

**FILE COPY**

**CORONARY ARTERY BYPASS GRAFT (CABG) SURGERY**

**ASSURING QUALITY WHILE CONTROLLING MEDICARE COSTS**



**OFFICE OF INSPECTOR GENERAL**  
**OFFICE OF ANALYSIS AND INSPECTIONS**

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August 1987

## Office of Inspector General

The mission of the Office of Inspector General (OIG) is to promote the efficiency, effectiveness and integrity of programs in the United States Department of Health and Human Services (HHS). It does this by developing methods to detect and prevent fraud, waste and abuse. Created by statute in 1976, the Inspector General keeps both the Secretary and the Congress fully and currently informed about programs or management problems and recommends corrective action. The OIG performs its mission by conducting audits, investigations and inspections with approximately 1,200 staff strategically located around the country.

## Office of Analysis and Inspections

This report is produced by the Office of Analysis and Inspections (OAI), one of the three major offices within the OIG. The other two are the Office of Audit and the Office of Investigations. OAI conducts inspections which are, typically, short-term studies designed to determine program effectiveness, efficiency and vulnerability to fraud or abuse.

### This Report

Entitled "Coronary Artery Bypass Graft (CABG) Surgery - Assuring Quality While Controlling Medicare Costs," this report suggests changes in Medicare policies that would assure quality of care and reduce program costs.

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# **CORONARY ARTERY BYPASS GRAFT (CABG) SURGERY**

**ASSURING QUALITY WHILE CONTROLLING MEDICARE COSTS**

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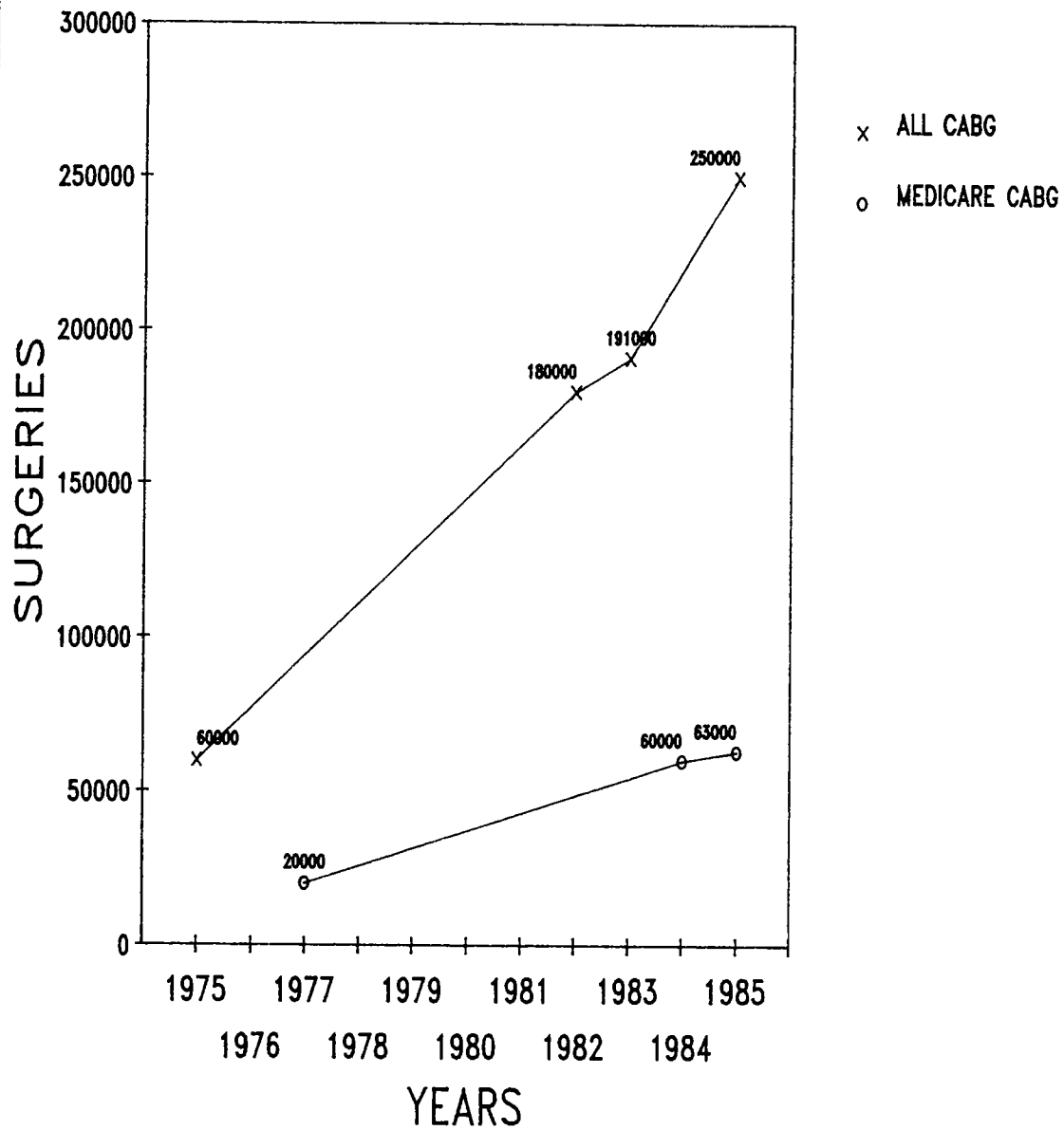
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# GROWTH IN CABG SURGERIES

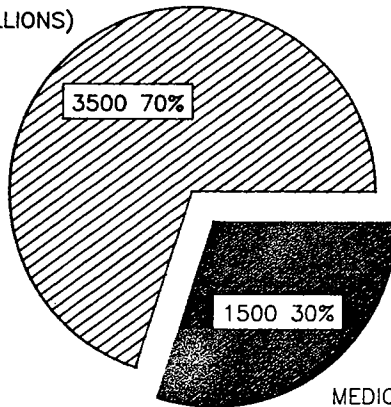


# INTRODUCTION

In 1985, approximately 250,000 persons underwent coronary artery bypass graft (CABG) surgery. Medicare beneficiaries accounted for over 25 percent of this total. More than 63,000 hospital bills were processed in 1985 by Medicare fiscal intermediaries for Diagnostic Related Group (DRG) codes 106 and 107 (coronary bypass with and without cardiac catheterization, respectively). Those bills resulted in payments to hospitals of over \$1 billion. The Office of Inspector General (OIG) estimates that physician and other Part B payments for these beneficiaries totaled approximately \$500 million, bringing Medicare's overall costs for services associated with coronary bypass surgery to over \$1.5 billion (see Appendix A).

## MEDICARE SHARE OF TOTAL CABG DOLLARS BASED ON PUBLISHED ESTIMATES OF TOTAL EXPENDITURES

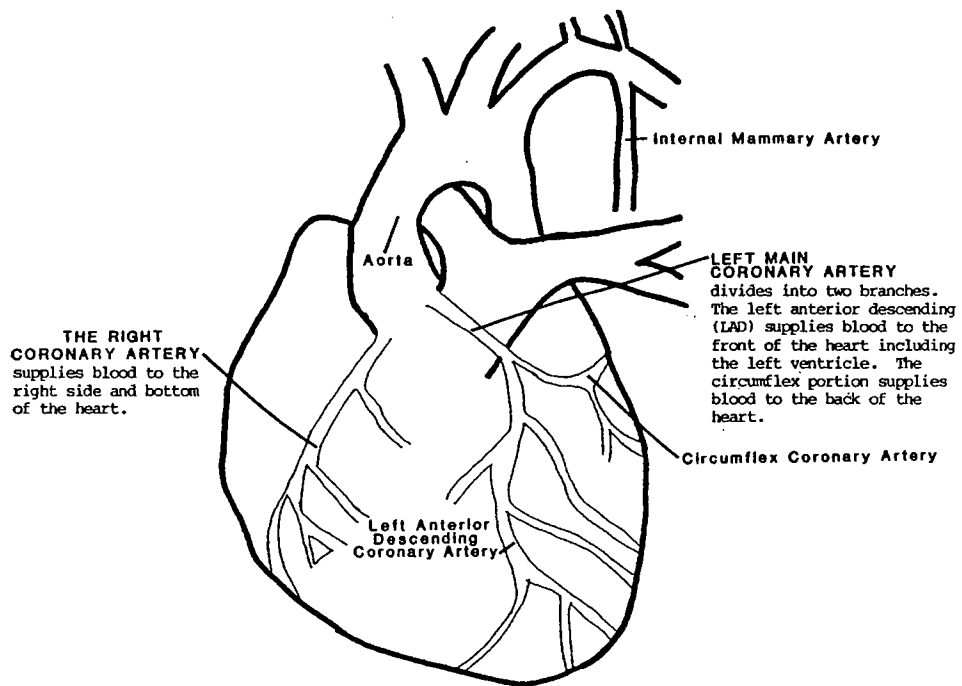
NON-MEDICARE CABG DOLLARS (IN MILLIONS)



