This section provides a comprehensive guide to improving outcomes and reducing costs in adult cardiac surgery.
No single organization has the perfect cardiac surgery system. Yet many organizations have at least one piece of such a system already in place.

One organization has established a same-day admission program for virtually all of its elective CABG patients. Another has reduced extubation time. Still another has dramatically decreased overall length of stay.

The objectives of the Cardiac Surgery Collaborative were, first, to identify the essential elements of an ideal cardiac surgery system—either by finding organizations that already had them in place or by developing them; and second, to use those elements to define and describe the ideal cardiac surgery system.

Of course, the ideal system lasts only until someone comes along and thinks of something better. The goal is to give such ideas exposure, to learn from them, and to bring them home and “reinvent” them in our specific organizational environments.

This section will walk a “virtual patient” through a CABG at an ideal cardiac surgical program—one that is both the highest in quality and the most cost-effective.

Although this section divides the cardiac surgery system into separate pieces, in actual practice many of these pieces overlap. Changes that are listed under one topic may apply to several others as well.
Adult Cardiac Surgery

Improving the Cardiac Surgery System

For each of the 11 topics in the diagram below, this section of the Guide addresses the following:

Goal and Benefits
The need and the opportunity for improvement and what might make improvement difficult

Changes
Useful process changes tested by organizations in the Collaborative

Measures
Measures that can be used to tell if changes are leading to improvement, including an explanation of when to use each measure and a graphic example of how to display the data

Resources
Resources developed by organizations that may prove useful to others interested in making changes in these particular areas

The symbol indicates when a resource is included at the end of the section.

“There is no single best performer in health care. There are best practices everywhere. Somebody probably puts in a central line better than I do. Somebody probably transports a patient from the operating room to the ICU better than I do. Somebody probably has a lower mortality rate and can tell me why. We need to work together to pool our knowledge and our expertise, and use the sum of all our good work to create a benchmark for cardiac surgery.”

William C. Nugent, MD, Chief, Section of Cardiothoracic Surgery
Dartmouth-Hitchcock Medical Center, Lebanon, NH

Postoperative Care outcomes

<table>
<thead>
<tr>
<th>ICU</th>
<th>Ventilator</th>
<th>Atrial Fibrillation</th>
<th>Floor</th>
<th>Discharge and Follow-up</th>
<th>Database</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>8</td>
<td>7</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td></td>
</tr>
</tbody>
</table>
Preoperative Care

1 Improving Decision Making

Goal

Decrease length of stay, reduce mortality, and increase patient satisfaction. The individual who has been diagnosed as having coronary disease faces important, and often urgent, questions: What are the treatment options—and what are my chances with each one? Coronary bypass surgery? Angioplasty or some other kind of catheter-based intervention? Or is medical management adequate to treat the disease?

Organizations need to establish a program of shared, informed decision making to help clinicians, patients, and families answer these questions. Providing patients with detailed information will help them decide which treatment option is best for them.

Benefits

• Better patient decisions
• Improved patient satisfaction
• Better prepared patients and families

Changes

Explain the purpose of catheterization before patients undergo the procedure. Before undergoing cardiac catheterization, patients should understand that the purpose of the procedure is to evaluate the need for intervention, surgical or otherwise. Clinicians should discuss the potential risks and benefits of the various modalities of therapy with patients and their families before catheterization.

Patients and their families should understand that the test may show that the patient needs surgery and that surgery might be scheduled right away, even if such surgery is not an emergency. Patients who have been properly prepared can make a decision as soon as the clinician has presented the results of the catheterization.

Use in-hospital data to provide patient-specific risk assessment. Using data from a system-wide database, hospitals can develop a risk-stratified model for cardiac surgery patients. Using patients’ individual characteristics, the model allows clinicians to assess patients preoperatively and calculate a patient-specific expected mortality and the probability of various major morbidities. In this way, individuals can make their own decisions, informed by data on patients who have actually undergone a particular operation within a particular program.
An Electronic Second Opinion

Cardiac surgeons in organizations that participate in the Northern New England Cardiovascular Disease Study Group (NNECDSG) have worked with risk modeling for a number of years. Besides developing a model for predicting the likelihood of survival for CABG based on patient-specific variables, the surgeons have been able to utilize this model clinically by programming it into a hand-held calculator. In addition, they have developed a computer module that allows clinicians to calculate likelihood of inhospital mortality, postoperative CVA, and likelihood of 5-year survival for each of the three major modalities of therapy: angioplasty (PTCA), CABG, and medical management.

Changes (continued) Provide information not only on in-hospital mortality, but also on five-year mortality. Several organizations have begun using larger databases to look beyond in-hospital mortality and compare the long-term survival rates associated with different interventions. For example, clinicians can use specific patient characteristics to compare the five-year survival rates for coronary angioplasty, coronary artery bypass graft, and medical therapy. Armed with this information, clinicians can discuss treatment options among themselves and can educate their patients more effectively.

Improve clinicians’ understanding of their patients’ expectations. Clinicians need to improve their understanding of patients’ expectations: What does the patient want from cardiac surgery? What level of risk is the patient willing to accept? Some organizations have developed simple computer programs to elicit and track this information from patients. Such programs ask, for example, what is the patient’s primary complaint? How much does the complaint bother the patient? What level of risk is the patient willing to accept in return for what level of functionality? Clinicians can then use this data to make decisions concerning treatment.

---


Patient satisfaction
As organizations improve care and reduce cost, they need to make sure that patients and their families are satisfied with their care. Cardiac surgery programs can use existing patient satisfaction surveys or design their own. Surveys should elicit information about all phases of care—preoperative, surgical, ICU, postoperative, discharge, and follow-up. Organizations should review patient satisfaction surveys monthly.

By including in these surveys specific questions about decision making and patient preparation for surgery, hospitals can measure the effectiveness of changes they make to these processes. Ideally, all individuals with coronary disease—those who choose to proceed with surgery as well as those who do not—should show increased satisfaction with the decision-making process.

Figure 1.2
Overall Patient Satisfaction with Cardiac ICU
Sentara Norfolk General Hospital
Norfolk, VA
### CABG Risk Model

<table>
<thead>
<tr>
<th>Risk Variable (in order of importance)</th>
<th>Risk Values</th>
<th>Error Check</th>
<th>Odds Ratio for Risk Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patient Name</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prior heart surgery (1 = No; 2 = Yes)</td>
<td>1</td>
<td></td>
<td>2.83</td>
</tr>
<tr>
<td>Age (in years) on date of surgery</td>
<td>7.5</td>
<td></td>
<td>1.37 (for a 10-year increase)</td>
</tr>
<tr>
<td>Priority of surgery (1 = elective; 2 = urgent; 3 = emergent)</td>
<td>2</td>
<td></td>
<td>1.44 (for an increment from elective to urgent or urgent to emergent)</td>
</tr>
<tr>
<td>Creatinine (in mg/dl)</td>
<td>2</td>
<td></td>
<td>1.18 (for an increment of 1.0 mg/dl)</td>
</tr>
<tr>
<td>ASA classification (estimated ASA classification 1-5)</td>
<td>2</td>
<td></td>
<td>3.32 (for an increase from any classification to class 5)</td>
</tr>
<tr>
<td>Prior myocardial infarction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 = none</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 = greater than 7 days before surgery</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 = less than or equal to 7 days before surgery</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cerebral vascular disease (1 = No; 2 = Yes)</td>
<td>2</td>
<td></td>
<td>1.40 (for an increment from one category to the next)</td>
</tr>
<tr>
<td>Preoperative IABP use (1 = No; 2 = Yes)</td>
<td>2</td>
<td></td>
<td>1.63</td>
</tr>
<tr>
<td>NYHAFC functional class for congestive heart failure (1-4)</td>
<td>2</td>
<td></td>
<td>1.17 (for an increase in one class)</td>
</tr>
<tr>
<td>Current digoxin use (1 = No; 2 = Yes)</td>
<td>2</td>
<td></td>
<td>1.41</td>
</tr>
<tr>
<td>Chronic obstructive pulmonary disease (1 = No; 2 = Yes)</td>
<td>2</td>
<td></td>
<td>1.3</td>
</tr>
<tr>
<td>Peripheral vascular disease (1 = No; 2 = Yes)</td>
<td>1</td>
<td></td>
<td>1.29</td>
</tr>
<tr>
<td>CCS functional class for angina (1-4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cardiomegaly (1 = No; 2 = Yes)</td>
<td>1</td>
<td></td>
<td>1.25</td>
</tr>
<tr>
<td>Physician’s preoperative estimate of operative mortality (%)—(required so this value will not be biased by the calculated risk estimate)</td>
<td>7.5</td>
<td>Percent</td>
<td>The physician’s estimate of operative mortality is the value to be used in the Cardiac Risk Assessment Forms.</td>
</tr>
</tbody>
</table>

### Enter Patient Risk Factors

Do not use the **Calculated Estimate of Operative Mortality** in the cardiac risk assessment forms.

In order to ensure that the models reflect the current VA patient population, new risk models are created every six months from the most recent three-year patient data. Consequently, the risk estimates calculated by this program may be somewhat different from the risk estimates for the same patients that are sent to you in the semiannual cardiac surgery reports. Although the overall estimated risk for a particular hospital tends to remain constant regardless of the model used, individual patient risk estimates may change fairly significantly as different risk variables move into or out of the model during different time periods.
2 Improving Patient Preparation and Preoperative Evaluation

Goal

Decrease length of stay, reduce mortality, and increase patient satisfaction.

Once the patient and clinician have decided together that surgery is the appropriate intervention, the next step is to clarify what will be expected of the patient—before entering the hospital, during the hospital stay, and during postoperative recovery.

Benefits

- Increased patient satisfaction
- Improved transfer of the patient from the cardiologist to the surgeon and anesthesiologist
- Reduced mortality

Changes

Educate patients and their families about what to expect from coronary bypass surgery.

Clinicians need to provide patients and their families with careful preoperative instructions, as well as the practical information—directions to the hospital, transportation options, instructions for parking, location and cost of nearby lodging—patients will need in order to arrive on time and at the proper place on the morning of surgery.

Just as clinicians use pathways to guide the care process, patients can also use pathways to guide their own activities in the course of their care. Clinicians in one organization use a checklist with patients. The checklist is a preoperative “patient pathway” that takes patients through all of the things they must do to prepare for surgery. Another program gives individuals a videotape and a folder of information as soon as they decide to have surgery.

Coordinate and standardize preoperative evaluation.

Elective CABG patients should undergo all preoperative evaluation before admission, preferably during a single visit to the cardiac surgeon’s office. Undergoing a complete evaluation in one visit is particularly important for patients who must travel long distances. Many organizations use a checklist to identify the necessary preoperative information, including laboratory and radiological data, and significant medical history. A scheduling secretary in the surgeon’s office should coordinate all consultations and clearances, and track test results.

Eliminate unnecessary preoperative testing and avoid duplication of preoperative evaluations, including physical examinations, blood tests, and x-rays.

Some preoperative tests, such as pulmonary function tests and coagulation studies, are often not necessary and can safely be eliminated. Duplicating history-taking and testing incurs unnecessary costs and places an unnecessary burden on the patient. Many programs accept chest x-rays performed within three months before surgery, provided the patient has no new respiratory complaints or findings. Many programs also accept electrocardiograms performed within one month before surgery, provided the patient has no new cardiac complaints.
Changes (continued) Have patients use guided imagery to help them prepare for surgery.
Controlled studies have shown that guided imagery— the practice of listening to audiotapes that guide the listener through relaxation exercises— can reduce patients’ anxiety before surgery, their lengths of stay in the hospital, and their pain after surgery. Some clinicians have their patients listen to guided imagery audiotapes during the weeks before surgery, as they go into surgery, and as they emerge from anesthesia.

Measures

Cost of preoperative testing
Track the total cost or the total number of preoperative tests, per patient or per type of test. For example, track the total cost of preoperative pulmonary function tests on a monthly basis; or track the percentage of patients receiving preoperative coagulation studies. Tracking these tests is a necessary step in achieving optimal utilization, reducing unnecessary testing, and reducing costs.

Figure 1.3
Low-risk Cardiac Surgery Patients with Preoperative Coagulation Studies
Scott & White Memorial Hospital, Clinic and Health Plan Temple, TX

Selected Dates
Average number of low-risk cardiac surgery patients per month = 11

---

# Cardiac Surgery Picture Pathway

<table>
<thead>
<tr>
<th>Before Surgery</th>
<th>After Surgery</th>
<th>1 Day After Date</th>
<th>Day #2 Date</th>
<th>Day #3 Date</th>
<th>Day #4 Date</th>
<th>After Discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nutrition</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>After Discharge</td>
</tr>
<tr>
<td>Nothing</td>
<td>Nothing</td>
<td>Liquids</td>
<td>Cardiac diet</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Activity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>After Discharge</td>
</tr>
<tr>
<td>Walking</td>
<td>Leg exercises</td>
<td>Out of bed</td>
<td>Walking short distances</td>
<td>Walking long distances</td>
<td>Walking long distances</td>
<td>Walking long distances</td>
</tr>
</tbody>
</table>

- **Equipment**

- **Pain Control and Other Medications**

- **Hygiene**

- **Discharge Plan**

- RN call and home visit

---

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Preoperative Cardiothoracic Surgery Evaluation

Referred by: ________________________________

**History of present illness:**

Most recent episode of ischemia within last 24 hours?  □ Yes  □ No
Myocardial infarction within 7 days?  □ Yes  □ No
Congestive heart failure current admit?  □ Yes  □ No
Congestive heart failure resolved?  □ Yes  □ No

Cath date: ________________________________
Cath data: ________________________________
Left ventricular end-diastolic pressure (LVEDP): ________________________________
Ejection fraction: ________________________________

**Allergies:**

Other medical problems/Past medical history (include surgeries):

**Social history:**  □ Alcohol  □ Cigarettes  □ Other (e.g., Jehovah’s Witness)

**Medications:**

Current meds include:

- Beta blocker  □ Yes  □ No
- Aspirin  □ Yes  □ No
- Intravenous heparin  □ Yes  □ No
- Intravenous nitroglycerin  □ Yes  □ No
- Partial thromboplastin time

**Review of systems: System subcheck**

Yes  No  Pulmonary

- □  □ Recent pneumonia (infiltrate on chest x-ray or antibiotics within 30 days)
- □  □ Chronic obstructive lung disease (COPD) on medical treatment (Obtain arterial blood gas if room air sat < 90%)

Renal insufficiency (creatinine > 2.0)

- □  □ Pre-cath
- □  □ Post-cath

Gastrointestinal

- □  □ Gastrointestinal hemorrhage within last 3 months
- □  □ Peptic ulcer disease (PUD)
- □  □ Gastroesophageal reflux disease (GERD)
**Preoperative Cardiothoracic Surgery Evaluation (continued)**

**Review of systems: System subcheck (continued)**

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
<th><strong>Peripheral vascular</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Severe occlusive disease</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Previous peripheral bypass</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Obtain carotid duplex if Sx within past year)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Previous stroke/Transient ischemic attack</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th><strong>Lower extremity venous disease</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Previous deep vein thrombosis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Obtain vein mapping and/or Allen’s test of radial and imaging of internal mammary artery in vascular lab if yes)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Varicosities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Vein stripping</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Obesity</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th><strong>Other</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>History of coagulation abnormality, thrombocytopenia, or anemia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Recent infection or elevated white blood count</td>
</tr>
<tr>
<td></td>
<td></td>
<td>History of radiation to chest/sternum</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other major organ system dysfunction or lab abnormality</td>
</tr>
</tbody>
</table>

*If yes to any of above, notify attending surgeon.*

**Lab results:**

- Lab-hematocrit value and date:
- Urine analysis if valve:
- Electrocardiogram:
- Chest x-ray:
- Physical exam:

**Physical exam:**

<table>
<thead>
<tr>
<th>Head, ear, eyes, nose, throat, and neck:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart</td>
</tr>
<tr>
<td>Lungs</td>
</tr>
<tr>
<td>Abdomen</td>
</tr>
<tr>
<td>Extremities</td>
</tr>
<tr>
<td>Neurological</td>
</tr>
</tbody>
</table>

**Assessment/Plan**

<table>
<thead>
<tr>
<th>Provider</th>
<th></th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Beeper</th>
<th>Date</th>
</tr>
</thead>
</table>

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3 Reducing the Time from Catheterization to CABG

**Goal**

Reduce the time from cardiac catheterization to coronary artery bypass graft (CABG) surgery to less than 48 hours.

