Adult Coronary Artery Bypass Graft Surgery in the Commonwealth of Massachusetts

Fiscal Year 2013 Report
(October 1, 2012 through September 30, 2013)

Hospital Risk-Standardized 30-Day Mortality Rates

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1 A Message from the Director of the Massachusetts Bureau of Health Care Safety and Quality

This is the twelfth in a series of reports on risk-standardized, 30-day mortality for the 14 cardiac surgery programs licensed by the Massachusetts Department of Public Health (the Department) in the Commonwealth. Risk-standardized, 30-day mortality is one of several indicators used to assess quality of care.

The Bureau of Health Care Safety and Quality within the Department contracts with the Massachusetts Data Analysis Center (Mass-DAC) to complete this report. The provision of this data is part of a broad, statewide initiative to increase accessibility of health care data to consumers, policy makers, and providers. This report is meant to give residents information about the relative performance of cardiac surgery programs as an aid to decision making, and to provide hospitals in the Commonwealth with key information to help drive quality improvement.

The Department, in collaboration with Mass-DAC, collects, monitors, and validates patient-specific outcome data from all hospitals that perform cardiac surgery. This report contains analysis of data on 2,941 hospital admissions in which an isolated coronary artery bypass graft (CABG) surgery was performed during the period October 1, 2012 through September 30, 2013. The Department and Mass-DAC do not publicly report on surgeon-specific mortality rates. However, data on individual cardiac surgeons are collected and analyzed. After review by a committee of medical experts, information about providers who have higher than expected mortality rates and for whom there are serious concerns about the quality of care that is provided will be shared with the leadership of the hospital department in which that provider operates, and with the Board of Registration in Medicine, the licensing body for physicians.

The data collection, verification, audit, and analytical procedures implemented in this report are comprehensive, reliable, and rigorous. This is due in no small part to the dedicated work

of the hospital data managers and cardiac surgeons, many of whom volunteered their efforts to participate in many late night meetings to review and adjudicate data.

I would also like to thank staff from the Board of Registration in Medicine and the Massachusetts Chapter of the Society of Thoracic Surgeons for their ongoing support, and of course, all the staff at Mass-DAC for their hard work and dedication.

Eric J. Sheehan, J.D.
Interim Bureau Director
Director, Bureau of Health Care Safety and Quality
Massachusetts Department of Public Health

2 Key Findings: Hospitals

2.1 Hospital Findings

- In the period October 1, 2012 through September 30, 2013 (fiscal year 2013), there were 7,151 hospital admissions in Massachusetts in which at least one cardiac surgery was performed.
  - ◇ 41.13% (2,941) of the admissions involved isolated coronary artery bypass graft (CABG) surgery.
- In the 14 hospitals that performed cardiac surgery during fiscal year 2013, the number of isolated CABG surgery admissions ranged from 69 to 413.
- The unadjusted 30-day all-cause mortality rate (defined as the number of patients dying from any cause within 30 days of surgery divided by the number of isolated CABG surgery admissions) in Massachusetts during fiscal year 2013 was 1.67%. This corresponded to 49 deaths out of 2,941 isolated CABG admissions.
- After adjusting for patient risk, the risk of 30-day mortality in a hospital one standard deviation above the state average was 1.7 times that of a hospital one standard deviation below the state average.
- **In fiscal year 2013, no hospital was identified as a statistical outlier for isolated coronary artery bypass surgery.**

3 Introduction

3.1 What is in this Report?

This document is the twelfth report (www.massdac.org/reports/surgery.html) describing hospital-specific risk-standardized mortality rates following isolated CABG surgery in Massachusetts. It describes procedures for calculating hospital-specific risk-standardized 30-day mortality rates following isolated coronary artery bypass graft (CABG) surgery performed in Massachusetts hospitals in the period October 1, 2012 through September 30, 2013 (fiscal year 2013). Surgeries performed in federal hospitals (e.g., VA Boston Healthcare System–Jamaica Plain Campus) are not included in this report. Information pertains to patients who were 18 years of age or older at the time of surgery.

Not all hospitals in Massachusetts are permitted to perform cardiac surgery. Hospitals wishing to establish a new cardiac surgery program must submit an application to the Determination of Need Program in the Massachusetts Department of Public Health. In fiscal year 2013, there were 14 cardiac surgery programs in Massachusetts, each of which submitted data to Mass-DAC.

3.2 What is Coronary Artery Bypass Surgery?

For a heart to function properly, it needs an oxygen-rich blood supply. Coronary arteries send oxygen-rich blood to the heart. When the coronary arteries are healthy, blood flows easily so that the heart muscle gets the oxygen it needs. Coronary artery disease begins when blood flow to the heart is reduced due to plaque buildup. Plaque may build up because of high cholesterol, high blood pressure, smoking, diabetes, genetic predisposition, or other factors. As the plaque buildup increases, the coronary arteries narrow and blood flow to the heart is reduced, often leading to angina (chest pain, arm pain, or jaw tightness that occurs with exertion, or in more

serious cases, at rest). If blood flow is completely blocked by the sudden development of a clot within a coronary artery, the presence of the clot usually results in a heart attack or myocardial infarction (MI), which may irreversibly damage the heart muscle.

Coronary artery disease is usually treated by one of three methods: medication, coronary intervention, or cardiac surgery. The choice of treatment depends on the degree of blockage, patient symptoms, and the number of coronary arteries involved. CABG surgery is a type of cardiac surgery that creates a new route or bypass around the blocked part of the artery, allowing the blood flow to reach the heart muscle again. During CABG surgery, the blocked coronary arteries are bypassed using some of the patient's own blood vessels. The internal mammary arteries are commonly used for the bypass, but the saphenous vein in the leg or the radial artery in the arm can also be used. Surgical procedures in which CABG surgery is the only major heart surgery performed are referred to as isolated CABG procedures.

3.3 Definition of Study Population

The patient population includes all patients aged 18 years or older undergoing isolated CABG surgery in Massachusetts adult acute care non-federal hospitals in the period October 1, 2012 through September 30, 2013. If multiple cardiac surgeries occur during an admission, admissions are categorized by the primary (initial) surgery. Isolated CABG surgery includes CABG alone as well as CABG undertaken in combination with the following procedures: maze (closed epicardial approach and radio frequency), pacemaker lead insertions, ventricular lead insertion for automatic implantable cardioverter defibrillator, patent foramen ovale closure, and femoral artery procedures. If CABG is performed in combination with maze (open heart approach), implantation of a cardioverter defibrillator, transmyocardial revascularization, or opening of the right atrium for tumor resection, then these surgeries are classified as "Other Cardiac Surgery." Lung biopsies performed in conjunction with a CABG are considered on a case by case basis

(see Appendix A, pg. 48). Table 3.1 lists the distribution of the 7,151 cardiac surgery admissions stratified by surgical procedure type in Massachusetts hospitals during fiscal year 2013.

3.4 Why Report on CABG Surgery?

CABG surgeries are costly procedures that account for the majority of cardiac surgeries performed nationally. In fiscal year 2013, isolated CABG surgeries accounted for 41.13% of all cardiac surgery hospital admissions in Massachusetts. Only data on patients who have undergone isolated CABG surgery are used to determine the mortality rates in this report.

Table 3.1: *Surgical Procedure Type Classification of Adult Cardiac Surgeries: Oct 1, 2012–Sep 30, 2013*

Procedure Type	No. of Admissions	% of Admissions
Isolated CABG	**2,941**	**41.13**
Mitral Valve Replacement (MVR)	179	2.50
Aortic Valve Replacement (AVR)	955	13.35
MVR and CABG	59	0.83
AVR and CABG	560	7.83
AVR and MVR	46	0.64
Other Cardiac Surgery	1,927	26.95
Mitral Valve Repair	263	3.68
Mitral Valve Repair and CABG	94	1.31
Non−Cardiac Procedures		
Thoracic Procedures	94	1.31
Cancelled CABG	10	0.14
Cancelled Other	23	0.32
Total	**7,151**	**100.00**

3.5 What is Mass-DAC?

Mass-DAC is a data-coordinating center responsible to the Massachusetts Department of Public Health for the collection, storage, cleaning, and analysis of the cardiac data submitted by Massachusetts hospitals. Mass-DAC is located in the Department of Health Care Policy within Harvard Medical School in Boston (www.massdac.org). Mass-DAC is advised by several committees on an ongoing basis, including the Massachusetts Cardiac Care Hospital Outlier Committee, the Cardiac Surgery Physician Reporting Committee, and the Cardiac Surgery Data Adjudication Committee. In addition, the national Society of Thoracic Surgeons (STS) and the Massachusetts STS serve as resources.

3.6 Software Utilized in Analysis

The data collection and analysis for this report utilized three different statistical software applications;

- SAS®, version 9.4 Unix/Windows [7];
- WinBUGS version 1.4 [3];
- R version 3.1 [6].

The data collection process utilized Base SAS to aggregate the core data elements for the analytic data sets. The statistical analysis used a combination of SAS/STAT, WinBUGS, and R to generate the results in this report. SAS Institute Inc. and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA.

4 Summary of Data Collection and Verification Procedures

4.1 Definition of Patient Outcome

Mortality, regardless of cause and measured within 30 days of the date of CABG surgery, is the primary patient outcome. Mortality was selected as the primary measure of quality because it is serious and unambiguous.

4.2 Massachusetts Cardiac Surgery Programs

Fourteen cardiac surgery centers treated patients in Massachusetts in the period October 1, 2012 through September 30, 2013.

4.3 Data Sources

The analytic data set for this report was created from Mass-DAC registry data and elements from external data resources used to validate hospital submitted data. Data sets included:

1. Mass-DAC cardiac surgery patient-specific data collected using the Society of Thoracic Surgeons (STS) National Cardiac Surgery data collection tool version 2.73 [8, 9] and supplemental Massachusetts data elements;

2. The Mass-DAC PCI database with data collected using the American College of Cardiology–National Cardiovascular Data Registry (ACC-NCDR–CathPCI) data collection tool [1];

3. Acute Hospital Case Mix Databases [4] from the Massachusetts Center for Health Information and Analysis;

4. Mortality data from the Massachusetts Registry of Vital Records and Statistics [5]; and

5. Mortality data from the Centers for Disease Control National Death Index [2];

4.3.1 Mass-DAC STS Registry Data

Patient-specific risk factor and outcome data were collected by hospital personnel using version 2.73 of the STS National Cardiac Surgery data collection tool (see Appendix B), containing 788 variables and supplemental Massachusetts variables for cardiac surgery procedures.

4.3.2 Mass-DAC PCI Registry Data

Patient-specific risk factor and outcome data were collected by hospital personnel using the ACC-NCDR CathPCI data collection tools. Patient information in the PCI registry was linked to the STS registry to validate patient information submitted in the STS registry. Fields validated include patient name, date of birth, gender, Social Security number, address, and consistency of dates related to episodes of care.

4.3.3 Massachusetts Acute Hospital Case Mix Database

The Massachusetts Center for Health Information and Analysis (CHIA) Acute Hospital Case Mix Databases were merged with Mass-DAC registry data to determine if all Massachusetts coronary artery bypass graft (CABG) surgeries performed during the fiscal year, (October 1, 2012 through September 30, 2013), were submitted by the participating Massachusetts hospitals as required by the Department of Public Health contract with Mass-DAC. Any CABG record in the CHIA data that did not merge to a Mass-DAC record was verified with the hospital data manager to see if the case must be submitted to the Mass-DAC registry. CHIA data elements included hos-

pital identifiers, patient date of birth, patient zip code, medical record number, diagnoses codes, procedure codes, procedure dates, admission date, discharge date, and discharge disposition. All cases determined to be a CABG surgery were submitted by the hospital, and processed through the normal Mass-DAC adjudication and validation processes.

4.3.4 Massachusetts Registry of Vital Records

The Registry of Vital Records and Statistics collects, processes, corrects and issues copies of birth, death and marriage records that occur in Massachusetts. Mass-DAC used the Registry to obtain death dates for deaths occurring in Massachusetts during the fiscal year, October 1, 2012 through September 30, 2013, and within 30 days of the surgical procedure. Death dates were requested through December 31, 2013, since a death date beyond 30 days validates a patient disposition of alive 30 days after procedure. While the primary source of 30-day mortality was the hospital-reported information, the mortality index database was employed as a verification tool.

Using a confidential and secure transmission procedure, Mass-DAC submitted records with the following information for all Mass-DAC patients: patient name, last known alive date (i.e., last discharge date or death date), date of birth, gender, and Social Security number. Registry personnel linked the Mass-DAC patient data to the mortality index using the following criteria:

- Any match on SSN (All invalid SSN set to 000000000);
- Any match on date of birth and first 3 letters of last name and first 3 letters of first name;
- Any match on full last name and first 3 letters of first name.

The resulting files were returned to Mass-DAC where additional processing was undertaken to determine exact matches and possible matches on patient records and the Registry death dates. If

a new death date was discovered, Mass-DAC contacted the hospital data manager to validate the new mortality for the patient.

4.3.5 National Death Index

The National Death Index (NDI) is a centralized database of death certificate information from all state vital statistics offices. NDI is maintained within the Census Bureau and the Centers for Disease Control (CDC) and Prevention's National Center for Health Statistics (NCHS). Identifiable data submitted to NCHS are kept confidential and secure before, during, and after the NDI computer matches. The data are protected by the Public Health Service Act [42 U.S.C. 242m Section 308(d)], as well as by the federal Privacy Act of 1974. Once the search is completed backups of the NDI user's records and of the NDI search results are removed from both the server at the CDC computer center in Atlanta and from the NDI programmers' computers in Hyattsville.

Due to cost limitations, Mass-DAC only submitted non-Massachusetts resident patient information to NDI to find deaths occurring in states other than Massachusetts. The Massachusetts Registry of Vital Records can only search for deaths that occurred in Massachusetts. The data was sent via express mail on a password-protected CD and NDI search result files were returned in the same manner. The search for possible matches was done on NDI calendar year 2012 and 2013 final files for patients having a procedure done during the fiscal year October 1, 2012 through September 30, 2013.

While the primary source of in-hospital mortality was the hospital-reported information, the NDI database was employed as a verification tool to find deaths occurring on the same day as discharge. Mass-DAC submitted records with the following information for all Mass-DAC patients: patient name, last known alive date (i.e., last discharge date or death date), date of birth, gender, race, and Social Security number for Mass-DAC patients that were non-Massachusetts residents. NDI personnel linked the Mass-DAC records and provided results files with information on ex-

act matches, probable matches, and probabilistic scores. Mass-DAC used the results to validate submitted 30-day follow-up death dates and discover possible death dates not reported. If a new death date was discovered, Mass-DAC contacted the hospital data manager to validate the new mortality for the patient.

4.4 Mass-DAC Data Collection Procedures

The majority of Massachusetts hospitals used clinical staff, such as physicians, nurses, and perfusionists, to collect information. Data were entered directly into the STS vendor software database by the clinical staff or by a data manager. Alternatively, the data manager collected the STS information under the direction of clinical staff and then entered the data following a retrospective chart review. Data managers were also responsible for maintaining their hospital database, ensuring the accuracy of the data, and transmitting data to both the STS and Mass-DAC.

Data were regularly transmitted by hospitals and harvested by Mass-DAC (Table 4.1). This process involved submitting protected data during specific harvest periods. Hospitals encrypted and password-protected the data, and transmitted it electronically using a secure repository on a secure website. Hospitals submitted subsequent corrected data as often as desired during the three months following a harvest, and they could sign off on its accuracy and completeness at any time during that period. However, all fiscal year 2013 cardiac surgery data were required to be complete by April 1, 2014, after which no changes were accepted without written permission from Mass-DAC.

Table 4.1: *Fiscal Year 2013 Cardiac Surgery Data Harvest Schedule*

Harvest Month	Corresponding Dates of Cardiac Surgery
March 2013	October 1, 2012–December 31, 2012
June 2013	January 1, 2013–March 31, 2013
September 2013	April 1, 2013–June 30, 2013
December 2013	July 1, 2013–September 30, 2013
April 2014	Final close date for fiscal year 2013 data

4.5 Cleaning and Validation Procedures

Hospital data submissions were cleaned and verified using a variety of procedures, including continuous feedback via ongoing data quality reports, meetings and communication, and reviews of concordance with administrative datasets and medical chart audits.