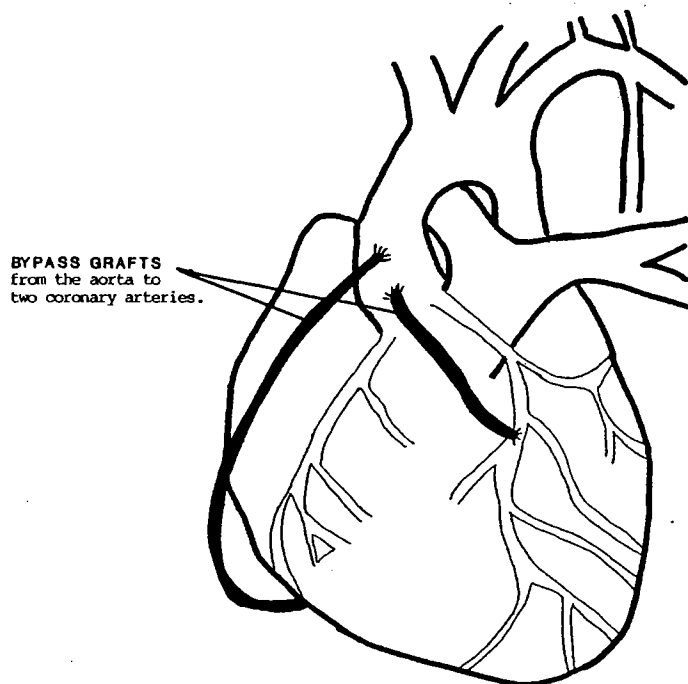
MEDICARE CABG DOLLARS (IN MILLIONS)

TOTAL 1985 ESTIMATED COSTS = \$5 BILLION

## CORONARY ARTERIES



## CORONARY ARTERY BYPASS GRAFTS



During the course of fieldwork, four of the inspection team members observed CABG surgery at seven major medical centers that specialize in cardiac care. By observing the surgery, the team members gained a better appreciation for the nature of the surgery and the functions and responsibilities of each member of the surgical team.

### What Is CABG Surgery?

Coronary artery bypass graft surgery is most commonly performed to alleviate the chest pain (angina pectoris) that results from the heart being deprived of an adequate supply of freshly oxygenated blood. Typical bypass surgery involves an hour or more of preparation by the nurses, technicians and anesthesiologist before the surgeon enters the operating room. After the patient has been "prepped," anesthetized and intubated, the surgeon and his assistant proceed to make incisions in the patient's leg and chest. The saphenous vein is extracted from the leg, the sternum is sawed in half and the chest cavity is clamped open. If the internal mammary artery (IMA) will be used, it is extracted from the chest wall. The patient is then put on the heart-lung pump which assumes the heart's functions during the grafting procedure. The grafting procedure consists of taking either or both of the extracted vessels and using them to circumvent coronary arteries that have become blocked and are restricting the flow of blood to the heart. The grafts are attached to the aorta and the affected coronary arteries below the places where they are clogged.

The surgery is usually elective. While it is not risk-free, it is generally considered a safe and effective remedy for angina. Although using one or both IMAs has increased the amount of time for surgery (because it is more difficult to remove), total surgical time rarely exceeds 4 hours. The average hospital stay has been reduced from 16 days in 1980 to less than 10 days in 1986.

### The Controversies Surrounding CABG

Although all the surgeons and cardiologists who were interviewed agree that CABG may be the only remedy for some victims of coronary disease, CABG has received a considerable amount of negative publicity in the last year or two. Questions have been raised about the medical necessity of the procedure for patients who have single or double vessel disease but are asymptomatic, patients who have stable angina and patients who have not been treated very aggressively with medical therapy. Some physicians have expressed opinions that not only is CABG overused, but also angioplasty and angiography (a diagnostic test where a catheter is inserted and dye is injected to visualize the locations and severity of blocked arteries) may not be medically necessary in as many as 50 percent of the cases.



Another controversy surrounding CABG involves the hospitals where the surgery is performed. Are better results obtained in facilities that specialize in cardiac surgery? If so, how many bypass surgeries should be done in a hospital for it to be considered satisfactory? How can hospitals be compared and how can surgical outcomes be measured? Are charges less in hospitals that specialize?

The costs associated with CABG have been nearly as controversial as the surgery itself. Among surgical procedures, CABG is one of the most expensive. Charges are generated by the hospital, the surgeon, one or more assistant surgeons, an anesthesiologist, a cardiologist and, sometimes, laboratories, pump perfusionists (who operate the heart-lung machine during surgery) and nurse anesthetists.

### Improved Quality and Efficiency at Higher Volume Hospitals

In January 1985, Blue Shield of California (BSC), the Medicare carrier for northern California, approached the OIG about sponsoring a study concerning CABG surgery. The carrier was concerned about the high cost of the surgery and was interested in finding some means of controlling CABG expenditures without compromising quality of care. The OIG arranged funding for the study through the Health Care Financing Administration (HCFA) and a contract was entered into between BSC and the Institute for Health Policy Studies of the University of California School of Medicine in San Francisco. Since there have been many major studies concerning the medical necessity of bypass surgery and its long-range benefits, BSC decided that its study should analyze hospital discharge data to see if there was any correlation between volume of surgery and surgical outcomes.

The April 1986 BSC report, which was published, in part, in the February 13, 1987 issue of the Journal of the American Medical Association (see Appendix B), states that hospitals in California that perform at least 200 CABG surgeries each year have better outcomes in terms of fewer deaths, lower charges and shorter lengths of stay than those that do not specialize in bypass surgery. Blue Shield concluded that selective contracting with high volume hospitals and physicians to perform CABG surgery would be beneficial for patients as well as insurers.

The need to assure that Medicare beneficiaries receive optimum medical care in highly qualified facilities was underscored by Otis R. Bowen, M.D., Secretary of Health and Human Services, in the proposed notice concerning Medicare coverage of heart transplants which was published in the Federal Register on October 17, 1986. Heart transplants would only be covered if they were performed in facilities that were approved by the Department because they have demonstrated experience, expertise and satisfactory patient outcomes. The criteria contained in the proposed notice address all of the quality of care concerns that were discussed in the BSC report on CABG.

## Objectives of This Inspection

The OIG inspection was designed to (1) document current medical practices for the delivery of quality CABG surgery, (2) obtain expert opinion on the most efficient and economical delivery of CABG surgery, (3) determine actual Medicare hospital and medical insurance allowances for a random sample of beneficiaries who underwent CABG surgery during 1984 and 1985 and (4) identify recommendations that would result in assuring quality of care for Medicare beneficiaries and significant program savings.

## Conceptual Approach and Methodology

The OIG Office of Analysis and Inspections worked closely with the University of California and BSC during the course of their study. Several issues from the BSC study and related work by the carrier were identified that could have significant relevance for the Medicare program if they exist in other States to the same degree they exist in California. After a series of interviews with prominent cardiologists and cardiovascular surgeons to verify the issues, the OIG decided that a national inspection should be conducted. The inspection was designed so that information could be obtained through data as well as interviews. By utilizing both interviews and record reviews, the inspection team obtained expert opinions which were compared with actual Medicare beneficiary history records.

Discussions were held with surgeons and cardiologists who had pioneered the CABG procedure as well as current practitioners. Representatives of private industry, regulatory agencies, State agencies and carrier medical staff were interviewed. Interviews were held with 28 thoracic/cardiovascular surgeons, 16 cardiologists and 2 hospital administrators. Detailed discussions were conducted with 19 health maintenance organizations and 4 companies with employee health plans offering coronary care coverage. Meetings were held with the American Medical Association, the American Hospital Association and the National Institute of Health. Contact was made with the American College of Thoracic Surgeons, the Society of Thoracic Surgeons and the American Association of Thoracic Surgeons.

The design of this inspection required that a method be developed to determine the combined CABG surgery costs for Medicare Parts A and B. This data is not available in current HCFA systems. To obtain total CABG costs, a sample of 204 Medicare beneficiaries was selected from the "Part A Intermediary Bill History" file maintained by the HCFA Bureau of Data Management and Strategy. The sampled beneficiaries were admitted to a hospital in fiscal years 1984 or 1985 and were discharged with a DRG code of 106 or 107. These 204 beneficiaries represent a random sample comprised of two-tenths



## FINDINGS

### MEDICARE CABG COSTS WILL CONTINUE TO ESCALATE

The physicians who were interviewed during this inspection indicated that they expect the demand for CABG surgery for Medicare beneficiaries to increase even though alternative therapies have been developed to treat coronary heart disease. Continued growth in the demand for bypass surgery is predicted because of the extent of cardiovascular disease in our society, the aging of the population, the reduced risk associated with the surgery, the number of people who will need re-operations 10 to 12 years after their first bypass surgery and the belief that alternative remedies are only temporary solutions.

The development of new medical therapies and the increased acceptance of percutaneous transluminal coronary angioplasty (PTCA) have altered the characteristics of the bypass patient population. Angioplasty is widely accepted as an appropriate procedure for coronary disease involving one or two occluded arteries, if the patient's condition and the locations and lengths of the blockages meet certain accepted medical criteria. The procedure, which is performed by cardiologists in catheterization laboratories rather than by surgeons in operating rooms, involves the use of a balloon catheter which is commonly inserted through the femoral artery. When the catheter reaches the blocked portion of the coronary artery, the balloon tip is inflated and, if the procedure is effective, the plaque is split and the artery is dilated allowing increased flow of blood.

Because the number of cardiologists recommending and performing angioplasty is constantly increasing, fewer patients are being referred to thoracic and cardiovascular surgeons for bypass consideration in the early or less acute stages of their coronary disease. Initial CABG referrals are commonly limited to patients who are not candidates for angioplasty or those whom angioplasty has failed. Like angioplasty, the development of new drugs, particularly the calcium and beta blockers, ultimately results in surgeons seeing patients who have more acute coronary artery disease. Because these drugs provide non-surgical relief from angina pain for many victims of coronary disease, it is only after drug therapy has failed that patients are recommended for CABG surgery.

