	0.6
Other Complication of Heart Valve Prosthesis	0	0.0	2	0.1
Other Complication of Other Cardiac Device, Implant and Graft	6	0.6	9	0.4
Other Complicaton of Vascular Device, Implant and Graft	1	0.1	2	0.1
Shock	0	0.0	0	0.0
Postoperative Shock	0	0.0	0	0.0
Cardiogenic Shock	0	0.0	0	0.0
Other Shock	0	0.0	0	0.0
Hemorrhage and Hematoma Complicating a Procedure	5	0.5	10	0.5
Foreign Body Accidentally Left or Accidental Laceration During a Procedure	0	0.0	0	0.0
Dehiscence and Rupture of Operation Wound	6	0.6	26	1.2
Other Complications of Surgical and Medical Care	64	6.9	113	5.1
Nervous System Complication	0	0.0	1	0.0
Circulatory System Complication	40	4.3	61	2.8

APPENDIX D: READMISSIONS DATA *continued*

2008 Data	7-Day N = 931 (6.8%) #	%	30-Day N = 2,208 (16.1%) #	%
Respiratory System Complication	22	2.4	44	2.0
Digestive System Complication	0	0.0	1	0.0
Urinary System Complication	0	0.0	1	0.0
Other Complications	2	0.2	5	0.2
INFECTIONS	**105**	**11.3**	**303**	**13.7**
Postoperative Infections	50	5.4	153	6.9
Sepsis and Bacteremia	20	2.1	38	1.7
Pneumonia	18	1.9	55	2.5
Pneumonia	18	1.9	49	2.2
Aspiration Pneumonia	0	0.0	6	0.3
Empyema and Abscess of Lung	1	0.1	2	0.1
Infection due to Device, Implant and Graft	1	0.1	5	0.2
Cardiac Device, Implant and Graft	1	0.1	4	0.2
Vascular Device, Implant and Graft	0	0.0	1	0.0
Other and Unspecified Infections due to Device, Implant and Graft	0	0.0	0	0.0
Urinary Tract Infection	6	0.6	18	0.8
Cellulitis	1	0.1	8	0.4
Osteomyelitis	0	0.0	0	0.0
Intestinal Infection due to Clostridium difficile	5	0.5	20	0.9
Other Infection Related Conditions and Symptoms	3	0.3	4	0.2
FLUID AND ELECTROLYTE IMBALANCE	**11**	**1.2**	**29**	**1.3**
Hyperosmolality and Hyposmolality	0	0.0	1	0.0
Acidosis and Alkalosis	1	0.1	1	0.0
Dehydration and Hypovolemia	5	0.5	20	0.9
Fluid Overload	1	0.1	2	0.1
Hyperpotassemia and Hypopotassemia	4	0.4	5	0.2
Other Electrolyte and Fluid Disorders	0	0.0	0	0.0
ANEMIA AND COAGULATION DEFECTS	**7**	**0.8**	**20**	**0.9**
Anemia	6	0.6	11	0.5
Acute Posthemorrhagic Anemia	1	0.1	2	0.1
Anemia	5	0.5	9	0.4
Coagulation Defects	1	0.1	9	0.4
Hemorrhagic Disorders due to Anticoagulants	0	0.0	0	0.0
Thrombocytopenia	0	0.0	2	0.1
Other Coagulation Defects	1	0.1	7	0.3

APPENDIX E: DEFINITIONS FOR POTENTIAL CANDIDATE VARIABLES

This appendix includes definitions of factors that were considered as potential candidate variables to be entered/tested in the risk-adjustment models. When variables were defined by the presence of ICD-9-CM codes in the discharge record, the ICD-9-CM codes are listed. As discussed earlier, not every variable was considered for every model. When definitions overlapped only one of the variables was considered and some variables were not applicable to particular models. Some variables were not tested in the model(s) because the preliminary analysis did not suggest that they would be predictive of the relevant event. The columns to the right indicate which variable definitions were entered/tested and not retained in a particular model (E or T) and which variables were entered/tested and included in a particular model (✓). When there is no entry beside a particular model the variables was not entered or tested (____).

Variable Definitions	2007-2008 Models	2008 Models
Year [P] Calendar year in which surgery was performed.	In-Hospital M ___ Operative M ___ 7-Day R ___ 30-Day R ___ PS-LOS ___	In-Hospital M ___ Operative M ___ 7-Day R ___ 30-Day R ___ PS-LOS ___
Demographic Variables		
Age in Years [P] This continuous variable is the patient's age in years.	In-Hospital M ✓ Operative M ✓ 7-Day R ✓ 30-Day R T PS-LOS ✓	In-Hospital M ✓ Operative M ✓ 7-Day R T 30-Day R T PS-LOS ✓
Age # Years > 65 [P] This continuous variable is the number of years that the patient is over age 65.	In-Hospital M ✓ Operative M ✓ 7-Day R T 30-Day R ✓ PS-LOS ✓	In-Hospital M ✓ Operative M ✓ 7-Day R ✓ 30-Day R ✓ PS-LOS ✓
Female [P]	In-Hospital M ✓ Operative M ✓ 7-Day R T 30-Day R ✓ PS-LOS ✓	In-Hospital M ✓ Operative M ✓ 7-Day R ✓ 30-Day R ✓ PS-LOS ✓
Race/Ethnicity [P] *Category 1:* Hispanic *Category 2:* White, non-Hispanic *Category 3:* Black, non-Hispanic *Category 4:* Other/Unknown	In-Hospital M T Operative M ___ 7-Day R ___ 30-Day R ___ PS-LOS ✓	In-Hospital M ___ Operative M ___ 7-Day R ___ 30-Day R ___ PS-LOS ___
Race (category) [P] *Category 1:* White *Category 2:* Black *Category 3:* Other/Unknown	In-Hospital M ___ Operative M ___ 7-Day R ✓ 30-Day R ✓ PS-LOS ___	In-Hospital M ___ Operative M ___ 7-Day R ___ 30-Day R T PS-LOS ✓
Laboratory Variables		
Albumin < 3.1 g/dL [MQ] Laboratory value for albumin was in the range < 3.0 g/dL, as indicated by any of the following: Albumin g/dL A (iv code 70001), which indicates a lab value in the range: 1 – 2.4 Albumin g/dL B (iv code 70001), which indicates a lab value in the range: 2.5 – 2.7. Albumin g/dL C (iv code 70002), which indicates a lab value in the range: 2.8 – 3. Note: Albumin levels are used to evaluate nutritional status, liver or kidney disease.	In-Hospital M ✓ Operative M ✓ 7-Day R ___ 30-Day R ___ PS-LOS ___	In-Hospital M E Operative M ✓ 7-Day R ___ 30-Day R ___ PS-LOS ___

[P] This variable was based on PHC4 data.

[MQ] This variable was based on data obtained from MediQual.

[C] This variable was based on both MediQual and PHC4 data.

_✓_ = variable included in final model
_E_ or _T_ = variable was entered/tested in the model and not retained

___ = variable not entered or tested in the model.

APPENDIX E: DEFINITIONS FOR POTENTIAL CANDIDATE VARIABLES *continued*

Variable Definitions	2007-2008 Models	2008 Models
BUN > 40 mg/dL [MQ] Laboratory value for blood urea nitrogen (BUN) was greater than 40 mg/dL, as indicated by any of the following: BUN mg/dL D (iv code70153), which indicates a lab value in the range: 41- 55. BUN mg/dL E (iv code70154), which indicates a lab value in the range: 56 – 250. Note: Evaluation of kidney function.	In-Hospital M ✓ Operative M ✓ 7-Day R 30-Day R PS-LOS	In-Hospital M ✓ Operative M ✓ 7-Day R 30-Day R PS-LOS
Creatinine > 1.4 mg/dL [MQ] Laboratory value for creatinine was greater than 1.4 mg/dL, as indicated by any of the following: Creatinine mg/dL B (iv code 70231), which indicates a lab value in the range: 1.5 - 2 Creatinine mg/dL C (iv code 70232), which indicates a lab value in the range: 2.1 – 2.5 Creatinine mg/dL D (iv code 70233), which indicates a lab value in the range: 2.6 - 3 Creatinine mg/dL E (iv code 70234), which indicates a lab value in the range: 3.1 – 25 Note: Evaluation of kidney function.	In-Hospital M ✓ Operative M ✓ 7-Day R 30-Day R PS-LOS	In-Hospital M ✓ Operative M ✓ 7-Day R 30-Day R PS-LOS
Glucose > 165 mg/dL [MQ] Laboratory value for glucose was greater than 165 mg/dL, as indicated by any of the following: Glucose mg/dL D (iv code70103), which indicates a lab value in the range: 166 – 240. Glucose mg/dL E (iv code70104), which indicates a lab value in the range: 241 – 2000.	In-Hospital M E Operative M E 7-Day R 30-Day R PS-LOS	In-Hospital M E Operative M E 7-Day R 30-Day R PS-LOS
Clinical Variables Other than Laboratory Variables		
Acute Myocardial Infarction [P] AMI as indicated by code 410.01, 410.11, 410.21, 410.31, 410.41, 410.51, 410.61, 410.71, 410.81, or 410.91 in the *principal diagnosis position* in PHC4 data.	In-Hospital M Operative M 7-Day R 30-Day R PS-LOS ✓	In-Hospital M Operative M 7-Day R 30-Day R PS-LOS T
AMI Except Other Anterior or Other Inferior Wall [P] AMI as indicated by code 410.01, 410.21, 410.31, 410.51, 410.61, 410.71, 410.81, or 410.91 in the *principal diagnosis position* in PHC4 data.	In-Hospital M ✓ Operative M ✓ 7-Day R T 30-Day R T PS-LOS	In-Hospital M ✓ Operative M ✓ 7-Day R 30-Day R PS-LOS
AMI Other Inferior Wall Initial Episode [C] AMI of other inferior wall, as indicated by 410.41 in the principal diagnosis position in PHC4 data, or 410.41 in any position in the MediQual data (iv code: 9991).	In-Hospital M ✓ Operative M ✓ 7-Day R 30-Day R PS-LOS	In-Hospital M ✓ Operative M ✓ 7-Day R 30-Day R PS-LOS
Anemia [P] Any of the following codes in any position in PHC4 data: 280.0, 280.1, 280.8, 280.9, 281.0, 281.1, 281.2, 281.3, 281.4, 281.8, 281.9, 282.0, 282.1, 282.2, 282.3, 282.41, 282.42, 282.49, 282.5, 282.60, 282.61, 282.62, 282.63, 282.64, 282.68, 282.69, 282.7, 282.8, 282.9, 283.0, 283.10, 283.11, 283.19, 283.2, 283.9, 284.0, 284.01, 284.09, 284.1, 284.2, 284.8†, 284.81‡, 284.89‡, 284.9, 285.0, 285.21, 285.22, 285.29, 285.8, 285.9	In-Hospital M Operative M 7-Day R T 30-Day R T PS-LOS ✓	In-Hospital M Operative M 7-Day R T 30-Day R T PS-LOS ✓
Angina [P] Any of the following codes in any position in PHC4 data: 411.1, 413.0, 413.1, 413.9.	In-Hospital M Operative M 7-Day R 30-Day R PS-LOS	In-Hospital M Operative M 7-Day R 30-Day R PS-LOS
Angina, Unstable [P] The following code in any position in PHC4 data: 411.1.	In-Hospital M Operative M 7-Day R 30-Day R PS-LOS	In-Hospital M Operative M 7-Day R 30-Day R PS-LOS

† Invalid 10/1/2007
‡ Effective 10/1/2007

[P] This variable was based on PHC4 data.

[MQ] This variable was based on data obtained from MediQual.

[C] This variable was based on both MediQual and PHC4 data.

✓ = variable included in final model
E or T = variable was entered/tested in the model and not retained

___ = variable not entered or tested in the model.

APPENDIX E: DEFINITIONS FOR POTENTIAL CANDIDATE VARIABLES *continued*

Variable Definitions	2007-2008 Models	2008 Models
ASA Class 5 [MQ] This dichotomous variable (iv code 5529) is based on the presence of an anesthesia class of 5 for the earliest open heart procedure episode. Physical status classification system created by American Society of Anesthesiologists. Scale: 1-5, where 5 is the highest risk category.	In-Hospital M ✓ Operative M ✓ 7-Day R 30-Day R PS-LOS	In-Hospital M ✓ Operative M ✓ 7-Day R 30-Day R PS-LOS
ASA Emergency [MQ] This dichotomous variable (iv code 5530) is based on the presence of an anesthesia emergency flag for the earliest open heart procedure episode. Physical status classification system created by American Society of Anesthesiologists. E designates an emergency operation.	In-Hospital M ✓ Operative M ✓ 7-Day R 30-Day R PS-LOS	In-Hospital M ✓ Operative M ✓ 7-Day R 30-Day R PS-LOS
Cachexia [P] Any of the following codes in any position in PHC4 data: 261, 262, 263.0, 263.1, 263.2, 263.8, 263.9, 799.4, V85.0.	In-Hospital M ✓ Operative M ✓ 7-Day R T 30-Day R ✓ PS-LOS ✓	In-Hospital M ✓ Operative M ✓ 7-Day R T 30-Day R T PS-LOS ✓
CAD > 70, 5-7 Vessels Group [MQ] This dichotomous variable (iv code: 6668) indicates the presence of coronary artery disease (CAD) with greater than 70 percent occlusion in 5 to 7 coronary arteries.	In-Hospital M ✓ Operative M ✓ 7-Day R 30-Day R PS-LOS	In-Hospital M ✓ Operative M ✓ 7-Day R 30-Day R PS-LOS
Cancer [P] Any of the following codes in any position in PHC4 data: Malignant neoplasms including primary and secondary (140.0-209.30[1]), Cancer In Situ and Neoplasms of Uncertain Behavior (230.0-239.9[2])	In-Hospital M Operative M 7-Day R 30-Day R PS-LOS T	In-Hospital M Operative M 7-Day R 30-Day R T PS-LOS T
Cardiac Adhesions [P] The following code in any position in PHC4 data: 423.1 (Adhesive Pericarditis).	In-Hospital M T Operative M T 7-Day R ✓ 30-Day R T PS-LOS T	In-Hospital M T Operative M 7-Day R 30-Day R PS-LOS T
Cardiogenic Shock, Preoperative [P] Chart review for clinical criteria.	In-Hospital M ✓ Operative M ✓ 7-Day R 30-Day R PS-LOS ✓	In-Hospital M ✓ Operative M ✓ 7-Day R 30-Day R T PS-LOS ✓
Cardiomyopathy [P] Any of the following codes in any position in PHC4 data: 414.8, 425.1, 425.3, 425.4, 425.5, 425.8, 425.9, 429.1, 429.3.	In-Hospital M T Operative M T 7-Day R T 30-Day R ✓ PS-LOS ✓	In-Hospital M T Operative M T 7-Day R 30-Day R T PS-LOS T
Cardiopulmonary Resuscitation (CPR) Prior to CABG/Valve Surgery Date [P] Any of the following codes in any position in PHC4 data: 93.93, 99.60, 99.62, or 99.63 prior to CABG/valve surgery date. Note: Use the earliest CPR date for analysis.	In-Hospital M Operative M 7-Day R 30-Day R PS-LOS	In-Hospital M Operative M 7-Day R 30-Day R PS-LOS

[1] This range includes new codes effective 10/1/2007: 200.3x, 200.4x, 200.5x, 200.6x, 200.7x and 10/1/2008: 209.0x, 209.1x, 209.2x, 209.3x.
[2] This range includes a new code effective 10/1/2007: 233.3x.

[P] This variable was based on PHC4 data.

[MQ] This variable was based on data obtained from MediQual.

[C] This variable was based on both MediQual and PHC4 data.

✓ = variable included in final model
E or T = variable was entered/tested in the model and not retained

— = variable not entered or tested in the model.