4.5.1 Hospital-Specific Data Quality Reports

For each data submission, Mass-DAC provided a data quality report to each hospital describing the distribution of all STS variables and identifying cases with missing, out of usual range, or inconsistent coding. The hospitals were given 30 days to correct the data deficiencies identified by Mass-DAC following receipt of each data quality report. There were a total of 153 data submissions sent by 14 hospitals during fiscal year 2013 with a mean of 2.73 submissions per hospital per collection period. Data submissions for fiscal year 2013 ranged from 1 to 6 per hospital per collection period.

4.5.2 Mortality Registry Data

Two mortality data sources, the CDC National Death Index and Massachusetts Registry of Vital Records, were used to validate known mortalities within 30 days of the surgery and find unknown mortality dates for matched patient records. Both merge results were found to have high agreement between the reported 30-day mortality information from the hospital and the registry death dates. After verifying the mortality status of these patients, four cases were changed to 30-day mortalities, two of which were isolated CABG patients.

4.5.3 Massachusetts Acute Hospital Case Mix Data

The Massachusetts CHIA inpatient case mix data was used as an additional method in determining whether all appropriate cases of cardiac surgery from each institution were submitted to Mass-DAC. One isolated CABG and two CABG plus other procedure type cases were found in the case mix data that had not been submitted to the Mass-DAC database. The cases were confirmed with each hospital and each case was submitted to the Mass-DAC registry.

4.5.4 Meetings and Communication

Mass-DAC communicated regularly via e-mail and telephone with the data managers to clarify definitions or procedural issues, resolve data submission concerns, and to serve as a facilitator to the national STS. Data managers were given the opportunity to ask and discuss questions at data manager meetings or through an e-mail network. Results were shared at the Mass-DAC Data Manager meetings. This process helped identify areas where data may be inconsistent, incorrectly coded, or outlying.

4.5.5 Audit Data

A sample of the fiscal year 2013 isolated CABG data was audited. Ten cardiac surgeons and three data managers, representing 8 of the 14 cardiac surgery programs, volunteered for the Adjudication Committee to perform audits. Records requested from the hospitals included those for:

1. All isolated coronary artery bypass graft (CABG) patients coded as a death within 30 days of surgery;

2. All isolated CABG patients coded as having shock prior to surgery;

3. All isolated CABG patients coded with emergent or emergent salvage status;

4. All isolated CABG patients coded as having peripheral vascular disease (PVD) as a risk factor;

5. Those admissions coded as having an "other" cardiac procedure in combination with isolated CABG (to determine if those should have been coded as an isolated CABG) and resulting in death within 30 days of surgery.

For the variable audit, 528 records were requested from the 14 hospitals. The records were reviewed to determine data consistency and accuracy of coding. A total of 95 variable coding changes were made.

For the procedure audit, 70 records were requested. The procedure audit records included a subset of surgery admissions having *CABG + other*, (see Appendix A, pg. 48, Procedure Identification Guidelines for Adult Cardiac Surgery, which outlines the rules used by Mass-DAC for classifying surgeries as isolated CABG versus *CABG + other*). These records were reviewed for the procedure audit to determine if some might be considered isolated CABG surgery. Documentation requested from the hospitals included discharge summaries, operative reports, anesthesia records, admission and history summaries, and catheterization reports. Records that were reviewed and subsequently identified by the auditors to be isolated CABG procedures were then also reviewed for the variables of shock, emergent or emergent salvage status, and PVD. A total of 39 *CABG + other* codings were changed to *isolated CABG*.

In all, 572 records (some records were in both the variable and procedure audits) were reviewed by the Adjudication Committee to determine agreement with the information submitted by the hospitals. If the Adjudication Committee did not agree with the coding of the presence of shock, emergent status, emergent salvage status, PVD, or procedure type of *CABG + other*, the coding was changed. Hospitals were notified of any disagreement in coding and given an

opportunity to appeal the Adjudication Committee decisions. All coding changes made by the Adjudication Committee were then implemented in the Mass-DAC database.

5 Risk Adjustment

5.1 Who Receives Isolated CABG Surgery in Massachusetts?

Table 5.1 on page 18 lists the age/sex/race distribution for 2,941 adult isolated CABG surgery patients at 14 cardiac surgery programs in Massachusetts. The STS data collection tool allows patients to be identified with more than one race; in addition, Hispanic is an ethnicity choice and is separate from the race designations. Patients not selecting any race designation are defined as "other race." The majority of patients were male (77.6%). In fiscal year 2013, 56.7% of the admissions corresponded to patients aged 65 years of age or older at the time of surgery. Patients who resided outside of Massachusetts at the time of surgery comprised 10.4% of the 2,941 isolated CABG admissions (data not shown).

5.2 Risk Adjustment for Assessing Hospital Mortality

Specific **risk** factors are known to contribute to heart disease. These risk factors include high cholesterol, smoking, high blood pressure, family history of heart disease, diabetes, age, sex, and general health status. Such factors have an impact on the risk of mortality following CABG surgery. Sicker patients or patients with more health-related risks may be more likely to die following a CABG surgery than healthier patients. Moreover, patients who are sicker may be more likely to be treated at particular hospitals while patients who are healthier may be more likely to be treated at other hospitals. To fairly assess hospitals and avoid penalizing hospitals that treat sicker patients, it is important to consider differences in a patient's health prior to surgery. Mass-DAC selects risk factors for the annual report based on advice obtained from its Senior Medical Advisors, Mass-DAC surgeon committees, as well as the Massachusetts STS.

Table 5.1: *Demographic Distribution for All Adult Isolated CABG Surgery Admissions ($N = 2,941$) in Massachusetts Hospitals: Oct 1, 2012–Sep 30, 2013.*

Note: Entries are counts. Patients may select more than one race category. The Hispanic Ethnicity category is independent of the race categories and may be selected in addition to a race.

Age Group	Total by Age		White	African American	Other Race	Hispanic Ethnicity
Male						
18–44 45–54 55–64	51 289 695	≤64	915	37	89	47
65–74 ≥75	742 505	≥65	1,136	27	88	34
Total	**2,282**		**2,051**	**64**	**177**	**81**
Female						
18–44 45–54 55–64	12 56 170	≤64	200	15	26	22
65–74 ≥75	211 210	≥65	376	25	23	16
Total	**659**		**576**	**40**	**49**	**38**
Total Male and Female						
18–44 45–54 55–64	63 345 865	≤64	1,115	52	115	69
65–74 ≥75	953 715	≥65	1,512	52	111	50
Total	**2,941**		**2,627**	**104**	**226**	**119**

The statistical process of accounting for differences in patient sickness prior to surgery is called risk adjustment. This statistical process aims to "level the playing field" by accounting for health risks that patients have prior to surgery. The hospital-specific 30-day mortality rates in this report have been adjusted in order to account for patient health prior to surgery. The numbers reported compare each hospital's mortality rate to what would be expected to happen given the health of patients undergoing surgery in its program. The numbers are not designed to provide

comparisons between pairs of hospitals—such comparisons would only be valid to the extent that the pairs of hospitals treated patients with very similar health status prior to surgery.

5.3 How are Hospital Differences in Patient Outcomes Measured?

If there are differences in hospital quality, due to staff, experience, or other factors, then the risks of 30-day mortality for two patients having exactly the same risk factors prior to a CABG surgery but who are treated in different hospitals should be different. The statistical model used to calculate mortality rates in this report, a hierarchical Poisson regression model, permits a difference to exist between the risks of mortality for patients with the same risk factors treated at different hospitals. This is accomplished by including a hospital-specific (random) effect. If no key risk factor that varies by hospital is missing from the statistical model, then the hospital-specific random effect represents quality for each hospital. If there are no differences in the hospital-specific effects across the hospitals, then there is no evidence of quality differences.

6 Identifying Outlying Cardiac Surgery Programs

One of the purposes of this report is to identify hospitals that have unusually high or unusually low mortality rates. Such hospitals are denoted as "outlying"—however, the designation of outlying depends on how large the difference is. Two methods are used to identify outlying hospitals. The first method calculates a 95% interval estimate for each hospital's risk-standardized mortality rate. If the interval estimate excludes the Massachusetts unadjusted 30-day mortality rate, the hospital is designated as "outlying."

Because any one hospital could influence the estimates of the risk-standardized mortality rate for other hospitals, Mass-DAC also calculates the expected number of mortalities at each hospital using the experience of all other hospitals in Massachusetts. If it is *unlikely* that the actual number of mortalities observed at a hospital and the number of mortalities predicted using the combined experience of all Massachusetts hospitals except the hospital under study is the same, then the hospital is classified as "outlying." We refer to the measure of the likelihood of this event as a cross-validated p-value. Intuitively, this strategy provides a quantitative measure of how likely the hospital's outcome is compared to its peers – the smaller the "p-value", the less likely it is like its peers.

If (1) the 95% interval estimate for a particular hospital excludes the Massachusetts unadjusted 30-day mortality rate or (2) the probability of the observed mortality predicted from all other hospitals for a particular hospital is small, then the hospital is designated as outlying. It is important to note that the classification in this report is relative to all hospitals in Massachusetts performing isolated CABG surgery. For example, a Massachusetts hospital identified as having higher (or lower) than expected mortality based on our analysis may not be classified as having higher (or lower) than expected mortality compared to hospitals outside of Massachusetts.

6.1 Standardized Mortality Incidence Rates (SMIR)

Mass-DAC calculated a standardized mortality incidence rate (SMIR) and a corresponding 95% posterior interval for each hospital. The SMIR is interpreted as the projected mortality rate at the hospital today if hospital quality remained the same as in fiscal year 2013. The SMIR consists of an estimate of the hospital's underlying (true) risk-adjusted rate divided by an estimate of the mortality rate expected at the hospital given its case mix. Each hospital's SMIR should only be interpreted in the context of its interval. If the 95% interval includes the unadjusted Massachusetts mortality rate, then the hospital mortality is not different than expected. If the interval excludes the Massachusetts unadjusted rate, then the hospital is an outlier. In this case, if the upper limit of the interval is lower than the unadjusted Massachusetts rate, then fewer patients than expected died. Such a hospital would be categorized as having lower than expected mortality. If the lower limit of the interval is higher than the Massachusetts unadjusted rate, then more patients than expected died. Such a hospital would be categorized as having higher than expected mortality.

Hospital-specific 30-day mortality rates, standardized to the population of adults undergoing isolated CABG surgery in Massachusetts hospitals, were calculated using the following procedure:

1. A hierarchical Poisson regression model was estimated that assumes the log of 30-day mortality is related linearly to the set of risk factors and permits baseline risk to vary across hospitals. Let $Y_{ij} = 1$ if the j^{th} patient treated at the i^{th} CABG hospital died within 30 days of CABG surgery and 0 otherwise, and let n_i equal the total number of CABG surgery admissions at the hospital. The model estimated had the general form:

$$\text{Log}[Probability(Y_{ij} = 1)] = \beta_{0i} + \beta(\text{Risk Factors})_{ij} \quad (1)$$

$$\text{where} \quad \beta_{0i} \sim \text{Normal}(\mu, \tau^2) \quad (2)$$

The parameters, μ and τ^2 represent the overall mean risk-adjusted log of mortality and between-hospital variation, respectively. If there are no mortality differences based on 30-day mortality across the 14 CABG surgery hospitals after adjusting for patient risk, then

$$\beta_{0,1} = \beta_{0,2} = \cdots = \beta_{0,14} = \beta_0 \quad \text{and this happens if and only if} \quad \tau^2 = 0 \tag{3}$$

The hierarchical regression models were estimated using WinBUGS software. The prior distributions assumed for β, μ, and τ^2 were, respectively: independent normal distributions with mean 0 and variance 1,000 for the components of β; μ from a normal distribution with mean 0 and variance 1,000. We assumed that between-hospital standard deviation, τ, arose from a half normal distribution with mean 0 and variance 0.26. This half normal distribution has its mode at 0, permitting no differences in between-hospital log-odds of mortality, but has a median of 0.39, permitting the range in the log-odds of 30-day mortality to be as large as 5. We vary these parameters as part of a sensitivity analysis. A burn-in of 25,000 draws was used and conclusions were based on an additional 5,000 draws. Convergence of the model was assessed using the Gelman-Rubin statistic via three parallel chains.

2. The risk factors are those listed in Table 7.1. The term β describes the association of each risk factor and log(30-day mortality). Large values of β indicate that patients with the particular risk factor are at higher risk of dying compared to patients without the risk factor.

3. The *expected* mortality rate at hospital i, π_i, is:

$$\pi_i = \frac{\sum_{j=1}^{n_i} \exp[\mu + \beta(\text{Risk Factors})_{ij}]}{n_i} \tag{4}$$

This is the mortality rate expected at hospital i using the mortality intensity for the entire state, β, and the case mix reported at the hospital, $(\text{Risk Factors})_{ij}$. Thus, it represents the severity of cases at the institution.

4. The *observed* mortality rate at hospital i, p_i, is:

$$p_i = \frac{\sum_{j=1}^{n_i} \exp[\beta_{0i} + \beta(\text{Risk Factors})_{ij}]}{n_i} \tag{5}$$

This is interpreted as the mortality rate at the i^{th} hospital adjusted for case mix. This mortality rate is not the actual observed rate but rather a *smoothed* rate. The estimate weights the observed mortality rate by the amount of information available at the hospital relative to the amount of information available between hospitals. Because the model assumes that the probability of dying is greater than 0, the smoothed estimate must be greater than 0.

5. The Massachusetts unadjusted 30-day mortality rate is:

$$\bar{Y} = 100 \times \frac{\sum_{ij} Y_{ij}}{\sum_i n_i} \tag{6}$$

6. The standardized mortality incidence rate (SMIR) at institution i is:

$$\text{SMIR}_i = \bar{Y} \times \frac{p_i}{\pi_i} \tag{7}$$

The SMIR is interpreted as the projected mortality rate at the hospital today if hospital quality remained the same as in fiscal year 2013.

7. Ninety-five percent posterior intervals were calculated for each hospital's SMIR.

6.2 Cross-Validated P-Values

Because data from all hospitals are used to estimate the expected number of deaths in any hospital and because the number of CABG hospitals in Massachusetts is small, there is a risk that outlying hospitals may influence the estimates of μ and, in particular, τ^2. One method to avoid this risk involves identifying hospitals as outlying through "cross-validation". This process involves systematically dropping each hospital from the data set and re-estimating the risk-adjusted model. Using the new model, the predicted number of deaths at the dropped hospital is calculated. This predicted number may be interpreted as the number of mortalities expected at the dropped hospital if the dropped hospital had the same level of quality as the remaining Massachusetts hospitals.

The p-value for the "cross-validation" analysis are calculated as follows for each draw:

- If observed mortality is less than replicated mortality, then $p1 = 1$
- If observed mortality equal to replicated mortality, then $p2 = 1$
  (this happens most frequently when observed mortality = 0)
- If observed mortality greater than replicated mortality, then $p3 = 1$

The p-value that we report, $p*$, is calculated as $1 - MAX(p1, p3)$. A p-value closer to 0 indicates that a hospital more consistently falls into either the "better than expected" or "worse than expected" group. A p-value closer to 1 indicates that a hospital falls evenly between $p1$ and $p3$, with some draws in $p2$ as well.

Mass-DAC compared the predicted number of deaths to the actual number of deaths at the dropped hospital and calculated a posterior *probability*. This probability, loosely called a posterior "p-value," quantifies how likely the observed number of deaths would be if the dropped hospital had the same level of quality as all remaining isolated CABG hospitals. Small p-values (those ≤ 0.01) indicate that the dropped hospital is outlying. When the p-value is small and the actual number of deaths is larger than that predicted by the remaining hospitals, the dropped

hospital is classified as having higher than predicted mortality. When the p-value is small and the actual number of deaths is smaller than predicted by its peers, then the hospital is classified as having lower than predicted mortality. Mass-DAC eliminated each isolated CABG hospital from the data set, re-estimated the regression parameters, predicted mortality at the eliminated hospital, and calculated a posterior probability of the comparison of the observed mortality and the predicted mortality. The eliminated hospital was replaced into the data set, and Mass-DAC eliminated another hospital from the data set, repeating the entire process.

6.3 Sensitivity Analyses

Several sensitivity analyses were undertaken to determine whether conclusions would change when making reasonable changes to some of the underlying assumptions. A key assumption, given the small number of hospitals in Massachusetts, is the assumed distribution for the between-hospital variance. The parameter τ represents the standard deviation of the hospital-specific risk-adjusted log(mortality) and τ^2 represents between-hospital variance. The main analyses assumed that τ arose from a half normal distribution with mean 0 and variance 0.26. Mass-DAC re-estimated the hierarchical model using different prior distributions for τ^2 to determine how sensitive results are to the assumed prior distribution of the variance component.