The reduced risk associated with CABG surgery means that patients who are 70 or 80 years old may now be considered bypass candidates and would not be automatically excluded because they have medical conditions or diseases that co-exist

with their coronary disease. Also, patients who had angioplasty or their first bypass operation before they became Medicare beneficiaries may need their first or second bypass surgery after the age of 65.

The net effect of these changes is that CABG patients are older and sicker. Furthermore, the increased use of alternative therapies may be merely delaying the need for surgery which will ultimately increase CABG costs for Medicare.

#### SELECTIVE CONTRACTING CAN ASSURE QUALITY CARE AND SAVE MONEY

The Blue Shield of California/University of California study validated the findings of previous studies that better surgical results are obtained in institutions that specialize in cardiac care. This OIG inspection found that hospitals which perform more than 200 coronary bypass surgeries annually not only have specialized personnel who participate in the surgical procedure, but also have discrete units devoted exclusively to cardiac patients. Frequently, these units are staffed with a coordinator (usually a registered nurse) who is employed by, or directly reports to, the cardiovascular surgery group that performs all of the bypass surgeries at that hospital. In some of the hospitals, the surgeons are salaried employees of the hospital corporation or a related corporation that staffs the facility. The continuity of treatment and care that these relationships provide may, at least in part, account for the lower mortality and morbidity rates found in the Blue Shield study. These arrangements may also facilitate the formulation of package pricing for CABG medical, surgical and hospital expenses.

#### The Development of Package Prices for CABG

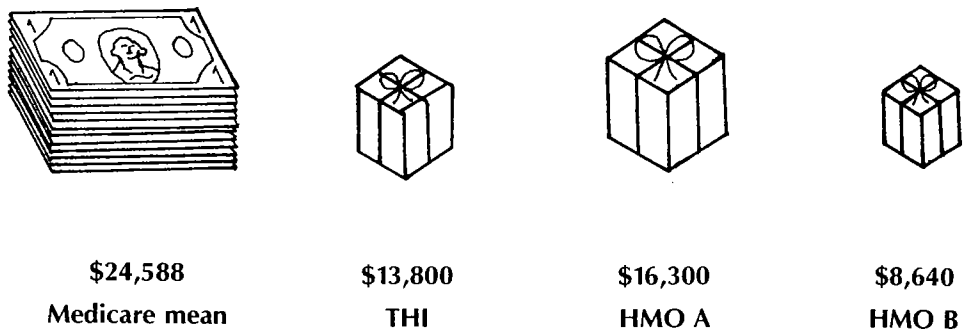
No longer the exclusive province of pioneering surgeons and hospitals, CABG surgery can now be performed by almost 2,000 thoracic and cardiovascular surgeons in 698 hospitals. Because there are more hospitals and surgeons performing coronary bypass surgery than there were 10 years ago, many of the pioneering hospitals and surgeons have fewer CABG patients. Also, cost cutting efforts by Medicare and other insurers have resulted in reduced hospital occupancy rates. For these reasons, there is increased competition for patients and increased willingness on the part of health care providers to negotiate rates. In some instances, providers have initiated the contracting concept while in others the primary payer has been the catalyst.

In the spring of 1984, the Texas Heart Institute (THI) established a subsidiary corporation whose purpose was to take advantage of "the economies of scale" by developing package

prices for certain cardiovascular procedures. Since THI is one of the largest providers of cardiac surgery in the Nation, the subsidiary, CardioVascular Care, was able to draw upon an extensive data base to arrive at a schedule of package prices. The Texas Heart Institute, like some other providers of CABG surgery, has experienced a reduction in its bypass patient census. Between 1980 and 1985, the number of surgeries had dropped from approximately 3,500 to 2,500. In a demonstration project proposal to HCFA, CardioVascular Care indicated that it is offering a package price of \$13,800 for coronary bypass surgery for Medicare and non-Medicare patients. The package price includes hospitalization for up to 12 days as well as the services of the cardiovascular surgeon, the cardiologist, associated staff and all customary laboratory tests. Contracts have been negotiated with more than 30 organizations that are primary payers of health care for over 1.5 million people.

Although THI was probably the first provider to offer a fixed price for CABG surgery, others were soon to follow. In the private sector, prudent buyers of health care have been able to purchase medical services at significantly lower costs when they take advantage of the fixed price offers or negotiate contracts on their own initiative. Of the 19 health maintenance organizations (HMOs) that were contacted during the course of this inspection, 7 have negotiated all-inclusive package price contracts with medical centers to provide CABG surgery for their enrollees. Package prices for HMOs range from a low of \$8,640 for a 12-day hospital stay to \$16,300 for stays of up to 11 days. This includes all institution-related costs as well as surgical team fees. In highly competitive markets, it was found that even lower rates can be obtained. In one metropolitan area, competition has led to package prices as low as \$7,000. In contrast, Medicare reimbursement continues at traditional cost levels based on Part A DRG rates and Part B reasonable charge determinations.

Medicare Mean Allowance Compared With Package Prices



The Medicare mean is based on the inspection sub-sample of 6 to 12-day hospital stays.

There is no question that the savings accrued from these negotiated rates are substantial. A study by the Metropolitan Life Insurance Company of the hospital and physician charges it received for CABG surgeries from January 1982 through July 1983 showed that the average national charges for CABG totalled \$21,800 per case. Metropolitan also found significant variations in the regional charges for bypass surgery. The highest average regional charge (\$29,500) was in the Pacific division (more specifically, California) and the lowest average regional charge (\$18,300) was in the East South Central division. Although the average length of stay for the Metropolitan data was between 12 and 15 days, this would not negate the substantial savings that the contract prices offer. A specific example of contract price savings further illustrates this: Texas Heart Institute's contract price of \$13,800 for a 12-day hospital stay is \$6,000 less than the Metropolitan study's average charge for a 13-day hospital stay in THI's home State, Texas.

In over 80 percent of the Medicare cases that were included in the OIG inspection sample, the hospital charges alone exceeded the THI contract price. In Texas, the hospital charges exceeded the contract price in 9 out of the 10 sample cases. In 7 out of 10 Texas cases, the actual DRG payment exceeded the \$13,800 THI price.

To determine potential savings for the Medicare program, sample cases that involved lengths of stay from 6 to 12 days were compared with the THI contract price of \$13,800. Annual savings are estimated to exceed \$192 million. Even more savings would accrue if the package price was the same as the one shown for HMO B in the chart on page 9. Details concerning the methodology for computing the projected cost savings are in Appendix A.

### Do Contracts Work?

Fixed price contracts frequently require that patients travel outside of their communities for surgery; in one contract, the patient is sent 2,000 miles away for his bypass operation. Even without contracts, patients, with or without the advice of their cardiologists, often choose to have their surgery at a major bypass center located away from home. At least three of the centers visited in this inspection receive more than 50 percent of their patients from other States. To encourage contract utilization, some insurance companies and HMOs offer free transportation and/or the waiver of coinsurance and deductibles.

In the most common scenario, the family physician refers his patient to a cardiologist when heart disease is suspected. Then, if coronary artery disease is diagnosed and alternative therapies fail, the cardiologist refers the patient to a thoracic or cardiovascular surgeon for bypass surgery. An

angiogram is sent to the surgeon at the time of the referral. The surgeons who were interviewed in this inspection indicated that more than 80 percent of the referrals actually undergo surgery. The bypass patient usually does not see the surgeon more than once or twice prior to surgery and, post-operatively, only sees the surgeon while in the coronary care unit. It is the cardiologist and the family physician who maintain an ongoing relationship with the patient. Therefore, the lack of any pre-existing relationship between the patient and the contract surgeon is not a unique situation. The only noticeable change in the physician/patient relationship is that a contract cardiologist will visit the patient while he is in the hospital, rather than the patient's personal cardiologist. When the patient leaves the hospital, a report is sent to the patient's cardiologist who renders any necessary follow-up care.

Office of Inspector General staff contacted four insurers to find out about their referral process and experience with actual patient care under their negotiated package price contracts. The earliest contract has been in effect since November 1984. A synopsis of their experience follows.

When it is determined that an enrollee is a candidate for bypass, the insurers notify the patient that he can have surgery at a local hospital or travel out of State to take advantage of the package contract arrangement. The insurers have found that even though transportation costs are borne by the patient, the majority of their bypass patients have chosen to travel to the contract facility. One HMO estimated that 90 percent of their patients would choose to travel out of State to the contract medical center because of its good reputation.

All the insurers implemented the contracts for cardiac care as an alternative to their usual reimbursement policy because the packages are less costly. One HMO has two cardiac care packages, both at the same price. The only difference is that one contract is with a local medical center and the other is with an out-of-State provider. Two of the insurers offer a financial incentive to the patients by waiving coinsurance and deductibles to compensate for the transportation and lodging expenses.

According to the insurers, both they and their patients have been very satisfied with the process of referral and the high quality of service under their contracts. All the insurers plan to renew the cardiac care contracts when the current ones expire. Two self-insured employers commented that local physicians rendering cardiac care services have approached the company about negotiating fixed-price contracts; however, the insurers are so satisfied with the quality of care rendered by the present provider, that they will automatically renew the contracts without soliciting other bids.



The purchasers have found that package price contract arrangements save program dollars and administrative costs, while maintaining high quality care. They not only eliminate the need for usual and customary or reasonable charge determinations but also the need for pre-payment and post-payment utilization screens.