APPENDIX E: DEFINITIONS FOR POTENTIAL CANDIDATE VARIABLES *continued*

Variable Definitions	2007-2008 Models	2008 Models
Cerebrovascular Disease [P] Any of the following codes in any position in PHC4 data: 433.00, 433.10, 433.20, 433.30, 433.80, 433.90, 434.00, 434.10, 434.90, 437.0, 437.1, 437.3, 437.4, 442.81, 446.5.	In-Hospital M _____ Operative M _____ 7-Day R _____ 30-Day R __T__ PS-LOS _____	In-Hospital M _____ Operative M _____ 7-Day R _____ 30-Day R __T__ PS-LOS _____
Chronic Lung Disease [P] Any of the following codes in any position in PHC4 data: 491.0, 491.1, 491.20, 491.21, 491.22, 492.0, 492.8, 493.20, 493.21, 493.22, 494.0, 494.1, 496, 500, 501, 502, 503, 504, 505, 506.4, 508.1, 518.2, 518.83.	In-Hospital M __T__ Operative M _____ 7-Day R __✓__ 30-Day R __✓__ PS-LOS __✓__	In-Hospital M _____ Operative M _____ 7-Day R __T__ 30-Day R __T__ PS-LOS __✓__
Chronic Pulmonary Hypertension [P] Any of the following codes in any position in PHC4 data: 416.0, 416.1, 416.8, 416.9.	In-Hospital M __T__ Operative M __T__ 7-Day R __T__ 30-Day R __T__ PS-LOS __T__	In-Hospital M __T__ Operative M __T__ 7-Day R _____ 30-Day R __T__ PS-LOS __T__
Coagulopathy [P] Any of the following codes in any position in PHC4 data: 286.0, 286.1, 286.2, 286.3, 286.4, 287.30, 287.31, 287.32, 287.33, 287.39, 289.81.	In-Hospital M _____ Operative M _____ 7-Day R _____ 30-Day R __✓__ PS-LOS __✓__	In-Hospital M _____ Operative M _____ 7-Day R _____ 30-Day R __✓__ PS-LOS _____
Current Med Immunosuppressive [MQ] This dichotomous variable (iv code 892) is based on the presence of the current med immunosuppressive history finding (steroids, chemotherapy drugs).	In-Hospital M __✓__ Operative M __✓__ 7-Day R _____ 30-Day R _____ PS-LOS _____	In-Hospital M __✓__ Operative M __✓__ 7-Day R _____ 30-Day R _____ PS-LOS _____
Current Med Insulin [MQ] This dichotomous variable (iv code 894) is based on the presence of the current med insulin history finding.	In-Hospital M __✓__ Operative M __✓__ 7-Day R _____ 30-Day R _____ PS-LOS _____	In-Hospital M __✓__ Operative M __✓__ 7-Day R _____ 30-Day R _____ PS-LOS _____
Depression [P] Any of the following codes in any position in PHC4 data: 296.20, 296.21, 296.22, 296.23, 296.24, 296.25, 296.26, 296.30, 296.31, 296.32, 296.33, 296.34, 296.35, 296.36, 298.0, 300.4, 309.1, 311.	In-Hospital M _____ Operative M _____ 7-Day R __✓__ 30-Day R __✓__ PS-LOS _____	In-Hospital M _____ Operative M _____ 7-Day R __T__ 30-Day R __✓__ PS-LOS _____
Diabetes (category) [P] *Category 1:* No diabetes *Category 2:* Diabetes without complications, as indicated by code 249.0x[‡‡] or 250.0x in any position in PHC4 data. *Category 3:* Diabetes with complications, as indicated by any code in the range 249.1x – 249.9x[‡‡] or 250.1x – 250.9x in any position in PHC4 data.	In-Hospital M _____ Operative M _____ 7-Day R __✓__ 30-Day R __✓__ PS-LOS _____	In-Hospital M _____ Operative M _____ 7-Day R _____ 30-Day R __T__ PS-LOS _____
Diabetes With Long-Term/Unspecified Complications [P] Diabetes with long-term or unspecified complications, as indicated by any code in the range 249.4x-249.9x[‡‡] or 250.4x-250.9x in any position in PHC4 data.	In-Hospital M _____ Operative M _____ 7-Day R _____ 30-Day R _____ PS-LOS __✓__	In-Hospital M _____ Operative M _____ 7-Day R _____ 30-Day R _____ PS-LOS __✓__

[‡‡] Effective 10/01/08.

[P] This variable was based on PHC4 data.

[MQ] This variable was based on data obtained from MediQual.

[C] This variable was based on both MediQual and PHC4 data.

__✓__ = variable included in final model
__E__ or __T__ = variable was entered/tested in the model and not retained

_____ = variable not entered or tested in the model.

APPENDIX E: DEFINITIONS FOR POTENTIAL CANDIDATE VARIABLES *continued*

Variable Definitions	2007-2008 Models	2008 Models
Ejection Fraction [MQ] *Category 1: EF < 25%* was based on the presence of one of the following: Ejection Fraction <25 % (iv code 25034), which indicates the presence of an ejection fraction less than or equal to 25% as a transfer, pre-admission or admission KCF. Fract Short <25 % (iv code 25035), which indicates the presence of a fractional shortening less than or equal to 25% as a transfer, pre-admission or admission KCF. *Category 2: 25% to 45%* consisted of all cases not included in Categories 1 or 3. *Category 3: EF > 45%* was based on the presence of one of the following: Ejection Fraction >45 (iv code 25040), which indicates the presence of an ejection fraction greater than 50% as a transfer, pre-admission or admission KCF. Fract Short >45 % (iv code 25041), which indicates the presence of a fractional shortening greater than 50% as a transfer, pre-admission or admission KCF.	In-Hospital M ✓ Operative M ✓ 7-Day R 30-Day R PS-LOS	In-Hospital M ✓ Operative M ✓ 7-Day R 30-Day R PS-LOS
Excision or Other Lesion/Heart Tissue/LAA, Open Approach – Same Date as Valve with or without CABG [P] The presence of code 37.33 or 37.36[‡‡] in any position in PHC4 data with a procedure date on the same date as the valve surgery. Note: Px 3733 or 37.36 date should be the same day as the Valve or Valve with CABG procedure date (if multiple valve/CABG surgeries were performed, use the earliest valve/CABG procedure date for analysis).	In-Hospital M T Operative M T 7-Day R T 30-Day R T PS-LOS T	In-Hospital M Operative M 7-Day R T 30-Day R T PS-LOS T
Fibrosis in Mediastinum and Heart [P] Any of the following codes in any position in PHC4 data: 423.1, 429.0, 429.1, 519.3.	In-Hospital M Operative M 7-Day R 30-Day R PS-LOS	In-Hospital M Operative M 7-Day R 30-Day R PS-LOS
Heart Failure [P] Any of the following codes in any position in PHC4 data: 398.91, 428.0, 428.1, 428.20, 428.21, 428.22, 428.23, 428.30, 428.31, 428.32, 428.33, 428.40, 428.41, 428.42, 428.43, 428.9. *For those cases having one of the above heart failure codes and a hypertension with congestive heart failure code (402.x1, 404.x1, or 404.x3), the case was assigned to hypertension with complications.*	In-Hospital M Operative M 7-Day R ✓ 30-Day R ✓ PS-LOS ✓	In-Hospital M Operative M 7-Day R T 30-Day R ✓ PS-LOS ✓
Heart Failure [C] Heart failure as indicated by either of the following: Any of the following codes in any position in PHC4 data: 398.91, 428.0, 428.1, 428.20, 428.21, 428.22, 428.23, 428.30, 428.31, 428.32, 428.33, 428.40, 428.41, 428.42, 428.43, 428.9. For those cases having one of these heart failure codes and a hypertension with congestive heart failure code (402.x1, 404.x1, or 404.x3), the case was assigned to hypertension with complications. The presence of congestive heart failure (CHF) as either a preadmission or admission KCF in MediQual data (iv1500).	In-Hospital M ✓ Operative M ✓ 7-Day R 30-Day R PS-LOS	In-Hospital M ✓ Operative M ✓ 7-Day R 30-Day R PS-LOS
History of CABG or Valve Surgery [P] History of CABG and/or valve surgery, as indicated by either of the following: Any of the following codes in the principal diagnosis position in PHC4 data: 996.02, 996.03, 996.61, 996.71, 996.72; or Any of the following codes in any position in PHC4 data: V42.2, V43.3, V45.81, 414.02 – 414.05.	In-Hospital M Operative M 7-Day R T 30-Day R ✓ PS-LOS ✓	In-Hospital M Operative M 7-Day R 30-Day R T PS-LOS ✓

[‡‡] Effective 10/01/08.

[P] This variable was based on PHC4 data.

[MQ] This variable was based on data obtained from MediQual.

[C] This variable was based on both MediQual and PHC4 data.

✓ = variable included in final model
E or T = variable was entered/tested in the model and not retained

___ = variable not entered or tested in the model.

APPENDIX E: DEFINITIONS FOR POTENTIAL CANDIDATE VARIABLES *continued*

Variable Definitions	2007-2008 Models	2008 Models
History of CABG or Valve Surgery [C] History of CABG and/or valve surgery, as indicated by any of the following: Any of the following codes in the principal diagnosis position in PHC4 data: 996.02, 996.03, 996.61, 996.71, 996.72; or Any of the following codes in any position in PHC4 data: V42.2, V43.3, V45.81, 414.02 – 414.05; or The presence of the Previous CABG History KCF in MediQual data (iv831).	In-Hospital M ✓ Operative M ✓ 7-Day R 30-Day R PS-LOS	In-Hospital M ✓ Operative M ✓ 7-Day R 30-Day R PS-LOS
History of a Cerebral Vascular Accident (CVA) or Stroke [P] Any of the following codes in any position in PHC4 data: 438.0, 438.10, 438.11, 438.12, 438.19, 438.20, 438.21, 438.22, 438.30, 438.31, 438.32, 438.40, 438.41, 438.42, 438.50, 438.51, 438.52, 438.53, 438.6, 438.7, 438.81, 438.82, 438.83, 438.84, 438.85, 438.89, 438.9, V12.54‡	In-Hospital M Operative M 7-Day R 30-Day R PS-LOS	In-Hospital M Operative M 7-Day R 30-Day R PS-LOS T
History of Chronic Steroid Use [P] History of chronic steroid use as indicated by code V58.65 in any position in PHC4 data.	In-Hospital M Operative M 7-Day R 30-Day R ✓ PS-LOS	In-Hospital M Operative M 7-Day R 30-Day R PS-LOS
History of Peripheral Vascular Disease [P] Any of the following codes in any position in PHC4 data: 440.0, 440.1, 440.20, 440.21 440.22, 440.23, 440.24, 440.29, 440.30, 440.31, 440.32, 440.4‡, 440.8, 440.9, 441.2, 441.4, 441.7, 441.9, 442.0, 442.1, 442.2, 442.3, 442.82, 442.83, 442.84, 443.0, 443.1, 443.81, 443.82, 443.89, 443.9, 454.0, 454.1, 454.2, 454.8, 454.9, 459.30, 459.31, 459.32, 459.33, 459.39, 459.81, 557.1, 593.81.	In-Hospital M Operative M 7-Day R T 30-Day R T PS-LOS T	In-Hospital M Operative M 7-Day R 30-Day R PS-LOS T
History of Peripheral Vascular Disease [C] History of peripheral vascular disease, as indicated by any of the following: Any of the following codes in any position in PHC4 data: 440.0, 440.1, 440.20, 440.21 440.22, 440.23, 440.24, 440.29, 440.30, 440.31, 440.32, 440.4‡, 440.8, 440.9, 441.2, 441.4, 441.7, 441.9, 442.0, 442.1, 442.2, 442.3, 442.82, 442.83, 442.84, 443.0, 443.1, 443.81, 443.82, 443.89, 443.9, 454.0, 454.1, 454.2, 454.8, 454.9, 459.30, 459.31, 459.32, 459.33, 459.39, 459.81, 557.1, 593.81; or The presence of the Peripheral Vascular Disease History KCF in MediQual data (iv817).	In-Hospital M ✓ Operative M ✓ 7-Day R 30-Day R PS-LOS	In-Hospital M ✓ Operative M ✓ 7-Day R 30-Day R PS-LOS
History of PTCA/Stent [P] History of a PTCA or stent as indicated by code V45.82 in any position in PHC4 data.	In-Hospital M Operative M 7-Day R 30-Day R PS-LOS	In-Hospital M Operative M 7-Day R 30-Day R PS-LOS
Hypercholesterolemia [P] Any of the following codes in any position in PHC4 data: 272.0, 272.1, 272.2, 272.3, 272.4.	In-Hospital M Operative M 7-Day R 30-Day R PS-LOS	In-Hospital M Operative M 7-Day R 30-Day R PS-LOS
Hypertension [P] Code 401.x in any position in PHC4 data.	In-Hospital M Operative M 7-Day R 30-Day R PS-LOS	In-Hospital M Operative M 7-Day R 30-Day R PS-LOS

‡ Effective 10/1/2007

[P] This variable was based on PHC4 data.

[MQ] This variable was based on data obtained from MediQual.

[C] This variable was based on both MediQual and PHC4 data.

✓ = variable included in final model
E or T = variable was entered/tested in the model and not retained

___ = variable not entered or tested in the model.

APPENDIX E: DEFINITIONS FOR POTENTIAL CANDIDATE VARIABLES *continued*

Variable Definitions	2007-2008 Models	2008 Models
Hypertension with Complications [P] Any of the following codes in any position in PHC4 data: 402.xx, 403.xx, 404.xx, 405.xx.	In-Hospital M __T__ Operative M __T__ 7-Day R __✓__ 30-Day R __✓__ PS-LOS __✓__	In-Hospital M __T__ Operative M __T__ 7-Day R __T__ 30-Day R __✓__ PS-LOS __✓__
Intra-Aortic Balloon Pump (IABP) Prior to Date of CABG/Valve Surgery [P] Code 37.61 in any position in PHC4 data with a procedure date prior to the CABG/valve surgery. Note: Use the earliest IABP date for analysis.	In-Hospital M __✓__ Operative M __T__ 7-Day R ____ 30-Day R ____ PS-LOS __✓__	In-Hospital M __✓__ Operative M __T__ 7-Day R ____ 30-Day R ____ PS-LOS __✓__
Ischemic Heart Disease [P] Code 414.9 in any position in PHC4 data.	In-Hospital M ____ Operative M ____ 7-Day R ____ 30-Day R ____ PS-LOS ____	In-Hospital M ____ Operative M ____ 7-Day R ____ 30-Day R ____ PS-LOS ____
Liver Disease [P] Any of the following codes in any position in PHC4 data: 456.0, 456.20, 456.21, 571.0, 571.1, 571.2, 571.3, 571.40, 571.41, 571.42[‡‡], 571.49, 571.5, 571.6, 571.8, 571.9, 572.3, 573.3	In-Hospital M __✓__ Operative M __✓__ 7-Day R ____ 30-Day R __✓__ PS-LOS __✓__	In-Hospital M __✓__ Operative M __✓__ 7-Day R ____ 30-Day R __✓__ PS-LOS __✓__
Lupus Erythematosus, Systemic [P] Code 710.0 in any position in PHC4 data.	In-Hospital M ____ Operative M ____ 7-Day R ____ 30-Day R __T__ PS-LOS ____	In-Hospital M ____ Operative M ____ 7-Day R ____ 30-Day R ____ PS-LOS ____
MediQual Predicted LOS (continuous) [MQ]	In-Hospital M ____ Operative M ____ 7-Day R __✓__ 30-Day R __✓__ PS-LOS __✓__	In-Hospital M ____ Operative M ____ 7-Day R __✓__ 30-Day R __✓__ PS-LOS __✓__
MI/AMI Other Anterior Wall [C] Myocardial infarction/acute myocardial infarction of other anterior wall, as indicatd by either one of the following: Code 410.11 as a principal diagnosis in PHC4 data, or The presence of myocardial infarction as either a preadmission or admission KCF and the diagnosis code 410.11 in any position in MediQual data (iv code: 6634).	In-Hospital M __✓__ Operative M __✓__ 7-Day R ____ 30-Day R ____ PS-LOS ____	In-Hospital M __✓__ Operative M __✓__ 7-Day R ____ 30-Day R ____ PS-LOS ____
Mild Moderate or Severe Altered Mental Status [MQ] Altered mental status is based on the presence of the following preadmission or admission KCF in MediQual data: Mild AMS (iv code 20017) – Disoriented, lethargy, or Glascow Coma Score from 10-14; or Severe AMS (iv code 20018) – Glascow Coma Score from 5-9; or Moderate AMS (iv code 25046) – Coma/stupor or Glascow Coma Score < 5.	In-Hospital M __✓__ Operative M __✓__ 7-Day R ____ 30-Day R ____ PS-LOS ____	In-Hospital M __✓__ Operative M __✓__ 7-Day R ____ 30-Day R ____ PS-LOS ____
Multiple Valve Procedures [P] Any combination of valve procedures, as indicated by any 2 or more valve procedure codes in any position in PHC4 data: 35.10, 35.11, 35.12, 35.13, 35.14, 35.20, 35.21, 35.22, 35.23, 35.24, 35.25 35.26, 35.27, 35.28, 35.33, 35.99.	In-Hospital M __✓__ Operative M __✓__ 7-Day R __T__ 30-Day R __✓__ PS-LOS __✓__	In-Hospital M __✓__ Operative M __✓__ 7-Day R __T__ 30-Day R __✓__ PS-LOS __✓__

[‡‡] Effective 10/01/08.

[P] This variable was based on PHC4 data.

[MQ] This variable was based on data obtained from MediQual.

[C] This variable was based on both MediQual and PHC4 data.