1. We assumed that the between-hospital standard deviation arose from a uniform distribution over the range 0 to 1.5. This translates to assuming that small values in between-hospital heterogeneity are just as likely as large values.

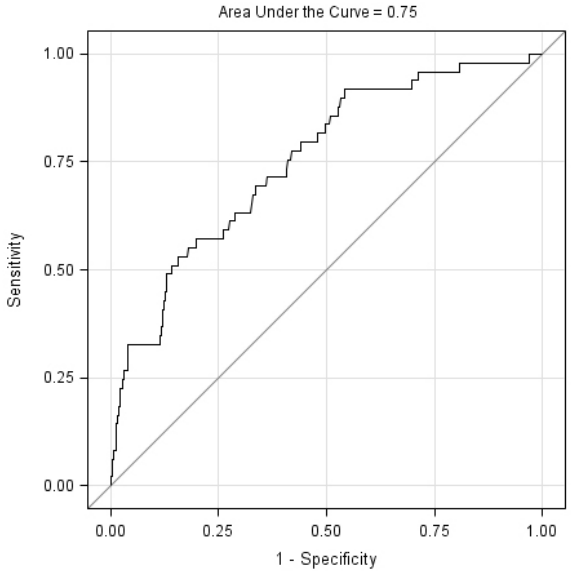
2. We assumed a vague prior distribution for the precision, $\frac{1}{\tau^2}$. Specifically, we assumed the precision parameter arose from a highly dispersed Gamma distribution having scale parameter 0.001 and rate parameter 0.001.

The original conclusions remained unchanged after running the sensitivity analyses.

7 Hospital Quality Following Isolated CABG Surgery

Of the 2,941 isolated CABG surgery admissions in fiscal year 2013 in Massachusetts, 49 patients (1.67%) died within 30 days of their surgery. Table 7.1 lists the prevalence (as a percentage) of important risk factors and the relationship of each risk factor (controlling for all other risk factors) to 30-day mortality following surgery. For example, 0.85% of the 2,941 isolated CABG surgery admissions were associated with patients who had a prior CABG surgery. Relative risks greater than 1 correspond to increased risk of mortality while those less than 1 correspond to decreased risk of mortality. The relative risk of 4.76 for those having a prior CABG surgery indicates that those with such a history are almost 5 times as likely as those not having a prior CABG surgery to die within 30 days of CABG surgery. Patients coded in cardiogenic shock prior to isolated CABG surgery are 5.87 times more likely to die within 30 days than patients not coded as in cardiogenic shock. Because age is measured in years, the table reports the average number of years over age 65 for the cohort.

Figure 7.1: *ROC Curve-Hierarchical: Isolated CABG Admissions*



The estimate of between-hospital variation after adjusting for patient case mix is 0.0745. This may be interpreted as indicating that the risk of dying if admitted to a Massachusetts cardiac surgery program one standard deviation above the state mean mortality is 1.7 times that of dying if admitted to a program one standard deviation below the state mortality mean. The estimated area under the ROC curve is 0.75 (Figure 7.1).

Table 7.1: *Prevalences and Relative Risks of 30-Day Mortality Following Isolated CABG Surgery in Adults: Oct 1, 2012–Sep 30, 2013. Based on 2,941 surgeries with 49 deaths (1.67%).*

Risk Factor	Prevalence (%)	Relative Risk	95% Interval for Relative Risk
Age in Years over 65	1.13[a]	1.03	(1.00, 1.06)
Renal Failure–Dialysis	2.14	4.98	(1.47, 11.20)
Peripheral Vascular Disease	12.61	2.28	(1.14, 4.04)
Diabetes	43.90	1.21	(0.64, 2.05)
Prior CABG Surgery	0.85	4.76	(0.62, 13.67)
Cardiogenic Shock	0.92	5.87	(1.18, 16.33)
Ejection Fraction (Ref: $\geq$30 and missing)	94.46	1.00	—
Less than 30%	5.54	3.46	(1.42, 6.75)
Status of CABG (Ref: Elective)	36.52	1.00	—
Urgent	60.93	1.62	(0.74, 3.16)
Emergent or Emergent Salvage	2.55	1.45	(0.18, 4.63)

Between-Hospital Parameters	Mean	95% Interval
Between-Hospital Average log, μ	-5.09	(-5.85, -4.34)
Between-Hospital Variance[b] in logs, τ^2	0.0745	$(1.541\times10^{-4}, 0.365)$

[a] Average age of patients undergoing isolated CABG surgery is $65 + 1.13 = 66.13$ years of age. For age, the mean is used instead of prevalence because age is continuous and not categorical.

[b] The between-hospital variance may be roughly interpreted as saying that the odds of dying when treated by a hospital one standard deviation above the state mortality mean is 1.7 times that when treated by a hospital one standard deviation below the state mortality mean.

Figure 7.2: *Model Covariate Summaries, by Hospital Oct 1, 2012–Sep 30, 2013.*

Each point corresponds to a Massachusetts CABG hospital. Hospitals sorted from lowest value to highest value for each covariate chart.

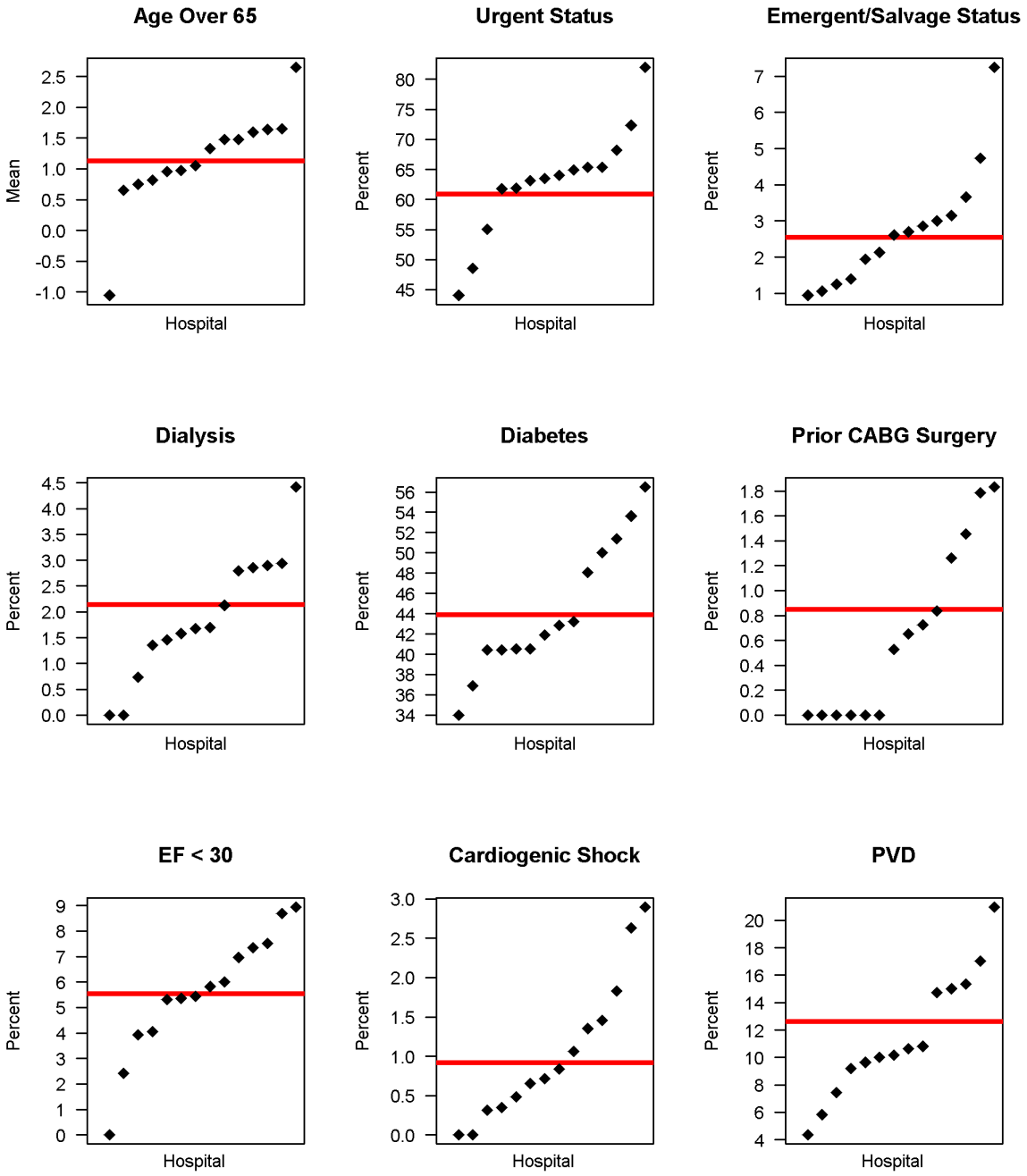
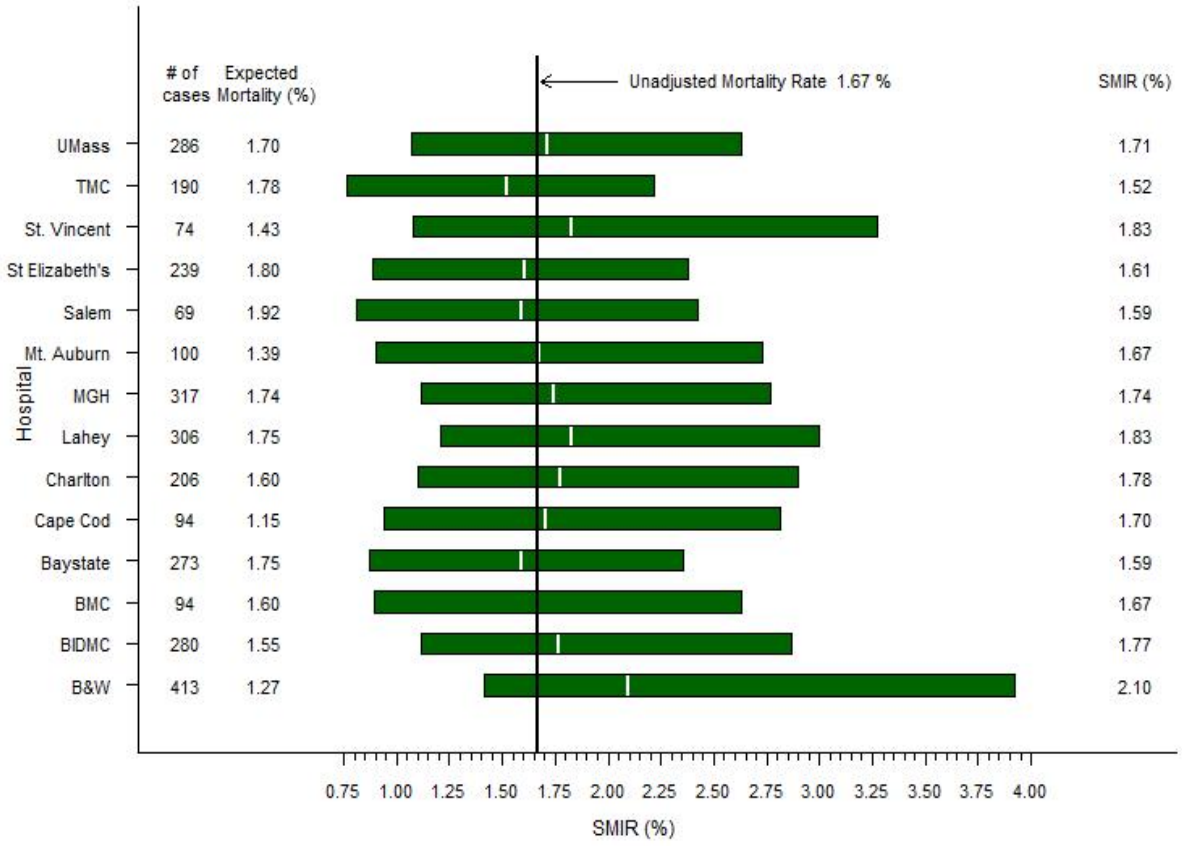


Figure 7.3: *Ninety-Five Percent Posterior Intervals for Standardized 30-Day Mortality Incidence Rates (SMIRs) Following Isolated CABG Surgery in Massachusetts: Oct 1, 2012–Sep 30, 2013*

# of cases refers to the number of isolated CABG surgery admissions; expected mortality is the percentage of cases expected to die given the case mix of the patients treated in the hospital. The white vertical line in each box is the hospital's SMIR while the black vertical line denotes the unadjusted Massachusetts 30-day mortality rate of 1.67%.



HOSPITAL KEY:
B&W = Brigham and Women's Hospital; **BIDMC** = Beth Israel Deaconess Medical Center; **BMC** = Boston Medical Center; **Baystate** = Baystate Medical Center; **Cape Cod** = Cape Cod Hospital; **Charlton** = Southcoast Health–Charlton Memorial Hospital; **Lahey** = Lahey Hospital & Medical Center; **MGH** = Massachusetts General Hospital ; **Mt. Auburn** = Mount Auburn Hospital; **Salem** = North Shore Medical Center–Salem Hospital; **St. Elizabeth's** = Saint Elizabeth's Medical Center; **St. Vincent** = Saint Vincent Hospital; **TMC** = Tufts Medical Center; **UMass** = UMass Memorial Medical Center.

Figure 7.2 on page 28 displays the model covariate summaries by hospital. The red horizontal line on each chart is the Massachusetts state average (prevalences) shown in Table 7.1 on page 27. Each chart point represents one of the 14 cardiac surgery programs and is sorted from lowest to highest prevalence for each covariate. For example, the figure indicates that in one hospital about 4% of its isolated CABG cases had PVD and another hospital had about 20% of its isolated CABG cases with PVD.

Figure 7.3 on page 29 displays the SMIRs and corresponding 95% posterior intervals. The solid black vertical line in the figure is the unadjusted state 30-day mortality rate of 1.67%. Listed on the left-hand side of the figure are the total number of isolated CABG surgery admissions and the expected 30-day mortality rates for each hospital. The expected mortality rate provides an overall assessment of case mix severity at each program. Increasing values of the expected 30-day mortality rates correspond to increasing admission severity. Listed on the right-hand side are the estimated SMIRs. All 95% posterior intervals (horizontal boxes) include the unadjusted Massachusetts rate of 1.67%.

Figure 7.4 on page 31 graphically depicts within and between-hospital differences in risk of isolated CABG cases treated in fiscal year 2013. We multiplied the risk factors for each hospital's CABG case observed in 2013 by the regression coefficients estimated in the prior year's report, summed this quantity within a case, and converted it to a probability. This probability represents the predicted risk of 30-day mortality. We then summarized the distribution of these predicted probabilities within each hospital. This was accomplished using a density estimator. For each CABG hospital in the figure, the number of isolated CABG cases relative to its total number of CABG cases is plotted against the "severity" (the predicted probability multiplied by 100) of its cases. Hospitals having long right tails correspond to those predicted to have treated sicker patients.

Figure 7.4: *Case-Mix Severity, by Hospital Oct 1, 2012–Sep 30, 2013.*

The x-axis depicts the predicted risk (multiplied by 100) of dying 30-days after isolated CABG surgery and the y-axis represents the relative number of isolated CABG surgery admissions at the predicted risk.