**SURGEON FEES AND PAYMENTS:  
THE REASONABLE CHARGE IS NOT ALWAYS REASONABLE**

In July 1981, The New England Journal of Medicine published an article by Dr. Benson Roe, one of the pioneer CABG surgeons. In his article and in an OIG interview in 1986, Dr. Roe questioned the efficacy of using the reasonable charge concept to determine physician payments. As an example of the failure of the reasonable charge methodology, Dr. Roe discussed the changes in the primary surgeon's role and responsibility since CABG surgery was developed. According to the article, the surgery has become safer and simpler and many of the surgeon's previous responsibilities have been delegated to other professionals (cardiologists, anesthesiologists and pump technicians). Nevertheless, the surgeon's fee has escalated and the fees of the other professionals, which are paid separately, merely add to the total cost of bypass surgery. The reasonable charge reimbursement system recognizes all of the charges but none of the changes that would reduce the surgeon's payment.

The concerns raised by Dr. Roe in 1981 are still valid in 1986. Almost all of the surgeons who were interviewed in the OIG inspection indicated that their CABG surgical fees were originally based on the charges that were being made by other surgeons who were performing the operation. None of the surgeons indicated that any criteria were used other than the charges of others or charges that they were making for what they deemed to be "comparable" surgeries when they began their CABG surgery practice. Although some of the surgeons indicated that their Medicare reimbursement was too low, none of them had ever reduced their charge to Medicare to reflect any economies, efficiencies, reduced risk or responsibility. Some of the surgeons complained about the high charges of their peers and the unfairness of Medicare recognizing the inflated charges of new surgeons without adjusting their allowances accordingly. Virtually all of the physicians that were interviewed voiced some dissatisfaction with the reasonable charge system.

**More Dollars for More Grafts?**

Medicare reasonable charge determinations for CABG surgery are based upon the HCFA Common Procedure Coding System (HCPCS). The HCPCS codes for CABG surgery are the same as those in the "Physicians' Current Procedural Terminology" (CPT) coding

system that was developed by the American Medical Association. There are six codes for coronary artery bypass surgery where the patient's leg vein and/or mammary artery are used for the grafts. The distinguishing factor among the six codes is the number of graftings performed during surgery:

CPT (HCPCS) CABG SURGERY CODES

33510	Coronary artery bypass, autogenous graft, e.g., saphenous vein or internal mammary artery; <u>single</u> graft
33511	<u>two</u> coronary grafts
33512	<u>three</u> coronary grafts
33513	<u>four</u> coronary grafts
33514	<u>five</u> coronary grafts
33516	<u>six or more</u> coronary grafts

One of these six codes was billed for each of the 204 Medicare beneficiaries in the inspection sample.

Before HCFA mandated that carriers use CPT codes, many carriers relied on the California Relative Value Studies (CRVS) of 1964, 1969 and 1974 to code and pay claims. The 1974 CRVS lists three codes for CABG surgery involving the saphenous vein or mammary artery:

33510	<u>single</u> artery
33515	<u>two</u> coronary arteries
33518	<u>three</u> (or more) coronary arteries

These codes were assigned unit values of 25, 32 and 38, respectively.

The three codes that were added when HCPCS was implemented have resulted in increased CABG expenditures by most Medicare carriers. Only 8 of the 38 carriers surveyed restrict payments to a given amount if the surgery involves 3 or more arteries. One of these actually allows the same amount if two or more arteries are involved. An additional six carriers make no pricing distinction among four or more arteries.

The thoracic surgeons who were interviewed agree that each additional graft takes approximately 10 to 20 minutes. The OIG analyzed carrier pricing for the six codes and found that for each additional graft a surgeon can receive as much as \$2,297 or as little as \$3 depending on the prevailing charge in a given locality. Five carriers actually pay less for more grafts. In one large Midwestern State, the carrier allows \$822 less for four grafts than for three. For these five carriers, the time for additional grafts does not yield additional compensation because reasonable charge determinations merely represent the charge data accumulated for each code without regard to the other codes.



Medicare Reasonable Charges Significantly Exceed Prudent Buyer Costs

While Medicare continues to reimburse surgeons based on its reasonable charge criteria, other purchasers of health care have been able to negotiate reductions of their "usual and customary" payments. When the revised payment is in the form of an all-inclusive package price, it is difficult to determine the discounted price for the hospital and physician components. The agreement is between the hospital or medical center and the physician group whose services are included in the package arrangement. The purchaser of the package is not aware of the distribution of the reimbursement between the hospital and physician group. In some cases, however, an HMO or insurance company has negotiated a discount price for the physician group only.

The most common discount arrangement involves a percentage of "usual and customary" or fee-for-service charges. Frequently, the agreement will provide the surgeon with 80 percent of his usual fee. In some agreements, the surgeon is expected to absorb the costs of assistant surgeons or physician assistants in the discounted payment. These arrangements are often the first step towards the development of all-inclusive package prices. Although the OIG did not determine the exact number of these agreements that have been negotiated, several of the physicians who were interviewed discussed their provisions. In southern California, one surgical group has agreed to accept \$5,000 (80 percent of its usual and customary) as payment for the services of the surgeon and any assistant surgeons or trained technicians who participate in the CABG surgery. For Medicare, those same services will cost \$1,681 more than the discounted price:

	<u>Billed</u>	<u>Allowed</u>	<u>Paid</u>
Surgeon	\$6,200	\$5,966	\$4,773
Assistant surgeon	1,240	1,193	954
Second assistant surgeon	<u>1,240</u>	<u>1,193</u>	<u>954</u>
	\$8,680	\$8,352	\$6,681

Several HMOs have negotiated similar agreements and at least one Medicare carrier, in a pilot project for its private business, has begun paying a "wrap price." The "wrap price" represents a single payment for all the physicians and technicians who would normally submit separate bills. It saves the carrier \$1,100 per CABG surgery. Based on the carrier's calculated savings, consolidating payments for the surgeon, anesthesiologist and assistant surgeons could save Medicare over \$69 million each year for 63,000 surgeries.

As these agreements proliferate around the country, the disparity between what Medicare pays and what other purchasers pay will become more pronounced.

## INCONSISTENT CARRIER UTILIZATION POLICIES CAN BE INEQUITABLE AND COSTLY

Because CABG surgery is so costly, it is essential that new economies and efficiencies become institutionalized as quickly as possible. As the economies are implemented, HCFA and its carriers must monitor claims to assure that providers do not diminish the impact of the savings by billing and being paid for unnecessary or inappropriate items and services.

The Health Care Financing Administration has not mandated any national utilization controls for CABG surgery. Each carrier, in consort with its own medical consultants and medical policy committee, must develop its screens. While some carriers have diligently formulated controls, others have chosen not to place any limitations on the CABG providers in their service area. The need for carrier screens for CABG surgery would be virtually eliminated if payments were packaged rather than paid according to the reasonable charge concept.

### CABG Surgical Fees Are Sometimes Fragmented

Several claims submitted to Blue Shield of California for 1986 CABG surgeries were identified by the plan's medical director for review. The surgeons who had submitted the claims had included separate charges for items that the medical director believed should have been included in the global fee for the surgery. The claims included charges for the following items:

1. monitoring lines
2. decompression catheters
3. intraaortic balloons
4. pacemaker electrodes
5. drainage tubes
6. resuscitation measures

Additional charges were also being submitted for re-operations due to post-operative thrombosis or hemorrhage.

The BSC medical policy committee determined that these items are part of the surgeon's global fee and should not be paid. Computerized pre-payment screens have been installed to automatically screen and deny these services when they are billed with any of the HCPCS CABG surgery codes. By doing this, BSC has closed a "loophole" and avoided paying these "fragmented" bypass surgery items.

Generally, carriers do not agree on which components of CABG surgery are included in the global fee. Also, their payment policies on re-operations are inconsistent. Only 6 of the 38 carriers that responded to the inspection query indicated that all of the listed items are included in the surgical fee and will not be paid if they are billed separately.

While almost 50 percent of the carriers will pay separate charges for use of an intraaortic balloon (a procedure used if the heart does not easily resume function when the heart-lung machine is disconnected), only 10 percent recognize separate charges for the insertion of catheters. Even within the same State, carrier policies may differ. For example, BSC now disallows all of the listed items, but Transamerica-Occidental in Los Angeles will pay separately for the balloon and pacemaker electrodes. In Missouri, one carrier pays for the balloon only while the other pays for the balloon and resuscitation.

Only two of the carriers routinely deny separate charges for re-operations because they consider them part of the global surgical fee. Some carriers require that all claims for re-operations be reviewed by their medical consultants. Others pay the claim at a reduced rate, or pay the claim at a reduced rate if the re-operation was within 24, 48 or 72 hours of the surgery.

The fragmentation of CABG surgery was not apparent in the claims sample for the inspection. However, the problem was identified by the northern California Medicare carrier in claims that were submitted during 1986. Since the inspection sample claims were for fiscal years 1984 and 1985, it is possible that fragmentation will become a costly problem if HCFA does not establish national policy guidelines and utilization screens.

#### Payments for Assistant Surgeons at CABG Surgery

Coronary bypass surgery is a complex procedure that requires a large surgical team. The skill of the surgeon-in-charge must be complemented by the skills of the anesthesiologist, the nurses, the assistant surgeon and the pump perfusionist to assure a successful outcome.

The OIG found that the CABG surgical team was composed of a dozen or more persons in some medical centers: the primary surgeon, two assistant surgeons, two pump perfusionists, an anesthesiologist, a nurse anesthetist, two circulating nurses, two scrub nurses, an orderly and, in teaching hospitals, a surgical resident. In other institutions, the team had eight members: the primary surgeon, one assistant surgeon, a physician assistant, one pump perfusionist, an anesthesiologist, one circulating nurse, one scrub nurse and an orderly. In most situations, the non-physician team members and the residents are salaried hospital employees and do not submit claims for reimbursement to Medicare carriers. Separate Part B bills are usually submitted by the surgeon, the anesthesiologist and the assistant surgeons.

