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Cardiac Surgery

The Elderly: Health Status Benefits and Recovery of Function One Year After Coronary Artery Bypass Surgery

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OBJECTIVES The purpose of this study was to describe the health status (symptoms, function, and quality of life) changes of elderly patients undergoing coronary artery bypass grafting (CABG) and compare these to younger patients.

BACKGROUND Despite increasing use of CABG in the elderly, few data exist about elderly patients' health status benefits from CABG.

METHODS A total of 690 consecutive patients (n = 156, >75 years of age; n = 534, ≤75 years of age) from a single center were administered the Seattle Angina Questionnaire (SAQ) at baseline and at one year. The first 224 patients were also given monthly questionnaires for six months after CABG.

RESULTS Although peri-operative mortality was similar (2.6% vs. 2.2%, p = NS), one-year mortality was greater in older patients (11.5% vs. 5.4%, p = 0.008). Among survivors, similar health status benefits were observed one year after surgery (SAQ change scores for Physical Function 21.5 ± 27.0 vs. 19.7 ± 27.0, p = 0.67; Angina Frequency 30.1 ± 25.7 vs. 24.6 ± 25.6, p = 0.07; and Quality of Life 37.7 ± 21.8 vs. 33.6 ± 25.2, p = 0.16). In 224 patients assessed monthly, elderly patients' physical function scores were significantly lower than the younger group until one year. The age-time interaction term was significant (p = 0.003), confirming a slower recovery of physical function. In contrast, angina relief and quality of life improvement did not differ by age.

CONCLUSIONS Despite a slower rate of physical recovery, older patients derived similar health status benefits from CABG compared with younger patients. These data should assist physicians in counseling elderly patients and suggest that age alone should not be a deterrent for recommending bypass surgery. (J Am Coll Cardiol 2003;42:1421–6) © 2003 by the American College of Cardiology Foundation

Cardiovascular disease is the major cause of death, disability, and health care use among the elderly (1). The Pan American Health Organization estimates that by the year 2010 the growth rate of the population ≥60 years will be 3.5 times that of the total population (2). Furthermore, the Society of Geriatric Cardiology anticipates that by the year 2030 there will be >51 million people in the U.S. over the age of 65, including >7 million over the age of 85. The growth of the elderly population and the prevalence of coronary disease among these individuals warrant careful evaluation of potential treatment options. Selecting among the potential choices of medical therapy, percutaneous coronary intervention, and coronary artery bypass grafting (CABG) requires careful evaluation of treatment risks and benefits.

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While peri-procedural risks are known to be higher in elderly patients (3), including greater peri-procedural mortality (4,5), few data regarding the benefits of coronary revascularization in the elderly are available. This stems, in part, from the systematic exclusion of older patients from randomized clinical trials of therapy (6,7). In the absence of clinical trials, however, information gleaned from observational registries may provide valuable evidence about the treatment benefits of revascularization in the elderly (8,9). Towards that end, we developed a procedural registry to define the health status benefits of CABG with a focus on the relief of symptoms, improvement in physical functioning, and augmentation of quality of life. The purpose of this report is twofold: 1) to report the one-year health status benefits of elderly patients (patients >75 years of age) undergoing CABG compared with younger patients, and 2) to provide descriptive data about the pace of health status improvement over time in a subset of this cohort. It is hoped that these data will be useful in counseling elderly patients about their expected outcomes from CABG.

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Abbreviations and Acronyms

CABG = coronary artery bypass grafting surgery
CHF = congestive heart failure
SAQ = Seattle Angina Questionnaire

METHODS

Patient population. The process of patient recruitment, success, and possible selection biases have been previously described (10). From February 1999 through August 2000, patients undergoing CABG at the Mid America Heart Institute, an urban tertiary care center, participated in an observational research study documenting their post-treatment health status recovery. During the collection period, 907 patients underwent cardiac surgery for a bypass procedure (valve surgeries with concomitant bypass were not included). Nineteen (2%) of these emergent cases could not be interviewed before their operation and died during their procedure. In addition, 37 patients (4%) were missed and not given the opportunity to participate. Finally, 18 (2%) patients were non-English-speaking and 143 (16%) refused to participate.

