Changes in Patient Characteristics and Surgical Outcomes for Coronary Artery Bypass Surgery 1972–82

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Abstract: Data from a national sample of hospitals were used to explore reasons for improved in-hospital survival rate for coronary artery bypass graft (CABG) surgery between 1972 and 1982. Increases in annual volumes of surgery explain a large fraction of the decline in death rates. The residual can be attributed to improved techniques, experience, and other factors, even though more operations were done on older patients and women in 1982 than 1972. (*Am J Public Health* 1987; 77:498–500.)

Introduction

During the past decade, in-hospital mortality dropped significantly among patients undergoing coronary artery bypass graft (CABG) surgery. Other important changes also occurred during this period. Microsurgical techniques have allowed many women, whose coronary arteries are smaller than men's, to undergo revascularization, and there are more operations on older patients. The volume of bypass surgery in the nation has increased markedly, and higher annual volume in a hospital has been associated with better outcomes.[1–5] Technological advances reducing perioperative myocardial infarction may also explain the drop in death rates.[6,7]

The purpose of this paper is to examine two changes—increases in annual volume of surgery in the hospital, and more operations on older patients and women—in relation to decline in in-hospital mortality from 1972–1982.

Methods and Data

Patient data were from the Commission on Professional and Hospital Activities (CPHA) of Ann Arbor, Michigan. In 1972, 117 hospitals reported 6,448 patients with a primary H-ICDA operative code of 30.5 (direct cardiac revascularization). In 1982, a two-thirds sample of participating hospitals yielded 107 hospitals with 29,488 patients with a primary ICD9 operative code of 36.1 (bypass anastomosis for heart revascularization). A separate analysis of the 41 hospitals in the sample in both years gives similar results (a more extensive report is available from the authors).

CHPA provided the number of patients and in-hospital deaths according to age (<50, 50–64, ≥65) and sex. Every hospital was placed in a volume category (2–89 patients, 90–149 patients, and 150+ patients) based on the number of bypass procedures during 1972 and 1982. For 1972, expected death rates (EDR) were calculated as the death rate that would occur if patients in a given volume category achieved the same outcomes as the overall national average for their age-sex classification cell.

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We considered three components of changing mortality rates for CABG surgery between 1972 and 1982: 1) changes in age and sex distribution; 2) changes in CABG volume; and 3) technological and other unmeasured changes. To disentangle the influence of the first two components, 1972 death rates were applied to the 1982 age, sex, and volume characteristics of patients and hospitals. To adjust for age and sex differences, the 1982 proportion of patients in each age-sex cell were multiplied by 1972 cell-specific death rates and summed over all cells.

Adjustment for increases in CABG volume from 1972–1982 is done in two steps. First, actual death rate (ADR) is compared to age and sex adjusted EDR for each 1972 volume category. This ADR/EDR ratio reflects the degree to which patients having CABG surgery in hospitals in a certain volume category in 1972 have better or worse outcomes than the overall average. A mortality rate adjusted for both age and sex as well as volume is obtained by multiplying the ADR/EDR value for each 1972 volume category by the age-sex adjusted death rate within that category, weighting results by the 1982 patient mix. Any difference between calculated death rate and actual 1982 death rates reflects changes between 1972 and 1982 other than the measured age, sex, and volume.

Hospital characteristics were obtained from the 1972 and 1982 Annual Surveys of the American Hospital Association.

Results

In 1972 and 1982, the hospitals are not significantly different in terms of ownership, regional location, or size (Table 1). However, there are major differences in both the volume of bypass patients and operative mortality. The average number of bypasses increased over five-fold and overall in-hospital mortality was nearly halved. This move toward more procedures and lower in-hospital death rates is clearer on a hospital-specific level. Whereas in 1972 only 15

TABLE 1—Characteristics of Selected 1972 and 1982 Hospitals Performing CABG Surgery

	1972	1982
Number of Hospitals	111	107
General Hospital Characteristics†		
Mean Number of Acute Care Beds	456	456
% Medical School Affiliated	46.0	64.0
% Proprietary	0.0	2.0
Regional Distribution†		
% East	14	11
% South	17	21
% Central	43	40
% West	26	27
Mean Number of CABG Patients	55	276
% Overall In-Hospital CABG Mortality	6.0	3.4
% of Hospitals with >100 Bypass Operations	14.5	80.4
% of Hospitals with <20 Bypass Operations	47.0	7.5

†For 1972 sample, n = 95 hospitals.