If two assistant surgeons participate in the operation, one usually harvests (removes) the saphenous vein while the other assists the primary surgeon in the chest cavity. The assistant who harvests the vein works on the leg from "skin to skin." Some of the surgeons who were interviewed do not routinely use a second surgeon to perform this function. They have, instead, hired and trained physician assistants. In one major CABG center that was visited, two physician assistants are used instead of any assistant surgeons. No Medicare charge is generated for the physician assistants who are the salaried employees of the thoracic surgeon or surgery group.

All of the surgeons who were interviewed agree that the vein harvesting can be done just as efficiently and competently by a physician assistant or a trained nurse as by another surgeon. The surgeons also agree that only one assistant surgeon is required for all but the most complex CABG surgeries. Although some surgeons think that Medicare should pay for physician assistants, most do not object to Medicare limiting payment to one assistant surgeon.

Medicare payment policy precludes payment for assistant surgeons at CABG surgery when the hospital has a residency program in cardiovascular or thoracic surgery. The OIG found that at least seven carriers have not implemented this policy. However, more than 50 percent of the carriers that were surveyed will routinely pay for only one assistant surgeon. Except for three carriers, all the rest limit the payment to two assistant surgeons. The three exceptions have formulated an alternative policy: The total amount that they pay for all assistant surgeons cannot exceed 20 percent of the primary surgeon's reasonable charge. Twenty to 25 percent of the primary surgeon's fee is the usual amount that is billed and paid for one assistant surgeon. Carriers that have adopted this policy have effectively reduced, or capped, program expenditures without addressing the issue of how many assistants are needed in the operating room.

## RECOMMENDATIONS

### RECOMMENDATION #1 – QUALITY OF CARE

**FINDING:** Hospitals and surgical teams that specialize in CABG surgery and perform more than 200 surgeries per year have better outcomes in terms of mortality rates, lengths of stay and charges. Contracting with selected high volume facilities would assure that Medicare beneficiaries receive the highest quality of care in the most efficient and economical settings.

**RECOMMENDATION:** HCFA should develop quality of care criteria for CABG surgery providers so that selective contracts can be negotiated.

**IMPACT:** Medicare beneficiaries would receive the highest quality care in the most efficient and economical settings.

**HCFA RESPONSE:** HCFA, in collaboration with eight PROs, is collecting clinical data on CABG cases and will explore the possibility of developing quality of care criteria specific to CABG providers.

### RECOMMENDATION #2 – SELECTIVE CONTRACTING

**FINDING:** Medicare payments for CABG surgery are based on hospital DRG rates and reasonable charge determinations for surgical and medical expenses. This method of reimbursement does not take advantage of the substantial program and administrative savings that can be realized through selective contracting.

**RECOMMENDATION:** HCFA should negotiate all-inclusive package payment prices with selected surgeons and medical centers for providing CABG surgery to Medicare beneficiaries. Since legislation is required, a demonstration project should be considered to determine the most efficient and cost-effective method for contracting. The "preferred provider" concept could be one way of encouraging beneficiaries to use the contract provider without restricting the beneficiary's freedom to use the provider of his choice.

**IMPACT:** Over \$192 million could be saved if Medicare implemented a selective contracting program that paid a fixed price of \$13,800 for CABG surgeries involving hospital stays of up to 12 days. The Texas Heart Institute proposed this price; however, some HMOs have negotiated lower prices with other medical centers and the estimated cost savings would be considerably greater if HCFA were able to take advantage of these lower prices. Package prices also eliminate the need for pre-payment and post-payment utilization screens and the administrative costs associated with them.

**HCFA RESPONSE:** A demonstration project will be considered.



**RECOMMENDATION #3 - MEDICAL NECESSITY**

**FINDING:** There is considerable controversy surrounding the medical necessity of coronary bypass surgery for certain patients.

**RECOMMENDATION:** PROs should be required to review the medical necessity and appropriateness of elective CABG surgeries.

**IMPACT:** Unnecessary surgeries could be avoided and patient and program savings could be realized.

**HCFA RESPONSE:** CABG will be included on the list of mandatory review procedures for PROs.

**RECOMMENDATION #4 - PRIMARY SURGEON PAYMENTS**

**FINDING:** Medicare reasonable charge allowances for the primary surgeon are often inconsistent and inequitable. The allowances do not consider the economies of the marketplace. At least one insurer has been able to "wrap" the physicians' payments so that separate fees are not paid to assistant surgeons and anesthesiologists.

**RECOMMENDATION:** Limitations should be placed on reasonable charges for the primary surgeon's fee for CABG surgery. The limitations should be determined by applying the guidelines of the Omnibus Budget Reconciliation Act of 1986. Consideration should be given to negotiating "wrap" prices for Part B services.

**IMPACT:** At least \$5 million would be saved if payments for the primary surgeon in CABG surgery were limited to the current payment for three grafts. Considerably more may be saved if the limitation is determined by applying the criteria in the Omnibus Budget Reconciliation Act of 1986. Additional savings would be realized if the payments for all Part B physicians' services during CABG surgery were consolidated into one payment and separate payments for assistant surgeons and anesthesiologists were eliminated. Based on the experience of one carrier in a pilot project, \$1,100 per case would be saved. For Medicare, this would amount to \$69.3 million annually.

**HCFA RESPONSE:** HCFA tentatively supports limiting allowances and will conduct additional data evaluation before making a final determination.

**RECOMMENDATION #5 - HCPCS CODES**

**FINDING:** HCPCS added three codes to describe CABG surgery. The additional codes have had an inflationary effect because most carriers have presumed that the additional codes, which distinguish among four, five and six arteries, add value to the surgery. The existence of multiple codes may encourage abuse by rewarding additional grafts that may not be necessary.

**RECOMMENDATION:** HCPCS codes for CABG surgery should be consolidated so that no distinction is made based on the number of grafts that take place during the surgery.

**IMPACT:** Although no specific savings projections have been calculated for this recommendation, savings would be considerable since the recommendation would eliminate codes that are considered to warrant additional payments.

**HCFA RESPONSE:** HCFA concurs with this recommendation.

**RECOMMENDATION #6 - UTILIZATION CONTROL SCREENS**

**FINDING:** This inspection found wide variations in carrier policies regarding utilization control screens for CABG surgery. HCFA has not mandated any national screens so each carrier must develop its own. There is no uniformity concerning payment for assistant surgeons, fragmentation of the global fee and post-surgical complications.

**RECOMMENDATION:** National utilization guidelines should be established to eliminate inconsistent carrier policies. Consideration should be given to limiting the number of assistant surgeons that Medicare will pay for in CABG surgery or paying only one payment of 20 or 25 percent for assistant surgeons regardless of the number that participate in the surgery. Utilization screens should be mandated to prevent payments for fragmented services and post-surgical complications within a specified time.

**IMPACT:** Estimated annual savings of at least \$4 million would result if uniform guidelines were implemented concerning payments for assistant surgeons. Additional savings could be realized if uniform utilization screens were mandated concerning fragmentation and post-surgical complications.

**HCFA RESPONSE:** HCFA will conduct further investigation into these areas.

Comments were solicited and received from the Society of Thoracic Surgeons. The Society agreed that the preferred provider option should improve quality of care and control costs. The Society also agreed with our recommendations concerning adjusting reasonable charges for CABG surgeons and preventing fragmentation of the global fee. According to the letter from the Society, "Regional variations may have been required to launch the Medicare program, but there is no longer justification for such regional variations ... uncoupling of fees is professionally inappropriate."

The Society did not agree with our recommendation regarding PRO review because "... many of the larger units would have their own control mechanisms in place and these would undoubtedly be superior to an external PRO."

<u>Recommendation</u>	<u>Estimated Savings</u>	<u>Annual Savings</u>
Selective Contracting		\$192.0 Million
Pay Single Professional Fee		69.3 Million
Limit Surgeon's Fee to Three Grafts		5.0 Million
Pay Only One Assistant Surgeon		4.0 Million

DATA BASE AND METHODOLOGYData Base

Data from the Medicare carriers and intermediaries was compiled into a file, which ultimately reflected identification data and Part A and Part B utilization data relative to the hospital stay, for each of the 204 beneficiaries in the sample. This data base was used in all micro-computer analyses.

The data base is incomplete in 47 cases with respect to the Part B claims data. Of these, 32 were bypass cases where the surgery took place in FY 1984, and the carriers were unable to reconstruct beneficiary claim histories that far in the past. In another two cases in FY 1984 and FY 1985, the beneficiaries were not entitled to Medicare Part B benefits at the time of the surgery; therefore, no Part B information exists. In the remaining 13 cases, 3 of which occurred in FY 1984, carriers could not provide any Part B information; it is possible that one carrier processed the CABG claims after the Part B deductible had been met through another carrier. If this happened, claims data from the carrier that processed the CABG claims would not appear on the Health Insurance Printout (HIPO).

Beneficiaries in the sample break out as follows:

	<u>FY 1984</u>	<u>FY 1985</u>	<u>Total</u>
DRG 106	33	49	82
DRG 107	74	48	122
Subtotal	107	97	204
Missing Part B	36	11	47
Remainder	71	86	157

Medicare Expenditures

By projecting the sampled mean reimbursement under Part A for CABG, the OIG estimates that total Part A expenditures for these procedures were between \$1.007 billion and \$1.128 billion in 1985 (at the 95 percent confidence interval). According to figures published by HCFA in July 1986, the total Part A reimbursement for CABG was \$1.013 billion. Since the total published by HCFA falls within the OIG 95 percent confidence interval, it is reasonable to apply the same methodology to estimate the Part B total.