Patients often remain in the hospital for several days between catheterization and cardiac surgery. In some cases—for example, patients with a recent myocardial infarction—this waiting period is intentional. For most patients, however, these hospital days are medically unnecessary.

The catheterization-to-CABG process is typically complicated and time-consuming. Often, the decision to proceed with cardiac surgery involves many individuals including the patient, the patient’s family, the cardiac catheterization physician, the consulting cardiologist, the primary care physician, and the surgeon. In many cases, delays between catheterization and CABG occur because the surgeon and the cardiologist are busy and unable to meet to review the case until the end of the day. The unavailability of operating room staff may also cause delays. Inefficiencies in operating room processes often create a bottleneck, adding to the time it takes to move patients through the system. Although the system is complex, many organizations have established processes that are efficient enough to reduce the time from catheterization to CABG to 48 hours or less.

**Benefits**

- Reduced cost of hospitalization
- Improved operating room scheduling (It is easier to schedule patients on an elective basis—DRG 107—than it is to keep them in the hospital after catheterization and try to fit them into the next available operating room opening—DRG 106.)
- Improved care following surgery (When surgery is scheduled on an elective basis, staff members have more time to devote to patient and family education and to prepare the home for post-discharge care.)
- Improved patient satisfaction due to the elimination of unnecessary inpatient days
- Reduced likelihood of adverse events during the wait for surgery
- Reduced complexity associated with managing patients who are waiting for surgery

**Changes**

Simplify the decision-making process.

Establishing criteria for the appropriateness of cardiac surgery simplifies the decision-making process. The cath lab cardiologist can use these criteria to make an initial treatment decision and then communicate that decision immediately to the surgeon or the surgeon’s office. In addition, cath labs may want to define a process for informing the primary care physician or the consulting cardiologist, perhaps allowing them a predefined period of time—for example, within two hours after completion of the catheterization—in which to assess the information and give input into the decision. Establishing criteria for surgery helps ensure that the clinicians involved are in agreement before the catheterization. This, in turn, will expedite care after the procedure.
Changes (continued)  

Make all essential patient information available to the surgeon as soon as possible. 
Poor access to pertinent patient information causes delays. To speed up the assessment process, make all necessary patient information available at the time of the consultation. This information should include laboratory values, cardiac catheterization results, other values that facilitate surgical risk assessment, and the patient’s and family’s preferences regarding surgical intervention.

One hospital identified that developing angiograms in batches caused delays. The hospital now makes it a rule to have the developed coronary angiograms in the surgeon’s “box” for review within 30 minutes of the study.

Once the decision is made to proceed with cardiac surgery, either move patients directly from catheterization to surgery, or discharge them and admit them at a later date for surgery as elective patients.

Once the decision is made to proceed with surgery, hospitals should eliminate unnecessary patient stays between catheterization and cardiac surgery. One way to do this is to move patients to surgery as soon as the decision for surgery has been made. Another way is to define criteria under which patients can be safely discharged and convert appropriate patients from DRG 106 to DRG 107 by discharging them right away and readmitting them for surgery on an elective basis.

Designate a staff person to receive referrals and schedule operations.

If it is not possible to make referrals directly to the cardiac surgeon on call, surgeons should authorize someone who is available throughout the day—a secretary, a nurse, or a physician’s assistant, for example—to receive referrals from the cath lab, assign patients, and schedule operations for the first available opening in the operating schedule. Surgeons can review these scheduled operations later and reserve the option of canceling cases.

Have a nurse practitioner on call to receive all patients referred for consultation. 
A nurse practitioner receives all patients referred for consultation and begins screening them. In this way, even if all the surgeons are in the operating room, the consultation process is not delayed.

Establish a nondirected referral pattern.

Instead of referring patients to a specific cardiac surgeon, refer consultations to the surgeon on call that day. Nondirected referrals can significantly simplify the scheduling process. Programs with directed referrals often experience bottlenecks around popular surgeons. Institutions that have more than one cardiac surgical group should at least strive to have nondirected referrals within each group. Nondirected referral patterns increase throughput by more evenly distributing the workload.
Eliminate unnecessary tests from the preoperative evaluation. Many preoperative tests are ordered routinely, often without evidence of their usefulness. Such tests include routine pulmonary function tests (PFTs), bleeding times, and carotid ultrasounds. Many centers have eliminated PFTs and bleeding times altogether, and perform carotid ultrasounds only in selected circumstances.

Have surgeons agree on a standard approach to preoperative evaluation for CABG patients. Developing a standard approach enables cardiologists to anticipate which additional tests—for example, evaluation of carotid bruits—are needed before surgery and to schedule them in advance on the day of catheterization.

Post the operating room schedule for the week (or the month) where everyone involved, including the cardiologists, can see it. Posting such a schedule allows cardiologists to see openings as well as constraints, for example, when surgical capacity is limited because surgeons or cardiologists are away. Provide a place on the schedule for the cardiologists to note the names of inpatients they wish to refer for surgery.

Have the operating room orchestrate the scheduling of surgery. Scheduling a patient for surgery should require no more than a single telephone call from the surgeon’s office to the operating room. The staff in the operating room should then assume responsibility for notifying the anesthesiologist, perfusionist, and open heart team.

Improve operating room efficiency. Lack of operating room time due to inefficient processes is often the primary reason for delayed surgery. Improving operating room efficiency significantly increases the total capacity of the cardiac surgery system, allowing for increased throughput. Increasing operating room capacity, in combination with the changes described in this section, can virtually eliminate delays from catheterization to surgery.
Measures

Average vs. Median

Finding the “average” and “median” are two different ways of locating the center or midpoint in a group of data points.

- The average, also known as the arithmetic mean, is the sum of all data point values divided by the total number of data points.

- The median is the middle point in a data set; there are an equal number of data points greater than and less than the median.

The average is affected by outlying values, while the median is not. Therefore, it is sometimes preferable to use median when a few outlying data points have a substantial effect on the average.

Average time from catheterization to CABG for inpatients

Measure how long patients wait in the hospital from the completion of catheterization to the start of cardiac surgery.

- Exclude patients who had a recent myocardial infarction because their surgery should be delayed.

- If possible, measure the time in hours, not days, to emphasize that waiting in the hospital for several days from catheterization to CABG is unacceptable.

- Display the data in run charts, both by day and by month. The daily measure shows day-to-day variation; the monthly measure shows general trends over time.

- Make it clear that data are being collected for the purpose of improvement, not to single out any individuals or departments for punishment.

Figure 1.4
Average Time from Catheterization to CABG (for Inpatients)
Veterans Administration Medical Center
Memphis, TN

Average number of patients in DRG 106 per month = 8
Ohio State University Medical Center

**Discharging Patients Awaiting CABG Surgery**

If scheduling problems delay surgery for a patient who is otherwise ready, the attending physician can use the following clinical and angiographic parameters to help determine whether to discharge a patient to await an elective admission when scheduling permits:

### Parameters in Favor of Discharge

1. No intravenous (IV) medications for 24 hours.
2. No angina at rest or with low-level ambulation for 24 hours.
3. Vital signs stable for 24 hours.
4. If patient has a history of a recent (non-Q-wave or transmural) myocardial infarction (MI), he or she should be pain-free for 72 hours and off IV medications for at least 24 hours.

### Key Parameters Against Discharge

5. Symptomatic congestive heart failure.
6. High-risk unstable angina (hemodynamic or ECG changes with pain, pulmonary edema, rales, dynamic mitral regurgitation with pain).
7. Any episode of ventricular tachycardia during hospitalization.
8. Angiographic evidence of intracoronary thrombus or significant left main stenosis.
9. Active, significant comorbid condition(s) (e.g., diabetes out of control).
10. Comorbid condition(s) that require further testing (e.g., CNS or pulmonary status). Patient may be evaluated as an outpatient at the discretion of the attending physician.

### General Considerations

11. If the patient is post-MI, the attending physician should discuss the appropriate timing of the proposed CABG with patient’s cardiothoracic surgeon. Characteristics of a patient who has low risk with early CABG (two to three days) post-MI:
   - Near normal ejection fraction
   - No cardiogenic shock history
   - Subendocardial MI vs. transmural MI
   - Male
   - Younger
   - No significant left main disease

12. The psychosocial situation of the patient should be addressed to document the ability and support of the patient to return to the hospital for surgery.

13. It may be reasonable to contact the referral physician to discuss the proposed discharge and plan of follow-up care.
Cath-to-CABG Delays
Data Abstraction Tool

Patient Name ______________________________________
Medical Record Number ______________________________________

Admit Date ___/___/___ Admit Time __________
Cath Date ___/___/___ Cath Time __________
Consult Date ___/___/___ Consult Time __________
Date Consult Completed ___/___/___ Time Consult Completed __________

Yes ☐ No ☐ Could the patient be discharged (according to criteria)?

☐ ☐ Was preoperative testing required? _______________________________

☐ ☐ Did the patient’s medical condition delay the case? _______________________________

☐ ☐ Was there a delay in scheduling the case? _______________________________

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<thead>
<tr>
<th>Schedule</th>
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4 Establishing a Same-day Admission Program

**Goal**

Admit 100% of elective patients (DRG 107) on the day of surgery.

Patients undergoing elective, scheduled coronary artery bypass graft surgery (DRG 107) typically have had their cardiac catheterization performed either during a prior hospitalization or as an outpatient procedure. Often, hospitals admit these patients on the day before surgery. However, this hospital day adds cost without adding value to the patient’s care. Programs that undertake good patient preparation and preoperative evaluation can admit these patients on the morning of surgery.

Same-day admission programs, in which patients are admitted on the morning of surgery, are rapidly becoming the norm for the elective open heart patient. At many centers, this change has not only reduced cost but has also improved patient satisfaction. Patients almost always prefer sleeping at home or in a comfortable hotel to spending an extra night in the hospital.

**Benefits**

- Improved patient satisfaction
- Reduced cost due to fewer unnecessary hospital days

**Changes**

Have a clinician contact patients the day before surgery.

Some programs require an office visit the day before surgery for final preparation. In others, a member of the anesthesia or nursing staff telephones the patient the evening before surgery. The clinician makes sure that the patient understands which medications to take and answers any last-minute questions the patient might have.

Have patients stay at home or in nearby accommodations the night before surgery.

Although clinicians often anticipate difficulty convincing patients that same-day admission is appropriate, patients overwhelmingly prefer it to spending the night before surgery in the hospital. Hospitals are loud and busy places; keeping patients out of the hospital helps reduce their anxiety. Patients coming from long distances can make arrangements to stay in local accommodations. Often, hospitals can arrange for reduced rates with local hotels for these patients.

Streamline the admission process on the morning of surgery.

The surgeon’s office should obtain and organize all of the necessary patient information—including patient demographic and insurance information—before the patient arrives at the admitting area on the morning of surgery. Such an efficient and streamlined admitting process avoids asking the patient to supply this information more than once.

One program shares appropriate information, eliminates the duplication of efforts, and improves efficiency by linking computers in the surgeon’s office with those in the hospital. Additionally, this program eliminates the admission office altogether by having patients proceed directly to the cardiac surgery floor. There, staff admit patients and prepare them for surgery. Later on the day of surgery, patients return from the ICU to these same beds.
Same-day Admission at Dartmouth-Hitchcock Medical Center

- On the night before surgery, the same-day admission staff screens patients’ charts to make sure that all lab tests are intact and available. Rather than repeat tests, the hospital accepts all outside laboratory tests performed within certain time frames—for example, chest x-rays performed within three months before surgery. Consequently, the number of preoperative laboratory tests performed in-house has decreased significantly.

- Patients who are scheduled as the first cases arrive at the admitting office at 6:00 AM where they are promptly escorted, along with their families, to the preoperative area. (Patients who live a long distance away from the hospital stay at a local motel on the night before surgery.)

- A nurse performs an assessment and starts an IV.

- If the patient is diabetic, a clinician checks the glucose level.

- The family stays with the patient until a member of the anesthesiology staff takes the patient to the operating room and begins the preoperative antibiotic.

Measures

Percentage of same-day admissions for patients in DRG 107 (coronary artery bypass without catheterization)

Track this measure by month, at first, and then by quarter.

If the rate is decreasing or not increasing, track the percentage of same-day admissions for individual surgeons to get a better understanding of the variation among surgeons in the use of same-day admission.

Figure 1.5
Same-day Admissions for Patients in DRG 107 (Elective Only)

Sample

Note: Track elective patients only. Use a “run chart,” in which each data point shows the percentage of all elective patients using same-day admission.
Cardiac Surgery Checklist for Patient

This checklist will help you to prepare for cardiac surgery. Use the checklist and write down your questions, so we can answer them when you return to the hospital for your surgery. If questions need an answer before surgery, please call the nurse on 3 West of Mercy Hospital at XXX-XXXX.

☐ Do not drink or eat anything after midnight on the day prior to surgery on ____________________.

☐ Do not take Coumadin, Aspirin, Persantin, and Ticlid the day before surgery, but continue to take other medications as ordered. The anesthesiologist will instruct you about which medications to take the day of surgery.

☐ Practice getting in and out of chair/bed/toilet with arms hugged around pillow across chest.

☐ Pack loose fitting clothes—pants with elastic waist and button-down or zippered shirt, such as a sweat suit. These clothes are to be brought to the hospital after you have been transferred to 3 West after surgery.

☐ Shower at home with Hibiclens soap the evening before or the day of your surgery. Take a 10-minute shower using a bottle of Hibiclens soap. (Wash from neck to toes.)

☐ Listen to Relaxation Tape 1 without interruptions. It is suggested you listen to the tape twice a day until surgery.

☐ Remove all jewelry before surgery and leave it at home. If you are unable to remove rings, we have special equipment to cut the rings. Rings are a hazard after heart surgery because of the normal swelling that occurs, especially in fingers.

☐ Do not remove ID Band, Blood Band, and Allergy Band (if applicable).

