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Outlook After Acute Myocardial Infarction in the Very Elderly Compared With That in Patients Aged 65 to 75 Years

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Little is known concerning late outcome and prognostic factors after acute myocardial infarction in the very elderly (>75 years of age). Accordingly, this study compared the clinical course and mortality rate for up to 1 year in a large multicenter data base that included 702 patients >75 years of age (mean ± SD 81 ± 4 years), with a less elderly subset of 1,321 patients between 65 and 75 years of age (mean 70 ± 3 years). The postdischarge 1 year cardiac mortality rate was 17.6% for those >75 years of age compared with 12.0% for patients between 65 and 75 years of age ($p < 0.01$). There were differences in the prevalence of several factors, including female gender, history of angina pectoris, history of congestive heart failure, smoking habits and incidence of congestive heart failure during hospitalization. Multivariate analyses of predictors of cardiac death in hospital survivors selected different factors as important in the two age subgroups; age was selected in the 65 to 75 year age group but was not an independent predictor in the very elderly. The survival curves beginning at day 10 for patients 65 to 75 and in those >75 years old were similar for up to 90 days but diverged later. In the very elderly, 63% of late cardiac deaths were sudden or due to new myocardial infarction, similar to the causes of 67% of deaths in the younger age group.

The findings that death is delayed and appears to be primarily due to an ischemic event or sudden death suggest that in the convalescent phase after acute myocardial infarction noninvasive studies currently applied in a significant number of patients 65 to 75 years of age could also be used to identify high risk patients >75 years of age suitable (in the absence of other major medical problems) for coronary angiography and possible revascularization therapy.

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Individuals >65 years of age account for 12% of the total population in the United States, twice the proportion existing 20 years ago (1). This group is expected to increase by 20% in the next decade and is predicted to comprise >20% of the population by the year 2030 (1). The fastest growing segment of the elderly is the group ≥85 years of age.

Cardiovascular disease is the most common disabling and lethal medical problem among the elderly. Coronary heart disease accounts for two thirds of all deaths in the age group >65 years (2) and >50% of all patients hospitalized with acute myocardial infarction are ≥65 years old (3). Although this age group currently constitutes only 12% of the total population, it utilizes 30% of the health care funds and resources (4).

In previous studies of myocardial infarction in older patients (5–10), the mortality rate was higher and signs of congestive heart failure were more common among older patients even though the older group has been differently defined as age >65 years (7), >70 years (5,8,9) or 65 to 75 years (10) or analyzed by decade (6). Only two previous studies (8,10) examined a broad spectrum of historical and clinical data in younger compared with older patients. One of these (8) was limited to patients with a first myocardial infarction and in the other study (10) the older group was

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only 65 to 75 years of age. Previous studies in our entire population (11–14) and other populations (15) have shown age to be an independent determinant of outcome, even when clinical signs of heart failure were included in multivariate analyses. Many clinical trials of patients after myocardial infarction (16–24) have had age restrictions for entry so that current mortality trends for older patients with and without newer therapies are not well established. Thus, little is known about the factors that affect the clinical course and survival after acute myocardial infarction in very elderly patients (>75 years of age).

The purpose of the present study was to compare patients >75 years of age with those between 65 and 75 years in a large multicenter group without an upper age restriction (the University of California, San Diego Collaborative Database). Age >75 years was selected as a dividing point to identify the very elderly subgroup because in the younger cohort (65 to 75 years) age is rarely a factor in selecting therapy.

Methods

Study patients. The study group consisted of 2,023 patients >65 years of age (including 702 patients >75 years old) who were admitted to the hospital with acute myocardial infarction. Patients in the current study comprised 46% of the total data base. All patients were admitted within 24 h after onset of symptoms to the University of California, San Diego Medical Center, the Veterans Affairs Medical Center, San Diego, the Naval Hospital of San Diego, Sharp Memorial Hospital, San Diego, Vancouver General Hospital, British Columbia, Canada and Hopital Cantonal, Geneva, Switzerland during the period from January 1, 1979 to August 1, 1989.