__✓__ = variable included in final model
__E__ or __T__ = variable was entered/tested in the model and not retained

____ = variable not entered or tested in the model.

APPENDIX E: DEFINITIONS FOR POTENTIAL CANDIDATE VARIABLES *continued*

Variable Definitions	2007-2008 Models	2008 Models
Myocardial Infarction, Old [P] Code 412 in any position in PHC4 data.	In-Hospital M ___ Operative M ___ 7-Day R ___ 30-Day R ___ PS-LOS ___	In-Hospital M ___ Operative M ___ 7-Day R ___ 30-Day R ___ PS-LOS ___
Obesity [P] *Category 1:* No obesity. *Category 2:* Unspecified obesity, as indicated by code 278.00 in any position in PHC4 data. *Category 3:* Morbid obesity, as indicated by code 278.01 in any position in PHC4 data.	In-Hospital M ___ Operative M ___ 7-Day R ___ 30-Day R ___ PS-LOS ___	In-Hospital M ___ Operative M ___ 7-Day R ___ 30-Day R ___ PS-LOS ___
Obesity, Morbid [P] Code 278.01 in any position in PHC4 data.	In-Hospital M ___ Operative M ___ 7-Day R ✓ 30-Day R ✓ PS-LOS ✓	In-Hospital M ___ Operative M ___ 7-Day R ✓ 30-Day R ✓ PS-LOS ✓
Other CV Procedure Group [C] Other cardiovascular procedures, as indicated by any of the following codes in any position: 35.00, 35.01, 35.02, 35.03, 35.04, 35.31, 35.32, 35.34, 35.35, 35.39, 35.50, 35.51, 35.53, 35.54, 35.60, 35.61, 35.62, 35.63, 35.70, 35.71, 35.72, 35.73, 35.81, 35.82, 35.83, 35.84, 35.91, 35.92, 35.93, 35.94, 35.95, 35.98, 36.2, 36.31, 36.32, 36.39, 36.91, 36.99, 37.10, 37.11, 37.12, 37.31, 37.32, 37.33, 37.36‡‡, 37.41, 37.49, 37.51, 37.52, or 37.53 in PHC4 data; *or* 36.31, 36.32, 36.39, 36.91, 36.99, 37.10, 37.11, 37.32, 37.33, 38.44, 38.45, 38.46, 39.51, or 39.52 in MediQual data (iv6627).	In-Hospital M ✓ Operative M ✓ 7-Day R T 30-Day R T PS-LOS ___	In-Hospital M ✓ Operative M ✓ 7-Day R ___ 30-Day R T PS-LOS ___
Other Open Heart Procedure [P] Any of the following codes in any position in PHC4 data: 35.00, 35.01, 35.02, 35.03, 35.04, 35.31, 35.32, 35.34, 35.35, 35.39, 35.50, 35.51, 35.53, 35.54, 35.60, 35.61, 35.62, 35.63, 35.70, 35.71, 35.72, 35.73, 35.81, 35.82, 35.83, 35.84, 35.91, 35.92, 35.93, 35.94, 35.95, 35.98, 36.2, 36.31, 36.32, 36.39, 36.91, 36.99, 37.10, 37.11, 37.12, 37.31, 37.32, 37.33, 37.36‡‡, 37.41, 37.49, 37.51, 37.52, 37.53.	In-Hospital M ___ Operative M ___ 7-Day R ___ 30-Day R ___ PS-LOS ✓	In-Hospital M ___ Operative M ___ 7-Day R T 30-Day R ___ PS-LOS ✓
Percent of Left Main Stenosis [MQ] Percent of occlusion in the left main coronary artery (continuous variable, iv code 6257 in MediQual data). This variable was not considered as a potential candidate variable to be tested in the models because the value was missing for 70 percent of cases.	In-Hospital M ✓ Operative M ✓ 7-Day R ___ 30-Day R ___ PS-LOS ___	In-Hospital M ✓ Operative M ✓ 7-Day R ___ 30-Day R ___ PS-LOS ___
Procedure Group [P] *Category 1:* CABG without valve, as indicated by any of the following codes with *no* valve procedure codes (PHC4 data): 36.10, 36.11, 36.12, 36.13, 36.14, 36.15, 36.16, 36.17, 36.19. *Category 2:* Valve without CABG, as indicated by any of the following codes with *no* CABG codes (PHC4 data): 35.10, 35.11, 35.12, 35.13, 35.14, 35.20, 35.21, 35.22, 35.23, 35.24, 35.25, 35.26, 35.27, 35.28, 35.33, 35.99. *Category 3:* Valve with CABG, as indicated by the presence of at least one CABG code *and* at least one valve code (see above).	In-Hospital M ✓ Operative M ✓ 7-Day R ✓ 30-Day R ✓ PS-LOS ✓	In-Hospital M ✓ Operative M ✓ 7-Day R ✓ 30-Day R ✓ PS-LOS ✓
PTCA/Stent Same Day as CABG/Valve Surgery [P] Any of the following codes in any position in PHC4 data with a procedure data the same day as the CABG/valve surgery: 00.66, 36.06, 36.07, 36.09.	In-Hospital M ___ Operative M ___ 7-Day R ___ 30-Day R ___ PS-LOS ✓	In-Hospital M ___ Operative M ___ 7-Day R ___ 30-Day R ___ PS-LOS ✓

‡‡ Effective 10/01/08.

[P] This variable was based on PHC4 data.

[MQ] This variable was based on data obtained from MediQual.

[C] This variable was based on both MediQual and PHC4 data.

_✓_ = variable included in final model
_E_ or _T_ = variable was entered/tested in the model and not retained

___ = variable not entered or tested in the model.

APPENDIX E: DEFINITIONS FOR POTENTIAL CANDIDATE VARIABLES *continued*

Variable Definitions	2007-2008 Models	2008 Models
PTCA/Stent/Tear Same Day as CABG/Valve Surgery [C] Based on either of the following: Any of the following codes in any position in PHC4 data with a procedure date the same day as the CABG/valve surgery: 00.66, 36.06, 36.07, 36.09, or A CABG procedure or valve procedure performed on the same day as a PTCA with the presence of a "vessel tear" as either a preadmission or admission KCF in MediQual data (iv6644).	In-Hospital M ✓ Operative M ✓ 7-Day R 30-Day R PS-LOS	In-Hospital M ✓ Operative M ✓ 7-Day R 30-Day R PS-LOS
Renal Failure/Dialysis (category) [P] *Category 1:* All cases not assigned to Category 2 and 3. *Category 2:* Chronic kidney disease, as indicated by any of the following codes in PHC4 data: 585.1 – 585.9. Note: for this variable, cases with one of these chronic kidney disease codes and a hypertensive chronic kidney disease (403.xx) or hypertensive heart and chronic kidney disease code (404.xx) will be assigned to Category 1. Additionally, cases with a chronic kidney disease code (585.1 – 585.9) and a hypertensive chronic kidney disease (403.xx) or hypertensive heart and chronic kidney disease code (404.xx) are assigned to the Hypertension with Complication variable. *Category 3:* Pre-operative acute renal failure or dialysis, as indicated by either of the following: Acute renal failure diagnosis code (584.5 – 584.9) along with medical record review confirmation that the acute renal failure occurred prior to the CABG/valve surgery; or Dialysis procedure code (39.95 or 54.98) occurred prior to the date of the CABG/valve surgery. Note: the date of dialysis should be prior to the date of the earliest CABG and/or valve procedure. If multiple dialysis procedures occurred, use the earliest date.	In-Hospital M ✓ Operative M ✓ 7-Day R 30-Day R T PS-LOS	In-Hospital M ✓ Operative M ✓ 7-Day R 30-Day R PS-LOS
Renal Failure/Dialysis (binary) [P] Renal failure (pre-op acute renal failure or chronic kidney disease) or preoperative dialysis: Chronic kidney disease, as indicated by any of the following codes in PHC4 data: 585.1 – 585.9. Note: cases with a chronic kidney disease code (585.1 – 585.9) and a hypertensive chronic kidney disease (403.xx) or hypertensive heart and chronic kidney disease code (404.xx) are assigned to the Hypertension with Complication variable; *or* Acute renal failure diagnosis code (584.5 – 584.9) along with medical record review confirmation that the acute renal failure occurred prior to the CABG/valve surgery; or Dialysis procedure code (39.95 or 54.98) occurred prior to the date of the CABG/valve surgery. Note: the date of dialysis should be prior to the date of the earliest CABG and/or valve procedure. If multiple dialysis procedures occurred, use the earliest date.	In-Hospital M Operative M 7-Day R T 30-Day R PS-LOS ✓	In-Hospital M Operative M 7-Day R 30-Day R T PS-LOS ✓
Pre-op Acute Renal Failure/Dialysis (binary) [P] Pre-operative acute renal failure or dialysis, as indicated by either of the following: A code in the range 584.5 – 584.9 and chart review to determine that the renal failure was present prior to the CABG/valve surgery; or Pre-op dialysis code 39.95 or 54.98 prior to CABG/valve surgery date. Note: dialysis should be prior to the earliest CABG and/or valve procedure. If multiple dialysis procedures occurred, use the earliest date.	In-Hospital M Operative M 7-Day R 30-Day R PS-LOS	In-Hospital M Operative M 7-Day R 30-Day R PS-LOS
Septal Other Anomalous Repair Heart [MQ] Repair of a septal defect in heart, as indicated by any of the following codes in the MediQual data (iv code: 6631): 35.41, 35.42, 35.50, 35.51, 35.52, 35.53, 35.54, 35.55, 35.60, 35.61, 35.62, 35.63, 35.70, 35.71, 35.72, 35.73, 35.81, 35.82, 35.83, 35.84, 35.91, 35.92, 35.93, 35.94, 35.95, 35.98.	In-Hospital M E Operative M E 7-Day R 30-Day R PS-LOS	In-Hospital M E Operative M E 7-Day R 30-Day R PS-LOS

[P] This variable was based on PHC4 data.

[MQ] This variable was based on data obtained from MediQual.

[C] This variable was based on both MediQual and PHC4 data.

✓ = variable included in final model
E or T = variable was entered/tested in the model and not retained

___ = variable not entered or tested in the model.

APPENDIX E: DEFINITIONS FOR POTENTIAL CANDIDATE VARIABLES *continued*

Variable Definitions	2007-2008 Models	2008 Models
SIRS Group [MQ] This variable (iv code 6429 in MediQual data) was based on the presence of any two of four criteria that define SIRS (Systemic Inflammatory Response Syndrome): Temperature > 38°C (> 100.4°F) or < 36°C (< 96.8°F) Heart rate > 89 beats/minute Respiration rate > 19/minute or $PaCO_2$ < 32 mmHg White blood cell count > 12.0 K/µl or < 4.0 K/µl or > 10% bands	In-Hospital M __✓__ Operative M __✓__ 7-Day R ____ 30-Day R ____ PS-LOS ____	In-Hospital M __E__ Operative M __✓__ 7-Day R ____ 30-Day R ____ PS-LOS ____
Valve Replacement [P] Any of the following codes in any position in PHC4 data: 35.20, 35.21, 35.22, 35.23, 35.24, 35.25, 35.26, 35.27, 35.28 Note: This variable was not tested in the models due to its interaction with "multiple valve" and "procedure group" variables.	In-Hospital M ____ Operative M ____ 7-Day R ____ 30-Day R ____ PS-LOS ____	In-Hospital M ____ Operative M ____ 7-Day R ____ 30-Day R ____ PS-LOS ____
Ventricular Assist Device (LVAD and PVAD) Prior to CABG/Valve Surgery Date [P] Code 37.66 or 37.68 in any position in the PHC4 data (prior to the date of CABG/valve surgery). Note: Use the earliest VAD date for analysis.	In-Hospital M ____ Operative M ____ 7-Day R ____ 30-Day R ____ PS-LOS ____	In-Hospital M ____ Operative M ____ 7-Day R ____ 30-Day R ____ PS-LOS ____

[P] This variable was based on PHC4 data.

[MQ] This variable was based on data obtained from MediQual.

[C] This variable was based on both MediQual and PHC4 data.

__✓__ = variable included in final model
__E__ or __I__ = variable was entered/tested in the model and not retained

____ = variable not entered or tested in the model.

APPENDIX F: CANDIDATE VARIABLE DATA

Mortality, 2007-2008

Candidate Variable	In-Hospital				Operative			
	Cases in Analysis		Mortality		Cases in Analysis		Mortality	
	#	%	#	%	#	%	#	%
Year[P]								
2008	15,631	50.0	421	2.7	14,105	50.1	448	3.2
2007	15,655	50.0	393	2.5	14,060	49.9	442	3.1
Total	31,286	100.0	814	2.6	28,165	100.0	890	3.2
Demographic Variables								
Age in Years[P] (tested as a continous variable)								
Age: 30 - 39	339	1.1	1	0.3	298	1.1	1	0.3
Age: 40 - 49	1,874	6.0	21	1.1	1,709	6.1	22	1.3
Age: 50 - 59	5,727	18.3	67	1.2	5,181	18.4	76	1.5
Age: 60 - 69	9,153	29.3	171	1.9	8,250	29.3	190	2.3
Age: 70 - 79	9,871	31.6	316	3.2	8,881	31.5	343	3.9
Age: 80 - 89	4,252	13.6	228	5.4	3,786	13.4	247	6.5
Age: 90 - 99	70	0.2	10	14.3	60	0.2	11	18.3
	Avg. Age = 67.1 (Female 69.5; Male 66.0)							
Age # of Years > 65[P] (tested as a continous variable)								
0	13,405	42.8	186	1.4	12,104	43.0	205	1.7
1	970	3.1	25	2.6	884	3.1	28	3.2
2	933	3.0	17	1.8	834	3.0	20	2.4
3	878	2.8	18	2.1	792	2.8	18	2.3
4	907	2.9	14	1.5	824	2.9	18	2.2
5	944	3.0	22	2.3	844	3.0	23	2.7
6	900	2.9	22	2.4	811	2.9	23	2.8
7	987	3.2	27	2.7	887	3.1	27	3.0
8	964	3.1	24	2.5	869	3.1	26	3.0
9	966	3.1	33	3.4	880	3.1	38	4.3
10	1,023	3.3	32	3.1	931	3.3	36	3.9
11	1,055	3.4	37	3.5	929	3.3	38	4.1
12	1,069	3.4	34	3.2	966	3.4	38	3.9
13	997	3.2	35	3.5	907	3.2	40	4.4
14	966	3.1	50	5.2	857	3.0	54	6.3
15	789	2.5	28	3.5	709	2.5	32	4.5
16	788	2.5	35	4.4	699	2.5	34	4.9
17	697	2.2	44	6.3	621	2.2	48	7.7
18	582	1.9	34	5.8	519	1.8	37	7.1
19	493	1.6	27	5.5	437	1.6	27	6.2
20	321	1.0	27	8.4	288	1.0	32	11.1
21	255	0.8	13	5.1	231	0.8	15	6.5
22	147	0.5	4	2.7	131	0.5	5	3.8
23	101	0.3	9	8.9	86	0.3	11	12.8
24	79	0.3	7	8.9	65	0.2	6	9.2
25	26	0.1	2	7.7	25	0.1	3	12.0
26	22	0.1	5	22.7	16	0.1	4	25.0
27	8	<0.1	1	12.5	6	<0.1	1	16.7
28	9	<0.1	2	22.2	8	<0.1	2	25.0
29	5	<0.1	0	0.0	5	<0.1	1	20.0
Female[P]								
no	20,979	67.1	430	2.0	18,884	67.0	473	2.5
yes	10,307	32.9	384	3.7	9,281	33.0	417	4.5
Race/Ethnicity[P]								
Hispanic	661	2.1	10	1.5	621	2.2	11	1.8
White (non-Hispanic)	27,536	88.0	689	2.5	24,952	88.6	773	3.1
Black (non-Hispanic)	1,354	4.3	44	3.2	1,250	4.4	50	4.0
Other/Unknown	1,735	5.5	71	4.1	1,342	4.8	56	4.2

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Mortality, 2007-2008

Candidate Variable	In-Hospital				Operative			
	Cases in Analysis		Mortality		Cases in Analysis		Mortality	
	#	%	#	%	#	%	#	%
Race (category) [P]								
Black	1,375	4.4	45	3.3	1,267	4.5	50	3.9
Other/Unknown	1,993	6.4	73	3.7	1,591	5.6	59	3.7
White	27,918	89.2	696	2.5	25,307	89.9	781	3.1
Laboratory Variables								
Albumin < 2.5 g/dL [MQ]								
no	31,111	99.4	804	2.6	28,015	99.5	880	3.1
yes	175	0.65	10	5.7	150	0.5	10	6.7
Albumin 2.5 - 3 g/dL [MQ]								
no	30,241	96.7	751	2.5	27,218	96.6	821	3.0
yes	1,045	3.3	63	6.0	947	3.4	69	7.3
BUN > 40 mg/dL [MQ]								
no	30,296	96.8	701	2.3	27,312	97.0	782	2.9
yes	990	3.2	113	11.4	853	3.0	108	12.7
Creatinine > 1.4 mg/dL [MQ]								
no	28,002	89.5	600	2.1	25,250	89.7	666	2.6
yes	3,284	10.5	214	6.5	2,915	10.3	224	7.7
Glucose > 165 mg/dL [MQ]								
no	24,492	78.3	588	2.4	21,988	78.1	646	2.9
yes	6,794	21.7	2265	3.3	6,177	21.9	244	4.0
Clinical Variables Other Than Laboratory Variables								
Acute Myocardial Infarction [P]								
no	25,896	82.8	569	2.2	23,290	82.7	628	2.7
yes	5,390	17.2	245	4.5	4,875	17.3	262	5.4
AMI Except Other Anterior or Other Inferior Wall [P]								
no	26,915	86.0	625	2.3	24,208	86.0	687	2.8
yes	4,371	14.0	189	4.3	3,957	14.0	203	5.1
AMI Other Inferior Wall Initial Episode [C]								
no	30,633	97.9	776	2.5	27,578	97.9	850	3.1
yes	653	2.1	38	5.8	587	2.1	40	6.8
Anemia [P]								
no	23,782	76.0	634	2.7	21,585	76.6	688	3.2
yes	7,504	24.0	180	2.4	6,580	23.4	202	3.1
Angina [P]								
no	23,494	75.1	723	3.1	21,124	75.0	782	3.7
yes	7,792	24.9	91	1.2	7,041	25.0	108	1.5
Angina, Unstable [P]								
no	25,598	81.8	748	2.9	23,036	81.8	812	3.5
yes	5,688	18.2	66	1.2	5,129	18.2	78	1.5
ASA Class 5 [MQ]								
no	31,123	99.5	780	2.5	28,017	99.5	852	3.0
yes	163	0.5	34	20.9	148	0.5	38	25.7
ASA Emergency [MQ]								
no	29,306	93.7	700	2.4	26,364	93.6	758	2.9
yes	1,980	6.3	114	5.8	1,801	6.4	132	7.3