☐ Magnesium Citrate. Drink one bottle early in the morning of the day before your surgery if ordered by your physician.

☐ We encourage you to limit visitors to close family members during your hospital stay. We suggest you request that friends and extended family wait to visit until after you return home.

☐ Upon returning to hospital for cardiac surgery, return bag with relaxation tape and tape player with headset (either your own or one borrowed from Mercy Hospital).

☐ List other questions for doctor/nurse:

__________________________________________________________________________
__________________________________________________________________________
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Intraoperative Care

5 Improving Operating Room Availability and Efficiency

Goal

Reduce operating room time for a standard three-vessel CABG to 180 minutes or less.

Reduce operating room costs—including supplies and personnel—for DRGs 106 and 107 to $4,500 per case.

Optimizing the use of the operating room involves improving operating room availability as well as improving operating room efficiency.

Improving Operating Room Availability

Sufficient operating room capacity may exist to meet demand, but that capacity may not be used effectively. To improve operating room availability, ensure that there is no wasted capacity by matching capacity and demand.

Understanding Operating Room Capacity and Demand

How to Measure Demand for Operating Rooms

The demand for operating rooms can be measured simply—by hour of the day or by day of the week. Basic sampling is all that’s needed.

This sample graph tracks the average number of people awaiting surgery at different hours of the day. The graph indicates that demand is relatively high from 8:00 AM to 3:00 PM and relatively low during the rest of the day.
How to Measure Demand for Operating Rooms (continued)

This sample graph tracks the average number of people awaiting surgery on different days of the week. The graph indicates that demand is relatively high at the beginning of the week and tapers off toward the end of the week.

![Operating Room Demand by Day of the Week](image)

How to Shape Demand for Operating Rooms

- Insert an acceptable delay. For example, send nonurgent cases home, converting DRG 107 to DRG 106.
- Avoid scheduling high-risk procedures on days and at times that are more likely to cause delays. For example, try not to schedule high-risk cardiac catheterizations on Fridays. If the results of catheterization indicate that these patients need surgery and are too sick to send home, they will need to wait in the hospital for at least two days before surgery. Instead, try to schedule elective low-risk catheterizations on Fridays.
- Leave space in the schedule for unexpected or urgent care.

How to Measure Operating Room Capacity

Two variables determine operating room capacity:

- The number of operating rooms available for use
- The number of available cardiac surgeons and operating room staff

The sample graph shows the number of surgeons available each day over a period of 2 weeks.

![Operating Room Capacity by Day of the Week](image)
Improving Operating Room Efficiency

The 180-minute CABG and the 20-minute Turnover

Some hospitals can routinely perform coronary artery bypass graft (CABG) surgery in 3 hours—measured from the time the patient enters the operating room to the time the patient leaves the operating room—with excellent outcomes. They regularly complete uncomplicated cases in 2 to 2 1/2 hours. The key to reducing operating room time is careful planning, organization, and teamwork—not faster cutting or sewing. These hospitals have carefully designed their surgical systems to achieve this level of performance.

Benefits

• Improved outcomes because shorter pump time is associated with lower morbidity and mortality, independent of preoperative patient factors
• Increased availability of surgeons and operating rooms, allowing for an increase in the volume of surgeries
• Reduced overtime on nights and weekends
• Reduced wear and tear on staff, increased morale and satisfaction
• Increased time for additional income-generating activities, as surgeons and other staff spend less time per case in the operating room
• Reduced total cost per case

Changes

The design of a system determines the results it will produce. The system that safely produces the 180-minute CABG is carefully designed to do so. These changes to improve operating room efficiency are based upon basic principles for improving processes. See Part 4, Change Concepts for Improving Adult Cardiac Surgery, pp. 101–113, for an explanation of these “change concepts.”

Redesign the system to do some or all tasks simultaneously, instead of doing each task sequentially.

Many systems are designed so that tasks are done sequentially: the second task is not begun until the first task is completed. This is often the case when different groups in the organization are involved in different steps of a process. To increase operating room efficiency, examine all of the tasks in the operating room and determine which ones can be done simultaneously. Begin by examining the tasks involved in room turnover and patient preparation.
Doing Tasks in Parallel

At Sentara Norfolk General Hospital in Norfolk, Virginia, clinicians begin performing several tasks in parallel as soon as the patient arrives in the operating room:

- A surgical assistant places an arterial line.
- The anesthesiologist begins induction.
- The circulating nurse places the Foley catheter and begins to prep the patient’s chest and legs.
- The scrub nurse prepares the back table (which has been set up previously and covered with a sterile drape).
- Once the induction is completed, the anesthesiologist intubates the patient and places a triple lumen central venous catheter and a Swan Ganz catheter.
- The surgical assistant drapes the patient in a standardized fashion, then begins to harvest the saphenous vein.

The total time elapsed from the patient’s entry into the room until the incision is approximately 25 minutes.

Changes (continued)

Standardize equipment, drugs, supplies, setups, and processes in the operating room.

Standardizing processes reduces variation in practice. Reducing variation among staff, particularly surgeons, allows other staff to anticipate steps in the process, reduce time between steps, and minimize the need for communication among team members.

One organization attempted to standardize every aspect of the cardiac surgery process, including draping the patient, taking down the internal mammary artery, and getting the patient onto the cardiopulmonary bypass machine. The team’s efforts resulted in CABG times under 180 minutes, with excellent outcomes. Likewise, standardizing the process of room turnover—such tasks as cleaning the room and preparing the anesthesia cart—resulted in turnover times of 20 minutes or less.

Standardizing the operating room setup entails assessing which instruments are needed and assembling an instrument table that is “lean” and cost-effective. Reducing the total quantity and variety of stocked items reduces costs and simplifies inventory management.

Standardizing supplies allows for volume discounts, which further reduce costs. Heart valves in particular are extremely expensive, and maintaining them in inventory is costly. Surgeons should agree on a small number of necessary valves and sizes and bargain with the manufacturer to secure the lowest price. Keep inventories low and order frequently to replenish the supply.
Changes (continued)

**Identify tasks that can be done at other times (external to the process), and perform them either before or after the surgery.**

Externalizing tasks can help the process flow more efficiently. If the task is one that causes delays or bottlenecks, externalizing it may reduce delays.

In operating rooms, one of the most time-consuming tasks is setting up the back table. Externalizing this task reduces operating room turnover time. One organization achieved a routine CABG turnover time of about 20 minutes—and even 10 minutes when necessary—by preparing surgical tables in setup rooms between the four operating rooms. The setup rooms were specifically designed to allow the preparation of tables for to-follow cases. Once the tables are prepared, staff drape them in sterile fashion and wheel them into the operating rooms when needed.

**Synchronize all steps in a process to an agreed-upon point—preferably, incision time.**

Synchronization helps cases start on time. Late starts consume valuable resources and cause further delays. The synchronization point should be defined clearly for all. For example, if the surgery is scheduled at 8:00 AM, does this mean the patient should arrive, the patient should be in the room, or the incision should be made at 8:00 AM? Making the synchronization point clear allows everyone in the system to understand what he or she needs to do in order to ensure that the incision occurs on time. The most useful synchronization point is incision time.

If the incision time is scheduled at 8:00 AM, for example, the admitting office knows the patient needs to arrive by 6:15 AM; anesthesia providers know the patient needs to be in the operating room by 7:30 AM; and the surgeon knows he or she must be present at 7:45 AM to scrub, gown, and prepare the patient.

Clearly defining the synchronization point also makes it possible to pinpoint clearly the causes of delays. If cases begin late, teams can record the reasons—for example, the surgeon was not on time, the lines took longer to place than anticipated, or certain supplies could not be located in time—and make changes to prevent these delays from happening again.

**Staff should know the next step in a process and anticipate what will need to happen in order to complete the step.**

By anticipating needs, the staff can prepare and smooth the work flow. Examples include the following:

- The scrub person or first assistant should be ready to cut a suture when a suture needs to be cut.
- The circulator should anticipate when extra suture or other supplies will be needed.
- The scrub person should anticipate the next surgical step and have the instruments prepared.
- The entire team should understand what needs to be done to prepare a patient and turn over a room efficiently.

In optimal cases, staff perform these activities with a minimal need for communication because work processes are standardized, and team members understand the tasks and anticipate the needs of their co-workers.
Consider people as a part of the same system and foster cooperative relationships. Individuals who see themselves as part of a team working toward common goals will try to optimize the entire system rather than optimizing only their own part of the system. All operating room team members are a part of the same system, sharing the common goal of providing optimal surgical care. As soon as an individual sees himself or herself as separate from, outside of, or more important than the system, the system's efficiency erodes. Surgeons, in particular, often see themselves as separate from and not responsible for the operating room system. Evidence of such attitudes includes late arrivals, poor cooperation with other surgeons to smooth the patient flow, and schedule demands that serve their own needs at the expense of the system.

Use pull systems to smooth the transfer of patients from the operating room to the ICU. In a “pull system,” work is pulled through a process instead of being pushed from one step to the next. In a pull system, the timely transition of work is the primary responsibility of the downstream process (that is, the next step in the process). For example, the ICU nurse goes to the operating room to get the report on the patient and help “pull” the patient to the ICU. This is in contrast to most traditional “push systems” in which the upstream process is responsible for the transition. For example, the operating room tries to “push” patients into the ICU.

Surgical scheduling is another situation in which pull systems can be helpful. The upstream step is the decision to proceed with surgery. Once the decision is made, caregivers often have to push the system to get the patient scheduled (the downstream step). They have to make numerous phone calls, fill out paperwork, request consultations, and so on—a process that can take days. In organizations that use pull systems, however, a request for cardiac surgery can take a single phone call to the cardiac surgical office. Once the call is made, the downstream process pulls the work.

Cross train staff. Cross training staff fosters flexibility and increases the skills of the team. In one organization, operating room staff promptly notify floor staff when operating room turnover is occurring. The floor staff proceed directly to the operating room, assist in the turnover, and then return to the floor to resume their prior activities. The organization also plans to train floor staff as intraoperative echocardiography technicians.
The following five changes are aimed at reducing operating room costs.

Understand variation in operating room use.
Monitoring and displaying variation in surgical practice can provide a powerful incentive for improvement. One organization studied the use of its operating rooms and discovered that variation in surgeons’ practices—duration of surgery, use of supplies, and cost per operation—was widespread and costly. The organization now regularly posts this information, not to judge but to educate surgeons concerning variation in practice within the hospital.

![Variation in Cost of Supplies per Operation](image)

Calculate the true cost of each item used in the operating room.
While organizations with the most cost-effective programs do not cut corners on the care they provide, they are aware of the cost of each item used. At one organization, for example, members of the cardiac surgical staff all know the true cost of each syringe they use, each packet of suture they open, and each special instrument they request. Such detailed knowledge of costs encourages staff members to manage and use supplies more effectively.
Understand the true cost of each surgical procedure.

Calculating and tracking the cost per surgical case, by surgeon, is an important step toward understanding and reducing variation in practice. One hospital has developed a program that calculates the true costs for each surgical procedure—not just the charges and the reimbursement rate. The data enable the organization to answer a range of questions about costs: How much of the total cost of surgery is consumed by supplies and labor? What is the cost of one minute in the operating room? What is the value of moving a patient in and out of the operating room more quickly?

![Figure 1.10 Operating Room Costs per Case for CABG](image)

Dartmouth-Hitchcock Medical Center Lebanon, NH

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<th>Category</th>
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Total $4,443 per Case

Improve operating room utilization.

Once an organization is aware of the costs involved in each surgical procedure, it can reduce the unnecessary use of supplies, procedures, and equipment, and calculate the cost savings per case. For example, one organization reduced the use of Cell Savers by 80%, Swan Ganz catheters by 40%, and blood gas tests by 60%. Substantial cost savings resulted. The staff monitored all of these changes carefully to make sure they were not associated with any increase in morbidity or mortality.

Reduce overtime costs.

Because of inefficient operating room processes, many programs routinely incur high staff overtime costs. Improving the efficiency of the operating room can reduce or even eliminate these costs while improving staff morale and increasing operating room throughput.
Total operating room time
This is the most important measure teams should track. Measure in minutes from the time the patient enters the operating room to the time the patient leaves the operating room.

Operating room turnover time
Measure from the time one patient leaves the operating room to the time the next patient enters the operating room.

Other operating room times
Many programs use the following times to monitor various aspects of the CABG process:

- In-room time: the time the patient enters the operating room
- Incision time: the time the surgeon makes the first cut
- On-pump time: the time the patient is put onto the cardiopulmonary bypass machine
- Off-pump time: the time the patient is taken off the cardiopulmonary bypass machine (Note: Strong evidence indicates that pump times greater than 90 minutes can be dangerous for patients.)
- Close time: the time chest closure is completed
- Out-of-room time: the time the patient leaves the operating room
Average rate of re-operation for bleeding
Track the rate of re-operation for bleeding to make sure that changes in operating room processes do not increase the risk to patients. Track this measure monthly.
## Parallel Processing in Anesthesia and Prep

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**Total time approx. 45 minutes**

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**Total time approx. 25 minutes**

Reprinted with permission of Baystate Medical Center.
Operating Room Cycle Time Worksheet
and Benchmarking Graph

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Average time

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6 Improving Ventilator Management

Goal

Reduce postoperative ventilator time to 6 hours or less.

Early extubation is achievable following open heart surgery. Experienced centers routinely extubate the majority of patients within 2 to 6 hours of completion of surgery. Neither the literature nor experience supports the idea that early extubation harms patients. In fact, evidence suggests that patients with underlying lung disease (such as COPD)—patients who were previously thought to require longer ventilatory support—do better if they are extubated early. Despite the advantages of early extubation, however, many cardiac surgical centers’ ventilation times still range from 12 to over 24 hours.

Benefits

• Improved cardiac output with spontaneous ventilation
• Improved venous return and concomitant cardiac performance
• Reduced patient anxiety (Intubation can be a frightening experience. Patients often experience feelings of suffocation and, because they are unable to communicate, helplessness.)
• Fewer episodes of postoperative hypertension because of reduced anxiety
• Reduced length of stay in the ICU
• Earlier mobilization and ambulation
• Reduced staff time (Managing ventilated patients requires extra resources.)
• Reduced physician time (Nurses and respiratory therapists can manage protocols for extubation safely and efficiently.)
• Reduced risk of ventilator-associated pneumonia
• Reduced costs of mechanical ventilation
• Increased patient satisfaction and comfort

Clinicians’ Comfort with Changes

When teams begin to test changes, clinicians initially often feel uncomfortable, at first, doing things in a new way. Physicians may dismiss some changes as “cookbook medicine” or may fear that changes made too quickly will harm their patients. To address these concerns, teams may want to begin testing changes on a small scale. For example, a team may begin by testing a nurse-driven weaning protocol on elective patients only. After nurses become comfortable with the protocol and physicians see that they haven’t lost control of their patients, the team can then implement the change among a larger patient population.

Establish criteria for early extubation.