## Methodology for Savings Projections

### 1. Comparison of Medicare costs to contract prices under selective contracting

It is estimated that \$192 million could be saved through selective contracting with a 95 percent confidence interval between \$188 million and \$197 million. To arrive at this estimate, the Part A reimbursement and the total Part B allowed charges were added for each sample beneficiary that had a 6 to 12-day hospital stay. The THI contract price of \$13,800 was compared to the Medicare figure and the savings projection was based on an inverse of the sampling fraction to the universe of Medicare CABG beneficiaries.

This projection is conservative because:

- a. As much as 25 percent of the FY 1985 Part A data may have been missing from the universe. The sample was selected from the Bill History file as updated through December 31, 1985. In prior studies conducted by the OIG, the average lag in Part A bill processing (the length of time from the date of service to final acceptance by HCFA) was determined to be approximately 15 weeks. Although the FY 1985 data is incomplete, more complete FY 1984 Part A data could not be used because some carriers could not locate the 1984 Part B information.
- b. There are no New York City hospital discharges in the sample. This is primarily due to an extraordinary lag in Part A processing of bills from intermediary 0030B. (OIG has determined that the average lag in Part A bill processing for this intermediary is over 31 weeks.) This intermediary typically accounts for about 5 percent of total Part A hospital billings, or about 700,000 discharges annually.
- c. There are other methods of projecting the potential savings from this type of sample. However, for this inspection, the most conservative approach, simply multiplying the projection by the inverse of the sampling factor (0.2 percent, or 500), was selected.

### 2. Calculation of savings that would accrue from limiting the primary surgeon's reasonable charge

The projected savings for this recommendation is \$5 million per year, plus or minus \$675,000 for a 95 percent confidence interval. The projection is limited to FY 1985 data because the figures must be annualized (the sample represents the activity for 2 years), and the FY 1984 Part B data is incomplete.

Only 34 cases were included in this projection. The remaining 63 cases were excluded because of incomplete Part B data or because the procedure code was for fewer than 4 grafts.

The savings estimated for this recommendation are conservative for similar reasons to those given for the projected savings for selective contracting.

3. Calculation of projected savings if assistant surgeons' payments were capped

The number of cases in the sample that fit the criteria are small and the projected annual savings of \$4.4 million for the recommendation are tentative. Only 10 cases from the sample were used to calculate the savings because they were the only cases that had separate payments for more than 1 assistant surgeon in the 1985 portion of the sample.



## Original Contributions

# Association of Volume With Outcome of Coronary Artery Bypass Graft Surgery

## Scheduled vs Nonscheduled Operations

Jonathan A. Showstack, MPH; Kenneth E. Rosenfeld; Deborah W. Garnick, ScD; Harold S. Luft, PhD; Ralph W. Schaffarzick, MD; Jinnet Fowles, PhD

Empirical evidence suggests that mortality rates for coronary artery bypass graft (CABG) surgery are lower in hospitals that perform a higher volume of the procedure. In recent years, the criteria for CABG surgery have been expanded to include patients with a wide variety of co-morbidities. To address the question of whether the volume-outcome relationship continues to exist for this new group of patients, discharge abstracts for 18 986 CABG operations at 77 hospitals in California in 1983 were analyzed using multiple-regression techniques. Higher-volume hospitals had lower in-hospital mortality (adjusted for case mix); this effect was greatest in patients who might be characterized as having "non-scheduled" CABG surgery. Higher-volume hospitals also had shorter average postoperative lengths of stay and fewer patients with extremely long stays. The results of this study suggest that the greatest improvement in average outcomes for CABG surgery would result from the closure of low-volume surgery units.

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EMPIRICAL evidence suggests that, for many surgical procedures, mortality rates are lower in hospitals performing a higher volume of a given procedure.<sup>1-5</sup> This association between volume of surgery at a hospital and outcome has received increasing attention both because it is measurable and because it may be amenable to policy intervention. Luft et al<sup>1</sup> reported substantially higher procedure-specific death rates in hospitals performing fewer than 200 coronary artery bypass graft (CABG) operations annually compared with hospitals that performed 200 or more procedures (5.7% mortality vs 3.4% for 1974 to

1975). If higher volume is associated with lower mortality and, potentially, lower costs because of shorter lengths of stay, then directing patients to higher-volume hospitals may lead to both better clinical outcomes and lower per-case costs. Recognizing the need for open heart surgery teams to perform a minimum number of operations, the American College of Surgeons has recommended that each team perform at least 150 operations per year.<sup>6</sup>

A variety of patient and hospital characteristics (other than the volume of surgery at the operative hospital) may be associated with the outcome of surgery. For CABG surgery, a significant association between volume and outcome remains when patient characteristics such as age, single or multiple diagnoses, and sex are accounted for, as well as when hospital-specific characteristics (eg, hospital size, teaching status, and geographic location) are considered. Advancing age and female sex are almost uniformly associated with in-

Errata: In Table 1, column 2 (Total Group), the  $\beta$ s are positive for the three hospital surgical volume groups and for the constant (not negative as printed).

creased risk of mortality for patients undergoing CABG.<sup>1,3,7-10</sup> Clinical risk factors found to be associated with poor surgical outcome include the presence and severity of angina<sup>7,10</sup> and the presence of heart failure,<sup>7,10</sup> although diabetes,<sup>7</sup> hypertension,<sup>7</sup> and previous acute myocardial infarction<sup>7,9,10</sup> have not been found to be significantly associated with in-hospital death.<sup>7,9,10</sup> Priority of surgery (emergency or urgent rather than elective)<sup>7,9</sup> and additional surgical procedures (eg, valve replacement)<sup>7</sup> are associated with higher mortality, while the number of coronary artery grafts inserted appears to be unrelated to outcome.<sup>9</sup>

In recent years, criteria for CABG surgery appear to have been expanded to allow more severely ill patients to undergo surgery. Previously reported empiric evidence of the association between the volume of CABG surgery and outcome, however, was generally drawn from the experience of patients who had surgery in the 1970s, and these studies accounted for relatively few patient characteristics. Previous studies also were limited to self-selected hospitals or samples of Medicare patients and, thus, may not be generalizable.

This study extends previous empiric work by addressing two key questions: First, has the volume-outcome relationship for CABG surgery continued to exist in recent years, particularly when data are drawn from hospitals and patients in a broad geographic area? Second, is the relationship between volume and outcome similar for all types of patients, or does it vary according to clinical and other patient characteristics, such as the emergency nature of the procedure?

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## MATERIALS AND METHODS

### Data Sources

The source of data for this analysis was individual patient discharge abstracts for 1983 obtained from the California Health Facilities Commission (CHFC). Each discharge abstract contained a variety of demographic, clinical, and hospitalization data that characterized a specific hospitalization. The patient's principal and secondary diagnoses, and the principal and secondary procedures performed on the patient during the hospital stay, were classified according to the *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)*.<sup>11</sup> All discharges with a primary or secondary ICD-9-CM procedure code of 36.1 through 36.19 ("bypass anastomosis for heart revascularization") were separated into a data file that included 20 093 cases.

Frequency distributions were computed for each variable in the data set. Several factors that were thought to be important to the subsequent data analysis were noted in these frequency distributions. Of the patients who had CABG surgery, 1077 also had a heart valve replacement during the same hospitalization. Because of the likely different outcome of these patients, we decided to exclude them from subsequent analyses. In addition, 15 hospitals that reported only one CABG operation during 1983, one hospital that reported only five operations, and two hospitals that had not yet reported their data to the CHFC at the time of this analysis were excluded. This left a total of 18 996 patients with CABG surgery (and no valve replacement) from 77 hospitals.

### Scheduled vs Nonscheduled Operations

Previous studies of the relation between volume of CABG surgery and in-hospital outcome did not distinguish between outcomes for different types of patients. Because of recent studies showing that new categories of patients may now be receiving CABG surgery, we hypothesized that the volume-outcome relationship might be different for higher-risk patients, such as patients admitted for an acute myocardial infarction.<sup>12</sup> There could be a variety of reasons for a different volume-outcome effect for "scheduled" compared with "nonscheduled" operations. For example, a patient who receives a nonscheduled CABG operation may be sicker and more acutely ill than one who receives a scheduled operation. Also, a hospital's open heart surgery team is much more likely to be on hand and

Table 1.—Association of Patient Characteristics and Hospital Surgical Volume With In-Hospital Death Rate for Coronary Artery Bypass Graft Surgery, California, 1983

	$\beta \pm SE$		
	Total Group	Scheduled*	Nonscheduled†
Patient characteristics			
Sex (male-1)	-0.0207 ± 0.0032‡	-0.0207 ± 0.0037‡	-0.0182 ± 0.0058§
Age, y			
<50	-0.0378 ± 0.0046‡	-0.0267 ± 0.0049‡	-0.0504 ± 0.0090‡
50-64	-0.0227 ± 0.0031‡	-0.0110 ± 0.0034§	-0.0365 ± 0.0058‡
≥75	0.0301 ± 0.0055‡	0.0292 ± 0.0067‡	0.0265 ± 0.0092‡
Ethnic group (white-1)	-0.0120 ± 0.0040§	-0.0100 ± 0.0043	-0.0129 ± 0.0076
Presence of			
Acute myocardial infarction (yes-1)	0.0602 ± 0.0039‡	0.0611 ± 0.0051‡	0.0536 ± 0.0062‡
Congestive heart failure (yes-1)	0.0964 ± 0.0071‡	0.0891 ± 0.0097‡	0.0937 ± 0.0110‡
Angina (yes-1)	-0.0123 ± 0.0030‡	-0.0079 ± 0.0032	-0.0161 ± 0.0059§
Cardiac catheterization (yes-1)	-0.0088 ± 0.0028§	0.0005 ± 0.0035	-0.0407 ± 0.0057‡
Coronary angioplasty (yes-1)	0.0252 ± 0.0069‡	0.0119 ± 0.0075	0.0429 ± 0.0133§
Other discharge (yes-1)	-0.0495 ± 0.0052‡	-0.0346 ± 0.0055‡	-0.0768 ± 0.0104‡
Hospital surgical volume			
20-100 (yes-1)	+0.0207 ± 0.0069§	0.0076 ± 0.0082	0.0304 ± 0.0117§
101-200 (yes-1)	+0.0077 ± 0.0039	0.0052 ± 0.0045	0.0077 ± 0.0070
201-350 (yes-1)	†0.0096 ± 0.0030§	0.0073 ± 0.0032	0.0125 ± 0.0059
Constant	†-0.0686 ± 0.0053‡	0.0515 ± 0.0058‡	0.1094 ± 0.0104‡
Adjusted R <sup>2</sup>	0.042	0.033	0.048
N	18 986	11 497	7 489

\*Surgery on first or second day after admission.