TABLE 2—In-hospital CABG Mortality Rates by Sex and Age

Sex/Age	1972	1982
Sex	%	%
Men	5.3	2.7
Women	9.5	5.8
Age (years)		
<50	4.8	1.6
50–60	5.6	2.3
≥65	12.5	6.2
Total	6.0	3.4

per cent (17/117) of hospitals reported over 100 bypass procedures, by 1982 over 80 per cent (86/107) reported over 100 operations, and 57 per cent reported over 200. Conversely, in 1972 nearly half (47 per cent) reported under 20 operations; by 1982 below 8 per cent reported this few operations.

Because CABG surgery volumes increased dramatically during the 1970s, some have argued that "easier" patients were operated on. Our data do not bear this out. Striking changes in age distribution lie in patients younger than 50 and older than 65. Patients under age 50 dropped from 32.1 per cent to 15.8 per cent of the total from 1972 to 1982, while patients over age 65 increased from 10.0 to 30.1 per cent. Significantly more women had bypass surgery in 1982 (22.1 per cent) than in 1972 (16.9 per cent).

Advancing age and female sex were associated with mortality in both 1972 and 1982 (Table 2). Women experienced about twice the in-hospital death rate of men, and patients over age 65 had approximately three-to-four times the in-hospital mortality of those under age 50. Since significantly more older patients and women were in the 1982 sample, these trends support the notion of a patient pool at increased risk. Nevertheless, from 1972 to 1982 death rates fell across all age and sex categories, with the largest absolute decrease in women, from 9.5 per cent to 5.8 per cent, and the greatest proportional reduction, 66 per cent, in patients under age 50.

Adjustments for 1972–82 changes in age, sex, and volume are shown in Table 3. Before adjustments, the overall death rate in 1982 is about half the death rate in 1972 (3.4 per cent vs 6.0 per cent). The projected death rate, taking account of the greater proportion of elderly and women patients in 1982, is 7.7 per cent, 28 per cent higher than the 1972 rate of 6.0 per cent. This contrasts with the notion that casemix has shifted towards easier patients. With an additional correction for increases in hospital volume of surgery from 1972–82, however, the projected rate drops to 5.2 per cent. This means that a 13 per cent reduction in death rate from 6.0 per cent to 5.2 per cent would be expected, due only to changes in age, sex, and volume.

Across volume groups, in-hospital mortality declines with increasing volume for both years. In 1972 hospitals with fewer than 90 CABG procedures had a 46 per cent higher mortality rate than expected; given their age-sex mix, hospitals with 90-149 procedures had an 8 per cent lower death rate, and institutions with the highest volumes had only 65 per cent of the expected death rate. For 1982 a drop in mortality was noted across volume groups. After age-sex and volume adjustments, the lowest 1982 volume group achieved the largest reduction over the decade (42.4 per cent), although its in-hospital death rate was still twice that of the high-volume group.