An effective postoperative weaning protocol must include a clearly defined set of criteria that patients must meet before extubation. Each institution’s weaning criteria will vary somewhat. Stan Brauer, M.D., Director of Cardiac Anesthesia at Loma Linda University Medical Center, Loma Linda, CA, developed the following sample weaning criteria:

- Core temperature > 35° C
- Chest tube drainage < 200 mL/hr
- Patient is awake and responsive to commands
- Pulse rate > 60 and < 120 bpm
- Spontaneous respiratory rate < 25 and > 8 bpm
- Spontaneous tidal volume > 3 mL/kg
- Vital capacity > 10 mL/kg
- \( \text{PaO}_2 \) > 70 on < 55% \( \text{O}_2 \)
- Bleeding < 80 mL/hr
- \( \text{PaCO}_2 \) < 55 torr

Vasopressor drips are not contraindications to extubation unless the vital signs are otherwise unstable. Often, the criteria are abbreviated to the following: an awake patient, sustained head lift, hemodynamically stable, with FiO\(_2\) < 50% and O\(_2\) Sat > 92%.
Simplify and standardize anesthesia and neuromuscular blockade protocols. The traditional high-dose narcotic routines of 50 to 70 µg/kg fentanyl or high-dose benzodiazepines are neither necessary nor appropriate. Induction can be achieved with thiopentol or with etomidate in patients with reduced ventricular performance.

Fentanyl, or its equivalent, should be limited to doses of 10 to 15 µg/kg for a typical case, with inhalation agents used as the primary anesthetic both before and during cardiopulmonary bypass. Alternatives include propofol infusion or a combination of narcotic and midazolam infusions with inhalation supplementation. These are adequate for most patients, even those with significantly impaired ventricles.

Titrate neuromuscular blockers as with any surgical case so that they can be reversed at the end of the procedure to allow patients to spontaneously ventilate as soon as possible. Pancuronium is a cost-effective agent that can be used with minimal tachycardia if titrated. Shorter-acting agents may be desirable for top-off doses after cardiopulmonary bypass.

Revise standards for postoperative pain management. Administer smaller, more frequent doses of narcotics to avoid over-sedation.

After comparing titration of low-dose narcotics with traditional high-dose narcotic techniques, many centers found no difference in outcomes, despite theoretical concern related to coronary ischemia in the early recovery period. Some found propofol sedation (25 µg/kg) to be useful for a brief period of time (~ 1 hour), until the patient was transferred and stabilized in the ICU and cardiopulmonary parameters were established.

The treatment of anxiety should itself be carefully scrutinized and managed. Although it is widely believed that Versed (midazolam) is shorter-acting than Valium (diazepam), there is no clinical evidence to support this belief.

A meta-analysis of 28 trials comparing midazolam and diazepam found the following: in 8 of the 28 trials, diazepam had faster recovery times; in 19 they were equivalent; and only in one did midazolam recover faster. This analysis clearly demonstrated that although the serum half-life of midazolam is shorter than that of diazepam, their duration of action does not differ. Therefore, Valium (diazepam) is equally effective by all parameters and costs much less than midazolam.

Establish a nurse- or respiratory therapy-driven weaning protocol.

Nurses and respiratory therapists are capable of using weaning protocols to assess and extubate patients. Once sufficiently trained, they can safely and effectively proceed with extubation and ongoing respiratory monitoring. Eliminating the need for physicians during the extubation improves the efficiency of the process and reduces delays. Programs that have effectively instituted such nurse- or respiratory therapy-driven weaning protocols have had no increase in reintubations or other complications.

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Changes (continued) Educate staff on the goals and procedures to achieve early extubation. An early extubation program requires a multidisciplinary approach. A task force including representatives and leaders from cardiac surgery, anesthesiology, respiratory therapy, intensive care, nursing, and an administrative representative should hold regular meetings to monitor the implementation of the early extubation protocol.

Establish an efficient monitoring system. Displaying data on extubation times can motivate staff and help change their behavior. Posting data prominently in the ICU allows staff to monitor their progress, understand the impact of the changes they are making, and examine outliers.

Measures

Average duration of postoperative intubation

Postoperative intubation time measures the time from the patient’s arrival in the ICU to extubation. ICU staff can plot individual patient intubation times by hand on a simple run chart. Staff can also aggregate the data and display the average intubation time for all CABG patients per month. Measure intubation time for all patients; do not exclude outliers.

Readmission to the ICU for pulmonary complications

When organizations test changes to reduce the time to extubation, they need to make sure the rate of readmission to the ICU for pulmonary complications is not increasing. Track this measure monthly.
**Reintubation rate**

When organizations test changes to reduce the time to extubation, they need to make sure the rate of reintubation is not increasing. If possible, track this measure monthly. In Figure 1.14, early extubation is defined as extubation within 12 hours or less; reintubation is defined as reintubation within 12 hours of extubation.

The graph indicates that, although the percentage of patients extubated within 12 hours increased steadily from 1990 to 1997, there was no increase in the reintubation rate.

*Note:* The data are not meant to imply that patients who were extubated more than 12 hours after surgery were more likely to need reintubation than they would have been if they had been extubated earlier. As the percentage of patients extubated within 12 hours increased over the years, the average severity level for the portion of the patient population that was not extubated within 12 hours also increased steadily. These patients were more likely to need reintubation because of the severity of their illness, not because they were extubated more than 12 hours postoperatively.

![Figure 1.14](image)

**Average ICU length of stay**

![Figure 1.15](image)
Standard of Care for Patients in the Cardiovascular Unit

Selected for Early Extubation Following Cardiac Surgery

1. Provide ventilator support as per physician order sheet.

2. **Protocol for pulse oximetry.** Immediately place on pulse oximetry and document O₂ saturation with vital signs.
   - After 20 minutes if O₂ saturation is \( \geq 94\% \), decrease FIO₂ to 0.5.
   - After further 20 minutes if O₂ saturation is \( \geq 94\% \), decrease FIO₂ to 0.4.
   - Increase FIO₂ as required to maintain SAO₂ \( \geq 94\% \).

3. **Criteria for patient selection for early extubation.** Use the following standards to determine when weaning may be initiated and continued.
   - Patient is awake, alert, neurologically intact.
   - Patient is able to maintain head lift.
   - pH is \( \geq 7.30 \)
   - PaCO₂ is \( \geq 50 \)
   - PaCO₂ is \( \geq 100 \) if on FIO₂ 0.6
     - or \( \geq 80 \) if on FIO₂ 0.5
     - or \( \geq 70 \) if on FIO₂ 0.4
   - SaO₂ is \( \geq 94\% \) by Pulse Oximetry
   - Respiratory rate is \( \geq 10 \), but \( \leq 25 \)
   - PEEP is \( \leq 7.5 \) cm H₂O
   - Patient Body Temperature is \( \geq 36 \) degrees Celsius
   - Chest Tube Drainage is \(< 200 \) ml/hour for 2 hours or since arrival to CVU
   - MAP is \( \geq 65 \) on NO or Low Dose Inotropic Support
     (i.e., Epinephrine \( \leq 3 \) µg/min, Milrinone \( \leq 0.5 \) µg/kg/min,
     Dopamine \( \leq 5 \) µg/kg/min, Dobutamine \( \leq 10 \) µg/kg/min,
     Norepinephrine \( \leq 5 \) µg/min)
   - No Malignant Arrhythmias (i.e., VT or VF) are present
   - Urine Output is \( > 0.5 \) ml/kg/hour

4. **Weaning parameters.** Use the following parameters (along with the above standards) to determine when the patient is ready for extubation:
   - Assess when patient is on an IMV rate of 4
   - The set parameters to be met are: Tidal Volume 5 ml/kg
     - Forced Vital Capacity 10 ml/kg
     - Negative Inspiratory Force \( > -20 \) cm H₂O
     - Respiratory Rate is \( \geq 10 \) but \( \leq 25/minute \)
Standard of Care for Patients in the Cardiovascular Unit (continued)

5. **Protocol for weaning** is as follows:
   - Decrease IMV rate from 8/minute to IMV 6/minute once the weaning standards are met at IMV 8.
   - Obtain ABG 30 minutes after decrease in IMV rate to 6.
   - Decrease IMV rate to 4/minute once the weaning standards are met at IMV 6.
   - Obtain ABG 30 minutes after decrease in IMV rate to 4.
   - Extubate patient to 61/minute nasal cannula if weaning standards and weaning parameters are met at IMV 4.
   - Obtain ABG 30 minutes post-extubation.
   - If the weaning standards are not met at any IMV rate:
     - Stop weaning patient from ventilator support.
     - Repeat the ABG in 1 hour.
     - Resume weaning as above once weaning standards are again met.
   - If the weaning parameters are not met at IMV 4:
     - Repeat ABG and weaning parameters in 1 hour.
     - Extubate as above once weaning standards and parameters are met at IMV 4.
   - Call M.D. for a pH < 7.28, PaCO₂ > 55, PaO₂ < 60 or respiratory rate > 25/min.

6. Suction secretions as needed while intubated.

7. **Protocol for post-extubation** is as follows:
   - Encourage patient to stay awake, deep breathe and cough in a controlled fashion for first 2 hours.
   - Monitor respiratory rate every 15 minutes for first 2 hours and document on flow sheet.
   - Suction as needed.
   - Provide Incentive Spirometry at bedside and encourage its use every 1 hour while awake.
   - After 2 hours, if Sat. O₂ is > or = to 94% by Pulse Oximeter, decrease to 41/min nasal cannula.
   - After 2 additional hours, if Sat. O₂ is > or = to 94% by Pulse Oximeter, decrease to 21/min nasal cannula.
   - If respiratory rate is < 10/min after extubation, administer Naloxone as per physician order sheet. Call M.D. if patient's respiratory rate does not increase to > 12/min after initial bolus.
   - Provide postoperative analgesia as per physician order sheet.
   - Provide management of postoperative nausea as per physician order sheet.
   - Provide management of postoperative shivering as per physician order sheet.
## Four-hour Extubation: Recommended Anesthetic Guidelines

<table>
<thead>
<tr>
<th>Stage</th>
<th>Medications/Procedures</th>
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</table>
| **Premedication**                          | • MSO₄ 0.1 mg/kg, scopolamine 0.3 mg IM  
• MSO₄ 0.1 mg/kg, midazolam 2 mg IM  
(midazolam 1 mg if < 70 kg)               |
| **Preinduction**                           | • Midazolam 1–3 mg IV for arterial line placement                                       |
| **Induction and Maintenance, pre-CPB**     | • Fentanyl 10–15 µg/kg, or sufentanil 1.0–2.0 µg/kg  
• TPL 1–3 mg/kg  
• Pancuronium 0.08–0.10 mg/kg, or muscle relaxant of choice  
• Potent agent supplementation and maintenance |
| **CPB**                                    | • Isoflurane 1.0–1.5%; d/c when pacemaker wires placed  
• Additional pancuronium up to 0.15 mg/kg  
• Rewarm to > 36.5° esophageal; > 72 degrees total esophageal and rectal |
| **Post-CPB**                               | • Isoflurane 0.4–0.6% upon initiation of ventilation, maintained as required until leaving OR or beginning propofol  
• + Propofol infusion 10–50 µg/kg/min  
• NTG, isoflurane to vasodilate for volume loading off CPB  
• NTG, NTP, metoprolol as indicated  
• Warmed IV fluids; other measures to maintain core temperature |
| **After Sternal Approximation**            | • Neostigmine/glycopyrrolate over 3–5 minutes  
• Physostigmine if scopolamine used as premedication                                      |
| **Post-op**                                | • Propofol 10–50 µg/kg/min                                                            |
| **Antifibrinolytics**                      | • EACA 100 mg/kg IV load preincision, followed by 10 mg/kg/hr maintenance infusion (approximately 1 gm/hr)  
• With renal insufficiency (Cr > 2.5 mg/dl) may consider loading dose without infusion |
7 Improving the Management of Atrial Fibrillation

Goal

Decrease incidence of atrial fibrillation (AFib) and minimize its impact on hospital length of stay. Postoperative atrial fibrillation is a common and significant problem, affecting some 20% to 50% of cardiac surgery patients. Evidence suggests that atrial fibrillation increases total length of stay, necessitates more utilization of ICU and telemetry beds, and correlates with poorer outcomes such as stroke, need for pacemaker implantation, and other complications. Moreover, the cost to the system is considerable—often adding two to three days to the length of stay.1, 8

Using protocols to prevent postoperative atrial fibrillation helps decrease its incidence. Standardizing the management of atrial fibrillation once it occurs eliminates waste, minimizes handoffs, and smooths the flow of work. Because atrial fibrillation typically occurs two to three days after the CABG procedure, delaying its treatment adds to the length of stay. Therefore, a nurse-driven protocol designed to treat atrial fibrillation as soon as it meets the defined criteria is crucial.

Benefits

- Shorter lengths of stay because treatment is initiated more quickly and patients are treated more efficiently
- An increase in physicians' efficiency, giving them more time to treat other patients
- An increasing comfort level among physicians and nurses as they gain experience with the protocols and the consensus process

Changes

Improve predictions about who is at risk for atrial fibrillation.

Preoperative risk factors for developing atrial fibrillation include the following:

- Advanced age
- Male sex
- History of atrial fibrillation
- History of congestive heart failure
- Pre-cardiopulmonary bypass heart rate of more than 100 beats per minute
- Hypertension

Intraoperative risk factors for developing atrial fibrillation include the following:

- Pulmonary vein venting
- Bicaval venous cannulation
- Postoperative atrial pacing
- Longer clamp times
- Intra-aortic balloon pump (IABP)


Changes (continued)  

Postoperative risk factors for developing atrial fibrillation include the following:
- Postoperative pneumonia
- Ventilation > 24 hrs
- Return to ICU

**Agree on an operational definition of atrial fibrillation.**

Before implementing any treatment protocol, a team must agree on a definition of atrial fibrillation. For example, one organization uses the following definition:

New onset postoperative atrial fibrillation (excluding those patients with preoperative chronic atrial fibrillation or paroxysmal atrial tachycardia) is characterized by at least one of the following:
- Atrial fibrillation persisting for more than 4 hours
- Atrial fibrillation with hemodynamic instability requiring treatment
- Tachycardia requiring treatment
- Recurrent episodes of atrial fibrillation, requiring antiarrhythmic therapy

**Treat patients prophylactically prior to surgery to reduce the incidence of postoperative atrial fibrillation.**

The first step in improving the prevention of atrial fibrillation is standardizing the prophylaxis regimen. Only then can staff make changes and collect data to see if those changes lead to improvement. Preventive treatment using a low dose of a beta blocker, preferably started the night before the operation or in the early postoperative period and continued for at least one week, reduces the incidence of atrial fibrillation. Clinicians should consider withholding beta blocker therapy in patients with hypotension, severe left ventricular systolic dysfunction (ejection fraction < 30%), decompensated congestive heart failure, and severe magnesium depletion.