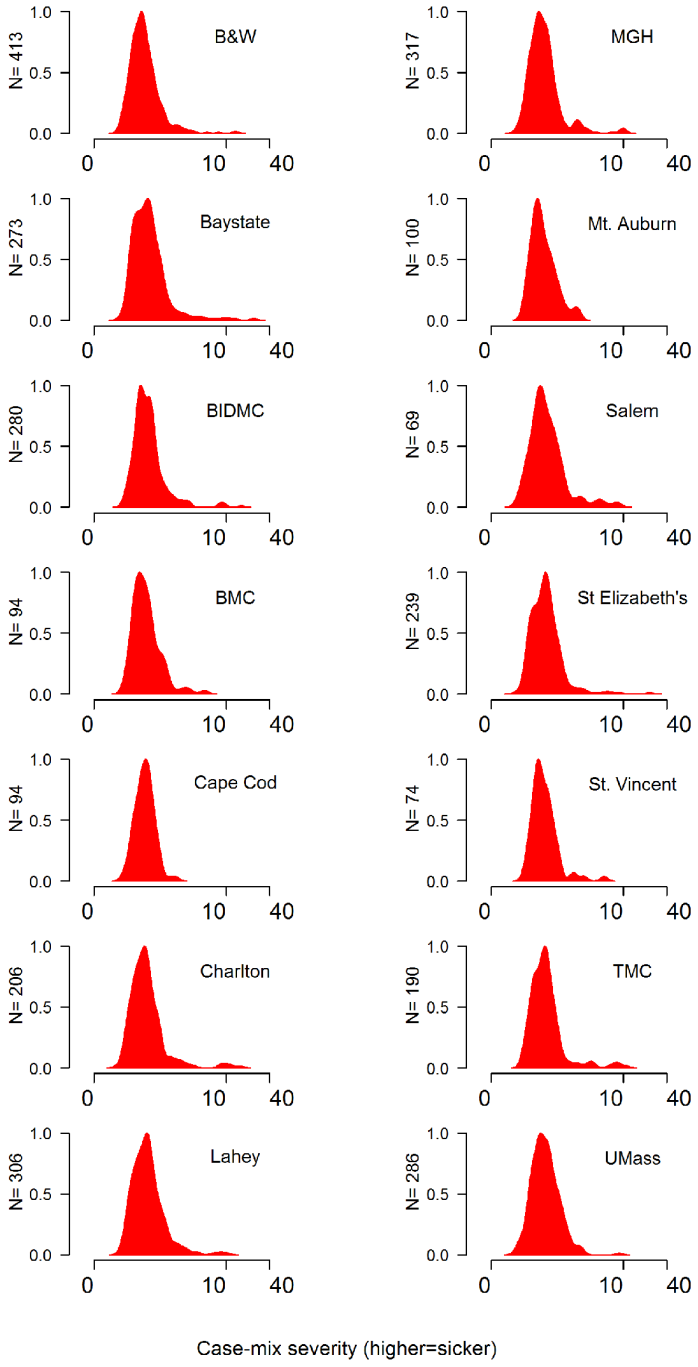


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Figure 7.5: *Cross-Validated P-Values: Isolated Cardiac Surgery Admissions Oct 1, 2012–Sep 30, 2013.*

Posterior probabilities (p-values) of observed with predicted mortality for each of the 14 cardiac surgery programs are listed on the y-axis; the x-axis identifies the hospital.

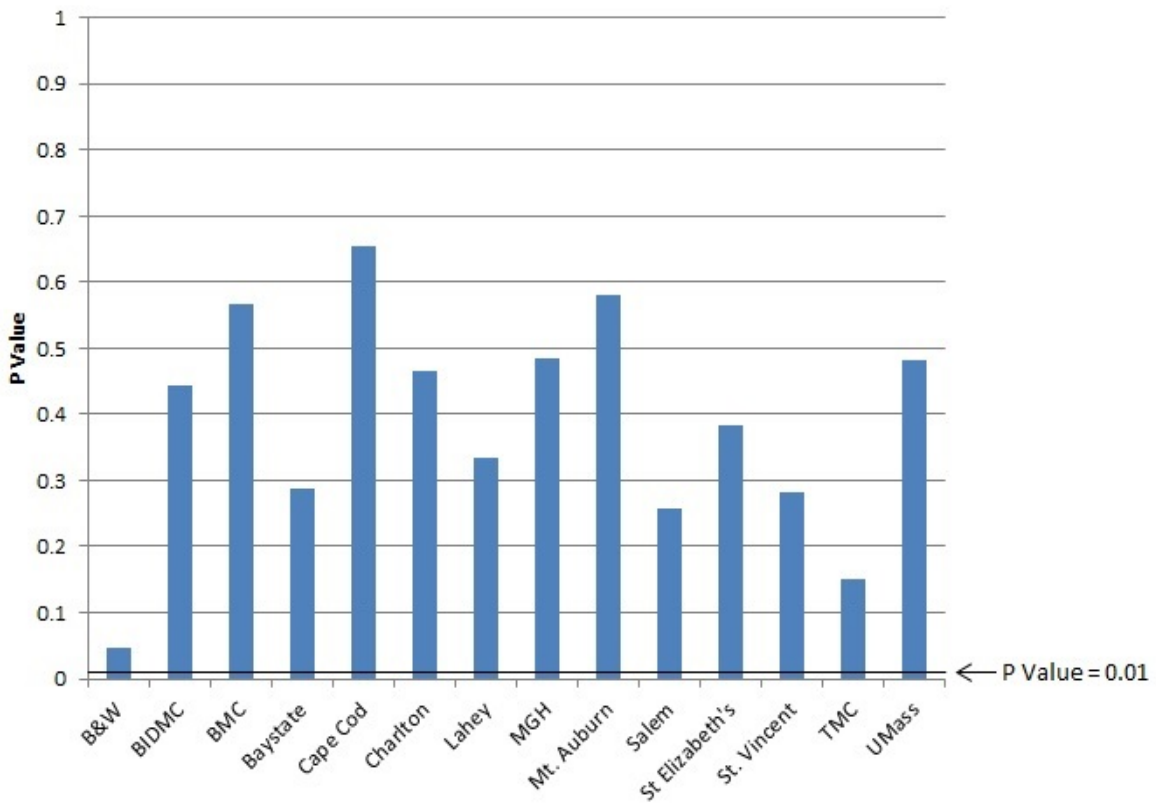

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Figure 7.5 on page 32 presents the cross-validated posterior probabilities (p-values) where the reference line on the graph at 0.01 indicates the cutoff for outliers based on the p-value. Any hospital with a bar entirely under this line is considered to be different than predicted. The cross validated p-values indicate that there were **no cardiac surgery program outliers** in fiscal year 2013.

8 Annual Hospital 30-Day Mortality Trends Following Isolated CABG Surgery Jan 1, 2002–Sep 30, 2013

8.1 Key Changes in Reporting

- FY 2006:
    1. Cohorts analyzed over a fiscal year October–September instead of a calendar year January–December;
    2. The number of categories for the MI variable was reduced from five to three in the hospital model.
- FY 2007:
    1. Admissions coded with shock, emergent status, or emergent salvage status were removed from the surgeon cohort.
- FY 2008:
    1. Renal failure was replaced with dialysis as a risk factor;
    2. Patients for whom ejection fraction (EF) was not done or its value missing were included with the reference group in the model, while the model variable EF<30 or missing or not done was changed to EF<30;
    3. Intra-aortic balloon pump was removed from the model.

- FY 2009:

    1. The number of categories for the MI variables was reduced from three to two in the surgeon model.

- FY 2010:

    1. The number of covariates in both the hospital and surgeon models were reduced by eliminating the following:

        ◇ Male;

        ◇ Hypertension;

        ◇ Prior PCI;

        ◇ Ejection fraction 30-39%;

        ◇ Myocardial infarction >24 hours.

    2. The categories describing timing of myocardial infarction (MI) combined within 6 hours and 7-24 hours to the category MI within 24 hours;

    3. The model changed from a hierarchical logistic–normal regression to a Poisson–normal regression.

- FY 2011:

    1. The number of covariates in the model was reduced, eliminating myocardial infarction within 24 hours;

    2. Suspended public reporting of individual surgeons to be consistent with the Massachusetts reporting for interventional cardiologists performing percutaneous coronary interventions. Data will continue to be collected and analyzed.

- FY 2012:

    1. The number of covariates in the model was reduced, eliminating peripheral vascular disease.

- FY 2013:

    1. The number of covariates in the model was increased, adding back in peripheral vascular disease.

Table 8.1: *Summary of Isolated CABG Admissions and 30-Day Crude Mortality Percentages CY 2002 through FY 2013*

Year of Surgery	Number of Hospitals	Number of Admissions	30-Day Crude Mortality (%)	Between-Hospital Variance in Log-Odds of Mortality	Between-Hospital Standard Deviation in SMIRS (%)
CY 2002	13	4,603	2.19	0.042	0.13
CY 2003	14	4,393	2.25	0.094	0.29
CY 2004	14	3,986	2.01	0.349	0.72
CY 2005	14	3,883	1.65	0.130	0.31
FY 2006	14	3,684	1.41	0.035	0.045
FY 2007	14	3,396	1.47	0.389	0.580
FY 2008	14	3,336	1.38	0.049	0.069
FY 2009	14	3,284	1.19	0.049	0.054
FY 2010	14	3,169	1.23	0.067	0.066
FY 2011	14	2,840	0.99	0.226	0.208
FY 2012	14	2,680	1.23	0.061	0.059
FY 2013	14	2,941	1.67	0.075	0.142

CY denotes calendar year (Jan-Dec); FY denotes fiscal year (Oct-Sep).

9 Important Definitions

STS version 2.73 was used for data collection for surgeries from October 1, 2012 through September 30, 2013. Many of the definitions used in this section were extracted from the STS Adult Cardiac Data Specifications, version 2.73.[8]

Admissions: Refers to a single episode of care at one facility from the date of admission to the date of discharge.

Aortic Valve Repair: Surgical repair of the aortic valve of the heart. The aortic valve is responsible for facilitating the flow of blood into the aorta.

Aortic Valve Replacement (AVR): A surgical procedure involving replacement of the aortic valve of the heart.

Cardiac Catheterization: A procedure that determines the extent and the location of the coronary artery obstruction or blockage.

Cardiac Surgery: Surgery on the heart and the thoracic great vessels. Examples of cardiac surgery include coronary artery bypass grafts, heart valve repair or replacement, heart transplantation, surgery of the thoracic aorta, repair of congenital heart defects, and minimally invasive heart surgery.

Cardiogenic Shock: Indicate whether the patient was, at the time of procedure, in a clinical state of end organ hypoperfusion due to cardiac failure according to the following criteria:

- **a.** persistent hypotension (Systolic BP <80-90 or mean arterial pressure 30 mmhg lower than baseline) and
- **b.** severe reduction in Cardiac Index (<1.8 without support or <2.2 with support).

Cardiovascular Disease: Includes diseases of the heart or vessels that supply the body and the heart muscle with blood and oxygen.

Coronary Artery Disease: A disease affecting the coronary arteries in which the flow of oxygen-containing blood to the heart muscle is partially or completely blocked, resulting in angina or a heart attack.

Coronary Artery Bypass Graft (CABG) Surgery: An operation in which the blocked coronary vessels are bypassed with the patient's own vessels to improve flow to the heart muscle. Coronary vessels are those vessels that supply the heart muscle with blood and oxygen.

Cross-Validation: Model validation is done to ascertain whether predicted values from a statistical model are likely to accurately predict responses on future subjects or on subjects not used to develop the analytical model. Cross-validation involves dropping a set of observations from the analytical process and the outcomes for the dropped set are predicted. This process is repeated many times in order to characterize the accuracy of the predictions.

Diabetes: Indicate whether patient has a history of diabetes diagnosed and/or treated by a physician. The American Diabetes Association criteria include documentation of the following:

a. A1c $\geq$ 6.5%; or

b. Fasting plasma glucose $\geq$ 126 mg/dl (7.0 mmol/l); or

c. Two-hour plasma glucose $\geq$ 200 mg/dl (11.1 mmol/l) during an oral glucose tolerance test; or

d. In a patient with classic symptoms of hyperglycemia or hyperglycemic crisis, a random plasma glucose $\geq$ 200 mg/dl (11.1 mmol/l). It does not include gestational diabetes.

Dialysis: Indicates whether the patient is currently undergoing dialysis.

Ejection Fraction: Indicates the percentage of the blood emptied from the ventricle at the end of the contraction.

Myocardial Infarction (MI): Indicate if the patient has a history of MI. A myocardial infarction is evidenced by any of the following:

a. A rise and fall of cardiac biomarkers (preferably troponin) with at least one of the values in the abnormal range for that laboratory [typically above the 99th percentile of the upper reference limit (URL) for normal subjects] together with at least one of the following manifestations of myocardial ischemia:

1. Ischemic symptoms;

2. ECG changes indicative of new ischemia (new ST-T changes, new left bundle branch block, or loss of R-wave voltage),

3. Development of pathological Q-waves in 2 or more contiguous leads in the ECG (or equivalent findings for true posterior MI);

4. Imaging evidence of new loss of viable myocardium or new regional wall motion abnormality;

5. Documentation in the medical record of the diagnosis of acute myocardial infarction based on the cardiac biomarker pattern in the absence of any items enumerated in a-d due to conditions that may mask their appearance (e.g., peri-operative infarct when the patient cannot report ischemic symptoms; baseline left bundle branch block or ventricular pacing)

b. ECG changes associated with prior myocardial infarction can include the following (with or without prior symptoms):

1. Any Q-wave in leads V2-V3 $\geq$0.02 seconds or QS complex in leads V2 and V3.

2. Q-wave $\geq$0.03 seconds and $\geq$0.1 mV deep or QS complex in leads I, II, aVL, aVF, or V4-V6 in any two leads of a contiguous lead grouping (I, aVL, V6; V4-V6; II, III, and aVF).

3. R-wave $\geq$0.04 seconds in V1-V2 and R/S $\geq$1 with a concordant positive T-wave in the absence of a conduction defect.

c. Imaging evidence of a region with new loss of viable myocardium at rest in the absence of a non-ischemic cause. This can be manifest as:

1. Echocardiographic, CT, MR, ventriculographic or nuclear imaging evidence of left ventricular thinning or scarring and failure to contract appropriately (i.e., hypokinesis, akinesis, or dyskinesis)

2. Fixed (non-reversible) perfusion defects on nuclear radioisotope imaging (e.g., MIBI, thallium)

d. Medical record documentation of prior myocardial infarction.

Percutaneous Coronary Intervention (PCI): A non-surgical procedure designed to open and maintain the patency of obstructed coronary vessels. This treatment is an invasive procedure performed in the cardiac catheterization lab (e.g., outside of an operating room) by an interventional cardiologist in which a balloon, stent, or other device is delivered to the affected vessel to open and maintain its patency.

Prior CABG Surgery: Indicates the patient had a previous coronary bypass graft prior to the current admission.

Renal Failure–Dialysis: Indicates whether the patient is currently undergoing dialysis.

Risk Factors: Factors that contribute to an individual's risk of coronary artery disease or of death. These factors are classified as those that can be modified or changed by an individual, and those that cannot be changed. Examples of risk factors that cannot be modified include age, gender, family history of coronary artery disease, and ethnicity. Risk factors that can be controlled include diet, cholesterol levels, obesity, smoking, hypertension, inactive lifestyle, stress, and diabetes.

Standardized Mortality Incidence Rate (SMIR): The ratio of smoothed number of deaths (the number of deaths adjusted for the number of admissions treated at the hospital and the hospital case mix) to expected number of deaths (the expected number of deaths calculated

on the basis of the mortality experience of all cardiac surgery programs) multiplied by the state unadjusted rate. SMIRs are interpreted in terms of their corresponding probability intervals. If the probability interval includes the state rate, then the SMIR is no different from what was expected. If the interval excludes the state rate, then the SMIR is "significantly different" from what was expected. In this case, if the upper limit of the interval is lower than the state rate, then fewer patients than expected died; if the lower limit of the 95% interval is higher than the state rate, then more patients than expected died.

Status of CABG: Indicate the clinical status of the patient prior to entering the operating room:

Elective: The patient's cardiac function has been stable in the days or weeks prior to the operation. The procedure could be deferred without increased risk of compromised cardiac outcome.

Urgent: Procedure required during same hospitalization in order to minimize chance of further clinical deterioration. Examples include but are not limited to: Worsening, sudden chest pain, congestive heart failure, acute myocardial infarction, anatomy, IABP, unstable angina with intravenous nitroglycerin or rest angina.

Emergent: Patients requiring emergency operations will have ongoing, refractory (difficult, complicated, and/or unmanageable) unrelenting cardiac compromise, with or without hemodynamic instability, and not responsive to any form of therapy except cardiac surgery. An emergency operation is one in which there should be no delay in providing operative intervention.

Emergent Salvage: The patient is undergoing CPR en route to the operating room or prior to anesthesia induction or has ongoing ECMO to maintain life.

10 Advisory Committees

Mass-DAC gratefully acknowledges the support from the members of the Mass-DAC Committees who have donated their time to improve the database and the quality of cardiac care in the Commonwealth of Massachusetts.

Massachusetts Cardiac Care Hospital Outlier Committee

A Massachusetts Department of Public Health Committee charged with reviewing hospital outlier findings.

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Bureau of Health Care Safety & Quality
Massachusetts Department of Public Health

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South Shore Hospital

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Massachusetts Cardiac Care Hospital Outlier Committee

A Massachusetts Department of Public Health Committee charged with reviewing hospital outlier findings.