TABLE 3—CABG Volume Group Analysis and 1982 Projected Death Rates

Analysis	1972 Volume Group			
	Total	<90	90–149	150+
Total Number of Patients	6,469	2,390	1,371	2,708
Total In-Hospital Deaths	388	209	72	107
% In-Hospital Actual Death Rate (ADR)	6.0	8.7	5.3	4.0
% Expected Death Rate (EDR)	6.0	6.0	5.7	6.2
ADR/EDR	1.00	1.46	0.92	0.64
	1982 Volume Group			
	Total	<90	90–149	150+
Total Number of Patients	29,488	754	1,754	26,980
Total In-Hospital Deaths	1,000	48	77	875
% In-Hospital Actual Death Rate (ADR)	3.4	6.4	4.4	3.2
% Projected Death Rate*	7.7	7.6	7.8	7.7
% Projected Death Rate§	5.2	11.1	7.2	4.9

*Based on 1972 death rates applied to 1982 age-sex distribution.
§Based on volume adjusted death rates applied to 1982 age, sex, and volume distribution.

Discussion

Death rates reported here are higher than in clinical studies which report death rates of 1.3 per cent or less.[6–10] One reason is the less restrictive criteria for patient and hospital eligibility for this study. A second reason is that a range of volume groups is included while the clinical studies cited above took place in high-volume institutions. Better outcomes for CABG surgery in higher-volume hospitals have been widely reported.[1–5] Thus, mortality rates in the clinical literature are far below those faced by the average patient.

The CABG patients analyzed here represented more difficult surgical cases in 1982 (according to age and sex) than in 1972. Unfortunately, additional clinical information such as left ventricular (LV) function, probably the best predictor of perioperative risk, was unavailable for this study. While possible differences in patients' LV function may account for some observed variation, there is no reason to suspect a bias against low-volume hospitals.

Interpretation must be cautious since these results are based upon the selected sample of hospitals subscribing to CPHA. Nonetheless, distribution of volumes of surgery in the subsample of hospitals 1982 is similar to national sample. Moreover, these data are valuable in reporting about a selected patient population. Indeed, the overall in-hospital mortality rate in these data is similar to that reported for all CABG patients in California in 1983.[5]

Improved mortality rates for CABG surgery cannot be attributed to better surgical technique and improved technology without first accounting for changes in age and sex distribution of patients and volume of surgery at specific institutions. While increased volume accounts for part of declining in-hospital mortality for CABG, other factors play a key role, including cumulative surgical team experience, better cardiac care organization, nursing training, and improvements in CABG technology.

ACKNOWLEDGMENTS

This research was supported by grant number HS-04329 from the National Center for Health Services Research, Department of Health and Human

Services. The authors wish to thank J. Calvert, MD, E. Feigenbaum, MD, Herbert Traxler, PhD, and Edward Yee, MD, for comments on an earlier draft.

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NIH Consensus Development Conference on Prostate Cancer

A Consensus Development Conference on the Management of Clinically Localized Prostate Cancer will be held at the National Institutes of Health (NIH), Bethesda, Maryland, June 15–17, 1987, sponsored by the National Cancer Institute and the NIH Office of Medical Applications of Research.

Discussion will center on questions about the diagnostic and therapeutic procedures for the management of nonmetastatic prostate cancer. Prostate cancer is the second most common cancer in the American male.

The consensus conference will bring together surgical, radiation, and medical oncologists, diagnostic and pathologic experts, and representatives of the public. After two days of presentations by medical experts and discussion by the audience, a consensus panel will weigh the scientific evidence and formulate a draft statement in response to the following key questions:

- What is the value of pathologic assessment and imaging techniques in staging of prostate cancer? When is pelvic node dissection necessary?
- Who is the optimal candidate for radical prostatectomy? What is the morbidity of the procedure and how can it be minimized with preservation of curative potential?
- Who are the candidates and what methods are optimal for definitive radiation therapy and what are the long-term results in terms of local control and survival? What is the morbidity of the procedures and how can it be minimized with preservation of curative potential?
- Should definitive radiation therapy, hormone and/or chemotherapy be employed as adjuvant treatment in high-risk patients?
- What future directions should be pursued?

On the final day of the meeting, the Consensus Panel Chairman will read the draft statement to the conference audience and invite comments and questions.

To register for the conference, contact Nancy Cowan, Prospect Associates, 1801 Rockville Pike, Suite 500, Rockville, MD 20852; telephone (301) 468–6555.