**Standardize the treatment of atrial fibrillation.**

Like atrial fibrillation prophylaxis, the treatment of atrial fibrillation, once it does occur, varies widely in most organizations. Organizations should set as their goal that patients with new onset atrial fibrillation stay in the hospital no more than 12 hours longer than patients without atrial fibrillation. To achieve this, organizations must develop a standard definition of new onset postoperative atrial fibrillation and a treatment plan to be implemented as soon as atrial fibrillation is diagnosed. Waiting a day or more to get a consultation for treatment or to institute therapy for new onset atrial fibrillation is unacceptable.
Measures

Average length of stay for patients with new onset atrial fibrillation compared to average length of stay for patients without new onset atrial fibrillation

Figure 1.16
Average Postoperative Length of Stay for CABG Patients Staying 14 Days or Less
St. Marys Hospital Medical Center, SSM Health Care System Madison, WI

Rate of new onset atrial fibrillation in patients without a history of preoperative chronic atrial fibrillation or paroxysmal atrial tachycardia

Rate of atrial fibrillation prophylaxis in patients without preoperative chronic atrial fibrillation or paroxysmal atrial tachycardia

Total number of patients treated for new onset atrial fibrillation

Morbidity (for example, readmission for stroke) in patients with new onset atrial fibrillation
## Beta Blocking Orders

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<thead>
<tr>
<th>Preoperative:</th>
<th>Give patients beta blocker the morning of surgery.</th>
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<tr>
<td>Drug and Dose:</td>
<td>_____________________________</td>
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| Postoperative: | Metoprolol 25 mg BID on postoperative day 1 or ____________________ |
| Hold for: | SBP < 90 mmHg, HR < 40 beats/min, CI < 2.2L/min, or if on inotropic agents |
| Contraindications: | Heart failure or shock, EF < 30%, AV Block (2nd or 3rd degree), Bronchospastic disease |

## Treatment Timeline for Atrial Fibrillation for Open Heart Patients

| Surgeon: | Controls rate with drugs |
| After 24 hours of AFib |
| Begins anticoagulation with Coumadin |
| Consults cardiologist |

| Cardiologist: | Treats with antidysrhythmic drug |
| Cardioverts per physician preference |

| Nursing: | Calls surgeon when AFib occurs |
| If patient remains in AFib the next morning, notify cardiologist between 7:00 and 9:00 AM. |

Note: Patients receive Lovenox 30 mg SQ BID after chest tubes are removed.

## Timeline

| When AFib occurs: | Surgeon controls rate with drugs |
| If patient still in AFib after: | 12–24 hours (day after AFib started): |
| Consult cardiologist—treats with antidysrhythmic drug |
| Surgeon begins anticoagulation with Coumadin |
| 24–48 hours (second day after AFib started): |
| Cardiologist considers cardioversion |
| Surgeon continues anticoagulation with Coumadin |

| Discharge patient: | After cardioversion |
| or |
| INR has shifted toward therapeutic |
| Follow INR and AFib as outpatient, home care agency prn |
8 Improving Care in the ICU and on the Floor

Goal

Reduce length of stay for DRGs 106 and 107 to 5 days or less.

While the CABG procedure and operating room costs together make up the largest proportion of total costs for cardiac surgery patients, ICU costs come in second. In many cases, patients are overmanaged postoperatively, with little evidence that this management improves the quality of care.9

Low-risk patients can be identified and transferred from the ICU to the floor on the day of surgery. Alternatively, this same low-risk population can bypass the ICU altogether and be moved from the operating room to a recovery area, from which they move directly to the floor. To accomplish same-day transfer, the ICU team must function quite efficiently. Transfers on the day of surgery are rare in most institutions—fewer than 5% of cardiac surgery patients—even in those with aggressive early extubation programs.

Benefits

• Lower ICU costs
• Improved patient and family satisfaction, patient rest, and interaction between patients and their families because patients are moved to less intensive environments more quickly
• Reduced risk of adverse drug events, including nosocomial infections, common in ICUs
• Earlier postoperative education and discharge planning

Changes

Establish criteria for transferring patients from the ICU to the floor on the day of surgery.

Requirements for same-day transfer typically include the following:

• Stable respiratory status after extubation
• Stable blood pressure off of inotropic agents or vasopressors
• Stable heart rhythm
• Awake, alert, and oriented patient with no mental status changes or neurologic findings
• Signs of early mobility, such as dangling the legs at the side of the bed and tolerating being up in a chair
• Urine output > 50 cc/hour

Educate patients and family before surgery about the possibility of same-day transfer to the floor.

Patients and family may expect to be in the ICU for a day or more following bypass surgery. They need to be educated that in many cases, patients can be safely transferred to the floor on the day of surgery.

Allow for nurse-initiated transfer, based on standardized criteria for transfer.
Initiation of the transfer does not require the presence of a physician, provided that the patient meets all criteria.

Combine the cardiac surgery ICU and postoperative floor into a single cardiac unit.
Most patients only require ICU monitoring for a brief period of time postoperatively, and transferring patients from one floor to another is time consuming, expensive, and prone to error. A single cardiac unit allows patients to move into the cardiac unit directly from the operating room and remain there for the duration of their hospital stay. “Intensive care” on this floor is provided by flexing the nursing staff, equipment, and resources around the patient, instead of moving the patient to the ICU or the floor.

A single cardiac unit also allows the nursing staff to develop deeper relationships with patients and families, fosters cross training of staff, and eliminates the need for separate units for intensive and routine postoperative care. One program even uses this unit for routine post-discharge care because the nursing staff is familiar with the patients, and all of the resources needed for follow-up care (for example, cardioversion and wound care) are available on the unit.

Institute 4:00 PM rounds.
Conducting rounds at 4:00 PM helps to identify problems early and respond to them rapidly. One organization examined its data to identify the causes of mortality for patients who survived their stays in the intensive care unit and were discharged to the floor. The team identified two primary causes of mortality on the floor: respiratory difficulties and neurological difficulties. The team then instituted surgeon-led rounds at 4:00 PM each day to identify any patients experiencing respiratory difficulties or neurologic changes. Nurses also led 11:00 PM rounds and checked with the on-call physician to discuss any problems that might have arisen. The team’s goal: “No one codes on the floor.”

Measures

- ICU cost
- Average intubation time
- Average length of stay in the ICU
- ICU readmission rate (patients who return to the ICU within 24 hours of same-day transfer)
- Patient satisfaction (percentage of patients surveyed responding “very good” or “excellent”)
Cardiovascular ICU bed capacity (percentage utilization of CVICU)

<table>
<thead>
<tr>
<th></th>
<th>All Patients</th>
<th>Traditional</th>
<th>Potential Rabbit</th>
<th>Rabbit</th>
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<tbody>
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<td>1/1/97-5/31/97</td>
<td>n = 495</td>
<td>n = 387</td>
<td>n = 26</td>
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<td>Average intubation time</td>
<td>7.0 hours</td>
<td>8.0 hours</td>
<td>4.6 hours</td>
<td>3.3 hours</td>
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<tr>
<td>% Exhusted 0-4 hours</td>
<td>38.7%</td>
<td>28.6%</td>
<td>61.5%</td>
<td>22.2%</td>
</tr>
<tr>
<td>% Exhusted 4.1-8 hours</td>
<td>36.2%</td>
<td>39.3%</td>
<td>34.6%</td>
<td>0%</td>
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<tr>
<td>% Exhusted &gt; 8 hours</td>
<td>24.9%</td>
<td>31.8%</td>
<td>3.8%</td>
<td>0%</td>
</tr>
<tr>
<td>ICU LOS in hours</td>
<td>35.7 hours</td>
<td>38.9 hours</td>
<td>22.8 hours</td>
<td>8.1 hours</td>
</tr>
<tr>
<td>Total LOS in days</td>
<td>7.9 days</td>
<td>8.5 days</td>
<td>7.0 days</td>
<td>5.0 days</td>
</tr>
</tbody>
</table>

Definitions

Rabbit (Rapid After Bypass Back Into Telemetry): Cardiac patient who transfers to the floor on the day of surgery.

Potential Rabbit: Cardiac surgery patient with no identifiable barriers to same-day transfer, by history, or operative course. Cardiac surgeon has written same-day transfer orders but patient does not transfer (typically due to lack of telemetry bed, timing of surgery, or not meeting criteria in time to transfer).

Traditional: Cardiac surgery patient for whom the surgeon has chosen not to write same-day transfer orders due to pathophysiology identified in the OR, other clinical issues, significant medical history, or personal preference.

Average hospital length of stay

Figure 1.18
Average Hospital Length of Stay (DRGs 104 to 108)

Mercy and Unity Hospitals,
Allina Health System
Minneapolis, MN

Average number of patients in DRGs 104 to 108 per two-week interval = 16
Guidelines for Transfer to 3 East

Patients must meet the following criteria in order to be eligible for transfer from the ICU to the floor on the day of surgery:

**Purpose:**
To effectively expedite the transfer of patients from the CVICU to 3rd Floor East on the same day that the open heart procedure is performed. This process will ensure cost-effectiveness and quality care.

**Process:**
- The physician will determine barriers to same-day transfers.
- If no barriers exist, the physician will complete the 3 East transfer order sheet when the post-op order sheet is completed.
- After recovery from anesthesia, the nurse will determine if the patient meets the transfer criteria by following these specifics:

**Neuro:**
- Easily aroused
- Alert and oriented x 3
- No neurological deficits

**Cardiovascular:**
- Hemodynamically stable
- Ejection fraction > 35%
- No IV vasoactive or inotropic medications (exception made with renal dose dopamine)
- Normal Sinus Rhythm
  (Exceptions) - History of atrial fibrillation
  - Temporary pacing required only if underlying rhythm supports systolic pressure of 80 mmHg
- Chest tube output < 50 cc/hr for 4 hours (exception made with 1x evacuation with turning or movement)
- Peripheral line in place with good blood return (cordis may remain if obtaining peripheral venous access is an issue)
- Lab values meet targeted parameters or treatment of abnormal values is in progress

**Pulmonary:**
- Extubated a minimum of 4 hours prior to transfer
- Oxygen saturation > 92% on 6L O₂ nasal cannula
- Incentive spirometry to 500 cc
- CVICU charge nurse notifies 3 East charge nurse that there is a patient for transfer and requests a bed assignment
- Final notification to 3 East is made by 4:30 PM and 3 East charge nurse will determine time of transfer
- CVICU will maintain one open bed for potential “bounce backs”
- Transfer will be completed at time previously designated
Nurse-initiated Transfer Criteria

1. Discontinue use of Swan Ganz catheter and A-line if the following criteria are met:
   - Pulmonary artery diastolic pressure > 12 < 18
   - Systolic blood pressure > 100 < 150
   - Heart rate < 110 and sinus rhythm
   - Urine output > 50 cc/hr
   - No vasopressors or inotropic agents
   - No intra-aortic balloon pump (IABP)

2. Patient may transfer to the floor if the following criteria are met:
   - Above criteria have been met and Swan Ganz catheter and A-line are discontinued
   - Patient is extubated
   - Patient is awake, alert, and oriented
   - Patient has dangled legs and been up in the chair at least once
   - No transfer between 10:00 PM and 7:30 AM
Single Cardiac Surgery Unit

Loma Linda University Medical Center in Loma Linda, California, uses a 23-bed combined ICU/step-down unit, in which 14 beds are dedicated ICU beds, 6 are dedicated acute care beds, and 3 are “swing” beds that function either as ICU or acute care beds as needed. Patients who are admitted preoperatively are admitted to the unit. All patients return to the unit immediately after surgery and stay there until discharge. After discharge, patients are called and receive follow-up care from a nurse who has experience from the unit. Nurses on the unit are trained to care for patients with all levels of acuity.

Advantages of a Single Cardiac Unit

1. All nurses are trained to care for patients during any part of their post-operative stay.
2. Patient satisfaction is high. Patients take comfort in seeing the same nurses and experience a high level of continuity in their care.
3. The unit eliminates the time needed for transfers, the added expense of transfers, the possibility of lost information during transfers, and the risk of transferring patients from the ICU too soon.
4. If the patient deteriorates clinically during the acute care phase, nurses and equipment are available without having to transfer the patient back to the ICU.
5. All cardiac patients are in one area for ease of physician rounding and night and weekend coverage.
6. Nursing staff experience the satisfaction of seeing patients through all phases of their care, from surgery to their return home.

Challenges to Instituting Single Cardiac Units

1. All staff will require extensive ICU orientation.
2. Because it cares for both ICU patients and stable recovering patients, the unit will become a noisier area for patients.
3. Stable and recovering patients will be more likely to witness critically ill patients who are doing poorly. Some might find this disturbing.
4. Nursing staff and physicians may not feel the same urgency to remove unnecessary lines as they would when needing to transfer patients out of the ICU to the telemetry unit.
5. Some nurses do not like caring for acute care patients, preferring the excitement of ICUs.
6. There is no pay differential for critical care nurses; all nurses on the unit are paid the same.
7. Other organizations will have to run separate budgets for the ICU, the telemetry unit, and the cardiac unit. Because single units are rare, benchmarking with other institutions for productivity will be difficult.
9 Improving Care after Discharge and Reducing Readmission Rates

Goal

Reduce the readmissions occurring within 30 days after cardiac surgery to less than 10% of all cases.

Accurately measuring readmission rates is critical to monitoring cardiac surgery outcomes. However, few organizations have systems in place to do this. The measurement of and interventions for post-cardiac surgery readmission go hand-in-hand. Measuring readmissions requires that clinicians maintain contact with patients and their families after discharge, which is also a central means of reducing readmissions.

Benefits

- Reduced costs
- Fewer unscheduled office visits and unnecessary emergency department visits
- Shorter hospital length of stay (It is easier to discharge patients following cardiac surgery when a smooth and efficient follow-up program is in place.)
- Improved quality of care (Any effort to reduce readmission rates must address complications that lead to readmissions.)
- Improved continuity of care
- Improved communication between primary care or referring physicians and the cardiac surgical staff
- Improved patient and family satisfaction, as surgical staff maintain postoperative communication with patients and their families

Changes

Provide appropriate education and preparation for patients and their families before surgery. Because patients who undergo cardiopulmonary bypass typically experience some mental sluggishness following surgery, the more education and preparation that is done before the surgery, the better. Preoperative education—letting patients and their families know what to expect, teaching them required exercises, and telling them how to equip their homes with necessary items—makes the discharge process easier and improves post-discharge care.

Use patient pathways for postoperative care.

Providing patients with clear instructions for their own care after discharge helps patients, who often need reminders of what they should be doing during the postoperative period, and reduces readmissions. Patients and their families can use patient pathways to guide care—for example, proper care of dressings, administration of medications, and so on—following discharge.
Continue contact with all patients until 30 days after surgery.

Given the relatively small number of patients in any one month for most cardiac surgery programs, and the significance of even a single unnecessary hospitalization or death, programs should strive for 100% follow-up of patients.

Programs should perform follow-up on a regular schedule, with surgical staff—ICU nurses, cardiac surgery physician assistants, nurses in the cardiac surgical office, or cardiac case managers—telephoning patients and their families. The phone call should consist of a structured set of follow-up questions, allowing time for trouble-shooting and addressing any other patient needs. Surgical staff members fill out forms to track these phone calls.

Surgical staff should call patients frequently following discharge and then less often toward the end of the month—for example, on post-discharge days 1, 3, 5, 7, 14, 21, and 30. Make these calls in conjunction with home health services, not as a substitute for them. In addition, patients should be encouraged to call if any questions or problems arise.

Examine all readmissions.

To understand the reasons for readmissions, examine each one in detail, even if the patient is admitted to another hospital. Because obtaining records from other hospitals can be difficult, programs may want to get permission from patients to obtain outside records before discharge.