†Surgery on day of admission or three or more days after admission.

‡P < .001.

§P < .01.

||P < .05.

prepared for a scheduled operation than for a nonscheduled operation.

The CHFC data did not list whether an operation was scheduled, and we were unable to go directly to a patient's medical record to determine the reason for the operative admission. There were, however, data available that allowed inference about the emergency nature of the CABG procedure. For example, the number of days after the admission that the operation took place was recorded. It might be hypothesized that "scheduled" operations are likely to take place on the first or second day after admission, with emergency CABG operations taking place on the day of admission. Patients who have a CABG operation on the third or subsequent day after admission also seem likely to be those who are at high risk, because they were likely admitted for another condition and/or deteriorated to the point of needing a CABG operation. Also recorded was the "reason for admission," which was coded according to whether the admission was "emergency," "urgent," or "elective." While the reason for admission might seem to be a good characterization of the concept that we were trying to assess, it is potentially biased: a medical record coder might be more likely to record "emergency" or "urgent" on the discharge abstract if there was a poor outcome. Because the day of surgery is an objective measure, the results re-

ported below are from analyses that used day of surgery as the criterion for defining scheduled or nonscheduled surgery. (Other analyses that used a variety of other characterizations of the nature of the admission, including whether the admission was emergency, urgent, or elective, produced results entirely consistent with the results of the analyses reported below that used day of surgery as the criterion.)

### Data Analysis

The methods used to analyze the data consisted of computing frequency distributions, simple bivariate correlation analyses to determine the relationships between individual independent variables, and regression equations to assess the independent associations of patient and hospital characteristics with the primary outcomes of interest: survival at the time of discharge and post-operative length of stay. Two units of analysis, patients and hospitals, are possible with this data set. Data reported below are from analyses in which the patient was the unit of analysis; when the hospital was defined as the unit of analysis, results were similar to results of analyses of patient-level data. With the patient as the unit of analysis, the final regression equations consisted of 18 986 cases (ten cases were omitted because individual data items were missing).

Two primary dependent variables

Table 2.—Distribution of Patients and Hospitals According to Hospital Volume of Coronary Artery Bypass Graft Surgery, California, 1983

No. of Operations	% of Hospitals	% of Patients
20-100	16	4
101-200	28	16
201-350	34	36
>350	22	44

were analyzed: (1) discharge status (in-hospital death vs other type of discharge), and (2) "poor outcome" (the total of in-hospital death and long postoperative length of stay [for survivors only, postoperative length of stay beyond the 90th percentile for all patients undergoing CABG surgery in the state]). In-hospital mortality is a limited, although easily measured, indicator of poor quality. While objective measures of complications would be desirable, discharge abstracts did not indicate whether specific listed diagnoses were present on admission or developed after the procedure. Therefore, postoperative length of stay was used as a proxy for complications that developed subsequent to the operation. It can be argued that, after adjusting for case mix, any hospital with a high rate of patients staying longer than 15 days after the day of operation (the 90th percentile postoperative length of stay) has an unusually high rate of complications.

The independent variables included in the analyses were the volume of CABG surgery at the operating hospital, sex, age group, ethnic group (white vs other), presence of primary or secondary diagnostic codes of current acute myocardial infarction, congestive heart failure, and/or angina, and presence of primary or secondary ICD-9-CM procedure codes of coronary catheterization, and/or coronary angioplasty. The volume of surgery at the hospital was coded to include all CABG surgery, whether a valve replacement was performed or not (although patients who had a concurrent valve replacement were excluded from the analysis). For purposes of interpretation, and because of a potential nonlinear relationship between age and the dependent variables, age was entered into the regression equations as three dichotomous variables plus one reference group: age less than 50 years, age 50 to 64 years, and age over 74 years, with age 65 to 74 years as the reference group. A variable was also included to characterize whether a patient was discharged to another facility, thus not having the "chance" to die in that hospitalization.

Adjusted means were calculated from

Table 3.—Characteristics of Patient Population\*

	Total Group	Scheduled Operations†	Nonscheduled Operations‡
Sex, % M	77.2	80.4	72.3
Mean age, y	61.2	60.4	62.5
Ethnicity, % W	86.7	86.6	87.0
% With diagnosis			
Acute myocardial infarction	14.2	9.1	21.8
Congestive heart failure	3.7	2.3	5.8
Angina	27.8	29.7	24.8
% With procedure (during operative hospitalization)			
Cardiac catheterization	42.4	22.9	72.4
Angioplasty	3.9	3.9	3.8
No. of patients	18 986	11 505	7 491

\*On all characteristics, except the percentage of patients who received angioplasty, scheduled patients were significantly different from nonscheduled patients ( $P < .001$ ).

†Surgery on first or second day after admission.

‡Surgery on day of admission or three or more days after admission.

regression equations that included all of the independent variables. An adjusted mean is an estimate based on the hypothetical situation that all (hospital volume) groups had the same values on each of the independent variables that were entered into the regression equation. (A complete description of the process of adjustment was provided by Cohen and Cohen.<sup>13</sup> The regression equations for discharge status are shown in Table 1.) Analyses of the volume-outcome relationship that did not include any covariates, ie, that were analyses of variance with the volume groups as the only independent variables, produced results similar to, although slightly less sensitive statistically than, the results produced in the full regression equations that included the entire set of covariates.

The use of secondary data to address clinical questions presents certain potential problems, such as possible miscoding of subjective data. In this study, data were derived from hospital discharge abstracts, which are coded after the fact by nonclinicians who are usually trained in abstracting medical records. The primary questions of interest addressed in this study, however, depend on the accurate coding of data elements that are relatively objective, such as day of surgery, length of stay, and discharge status. The addition of more subjective data elements to the analyses, such as presence of angina, made the results somewhat more sensitive statistically but did not alter the inferences that one might have drawn from unadjusted results. Also, there is little reason to believe that any of the data elements studied was recorded systematically in one way at higher-volume hospitals and in another way at lower-volume hospitals. Therefore, it seems reasonable to assume that the results of this study would be confirmed if detailed primary data were collected directly from pa-

Table 4.—Adjusted\* In-Hospital Deaths and Poor Outcomes According to Hospital Volume of Coronary Artery Bypass Graft Surgery, California, 1983

No. of Operations	Mean %		
	Total Group (N=18 986)	Scheduled† (N=11 497)	Non-scheduled‡ (N=7 489)
	In-Hospital Deaths		
20-100	5.2§	3.0	7.7§
101-200	3.9	2.7	5.5
201-350	4.1§	2.9	5.9
>350	3.1	2.2	4.6
	Poor Outcomes†		
20-100	21.7#	16.1#	27.9#
101-200	15.5#	11.5§	20.6#
201-350	11.8	8.9	16.3
>350	12.0	9.3	16.3

\*Adjusted for sex, age, ethnic group, and presence of acute myocardial infarction, congestive heart failure, angina, cardiac catheterization, and coronary angioplasty.

†Surgery on first or second day after admission.

‡Surgery on day of admission or three or more days after admission.

§ $P < .01$  vs highest-volume group.

|| $P < .05$  vs highest-volume group.

††"Poor outcome" is the sum of the in-hospital death rate and the percentage of patients discharged alive who had a postoperative length of stay beyond the 90th percentile (15 days).