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Mortality, 2007-2008

Candidate Variable	In-Hospital				Operative			
	Cases in Analysis		Mortality		Cases in Analysis		Mortality	
	#	%	#	%	#	%	#	%
Cachexia [P]								
no	30,365	97.1	720	2.4	27,397	97.3	793	2.9
yes	921	2.9	94	10.2	768	2.7	97	12.6
CAD >70, 5-7 Vessels Group [MQ]								
no	30,218	96.6	785	2.6	27,191	96.5	855	3.1
yes	1,068	3.4	29	2.7	974	3.5	35	3.6
Cancer [P]								
no	30,441	97.3	793	2.6	27,414	97.3	863	3.1
yes	845	2.7	21	2.5	751	2.7	27	3.6
Cardiac Adhesions [P]								
no	30,987	99.0	796	2.6	27,884	99.0	871	3.1
yes	299	1.0	18	6.0	281	1.0	19	6.8
Cardiogenic Shock, Pre-Operative [P]								
no	31,105	99.4	769	2.5	28,002	99.4	845	3.0
yes	181	0.6	45	24.9	163	0.6	45	27.6
Cardiomyopathy[P]								
no	26,668	85.2	636	2.4	24,099	85.6	707	2.9
yes	4,618	14.8	178	3.9	4,066	14.4	183	4.5
Cardiopulmonary Resuscitation (CPR) Prior to CABG/Valve Surgery Date [P]								
no	31,242	99.9	812	2.6	28,122	99.8	887	3.2
yes	44	0.1	2	4.5	43	0.2	3	7.0
Cerebrovascular Disease [P]								
no	29,422	94.0	767	2.6	26,477	94.0	846	3.2
yes	1,864	6.0	47	2.5	1,688	6.0	44	2.6
Chronic Lung Disease [P]								
no	24,930	79.7	613	2.5	22,375	79.4	678	3.0
yes	6,356	20.3	201	3.2	5,790	20.6	212	3.7
Chronic Pulmonary Hypertension [P]								
no	28,193	90.1	682	2.4	25,446	90.3	744	2.9
yes	3,093	9.9	132	4.3	2,719	9.7	146	5.4
Coagulopathy[P]								
no	31,104	99.4	809	2.6	28,002	99.4	881	3.1
yes	182	0.6	5	2.7	163	0.6	9	5.5
Current Med Immunosuppressive [MQ]								
no	30,354	97.0	776	2.6	27,330	97.0	845	3.1
yes	932	3.0	38	4.1	835	3.0	45	5.4
Current Med Insulin [MQ]								
no	28,239	90.3	695	2.5	25,398	90.2	761	3.0
yes	3,047	9.7	119	3.9	2,767	9.8	129	4.7
Depression [P]								
no	29,268	93.5	789	2.7	26,325	93.5	858	3.3
yes	2,018	6.5	25	1.2	1,840	6.5	32	1.7
Diabetes (category)[P]								
No diabetes	19,657	62.8	531	2.7	17,611	62.5	566	3.2
Diabetes without complication	9,403	30.1	226	2.4	8,527	30.3	255	3.0
Diabetes with complications	2,226	7.1	57	2.6	2,027	7.2	69	3.4

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Mortality, 2007-2008

Candidate Variable	In-Hospital				Operative			
	Cases in Analysis		Mortality		Cases in Analysis		Mortality	
	#	%	#	%	#	%	#	%
Diabetes With Long-Term/Unspecified Complications [P]								
no	29,080	92.9	758	2.6	26,157	92.9	822	3.1
yes	2,206	7.1	56	2.5	2,008	7.1	68	3.4
Ejection Fraction [MQ]								
EF ≤25%	1,109	3.5	65	5.9	958	3.4	70	7.3
EF >25% and ≤45% or missing	13,784	44.1	444	3.2	12,444	44.2	486	3.9
EF >45%	16,393	52.4	305	1.9	14,763	52.4	334	2.3
Excision of Other Lesion/Heart Tissue/LAA, Open Approach – Same Date as Valve with or without CABG [P]								
no	30,014	95.9	767	2.6	27,029	96.0	841	3.1
yes	1,272	4.1	47	3.7	1,136	4.0	49	4.3
Fibrosis in Mediastinum and Heart [P]								
no	31,238	99.8	814	2.6	28,121	99.8	890	3.2
yes	48	0.2	0	0.0	44	0.2	0	0.0
Heart Failure [P]								
no	22,901	73.2	362	1.6	20,891	74.2	415	2.0
yes	8,385	26.8	452	5.4	7,274	25.8	475	6.5
Heart Failure [C]								
no	21,211	67.8	298	1.4	19,356	68.7	344	1.8
yes	10,075	32.2	516	5.1	8,809	31.3	546	6.2
History of CABG or Valve Surgery [P]								
no	29,444	94.1	706	2.4	26,529	94.2	781	2.9
yes	1,842	5.9	108	5.9	1,636	5.8	109	6.7
History of CABG or Valve Surgery [C]								
no	28,945	92.5	677	2.3	26,092	92.6	754	2.9
yes	2,341	7.5	137	5.9	2,073	7.4	136	6.6
History of Chronic Steroid Use [P]								
no	31,131	99.5	812	2.6	28,023	99.5	885	3.2
yes	155	0.5	2	1.3	142	0.5	5	3.5
History of Peripheral Vascular Disease[P]								
no	26,500	84.7	656	2.5	23,825	84.6	712	3.0
yes	4,786	15.3	158	3.3	4,340	15.4	178	4.1
History of Peripheral Vascular Disease [C]								
no	25,448	81.3	587	2.3	22,877	81.2	634	2.8
yes	5,838	18.7	227	3.9	5,288	18.8	256	4.8
History of PTCA/Stent [P]								
no	27,376	87.5	735	2.7	24,611	87.4	796	3.2
yes	3,910	12.5	79	2.0	3,554	12.6	94	2.6
Hypercholesterolemia [P]								
no	10,954	35.0	510	4.7	9,788	34.8	543	5.5
yes	20,332	65.0	304	1.5	18,377	65.2	347	1.9
Hypertension [P]								
no	12,003	38.4	507	4.2	10,694	38.0	531	5.0
yes	19,283	61.6	307	1.6	17,471	62.0	359	2.1

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Mortality, 2007-2008

Candidate Variable	In-Hospital				Operative			
	Cases in Analysis		Mortality		Cases in Analysis		Mortality	
	#	%	#	%	#	%	#	%
Hypertension with Complications [P]								
no	27,339	87.4	629	2.3	24,626	87.4	694	2.8
yes	3,947	12.6	185	4.7	3,539	12.6	196	5.5
Intra-Aortic Balloon Pump (IABP) Prior to Date of CABG/Valve Surgery [P]								
no	29,867	95.5	730	2.4	26,859	95.4	807	3.0
yes	1,419	4.5	84	5.9	1,306	4.6	83	6.4
Ischemic Heart Disease [P]								
no	31,258	99.9	813	2.6	28,141	99.9	889	3.2
yes	28	0.1	1	3.6	24	0.1	1	4.2
Liver Disease [P]								
no	30,995	99.1	792	2.6	27,915	99.1	866	3.1
yes	291	0.9	22	7.6	250	0.9	24	9.6
Lupus Erythematosus, Systemic [P]								
no	31,201	99.7	809	2.6	28,092	99.7	884	3.1
yes	85	0.3	5	5.9	73	0.3	6	8.2
MI/AMI Other Anterior Wall[C]								
no	30,803	98.5	789	2.6	27,727	98.4	864	3.1
yes	483	1.5	25	5.2	438	1.6	26	5.9
Mild, Moderate or Severe Altered Mental Status [MQ]								
no	30,191	96.5	752	2.5	27,155	96.4	827	3.0
yes	1,095	3.5	62	5.7	1,010	3.6	63	6.2
Multiple Valve Procedures [P]								
no	29,739	95.1	694	2.3	26,803	95.2	770	2.9
yes	1,547	4.9	120	7.8	1,362	4.8	120	8.8
Myocardial Infarction, Old [P]								
no	26,920	86.0	722	2.7	24,188	85.9	788	3.3
yes	4,366	14.0	92	2.1	3,977	14.1	102	2.6
Obesity [P]								
no obesity	26,131	83.5	721	2.8	23,439	83.2	784	3.3
unspecified obesity	3,538	11.3	55	1.6	3,231	11.5	65	2.0
Morbid obesity	1,617	5.2	38	2.4	1,495	5.3	41	2.7
Obesity, Morbid [P]								
no	29,669	94.8	776	2.6	26,670	94.7	849	3.2
yes	1,617	5.2	38	2.4	1,495	5.3	41	2.7
Other Open Heart Procedure [P]								
no	28,850	92.2	686	2.4	25,976	92.2	759	2.9
yes	2,436	7.8	128	5.3	2,189	7.8	131	6.0
Other CV Procedure Group[C]								
no	28,804	92.1	680	2.4	25,934	92.1	755	2.9
yes	2,482	7.9	134	5.4	2,231	7.9	135	6.1
Percent of Left Main Stenosis [MQ] (tested as a continous variable)								
0 or missing	22,452	71.8	580	2.6	20,189	71.7	641	3.2
1-10	172	0.5	4	2.3	152	0.5	4	2.6
11-20	763	2.4	13	1.7	711	2.5	14	2.0
21-30	1,015	3.2	22	2.2	901	3.2	22	2.4
31-40	733	2.3	17	2.3	677	2.4	19	2.8

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Mortality, 2007-2008

Candidate Variable	In-Hospital				Operative			
	Cases in Analysis		Mortality		Cases in Analysis		Mortality	
	#	%	#	%	#	%	#	%
Percent of Left Main Stenosis [MQ] *continued*								
41-50	1,385	4.4	34	2.5	1,231	4.4	38	3.1
51-60	1,031	3.3	20	1.9	919	3.3	22	2.4
61-70	1,257	4.0	31	2.5	1,137	4.0	35	3.1
71-80	1,116	3.6	27	2.4	995	3.5	27	2.7
81-90	757	2.4	31	4.1	692	2.5	32	4.6
> 90	605	1.9	35	5.8	561	2.0	36	6.4
Procedure Group [P]								
CABG without Valve	20,265	64.8	370	1.8	18,555	65.9	433	2.3
Valve without CABG	6,137	19.6	191	3.1	5,281	18.8	185	3.5
Valve with CABG	4,884	15.6	253	5.2	4,329	15.4	272	6.3
PTCA/Stent Same Day as CABG/Valve Surgery [P]								
no	31,018	99.1	792	2.6	27,924	99.1	866	3.1
yes	268	0.9	22	8.2	241	0.9	24	10.0
PTCA/Stent/Tear Same Day as CABG/Valve Surgery [C]								
no	30,929	98.9	786	2.5	27,840	98.8	859	3.1
yes	357	1.1	28	7.8	325	1.2	31	9.5
Renal Failure/Dialysis (category) [P]								
All cases not assigned to chronic and acute/dialysis categories	30,307	96.9	721	2.4	27,301	96.9	796	2.9
Chronic	627	2.0	47	7.5	549	1.9	48	8.7
Acute/dialysis	352	1.1	46	13.1	315	1.1	46	14.6
Renal Failure/Dialysis (binary) [P]								
no	30,307	96.9	721	2.4	27,301	96.9	796	2.9
yes	979	3.1	93	9.5	864	3.1	94	10.9
Pre-op Acute Renal Failure/Dialysis (binary) [P]								
no	30,934	98.9	768	2.5	27,850	98.9	844	3.0
yes	352	1.1	46	13.1	315	1.1	46	14.6
Septal Other Anomalous Repair Heart [MQ]								
no	30,888	98.7	800	2.6	27,826	98.8	877	3.2
yes	398	1.3	14	3.5	339	1.2	13	3.8
SIRS Group [MQ]								
no	21,450	68.6	465	2.2	19,186	68.1	504	2.6
yes	9,836	31.4	349	3.5	8,979	31.9	386	4.3
Ventricular Assist Device (LVAD and PVAD) Prior to CABG/Valve Surgery Date [P]								
no	31,283	100.0	813	2.6	28,162	100.0	889	3.2
yes	3	< 0.1	1	33.3	3	< 0.1	1	33.3

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Mortality, 2008

Candidate Variable	In-Hospital				Operative			
	Cases in Analysis		Mortality		Cases in Analysis		Mortality	
	#	%	#	%	#	%	#	%
Demographic Variables								
Age in Years [P] (tested as a continous variable)								
Age: 30 – 39	161	1.0	1	0.6	140	1.0	1	0.7
Age: 40 – 49	908	5.8	11	1.2	836	5.9	9	1.1
Age: 50 – 59	2,852	18.2	38	1.3	2,593	18.4	43	1.7
Age: 60 – 69	4,604	29.5	92	2.0	4,145	29.5	100	2.4
Age: 70 – 79	4,949	31.7	156	3.2	4,445	31.6	164	3.7
Age: 80 – 89	2,116	13.5	120	5.7	1,868	13.3	122	6.5
Age: 90 – 99	41	0.3	3	7.3	33	0.2	3	9.1
	Avg. Age = 67.2 (Female 69.4; Male 66.1)							
Age # of Years > 65[P] (tested as a continous variable)								
0	6,663	42.6	106	1.6	6,031	42.9	115	1.9
1	480	3.1	14	2.9	438	3.1	14	3.2
2	474	3.0	8	1.7	425	3.0	9	2.1
3	441	2.8	6	1.4	397	2.8	6	1.5
4	467	3.0	8	1.7	423	3.0	9	2.1
5	518	3.3	14	2.7	461	3.3	14	3.0
6	464	3.0	12	2.6	415	3.0	13	3.1
7	506	3.2	11	2.2	452	3.2	9	2.0
8	501	3.2	15	3.0	452	3.2	17	3.8
9	448	2.9	16	3.6	415	3.0	18	4.3
10	487	3.1	12	2.5	442	3.1	13	2.9
11	508	3.2	17	3.3	450	3.2	17	3.8
12	553	3.5	14	2.5	498	3.5	16	3.2
13	519	3.3	20	3.9	469	3.3	22	4.7
14	445	2.8	25	5.6	391	2.8	25	6.4
15	383	2.5	16	4.2	341	2.4	15	4.4
16	381	2.4	19	5.0	342	2.4	19	5.6
17	333	2.1	20	6.0	294	2.1	23	7.8
18	295	1.9	16	5.4	260	1.8	15	5.8
19	251	1.6	14	5.6	222	1.6	14	6.3
20	168	1.1	14	8.3	149	1.1	13	8.7
21	134	0.9	6	4.5	119	0.8	7	5.9
22	69	0.4	2	2.9	58	0.4	3	5.2
23	62	0.4	8	12.9	52	0.4	9	17.3
24	40	0.3	5	12.5	31	0.2	4	12.9
25	15	0.1	1	6.7	14	0.1	1	7.1
26	12	0.1	2	16.7	8	0.1	1	12.5
27	5	< 0.1	0	0.0	3	< 0.1	0	0.0
28	6	< 0.1	0	0.0	5	< 0.1	0	0.0
29	3	< 0.1	0	0.0	3	< 0.1	1	33.3
Female [P]								
no	10,463	66.9	225	2.2	9,397	66.8	242	2.6
yes	5,168	33.1	196	3.8	4,663	33.2	200	4.3
Race/Ethnicity [P]								
Hispanic	403	2.6	6	1.5	382	2.7	6	1.6
White (non-Hispanic)	13,684	87.5	354	2.6	12,365	87.9	380	3.1
Black (non-Hispanic)	688	4.4	25	3.6	631	4.5	27	4.3
Other/Unknown	856	5.5	36	4.2	682	4.9	29	4.3