Delineate responsibility for postoperative care and provide easy access to providers.

Cardiac surgery programs should claim responsibility for all primary contact with patients for the 30 days following discharge, even if the patient lives a significant distance from the surgeon’s office or the hospital. Programs need to make this clear to referring physicians and primary care physicians.

Programs should instruct patients to call the surgeon’s office first for any and all problems they encounter during the 30-day postoperative period. In order to do this, patients and their families will need 24-hour telephone access to doctors. To avoid overwhelming physicians with routine patient calls, have other surgical staff such as nurse practitioners triage these calls. Creating careful prospective systems for follow-up care will also help minimize the number of patient calls.

If surgeons do not take primary responsibility for postoperative care, physicians who are unfamiliar with the patient’s hospitalization may try to manage patients with incomplete information. Referral physicians often overreact to situations that a cardiac surgeon could easily handle. For example, atrial fibrillation is a common reason for unnecessary readmissions when cardiac surgeons do not maintain primary responsibility for follow-up care.
Changes (continued)

Allow patients easy access to treatment when necessary.
Discharged patients should have ready and easy access to follow-up ambulatory care after discharge and in a location where procedures such as wound care, cardioversion, and thoracocentesis can easily be performed. At one hospital, for example, discharged patients may return to the postoperative unit at any time for evaluation, information, or other care. Discharged patients often make use of this service, which, in turn, allows providers to address problems efficiently.

Allow patients easy access to providers by telephone at all times.
Patients need 24-hour access to staff who know them and can respond competently to their questions, concerns, or problems. One way of accomplishing this is to have ICU or floor nurses available at all times for follow-up with patients or families. These staff members typically are familiar with the patients, understand their problems, and are knowledgeable about care options. Properly trained and supported by cardiac surgeons, these nurses can address most problems or questions that might arise. Staff should track these communications with patients and include them in the patient’s medical record.

One organization established an “Ask a Nurse” program, that assigned a nurse to be available to answer questions from any patient discharged from the cardiac unit. Patients can use an 800 number and call 24 hours a day. The nurse becomes skilled at guiding patients through insecure times at home, and patients feel that they have continuous support provided to them. Consequently, readmission rates are low.

Coordinate care with primary care physicians.
Cardiac surgeons should view primary care and other referring physicians as suppliers—and surgical programs should include a supplier relationship program to improve the coordination of care in both the preoperative and postoperative periods. In the preoperative period, surgical programs need systems that automatically receive all necessary patient information including laboratory data and medical and social history.

In the postoperative period, cardiac surgeons should convey appropriate clinical information to referring physicians (there may be more than one per patient, for example, the primary care physician and the cardiologist). Such communication builds relationships among these various providers and improves both preoperative and postoperative care.

Providers should clarify who is responsible for postoperative care, communicate this to patients, and establish clear procedures for post-op management. For instance, primary care staff can simply refer the patient to the surgical staff during the month following surgery. Most importantly, other providers should not admit patients during the month following surgery without consulting the surgeon. While primary care providers can be taught to care for post-bypass patients, the cardiac surgeon’s staff should manage and coordinate this care.
Measures

30-day readmission rate for all CABG patients, with reasons for readmission
When programs reduce length of stay and make changes in processes of care, they need to track the 30-day readmission rate. The accuracy of this measure depends on 100% follow-up of all patients to 30 days after surgery.

Figure 1.19
30-Day Readmission with Diagnosis of Congestive Heart Failure
St. Marys Health Center,
SSM Health Care System
St. Louis, MO

Rate of emergency department visits and unscheduled office visits by postoperative cardiac surgery patients

Figure 1.20
Unscheduled Office Visits by Postoperative Cardiac Surgery Patients
St. Marys Health Center,
SSM Health Care System
St. Louis, MO
## Patient Pathway

<table>
<thead>
<tr>
<th>Postoperative Day #1</th>
<th>Postoperative Day #2</th>
<th>Postoperative Day #3</th>
<th>Postoperative Day #4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Activity</strong></td>
<td><strong>Activity</strong></td>
<td><strong>Activity</strong></td>
<td><strong>Activity</strong></td>
</tr>
<tr>
<td>Sit in chair for all meals.</td>
<td>Sit in chair for all meals.</td>
<td>Sit in chair for all meals.</td>
<td>Sit in chair for all meals.</td>
</tr>
<tr>
<td>Relaxation tapes. AM PM</td>
<td>Relaxation tapes. AM PM</td>
<td>Relaxation tapes. AM PM</td>
<td>Relaxation tapes. AM PM</td>
</tr>
<tr>
<td>Bathroom privileges with help.</td>
<td>Walk 4 minutes 4-6x a day (with help).</td>
<td>Walk in evening with help.</td>
<td>Wear loose-fitting clothes from home.</td>
</tr>
<tr>
<td>Calisthenics up to 6 minutes. Walk up to 3 minutes.</td>
<td>Walk/treadmill up to 5 minutes. Bike up to 4 minutes. Steps up to 6.</td>
<td>Walk/treadmill up to 6 minutes. Bike up to 5 minutes. Steps up to 12.</td>
<td>Walk/treadmill up to 7 minutes. Bike up to 6 minutes. Steps up to 12.</td>
</tr>
<tr>
<td>IS</td>
<td>IS</td>
<td>IS</td>
<td>IS</td>
</tr>
<tr>
<td>Use incentive spirometer every hour while awake.</td>
<td>Use incentive spirometer every hour while awake.</td>
<td>Use incentive spirometer every hour while awake.</td>
<td>Use incentive spirometer every hour while awake.</td>
</tr>
<tr>
<td>cc’s</td>
<td>cc’s</td>
<td>cc’s</td>
<td>cc’s</td>
</tr>
<tr>
<td><strong>Diet/Bowels</strong></td>
<td><strong>Diet/Bowels</strong></td>
<td><strong>Diet/Bowels</strong></td>
<td><strong>Diet/Bowels</strong></td>
</tr>
<tr>
<td>Eat regular diet for supper. Laxative in evening.</td>
<td>Regular diet; family may bring in favorite foods. Laxative and/or suppository if no bowel movement.</td>
<td>Regular diet.</td>
<td>Regular diet.</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td><strong>Education</strong></td>
<td><strong>Education</strong></td>
<td><strong>Education</strong></td>
</tr>
</tbody>
</table>
# Home Patient Pathway

## Things to do the first two weeks following cardiac surgery!

<table>
<thead>
<tr>
<th>Activity</th>
<th>Stay active!</th>
<th>Limit visitors for several weeks:</th>
<th>Rest, too!</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Exercise daily</td>
<td>• 2–3 friends at a time</td>
<td>• Between activities</td>
</tr>
<tr>
<td></td>
<td>• Get up and get dressed every day!</td>
<td>• Short 1/2 hour visits</td>
<td>• After meals</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Excuse yourself when tired</td>
<td>• Short naps</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Eating healthily</th>
<th>Eat what sounds good. Try supplements.</th>
<th>Six small meals are easier than three large ones.</th>
<th>Drink several glasses of fluid daily. See the dietician as scheduled.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Medications</th>
<th>Take your medications on schedule.</th>
<th>Use your pain pills:</th>
<th>See your doctor as scheduled.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>• Before activity</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• At bedtime</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• When needed</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Don’t “tough it out.”</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Self-care</th>
<th>First thing in the morning: Weigh yourself</th>
<th>Every day:</th>
<th>Breathing exercises:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>• Shower</td>
<td>• 4–5 times during the day</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Check incisions</td>
<td>• 10 puffs each time</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Remember good handwashing</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Call and report</th>
<th>Chills and fever over 101° (by mouth)</th>
<th>Unusual shortness of breath.</th>
<th>Gradual weight gain of 5 pounds in 3–5 days. Puffiness or swelling in fingers or ankles.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No bowel movement in the first week.</td>
<td>Incisions with:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Redness</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Pus-like drainage</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Swelling</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pain not helped with pills.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Any questions or concerns!</td>
</tr>
</tbody>
</table>

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## Postoperative Script

### Activity:
- How far are you walking?
- How many times a day?

### Possible Interventions:
- Encourage patient to increase activity: start at 5 min./2x day, increase by 1 min./day. Goal is 10 min. by 1 week post-discharge, 15 min. by 2nd week, and 20 min. by 3rd week.
- This is non-stop ambulating.
- Suggest ambulating in a mall, school, church, or grocery store in inclement weather. Climbing up and down stairs is not contraindicated.
- No driving for 2–4 weeks after surgery.

### Breathing Pattern:
- Are you having any problems with shortness of breath? At rest? With activity?
- Auscultate lungs bilat: Any rales? Any wheezes?
- (Frequently patients have decreased breath sounds in the LLL due to atelectasis/effusion.)

### Possible Interventions:
- Report any problems with shortness of breath, rales, or wheezes to the surgeon’s office.
- Report shortness of breath not relieved by rest.

### Sleeping:
- Are you having any problems sleeping?
- Do you sleep through the night?
- Can you fall back to sleep easily?
- Are you taking your pain pill (Darvocet/Percocet) 20 minutes before bedtime?

### St. Marys Hospital, SSM Health Care System, St. Louis, MO

### Possible Interventions:
- Encourage taking pain pill at bedtime.
- Other suggestions include increasing activity and no napping.

### Appetite:
- Are you eating?
- Are you having any problems with nausea or vomiting?

### Possible Interventions:
- Decreased appetite is normal post-op.
- Encourage patient to eat as much as possible.
- Report problems of nausea and/or vomiting to the surgeon’s office. Most common causes are constipation and medications.

### Incisional Healing:
- Are the incisions well approximated?
- Are the incisions red, warm, tender or draining any fluid? Is this a change from the wound’s appearance at discharge?
- Remember to check sternum, legs bilaterally, arms, and CT sites.

### Possible Interventions:
- Report any signs of erythema, heat, tenderness, drainage—especially drainage that is not serous—to the surgeon’s office.
### Postoperative Script (continued)

#### Lifting:
- Do not lift over 10 lbs. for 8 weeks.
- Do nothing to strain the breast bone (big swinging motion), e.g., vacuuming, raking, tennis, bowling.

#### Edema:
- Is there any edema?
- If yes, where? How much?
- Is there less or more edema compared to the last visit?
- Bilateral or just operative leg?
- Better in the AM, worse in the evening?
- Are you keeping your legs elevated whenever you are sitting?

<table>
<thead>
<tr>
<th>Possible Interventions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remind patients to elevate their feet when sitting. Report increasing edema to the surgeon’s office.</td>
</tr>
</tbody>
</table>

#### Elimination Pattern:
- Are your bowels moving?
- When was your last BM?
- Is this a normal pattern for you?
- Were you on any laxative routine pre-op?
- If yes, what?

<table>
<thead>
<tr>
<th>Possible Interventions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is normal for “regular” bowel patterns to be disrupted.</td>
</tr>
<tr>
<td>Patients who were on laxatives pre-op should have them restarted post-op.</td>
</tr>
<tr>
<td>Encourage increased activity to assist with bowel stimulation. If patient c/o diarrhea, check medications—quinidine, digoxin, antibiotics.</td>
</tr>
<tr>
<td>If patient c/o constipation, check medications—iron, Darvocet, Percocet. There is no standard as to when to call or treat. This depends on the patient’s routine.</td>
</tr>
</tbody>
</table>

#### Pain Control:
- Are you having any problems with pain, soreness, discomfort, or aches?
- How often are you taking your pain pill?
- Are you getting relief?

<table>
<thead>
<tr>
<th>Possible Interventions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encourage taking pain pill. May alternate Darvocet/Percocet with Tylenol ES.</td>
</tr>
<tr>
<td>Other suggestions for pain control include the use of a heating pad (not recommended on someone elderly with poor heat sensation, fragile skin, or diabetic).</td>
</tr>
<tr>
<td>When near end of Percocet prescription, start to alternate with Tylenol ES. Motrin is an option for patient without history of GI or bleeding problems.</td>
</tr>
</tbody>
</table>
### Postoperative Script (continued)

<table>
<thead>
<tr>
<th>Psychological Status:</th>
<th>Possible Interventions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• How are you feeling mentally?</td>
<td>• It is normal to have “good days” and “bad days.” Encourage patients to socialize with family and friends for emotional and mental support—but also do not “overdo” it.</td>
</tr>
<tr>
<td>• Emotionally?</td>
<td>• Encourage them to be patient with themselves. May take 2–3 months to feel like their normal self again.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Temperature:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Report temperatures of greater than 100°F Fahrenheit to the surgeon’s office.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Weight:</th>
<th>Possible Interventions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>(All patients are weighed daily.)</td>
<td>• Report weight gain of 3 lbs./day or 5 lbs./week to the surgeon’s office, especially if accompanied by increasing edema, rales, or increasing dyspnea.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cardiac Rhythm:</th>
<th>Possible Interventions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• If heart rate is elevated, is it after activity?</td>
<td>• Report if rhythm becomes irregular or heart rate greater than 100 at rest.</td>
</tr>
<tr>
<td>• Has the patient just showered or walked? If so, wait 10–20 minutes and recheck pulse.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Valves:</th>
<th>Possible Interventions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Monitor anticoagulation.)</td>
<td>• Draw PT as ordered. Take medication at the same time daily.</td>
</tr>
<tr>
<td>(Monitor infection signs and symptoms.)</td>
<td>• Prophylactic ATB.</td>
</tr>
</tbody>
</table>
10 Developing, Maintaining, and Using a Cardiac Surgery Database

Goal
Continuously monitor a program's performance including clinical outcomes, patient satisfaction, and financial results.

Published mortality rates, competition for managed care contracts, and reductions in reimbursements have forced cardiac surgical programs to find ways to understand and improve their performance.

A simple, well-constructed database can provide ongoing answers to three basic and critical questions:

- The physician’s question: How am I doing?
- The patient’s question: What are my chances?
- The organization’s question: How can we improve?

Benefits
- Provides data to monitor system performance in real time
- Allows clinicians to improve their performance based on high-quality data

Changes
Create the data collection form

- Keep it simple. Limit the data collection form to a single side of a single page. At the same time, insist that each form be complete and accurate.
- Begin by looking only at isolated CABG surgery. Exclude valves and other procedures for now.
- Collect data only for key measures. Don’t try to measure everything; the quality of the data should take precedence over quantity, especially during the early phases of development. Choose data elements carefully so that they can be collected reliably and provide useful information on an ongoing basis.
- Create acceptable definitions of data elements. Few definitions are perfect and acceptable to everyone. The key is to seek definitions that are useful, not perfect.

Decide what patient and disease characteristics and what clinical outcomes interest you:

- Patient characteristics should include some demographic information (for example, age, sex, height and weight), as well as key comorbidity information (for example, diabetes, hypertension, peripheral vascular disease, and prior cardiac surgery).
- Disease characteristics might include priority at surgery (elective, urgent, emergent, salvage), assessment of myocardial function (left ventricular end diastolic pressure, ejection fraction), and presence or absence of left main stenosis greater than 50%.
Changes (continued)

- **Clinical outcomes** might include in-hospital mortality and 30-day mortality, as well as morbid events such as stroke, major infection, atrial fibrillation, and overall length of stay.