All consenting patients were administered a series of questionnaires at baseline and at one year after their procedure. In addition, patients enrolled in the first phase of the study (n = 224) were given monthly questionnaires for six months after their procedure. Approval from the Saint Luke's Hospital Institutional Review Board was obtained before the conduct of this study.

Health status. Health status assessments were performed with the Seattle Angina Questionnaire (SAQ), a 19-item, disease-specific measure for patients with coronary artery disease. The SAQ quantifies five clinically relevant dimensions of coronary artery disease: physical limitation, recent change in anginal symptoms, angina frequency, treatment satisfaction, and quality of life. Of these five scales, we chose to focus upon the three most clinically relevant domains, physical limitation, angina frequency, and quality of life. The treatment satisfaction results are also described to provide insights into the perception of older and younger patients with respect to their satisfaction with care. The scales used in these analyses range from 0 to 100, where higher scores indicate better function, fewer symptoms, and higher quality of life. The SAQ has well-established validity, reproducibility, and sensitivity to clinical change (11,12). In addition, it has been shown to be predictive of one-year mortality (13).

CLINICAL AND PROCEDURAL ASSESSMENTS OF DISEASE SEVERITY. The Mid America Heart Institute has maintained a procedural database for patients undergoing coronary interventions since 1982. This database provides a detailed description of the coronary anatomy, the type of revascularization performed, procedural results, and post-procedure complications; it uses the American College of Cardiology and Society of Thoracic Surgeons data definitions.

FOLLOW-UP. Patients were contacted one year after their procedure to reassess their health status. Before contacting patients, a query of the Social Security Administration Death Master File was conducted, and local hospital records were examined to minimize the likelihood of contacting the family of someone who had expired. Patients were then contacted by telephone for an interview that included a report of interval events, cardiac procedures outside of the Mid America Heart Institute, and their health status. A minimum of eight and, in some cases, over 20 attempts were made to contact each patient.

In addition to the one-year follow-up data collected for all patients, the first 224 patients undergoing CABG were resurveyed at monthly intervals throughout the first six months of their recovery. The purpose of these assessments was to document the recovery of health status after revascularization. These patients, upon discharge from the hospital, were given a set of six questionnaire packets and instructed to complete one each month. Patients were reminded by telephone before the due date of each packet to complete and return the questionnaires. If they misplaced their packets they were either sent new ones or had the instruments administered by telephone.

Statistical analysis. Patients were divided into two age groups: those ≤75 years of age and those >75 years of age (6). For descriptive purposes, categorical data are reported as frequencies, and differences between age groups were compared with a chi-square or Fisher exact test when the frequency in any given cell was <5. Continuous data are reported as the mean ± SD, and differences between age groups were tested using an analysis of variance.

The primary analysis evaluated the one-year change in health status scores for the SAQ Physical Limitation, Angina Frequency, and Quality of Life domains. An analysis of variance was used to compare the change in scores between the elderly and younger cohorts. To measure the independent effect of age, a multivariate analysis of variance was used to control for sociodemographic, clinical, and health status characteristics that differed by age at baseline. Those variables that differed significantly by age group on a univariate basis ($p < 0.2$) were included as covariates in the final model and included gender, race, smoking, diabetes, hypercholesterolemia, congestive heart failure (CHF), cerebrovascular disease, left main coronary artery disease, number of diseased vessels, and permanent neurologic complications.