. . . Continued from prior page

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President-Elect of Mass. Chapter of STS

David Shahian, M.D.
Research Director
Center for Quality and Safety
Department of Surgery
Massachusetts General Hospital

Mass-DAC Oversight Committee for Cardiac Surgery

The members of this committee are charged with the task of reviewing blinded summary data for all cardiac surgeons in Massachusetts in the review year. Such data include risk-standardized 30-day all-cause mortality rates (SMIR), surgeon volume, surgeon complication rates, and other STS recommended process measures. For surgeons identified as having statistically significant higher than expected mortality, unblinded case fatality reports are also reviewed. Selection of Committee members is the responsibility of the current President of the Massachusetts chapter of STS.

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Mass-DAC Cardiac Surgery Data Adjudication Committee

This committee reviewed patient-specific data elements and corresponding data documentation submitted by hospitals to Mass-DAC in order to determine validity of coding.

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Tufts Medical Center

Publications Committee for Cardiac Surgery

The charge of this committee is to facilitate utilization of shared data from the Massachusetts Cardiac Surgery Data Registry for purposes of reporting observations that are of interest to the medical community and are based on sound scientific principles of study design and analysis. This committee will approve or deny the request before sending the proposal to the Massachusetts Department of Public Health for final approval. The selection of committee members is done by the current president of the Massachusetts STS.

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A Appendix

Procedure Identification Guidelines for Adult Cardiac Surgery
A comparison of rules used by Mass-DAC, New York State, and the National Society of Thoracic Surgeons for classifying surgeries as *isolated CABG* versus *CABG + other*.

Procedure	Mass-DAC	New York State	STS v2.61	STS v2.73
Maze: **Open** heart approach	Other	Other	Other	Other
Maze: **Closed** epicardial approach and radio frequency	CABG	CABG	Other	CABG
Implantable Cardioverter Defibrillator (ICD)	Other	CABG	Other	CABG
Ventricular Lead Insertion for ICD	CABG	CABG	Other	CABG
Pacemaker Lead Insertions	CABG	CABG	CABG	CABG
Lung Biopsy	Case Specific	CABG	Other	Other
Patent Foramen Ovale Closure	CABG	CABG	Other	CABG
Femoral Artery Procedures	CABG	CABG	Other	CABG
Transmyocardial Revascularization	Other	CABG	Other	CABG
Opening of the right atrium for tumor resection	Other	Other	Other	Other
Atrial Appendage	CABG	CABG	CABG	CABG
Myoxoma	Other	Other	Other	Other
Unplanned Ventricular Assist Device (VAD) Placement	CABG	CABG	Other	CABG
Planned Ventricular Assist Device (VAD) Placement	Other	Other	Other	Other
Carotid Surgery	Other	CABG	Other	Other
Lead and Device Explants	Other	CABG	[a]	Other

[a] No information available regarding how this procedure is categorized by STS.

B Appendix

STS DATA ABSTRACTION TOOL [9, 8]
VERSION 2.73

Mass-DAC harvests all optional and not harvested STS variables

The Society of Thoracic Surgeons

Adult Cardiac Surgery Database

Data Collection Form Version 2.73

January 14, 2011

A. Administrative			
Participant ID:	Record ID: (software generated)	STS Cost Link:	Patient ID: (software generated)

B. Demographics			
Patient Last Name:	Patient First Name:	Patient Middle Name:	
Date of Birth: __ __/__ __/__ __ __ __(mm/dd/yyyy)	Patient Age: _____	Sex: ☐ Male ☐ Female	
Social Security Number: __ __ __ - __ __ - __ __ __ __	Medical Record Number:		
Patient's Address:			
Street Address:	City:		
Region:	ZIP Code:	Country:	
Is This Patient's Permanent Address: ☐ Yes ☐ No			
(If No →) Patient's Permanent Address:			
Street Address:	City:		
Region:	ZIP Code:	Country:	

Race (Select all that apply:)

White:	☐ Yes	☐ No	Black/African American:	☐ Yes ☐ No
Asian:	☐ Yes	☐ No	Am Indian/Alaskan Nat:	☐ Yes ☐ No
Native Hawaiian/Pacific Islander:	☐ Yes	☐ No	Other:	☐ Yes ☐ No

Hispanic, Latino or Spanish Ethnicity: ☐ Yes ☐ No

Referring Cardiologist:	Referring Physician:

C. Hospitalization

Hospital Name: _____ (If Not Missing →) Hospital ZIP Code: Hospital State:

Hospital National Provider Identifier: _____

Payor - (Select all that apply↓)

Government Health Insurance: ☐ Yes ☐ No (If Yes, select all that apply ↓)

Medicare: ☐ Yes ☐ No (If Yes →) Health Insurance Claim Number: _____

Medicare Fee For Service: ☐ Yes ☐ No

Medicaid: ☐ Yes ☐ No

Military Health Care: ☐ Yes ☐ No

State-Specific Plan: ☐ Yes ☐ No

Indian Health Service: ☐ Yes ☐ No

Correctional Facility: ☐ Yes ☐ No

Commercial Health Insurance: ☐ Yes ☐ No

Health Maintenance Organization: ☐ Yes ☐ No

Non-U.S. Insurance: ☐ Yes ☐ No

None / Self: ☐ Yes ☐ No

Arrival Date:__ __/__ __/__ __ __ __(mm/dd/yyyy)	Arrival Time: __ __:__ __ (hh:mm 24-hour clock)	Admit Date:__ __/__ __/__ __ __ __(mm/dd/yyyy)

Admit Source:

☐ Elective Admission

☐ Emergency Department

☐ Transfer in from another acute care facility (If Transfer →) Other Hospital Performs Cardiac Surgery ☐ Yes ☐ No

☐ Other

Surgery Date: __ __/__ __/__ __ __ __(mm/dd/yyyy)	Discharge Date: __ __/__ __/__ __ __ __(mm/dd/yyyy)

D. Risk Factors

Weight (kg): _____	Height (cm): _____	
Cigarette Smoker: ☐ Yes ☐ No (If Yes →) Current Cigarette Smoker: ☐ Yes ☐ No Other Tobacco Use: ☐ Yes ☐ No		
Family History of Premature Coronary Artery Disease: ☐ Yes ☐ No	Last Hematocrit: _____	Last WBC Count: _____
Platelet Count Prior to Surgery: _____	International Normalized Ratio prior to Surgery: _____	
HIT Antibodies ☐ Yes ☐ No ☐ Not Applicable	Total Bilirubin Prior to Surgery: _____	
Total Albumin Prior to Surgery:_____	A1c Level prior to surgery: _____	Last Creatinine Level Prior to Surgery: _____
Diabetes: ☐ Yes ☐ No (If Yes →) Diabetes-Control: ☐ None ☐ Diet ☐ Oral ☐ Insulin ☐ Other		

Dyslipidemia: ☐ Yes ☐ No	Dialysis: ☐ Yes ☐ No	MELD Score: _____ (System Calculation)	Hypertension: ☐ Yes ☐ No

Infectious Endocarditis: ☐ Yes ☐ No
(If Yes →) Infectious Endocarditis Type: ☐ Treated ☐ Active
Infectious Endocarditis Culture:
☐ Culture negative ☐ Staphylococcus aureus ☐ Streptococcus species
☐ Coagulase negative staphylococcus ☐ Enterococcus species ☐ Fungal ☐ Other

Chronic Lung Disease: ☐ No ☐ Mild ☐ Moderate ☐ Severe

Pulmonary Function Test Done: ☐ Yes ☐ No
(If Yes →) FEV1 % Predicted: _____
DLCO Test Performed: ☐ Yes ☐ No (If Yes →) DLCO % Predicted: _____

Arterial Blood Gas Performed: ☐ Yes ☐ No (If Yes →) Oxygen Level : _____ Carbon Dioxide Level: _____

Home Oxygen: ☐ Yes ☐ No	Inhaled Medication or Oral Bronchodilator Therapy: ☐ Yes ☐ No
Sleep Apnea: ☐ Yes ☐ No	Liver Disease: ☐ Yes ☐ No
Immunocompromise Present: ☐ Yes ☐ No	Peripheral Artery Disease: ☐ Yes ☐ No
Unresponsive Neurologic State: ☐ Yes ☐ No	Syncope: ☐ Yes ☐ No

Cerebrovascular Disease: ☐ Yes ☐ No
(If Yes →) Prior CVA: ☐ Yes ☐ No (If Yes →) Prior CVA-When: ☐ Recent (<=2 wk.) ☐ Remote (>2 wk.)
CVD TIA: ☐ Yes ☐ No
CVD Carotid stenosis: ☐ None ☐ Right ☐ Left ☐ Both
(If "Right" or "Both" →) Severity of stenosis on the right carotid artery: ☐ 80 - 99% ☐ 100%
(If "Left" or "Both" →) Severity of stenosis on the left carotid artery: ☐ 80 - 99% ☐ 100%
History of previous carotid artery surgery and/or stenting: ☐ Yes ☐ No

Illicit Drug Use: ☐ Yes ☐ No	Alcohol Use: ☐ <=1 drink/week ☐ 2-7 drinks/week ☐ >=8 drinks/week	
Pneumonia: ☐ No ☐ Recent ☐ Remote	Mediastinal Radiation: ☐ Yes ☐ No	Cancer Within 5 Years : ☐ Yes ☐ No

Five Meter Walk Test Done: ☐ Yes ☐ No
(If Yes →) Time 1: _____ (secs) Time 2: _____(secs) Time 3 : _____ (secs)

E. Previous Cardiac Interventions

Previous Cardiac Interventions: ☐ Yes ☐ No (If Yes ↓)
Previous CAB prior to current admission: ☐ Yes ☐ No
Previous Valve: ☐ Yes ☐ No (If Yes ↓)
Previous Aortic Valve Replacement - Surgical: ☐ Yes ☐ No
Previous Aortic Valve Repair - Surgical : ☐ Yes ☐ No
Previous Mitral Valve Replacement - Surgical: ☐ Yes ☐ No
Previous Mitral Valve Repair - Surgical: ☐ Yes ☐ No
Previous Tricuspid Valve Replacement - Surgical: ☐ Yes ☐ No
Previous Tricuspid Valve Repair - Surgical: ☐ Yes ☐ No
Previous Pulmonic Valve Repair / Replacement - Surgical: ☐ Yes ☐ No
Previous Aortic Valve Balloon Valvuloplasty: ☐ Yes ☐ No
Previous Mitral Valve Balloon Valvuloplasty: ☐ Yes ☐ No
Previous Transcatheter Valve Replacement: ☐ Yes ☐ No
Previous Percutaneous Valve Repair: ☐ Yes ☐ No
Indication for Reoperation: ☐ Structural Prosthetic Valve Deterioration
☐ Non-structural prosthetic valve dysfunction
(If Non-structural prosthetic →)Primary type: ☐ Paravalvular Leak ☐ Hemolysis
☐ Entrapment by pannus, tissue, or suture
☐ Sizing or positioning issue
☐ Other
☐ Prosthetic Valve Endocarditis
☐ Valve Thrombosis
☐ Failed Repair
☐ Repeat valve procedure on a different valve
☐ Other
Exact Date of Previous Valve Procedure Known: ☐ Yes ☐ No
(If Yes →) Date of Previous Valve Procedure: __ __ /__ __ /__ __ __ __
(If No →) Estimate Number of Months Since Previous Valve Procedure: _____
Previous Other Cardiac: ☐ Yes ☐ No (If Yes →) Previous Arrhythmia Surgery: ☐ Yes ☐ No
Previous Congenital: ☐ Yes ☐ No
Previous ICD (Implantable Cadioverter/Defibrillator): ☐ Yes ☐ No
Previous Pacemaker: ☐ Yes ☐ No
Previous PCI (Percutaneous Cardiac Intervention): ☐ Yes ☐ No
(If Yes →) PCI Performed Within This Episode Of Care: ☐ Yes, at this facility ☐ Yes, at some other acute care facility ☐ No
(If Yes →) Indication for Surgery: ☐ PCI Complication
☐ PCI Failure without Clinical Deterioration
☐ PCI/CABG Hybrid Procedure
PCI Stent : ☐ Yes ☐ No (If Yes →) Stent Type: ☐ Bare metal ☐ Drug-eluting ☐ Unknown
PCI Interval: ☐ <= 6 Hours ☐ > 6 Hours
Other Previous Cardiovascular Intervention: ☐ Yes ☐ No

F. Preoperative Cardiac Status

Prior Myocardial Infarction: ☐ Yes ☐ No (If Yes ↓)
MI When: ☐ <=6 Hrs ☐ >6 Hrs but <24 Hrs ☐ 1 to 7 Days ☐ 8 to 21 Days ☐ >21 Days

Anginal Classification Within 2 weeks: ☐ No Symptoms, No Angina ☐ CCA I ☐ CCA II ☐ CCA III ☐ CCA IV

Heart Failure Within 2 weeks : ☐ Yes ☐ No (If Yes→) Classification-NYHA: ☐ Class I ☐ Class II ☐ Class III ☐ Class IV

Prior Heart failure: ☐ Yes ☐ No

Cardiac Presentation on Admission: ☐ No Symptoms,No Angina ☐ Symptoms Unlikely to be Ischemia ☐ Stable Angina
☐ Unstable Angina ☐ Non-ST Elevation MI (Non-STEMI) ☐ ST Elevation MI (STEMI)

Cardiogenic Shock : ☐ Yes ☐ No

Resuscitation: ☐ Yes ☐ No

Arrhythmia When : ☐ None ☐ Remote ☐ Recent (If Recent ↓)
Arrhythmia Type: Vtach/Vfib: ☐ Yes ☐ No Second Degree Heart Block : ☐ Yes ☐ No
Sick Sinus Syndrome: ☐ Yes ☐ No Third Degree Heart Block: ☐ Yes ☐ No
Afib/Aflutter : ☐ Yes ☐ No
(If Yes→) Type: ☐ Paroxysmal ☐ Continuous/Persistent

G. Preoperative Medications

Beta Blockers : ☐ Yes ☐ No ☐ Contraindicated

ACE or ARB Inhibitors Within 48 Hours: ☐ Yes ☐ No

Nitrates-I.V.: ☐ Yes ☐ No

Anticoagulants : ☐ Yes ☐ No (If Yes→) Medication Name : ☐ Heparin (Unfractionated) ☐ Heparin (Low Molecular)
☐ Thrombin Inhibitors ☐ Other

Preoperative Antiarrhythmics: ☐ Yes ☐ No

Coumadin: ☐ Yes ☐ No

Inotropes : ☐ Yes ☐ No

Steroids : ☐ Yes ☐ No

Aspirin: ☐ Yes ☐ No

Lipid Lowering: ☐ Yes ☐ No (If Yes→) Medication Type : ☐ Statin ☐ Non-statin ☐ Both

ADP Inhibitors Within Five Days : ☐ Yes ☐ No (If Yes→) ADP Inhibitors Discontinuation: _____ (# days prior to surgery)

Antiplatelets Within 5 Days : ☐ Yes ☐ No

Glycoprotein IIb/IIIa Inhibitor: ☐ Yes ☐ No (If Yes→) Medication Name: ☐ Abciximab (ReoPro) ☐ Eptifibatide (Integrilin)
☐ Tirofiban (Aggrastat)

Thrombolytics within 48 hours: ☐ Yes ☐ No

H. Hemodynamics/Cath/Echo

Cardiac Catheterization Performed : ☐ Yes ☐ No (If Yes→) Cardiac Catheterization Date: __ __/ __ __/__ __ __ __

Number Diseased Vessels: ☐ None ☐ One ☐ Two ☐ Three
Left Main Disease >= 50%: ☐ Yes ☐ No
Proximal LAD >= 70%: ☐ Yes ☐ No

Ejection Fraction Done: ☐ Yes ☐ No (If Yes ↓)
Ejection Fraction: _____ (%)
Ejection Fraction Method: ☐ LV Gram ☐ Radionucleotide ☐ Estimate ☐ ECHO ☐ MRI/CT ☐ Other

LV Systolic Dimension: _____ (mm) | LV End-Diastolic Dimension: _____ (mm)

PA Systolic Pressure Measured: ☐ Yes ☐ No (If Yes→) PA Systolic Pressure: _____ mmHg(highest prior to surgery)