- **Key process measures** might include cath-to-CABG time, total operating room time (in room to out of room), pump time, ventilation time, and ICU length of stay.

The data collection form created by the Northern New England Cardiovascular Disease Study Group includes all the necessary components of a risk stratification database—patient demographics, co-morbidity, severity of disease, and outcomes—in a single page. Definitions can be printed on the back of the data form.

**Collect the Data**

A simple data form makes for easy data collection. The data form travels with the patient. The perfusionist can fill in much of the clinical data from the patient’s chart, while the patient is being prepared for surgery in the operating room. A cardiac nurse specialist can fill in the remainder of the data upon hospital discharge. A well-designed data form should require less than a total of 15 minutes to complete.

**Validate the Data**

Find ways to validate the data, especially concerning major issues such as what problems received a particular procedure and the ultimate outcomes.

- To validate who received the procedure, check the data against ICD9 coding.
- To validate in-hospital mortality, check the data against administrative data sets documenting patients’ status at discharge.
- To ensure 100% capture of data, compare the number of data forms to the number of hospital discharges per month.

**Display the Data**

Data must be used, not just collected. Plot the data in an easy-to-understand format. Control charts are an excellent way to plot data against time as they make it easier to identify trends, as well as causes and effects. Display process measures and outcomes prominently. Posting data in a central location makes everyone aware of the outcomes being tracked and encourages staff to follow the progress and become involved in the process of improvement.

Data from the collection form can be summarized in a one-page digest, as in Dartmouth-Hitchcock Medical Center’s “instrument panel” (see page 65).

For greater detail, each indicator summarized in the instrument panel can be tracked over time.

---

### Data Collection Form

**NORTHERN NEW ENGLAND CARDIOVASCULAR DISEASE STUDY GROUP**

**Data Collection Form**

**PATIENT ID DATA**

- **Patient last name**
- **Patient first name**
- **Med. record #**
- **Soc. Sec. #**
- **Surgeon**
- **Patient zip code**
- **Date of birth (m/d/yy)**
- **Date of admit (m/d/yy)**
- **Date of surgery (m/d/yy)**
- **Date of discharge (m/d/yy)**

**PRE-OP DATA**

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>[ ] male</td>
</tr>
<tr>
<td>Height</td>
<td>[ ] cm</td>
</tr>
<tr>
<td>Weight</td>
<td>[ ] kg</td>
</tr>
<tr>
<td>COPD requiring treatment</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>Renal failure requiring dialysis prior to surgery</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>Last pre-op serum creatinine</td>
<td>[ ] mg/dL</td>
</tr>
<tr>
<td>CHF prior to surgery</td>
<td>[ ] no, [ ] yes, [ ] yes, prior to admit</td>
</tr>
<tr>
<td>Peptic ulcer prior to surgery</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>Liver disease</td>
<td>[ ] no, [ ] yes, mild, [ ] yes, mod(sev)</td>
</tr>
<tr>
<td>PVD</td>
<td>[ ] no, [ ] yes, cerebrovascular dis, [ ] yes, LE dis, [ ] yes, both, [ ] yes, no info</td>
</tr>
<tr>
<td>Diabetes if DM, what treatment</td>
<td>[ ] none, [ ] diet only, [ ] oral meds, [ ] insulin</td>
</tr>
<tr>
<td>Hypertension Cancer (except non-melanoma skin cancer)</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>Other comorbid condition</td>
<td>[ ] no, [ ] yes, specify:</td>
</tr>
<tr>
<td>Unstable angina this admit</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>M.I. prior to surgery</td>
<td>[ ] no, [ ] yes, [ ] yes, 6-24 hrs pre-op, [ ] yes, &gt;24 hrs to &gt;7 days, [ ] yes, &gt;7 to &lt;365 days, [ ] yes, &gt;365 days</td>
</tr>
<tr>
<td>Prior CABG surgery</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>Prior angioplasty (or attempt)</td>
<td>[ ] no, [ ] yes, prior to admit</td>
</tr>
<tr>
<td>Prior valve surgery</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>Failed medical therapy</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>Objective evidence of ischemia</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>Thrombolytic therapy within 48 hrs, prior to surgery</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>Aspirin within 7 days pre-op</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>IV NGT within 24 hrs pre-op</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>IV heparin within 24 hrs pre-op</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>If heparin, stopped bef surg?</td>
<td>[ ] no, [ ] yes</td>
</tr>
</tbody>
</table>

**CARDIAC CATHETERIZATION DATA**

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ejection fraction</td>
<td>[ ] %  (B8B not done)</td>
</tr>
<tr>
<td>LVESP (pre-dye, post A-wave)</td>
<td>[ ] mm Hg (B8B not done)</td>
</tr>
<tr>
<td>Left main disease, % stenosis</td>
<td>[ ] % (R, 0 if none)</td>
</tr>
<tr>
<td>Dominance</td>
<td>[ ] right, [ ] balanced, [ ] indeterminate, [ ] left</td>
</tr>
<tr>
<td>LAD stenosis &gt;70%</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>Proximal LAD stenosis</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>Circumflex stenosis &gt;70%</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>RCA stenosis &gt;70%</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>PDA stenosis &gt;70%</td>
<td>[ ] no, [ ] yes</td>
</tr>
</tbody>
</table>

**PROCEDURE DATA**

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Priority at operation</td>
<td>[ ] emergent, [ ] urgent, [ ] non-urgent</td>
</tr>
<tr>
<td>Was an IABP inserted</td>
<td>[ ] no, [ ] yes, pre-op, [ ] yes, intra-op, [ ] yes, post-op</td>
</tr>
<tr>
<td>Method of pericardiectomy</td>
<td>[ ] midline, [ ] pericardial flap</td>
</tr>
<tr>
<td>Number of distal anastomoses</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>Did only a single coronary artery bypass, was it for LM stenosis</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>Did patient receive IMA graft</td>
<td>[ ] no, [ ] yes, [ ] yes, [ ] bilateral</td>
</tr>
<tr>
<td>Cardiopulmonary bypass</td>
<td>[ ] blood, [ ] crystalloid</td>
</tr>
<tr>
<td>Delivery route</td>
<td>[ ] antegrade, [ ] retrograde, [ ] both</td>
</tr>
<tr>
<td>Temperature</td>
<td>[ ] warm, [ ] cold, [ ] warm/cold/warm</td>
</tr>
<tr>
<td>“hot shot” used</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>Total pump time</td>
<td>[ ] minutes</td>
</tr>
<tr>
<td>Did pt return to bypass pump</td>
<td>[ ] no, [ ] yes, once, [ ] yes, &gt;once</td>
</tr>
<tr>
<td>If yes, for how long</td>
<td>[ ] minutes</td>
</tr>
<tr>
<td>Total clamp time</td>
<td>[ ] minutes</td>
</tr>
<tr>
<td>Other procedure performed at time of operation</td>
<td>[ ] none, [ ] AVR, [ ] MVR, [ ] LV</td>
</tr>
<tr>
<td>Did patient return to OR for tx of post-op thoracic bleeding?</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>Did pt develop mediastinitis or sternal dehisc requiring re-op?</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>Did pt have a CVA intra- or post-operatively?</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>Did pt develop mediastinitis or sternal dehisc requiring re-op?</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>Post-op leg wound infection</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>Post-op AFib requiring treatment</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>Status at discharge</td>
<td>[ ] alive, [ ] dead</td>
</tr>
</tbody>
</table>

**OUTCOME DATA**

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Last pre-op WBC</td>
<td>[ ] thousands</td>
</tr>
<tr>
<td>Last pre-op HCT</td>
<td>[ ] g/dL</td>
</tr>
<tr>
<td>Cardiomegaly</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>Hx of bleeding disorder</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>Pre-op LHR (by EKG)</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>Pre-op NCD (by EKG)</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>Was this a “mini-CAB”?</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>If IMA not used, why not</td>
<td>[ ] not used, [ ] too old, [ ] too little, [ ] too much</td>
</tr>
</tbody>
</table>

**FLEX SPACE**

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to initial intubation</td>
<td>[ ] hours</td>
</tr>
<tr>
<td>Was patient re-intubated?</td>
<td>[ ] no, [ ] yes</td>
</tr>
<tr>
<td>Cardiac index on arrival in ICU</td>
<td>[ ] min/m2</td>
</tr>
<tr>
<td>Patient on 2 or more inotropes at 48 hrs, post bypass?</td>
<td>[ ] no, [ ] yes</td>
</tr>
</tbody>
</table>
Data Collection Form (continued)  

Definition of Terms

**PRE-OP DATA**
Chronic obstructive pulmonary disease: COPD, or asthma requiring inhaled, theophyllines/aminophylline, or steroids.

Renal failure prior to surgery: On peritoneal or hemo-dialysis.

Pre-op creatinine: Last pre-operative creatinine measurement taken before procedure. Documented in medical record or patient history.

CHF prior to surgery: Physician’s statement in medical record indicating Congestive Heart Failure during current admission, and prior to surgery; clinically manifested by one or more features including exertional dyspnea or fatigue, bilateral pedal edema, orthopnea, paroxysmal nocturnal dyspnea, acute pulmonary edema, or rales.

Peptic ulcer prior to surgery: Known current problem requiring treatment.

Liver disease: Mild, no sequelae; cirrhosis, chronic active hepatitis, or primary biliary cirrhosis, without sequelae described below; moderate to severe, with sequelae; cirrhosis, chronic active hepatitis, primary biliary cirrhosis, with any of the following sequelae: ascites, esophageal varices, portal hypertension, or hepatic encephalopathy.

Peripheral vascular disease: a) cerebrovascular disease prior CVA, prior TIA, prior carotid surgery, carotid stenosis by history or radiographic studies, or carotid bruit; b) lower extremity LEI disease: claudication, amputation, prior lower extremity bypass, absent pedal pulses or lower extremity ulcers.

Diabetes: Documented in medical record or patient history. Diabetes with no sequelae: Diabetes without sequelae described as follows. Diabetes with sequelae: Diabetes with renal disease, retinopathy, peripheral neuropathy, gastroparesis, or peripheral circulatory disease.

Hypertension: Documented in medical record or patient history.

Cancer: Physician’s statement in medical record indicating leukemia, lymphoma or solid cancer as a current medical problem.

Other comorbidity: Significant current comorbid condition requiring treatment, existing prior to surgery, not included among categories above.

Unstable angina: Physician’s statement in medical record indicating unstable angina during current admission, and prior to surgery; clinically manifested by new onset angina, rest angina, angina of increasing frequency and/or intensity; angina lasting ≥ 20 minutes despite medication occurring within two weeks of an MI.

MI prior to surgery: The development of a) new Q waves on EKG, or b) new ST-T changes with a significant rise (defined locally) in CPK with positive (defined locally) isoenzymes.

Failed medical therapy: Patients with NYHA or CCS Class 6-IV angina who show evidence of ischemia while on medical therapy, have angina that is inadequately responsive to medical therapy (patient and physician agree that angina significantly interferes with the patient’s occupation or ability to perform usual activities), are intolerant of medical therapy because of uncontrollable side effects. Patients with unstable or post-infarction angina who can not be safely weaned from intravenous heparin or nitroglycerine.

Objective evidence of ischemia: On ETT at stage 2 Bruce or 6 METS: a) ≥ 1 mm ST segment depression in ≥ 2 leads; b) EKG changes lasting ≥ 3 minutes into recovery; c) ≥ 10 mm Hg decrease in systolic BP or BP response to exercise ≥ 130 mm Hg; d) ventricular tachycardia; e) angina. On thallium ETT: a) reversible defects in ≥ 2 area or a large defect in one area; b) increased lung uptake; c) cavity dilatation. On stress Echo a change in systolic wall function from normal to hypoakinetic, hypokinetic to akinetic or recruitment of function in at least 216 segments. On stress, radionuclide testing: a) a reduction in EF ≥ 0.10; b) development of segmental wall motion abnormalities; c) cavity dilatation. Unstable or post-MI angina.

Thrombolytic therapy: Injection of thrombolytic agent i.e., streptokinase, tissue plasminogen activator, or urokinase.

**CARDIAC CATHETERIZATION DATA**
Left main disease, % stenosis: If a range is specified on angiography report give an integer midpoint of the range.

Dominance: PDA is subsumed under the right coronary dominance in right dominant anatomy, and under the circumflex distribution in left domi- nant anatomy. Balanced or indeterminate (not ascertainable or missing) anatomy is treated as right dominant for purposes of classification of single/double/triple vessel disease. An intermediate or ramus is considered a diagonal branch of the LAD distribution.

LAD: Left Anterior Descending artery. RCA: Right Coronary Artery. PDA: Posterior Descending Artery.

Proximal LAD stenosis: A ≥ 70% stenosis in the LAD prior to the 1st septal perforator.

**PROCEDURE DATA**
Priority: Emergent: Medical factors relating to the patient’s cardiac disease dictate that surgery should be performed within hours to avoid unnecessary morbidity or death. Examples: failed PTCA with acute coronary insufficiency and/or hemodynamic instability, similar situation in absence of PTCA. This case should take precedence in time over an elective case, open a new room, or be done at night, if necessary. Urgent: Medical factors require patient to stay in hospital to have operation before discharge. The risk of immediate morbidity and death are not present. Examples: threatening pathologic anatomy such as high grade Left Main Coronary Disease, particularly with moderately severe symptoms or history of life threatening arrhythmia (VF) related to ischemia. May have intra-aortic balloon pump (IABP) or intravenous (IV) nitroglycerin (NTG) as part of treatment program. This case might be done in the next available surgical slot but would not necessarily take precedence over an elective case and could possibly wait for several days. Non-urgent: Medical factors indicate the need for operation but the clinical picture allows discharge from the hospital with readmission at a later date for more elective surgery. Little risk of incuring morbidity or death outside of the hospital with good medical management and restricted physical activities.


Intra-op: while in the operating room. Post-op: after departure from the operating room.

Single artery by-pass of left main: Aortocoronary bypass of lesion in left main coronary artery with no other significant lesions bypassed, as documented in the operative report.

Was “hot shot” used: Total pump time: Time (in minutes) from point pump is turned on until it is turned off, or sum of these if bypass reinitiated.

Return to pump: Returned to cardiopulmonary bypass after initial complete separation.

Total clamp time: The sum of all times when the aortic cross clamp is in place.

Other procedures: AVR: Aortic Valve Replacement or Repair; MVR: Mitral Valve Replacement or Repair; VSD: Ventricular Septal Defect repair; ASD: Atrial Septal Defect repair; Surgical treatment of arrhythmias: ablation or resection of conduction system; AICD, placement: Automatic Implantable Cardioverter/Defibrillator implantation; Combinations: any two or more; Other: any significant cardiovascular surgery not included in this list.

**OUTCOME DATA**
Treatment of post-op thoracic bleedings: Performance of median sternotomy to assess bleeding after initial departure from OR.

CVA: cerebrovascular Accident; Diagnosis documented by MD and defined by the following: new focal neurological deficit which appears and is still at least partially evident more than 24 hours after its onset, occurring during or following the CABG procedure and established prior to discharge.

Mediastinitis/sternal dehiscence: Mediastinitis (two of the following with no other recognized cause: a) Organisms and white blood cells seen on gram stain aspirated fluid. b) Positive deep culture. c) Radiographic evidence of infection) or sternal dehiscence requiring re-operation.