Patients enrolled in the first phase of the study had SAQ data at monthly intervals for the first six months after CABG. This analysis was conducted to evaluate the recovery process and compare that rate of recovery between elderly and non-elderly patients. Repeated measures analysis of variance was performed using change in SAQ scores at 1, 2, 3, 4, 5, 6, and 12 months as dependent variables, with

Table 1. Patient Demographics and Characteristics

Characteristic	Age ≤75 (n = 505)	Age >75 (n = 138)	p Value
Demographics			
Mean age	62.8 ± 8.7	79.8 ± 3.5	
Male	375 (74.3%)	84 (61.3%)	0.003
White	474 (94.8%)	133 (98.0%)	0.138
Comorbidities			
Currently smoking	94 (19.8%)	4 (3.0%)	<0.0001
Diabetes	149 (30.0%)	22 (16.0%)	0.001
Hypertension	403 (79.8%)	110 (79.7%)	0.981
Hypercholesterolemia	342 (77.9%)	142 (71.4%)	0.073
History of CHF	55 (10.9%)	28 (20.3%)	0.004
Renal failure	17 (3.4%)	7 (5.1%)	0.349
Peripheral vascular disease	66 (13.1%)	22 (15.9%)	0.384
Cerebrovascular disease	46 (9.1%)	30 (21.7%)	<0.0001
COPD	46 (9.1%)	14 (10.1%)	0.711
Disease severity			
Intra-aortic balloon pump	20 (4.0%)	7 (5.1%)	0.562
Urgent status	85 (16.9%)	26 (18.8%)	0.587
Poor LV function	161 (38.4%)	45 (32.6%)	0.871
Left main disease	110 (24.9%)	36 (18.2%)	0.062
Three-vessel disease	330 (74.7%)	120 (60.9%)	0.0004

CHF = congestive heart failure; COPD = chronic obstructive pulmonary disease; LV = left ventricle.

Table 2. Peri-Procedural Complications

Characteristic	Age ≤75 (n = 505)	Age >75 (n = 138)	p Value
Temporary (<72 h) neurologic deficit	5 (1.0%)	6 (4.4%)	0.007
Permanent (>72 h) neurologic deficit	4 (0.8%)	6 (4.4%)	0.003
Perioperative myocardial infarction	1 (0.2%)	1 (0.7%)	0.326
Prolonged ventilator support	15 (3.0%)	8 (5.8%)	0.116
Postoperative renal dysfunction	22 (4.4%)	13 (9.4%)	0.020
Postoperative bleeding requiring repeat surgery	9 (1.8%)	1 (0.7%)	0.372

age, time, and an age × time interaction term as independent variables. To evaluate the independent influence of age on health status recovery curves, a multivariate repeated measures model was developed using the same independent covariates described for the analysis of one-year change scores. A compound symmetry covariance structure was used (14). Significance for all statistical tests was established as a p value of ≤0.05.

Handling of missing data. The vital status of all patients was determined through query of the Social Security Master Death File and inpatient and outpatient records. Health status data may have been missing from one of three possible causes: 1) patients died during follow-up (n = 47; 6.8%); 2) patients were lost to follow-up (n = 45; 6.5%); or 3) patients did not complete enough of the SAQ at either baseline or follow-up to generate a change score (i.e., contacted by telephone but did not want to participate in the follow-up survey, ran out of time and did not want to be recontacted, and so forth [n = 145; 20.5%]). Only data from those who survived for 12 months of follow-up are reported. This is consistent with our intention that clinicians interpreting these reported changes in health status would predicate them on the patient surviving for at least one year.

To explore potential selection biases introduced by incomplete data, we compared each of the clinical characteristics described in Table 1 among those patients with at least one SAQ domain change score to those without any available change scores. Patients without a change score more frequently had CHF (22% vs. 9%), chronic obstructive pulmonary disease (14% vs. 7%), and single-vessel disease (15% vs. 5%) and less often had had three-vessel disease (61% vs. 75%). Age was not associated with the presence of incomplete data.

To further examine the impact of missing data, multiple imputations using a Markov-chain Monte Carlo method were generated (15). The complete data set (using imputed SAQ scores) was then reanalyzed using the methods described earlier. Multiple imputation analyses suggested no systematic bias resulting from missing data. Accordingly, only complete data are presented.