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Mortality, 2008

Candidate Variable	In-Hospital				Operative			
	Cases in Analysis		Mortality		Cases in Analysis		Mortality	
	#	%	#	%	#	%	#	%
Race (category) [P]								
Black	696	4.5	26	3.7	637	4.5	27	4.2
Other/Unknown	1,020	6.5	37	3.6	840	6.0	31	3.7
White	13,915	89.0	358	2.6	12,583	89.5	384	3.1
Laboratory Variables								
Albumin < 2.5 g/dL [MQ]								
no	15,541	99.4	419	2.7	13,988	99.5	441	3.2
yes	90	0.6	2	2.2	72	0.5	1	1.4
Albumin 2.5 – 3 g/dL [MQ]								
no	15,112	96.7	390	2.6	13,589	96.7	408	3.0
yes	519	3.3	31	6.0	471	3.3	34	7.2
BUN > 40 mg/dL [MQ]								
no	15,102	96.6	347	2.3	13,601	96.7	372	2.7
yes	529	3.4	74	14.0	459	3.3	70	15.3
Creatinine > 1.4 mg/dL [MQ]								
no	14,034	89.8	305	2.2	12,646	89.9	323	2.6
yes	1,597	10.2	116	7.3	1,414	10.1	119	8.4
Glucose > 165 mg/dL [MQ]								
no	12,318	78.8	302	2.5	11,049	78.6	322	2.9
yes	3,313	21.2	119	3.6	3,011	21.4	120	4.0
Clinical Variables Other Than Laboratory Variables								
Acute Myocardial Infarction [P]								
no	12,966	83.0	291	2.2	11,658	82.9	312	2.7
yes	2,665	17.0	130	4.9	2,402	17.1	130	5.4
AMI Except Other Anterior or Other Inferior Wall [P]								
no	13,430	85.9	320	2.4	12,076	85.9	345	2.9
yes	2,201	14.1	101	4.6	1,984	14.1	97	4.9
AMI Other Inferior Wall Initial Episode [C]								
no	15,322	98.0	404	2.6	13,784	98.0	421	3.1
yes	309	2.0	17	5.5	276	2.0	21	7.6
Anemia [P]								
no	11,805	75.5	321	2.7	10,728	76.3	334	3.1
yes	3,826	24.5	100	2.6	3,332	23.7	108	3.2
Angina [P]								
no	11,960	76.5	377	3.2	10,759	76.5	390	3.6
yes	3,671	23.5	44	1.2	3,301	23.5	52	1.6
Angina, Unstable [P]								
no	12,948	82.8	388	3.0	11,657	82.9	402	3.4
yes	2,683	17.2	33	1.2	2,403	17.1	40	1.7
ASA Class 5 [MQ]								
no	15,546	99.5	399	2.6	13,980	99.4	421	3.0
yes	85	0.5	22	25.9	80	0.6	21	26.3
ASA Emergency [MQ]								
no	14,683	93.9	356	2.4	13,191	93.8	373	2.8
yes	948	6.1	65	6.9	869	6.2	69	7.9

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Mortality, 2008

Candidate Variable	In-Hospital				Operative			
	Cases in Analysis		Mortality		Cases in Analysis		Mortality	
	#	%	#	%	#	%	#	%
Cachexia [P]								
no	15,140	96.9	363	2.4	13,648	97.1	389	2.9
yes	491	3.1	58	11.8	412	2.9	53	12.9
CAD >70, 5-7 Vessels Group [MQ]								
no	15,144	96.9	406	2.7	13,608	96.8	425	3.1
yes	487	3.1	15	3.1	452	3.2	17	3.8
Cancer [P]								
no	15,202	97.3	413	2.7	13,671	97.2	429	3.1
yes	429	2.7	8	1.9	389	2.8	13	3.3
Cardiac Adhesions [P]								
no	15,497	99.1	413	2.7	13,932	99.1	432	3.1
yes	134	0.9	8	6.0	128	0.9	10	7.8
Cardiogenic Shock, Pre-Operative [P]								
no	15,550	99.5	399	2.6	13,987	99.5	423	3.0
yes	81	0.5	22	27.2	73	0.5	19	26.0
Cardiomyopathy[P]								
no	13,236	84.7	314	2.4	11,964	85.1	345	2.9
yes	2,395	15.3	107	4.5	2,096	14.9	97	4.6
Cardiopulmonary Resuscitation (CPR) Prior to CABG/Valve Surgery Date [P]								
no	15,606	99.8	420	2.7	14,035	99.8	441	3.1
yes	25	0.2	1	4.0	25	0.2	1	4.0
Cerebrovascular Disease [P]								
no	14,658	93.8	397	2.7	13,184	93.8	422	3.2
yes	973	6.2	24	2.5	876	6.2	20	2.3
Chronic Lung Disease [P]								
no	12,569	80.4	328	2.6	11,280	80.2	352	3.1
yes	3,062	19.6	93	3.0	2,780	19.8	90	3.2
Chronic Pulmonary Hypertension [P]								
no	14,009	89.6	347	2.5	12,648	90.0	368	2.9
yes	1,622	10.4	74	4.6	1,412	10.0	74	5.2
Coagulopathy[P]								
no	15,539	99.4	417	2.7	13,977	99.4	436	3.1
yes	92	0.6	4	4.3	83	0.6	6	7.2
Current Med Immunosuppressive [MQ]								
no	15,225	97.4	401	2.6	13,695	97.4	419	3.1
yes	406	2.6	20	4.9	365	2.6	23	6.3
Current Med Insulin [MQ]								
no	14,136	90.4	354	2.5	12,702	90.3	374	2.9
yes	1,495	9.6	67	4.5	1,358	9.7	68	5.0
Depression [P]								
no	14,597	93.4	411	2.8	13,118	93.3	428	3.3
yes	1,034	6.6	10	1.0	942	6.7	14	1.5

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Mortality, 2008

Candidate Variable	In-Hospital				Operative			
	Cases in Analysis		Mortality		Cases in Analysis		Mortality	
	#	%	#	%	#	%	#	%
Diabetes [P]								
No diabetes	9,755	62.4	260	2.7	8,747	62.2	271	3.1
Diabetes without complication	4,723	30.2	125	2.6	4,262	30.3	132	3.1
Diabetes with complications	1,153	7.4	36	3.1	1,051	7.5	39	3.7
Diabetes With Long-Term/Unspecified Complications [P]								
no	14,486	92.7	385	2.7	13,016	92.6	403	3.1
yes	1,145	7.3	36	3.1	1,044	7.4	39	3.7
Ejection Fraction [MQ]								
EF ≤25%	524	3.4	35	6.7	445	3.2	34	7.6
EF >25% and ≤45% or missing	6,876	44.0	234	3.4	6,216	44.2	245	3.9
EF >45%	8,231	52.7	152	1.8	7,399	52.6	163	2.2
Excision of Other Lesion/Heart Tissue/ LAA, Open Approach – Same Date as Valve with or without CABG [P]								
no	14,979	95.8	395	2.6	13,486	95.9	418	3.1
yes	652	4.2	26	4.0	574	4.1	24	4.2
Fibrosis in Mediastinum and Heart [P]								
no	15,599	99.8	421	2.7	14,030	99.8	442	3.2
yes	32	0.2	0	0.0	30	0.2	0	0.0
Heart Failure [P]								
no	11,525	73.7	196	1.7	10,522	74.8	218	2.1
yes	4,106	26.3	225	5.5	3,538	25.2	224	6.3
Heart Failure [C]								
no	10,735	68.7	163	1.5	9,805	69.7	185	1.9
yes	4,896	31.3	258	5.3	4,255	30.3	257	6.0
History of CABG or Valve Surgery [P]								
no	14,687	94.0	371	2.5	13,225	94.1	391	3.0
yes	944	6.0	50	5.3	835	5.9	51	6.1
History of CABG or Valve Surgery [C]								
no	14,509	92.8	357	2.5	13,072	93.0	380	2.9
yes	1,122	7.2	64	5.7	988	7.0	62	6.3
History of Cerebral Vascular Accident (CVA) or Stroke [P]								
no	14,646	93.7	408	2.8	13,171	93.7	422	3.2
yes	985	6.3	13	1.3	889	6.3	20	2.2
History of Chronic Steroid Use [P]								
no	15,557	99.5	421	2.7	13,992	99.5	441	3.2
yes	74	0.5	0	0.0	68	0.5	1	1.5
History of Peripheral Vascular Disease [P]								
no	13,191	84.4	340	2.6	11,859	84.3	358	3.0
yes	2,440	15.6	81	3.3	2,201	15.7	84	3.8
History of Peripheral Vascular Disease [C]								
no	12,720	81.4	307	2.4	11,431	81.3	319	2.8
yes	2,911	18.6	114	3.9	2,629	18.7	123	4.7

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Mortality, 2008

Candidate Variable	In-Hospital				Operative			
	Cases in Analysis		Mortality		Cases in Analysis		Mortality	
	#	%	#	%	#	%	#	%
History of PTCA/Stent [P]								
no	13,575	86.8	385	2.8	12,201	86.8	395	3.2
yes	2,056	13.2	36	1.8	1,859	13.2	47	2.5
Hypercholesterolemia [P]								
no	5,202	33.3	264	5.1	4,655	33.1	270	5.8
yes	10,429	66.7	157	1.5	9,405	66.9	172	1.8
Hypertension [P]								
no	5,941	38.0	263	4.4	5,321	37.8	269	5.1
yes	9,690	62.0	158	1.6	8,739	62.2	173	2.0
Hypertension with Complications [P]								
no	13,558	86.7	318	2.3	12,204	86.8	336	2.8
yes	2,073	13.3	103	5.0	1,856	13.2	106	5.7
Intra-Aortic Balloon Pump (IABP) Prior to Date of CABG/Valve Surgery[P]								
no	14,928	95.5	377	2.5	13,407	95.4	399	3.0
yes	703	4.5	44	6.3	653	4.6	43	6.6
Ischemic Heart Disease [P]								
no	15,614	99.9	421	2.7	14,046	99.9	442	3.1
yes	17	0.1	0	0.0	14	0.1	0	0.0
Liver Disease [P]								
no	15,477	99.0	410	2.6	13,926	99.0	431	3.1
yes	154	1.0	11	7.1	134	1.0	11	8.2
Lupus Erythematosus, Systemic [P]								
no	15,591	99.7	420	2.7	14,028	99.8	441	3.1
yes	40	0.3	1	2.5	32	0.2	1	3.1
MI/AMI Other Anterior Wall [C]								
no	15,430	98.7	407	2.6	13,876	98.7	428	3.1
yes	201	1.3	14	7.0	184	1.3	14	7.6
Mild, Moderate or Severe, Altered Mental Status [MQ]								
no	15,109	96.7	391	2.6	13,577	96.6	412	3.0
yes	522	3.3	30	5.7	483	3.4	30	6.2
Multiple Valve Procedures [P]								
no	14,886	95.2	367	2.5	13,410	95.4	388	2.9
yes	745	4.8	54	7.2	650	4.6	54	8.3
Myocardial Infarction, Old [P]								
no	13,425	85.9	379	2.8	12,071	85.9	392	3.2
yes	2,206	14.1	42	1.9	1,989	14.1	50	2.5
Obesity [P]								
no obesity	12,962	82.9	374	2.9	11,628	82.7	389	3.3
unspecified obesity	1,847	11.8	27	1.5	1,673	11.9	31	1.9
Morbid obesity	822	5.3	20	2.4	759	5.4	22	2.9
Obesity, Morbid [P]								
no	14,809	94.7	401	2.7	13,301	94.6	420	3.2
yes	822	5.3	20	2.4	759	5.4	22	2.9
Other Open Heart Procedure [P]								
no	14,417	92.2	358	2.5	12,981	92.3	383	3.0
yes	1,214	7.8	63	5.2	1,079	7.7	59	5.5

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Mortality, 2008

Candidate Variable	In-Hospital				Operative			
	Cases in Analysis		Mortality		Cases in Analysis		Mortality	
	#	%	#	%	#	%	#	%
Other CV Procedure Group[C]								
no	14,399	92.1	355	2.5	12,964	92.2	381	2.9
yes	1,232	7.9	66	5.4	1,096	7.8	61	5.6
Percent of Left Main Stenosis [MQ] (tested as a continous variable)								
0 or missing	11,241	71.9	292	2.6	10,109	71.9	307	3.0
1-10	91	0.6	3	3.3	80	0.6	3	3.8
11-20	399	2.6	9	2.3	363	2.6	8	2.2
21-30	503	3.2	13	2.6	439	3.1	13	3.0
31-40	350	2.2	9	2.6	324	2.3	10	3.1
41-50	667	4.3	18	2.7	601	4.3	23	3.8
51-60	511	3.3	12	2.3	456	3.2	14	3.1
61-70	629	4.0	13	2.1	563	4.0	17	3.0
71-80	569	3.6	16	2.8	503	3.6	14	2.8
81-90	354	2.3	16	4.5	329	2.3	13	4.0
> 90	317	2.0	20	6.3	293	2.1	20	6.8
Procedure Group [P]								
CABG without Valve	10,099	64.6	192	1.9	9,244	65.7	213	2.3
Valve without CABG	3,162	20.2	96	3.0	2,707	19.3	88	3.3
Valve with CABG	2,370	15.2	133	5.6	2,109	15.0	141	6.7
PTCA/Stent Same Day as CABG/Valve Surgery [P]								
no	15,491	99.1	409	2.6	13,933	99.1	429	3.1
yes	140	0.9	12	8.6	127	0.9	13	10.2
PTCA/Stent/Tear Same Day as CABG/Valve Surgery [C]								
no	15,453	98.9	407	2.6	13,895	98.8	427	3.1
yes	178	1.1	14	7.9	165	1.2	15	9.1
Renal Failure/Dialysis [P]								
All cases not assigned to chronic and acute/dialysis categories	15,190	97.2	363	2.4	13,661	97.2	388	2.8
Chronic	251	1.6	25	10.0	227	1.6	23	10.1
Acute/dialysis	190	1.2	33	17.4	172	1.2	31	18.0
Renal Failure/Dialysis (binary) [P]								
no	15,190	97.2	363	2.4	13,661	97.2	388	2.8
yes	441	2.8	58	13.2	399	2.8	54	13.5
Pre-op Acute Renal Failure/Dialysis (binary) [P]								
no	15,441	98.8	388	2.5	13,888	98.8	411	3.0
yes	190	1.2	33	17.4	172	1.2	31	18.0
Septal Other Anomalous Repair Heart[MQ]								
no	15,434	98.7	413	2.7	13,896	98.8	435	3.1
yes	197	1.3	8	4.1	164	1.2	7	4.3
SIRS Group [MQ]								
no	10,893	69.7	248	2.3	9,738	69.3	257	2.6
yes	4,738	30.3	173	3.7	4,322	30.7	185	4.3
Ventricular Assist Device (LVAD and PVAD) Prior to CABG/Valve Surgery Date[P]								
no	15,629	100.0	420	2.7	14,058	100.0	441	3.1
yes	2	< 0.1	1	50.0	2	< 0.1	1	50.0

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Readmissions, 2007-2008

Candidate Variable	Cases in Analysis		7-Day Readmissions		30-Day Readmissions	
	#	%	#	%	#	%
Year						
2007	13,753	50.1	914	6.6	2,212	16.1
2008	13,698	49.9	931	6.8	2,208	16.1
Total	27,451	100.0	1,845	6.7	4,420	16.1
Demographic Variables						
Age in Years [P] (tested as a continous variable)						
Age: 30 – 39	297	1.1	15	5.1	48	16.2
Age: 40 – 49	1,690	6.2	84	5.0	233	13.8
Age: 50 – 59	5,120	18.7	253	4.9	654	12.8
Age: 60 – 69	8,099	29.5	488	6.0	1,157	14.3
Age: 70 – 79	8,604	31.3	656	7.6	1,552	18.0
Age: 80 – 89	3,590	13.1	343	9.6	761	21.2
Age: 90 – 99	51	0.2	6	11.8	15	29.4
Age # of Years > 65[P] (tested as a continous variable)						
0	11,941	43.5	638	5.3	1,619	13.6
1	860	3.1	56	6.5	121	14.1
2	818	3.0	46	5.6	112	13.7
3	776	2.8	43	5.5	116	14.9
4	811	3.0	57	7.0	124	15.3
5	825	3.0	62	7.5	137	16.6
6	794	2.9	59	7.4	138	17.4
7	863	3.1	56	6.5	142	16.5
8	849	3.1	59	6.9	136	16.0
9	849	3.1	65	7.7	150	17.7
10	902	3.3	64	7.1	162	18.0
11	898	3.3	64	7.1	161	17.9
12	935	3.4	72	7.7	189	20.2
13	875	3.2	83	9.5	174	19.9
14	814	3.0	72	8.8	163	20.0
15	684	2.5	60	8.8	140	20.5
16	673	2.5	70	10.4	129	19.2
17	583	2.1	57	9.8	118	20.2
18	490	1.8	53	10.8	111	22.7
19	412	1.5	35	8.5	86	20.9
20	267	1.0	25	9.4	65	24.3
21	218	0.8	25	11.5	55	25.2
22	127	0.5	10	7.9	26	20.5
23	77	0.3	6	7.8	21	27.3
24	59	0.2	2	3.4	10	16.9
25	23	0.1	4	17.4	6	26.1
26	12	<0.1	0	0.0	5	41.7
27	5	<0.1	0	0.0	0	0.0
28	6	<0.1	2	33.3	4	66.7
29	5	<0.1	0	0.0	0	0.0
Female [P]						
no	18,511	67.4	1,113	6.0	2,634	14.2
yes	8,940	32.6	732	8.2	1,786	20.0
Race/Ethnicity [P]						
Hispanic	613	2.2	42	6.9	89	14.5
White (non-Hispanic)	24,340	88.7	1,612	6.6	3,844	15.8
Black (non-Hispanic)	1,208	4.4	121	10.0	279	23.1
Other/Unknown	1,290	4.7	70	5.4	208	16.1