Aortic Valve Disease: ☐ Yes ☐ No (If Yes ↓)
Aortic Etiology: ☐ Degenerative (senile)
☐ Endocarditis (If Endocarditis→) Root Abscess: ☐ Yes ☐ No
☐ Congenital (If Congenital→) Type: ☐ Bicuspid ☐ Other
☐ Rheumatic
☐ Primary Aortic Disease: (If PAD→) Type: ☐ Marfans ☐ Other Connective tissue disorder
☐ Atherosclerotic Aneurysm ☐ Inflammatory
☐ Aortic Dissection ☐ Idiopathic Root Dilation
☐ LV Outflow Tract Obstruction: (If LV outflow tract obstruction↓)
Type: ☐ HOCM
☐ Sub-aortic membrane
☐ Sub-aortic Tunnel
☐ Supravalvular Aortic Stenosis
☐ Tumor: (If Tumor→) Type: ☐ Myxoma ☐ Papillary fibroelastoma ☐ Carcinoid ☐ Other
☐ Trauma
☐ Other
Aortic Stenosis: ☐ Yes ☐ No (If Yes ↓)
Smallest Aortic Valve Area: _____ cm^2
Highest Mean Gradient : _____ mmHg
Aortic Insufficiency: ☐ None ☐ Trace/Trivial ☐ Mild ☐ Moderate ☐ Severe

Mitral Valve Disease: ☐ Yes ☐ No (If Yes ↓)

Mitral Etiology: ☐ Annular or Degenerative Disease (If Annular or Degenerative Disease↓)

Location: ☐ Posterior Leaflet ☐ Anterior Leaflet ☐ Bileaflet

Type: ☐ Pure Annular Dilation ☐ Mitral Annular Calcification

☐ Endocarditis

☐ Rheumatic

☐ Ischemic (If Ischemic→) Type: ☐ Acute (If acute →) Papillary Muscle Rupture: ☐ Yes ☐ No ☐ Chronic

☐ Congenital

☐ Hypertrophic Obstructive Cardiomyopathy (HOCM)

☐ Tumor: (If Tumor→) Type: ☐ Myxoma ☐ Papillary fibroelastoma ☐ Carcinoid ☐ Other

☐ Trauma

☐ Non-ischemic cardiomyopathy

☐ Other

Mitral Valve Disease Functional Class: ☐ Type I ☐ Type II ☐ Type IIIa ☐ Type IIIb

Mitral Stenosis: ☐ Yes ☐ No (If Yes ↓)

Smallest Mitral Valve Area : _____ cm^2

Highest Mean Gradient: _____ mm Hg

Mitral Insufficiency: ☐ None ☐ Trace/trivial ☐ Mild ☐ Moderate ☐ Severe

Tricuspid Valve Disease: ☐ Yes ☐ No (If Yes ↓)

Tricuspid Etiology: ☐ Functional

☐ Endocarditis

☐ Congenital

☐ Tumor

☐ Trauma

☐ Other

Tricuspid Stenosis: ☐ Yes ☐ No

Tricuspid Insufficiency: ☐ None ☐ Trace/trivial ☐ Mild ☐ Moderate ☐ Severe

Pulmonic Valve Disease: ☐ Yes ☐ No (If Yes ↓)

Pulmonic Stenosis: ☐ Yes ☐ No

Pulmonic Insufficiency: ☐ None ☐ Trace/trival ☐ Mild ☐ Moderate ☐ Severe

I. Operative

Surgeon: _____ Surgeon NPI: _____

Taxpayer Identification Number: _____

Incidence: ☐ First cardiovascular surgery ☐ Third re-op cardiovascular surgery

☐ First re-op cardiovascular surgery ☐ Fourth or more re-op cardiovascular surgery

☐ Second re-op cardiovascular surgery

Status: ☐ Elective

☐ Urgent (If Urgent↓)

Reason: ☐ AMI ☐ IABP ☐ Worsening CP ☐ CHF ☐ Anatomy ☐USA ☐ Rest Angina ☐ Valve Dysfunction ☐Aortic Dissection ☐Angiographic Accident ☐Cardiac Trauma ☐ Infected Device ☐ Syncope ☐ PCI/CABG Hybrid ☐ PCI Failure w/out clinical deterioration

☐ Emergent (If Emergent↓)

Reason: ☐ Shock Circ Support ☐ Shock No Circ Support ☐ Pulmonary Edema ☐ AEMI ☐ Ongoing Ischemia ☐ Valve Dysfunction ☐ Aortic Dissection ☐ Angiographic Accident ☐ Cardiac Trauma ☐ Infected Device ☐ Syncope ☐ PCI/CABG Hybrid ☐ Anatomy

☐ Emergent Salvage

Was case previously attempted during this admission, but canceled: ☐ Yes ☐ No

(If Yes→) Date of previous case: __ __/__ __/__ __ __ __ (mm/dd/yyyy)

Timing of previous case: ☐ Prior to induction of anesthesia ☐ After induction, prior to incision ☐ After incision made

Reason previous case was canceled: ☐ Anesthesiology event ☐ Cardiac arrest ☐ Equipment/supply issue ☐ Unanticipated tumor ☐ Other

Planned previous procedure:

CABG	☐ Yes ☐ No	Valve	☐ Yes ☐ No
Mechanical Assist Device	☐ Yes ☐ No	Other Cardiac	☐ Yes ☐ No
Other Non-cardiac	☐ Yes ☐ No		

Was the current procedure canceled: ☐ Yes ☐ No

(If Yes→) Canceled Timing: ☐ Prior to induction of anesthesia ☐ After induction, prior to incision ☐ After incision made

Canceled Reason: ☐ Anesthesiology event ☐ Cardiac arrest ☐ Equipment/supply issue ☐ Unanticipated tumor ☐ Other

Planned procedure:

CABG	☐ Yes ☐ No	Valve	☐ Yes ☐ No
Mechanical Assist Device	☐ Yes ☐ No	Other Cardiac	☐ Yes ☐ No
Other Non-cardiac	☐ Yes ☐ No		

Operative Approach: ☐ Full conventional sternotomy ☐ Partial sternotomy ☐ Right or left parasternal incision ☐ Left Thoracotomy ☐ Right Thoracotomy ☐ Transverse sternotomy (includes clamshell) ☐ Minimally invasive

Robotic Technology Assisted: ☐ Yes ☐ No

Coronary Artery Bypass: ☐ Yes ☐ No
(If "Yes" complete Section J)

Valve Surgery: ☐ Yes ☐ No (If Yes↓) (If "Yes" complete Section K)

Valve Prosthesis Explant: ☐ Yes ☐ No (If Yes ↓)

Explant Position: ☐ Aortic ☐ Mitral ☐ Tricuspid ☐ Pulmonic

Explant Type: ☐ Unknown ☐ Annuloplasty Device ☐ Mechanical Valve ☐ Mitral Clip ☐ Bioprosthetic Valve ☐ Transcatheter Device

Device Manufacturer: ☐ None (Homograft or Pulmonary Autograft) ☐ ATS ☐ Baxter ☐ Biocore ☐ Björk-Shiley ☐ CarboMedics ☐ Carpentier-Edwards ☐ Cosgrove-Edwards ☐ Cryolife ☐ Cryolife O'Brien ☐ Edwards ☐ Genesee ☐ Hancock ☐ Ionescu-Shiley ☐ Labcor ☐ LifeNet ☐ Lillehei-Kaster ☐ MCRI ☐ Medtronic ☐ Medtronic Colvin Galloway ☐ Medtronic-Duran ☐ Medtronic-Hall ☐ Mitroflow ☐ OmniCarbon ☐ OmniScience ☐ Sorin ☐ Sorin-Puig ☐ St. Jude Medical ☐ St. Jude Tailor ☐ Starr-Edwards ☐ Ultracor ☐ Unknown ☐ Other

Explant Device: _____ (Refer to Explant Device Key below)

Second Valve Prosthesis Explant: ☐ Yes ☐ No (If Yes↓)

Explant Position: ☐ Aortic ☐ Mitral ☐ Tricuspid ☐ Pulmonic

Explant Type: ☐ Unknown ☐ Annuloplasty Device ☐ Mechanical Valve ☐ Mitral Clip ☐ Bioprosthetic Valve ☐ Transcatheter Device

Device Manufacturer: ☐ None (Homograft or Pulmonary Autograft) ☐ ATS ☐ Baxter ☐ Biocore ☐ Björk-Shiley ☐ CarboMedics ☐ Carpentier-Edwards ☐ Cosgrove-Edwards ☐ Cryolife ☐ Cryolife O'Brien ☐ Edwards ☐ Genesee ☐ Hancock ☐ Ionescu-Shiley ☐ Labcor ☐ LifeNet ☐ Lillehei-Kaster ☐ MCRI ☐ Medtronic ☐ Medtronic Colvin Galloway ☐ Medtronic-Duran ☐ Medtronic-Hall ☐ Mitroflow ☐ OmniCarbon ☐ OmniScience ☐ Sorin ☐ Sorin-Puig ☐ St. Jude Medical ☐ St. Jude Tailor ☐ Starr-Edwards ☐ Ultracor ☐ Unknown ☐ Other

Explant Device: _____ (Refer to Explant Device Key below)

Explant Device Key (Note this list is different from the implant list used below).

Mechanical

2 = ATS Mechanical Prosthesis
3 = Björk-Shiley Convex-Concave Mechanical Prosthesis
4 = Björk-Shiley Monostrut Mechanical Prosthesis
6 = CarboMedics Mechanical Prosthesis
57 = CarboMedics Carbo-Seal Ascending Aortic Valved Conduit Prosthesis
58 = CarboMedics Carbo-Seal Valsalva Ascending Aortic Valved Conduit Prosthesis
59 = CarboMedics Reduced Cuff Aortic Valve
60 = CarboMedics Standard Aortic Valve
61 = CarboMedics Top-Hat Supra-annular Aortic Valve
62 = CarboMedics OptiForm Mitral Valve
63 = CarboMedics Standard Mitral Valve
64 = CarboMedics Orbis Universal Valve
65 = CarboMedics Small Adult Aortic and Mitral Valves
53 = Lillehei-Kaster Mechanical Prosthesis
10 = MCRI On-X Mechanical Prosthesis
8 = Medtronic-Hall/Hall Easy-Fit Mechanical Prosthesis
66 = Medtronic ADVANTAGE Mechanical Prosthesis
9 = OmniCarbon Mechanical Prosthesis
54 = OmniScience Mechanical Prosthesis
11 = Sorin Bicarbon (Baxter Mira) Mechanical Prosthesis
12 = Sorin Monoleaflet Allcarbon Mechanical Prosthesis
13 = St. Jude Medical Mechanical Heart Valve
67 = St. Jude Medical Masters Series Mechanical Heart Valve
68 = St. Jude Medical Masters Series Aortic Valve Graft Prosthesis
69 = St. Jude Medical Mechanical Heart Valve Hemodynamic Plus (HP) Series
70 = St. Jude Medical Masters Series Hemodynamic Plus Valve with FlexCuff Sewing Ring
71 = St. Jude Medical Regent Valve
14 = Starr-Edwards Caged-Ball Prosthesis
15 = Ultracor Mechanical Prosthesis
133 = Medtronic Hall Conduit

Bioprosthesis

108 = ATS 3f Aortic Bioprosthesis
72 = Edwards Prima Stentless Porcine Bioprosthesis - Subcoronary
73 = Edwards Prima Stentless Porcine Bioprosthesis - Root
19 = Biocor Porcine Bioprosthesis
74 = Biocor Stentless Porcine Bioprosthesis - Subcoronary
75 = Biocor Stentless Porcine Bioprosthesis - Root
21 = CarboMedics PhotoFix Pericardial Bioprosthesis
76 = Carpentier-Edwards Porcine Bioprosthesis
77 = Edwards Prima Plus Stentless Porcine Bioprosthesis - Subcoronary
78 = Edwards Prima Plus Stentless Porcine Bioprosthesis - Root
22 = Carpentier-Edwards PERIMOUNT Pericardial Bioprosthesis
103 = Carpentier-Edwards PERIMOUNT Pericardial Magna Bioprosthesis
23 = Carpentier-Edwards Standard Porcine Bioprosthesis
25 = Carpentier-Edwards Supra-Annular Aortic Porcine Bioprosthesis
79 = Cryolife O'Brien Stentless Porcine Bioprosthesis - Subcoronary
80 = Cryolife O'Brien Stentless Porcine Bioprosthesis - Root
55 = Hancock Standard Porcine Bioprosthesis
28 = Hancock II Porcine Bioprosthesis
29 = Hancock Modified Orifice Porcine Bioprosthesis
30 = Ionescu-Shiley Pericardial Bioprosthesis
31 = Labcor Stented Porcine Bioprosthesis
81 = Labcor Stentless Porcine Bioprosthesis - Subcoronary
82 = Labcor Stentless Porcine Bioprosthesis - Root
83 = Medtronic Freestyle Stentless Porcine Bioprosthesis - Subcoronary
84 = Medtronic Freestyle Stentless Porcine Bioprosthesis - Root
35 = Medtronic Intact Porcine Bioprosthesis
36 = Medtronic Mosaic Porcine Bioprosthesis
85 = Medtronic Contegra Bovine Jugular Bioprosthesis
37 = Mitroflow Pericardial Bioprosthesis
39 = St. Jude Medical Toronto SPV Stentless Porcine Bioprosthesis
40 = St. Jude Medical-Bioimplant Porcine Bioprosthesis
86 = St. Jude Medical Biocor Stented Tissue Valve
87 = St. Jude Medical Epic Stented Porcine Bioprosthesis
88 = St. Jude Medical Toronto Root Stentless Porcine Bioprosthesis
38 = Sorin Pericarbon Stentless Pericardial Bioprosthesis
111 = Carpentier-Edwards PERIMOUNT MAGNA Pericardial Bioprosthesis with Carpentier-Edwards Thermafix Tissue Process
112 = Carpentier-Edwards PERIMOUNT Theon RSR Pericardial Bioprosthesis
113 = Carpentier-Edwards PERIMOUNT RSR Pericardial Bioprosthesis
114 = Carpentier-Edwards PERIMOUNT Theon Pericardial Bioprosthesis
115 = Carpentier-Edwards S.A.V. Porcine Bioprosthesis
116 = Edwards Prima Plus Stentless Bioprosthesis
117 = Carpentier-Edwards PERIMOUNT Plus Pericardial Bioprosthesis with Tricentrix Holder
118 = Carpentier-Edwards Duraflex Low Pressure Porcine Bioprosthesis
119 = Carpentier-Edwards Duraflex Low Pressure ESR Porcine Bioprosthesis
120 = Carpentier-Edwards PERIMOUNT Theon Pericardial Bioprosthesis with Tricentrix Holder.
121 = St. Jude Medical Biocor Supra Stented Porcine Bioprosthesis
122 = St. Jude Medical Epic Supra Stented Porcine Bioprosthesis.
134 = Carpentier Edwards Physio II
135 = Carpentier Edwards Perimount Magna Mitral Valve

Homograft

89 = CryoLife Aortic Homograft
90 = CryoLife Pulmonary Homograft
91 = CryoLife CryoValve SG(Decellularized)Aortic Homograft
92 = CryoLife CryoValve SG Pulmonary Homograft
41 = Homograft Aortic - Subcoronary
42 = Homograft Aortic - Root
43 = Homograft Mitral
44 = Homograft Pulmonic Root
93 = LifeNet CV Allografts

Autograft

45 = Pulmonary Autograft to aortic root (Ross Procedure)

Ring - Annuloplasty

109 = ATS Simulus Flex-O Ring
94 = CarboMedics AnnuloFlo Ring
95 = CarboMedics AnnuloFlex Ring
96 = CarboMedics CardioFix Bovine Pericardium with PhotoFix Technology
46 = Carpentier-Edwards Classic Annuloplasty Ring
104 = Carpentier-Edwards Geoform Ring
105 = Carpentier-Edwards IMR Etlogix Ring
47 = Carpentier-Edwards Physio Annuloplasty System Ring
48 = Cosgrove-Edwards Annuloplasty System Ring
97 = Edwards MC³ Tricuspid Annuloplasty System
98 = Genesee Sculptor Annuloplasty Ring
49 = Medtronic Sculptor Ring
50 = Medtronic-Duran AnCore Ring
51 = Sorin-Puig-Messana Ring
52 = St. Jude Medical Séguin Annuloplasty Ring.
106 = St. Jude Medical Rigid Saddle Ring
99 = St. Jude Medical Tailor Annuloplasty Ring
123 = ATS Simulus Flexible Annuloplasty ring.
124 = ATS Simulus Semi-Rigid Annuloplasty ring
125 = Carpentier-Edwards Classic Annuloplasty Ring with Duraflo Treatment
126 = Carpentier-Edwards Physio Annuloplasty Ring with Duraflo Treatment
127 = Cosgrove-Edwards Annuloplasty System with Duraflo Treatment
128 = Myxo Etlogix Annuloplasty Ring
131 = Sorin Memo 3D Ring
132 = UNIRING, Universal Annuloplasty System
137 = Medtronic Colvin Galloway Future Ring
138 = Medtronic Profile 3D Ring