RESULTS

Of the 690 patients enrolled in the study, 156 (22.6%) were over 75 and 534 were younger. Their baseline characteristics are described in Table 1. Peri-procedural complications were infrequent. Among the 16 (2.3%) peri-procedural deaths, 12 were in the younger patients and 4 were in the elderly (2.2% vs. 2.6%, p = NS). Table 2 demonstrates the non-fatal peri-operative complications by age. Older patients were more likely to experience neurologic, operative, and renal complications. They also were more likely to require prolonged ventilatory support. Within 12 months, there were an additional 31 deaths, of which 13 (8.6%) were in the >75 age group and 18 (3.5%) were in the ≤75 group (p = 0.008).

Ultimately, 138 patients (mean age = 79.8 ± 3.5) over 75 years of age and 505 patients ≤75 years of age (mean age = 62.8 ± 8.7) were eligible for health status follow-up. Table 1 shows the demographic, clinical, and disease severity characteristics of the patients by age group. In brief, our patient population tended to be male, with a larger proportion of younger patients currently smoking, having diabetes or three-vessel disease. A history of CHF and cerebrovascular disease was nearly twice as prevalent among elderly patients.

Baseline and changes from baseline in health status. Table 3 presents the baseline, one-year, and unadjusted change scores in SAQ physical limitation, angina frequency, and quality of life scores for those >75 years of age and those ≤75 years of age. At baseline, SAQ physical limitation scores (67.4 ± 23.9 vs. 70.8 ± 25.0 in younger patients, p = 0.36), angina frequency scores (66.7 ± 23.9 vs. 71.3 ±

Table 3. SAQ_Baseline and One-Year Scores

SAQ_Domains	Age ≤75	Age >75	p Value
Physical limitation			
Baseline score	70.8 ± 25.0	67.4 ± 23.9	0.363
One-year score	90.5 ± 19.0	88.9 ± 20.0	0.569
Change score	19.7 ± 27.0	21.5 ± 27.0	0.665
Angina frequency			
Baseline score	71.3 ± 25.0	66.7 ± 23.9	0.120
One-year score	95.9 ± 13.3	96.8 ± 10.9	0.530
Change score	24.6 ± 25.6	30.1 ± 25.7	0.069
Quality of life			
Baseline score	56.1 ± 23.6	55.7 ± 20.4	0.876
One-year score	89.7 ± 14.6	93.4 ± 12.6	0.031
Change score	33.6 ± 25.2	37.7 ± 21.8	0.161
Treatment satisfaction			
Baseline score	86.6 ± 17.8	85.3 ± 13.5	0.571
One-year score	92.1 ± 16.5	89.8 ± 17.7	0.425
Change score	5.5 ± 19.0	4.5 ± 18.2	0.648

SAQ_ = Seattle Angina Questionnaire.

25, p = 0.12), and quality of life scores (55.7 ± 20.4 vs. 56.1 ± 23.6, p = 0.88) were similar.

At one year, the SAQ_ angina frequency and physical limitation scores of older and younger patients were similar, but a slightly higher SAQ_quality of life score was reported among the elderly (SAQ_quality of life score = 93.4 ± 12.6 vs. 89.7 ± 14.6, p = 0.03). Importantly, the change scores of the SAQ_ reflecting the health status benefits conferred by CABG, were not significantly different. The mean change in SAQ_quality of life scores for those >75 was 37.7 ± 21.8 points, compared with a mean improvement in the younger cohort of 33.6 ± 25.2 points (p = 0.16). The SAQ_ physical limitation change scores were 21.5 ± 27.0 for those >75 and 19.7 ± 27.0 for those ≤75 (p = 0.67), and the mean change in SAQ_angina frequency scores was 30.1 ± 25.7 for those >75 and 24.6 ± 25.6 points for those ≤75 (p = 0.07). Patients' satisfaction with their treatment for coronary disease was high at baseline and improved further by one year. No differences between older and younger patients were observed.

The recovery process. As demonstrated in the primary analyses, both age groups experienced substantial improvements in their health status scores by one year. Among the subset of patients (n = 224; 56 >75 years old and 168 ≤ 75 years old) in whom we tracked serial monthly changes in health status, interesting differences in the rates of recovery for different domains of health were detected (Fig. 1).