The diagnosis of acute myocardial infarction was established by the presence of two of the following three criteria: 1) elevation of serum creatine kinase, 2) characteristic chest pain, or 3) electrocardiographic (ECG) changes with evolution of Q waves. Non-Q wave infarction was diagnosed by typical ST segment or T wave changes, or both, associated with serum creatine kinase elevation. Data were obtained prospectively with special data collection forms and were maintained in a data base supported by the Specialized Center of Research (SCOR) on Ischemic Heart Disease at the University of California, San Diego Medical Center. Data acquisition methods and definitions have been previously described in detail (11,12). All patients were enrolled after they signed written informed consent statements. The purpose of the data base was to provide material for studies concerning prognosis after acute myocardial infarction. Although general hypotheses were specified beforehand, the present study should be considered a retrospective subgroup analysis.

Follow-up. Patients were contacted by telephone at 3, 6 and 12 months after admission. Follow-up data at 1 year were obtained in >97% of patients eligible for 1 year follow-up evaluation at the time of this analysis. Information concerning deaths was obtained from hospital records or death certificates. For some patients, telephone interviews with the personal physician or family members were made to clarify details. All available data were reviewed by a research cardiologist or, in cases where there was doubt, by a committee to establish cause of death by consensus decision. Cardiac deaths included those due to shock, congestive heart failure, extension of myocardial infarction or new myocardial infarction, as well as "other" cardiac deaths such as those associated with catheterization procedures or cardiac surgery and sudden deaths. Sudden cardiac death was defined as that caused by a documented fatal arrhythmia or unexpected death with no other apparent cause.

Only cardiac deaths were analyzed. In patients >75 years of age, 15 deaths (14%) within 1 year were noncardiac compared with 19 (13%) in patients between 65 and 75 years of age.

Variables

Historical factors and findings from the physical examination, laboratory data, ECGs and chest X-ray films were examined. Although age and gender were analyzed as part of the historical data, race was not. The centers participating in the study were known beforehand to have only small minority representation (later determined to be at most 3% black) and race was not included as a study variable. Factors were also examined from the discharge physical examination and chest X-ray study and medications prescribed at discharge were noted. The occurrence of angina pectoris after hospital discharge was recorded at the follow-up evaluation, and the first notation within 6 months was analyzed in the present study.

Congestive heart failure. Patients were classified as having congestive heart failure if two of the following findings were present during the first 3 days: 1) S_3 gallop, 2) pulmonary rales, or 3) grade ≥2 pulmonary venous congestion on the chest X-ray film. These findings did not have to be observed simultaneously. Pulmonary venous congestion on X-ray film was graded as follows: 0 = no pulmonary congestion, 1 = redistribution of blood flow, 2 = interstitial pulmonary edema, 3 = localized intraalveolar edema, and 4 = diffuse alveolar edema (25).

Special studies. The rates of performance of various diagnostic procedures (radionuclide ventriculography for ejection fraction determination, 24 h ambulatory ECG monitoring, exercise stress testing and coronary angiography) and their results for patients discharged from the hospital were examined. Such studies, generally performed using standard procedures, were an optional part of the SCOR protocol. The decisions to perform the studies were made by the patient's physician; it is possible that some bias exists that may influence the reported results. Although standard automated procedures were used for the tests, the exact protocols and methods of data analysis were not standardized.

Complex ventricular premature beats were coded according to the criteria of Lown and Wolf (26), with the highest grade observed being recorded. Patients were classified as having no complex ventricular premature beats (Lown grade 0 or 1) if they had no or only occasional isolated unifocal ventricular premature beats (<30/h in all hours) and as having complex ventricular premature beats (Lown grade ≥2) if they had frequent ventricular premature beats (>1 beat/min or ≥30 beats/h in any hour), multiform ventricular premature beats, early ventricular premature beats (R on T phenomenon) or ventricular tachycardia (more than 3 consecutive ventricular premature beats with a heart rate >100 beats/min). Thus, patients in the group with complex ventricular premature beats were classified on the basis of ventricular premature beat frequency or multiformity.

An exercise test was considered positive if the patient experienced ischemia (angina pectoris or ≥1 mm of ST segment depression). The test was considered negative if the patient reached ≥6 metabolic exercise equivalents and a heart rate ≥100 beats/min if taking a beta-adrenergic blocking agent or ≥5 metabolic exercise equivalents (METs) and 70% of predicted maximal heart rate if not taking a beta-blocker without experiencing ischemia. Otherwise, the test was considered indeterminant. In addition, a few tests were considered indeterminant if the patient was taking digitalis or had bundle branch block.