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Readmissions, 2007-2008

Candidate Variable	Cases in Analysis		7-Day Readmissions		30-Day Readmissions	
	#	%	#	%	#	%
Race [P]						
Black	1,225	4.5	121	9.9	282	23.0
Other/Unknown	1,537	5.6	88	5.7	256	16.7
White	24,689	89.9	1,636	6.6	3,882	15.7
Clinical Variables						
Acute Myocardial Infarction [P]						
no	22,790	83.0	1,510	6.6	3,620	15.9
yes	4,661	17.0	335	7.2	800	17.2
AMI Except Other Anterior or Other Inferior Wall [P]						
no	23,658	86.2	1,570	6.6	3,766	15.9
yes	3,793	13.8	275	7.3	654	17.2
AMI Other Inferior Wall Initial Episode [C]						
no	26,897	98.0	1,803	6.7	4,331	16.1
yes	554	2.0	42	7.6	89	16.1
Anemia [P]						
no	21,025	76.6	1,341	6.4	3,228	15.4
yes	6,426	23.4	504	7.8	1,192	18.5
Angina [P]						
no	20,489	74.6	1,425	7.0	3,446	16.8
yes	6,962	25.4	420	6.0	974	14.0
Angina, Unstable [P]						
no	22,377	81.5	1,525	6.8	3,686	16.5
yes	5,074	18.5	320	6.3	734	14.5
ASA Class 5 [MQ]						
no	27,335	99.6	1,835	6.7	4,394	16.1
yes	116	0.4	10	8.6	26	22.4
ASA Emergency [MQ]						
no	25,756	93.8	1,734	6.7	4,143	16.1
yes	1,695	6.2	111	6.5	277	16.3
Cachexia [P]						
no	26,758	97.5	1,771	6.6	4,244	15.9
yes	693	2.5	74	10.7	176	25.4
CAD >70, 5-7 Vessels Group [MQ]						
no	26,504	96.6	1,780	6.7	4,264	16.1
yes	947	3.4	65	6.9	156	16.5
Cancer [P]						
no	26,717	97.3	1,779	6.7	4,272	16.0
yes	734	2.7	66	9.0	148	20.2
Cardiac Adhesions [P]						
no	27,187	99.0	1,813	6.7	4,365	16.1
yes	264	1.0	32	12.1	55	20.8
Cardiogenic Shock, Pre-Operative [P]						
no	27,327	99.5	1,837	6.7	4,393	16.1
yes	124	0.5	8	6.5	27	21.8
Cardiomyopathy [P]						
no	23,533	85.7	1,527	6.5	3,635	15.4
yes	3,918	14.3	318	8.1	785	20.0

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Readmissions, 2007-2008

Candidate Variable	Cases in Analysis		7-Day Readmissions		30-Day Readmissions	
	#	%	#	%	#	%
Cardiopulmonary Resuscitation (CPR) Prior to CABG/Valve Surgery Date [P]						
no	27,410	99.9	1,842	6.7	4,414	16.1
yes	41	0.1	3	7.3	6	14.6
Cerebrovascular Disease [P]						
no	25,803	94.0	1,715	6.6	4,110	15.9
yes	1,648	6.0	130	7.9	310	18.8
Chronic Lung Disease [P]						
no	21,835	79.5	1,378	6.3	3,302	15.1
yes	5,616	20.5	467	8.3	1,118	19.9
Chronic Pulmonary Hypertension [P]						
no	24,853	90.5	1,626	6.5	3,843	15.5
yes	2,598	9.5	219	8.4	577	22.2
Coagulopathy[P]						
no	27,293	99.4	1,836	6.7	4,381	16.1
yes	158	0.6	9	5.7	39	24.7
no	24,787	90.3	1,590	6.4	3,824	15.4
yes	2,664	9.7	255	9.6	596	22.4
Depression [P]						
no	25,635	93.4	1,694	6.6	4,073	15.9
yes	1,816	6.6	151	8.3	347	19.1
Diabetes [P]						
No diabetes	17,147	62.5	1,055	6.2	2,531	14.8
Diabetes without complication	8,329	30.3	608	7.3	1,447	17.4
Diabetes with complications	1,975	7.2	182	9.2	442	22.4
Diabetes With Long-Term/Unspecified Complications [P]						
no	25,494	92.9	1,666	6.5	3,985	15.6
yes	1,957	7.1	179	9.1	435	22.2
Excision of Other Lesion/Heart Tissue/ LAA, Open Approach – Same Date as Valve with or without CABG [P]						
no	26,354	96.0	1,752	6.6	4,194	15.9
yes	1,097	4.0	93	8.5	226	20.6
Fibrosis in Mediastinum and Heart [P]						
no	27,407	99.8	1,842	6.7	4,414	16.1
yes	44	0.2	3	6.8	6	13.6
Heart Failure [P]						
no	20,566	74.9	1,197	5.8	2,853	13.9
yes	6,885	25.1	648	9.4	1,567	22.8
History of CABG or Valve Surgery [P]						
no	25,914	94.4	1,725	6.7	4,114	15.9
yes	1,537	5.6	120	7.8	306	19.9
History of Chronic Steroid Use [P]						
no	27,311	99.5	1,829	6.7	4,384	16.1
yes	140	0.5	16	11.4	36	25.7

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Readmissions, 2007-2008

Candidate Variable	Cases in Analysis		7-Day Readmissions		30-Day Readmissions	
	#	%	#	%	#	%
History of Peripheral Vascular Disease [P]						
no	23,251	84.7	1,520	6.5	3,640	15.7
yes	4,200	15.3	325	7.7	780	18.6
History of PTCA/Stent [P]						
no	23,972	87.3	1,601	6.7	3,881	16.2
yes	3,479	12.7	244	7.0	539	15.5
Hypercholesterolemia [P]						
no	9,343	34.0	725	7.8	1,710	18.3
yes	18,108	66.0	1,120	6.2	2,710	15.0
Hypertension [P]						
no	10,257	37.4	759	7.4	1,861	18.1
yes	17,194	62.6	1,086	6.3	2,559	14.9
Hypertension with Complications [P]						
no	24,073	87.7	1,521	6.3	3,645	15.1
yes	3,378	12.3	324	9.6	775	22.9
Intra-Aortic Balloon Pump (IABP) Prior to Date of CABG/Valve Surgery [P]						
no	26,217	95.5	1,767	6.7	4,224	16.1
yes	1,234	4.5	78	6.3	196	15.9
Ischemic Heart Disease [P]						
no	27,428	99.9	1,844	6.7	4,417	16.1
yes	23	0.1	1	4.3	3	13.0
Liver Disease [P]						
no	27,221	99.2	1,821	6.7	4,362	16.0
yes	230	0.8	24	10.4	58	25.2
Lupus Erythematosus, Systemic [P]						
no	27,382	99.7	1,839	6.7	4,399	16.1
yes	69	0.3	6	8.7	21	30.4
MediQual Predicted LOS [MQ, 1] (tested as a continous variable)						
0	617	2.2	22	3.6	51	8.3
1	3,801	13.8	174	4.6	403	10.6
2	18,871	68.7	1,244	6.6	2,982	15.8
3	3,606	13.1	342	9.5	818	22.7
4	556	2.0	63	11.3	166	29.9
MI/AMI Other Anterior Wall [C]						
no	27,037	98.5	1,815	6.7	4,340	16.1
yes	414	1.5	30	7.2	80	19.3

[1] The ranges (number of days) for the predicted length of stay categories were calculated for each combination of procedure group and calendar year.

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Readmissions, 2007-2008

Candidate Variable	Cases in Analysis		7-Day Readmissions		30-Day Readmissions	
	#	%	#	%	#	%
Multiple Valve Procedures [P]						
no	26,193	95.4	1,735	6.6	4,099	15.6
yes	1,258	4.6	110	8.7	321	25.5
Myocardial Infarction, Old [P]						
no	23,557	85.8	1,576	6.7	3,795	16.1
yes	3,894	14.2	269	6.9	625	16.1
Obesity [P]						
no obesity	22,809	83.1	1,505	6.6	3,614	15.8
unspecified obesity	3,182	11.6	202	6.3	475	14.9
Morbid obesity	1,460	5.3	138	9.5	331	22.7
Obesity, Morbid [P]						
no	25,991	94.7	1,707	6.6	4,089	15.7
yes	1,460	5.3	138	9.5	331	22.7
Other Open Heart Procedure [P]						
no	25,377	92.4	1,676	6.6	4,006	15.8
yes	2,074	7.6	169	8.1	414	20.0
Other CV Procedure Group [C]						
no	25,339	92.3	1,674	6.6	3,997	15.8
yes	2,112	7.7	171	8.1	423	20.0
Percent of Left Main Stenosis [MQ] (tested as a continous variable)						
0 or missing	19,640	71.5	1,383	7.0	3,286	16.7
1-10	188	0.7	11	5.9	33	17.6
11-20	699	2.5	45	6.4	99	14.2
21-30	882	3.2	54	6.1	129	14.6
31-40	662	2.4	39	5.9	97	14.7
41-50	1,203	4.4	73	6.1	174	14.5
51-60	901	3.3	53	5.9	127	14.1
61-70	1,108	4.0	62	5.6	167	15.1
71-80	972	3.5	52	5.3	134	13.8
81-90	665	2.4	34	5.1	88	13.2
> 90	531	1.9	39	7.3	86	16.2
Procedure Group [P]						
CABG without Valve	18,223	66.4	1,096	6.0	2,601	14.3
Valve without CABG	5,125	18.7	379	7.4	967	18.9
Valve with CABG	4,103	14.9	370	9.0	852	20.8
PTCA/Stent Same Day as CABG/Valve Surgery [P]						
no	27,231	99.2	1,825	6.7	4,380	16.1
yes	220	0.8	20	9.1	40	18.2
PTCA/Stent/Tear Same Day as CABG/Valve Surgery [C]						
no	27,153	98.9	1,821	6.7	4,370	16.1
yes	298	1.1	24	8.1	50	16.8
Renal Failure/Dialysis (category) [P]						
All cases not assigned to chronic and acute/dialysis categories	26,668	97.1	1,767	6.6	4,239	15.9
Chronic	510	1.9	48	9.4	108	21.2
Acute/dialysis	273	1.0	30	11.0	73	26.7

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Readmissions, 2007-2008

Candidate Variable	Cases in Analysis		7-Day Readmissions		30-Day Readmissions	
	#	%	#	%	#	%
Renal Failure/Dialysis (binary)[P]						
no	26,668	97.1	1,767	6.6	4,239	15.9
yes	783	2.9	78	10.0	181	23.1
Pre-op Acute Renal Failure/Dialysis (binary)[P]						
no	27,178	99.0	1,815	6.7	4,347	16.0
yes	273	1.0	30	11.0	73	26.7
Septal Other Anomalous Repair Heart[MQ]						
no	27,125	98.8	1,824	6.7	4,360	16.1
yes	326	1.2	21	6.4	60	18.4
Ventricular Assist Device (LVAD and PVAD) Prior to CABG/Valve Surgery Date[P]						
no	27,449	100.0	1,845	6.7	4,419	16.1
yes	2	< 0.1	0	0.0	1	50.0

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Readmissions, 2008

Candidate Variable	Cases in Analysis		7-Day Readmissions		30-Day Readmissions	
	#	%	#	%	#	%
Demographic Variables						
Age in Years [P] (tested as a continous variable)						
Age: 30 – 39	139	1.0	10	7.2	22	15.8
Age: 40 – 49	827	6.0	48	5.8	119	14.4
Age: 50 – 59	2,557	18.7	138	5.4	340	13.3
Age: 60 – 69	4,062	29.7	229	5.6	561	13.8
Age: 70 – 79	4,312	31.5	344	8.0	786	18.2
Age: 80 – 89	1,770	12.9	160	9.0	370	20.9
Age: 90 – 99	31	0.2	2	6.5	10	32.3
Age # of Years > 65[P] (tested as a continous variable)						
0	5,935	43.3	325	5.5	799	13.5
1	425	3.1	27	6.4	62	14.6
2	417	3.0	25	6.0	60	14.4
3	392	2.9	17	4.3	54	13.8
4	416	3.0	31	7.5	67	16.1
5	450	3.3	36	8.0	78	17.3
6	405	3.0	31	7.7	67	16.5
7	444	3.2	28	6.3	72	16.2
8	439	3.2	30	6.8	68	15.5
9	400	2.9	32	8.0	69	17.3
10	430	3.1	31	7.2	79	18.4
11	435	3.2	29	6.7	75	17.2
12	485	3.5	41	8.5	101	20.8
13	452	3.3	43	9.5	95	21.0
14	372	2.7	43	11.6	82	22.0
15	327	2.4	31	9.5	66	20.2
16	329	2.4	32	9.7	62	18.8
17	276	2.0	25	9.1	57	20.7
18	249	1.8	28	11.2	54	21.7
19	209	1.5	16	7.7	46	22.0
20	140	1.0	10	7.1	32	22.9
21	113	0.8	9	8.0	21	18.6
22	56	0.4	6	10.7	14	25.0
23	44	0.3	3	6.8	13	29.5
24	27	0.2	0	0.0	5	18.5
25	13	0.1	0	0.0	2	15.4
26	7	0.1	0	0.0	4	57.1
27	3	< 0.1	0	0.0	0	0.0
28	5	< 0.1	2	40.0	4	80.0
29	3	< 0.1	0	0.0	0	0.0
Female [P]						
no	9,205	67.2	572	6.2	1,329	14.4
yes	4,493	32.8	359	8.0	879	19.6
Race/Ethnicity [P]						
Hispanic	378	2.8	27	7.1	57	15.1
White (non-Hispanic)	12,057	88.0	809	6.7	1,904	15.8
Black (non-Hispanic)	607	4.4	60	9.9	140	23.1
Other/Unknown	656	4.8	35	5.3	107	16.3
Race [P]						
Black	613	4.5	60	9.8	141	23.0
Other/Unknown	813	5.9	48	5.9	140	17.2
White	12,272	89.6	823	6.7	1,927	15.7

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Readmissions, 2008

Candidate Variable	Cases in Analysis		7-Day Readmissions		30-Day Readmissions	
	#	%	#	%	#	%
Clinical Variables						
Acute Myocardial Infarction [P]						
no	11,408	83.3	760	6.7	1,812	15.9
yes	2,290	16.7	171	7.5	396	17.3
AMI Except Other Anterior or Other Inferior Wall [P]						
no	11,799	86.1	789	6.7	1,873	15.9
yes	1,899	13.9	142	7.5	335	17.6
AMI Other Inferior Wall Initial Episode[C]						
no	13,438	98.1	909	6.8	2,173	16.2
yes	260	1.9	22	8.5	35	13.5
Anemia [P]						
no	10,449	76.3	675	6.5	1,602	15.3
yes	3,249	23.7	256	7.9	606	18.7
Angina [P]						
no	10,435	76.2	716	6.9	1,712	16.4
yes	3,263	23.8	215	6.6	496	15.2
Angina, Unstable [P]						
no	11,323	82.7	770	6.8	1,832	16.2
yes	2,375	17.3	161	6.8	376	15.8
ASA Class 5[MQ]						
no	13,638	99.6	926	6.8	2,195	16.1
yes	60	0.4	5	8.3	13	21.7
ASA Emergency [MQ]						
no	12,888	94.1	875	6.8	2,076	16.1
yes	810	5.9	56	6.9	132	16.3
Cachexia [P]						
no	13,330	97.3	895	6.7	2,121	15.9
yes	368	2.7	36	9.8	87	23.6
CAD >70, 5-7 Vessels Group [MQ]						
no	13,260	96.8	899	6.8	2,134	16.1
yes	438	3.2	32	7.3	74	16.9
Cancer [P]						
no	13,316	97.2	901	6.8	2,130	16.0
yes	382	2.8	30	7.9	78	20.4
Cardiac Adhesions [P]						
no	13,578	99.1	917	6.8	2,185	16.1
yes	120	0.9	14	11.7	23	19.2
Cardiogenic Shock, Pre-Operative [P]						
no	13,644	99.6	926	6.8	2,194	16.1
yes	54	0.4	5	9.3	14	25.9
Cardiomyopathy[P]						
no	11,687	85.3	769	6.6	1,813	15.5
yes	2,011	14.7	162	8.1	395	19.6
Cardiopulmonary Resuscitation (CPR) Prior to CABG/Valve Surgery Date [P]						
no	13,674	99.8	930	6.8	2,204	16.1
yes	24	0.2	1	4.2	4	16.7