Band - Annuloplasty

100 = Medtronic Colvin Galloway Future Band
101 = Medtronic Duran Band
102 = Medtronic Duran - Ancore Band
107 = St. Jude Medical Tailor Annuloplasty Band
110 = ATS Simulus Flex-C Band

Other

777 = Other

VAD Implanted or Removed: ☐ No ☐ Yes, implanted ☐ Yes, explanted ☐ Yes, implanted and explanted (If "Yes" complete Section L)

Other Cardiac Procedure: ☐ Yes ☐ No (If "Yes" complete Section M)

Other Non-Cardiac Procedure: ☐ Yes ☐ No (If "Yes" complete Section N)

Unplanned Procedure:
☐ No
☐ Yes, unsuspected patient disease or anatomy
☐ Yes, surgical complication
(If Yes ↓)

- Unplanned CABG: ☐ Yes ☐ No
- Unplanned Aortic Valve Procedure: ☐ Yes ☐ No
- Unplanned Mitral Valve Procedure: ☐ Yes ☐ No
- Unplanned Aorta Procedure: ☐ Yes ☐ No
- Unplanned VAD Insertion: ☐ Yes ☐ No
- Unplanned Other Procedure: ☐ Yes ☐ No

Enter up to 10 CPT-1 Codes pertaining to the surgery for which the data collection form was initiated:
1. _____ 2. _____ 3. _____ 4. _____ 5. _____ 6. _____ 7. _____ 8. _____ 9. _____ 10. _____

OR Entry Date And Time: __ __/__ __/__ __ __ __ __ __: __ __ mm/dd/yyyy hh:mm - 24 hr clock)

OR Exit Date And Time: __ __/__ __/__ __ __ __ __ __:__ __ (mm/dd/yyyy hh:mm - 24 hr clock)

Initial Intubation Date and Time: __ __/__ __/__ __ __ __ __ __: __ __ (mm/dd/yyyy hh:mm - 24 hr clock)

Initial Extubation Date and Time: __ __/__ __/__ __ __ __ __ __: __ __ (mm/dd/yyyy hh:mm - 24 hr clock)

Skin Incision Start Date and Time: __ __/__ __/__ __ __ __ __ __: __ __ (mm/dd/yyyy hh:mm - 24 hr clock)

Skin Incision Stop Date and Time: __ __/__ __/__ __ __ __ __ __: __ __ (mm/dd/yyyy hh:mm - 24 hr clock)

Appropriate Antibiotic Selection:	Appropriate Antibiotic Administration Timing:	Appropriate Antibiotic Discontinuation:
☐ Yes ☐ No ☐ Exclusion	☐ Yes ☐ No ☐ Exclusion	☐ Yes ☐ No ☐ Exclusion

CPB Utilization:

☐ None

☐ Combination

(If Combination↓)

Combination Plan:

☐ Planned

☐ Unplanned

(If Unplanned↓)

Reason:

☐ Exposure/visualization
☐ Bleeding
☐ Inadequate size and/or diffuse disease of distal vessel
☐ Hemodynamic instability (hypotension/arrhythmias)
☐ Conduit quality and/or trauma
☐ Other

☐ Full

(If "Combination" or "Full"↓)

Cardiopulmonary Bypass Time (minutes): _____

Lowest Temperature (°C): _____

Lowest Hematocrit : _____

Arterial Cannulation Site:

(Select all that apply→)

Aortic	☐ Yes ☐ No	Axillary	☐ Yes ☐ No
Femoral	☐ Yes ☐ No	Other	☐ Yes ☐ No

Venous Cannulation Site:

(Select all that apply→)

Femoral	☐ Yes ☐ No	Pulmonary Vein	☐ Yes ☐ No
Jugular	☐ Yes ☐ No	Caval/Bicaval	☐ Yes ☐ No
Right Atrial	☐ Yes ☐ No	Other	☐ Yes ☐ No
Left Atrial	☐ Yes ☐ No		

Circulatory Arrest: ☐ Yes ☐ No (If Yes↓)

Circulatory Arrest Without Cerebral Perfusion Time: _____ (min)

Circulatory Arrest With Cerebral Perfusion: ☐ Yes ☐ No

(If Yes→) Cerebral Perfusion Time: _____ (min)

Cerebral Perfusion Type: ☐ Antegrade ☐ Retrograde ☐ Both antegrade and retrograde

Aortic Occlusion:

☐ None - beating heart
☐ None - fibrillating heart
☐ Aortic Crossclamp (If "Aortic crossclamp" or "Balloon occlusion" →): Cross Clamp Time: _____ (min)
☐ Balloon Occlusion

Cardioplegia Delivery: ☐ None ☐ Antegrade ☐ Retrograde ☐Both

(If "Antegrade", "Retrograde" or "Both"→) Type of cardioplegia used: ☐ Blood ☐ Crystalloid ☐ Both ☐ Other

Cerebral Oximetry Used: ☐ Yes ☐ No (If Yes↓)

Pre-Induction Baseline Regional Oxygen Saturation:	Left: _____ (%)	Right: _____ (%)
Cumulative Saturation Below Threshold:	Left: _____ (min -%)	Right: _____ (min -%)
Cerebral Oximeter Provided First Indication:	☐ Yes ☐ No	
Skin Closure Regional Oxygen Saturation:	Left: _____ (%)	Right: _____ (%)

Concentric Calcification: ☐ Yes ☐ No

Echo Assessment of Ascending Aorta/Arch:☐ Yes ☐ No (If Yes ↓)

Assessment of Aorta Disease:

☐ Normal Aorta	☐ Extensive intimal thickening
☐ Protruding Atheroma < 5 mm	☐ Protruding Atheroma >= 5 mm
☐ Mobile plaques	☐ Not documented

Assessment Altered Plan: ☐ Yes ☐ No

Intraop Blood Products Used: ☐ Yes ☐ No

(If No →) Intraop Blood Products Refused: ☐ Yes ☐ No

(If Yes →)

Red Blood Cell Units: _____
Fresh Frozen Plasma Units: _____
Cryoprecipitate Units: _____
Platelet Units: _____
Factor VIIa: _____

Intraop Antifibrinolytic Medications: Epsilon Amino-Caproic Acid: ☐ Yes ☐ No Tranexamic Acid: ☐ Yes ☐ No

Intraoperative TEE Performed post procedure: ☐ Yes ☐ No (If Yes ↓)

Highest level aortic insufficiency found: ☐ None ☐ Trace/trivial ☐ Mild ☐ Moderate ☐ Severe
Highest level mitral insufficiency found: ☐ None ☐ Trace/trivial ☐ Mild ☐ Moderate ☐ Severe
Highest level tricuspid insufficiency found: ☐ None ☐ Trace/trivial ☐ Mild ☐ Moderate ☐ Severe

J. Coronary Bypass

(If OpCAB = Yes ↓)

Hybrid Procedure CAB and PCI Performed: ☐ Yes ☐ No (If Yes ↓)
Status: ☐ Planned - concurrent ☐ Planned - staged ☐ Unplanned
PCI Procedure Performed: ☐ Angioplasty ☐ Stent

Number of Distal Anastomoses with Arterial Conduits: _____

Number of Distal Anastomoses with Venous Conduits: _____(If >0 ↓)
Vein Harvest Technique: ☐ Endoscopic ☐ Direct Vision (open) ☐ Both ☐ Cryopreserved
(If "Endoscopic", "Direct Vision (open)" or "Both"→) Saphenous Vein Harvest Time: _____ (minutes)
Saphenous Vein Preparation Time: _____ (minutes)

Internal Mammary Artery used for Grafts: ☐ Left IMA ☐ Right IMA ☐ Both IMAs ☐ No IMA

(If No IMA→) Indicate **Primary** Reason:
☐ The IMA is not a suitable conduit due to size or flow
☐ Subclavian stenosis
☐ Previous cardiac or thoracic surgery
☐ Previous mediastinal radiation
☐ Emergent or salvage procedure
☐ No LAD disease

(If Left, Right or Both IMAs→) Total # of Distal Anastomoses done using IMA grafts: _____
IMA Harvest Technique: ☐ Direct Vision (open) ☐ Thoracoscopy
☐ Combination ☐ Robotic Assist

Number of Radial Arteries Used for Grafts: _____ (If >0 ↓)
Number of Radial Artery Distal Anastomoses : _____
Radial Distal Anastomoses Harvest Technique: ☐ Endoscopic ☐ Direct Vision (open) ☐ Both
Radial Artery Harvest Time: _____ (minutes)
Radial Artery Preparation Time: _____ (minutes)

Number Other Arterial Distal Anastomoses Used (other than radial or IMA): _____

Native Coronary Disease Location Key:

1 = Left Main	4 = Distal LAD	7 = Circumflex	10 = OM 3	13 = PLB
2 = Prox LAD	5 = Diagonal 1	8 = OM 1	11 = RCA	14 = AM branches
3 = Mid LAD	6 = Diagonal 2	9 = OM 2	12 = PDA	15 = Ramus

For each question, check the one choice that applies for each graft:

	CABG NUMBER	1	2	3	4	5	6	7	8	9	10
GRAFT DONE	Yes	NA									
	No										
NATIVE CORONARY DISEASE LOCATION (See key above)											
HIGHEST PERCENT STENOSIS IN NATIVE VESSEL											
PREVIOUS CONDUIT	Yes - Diseased										
	Yes - No disease										
	No previous conduit										
PROXIMAL SITE	In Situ Mammary										
	Ascending aorta										
	Descending aorta										
	Subclavian artery										
	Innominate artery										
	T-graft off SVG										
	T-graft off Radial										
	T-graft off LIMA										
	T-graft off RIMA										
PROXIMAL TECHNIQUE	In Situ Mammary										
	Running										
	Interrupted										
	Anastomotic Device										
	Anastomotic Assist Device										
CONDUIT	Vein graft										
	In Situ LIMA										
	In Situ RIMA										
	Free IMA										
	Radial artery										
	Other arteries, homograft										
DISTAL INSERTION SITE	Right Coronary (RCA)										
	Acute Marginal (AM)										
	Posterior Descending Artery (PDA)										
	Posterolateral Branch (PLB)										
	Proximal LAD										
	Mid LAD										
	Distal LAD										
	Diagonal 1										
	Diagonal 2										
	Ramus										
	Obtuse Marginal 1										
	Obtuse Marginal 2										
	Obtuse Marginal 3										
	Other										
DISTAL TECHNIQUE	Running										
	Interrupted										
	Clips										
	Anastomotic device										
DISTAL POSITION	End to Side										
	Sequential (side to side)										
ENDARTERECTOMY	Yes										
	No										
HYBRID	No										
	Angioplasty										
	Stent										

K. Valve Surgery

(If Valve Surgery=Yes ↓)

Aortic Valve Procedure Performed: ☐ Yes ☐ No

(If Yes ↓)

Procedure Performed:

☐ Replacement

☐ Repair / Reconstruction

(If Repair / Reconstruction ↓)

Primary Repair Type: (Select all that apply)

Commissural Annuloplasty	☐ Yes ☐ No	Ring Annuloplasty	☐ Yes ☐ No
Leaflet plication	☐ Yes ☐ No	Leaflet resection suture	☐ Yes ☐ No
Leaflet free edge reinforcement (PTFE)	☐ Yes ☐ No	Leaflet pericardial patch	☐ Yes ☐ No
Leaflet commissural resuspension suture	☐ Yes ☐ No	Leaflet debridement	☐ Yes ☐ No
Division of fused leaflet raphe	☐ Yes ☐ No		

☐ Root Reconstruction with valved conduit

☐ Replacement and insertion aortic non-valved conduit

☐ Resuspension AV without replacement of ascending aorta

☐ Resuspension AV with replacement of ascending aorta

☐ Apico-aortic conduit (Aortic valve bypass)

☐ Autograft with pulmonary valve-Ross procedure

☐ Homograft

☐ Valve sparing root reimplantation (David)

☐ Valve sparing root remodeling (Yacoub)

Transcatheter Valve Replacement: ☐ Yes ☐ No

(If Yes →) Replacement approach: ☐ Transapical ☐ Transaxillary ☐ Transfemoral

Aortic Annular Enlargement: ☐ Yes ☐ No

Resection of sub-aortic stenosis: ☐ Yes ☐ No

Implant Model Number :_____ Size: _____

Mitral Valve Procedure Performed: ☐ Yes ☐ No

(If Yes ↓)

Procedure Performed:

☐ Repair

(If Repair→) Repair Type: (Select all that apply↓)

Annuloplasty	☐ Yes ☐ No	
Leaflet Resection	☐ Yes ☐ No	(If Yes↓) Resection Type: ☐ Triangular ☐ Quadrangular ☐ Other Location: ☐ Anterior ☐ Posterior ☐ Both Anterior and Posterior
Sliding Plasty	☐ Yes ☐ No	
Annular decalcification	☐ Yes ☐ No	
Neochords (PTFE)	☐ Yes ☐ No	(If Yes ↓) Number of neochords inserted: _____
Chordal /Leaflet transfer	☐ Yes ☐ No	
Leaflet extension/replacement/patch	☐ Yes ☐ No	
Edge to Edge Repair	☐ Yes ☐ No	
Mitral commissurotomy	☐ Yes ☐ No	

☐ Replacement (If Replacement→) Repair attempted prior to Mitral Valve Replacement: ☐ Yes ☐ No

Implant Model Number:_____ Size: _____

Mitral Chords Preserved: ☐ None ☐Anterior ☐ Posterior ☐ Both

Tricuspid Valve Procedure Performed:

☐ No

☐ Annuloplasty only

☐ Replacement

☐ Reconstruction with Annuloplasty

☐ Reconstruction without Annuloplasty

☐ Valvectomy

(If "Annuloplasty only" OR "Reconstruction with Annuloplasty" ↓)

Type of Annuloplasty: ☐ Pericardium ☐Suture ☐ Prosthetic Ring

Implant Model Number:_____ Size: _____

Pulmonic Valve Procedure Performed:

☐ No

☐ Replacement

☐ Reconstruction

☐ Valvectomy

Implant Model Number:_____ Size: _____

L. Mechanical Cardiac Assist Devices

Intra Aortic Balloon Pump (IABP): ☐ Yes ☐ No (If Yes ↓)
IABP Insertion: ☐ Preop ☐ Intraop ☐ Postop
Primary Reason for Insertion: ☐ Hemodyn Instability ☐ PTCA Support ☐ Unstable Angina ☐ CPB Weaning Failure ☐ Prophylactic
Date IABP Removed: __ __/__ __/ __ __ __ __ (mm/dd/yyyy)

Catheter Based Assist Device Used: ☐ Yes ☐ No (If Yes ↓)
Device: ☐ Impella ☐ Tandem Heart ☐ Other
When Inserted: ☐ Preop ☐ Intraop ☐ Postop
Primary Reason for Insertion: ☐ Hemodynamic instability ☐ CPB weaning failure ☐ PCI failure ☐ Other
Date Device Removed: __ __/__ __/ __ __ __ __ (mm/dd/yyyy)

Extracorporeal Membrane Oxygenation (ECMO): ☐ Yes ☐ No (If Yes ↓)
ECMO Initiated: ☐ Preop ☐ Intraop ☐ Postop ☐ Non-operative
Clinical Indication for ECMO Placement: ☐ Cardiac Failure ☐ Respiratory Failure ☐ Hypothermia ☐ Rescue/salvage

Previous VAD: ☐ Yes ☐ No (If Yes ↓)
Implanted at another facility: ☐ Yes ☐ No
Prev VAD Insertion Date: __ __ / __ __ / __ __ __ __ (mm/dd/yyyy)
Prev VAD Indication: ☐Bridge to Transplantation ☐ Bridge to Recovery ☐ Destination ☐ Post Cardiotomy Ventricular failure ☐ Device Malfunction ☐ End of Life
Prev VAD Type: ☐ RVAD ☐ LVAD ☐ BiVAD ☐ TAH
Prev VAD Device: _____(refer to current "On-Demand Device Lists" document)

(If VAD Implanted or Removed↓)

References to "Initial VAD" refer to the initial VAD for this hospitalization, not a VAD placed during a previous hospitalization.