The extent of coronary artery disease determined from coronary angiography was classified according to the criteria from the Coronary Artery Surgery Study (CASS) (27). These criteria used ≥70% stenosis (50% for the left main coronary artery) to define significant disease.

Comparison with another age group. Patients in our study between ages 65 and 75 years of age were compared with patients in this age group from the Multicenter Investigation of the Limitation of Infarct Size (MILIS) (10). When available, data from this report are included in the tables of this study.

Statistics. Student's t test was used to compare group means for continuous variables, and the chi-square test with Yates' correction was used to compare the incidence of discrete variables between groups. Standard deviations are reported for continuous variables. Survival curves were computed with standard actuarial methods (program P1L of the Biomedical Statistical Software Package), and curves for different subgroups were compared with the Mantel-Cox statistic (28). Stepwise Cox regression analyses were performed to evaluate the independent importance of prognostic variables for cardiac death after hospital discharge to 1 year (program P2L) (28). For some predictor variables, risk ratios (mortality for subgroup with factor/mortality for subgroup without factor) were computed and compared (29).

Results

Comparison of Patients Aged >75 Years With Those Aged 65 to 75 Years

History and clinical course in all study patients (≥65 years of age) (Table 1). The mean age of patients >75 years old (n = 702, 16% of the total study group) was 81 ± 4 years (range 76 to 95). For patients 65 to 75 years of age (n = 1,321, 30% of the total study group), the mean age was 70 ± 3 years. Patients >75 years old were more often women, more often had a history of congestive heart failure and less often were smokers than were those 65 to 75 years. Patients >75 years old exhibited evidence of heart failure more often (65% versus 53%, $p < 0.001$) and atrial fibrillation (29% versus 19%, $p < 0.001$), but did not have a higher incidence of other severe complications (Table 1).

The combined rate of acute thrombolysis, percutaneous transluminal coronary angioplasty and emergent coronary artery bypass graft surgery was higher in patients 65 to 75 years of age (5%) than in those >75 years old (1%). All of these acute interventions were performed in patients admitted after mid 1984 and would represent a higher proportion of patients admitted since then.

The MILIS cohort patients 65 to 75 years of age (10) were generally similar to our patients 65 to 75 years of age for the historical and in-hospital variables recorded, except that more patients in the MILIS group were women (37% versus 29%, $p < 0.02$). Rates of previous hypertension or congestive heart failure in the hospital were not compared statistically because of differences in definitions.

In-hospital cardiac death. In-hospital cardiac death for patients >75 years of age was 19.9% compared with 12.2% for patients between 65 and 75 years ($p < 0.001$) and patients >75 years had a slightly longer hospital stay. The in-hospital cardiac mortality rate of patients with a Q wave myocardial infarction was more than twice that of patients with a non-Q wave infarction in both age groups ($p < 0.01$). Patients with indeterminate location of infarction are also included in the data for total cardiac deaths. In the MILIS cohort (10), patients 65 to 75 years had a 13.8% in-hospital mortality rate. Even in the absence of congestive heart failure, patients >75 years old in our study experienced nearly twice the in-hospital mortality rate of those aged 65 to 75 years (8.1% versus 4.6%, respectively, $p < 0.06$). Both age groups had a high in-hospital mortality rate if congestive heart failure was present (26% and 19%, respectively, p = NS) compared with that in the older and younger cohorts if heart failure was absent (8% and 5%, respectively). The in-hospital mortality

Table 1. Comparison of Variables From the History and Clinical Course for All 2,023 Patients >65 Years of Age Admitted to the Study

	Current Study		MILIS
	>75 Years	65–75 Years	65–75 Years
No.	702	1,321	217
Age (yr)	81 ± 4	70 ± 3*	69 ± 3
Women (%)	44	29*	37§
History (%)			
Angina pectoris	50	44‡	42
Previous MI	33	33	28
Cong heart failure	23	14*	14
Hypertension	47	48	64
Diabetes	17	20	24
Smoking (%)			
Never	50	32*	
Quit	34	35	
Presently	26	32	35
Location of infarction (%)			
Inferoposterior	28	34	63
Anterolateral	33	32	
Non-Q wave	28	24	
Indeterminate	11	10	
Laboratory values			
Max CK (IU/liter)	1,008 ± 829	1,162 ± 829†	
Max BUN (mg/dl)	31 ± 15	25 ± 15*	
Complications (%)			
Cong heart failure	65	53*	44
3° AV block	6	5	
Atrial fibrillation	29	19*	14
Persistent pain	25	24	
Extension of MI	5	6	8
Hospital cardiac mortality (%)			
Q wave	25.1	22.7*	
Non-Q wave	10.2	6.5	
Total	19.9	12.2*	13.8
Time in hospital (days)	17 ± 12	14 ± 7	