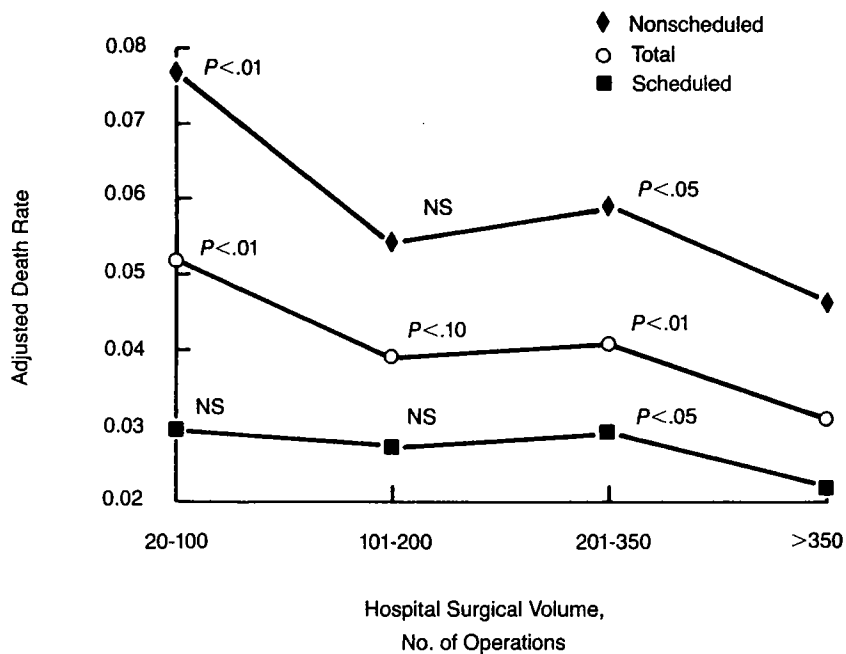
# $P < .001$  vs highest-volume group.

tients' clinical records.

Reported below are analyses of the total group of patients, and subgroups divided according to the day after admission that their operation took place (one or two days ["scheduled"] vs any other day ["nonscheduled"]). The central questions addressed by this analysis are whether the volume of CABG surgery at a hospital is associated with in-hospital death and postoperative length of stay and how this relationship differs for scheduled surgery compared with nonscheduled surgery.

## RESULTS

The 22% of hospitals with over 350 operations in 1983 accounted for 44% of all CABG surgery, while the 16% of



Adjusted death rate according to hospital surgical volume. *P* values shown are for difference between lower-volume group and highest-volume group. NS indicates not significant.

hospitals with 100 or fewer operations accounted for only 4% of all CABG surgery (Table 2). Almost half (44%) of the hospitals studied had fewer than 200 operations, accounting for one fifth of all surgeries.

Table 3 shows the characteristics of the total group of patients studied and of patients whose operations were scheduled or nonscheduled. Most of the operations were performed on men, although there was a relatively high number of women in the nonscheduled group. Almost 90% of patients were white. Approximately one of seven patients had a current acute myocardial infarction, one of 25 patients had congestive heart failure, one of four patients had angina, slightly fewer than half of all patients had a coronary catheterization during the operative hospitalization, and approximately one of 25 patients had a coronary angioplasty performed during the study hospitalization (Table 3).

Patients undergoing nonscheduled surgery were much more likely to have had a current acute myocardial infarction (22% vs 9%;  $P < .001$ ) and/or congestive heart failure (6% vs 2%;  $P < .001$ ) and/or a cardiac catheterization during the study hospitalization (72% vs 23%;  $P < .001$ ). Thus, these data suggest that the characterization of scheduled vs nonscheduled is capturing a real effect; patients with scheduled operations are much more likely to have had their cardiac catheterization prior to the operative admission, implying earlier

preparation for the procedure, and are less likely to have other current serious medical conditions. All of the characteristics listed in Table 3, except ethnic group, were found in subsequent analyses to be significantly associated with the outcomes of interest.

The association of volume of surgery with in-hospital death rates, adjusted for patient characteristics, is shown in Table 4 and the Figure. For the entire group of patients there was a fairly strong association of volume with adjusted death rate. For patients who received CABG surgery in hospitals performing 20 to 100 operations per year, the adjusted death rate was 0.052, falling to 0.039, 0.041, and 0.031 for patients who had surgery in hospitals with volumes of 101 to 200 operations, 201 to 350 operations, and 351 or more operations, respectively. When patients were divided according to whether they received scheduled or nonscheduled operations (as defined by their day of operation), there was a trend toward an association of volume with outcome in the group that was admitted for scheduled surgery, with a much stronger association of volume with outcome occurring for patients who were admitted for nonscheduled surgery (Table 4). Similar effects were seen when this effect was modeled using other categorizations of scheduled vs nonscheduled operations. For example, a substantial association of volume with adjusted in-hospital death rate was found for patients with an "emergency/

Table 5.—Estimated Lives Saved if Patients at Lower-Volume Hospitals Had Outcomes Similar to Those of Patients at Higher-Volume Hospitals

Comparison Group	Estimated Lives Saved*		
	Scheduled†	Non-scheduled‡	Total
Volume ≤100	1.7	9.9	11.6
Volume 101-200	2.9	3.1	6.0
Total (volume ≤200)	4.6	13.0	17.6

\*Compared with hospitals with a volume of more than 200 operations per year.

†Surgery on first or second day after admission.  
‡Surgery on day of admission or three or more days after admission.

urgent" admission compared with a much lower volume-outcome association for patients with an "elective" admission.

To assess total "poor outcome," patients were defined as having a poor outcome if they either died in the hospital or stayed beyond 15 days (the 90th percentile postoperative length of stay). A strong volume-outcome association was apparent, with the likelihood of poor outcome in the highest-volume hospitals approximately two thirds of that in the lowest-volume hospitals (Table 4). The magnitude of the volume-outcome effect is by far largest in the nonscheduled group, with 28% of nonscheduled patients in the lowest-volume group having a poor outcome.

To understand better the implications of these data, several estimates were derived based on the hypothetical situation that patients in the lowest-volume hospitals could be treated with the same efficacy and efficiency as patients in higher-volume hospitals. Of the 18986 patients studied who received CABG surgery in California in 1983, 789 (approximately 4%) were operated on in hospitals providing 100 or fewer operations. Their adjusted death rate was 0.053 compared with an adjusted death rate of 0.035 in hospitals with volumes above 200 CABG operations a year. Hypothetically, if the death rate for the 789 patients was similar to the case mix-adjusted death rate for patients who received their surgery in hospitals with volumes above 200 CABG operations a year, 12 lives might be saved (28% of deaths in the low-volume hospitals), 85% of which would be in the nonscheduled group (Table 5). If the group of patients from the lower-volume hospitals is broadened to include patients who had surgery in hospitals with 200 or fewer operations (approximately 20% of total patients), the total number of lives saved might increase to 18 (about 11% of deaths in hospitals with 200 or fewer operations), with 74% in the nonscheduled group. Thus, over half of the

potential lives saved would be in non-scheduled operations in the lowest-volume hospitals.

## COMMENT

The results of this study suggest that the association of volume of CABG surgery with in-hospital survival found by other investigators occurs for both scheduled and nonscheduled procedures, while the lifesaving potential of regionalization may be concentrated in patients who are sicker and need surgery on an emergency basis. These results imply that the greater skills of surgical teams at higher-volume hospitals may be particularly necessary to care for patients undergoing non-scheduled CABG surgery. In particular, recent evidence suggests that members of the team in addition to the primary surgeon, in particular the anesthesiologist, may be equally important in determining outcome.<sup>14</sup> Empiric support is also provided for the recommendation by the American College of Surgeons that at least 150 open heart procedures be performed by a surgical team each year.<sup>2</sup> The volume of surgery at a hospital was also found to be positively associated with outcomes other than survival; average post-operative length of stay and the percentage of patients who had long stays were significantly lower for patients who received surgery in higher-volume hospitals.

The hypothetical savings that might result from performing all operations at higher-volume hospitals are based on several assumptions that might not prove to be true if patients were actually diverted to higher-volume hospitals. In particular, most of the lifesaving potential is seen in patients having non-scheduled surgery. Thus, the availability of a *nearby* higher-volume hospital performing CABG surgery is

an essential assumption. On the other hand, the comparison group for this hypothetical analysis is the 80% of patients in hospitals with volumes greater than 200 operations. If the comparison group had been, for example, patients who received surgery in hospitals with yearly volumes of greater than 350 CABG operations, the savings might be even larger, although a focus of concern would then shift increasingly to issues such as access. These hypothetical projections should be viewed with some caution, but they may be regarded as rough approximations of the savings in lives that might occur if CABG surgery were provided to patients only in higher-volume hospitals.

The elimination of non-scheduled surgery at lower-volume hospitals would result in even lower volumes, and possibly poorer outcomes for the remaining scheduled patients. A more attractive strategy might be to shift all CABG surgery to medium- and higher-volume facilities. This shift could be accomplished in a variety of ways, such as by making hospital and/or specialty accreditation dependent on the volume of surgery performed, or by selective contracting by health insurers. Given the poor outcomes at lower-volume hospitals reported in this and other studies, the likelihood of increased numbers of malpractice suits at lower-volume hospitals might also have the effect of forcing the closure of lower-volume surgery units.

The implications of this study for regionalization and other policies related to selective use of certain hospitals will depend, to some extent, on future studies of the reasons for the differential outcomes of CABG surgery and on the location of hospitals in a particular geographic area. The fact that, in this study, most of the low-volume hospitals with poor outcomes were located within

40 miles of a high-volume hospital implies that, at least in California, further regionalization of CABG surgery may be possible without major access problems. Outcomes have to be linked closely to the clinical conditions of patients and the medical appropriateness of referral prior to admission or transferring a severely ill patient in need of surgery to another (higher-volume) hospital. Because a perforated coronary artery during coronary angioplasty necessitates immediate CABG surgery, the results of this study also suggest that coronary angioplasty should be performed only in facilities with a readily available, experienced, high-volume CABG surgery team.

The question of which specific hospitals should perform CABG surgery cannot be answered directly by this study. Despite the overall results that show a positive effect for volume, it is always possible that a particular lower-volume hospital may have good outcomes, while an individual high-volume hospital may have poor outcomes.<sup>15</sup> In the aggregate, however, the data suggest strongly that average outcomes would be improved if patients who require CABG surgery, particularly non-scheduled surgery, have this procedure in higher-volume hospitals.

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