Post-op leg wound infection: Leg incision infection requiring dressings and treatment with antibiotics.

Post-op AFib requiring treatment: Significant atrial arrhythmia requiring either medications or pacing.

**FLEX SPACE**
Last pre-op WBC: Last pre-operative measurement of WBC taken before procedure.

Last pre-op HCT: Last pre-operative measurement of hematocrit taken before procedure.

**Cardiogenic shock:** A heart/lung ratio on CXR >50%, a moderately or severely dilated left heart echo, a diastolic heart on radionuclide studies.

**Hx of bleeding disorder:** Hemophilia, thrombocytopenia, DIC.

Pre-op LVH (by EKG): From EKG report.

Pre-op WCD (by EKG): From EKG report.

“Mini-CAB”: Surgical revascularization without sternotomy.

Time to initial extubation: Hours from leaving OR to extubation.
Instrument Panel—Isolated CABG Surgery

Quarterly report: Q4 '96 ending 12/31/96 with 2-year summary by procedure date

**Patient Case-Mix**

**Patient Descriptors**

<table>
<thead>
<tr>
<th>Descriptor</th>
<th>Q4 96</th>
<th>2 Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Priority (% elective)</td>
<td>29.3</td>
<td>35.2</td>
</tr>
<tr>
<td>(% emergent)</td>
<td>0.9</td>
<td>2.1</td>
</tr>
<tr>
<td>Age (mean)</td>
<td>65.1</td>
<td>2.1</td>
</tr>
<tr>
<td>Sex (% male)</td>
<td>69.2</td>
<td>72.9</td>
</tr>
<tr>
<td>Prior heart surgery (%)</td>
<td>3.4</td>
<td>7.9</td>
</tr>
<tr>
<td>Diabetes (%)</td>
<td>37.6</td>
<td>28.3</td>
</tr>
<tr>
<td>PVD (%)</td>
<td>22.2</td>
<td>20.0</td>
</tr>
<tr>
<td>COPD (%)</td>
<td>8.5</td>
<td>7.9</td>
</tr>
<tr>
<td>Volume (quarterly mean)</td>
<td>127</td>
<td>133</td>
</tr>
<tr>
<td>Total volume (total)</td>
<td>137</td>
<td>903</td>
</tr>
</tbody>
</table>

**Clinical Processes**

**Process Variables**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Q4 96</th>
<th>2 Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump time (med mins)</td>
<td>62</td>
<td>88</td>
</tr>
<tr>
<td>Return to pump (%)</td>
<td>1.7</td>
<td>5.6</td>
</tr>
<tr>
<td>Reexplore for bleeding (%)</td>
<td>0.9</td>
<td>2.0</td>
</tr>
<tr>
<td>IMA usage (%)</td>
<td>94.9</td>
<td>88.9</td>
</tr>
<tr>
<td>Introp (IAP) insertion (%)</td>
<td>2.6</td>
<td>2.7</td>
</tr>
<tr>
<td>Intubation (%)</td>
<td>44.7</td>
<td>45.5</td>
</tr>
<tr>
<td>Intubation time (mean hrs)</td>
<td>13.9</td>
<td>14.9</td>
</tr>
</tbody>
</table>

**Outcomes**

**SF-36 Functional Outcomes**

<table>
<thead>
<tr>
<th>Domain</th>
<th>Q4 96</th>
<th>18 Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical function</td>
<td>55.5</td>
<td>48.5</td>
</tr>
<tr>
<td>6 months after</td>
<td>72.0</td>
<td></td>
</tr>
<tr>
<td>Role physical</td>
<td>20.0</td>
<td>21.0</td>
</tr>
<tr>
<td>6 months after</td>
<td>56.3</td>
<td></td>
</tr>
<tr>
<td>Bodily pain</td>
<td>50.18</td>
<td>53.4</td>
</tr>
<tr>
<td>6 months after</td>
<td>72.8</td>
<td></td>
</tr>
<tr>
<td>General health</td>
<td>58.2</td>
<td>55.7</td>
</tr>
<tr>
<td>6 months after</td>
<td>64.7</td>
<td></td>
</tr>
</tbody>
</table>

**Clinical Outcomes**

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Q4 96</th>
<th>2 Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality (%)</td>
<td>4.3</td>
<td>3.2</td>
</tr>
<tr>
<td>SMR (O/E using NNE rule)</td>
<td>0.72</td>
<td>0.57</td>
</tr>
<tr>
<td>Sternal inf or dehisc (%)</td>
<td>0.9</td>
<td>1.4</td>
</tr>
<tr>
<td>Leg infection (%)</td>
<td>17.9</td>
<td>18.4</td>
</tr>
<tr>
<td>O/A (%)</td>
<td>3.4</td>
<td>2.5</td>
</tr>
<tr>
<td>Readmit &lt;30 days (%)</td>
<td>6.0</td>
<td>12.0</td>
</tr>
<tr>
<td>Post-op ARB (%)</td>
<td>23.1</td>
<td>24.6</td>
</tr>
<tr>
<td>Pneumonia (%)</td>
<td>1.7</td>
<td>2.1</td>
</tr>
</tbody>
</table>

**Cost & Utilization**

<table>
<thead>
<tr>
<th>Category</th>
<th>Q4 96</th>
<th>2 Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total changes (mean)</td>
<td>$30,164</td>
<td>$32,230</td>
</tr>
<tr>
<td>LOS (med days)</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Post-op LOS (med)</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Post-op ICU LOS (mean)</td>
<td>2.3</td>
<td>2.1</td>
</tr>
<tr>
<td>Preop LOS (urgents-med)</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Cath same admitt (%)</td>
<td>62.4</td>
<td>28.3</td>
</tr>
<tr>
<td>Cath to CABG (mean)</td>
<td>3.5</td>
<td>3.2</td>
</tr>
</tbody>
</table>

* 12 months of data
** 18 months of data
11 Reducing Institutional Mortality Following Coronary Artery Bypass Surgery

Goal

Reduce 30-day mortality for all CABG cases, excluding re-operations, to 2% or less.

The recent effort to “educate” the public about the “quality” of cardiac surgical programs by comparing risk-adjusted mortality rates has made maintaining an exceptionally low institutional mortality rate a survival tactic for many programs. Yet, despite the obvious importance of understanding and reducing their cardiac surgical mortality rate, few programs have an organized approach to gaining such information and using it to make changes.

The Northern New England Cardiovascular Disease Study Group (NNECDSG) has developed and tested a regional model aimed at reducing the mortality rate following CABG. Combining regular feedback from its regional risk-stratified database with organized site visits among participating centers, the model has allowed centers to identify best practices and implement practice changes to improve outcomes and reduce regional variation. Finally, a strategy of identifying “cause-specific mortality rates” has allowed for targeted improvements on both the local and regional levels.11, 12

Changes

Track outcomes and display data openly.

Tracking outcomes such as mortality rate can help individuals within an institution to become more comfortable with sensitive issues associated with improving care and to understand whether improvements efforts have been effective or not. Openly display data outcomes, perhaps by placing run charts on a bulletin board in the section chief’s office or in the section conference room.

Conduct structured site visits to learn about other organizations’ processes of care.

Teams consisting of a surgeon, an anesthesiologist, a nurse, a perfusionist, and an administrator should visit other institutions to understand their processes of care, compare them with their own, and identify best practices.

Organize multidisciplinary teams to identify improvement opportunities and facilitate implementation of practice changes.

Use organized multidisciplinary teams charged with specific goals, such as reducing mortality or reducing the incidence of certain morbidities, to understand and implement change initiatives. Implementing practice changes requires broad understanding of the implications involved.


CABG Cause of Death Form
Northern New England Cardiovascular Disease Study Group

Changes (continued)

Retrospectively code “mode of death” and identify a cause-specific mortality to focus improvement efforts.

Mortality following open-heart surgery is often the end result of a cascade of events that frequently takes weeks to play out. In most cases, a seminal event can be identified that initiated the chain of events that result in a death. A “Mode of Death” (MOD) study attempts to identify that seminal event, thus allowing improvement efforts to be targeted at root causes.

The NNECDG developed a Mode of Death (MOD) coding form that places the events preceding death in chronological sequence. The coder then picks the seminal event that started the subsequent downward spiral of the patient in question.

Examples of two different modes of death:

Patient #1 has an uncomplicated CABG. On postoperative day 2, the patient develops a dense right hemiparesis (CVA) and expires of pneumonia on postoperative day 14.

CVA → PNEUMONIA → DEATH

Patient #2 has a CABG complicated by difficulty weaning from cardiopulmonary bypass. In the OR, the patient needs an intra-aortic balloon pump and high-dose inotropic support. On postoperative day 2, the patient awakens with a dense right hemiparesis and expires of pneumonia on postoperative day 14.

LOW OUTPUT → CVA → PNEUMONIA → DEATH

Although both of the patients described had strokes and died of pneumonia on the fourteenth day, the MOD in the first example was the CVA experienced on day 2, while the MOD in the second example was the low cardiac output noticed in the operating room.

A MOD study might start with a two- or three-year retrospective chart review and coding of all deaths into their respective MODs. Improvement efforts would thus be targeted at the most common MOD with the expectation of reducing the incidence of this occurrence. This should result in overall reduction of mortality.

Begin an institutional effort to identify high-leverage areas with the goal to reduce the incidence of what has been identified as the most frequent “mode of death.” This would include a literature review as well as additional site visits.

Once a team has identified the primary mode of death, it needs to identify areas of activity that might have affected the outcome. Major handoffs (cardiology to cardiothoracic surgery, OR to the ICU, ICU to the floor) are typically areas in which confusion of roles leads to errors and inefficiencies. To identify other sensitive areas, teams might find it helpful to examine the cardiac surgery process sequentially, looking at preoperative, intraoperative, and postoperative factors that might contribute to the incidence of a particular MOD.
A Targeted Approach to Reducing Mortality

Analysis of mortality data in one cardiac surgery program showed that low cardiac output was the most common sentinel event leading to death following CABG (see Figure 1.21). Therefore, the program targeted its efforts on reducing the incidence of low cardiac output prior to and following CABG and made the following changes:

- Developed a preoperative protocol for the treatment of unstable angina
- Started a program aimed at risk stratifying all patients awaiting CABG, utilizing accepted risk stratification algorithms (for example, the Parsonnet tool).  
- Formed a patient care committee consisting of a cardiac surgeon, a cardiologist, and an anesthesiologist to review the indications for and timing of CABG for all patients, based on their predicted preoperative risk of death following CABG. If this group agrees that surgery is indicated, another surgical group provides a second opinion
- Made cardiology (rather than cardiac surgery) responsible for medical management until surgery
- Documented this entire process in the medical record

Changes (continued)

Use the existing database to help identify process variables that, if modified, are likely to improve outcomes.

How data are displayed is important. Run charts that track outcomes over time and define statistical boundaries are the most effective means of following progress and identifying trends (see, for example, Figure 1.23, Sternal Wound Complication Rate).

Organizations with access to a risk-stratified database can use logistic regression analysis techniques to identify process variables that function as independent predictors of improved survival or reduced adverse outcomes following CABG. Examples of such variables include the following:

- Internal mammary artery (IMA) utilization rate as it relates to both short-term and long-term survival
- Re-exploration for bleeding rate, particularly with respect to use of anti-fibrinolytics
- Blood utilization and maintenance of hemoglobin levels while on bypass

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Measures

**In-hospital mortality**

Figure 1.22
Reduction in Mortality Rate in First-time Elective CABG Patients

North Memorial Medical Center
Robbinsdale, MN

![Graph showing reduction in mortality rate](image)

**30-day mortality**

In addition to tracking in-hospital mortality, programs should track 30-day mortality. Accurate measurement requires 100% follow-up on all patients to 30 days. Missing even one patient who might have expired will alter these data significantly.

**Morbidity**

Figure 1.23
Sternal Wound Complication Rate

Dartmouth-Hitchcock Medical Center
Lebanon, NH

![Graph showing sternal wound complication rate](image)
CABG Cause of Death Form

Please staple a copy of the discharge summary (identified by HOBGIN only) describing intra- and post-op events

Medical Center: __________________________________________

HOBGIN code*: __________________________ Op Date: ________________

Social Security #: __________________________ Date of Death: ___________

*HOBGIN code = first 3 letters of last name, first letter of first name and the six digit birthdate. For example, John Smith 6/20/45 = SMj062045.

Reviewer’s assessment of the chronological sequence of events leading to the patient’s demise. (May consider autopsy findings, clinician’s appraisal, and certificate of death.)

Use letters corresponding to the glossary terms on back of sheet.

1. _______ 2. _______ 3. _______ 4. _______

(POD#) (POD#) (POD#) (POD#)

Primary cause of death (pick one): 
1 = low output failure
2 = ventricular arrhythmia
3 = primary respiratory failure
4 = bleeding
5 = infection
6 = CVA/neurological
7 = other _______________________

Notes for clarification: ____________________________________________

Reviewer’s confidence in his/her assessment of cause of death: _______

(1 = very certain
2 = fairly certain
3 = uncertain)

Autopsy performed: _______

(0, 1, X, ?)

If yes, evidence of:
Acute myocardial infarction (intra- or postoperative) _______
Coronary graft occlusion _______
Pulmonary embolus _______
Cerebral infarct _______
Papillary muscle rupture _______
Ventricular rupture _______

(0=documented no; 1=documented yes; X=not specified; ?=indeterminate)
CABG Cause of Death Form (continued)

Glossary of events:
A. Significant cardiac failure, first noted intraoperatively, must contribute to subsequent events
B. Significant cardiac failure, first noted postoperatively, must contribute to subsequent events
C. Myocardial infarction (excluding preoperative MIs)
D. Ventricular arrhythmia
E. Other unexpected cardiac arrest (includes EMD [electromechanical dissociation])
F. Bleeding (significant thoracic bleeding, must contribute to subsequent events)
G. Sternal wound infection
H. Re-exploration (specify indication)
I. Respiratory failure
J. Sepsis—cause unknown
K. Pneumonia
L. Stroke
M. Coma
N. Renal failure (requiring dialysis or contributing to subsequent events)
O. Abdominal catastrophe (including GI bleeding)
P. Peripheral arterial complication
Q. Pulmonary embolus
R. Total body failure (multi-system failure)
S. Other (specify)

Example #1: A patient doing well otherwise suffers a fatal V. fib arrest on POD#2. Autopsy reveals an occluded graft and acute myocardial infarction.

Example #2: A patient, with pre-op COPD, can’t wean from the ventilator postoperatively, despite reasonable cardiac function. One week later, she develops pneumonia, followed by sepsis and multiple other complications leading to death (“total body failure”).

Example #3: A patient, who weans off cardiopulmonary bypass with great difficulty and an IABP, has postoperative cardiac failure without a discrete myocardial infarction. He dies 8 days later with total body failure.

Example #4: A patient undergoes re-exploration for bleeding on POD#2. She then has a major stroke and many subsequent medical catastrophes leading to death.

Example #5: A patient, who did well intraoperatively, suffers an MI on POD#1 with associated cardiac failure. He dies the following week after several other medical catastrophes.

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