*p < 0.001, †p < 0.01 and ‡p < 0.05 for our patients aged 65–75 versus >75 years; §p < 0.05 for our patients aged 65–75 years versus MILIS (10). AV = atrioventricular; BUN = blood urea nitrogen; CK = creatine kinase; Cong = congestive; DBP = diastolic blood pressure; Max = maximal; MI = myocardial infarction; MILIS = Multicenter Investigation of the Limitation of Infarct Size; 3° = third degree.

Table 2. Comparison of Discharge Evaluation and Therapy in 1,710 Patients Discharged Alive From the Hospital

	>75 Years	65–75 Years
Patients discharged (no.)	559	1,151
Discharge examination (%)		
S_3 gallop	6	4
Basilar rales	8	5
Discharge X-ray study		
Pulm cong grade ≥2 (%)	8	7
Cardiothoracic ratio	0.52 ± 0.06	0.50 ± 0.05*
Discharge medication (%)		
Antiarrhythmic agent	24	19‡
Beta-blocker	27	37*
Digitalis	44	29*
Diuretic drug	50	32*
Special studies		
Radionuclide vent (%)	63	58
LVEF	0.46 ± 0.15	0.45 ± 0.15
Ambulatory ECG (%)	58	55
Complex VPCs (%)	52	50
Exercise test (%)	17	33*
Abnormal (%)	30	35
Coronary angiogram	8	25*
3 vessel disease (%)	32	43
Interventions (%)		
CABG or PTCA within 60 days	1	8*
CABG or PTCA within 1 year	3	14†
Follow-up (%)		
Angina within 6 months	36	34
Nonfatal MI		
Index Q wave	6.4	4.1
Index non-Q wave	7.4	5.5
Total	6.2	5.3
Cardiac mortality postdischarge to 1 year		
Index Q wave MI	15.7	12.1‡
Index non-Q wave MI	17.8	8.6†
Total	17.6	12.0†

*p < 0.001, †p < 0.01 and ‡p < 0.05 for 65–75 versus >75 years of age. CABG = coronary artery bypass grafting; ECG = electrocardiogram; LVEF = left ventricular ejection fraction; MI = myocardial infarction; PTCA = percutaneous transluminal coronary angioplasty; Pulm cong = pulmonary congestion; vent = ventriculography; VPCs = ventricular premature complexes during 24 h ambulatory ECG monitoring.

rate for patients without congestive heart failure in the MILIS patients (10) was about 7%.

Findings at hospital discharge in all patients discharged alive from the hospital (Table 2). The two age groups in our study were similar with regard to findings on the discharge physical examination. Although both groups had nearly the same rate of pulmonary congestion on the discharge chest X-ray study, patients >75 years of age had a slightly higher cardiothoracic ratio (0.52 ± 0.06 versus 0.50 ± 0.05, respectively, p < 0.001). Patients >75 years of age were taking a beta-blocker less frequently but other medications more frequently than were patients in the younger group.

The rates of performance of radionuclide ventriculography and 24 h ambulatory ECG monitoring were similar, but patients between 65 and 75 years of age more frequently underwent exercise testing and coronary angiography. Radionuclide left ventricular ejection fraction was similar (0.46 ± 0.15 and 0.45 ± 0.15 for the older and younger groups, respectively). Also, the proportions of patients with complex ventricular arrhythmias on 24 h ambulatory ECG monitoring and with a positive exercise test were similar. Of the patients undergoing coronary angiography, there was a trend toward a higher incidence of three vessel disease in patients >75 years of age (16 [43%] of 37) than in those 65 to 75 years of age (74 [32%] of 230, p = NS).