VAD Implant Type: **Right VAD (RVAD)** **Left VAD (LVAD)** **Biventricular VAD (BiVAD)** **Total Artificial Heart (TAH)**

VAD Device: (refer to current "On-Demand Device Lists" document)

Explant Reason: **1. Cardiac Transplant 2. Recovery 3. Device Transfer 4. Device-Related Infection 5. Device Malfunction 6. End of Life**

Indication for this VAD: ☐ Bridge to Transplantation ☐ Bridge to Recovery ☐ Destination ☐ Postcardiotomy Ventricular Failure ☐ Device Malfunction ☐ End of Life

Initial Implant Data

Implant Type	VAD Device	Implant Date	Explant	Explant Date	Explant Reason	Transplant Date
_____	_____	___ / __ / _____ mm dd yyyy	☐ Yes ☐ No	___ / __ / _____ mm dd yyyy	_____	___ / __ / _____ mm dd yyyy

Additional Implant(s) Data

Second Device Implanted: ☐ Yes ☐ No (If Yes ↓)

Implant Type#2	VAD Device #2	Implant Date#2	Explant#2	Explant Date#2	Explant Reason#2	Transplant Date#2
_____	_____	___ / __ / _____ mm dd yyyy	☐ Yes ☐ No	___ / __ / _____ mm dd yyyy	_____	___ / __ / _____ mm dd yyyy

Third Device Implanted: ☐ Yes ☐ No (If Yes ↓)

Implant Type#3	VAD Device #3	Implant Date#3	Explant#3	Explant Date#3	Explant Reason#3	Transplant Date#3
_____	_____	___ / __ / _____ mm dd yyyy	☐ Yes ☐ No	___ / __ / _____ mm dd yyyy	_____	___ / __ / _____ mm dd yyyy

Primary VAD Complications Data:

Intracranial Bleed	☐ Yes ☐ No
Embolic Stroke	☐ Yes ☐ No
Driveline and/or cannula Infection	☐ Yes ☐ No
Pump Pocket Infection	☐ Yes ☐ No
Endocarditis	☐ Yes ☐ No
Device Malfunction	☐ Yes ☐ No
Hemolysis	☐ Yes ☐ No
Bowel Obstruction	☐ Yes ☐ No

Additional Complications (not specific to initial VAD as above) to be collected in Postoperative Events section.

VAD Discharge Status:
☐ With VAD
☐ Without VAD
☐ Expired in Hospital

M. Other Cardiac Procedure

(If Other Card = Yes ↓)

Left Ventricular Aneurysm Repair: ☐ Yes ☐ No

Ventricular Septal Defect Repair: ☐ Yes ☐ No

Atrial Septal Defect Repair: ☐ Yes ☐ No
(If Yes →) ASD Type: ☐ Secundum ☐ Sinus Venosus ☐ PFO

Surgical Ventricular Restoration: ☐ Yes ☐ No

Congenital Defect Repair: ☐ Yes ☐ No (If Yes ↓)

Congenital Diagnoses: Select up to three most significant diagnoses: (refer to "Congenital Diagnoses/Procedures List" document)
Diagnosis 1: _____ Diagnosis 2: _____ Diagnosis 3: _____

Congenital Procedures: Select up to three most significant: (refer to "Congenital Diagnoses/Procedures List" document)
Procedure 1: _____ Procedure 2: _____ Procedure 3: _____

Transmyocardial Laser Re-vascularization (TMR): ☐ Yes ☐ No

Cardiac Trauma: ☐ Yes ☐ No

Cardiac Transplant: ☐ Yes ☐ No

Arrhythmia Correction Surgery: ☐ None ☐ Permanent Pacemaker
☐ Permanent Pacemaker with Cardiac Resynchronization Technique (CRT)
☐ Implantable Cardioverter Defibrillator (ICD) ☐ ICD with CRT
(If not None →) Arrhythmia Correction Surgery Lead Insertion or Replacement: ☐ Yes ☐ No

Arrhythmia Correction Surgery Lead Extraction: ☐ Yes ☐ No

Atrial Fibrillation Surgical Procedure: ☐ Yes ☐ No
(If Yes →) Surgical Procedure Location: ☐ Biatrial ☐ Left atrial only ☐ Right atrial only
Left Atrial Appendage Obliterated ☐ Yes ☐ No
Method of Lesion Creation: (Select all that apply↓)
Radio frequency ☐ Yes ☐ No Cryo ☐ Yes ☐ No Laser ☐ Yes ☐ No
Ultrasound ☐ Yes ☐ No Microwave ☐ Yes ☐ No Cut-and-sew ☐ Yes ☐ No
Atrial Fibrillation Ablation Procedure:
☐ Primarily epicardial procedure (e.g., pulmonary vein isolation with or without connection to left atrial appendage).
☐ Primarily intracardiac procedure (e.g., Maze procedures; lesions to mitral annulus; etc.)

Aortic Procedure Type:
☐ None

☐ Aneurysm
(If Aneurysm ↓)
Aortic Root: ☐ Yes ☐ No
(If Yes →) Dacron graft used: ☐ Yes ☐ No
Repair of ascending aortic aneurysm: ☐ Yes ☐ No
Repair of aneurysm in the arch of the aorta: ☐ Yes ☐ No
(If Yes →) Extent of repair: ☐ Hemi-arch ☐ Total arch
Repair of a descending aortic aneurysm: ☐ Yes ☐ No
Repair of a thoracoabdominal aneurysm: ☐ Yes ☐ No
(If Yes →) Graft replacement used: ☐ Yes ☐ No
(If Yes →) Intercostal vessels re-implanted: ☐ Yes ☐ No
CSF drainage utilized: ☐ Yes ☐ No
Extent of descending aorta replacement:
☐ Proximal ☐ Mid ☐ Distal
☐ Proximal - Mid
☐ Proximal - Mid - Distal
☐ Mid - Distal

☐ Dissection (including intramural hematoma)
(If Disection ↓)
Aortic dissection is acute: ☐ Yes ☐ No
Dissection type: ☐ Stanford Type A ☐ Stanford Type B

☐ Trauma
(If Trauma →) Aortic Trauma type: ☐ Blunt ☐ Penetrating

☐ Coarctation

☐ Other

Endovascular Procedure (TEVAR): ☐ Yes ☐ No
(If Yes →)Endovascular Debranching: ☐ Yes ☐ No

Tumor Resection: ☐ None ☐ Myxoma ☐ Fibroelastoma ☐ Hypernephroma ☐ Sarcoma ☐ Other

Pulmonary Thromboembolectomy: ☐ None ☐ Yes, Acute ☐ Yes, Chronic

Other: ☐ Yes ☐ No

N. Other Non Cardiac Procedures

(If Other Non-Card = Yes ↓)

Carotid Endarterectomy: ☐ Yes ☐ No

Other Vascular: ☐ Yes ☐ No

Other Thoracic: ☐ Yes ☐ No

Other: ☐ Yes ☐ No

O. Post Operative

Postoperative Creatinine Level: _____

Blood Products Used Postoperatively: ☐ Yes ☐ No (If Yes ↓)

Red Blood Cell Units: _____ Fresh Frozen Plasma Units: _____ Cryoprecipitate Units: _____ Platelet Units: _____

Extubated in OR: ☐ Yes ☐ No

Re-intubated During Hospital Stay: ☐ Yes ☐ No (If yes →) Additional Hours Ventilated: _____

ICU Visit: ☐ Yes ☐ No (If Yes →) Initial ICU Hours: _____

Readmission to ICU: ☐ Yes ☐ No (If Yes →) Additional ICU Hours: _____

Post Op Echo Performed: ☐ Yes ☐ No (If Yes ↓)

Highest level aortic insufficiency found: ☐ None ☐ Trace/trivial ☐ Mild ☐ Moderate ☐ Severe

Highest level mitral insufficiency found: ☐ None ☐ Trace/trivial ☐ Mild ☐ Moderate ☐ Severe

Highest level tricuspid insufficiency found: ☐ None ☐ Trace/trivial ☐ Mild ☐ Moderate ☐ Severe

Post Op Ejection Fraction Done: ☐ Yes ☐ No (If Yes ↓)

Post Op Ejection Fraction: _____ (%)

Cardiac Enzymes (biomarkers) Drawn: ☐ Yes ☐ No (If Yes →) Peak CKMB: _____ Peak Troponin I _____ Peak Troponin T _____

12-Lead EKG Findings: ☐ Not performed ☐ No significant changes ☐ New Pathological Q-wave or LBBB

Imaging Study Findings:

☐ Not performed

☐ Angiographic evidence of new thrombosis or occlusion of graft or native coronary

☐ Imaging evidence of new loss of viable myocardium

☐ No evidence of new myocardial injury

P. Postoperative Events

In Hospital Postoperative Event Occurred: ☐ Yes ☐ No (If Yes ↓)

Operative

ReOp for Bleeding /Tamponade: ☐ Yes ☐ No (If Yes →) Bleed Timing: ☐ Acute ☐ Late

ReOp for Valvular Dysfunction: ☐ Yes ☐ No

ReOp for Graft Occlusion: ☐ Yes ☐ No

ReOp for Other Cardiac Reasons: ☐ Yes ☐ No

ReOp for Other Non-Cardiac Reasons: ☐ Yes ☐ No

Open chest with planned delayed sternal closure: ☐ Yes ☐ No

Sternotomy Issue: ☐ Yes ☐ No (If Yes →) Sternal instability/dehiscence (sterile): ☐ Yes ☐ No

Infection (see CDC definitions in training manual)

Surgical Site Infection: ☐ Yes ☐ No (If Yes ↓)

Sternal Superficial Wound Infection: ☐ Yes ☐ No

Deep Sternal Infection: ☐ Yes ☐ No

Mediastinitis: ☐ Yes ☐ No (If Yes ↓)

Diagnosis Date: __ __/ __ __/ __ __ __ __ (mm/dd/yyyy)

Secondary Procedure Open with Packing/Irrigation: ☐ Yes ☐ No

Secondary Procedure Wound Vac: ☐ Yes ☐ No

Secondary Procedure Muscle Flap: ☐ Yes ☐ No

Secondary Procedure Omental Flap: ☐ Yes ☐ No

Thoracotomy: ☐ Yes ☐ No

Conduit Harvest or Cannulation Site: ☐ Yes ☐ No

Wound Intervention – Open with Packing/Irrigation: ☐ Yes ☐ No

Wound Intervention – Wound Vac - ☐ Yes ☐ No

Sepsis: ☐ Yes ☐ No (If Yes →) Positive Blood Cultures: ☐ Yes ☐ No

Neurologic

Postoperative Stroke (Perm>24 hours): ☐ Yes ☐ No

Transient Ischemic Attack (TIA): ☐ Yes ☐ No

Encephalopathy: ☐ None ☐ Anoxic ☐ Embolic ☐ Drug ☐ Metabolic ☐ Intracranial Bleeding ☐ Other

Paralysis: ☐ Yes ☐ No (If Yes →) Paralysis Type: ☐ Transient ☐ Permanent

Pulmonary

Prolonged Ventilation: ☐ Yes ☐ No

Pneumonia: ☐ Yes ☐ No

Venous Thromboembolism – VTE: ☐ Yes ☐ No (If Yes ↓)

Pulmonary Thromboembolism: ☐ Yes ☐ No

Deep Venous Thrombosis: ☐ Yes ☐ No

Pleural Effusion Requiring Drainage: ☐ Yes ☐ No

Renal

Renal Failure: ☐ Yes ☐ No) (If Yes ↓)

Dialysis (Newly Required): ☐ Yes ☐ No (If Yes →) Required after Hospital Discharge: ☐ Yes ☐ No

Ultra Filtration Required: ☐ Yes ☐ No

Vascular

Iliac/Femoral Dissection: ☐ Yes ☐ No

Acute Limb Ischemia: ☐ Yes ☐ No

Other

Rhythm Disturbance Requiring Permanent Device: ☐ Pacemaker ☐ ICD ☐ Pacemaker/ICD ☐ None
Cardiac Arrest: ☐ Yes ☐ No
Anticoagulant Event: ☐ Yes ☐ No
Tamponade (Non-Surgical Intervention): ☐ Yes ☐ No
Gastro-Intestinal Event: ☐ Yes ☐ No
Multi-System Failure: ☐ Yes ☐ No
Atrial Fibrillation: ☐ Yes ☐ No
Aortic Dissection: ☐ Yes ☐ No
Recurrent Laryngeal Nerve Injury: ☐ Yes ☐ No
Phrenic Nerve Injury: ☐ Yes ☐ No
Other: ☐ Yes ☐ No

Q. Mortality

Mortality: ☐ Yes ☐ No | Discharge Status: ☐ Alive ☐ Dead | Status at 30 days After Surgery: ☐ Alive ☐ Dead ☐ Unknown

Primary method used to verify 30-day status:
☐ Phone call to patient or family ☐ Evidence of life in medical record ☐ Social Security Death Master File
☐ Letter from medical provider ☐ Office visit to surgeon >= 30 days after procedure ☐ Other

(If Mortality = Yes ↓)

Operative Death: ☐ Yes ☐ No
Mortality - Date __ __/__ __/__ __ __ __ (mm/dd/yyyy)
Location of Death: ☐ OR During Initial Surgery ☐ Hospital (Other than OR) ☐ Home ☐ Extended Care Facility
☐ Hospice ☐ Acute Rehabilitation ☐ OR During Reoperation ☐ Unknown ☐ Other
Primary Cause of Death (select only one)
☐ Cardiac ☐ Neurologic ☐ Renal ☐ Vascular ☐ Infection ☐ Pulmonary ☐ Valvular ☐ Unknown ☐ Other

R. Discharge

(If Discharge Status = Alive↓)

ADP Inhibitors:	☐ Yes ☐ No
Antiarrhythmics:	☐ Yes ☐ No
Aspirin:	☐ Yes ☐ No ☐ Contraindicated
ACE or ARB Inhibitors:	☐ Yes ☐ No, contraindicated ☐ No, not indicated
Beta Blockers:	☐ Yes ☐ No ☐ Contraindicated
Lipid Lowering:	☐ Yes ☐ No ☐ Contraindicated (If Yes →) ☐ Statin ☐ Non Statin ☐ Both ☐ Other
Coumadin:	☐ Yes ☐ No
Direct Thrombin Inhibitors:	☐ Yes ☐ No
Discharge Location:	☐ Home ☐ Extended Care/Transitional Care Unit/Rehab ☐ Other Hospital ☐ Nursing Home ☐ Hospice ☐Other
Cardiac Rehabilitation Referral:	☐ Yes ☐ No ☐ Not Applicable
Smoking Cessation Counseling:	☐ Yes ☐ No ☐ Not Applicable

S. Readmission

(If Discharge Status = Alive↓)

Readmit <=30 Days from Date of Procedure: ☐ Yes ☐ No (If Yes ↓)

Readmit Primary Reason:
- ☐ Anticoagulation Complication - Valvular
- ☐ Anticoagulation Complication - Pharmacological
- ☐ Arrhythmia/Heart Block
- ☐ Congestive Heart Failure
- ☐ Myocardial Infarction and/or Recurrent Angina
- ☐ Pericardial Effusion and/or Tamponade
- ☐ Pneumonia or other Respiratory Complication
- ☐ Coronary Artery Dysfunction
- ☐ Valve Dysfunction
- ☐ Infection - Deep Sternum / Mediastinitis
- ☐ Infection - Conduit Harvest Site
- ☐ Renal Failure
- ☐ TIA
- ☐ Permanent CVA
- ☐ Acute Vascular Complication
- ☐ Subacute Endocarditis
- ☐ VAD Complication
- ☐ Transplant Rejection
- ☐ PE
- ☐ DVT
- ☐ Other - Related Readmission
- ☐ Other - Nonrelated Readmission

Readmit Primary Procedure:
- ☐ OR for Bleeding
- ☐ Pacemaker Insertion / AICD
- ☐ PCI
- ☐ Pericardiotomy / Pericardiocentesis
- ☐ OR for Coronary Arteries
- ☐ OR for Valve
- ☐ OR for Sternal Debridement / Muscle Flap
- ☐ Dialysis
- ☐ OR for Vascular
- ☐ No Procedure Performed
- ☐ Other Procedure
- ☐ Unknown

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