After CABG, the physical limitation scores of both cohorts decreased during the first post-procedure month, but by the second postoperative month both older and younger patients' physical limitation scores began to improve, a process that continued throughout follow-up. Elderly patients' mean physical limitation score however, remained consistently lower than the younger group until one year, suggesting a slower pace of physical recovery (Fig. 1a). The age-time interaction term of the repeated measures model was statistically significant (p = 0.009), confirming a slower recovery of physical function.

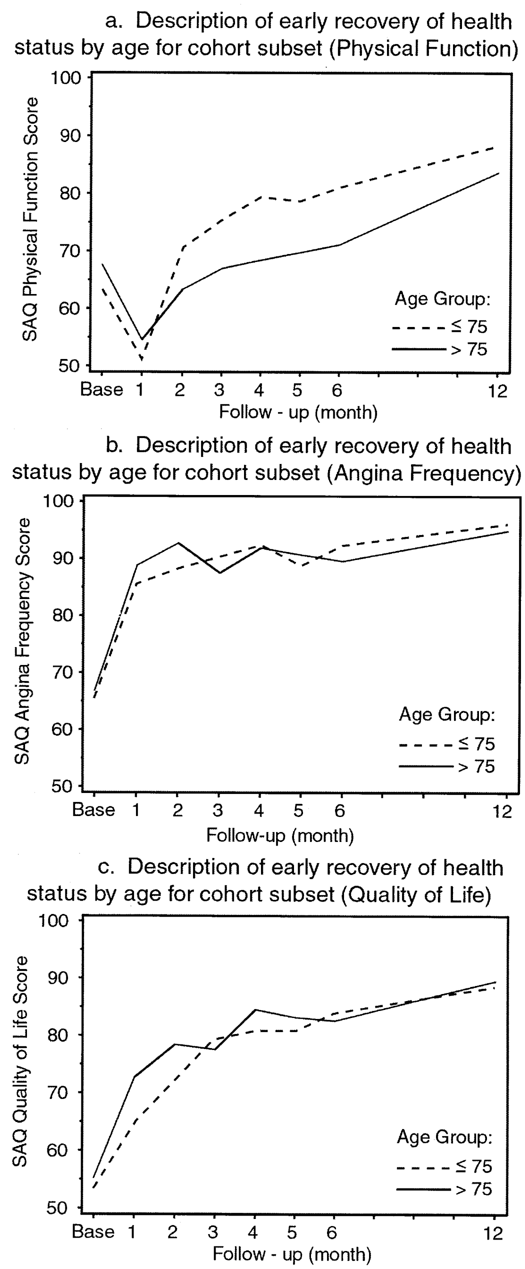

Figure 1. Monthly health status recovery curves among the 224 patients enrolled in the substudy focusing upon the recovery of health status after coronary artery bypass grafting surgery. SAQ_ = Seattle Angina Questionnaire.

In contrast to the slow recovery of physical function, angina relief occurs rapidly and is sustained throughout follow-up (Fig. 1b) in both groups. One month after CABG, both the elderly and the younger patients have improved their SAQ_ Angina Frequency scores (i.e., less angina) dramatically and similarly (1-month change = 22.3 ± 23.8 vs. 21.3 ± 30.6; p = 0.86 for the difference between older and younger patients), and the rate of symptom improvement over time did not differ (p = 0.55).

Consistent with the improvement in symptoms, quality of life improved significantly in both the older and younger cohorts (Fig. 1c), although at a pace intermediate between symptom relief and physical function. Improvements in SAQ quality of life scores occurred rapidly in both the older (1-month change = 17.4 ± 23.9) and younger patients (1-month change = 11.1 ± 30.0; p = 0.81 for the difference) and continued throughout the year of follow-up (Fig. 1c). The rate of recovery was not significantly different between the two age groups (p = 0.44).