Outcome after hospital discharge (Table 2). The occurrence of angina during the first 6 months of follow-up study

JACC Vol. 16, No. 4
October 1990:784–92

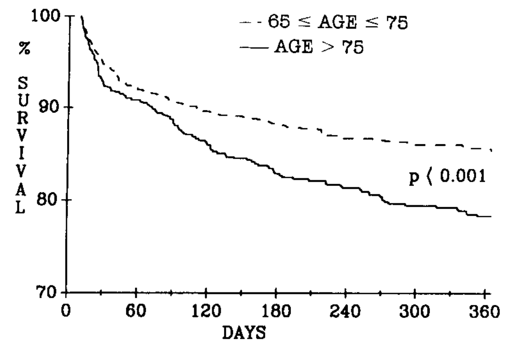

Figure 1. Actuarial survival curves beginning the 10th day after hospital admission for patients between 65 and 75 years of age (**dashed line**) and patients >75 years of age (**solid line**).

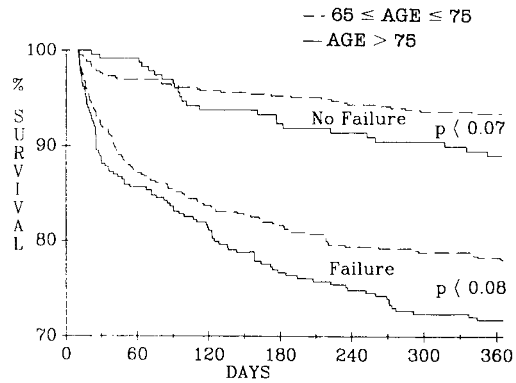

Figure 2. Actuarial survival curves beginning the 10th day after hospital admission for patients between 65 and 75 years of age (**dashed line**) and patients >75 years of age (**solid line**) stratified according to the absence (**top two curves**) or presence (**bottom two curves**) of congestive heart failure during hospitalization.

was similar in the two age cohorts, as was the rate of recurrent nonfatal myocardial infarction. Rates of recurrent nonfatal infarction were not different for patients with or without a Q wave index infarction and these rates did not differ between age groups. Significantly more patients between 65 and 75 years old had coronary angioplasty or coronary artery bypass surgery both before 60 days and during the 1st year than did patients >75 years old. After hospital discharge, the cardiac mortality rate by 1 year was 17.6% for patients >75 years old compared with 12.0% for those 65 to 75 years old ($p < 0.01$). Although the cardiac mortality rate was not significantly different for patients with a Q wave compared with a non-Q wave index infarction in either age group, the trend was toward a slightly higher mortality rate in the non-Q wave group in patients >75 years old and a slightly lower mortality rate in patients 65 to 75 years old. Data in Table 2 for total mortality rate also include patients with indeterminate location of infarction. The cardiac mortality rate in our younger group was significantly lower than that in the 65 to 75 year MILIS group (12% versus 19%, $p < 0.01$) (10).

Figure 1 shows actuarial survival curves for both age groups in the current study after day 10 up to 1 year. Because patients >75 years tended to have a longer hospital stay and a higher in-hospital mortality rate (Table 1), in both subgroups the analysis was commenced at day 10 (the current average hospital stay for our entire study group) rather than at hospital discharge. Up to 90 days, the two curves were remarkably close; thereafter, patients >75 years old experienced a higher mortality rate ($p < 0.001$) (Fig. 1). By 1 year, the actuarial mortality rate was 22% for patients >75 years old compared with 14% for those 65 to 75 years old. When patients were stratified according to the presence or absence of congestive heart failure (Fig. 2), the mortality rate was slightly but not significantly higher for patients >75 years old compared with those 65 to 75 years old both in patients with ($p < 0.08$) and in those without ($p < 0.07$) congestive heart failure; again, the survival curves for the two age groups do not appear to diverge until about 90 days. The actuarial mortality rate in patients without heart failure was 3.8% and 3.6% at 90 days and 6.1% and 11.1% at 1 year in the younger and older cohorts, respectively (Fig. 2). In patients with heart failure, it was 14.5% and 16.7% at 90 days in the younger and older group, respectively (Fig. 2).