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Readmissions, 2008

Candidate Variable	Cases in Analysis		7-Day Readmissions		30-Day Readmissions	
	#	%	#	%	#	%
Cerebrovascular Disease [P]						
no	12,840	93.7	863	6.7	2,047	15.9
yes	858	6.3	68	7.9	161	18.8
Chronic Lung Disease [P]						
no	10,993	80.3	694	6.3	1,672	15.2
yes	2,705	19.7	237	8.8	536	19.8
Chronic Pulmonary Hypertension [P]						
no	12,351	90.2	821	6.6	1,931	15.6
yes	1,347	9.8	110	8.2	277	20.6
Coagulopathy[P]						
no	13,619	99.4	924	6.8	2,186	16.1
yes	79	0.6	7	8.9	22	27.8
Depression [P]						
no	12,766	93.2	852	6.7	2,023	15.8
yes	932	6.8	79	8.5	185	19.8
Diabetes [P]						
No diabetes	8,525	62.2	536	6.3	1,252	14.7
Diabetes without complication	4,155	30.3	309	7.4	731	17.6
Diabetes with complications	1,018	7.4	86	8.4	225	22.1
Diabetes With Long-Term/Unspecified Complications [P]						
no	12,687	92.6	845	6.7	1,984	15.6
yes	1,011	7.4	86	8.5	224	22.2
Excision of Other Lesion/Heart Tissue/ LAA, Open Approach – Same Date as Valve with or without CABG [P]						
no	13,144	96.0	877	6.7	2,092	15.9
yes	554	4.0	54	9.7	116	20.9
Fibrosis in Mediastinum and Heart [P]						
no	13,668	99.8	929	6.8	2,205	16.1
yes	30	0.2	2	6.7	3	10.0
Heart Failure [P]						
no	10,348	75.5	622	6.0	1,445	14.0
yes	3,350	24.5	309	9.2	763	22.8
History of CABG or Valve Surgery [P]						
no	12,909	94.2	876	6.8	2,052	15.9
yes	789	5.8	55	7.0	156	19.8
History of Cerebral Vascular Accident (CVA) or Stroke [P]						
no	12,821	93.6	858	6.7	2,030	15.8
yes	877	6.4	73	8.3	178	20.3
History of Chronic Steroid Use [P]						
no	13,630	99.5	919	6.7	2,191	16.1
yes	68	0.5	12	17.6	17	25.0
History of Peripheral Vascular Disease [P]						
no	11,564	84.4	768	6.6	1,822	15.8
yes	2,134	15.6	163	7.6	386	18.1

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Readmissions, 2008

Candidate Variable	Cases in Analysis		7-Day Readmissions		30-Day Readmissions	
	#	%	#	%	#	%
History of PTCA/Stent [P]						
no	11,875	86.7	803	6.8	1,946	16.4
yes	1,823	13.3	128	7.0	262	14.4
Hypercholesterolemia [P]						
no	4,429	32.3	349	7.9	820	18.5
yes	9,269	67.7	582	6.3	1,388	15.0
Hypertension [P]						
no	5,096	37.2	367	7.2	910	17.9
yes	8,602	62.8	564	6.6	1,298	15.1
Hypertension with Complications [P]						
no	11,928	87.1	763	6.4	1,804	15.1
yes	1,770	12.9	168	9.5	404	22.8
Intra-Aortic Balloon Pump (IABP) Prior to Date of CABG/Valve Surgery [P]						
no	13,082	95.5	892	6.8	2,112	16.1
yes	616	4.5	39	6.3	96	15.6
Ischemic Heart Disease [P]						
no	13,684	99.9	931	6.8	2,208	16.1
yes	14	0.1	0	0.0	0	0.0
Liver Disease [P]						
no	13,573	99.1	917	6.8	2,176	16.0
yes	125	0.9	14	11.2	32	25.6
Lupus Erythematosus, Systemic [P]						
no	13,667	99.8	927	6.8	2,198	16.1
yes	31	0.2	4	12.9	10	32.3
MediQual Predicted LOS [MQ] (tested as a continous variable)						
CABG w/o Valve / Valve w/o CABG / Valve w/CABG						
< 5.408 days / < 6.733 days / < 8.339 days	321	2.3	15	4.7	30	9.3
5.408 – 6.619 / 6.734 – 8.258 / 8.339 – 9.797	1,884	13.8	88	4.7	196	10.4
6.620 – 11.794 / 8.259 – 14.381 / 9.798 – 16.542	9,423	68.8	630	6.7	1,494	15.9
11.795 – 17.721 / 14.382 – 21.342 / 16.543 – 23.297	1,800	13.1	168	9.3	410	22.8
> 17.721 / > 21.342 / > 23.297	270	2.0	30	11.1	78	28.9
MI/AMI Other Anterior Wall [C]						
no	13,527	98.8	917	6.8	2,174	16.1
yes	171	1.2	14	8.2	34	19.9
Multiple Valve Procedures [P]						
no	13,093	95.6	875	6.7	2,053	15.7
yes	605	4.4	56	9.3	155	25.6
Myocardial Infarction, Old [P]						
no	11,747	85.8	799	6.8	1,900	16.2
yes	1,951	14.2	132	6.8	308	15.8
Obesity [P]						
no obesity	11,309	82.6	744	6.6	1,774	15.7
unspecified obesity	1,650	12.0	117	7.1	271	16.4
Morbid obesity	739	5.4	70	9.5	163	22.1
Obesity, Morbid [P]						
no	12,959	94.6	861	6.6	2,045	15.8
yes	739	5.4	70	9.5	163	22.1

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Readmissions, 2008

Candidate Variable	Cases in Analysis		7-Day Readmissions		30-Day Readmissions	
	#	%	#	%	#	%
Other Open Heart Procedure [P]						
no	12,672	92.5	846	6.7	2,005	15.8
yes	1,026	7.5	85	8.3	203	19.8
Other CV Procedure Group [C]						
no	12,657	92.4	846	6.7	2,002	15.8
yes	1,041	7.6	85	8.2	206	19.8
Percent of Left Main Stenosis [MQ] (tested as a continous variable)						
0 or missing	9,856	72.0	691	7.0	1,641	16.6
1-10	77	0.6	4	5.2	10	13.0
11-20	355	2.6	24	6.8	47	13.2
21-30	428	3.1	25	5.8	65	15.2
31-40	316	2.3	20	6.3	47	14.9
41-50	587	4.3	31	5.3	82	14.0
51-60	445	3.2	28	6.3	65	14.6
61-70	550	4.0	36	6.5	81	14.7
71-80	491	3.6	23	4.7	66	13.4
81-90	316	2.3	20	6.3	46	14.6
> 90	277	2.0	29	10.5	58	20.9
Procedure Group [P]						
CABG without Valve	9,075	66.3	568	6.3	1,322	14.6
Valve without CABG	2,632	19.2	183	7.0	468	17.8
Valve with CABG	1,991	14.5	180	9.0	418	21.0
PTCA/Stent Same Day as CABG/Valve Surgery [P]						
no	13,582	99.2	923	6.8	2,191	16.1
yes	116	0.8	8	6.9	17	14.7
PTCA/Stent/Tear Same Day as CABG/Valve Surgery [C]						
no	13,546	98.9	920	6.8	2,184	16.1
yes	152	1.1	11	7.2	24	15.8
Renal Failure/Dialysis (category) [P]						
All cases not assigned to chronic and acute/dialysis categories	13,348	97.4	897	6.7	2,133	16.0
Chronic	207	1.5	19	9.2	40	19.3
Acute/dialysis	143	1.0	15	10.5	35	24.5
Renal Failure/Dialysis (binary) [P]						
no	13,348	97.4	897	6.7	2,133	16.0
yes	350	2.6	34	9.7	75	21.4
Pre-op Acute Renal Failure/Dialysis (binary) [P]						
no	13,555	99.0	916	6.8	2,173	16.0
yes	143	1.0	15	10.5	35	24.5
Septal Other Anomalous Repair Heart[MQ]						
no	13,541	98.9	919	6.8	2,181	16.1
yes	157	1.1	12	7.6	27	17.2
Ventricular Assist Device (LVAD and PVAD) Prior to CABG/Valve Surgery Date[P]						
no	13,697	100.0	931	6.8	2,208	16.1
yes	1	< 0.1	0	0.0	0	0.0

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Post-Surgical Length of Stay, 2007-2008

Candidate Variable	Number of Cases			Arithmetic Avg. Post-Surgical LOS		
	Development Sample	Cross-validation Sample	Full	Development Sample	Cross-validation Sample	Full
Demographic Variables						
Age in Years [P] (tested as a continous variable)						
Age: 30 - 39	163	173	336	6.6	5.7	6.1
Age: 40 - 49	957	889	1,846	6.1	5.9	6.0
Age: 50 - 59	2,834	2,781	5,615	6.2	6.4	6.3
Age: 60 - 69	4,413	4,482	8,895	7.0	6.9	6.9
Age: 70 - 79	4,703	4,762	9,465	8.0	8.0	8.0
Age: 80 - 89	1,992	1,981	3,973	9.3	9.1	9.2
Age: 90 - 99	33	26	59	12.8	10.9	12.0
Age Number of Years > 65[P] (tested as a continous variable)						
0	6,560	6,559	13,119	6.5	6.4	6.5
1	463	474	937	7.2	6.9	7.1
2	453	453	906	7.3	6.9	7.1
3	423	425	848	7.2	7.2	7.2
4	468	414	882	7.2	7.3	7.3
5	446	466	912	7.5	7.1	7.3
6	431	438	869	7.7	7.7	7.7
7	508	444	952	7.5	7.6	7.5
8	439	493	932	7.9	7.8	7.8
9	457	466	923	8.0	8.0	8.0
10	498	487	985	7.9	8.2	8.0
11	489	517	1,006	8.3	8.3	8.3
12	518	507	1,025	8.6	8.6	8.6
13	465	488	953	8.2	8.3	8.2
14	452	456	908	8.9	8.7	8.8
15	382	376	758	8.9	9.1	9.0
16	373	368	741	9.2	8.8	9.0
17	313	329	642	9.5	9.4	9.4
18	268	277	545	9.7	9.2	9.5
19	224	238	462	9.0	9.1	9.0
20	165	127	292	9.1	8.9	9.0
21	120	120	240	10.6	8.6	9.6
22	71	67	138	9.4	10.6	10.0
23	43	43	86	8.7	9.8	9.3
24	33	36	69	10.4	9.2	9.8
25	13	11	24	13.8	9.4	11.8
26	10	6	16	14.0	13.2	13.7
27	4	3	7	9.0	10.3	9.6
28	3	4	7	9.0	11.3	10.3
29	3	2	5	13.3	13.0	13.2
Female [P]						
no	10,207	10,171	20,378	7.1	7.0	7.0
yes	4,888	4,923	9,811	8.2	8.1	8.2
Race/Ethnicity [P]						
Hispanic	331	313	644	6.1	5.6	5.9
White (non-Hispanic)	13,262	13,349	26,611	7.4	7.3	7.3
Black (non-Hispanic)	683	605	1,288	8.8	8.7	8.7
Other/Unknown	819	827	1,646	8.2	8.1	8.2
Race [P]						
Black	689	619	1,308	8.7	8.6	8.7
Other/Unknown	948	949	1,897	8.0	7.9	8.0
White	13,458	13,526	26,984	7.3	7.3	7.3

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Post-Surgical Length of Stay, 2007-2008

Candidate Variable	Number of Cases			Arithmetic Avg. Post-Surgical LOS		
	Development Sample	Cross-validation Sample	Full	Development Sample	Cross-validation Sample	Full
Clinical Variables						
Acute Myocardial Infarction [P]						
no	12,514	12,618	25,132	7.4	7.3	7.3
yes	2,581	2,476	5,057	7.9	7.9	7.9
Anemia [P]						
no	11,453	11,476	22,929	7.3	7.1	7.2
yes	3,642	3,618	7,260	8.0	8.2	8.1
Angina [P]						
no	11,320	11,211	22,531	7.8	7.7	7.8
yes	3,775	3,883	7,658	6.4	6.3	6.3
Angina, Unstable [P]						
no	12,328	12,278	24,606	7.7	7.6	7.7
yes	2,767	2,816	5,583	6.4	6.3	6.3
Cachexia [P]						
no	14,732	14,718	29,450	7.2	7.2	7.2
yes	363	376	739	17.3	15.9	16.6
Cancer [P]						
no	14,662	14,708	29,370	7.4	7.4	7.4
yes	433	386	819	8.2	8.0	8.1
Cardiac Adhesions [P]						
no	14,960	14,955	29,915	7.4	7.4	7.4
yes	135	139	274	8.8	8.6	8.7
Cardiogenic Shock, Pre-Operative [P]						
no	15,039	15,027	30,066	7.4	7.4	7.4
yes	56	67	123	16.5	11.9	14.0
Cardiomyopathy [P]						
no	12,910	12,896	25,806	7.2	7.2	7.2
yes	2,185	2,198	4,383	8.9	8.6	8.7
Cardiopulmonary Resuscitation (CPR) Prior to CABG/Valve Surgery Date [P]						
no	15,072	15,076	30,148	7.4	7.4	7.4
yes	23	18	41	8.2	8.4	8.3
Cerebrovascular Disease [P]						
no	14,191	14,194	28,385	7.4	7.4	7.4
yes	904	900	1,804	7.4	7.3	7.3
Chronic Lung Disease [P]						
no	12,063	12,050	24,113	7.2	7.1	7.2
yes	3,032	3,044	6,076	8.3	8.5	8.4
Chronic Pulmonary Hypertension [P]						
no	13,638	13,619	27,257	7.2	7.2	7.2
yes	1,457	1,475	2,932	9.4	9.5	9.4
Coagulopathy[P]						
no	15,001	15,012	30,013	7.4	7.4	7.4
yes	94	82	176	9.3	8.3	8.8
Depression [P]						
no	14,134	14,082	28,216	7.4	7.3	7.4
yes	961	1,012	1,973	7.6	7.8	7.7

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Post-Surgical Length of Stay, 2007-2008

Candidate Variable	Number of Cases			Arithmetic Avg. Post-Surgical LOS		
	Development Sample	Cross-validation Sample	Full	Development Sample	Cross-validation Sample	Full
Diabetes [P]						
No diabetes	9,549	9,394	18,943	7.4	7.2	7.3
Diabetes without complication	4,455	4,651	9,106	7.4	7.5	7.4
Diabetes with complications	1,091	1,049	2,140	8.3	8.6	8.5
Diabetes With Long-Term/Unspecified Complications [P]						
no	14,017	14,051	28,068	7.4	7.3	7.3
yes	1,078	1,043	2,121	8.3	8.6	8.5
Excision of Other Lesion/Heart Tissue/LAA, Open Approach – Same Date as Valve with or without CABG [P]						
no	14,528	14,445	28,973	7.4	7.3	7.3
yes	567	649	1,216	9.2	9.7	9.5
Fibrosis in Mediastinum and Heart [P]						
no	15,070	15,071	30,141	7.4	7.4	7.4
yes	25	23	48	9.7	7.2	8.5
Heart Failure [P]						
no	11,170	11,251	22,421	6.5	6.5	6.5
yes	3,925	3,843	7,768	10.1	9.9	10.0
History of CABG or Valve Surgery [P]						
no	14,250	14,231	28,481	7.4	7.3	7.3
yes	845	863	1,708	8.5	8.3	8.4
History of Chronic Steroid Use [P]						
no	15,012	15,025	30,037	7.4	7.4	7.4
yes	83	69	152	7.9	7.3	7.6
History of Peripheral Vascular Disease [P]						
no	12,760	12,839	25,599	7.4	7.3	7.4
yes	2,335	2,255	4,590	7.6	7.6	7.6
History of PTCA/Stent [P]						
no	13,231	13,151	26,382	7.5	7.5	7.5
yes	1,864	1,943	3,807	6.7	6.6	6.6
Hypercholesterolemia [P]						
no	5,124	5,126	10,250	8.6	8.5	8.6
yes	9,971	9,968	19,939	6.8	6.8	6.8
Hypertension [P]						
no	5,762	5,549	11,311	8.5	8.5	8.5
yes	9,333	9,545	18,878	6.8	6.7	6.8
Hypertension with Complications [P]						
no	13,211	13,290	26,501	7.2	7.1	7.1
yes	1,884	1,804	3,688	9.2	9.5	9.4
Intra-Aortic Balloon Pump (IABP) Prior to Date of CABG/Valve Surgery [P]						
no	14,433	14,448	28,881	7.4	7.3	7.3
yes	662	646	1,308	9.0	8.9	9.0
Ischemic Heart Disease [P]						
no	15,085	15,077	30,162	7.4	7.4	7.4
yes	10	17	27	7.1	6.5	6.7
Liver Disease [P]						
no	14,973	14,951	29,924	7.4	7.4	7.4
yes	122	143	265	8.5	8.9	8.7

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Post-Surgical Length of Stay, 2007-2008

Candidate Variable	Number of Cases			Arithmetic Avg. Post-Surgical LOS		
	Development Sample	Cross-validation Sample	Full	Development Sample	Cross-validation Sample	Full
Lupus Erythematosus, Systemic [P]						
no	15,050	15,059	30,109	7.4	7.4	7.4
yes	45	35	80	7.3	8.5	7.8
MediQual Predicted LOS [MQ, 1] (tested as a continuous variable)						
0	336	345	681	5.0	5.2	5.1
1	2,146	2,084	4,230	5.7	5.6	5.6
2	10,354	10,434	20,788	7.3	7.2	7.2
3	1,967	1,933	3,900	10.0	9.8	9.9
4	292	298	590	12.1	12.0	12.1
Multiple Valve Procedures [P]						
no	14,405	14,378	28,783	7.3	7.2	7.2
yes	690	716	1,406	11.4	11.5	11.4
Myocardial Infarction, Old [P]						
no	13,013	12,925	25,938	7.5	7.5	7.5
yes	2,082	2,169	4,251	7.1	6.9	7.0
Obesity [P]						
no obesity	12,605	12,554	25,159	7.5	7.4	7.5
unspecified obesity	1,699	1,768	3,467	6.9	6.8	6.9
Morbid obesity	791	772	1,563	7.8	8.0	7.9
Obesity, Morbid [P]						
no	14,304	14,322	28,626	7.4	7.3	7.4
yes	791	772	1,563	7.8	8.0	7.9
Other Open Heart Procedure [P]						
no	14,004	13,917	27,921	7.3	7.2	7.2
yes	1,091	1,177	2,268	9.5	9.6	9.5
Procedure Group [P]						
CABG without Valve	9,852	9,852	19,704	6.5	6.5	6.5
Valve without CABG	2,948	2,948	5,896	8.5	8.4	8.5
Valve with CABG	2,295	2,294	4,589	10.0	9.9	9.9
PTCA/Stent Same Day as CABG/Valve Surgery [P]						
no	14,975	14,975	29,950	7.4	7.4	7.4
yes	120	119	239	9.2	8.2	8.7
Renal Failure/Dialysis (category) [P]						
All cases not assigned to chronic and acute/dialysis categories	14,657	14,677	29,334	7.3	7.3	7.3
Chronic	286	279	565	12.0	12.1	12.0
Acute/dialysis	152	138	290	12.0	10.4	11.2
Renal Failure/Dialysis (binary) [P]						
no	14,657	14,677	29,334	7.3	7.3	7.3
yes	438	417	855	12.0	11.5	11.8

[1] The ranges (number of days) for the predicted length of stay categories were calculated for each combination of procedure group and calendar year.