DISCUSSION

The elderly are currently the fastest growing segment of a cardiologist's practice (16) and data are needed to adequately counsel patients so that their expectations are aligned with their likely outcomes. This study reveals that older patients have similar peri-procedural mortality but die more frequently over the following year than younger patients. In addition, they experienced a higher frequency of peri-procedural complications than younger patients. Yet, despite these transient complications, the health status benefits one year after the procedure are at least as good in the elderly as in younger patients. One year after CABG, the elderly attain similar symptom relief, functional improvement, and quality of life augmentation from surgical revascularization as younger patients. This is the first study that we are aware of that describes elderly patients' disease-specific health status and recovery after CABG.

Interestingly, the recovery of physical function is slower among the elderly when compared with younger patients. We found that while all patients had a transient decrement in function one month after CABG, the amount of deterioration was greater in the elderly and the recovery was slower than that of younger patients. At one year, however, physical function was similar between groups. This insight should inform clinicians that when counseling older patients about CABG, a slow recovery of physical function—lasting throughout an entire year—should be anticipated. In contrast, the relief of symptoms and improvement in quality of life is rapid and not affected by age.

Given the similar health status benefits, the principal barrier in recommending CABG to elderly patients is their greater perceived risk. Yet, several studies have shown that age alone is not sufficient to avoid recommending CABG (17–20) and that the elderly may benefit in terms of their functional status and quality of life (19,20). For example, Keon demonstrated a steady reduction in mortality from isolated CABG in the elderly over the past three decades (21). While he attributed these results to improved surgical techniques, better postoperative care, and more careful selection of surgical candidates, his finding of only a slight increase in mortality among older patients (3.7% vs. 1.6%) argues that age alone is insufficient to avoid coronary surgery (21). Our current study demonstrates no significant difference in peri-operative mortality, although other peri-operative complications did occur more often in the elderly. Furthermore, our finding of higher mortality one year after surgery does not necessarily reflect poor outcomes from surgery, because older patients are naturally expected to have a higher mortality over time than younger patients. In fact, among a cohort of stable outpatients with coronary disease, age was the strongest predictor of one-year mortality (13).

Several limitations to the present study are noteworthy. First, this prospective registry included only those patients selected by their physician to undergo CABG. Without a careful description of the patients considered but not selected for CABG, we cannot describe what characteristics the surgeons used in identifying suitable candidates. It is possible that careful selection of patients at the Mid America Heart Institute may have identified those most likely to derive health status benefits from CABG while alternative treatments were used in those with less potential to benefit. Replicating these findings at other institutions should dispel this possibility. A second concern is our incomplete follow-up (6.5% lost to follow-up and 20.5% incomplete follow-up). Those who responded to follow-up differed slightly from those that did not in that they had more heart failure, lung disease, and less severe coronary disease. Yet, the similarity of their SAQ scores at baseline, the absence of a difference in follow-up rates by age, and the failure of multiple imputation techniques to suggest different results reassure us that these findings are generalizable to our total population.

Finally, patients who died during follow-up were excluded from our analyses. This may cause a false elevation of SAQ scores as those who died may have had worse health status before their death. However, we feel that clinically, the integration of death and health status is best done by individually describing the outcomes of each and allowing patients and their physicians to independently incorporate both pieces of information to select a treatment most aligned with patients' individual goals and preferences. Others have proposed imputing scores of 0 for those who died, substituting the last value carried forward, or developing probabilities of "good function" at a future point in time while substituting a 0 probability for those who die (22,23). Although these approaches are valuable tools in clinical trials, where the scientific question is which treatment results in better outcomes, the purpose of this paper is to provide a description of the relative benefits of CABG among older compared with younger patients. Thus, we feel that presenting the risks of death and the health status benefits independently is the most appropriate strategy.

In conclusion, this observational study reveals important information about the recovery of the elderly from CABG. Age alone does not appear to exert an important influence on the health status outcomes of CABG—often the principal indication for the procedure. Rather, the potential for surgery to improve patients' symptoms, function, and quality of life along with a careful quantification of procedural risk using appropriate risk models (3) should dominate the decision process. It is important, however, to inform elderly patients of the slower recovery of physical function that is anticipated so that their expectations for the pace of recovery are appropriate. With such counseling, the choice to pursue surgical revascularization may be better tailored to the goals and preferences of individual patients.

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