Cause of death in patients dying after hospital discharge up to 1 year (Table 3). The percent of patients dying from the various cardiac causes was not different for patients between 65 and 75 and >75 years of age. Although slightly more patients died from congestive heart failure in the older group, about two thirds of deaths in both groups were sudden or from a new myocardial infarction. Among patients who had congestive heart failure in the hospital, 55% of deaths in those between 65 and 75 years old and 58% in those >75 years old were sudden or due to a new myocardial infarction, and congestive heart failure was the cause of death in 21% and 31%, respectively. Among patients dying suddenly or of a new myocardial infarction, 75% of those between 65 and 75 years of age had congestive heart failure in the hospital compared with 68% of those >75 years of age; at hospital discharge, 17% and 7%, respectively, had congestive heart failure. Among patients who died but had at least one follow-up examination before death, 41% of those between 65 and 75 years old and 61% of those >75 years old experienced angina pectoris. These differences did not reach

Table 3. Cause of Death After Hospital Discharge in 215 Patients 65 to 75 and >75 Years of Age

	>75 Years (n = 90)	65–75 Years (n = 125)
Sudden death	32 (36%)	54 (43%)
New myocardial infarction	24 (27%)	30 (24%)
Congestive heart failure	26 (29%)	25 (20%)
Other cardiac	8 (9%)	16 (13%)

Table 4. Comparison of Factors Related to Mortality for the Two Age Groups in 1,335 Patients Followed up for 1 Full Year Versus 215 Dying of Cardiac Cause After Hospital Discharge

	Current Study						MILIS
	>75 Years			65–75 Years			65–75 Years
	Survivors	Deaths	RR	Survivors	Deaths	RR	RR
No.	421	90		914	125		
History							
Previous MI	31†	49	1.9	35*	50	1.9	1.9
Cong heart failure	20*	42	2.3	10*	26	2.7	2.1
Angina	46*	71	2.4	42†	56	1.7	1.4
Diabetes	16‡	25	1.6	16*	29	1.9	1.5
Clinical course							
Cong heart failure	56*	73	1.9	45*	75	3.6	1.6
Extension of MI	4	7	1.5	3*	13	3.5	
HR >100 beats/min	27	54	2.5	25*	48	2.4	
Q wave MI	66	62	0.9	74	65	0.7	0.9
QRS duration ≥0.1 s	44‡	58	1.6	33*	56	2.3	
Atrial fib	24	29	1.2	17‡	26	1.6	1.2
Discharge							
S_3 gallop	5‡	11	1.9	3*	19	4.8	
Digitalis	42*	59	1.8	26*	52	2.6	
Diuretic	45*	73	2.8	30*	46	1.8	
Beta-blocker (nonuse)	73	79	1.4	60†	73	1.7	
Special studies							
CTR ≥0.51	61	65	0.8	42‡	54	1.5	
RN LVEF <0.45	43	55	1.5	41*	78	4.1	
Complex VPCs	48‡	64	1.7	46*	70	2.4	

*$p < 0.001$, †$p < 0.01$ and ‡$p < 0.05$, means or proportions, survivors versus deaths. CTR = cardiothoracic ratio; HR = heart rate; RN LVEF = radionuclide left ventricular ejection fraction; RR = risk ratio; other abbreviations as in Tables 1 and 2.

statistical significance because of the small number of patients.

Factors Related to 1 Year Mortality Rate in Patients >75 and Between 65 and 75 Years (Table 4)

Univariate analysis. Table 4 univariately examines prognostic factors in patients discharged from the hospital who were followed up for the full year compared with those who had died by 1 year. Many of the variables univariately important for the 1 year cardiac mortality rate in patients 65 to 75 years of age showed the same trend in the older group. The magnitude of the differences in prevalence of these factors between survivors and nonsurvivors tended to be less, and statistical significance was not always reached with smaller sample sizes. For some factors, the risk ratios for 1 year cardiac mortality appear different for the two groups, but the respective 95% confidence intervals overlap. When available, the risk ratios from the MILIS cohort (10) are included in Table 4. Although the MILIS risk ratios are for 4 year total mortality (without complete follow-up data), they agreed closely with the ratios in our 65 to 75 year old group. The main exceptions are congestive heart failure and ejection fraction, but 95% confidence intervals for the risk ratios overlap.

Multivariate analysis. Within each age group, the following 13 variables, collected for all patients and found univariately significant for the cardiac mortality at 1 year after hospital discharge in one or both age cohorts, were utilized in a stepwise Cox regression analysis: age, history of previous myocardial infarction, angina pectoris, congestive heart failure, diabetes, maximal heart rate, maximal QRS duration, extension of myocardial infarction, heart failure status in the hospital, S_3 gallop at the discharge physical examination and use of diuretic drugs, digitalis or beta-blockers at discharge. Although left ventricular ejection fraction was highly significant for patients between 65 and 75 years, this factor was not included in the multivariate analysis because it is available in only about 60% of the patients. The Cox regression selected different sets of variables within each age group. For patients between 65 and 75 years of age, the nine variables selected in order of importance for 1 year cardiac mortality were S_3 gallop at the discharge physical examination, infarct extension, heart failure status, age, maximal

JACC Vol. 16, No. 4
October 1990:784–92

QRS duration, history of diabetes, previous myocardial infarction, nonuse of a beta-blocker at discharge and use of digitalis at discharge. For patients >75 years old, the four variables selected were history of angina pectoris, use of diuretic drugs at discharge, maximal heart rate and history of congestive heart failure. Age was an important independent factor for the younger but not the older group.