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Post-Surgical Length of Stay, 2007-2008

Candidate Variable	Number of Cases			Arithmetic Avg. Post-Surgical LOS		
	Development Sample	**Cross-validation Sample**	Full	Development Sample	Cross-validation Sample	Full
Pre-op Acute Renal Failure/Dialysis (binary) [P]						
no	14,943	14,956	29,899	7.4	7.4	7.4
yes	152	138	290	12.0	10.4	11.2
Ventricular Assist Device (LVAD and PVAD) Prior to CABG/Valve Surgery Date [P]						
no	15,094	15,094	30,188	7.4	7.4	7.4
yes	1	0	1	7.0	0	7.0

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Post-Surgical Length of Stay, 2008

Candidate Variable	Number of Cases			Arithmetic Avg. Post-Surgical LOS		
	Development Sample	Cross-validation Sample	Full	Development Sample	Cross-validation Sample	Full
Demographic Variables						
Age in Years [P] (tested as a continous variable)						
Age: 30 - 39	77	82	159	6.4	5.9	6.1
Age: 40 - 49	460	436	896	5.8	5.9	5.8
Age: 50 - 59	1,369	1,419	2,788	6.3	6.3	6.3
Age: 60 - 69	2,227	2,240	4,467	6.9	6.9	6.9
Age: 70 - 79	2,398	2,352	4,750	8.0	8.0	8.0
Age: 80 - 89	982	983	1,965	9.3	9.1	9.2
Age: 90 - 99	19	18	37	14.6	9.8	12.3
Age # of Years > 65[P] (tested as a continous variable)						
0	3,253	3,252	6,505	6.5	6.5	6.5
1	223	238	461	6.9	7.2	7.1
2	224	239	463	6.9	7.0	7.0
3	207	221	428	7.0	6.9	7.0
4	226	227	453	7.3	7.2	7.2
5	259	242	501	7.6	6.9	7.3
6	216	234	450	7.1	7.4	7.3
7	238	252	490	7.4	7.4	7.4
8	250	232	482	7.4	8.0	7.7
9	227	202	429	7.7	7.7	7.7
10	238	235	473	7.9	8.1	8.0
11	235	250	485	8.3	8.3	8.3
12	264	269	533	8.5	8.7	8.6
13	259	232	491	9.1	8.4	8.7
14	212	204	416	8.8	9.0	8.9
15	185	180	365	8.9	8.7	8.8
16	176	179	355	8.4	9.4	8.9
17	150	156	306	9.2	8.9	9.0
18	146	130	276	9.7	9.3	9.5
19	112	121	233	9.9	8.9	9.4
20	71	82	153	9.7	9.0	9.3
21	65	61	126	9.3	8.9	9.1
22	33	33	66	11.2	10.5	10.9
23	27	25	52	10.2	8.7	9.5
24	17	16	33	8.8	10.3	9.5
25	6	8	14	15.7	10.5	12.7
26	7	2	9	15.7	9.5	14.3
27	3	2	5	13.7	4.5	10.0
28	3	3	6	10.7	11.3	11.0
29	0	3	3	0.0	10.3	10.3
Female [P]						
no	5,122	5,023	10,145	7.1	7.1	7.1
yes	2,410	2,507	4,917	8.1	8.0	8.0
Race/Ethnicity [P]						
Hispanic	191	200	391	5.6	5.5	5.5
White (non-Hispanic)	6,627	6,579	13,206	7.3	7.3	7.3
Black (non-Hispanic)	310	344	654	8.4	8.7	8.6
Other/Unknown	404	407	811	8.3	7.9	8.1
Race [P]						
Black	313	348	661	8.5	8.7	8.6
Other/Unknown	474	496	970	8.1	7.5	7.8
White	6,745	6,686	13,431	7.3	7.3	7.3

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Post-Surgical Length of Stay, 2008

Candidate Variable	Number of Cases			Arithmetic Avg. Post-Surgical LOS		
	Development Sample	Cross-validation Sample	Full	Development Sample	Cross-validation Sample	Full
Clinical Variables						
Acute Myocardial Infarction						
no	6,303	6,265	12,568	7.3	7.3	7.3
yes	1,229	1,265	2,494	7.8	7.8	7.8
Anemia [P]						
no	5,735	5,635	11,370	7.2	7.1	7.2
yes	1,797	1,895	3,692	8.0	8.1	8.0
Angina [P]						
no	5,718	5,742	11,460	7.7	7.7	7.7
yes	1,814	1,788	3,602	6.5	6.3	6.4
Angina, Unstable [P]						
no	6,178	6,256	12,434	7.6	7.6	7.6
yes	1,354	1,274	2,628	6.6	6.3	6.4
Cachexia [P]						
no	7,356	7,327	14,683	7.2	7.1	7.1
yes	176	203	379	17.7	17.1	17.4
Cancer [P]						
no	7,310	7,334	14,644	7.4	7.3	7.4
yes	222	196	418	8.0	8.3	8.1
Cardiac Adhesions [P]						
no	7,479	7,460	14,939	7.4	7.4	7.4
yes	53	70	123	9.0	8.9	8.9
Cardiogenic Shock, Pre-Operative [P]						
no	7,503	7,504	15,007	7.4	7.3	7.4
yes	29	26	55	13.5	13.2	13.4
Cardiomyopathy [P]						
no	6,405	6,406	12,811	7.2	7.1	7.1
yes	1,127	1,124	2,251	8.7	8.7	8.7
Cardiopulmonary Resuscitation (CPR) Prior to CABG/Valve Surgery Date [P]						
no	7,522	7,516	15,038	7.4	7.4	7.4
yes	10	14	24	6.7	9.3	8.2
Cerebrovascular Disease [P]						
no	7,074	7,046	14,120	7.4	7.4	7.4
yes	458	484	942	7.2	7.1	7.2
Chronic Lung Disease [P]						
no	6,069	6,059	12,128	7.2	7.1	7.2
yes	1,463	1,471	2,934	8.2	8.3	8.2
Chronic Pulmonary Hypertension [P]						
no	6,762	6,767	13,529	7.1	7.2	7.1
yes	770	763	1,533	9.8	9.2	9.5
Coagulopathy[P]						
no	7,487	7,488	14,975	7.4	7.4	7.4
yes	45	42	87	8.0	10.4	9.2
Depression [P]						
no	7,036	7,011	14,047	7.4	7.3	7.4
yes	496	519	1,015	7.3	7.8	7.6

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Post-Surgical Length of Stay, 2008

Candidate Variable	Number of Cases			Arithmetic Avg. Post-Surgical LOS		
	Development Sample	Cross-validation Sample	Full	Development Sample	Cross-validation Sample	Full
Diabetes [P]						
No diabetes	4,725	4,669	9,394	7.3	7.3	7.3
Diabetes without complication	2,281	2,284	4,565	7.4	7.3	7.4
Diabetes with complications	526	577	1,103	8.4	8.3	8.3
Diabetes With Long-Term/Unspecified Complications [P]						
no	7,012	6,955	13,967	7.3	7.3	7.3
yes	520	575	1,095	8.4	8.3	8.3
Excision of Other Lesion/Heart Tissue/LAA, Open Approach – Same Date as Valve with or without CABG [P]						
no	7,208	7,233	14,441	7.3	7.3	7.3
yes	324	297	621	9.0	9.1	9.1
Fibrosis in Mediastinum and Heart [P]						
no	7,518	7,512	15,030	7.4	7.4	7.4
yes	14	18	32	7.6	9.6	8.8
Heart Failure [P]						
no	5,624	5,638	11,262	6.5	6.6	6.5
yes	1,908	1,892	3,800	10.0	9.8	9.9
History of CABG or Valve Surgery [P]						
no	7,103	7,078	14,181	7.3	7.3	7.3
yes	429	452	881	8.3	8.7	8.5
History of Cerebral Vascular Accident (CVA) or Stroke [P]						
no	7,059	7,041	14,100	7.4	7.4	7.4
yes	473	489	962	7.7	7.4	7.6
History of Chronic Steroid Use [P]						
no	7,492	7,496	14,988	7.4	7.4	7.4
yes	40	34	74	7.5	6.2	6.9
History of Peripheral Vascular Disease [P]						
no	6,384	6,339	12,723	7.3	7.3	7.3
yes	1,148	1,191	2,339	7.8	7.6	7.7
History of PTCA/Stent [P]						
no	6,539	6,515	13,054	7.5	7.5	7.5
yes	993	1,015	2,008	6.6	6.7	6.7
Hypercholesterolemia [P]						
no	2,411	2,432	4,843	8.6	8.4	8.5
yes	5,121	5,098	10,219	6.8	6.9	6.8
Hypertension [P]						
no	2,825	2,762	5,587	8.5	8.4	8.5
yes	4,707	4,768	9,475	6.7	6.8	6.8
Hypertension with Complications [P]						
no	6,559	6,573	13,132	7.1	7.1	7.1
yes	973	957	1,930	9.4	9.2	9.3
Intra-Aortic Balloon Pump (IABP) Prior to Date of CABG/Valve Surgery [P]						
no	7,201	7,218	14,419	7.3	7.3	7.3
yes	331	312	643	8.8	8.9	8.8

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Post-Surgical Length of Stay, 2008

Candidate Variable			Number of Cases			Arithmetic Avg. Post-Surgical LOS		
			Development Sample	Cross-validation Sample	Full	Development Sample	Cross-validation Sample	Full
Ischemic Heart Disease [P]								
no			7,525	7,520	15,045	7.4	7.4	7.4
yes			7	10	17	4.9	8.1	6.8
Liver Disease [P]								
no			7,465	7,455	14,920	7.4	7.4	7.4
yes			67	75	142	8.5	7.7	8.1
Lupus Erythematosus, Systemic [P]								
no			7,509	7,514	15,023	7.4	7.4	7.4
yes			23	16	39	7.2	6.3	6.8
MediQual Predicted LOS [MQ] (tested as a continuous variable)								
CABG w/o Valve	Valve w/o CABG	Valve w/CABG						
< 5.408 days	< 6.733 days	< 8.339 days	183	165	348	5.0	5.3	5.1
5.408 – 6.619	6.734 – 8.258	8.339 – 9.797	1,022	1,084	2,106	5.7	5.7	5.7
6.620 – 11.794	8.259 – 14.381	9.798 – 16.542	5,223	5,144	10,367	7.2	7.2	7.2
11.795 – 17.721	14.382 – 21.342	16.543 – 23.297	961	991	1,952	10.1	9.7	9.9
> 17.721	> 21.342	> 23.297	143	146	289	10.6	13.0	11.8
Multiple Valve Procedures [P]								
no			7,203	7,179	14,382	7.2	7.2	7.2
yes			329	351	680	11.1	11.2	11.1
Myocardial Infarction, Old [P]								
no			6,446	6,466	12,912	7.5	7.4	7.4
yes			1,086	1,064	2,150	7.0	7.2	7.1
Obesity [P]								
no obesity			6,261	6,196	12,457	7.5	7.4	7.5
unspecified obesity			896	914	1,810	6.8	6.7	6.7
Morbid obesity			375	420	795	7.7	7.8	7.7
Obesity, Morbid [P]								
no			7,157	7,110	14,267	7.4	7.3	7.4
yes			375	420	795	7.7	7.8	7.7
Other Open Heart Procedure [P]								
no			6,965	6,965	13,930	7.2	7.2	7.2
yes			567	565	1,132	9.4	9.3	9.4
Procedure Group [P]								
CABG without Valve			4,902	4,901	9,803	6.6	6.5	6.5
Valve without CABG			1,523	1,522	3,045	8.4	8.2	8.3
Valve with CABG			1,107	1,107	2,214	9.7	9.9	9.8
PTCA/Stent Same Day as CABG/Valve Surgery [P]								
no			7,475	7,463	14,938	7.4	7.4	7.4
yes			57	67	124	8.4	8.1	8.2
Renal Failure/Dialysis (category) [P]								
All cases not assigned to chronic and acute/dialysis categories			7,364	7,327	14,691	7.3	7.2	7.3
Chronic			101	119	220	11.3	12.7	12.1
Acute/dialysis			67	84	151	10.9	10.6	10.7

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX F: CANDIDATE VARIABLE DATA *continued*

Post-Surgical Length of Stay, 2008

Candidate Variable	Number of Cases			Arithmetic Avg. Post-Surgical LOS		
	Development Sample	Cross-validation Sample	Full	Development Sample	Cross-validation Sample	Full
Renal Failure/Dialysis (binary) [P]						
no	7,364	7,327	14,691	7.3	7.2	7.3
yes	168	203	371	11.2	11.8	11.5
Pre-op Acute Renal Failure/Dialysis (binary) [P]						
no	7,465	7,446	14,911	7.4	7.3	7.4
yes	67	84	151	10.9	10.6	10.7
Ventricular Assist Device (LVAD and PVAD) Prior to CABG/Valve Surgery Date [P]						
no	7,532	7,529	15,061	7.4	7.5	7.4
yes	0	1	1	0	7.0	7.0

[P] This variable was based on PHC4 data.
[MQ] This variable was based on data obtained from MediQual.
[C] This variable was based on both MediQual and PHC4 data.

APPENDIX G: *ATLAS OUTCOMES*™ APPROACH TO RISK-ADJUSTMENT

Hospitals used the MediQual *Atlas Outcomes*™ System to abstract patient severity information, which is an objective severity of illness grouping, and risk-adjustment system that classifies each patient's risk on admission using data known as Key Clinical Findings (KCF). The *Atlas Outcomes*™ system is based on the examination of numerous KCFs such as lab test results, EKG findings, vital signs, the patient's medical history, imaging results, pathology, age, sex, and operative/endoscopy findings. Hospital personnel abstract these KCFs from the medical record during specified time frames in the hospitalization. Some pre-admission data are also captured (e.g., cardiac catheterization findings), as are some history findings.

MediQual, in consultation with their Clinical Advisory Panel, designed in-hospital mortality and length of stay models focusing specifically on the patients who underwent a CABG and/or valve procedure. These models have many similarities to other disease group models used to calculate Admission Severity Groups (ASGs) in the *Atlas Outcomes*® system, though some differences were introduced to account for the unique characteristics of this population. The KCF variables were entered into algorithms that calculated the overall predicted probability of death or the predicted length of stay for patients undergoing a CABG and/or valve procedure. The predicted probability of death was derived from a logistic regression model and has a value from 0.000 to 1.000. The predicted length of stay was derived from a linear regression model and has a value greater than zero.

For PHC4's in-hospital and operative mortality models, data on the individual KCFs that were found by MediQual to be predictive of in-hospital mortality were obtained and the variables were retained in PHC4's mortality models, unless the coefficient was negative. For PHC4's readmissions models, MediQual's Predicted Length of Stay and individual KCFs from MediQual's mortality model that were not in MediQual's Predicted Length of Stay were tested as candidate variables. For PHC4's post-surgical length of stay model, MediQual's Predicted Length of Stay was tested as a candidate variable.