Discussion

Previous studies. Our very elderly patients (>75 years old) resemble somewhat younger patients reported previously (5–8,10) in that patients were more often women, had more previous angina pectoris and congestive heart failure (7,10), were more likely to be nonsmokers and experienced a higher incidence of congestive heart failure during hospitalization than younger groups.

Several previous studies mentioned lack of evidence in the elderly for an increased incidence of anterior location of infarction (5,6,8,10) or larger infarction assessed by higher peak creatine kinase (CK) or MB CK enzyme levels (10), and our results are consistent with these findings (Table 1). In other reports, it was suggested that myocardial infarction is less well tolerated in older patients because of preexisting heart failure (6,7), a decline in myocardial reserve (7), a higher incidence of multivessel disease (10), age-related hypertrophy of the left ventricle, reduced ventricular compliance, hypertension and cardiac amyloidosis (10). However, few data exist relating age to the condition of the myocardium in humans.

Even patients without congestive heart failure in our very elderly patients experienced a 14% total mortality rate (cardiac and noncardiac) by 1 year. In the general white population matched for the age and gender distribution with our patients >75 years of age who survived hospitalization, an 8% mortality rate at the end of 1 year would be expected (30), indicating that in those patients without congestive heart failure in our study group, other factors were responsible for the increased cardiac and total mortality. Also, in patients >75 years of age who died, only 55% of those undergoing radionuclide ventriculography had a depressed ejection fraction (<0.45) compared with 78% among those who died in the 65 and 75 year age group (Table 4).

We previously investigated (31) the relation of infarct type (Q or non-Q wave) to in-hospital and postdischarge mortality. In that analysis (31), patients with Q wave infarction showed an overall higher in-hospital mortality, but by 1 year it was the same for both infarct types. Significantly increased postdischarge mortality was, however, evident for patients >70 years of age without prior infarction (31). In the present analysis, in-hospital mortality was much lower and postdischarge mortality tended to be slightly higher in the very elderly patients with a non-Q wave infarction than in patients with a Q wave infarction, but in patients between 65 and 75 years of age mortality after hospital discharge tended to be lower in those with non-Q wave infarction.

Comparison with the MILIS study. The younger group of the present study (n = 1,321) includes the same age range (65 to 75 years) as the older group in MILIS (10) (n = 217), and these two groups were similar in a number of respects (Table 1). However, the MILIS study found that even though other risk factors were equally predictive in their patients <65 and between 65 and 75 years of age, the ejection fraction was not related to death for patients 65 to 75 years old. In our study cohort, we previously showed that ejection fraction is not related to the 1 year mortality rate in women (32), and in the present study it was not a significant predictor of death by 1 year in patients >75 years old, 44% of whom were women. The MILIS patients between 65 and 75 years of age also included a higher proportion of women (37%) than did our study group (29%). Using 0.40 as a breakpoint for ejection fraction (as in the MILIS) did not substantially alter our findings.

Our study in an unselected group of patients indicates that patients 65 to 75 years of age have a lower 1 year mortality rate (12% cardiac, 14% total) than the total mortality rate (19%) in the MILIS study group (10). Although this subgroup is at increased risk compared with younger patients, the findings that only about 25% who died in the 1st year after discharge died from congestive heart failure and that most died suddenly or from a new infarction suggest that the same criteria could be used in selecting patients for coronary angiography (33) and potential revascularization in this age group as in patients <65 years old.

Age >75 years. In patients >75 years of age, neither the presence of congestive heart failure during hospitalization nor increased age was an independent predictor of increased mortality. A history of angina pectoris was the most important factor in the multivariate analysis, and the causes of late death resembled those in the younger cohort, with most patients dying suddenly or from a new infarction. Slightly fewer patients >75 years of age who died suddenly or of a new myocardial infarction had congestive heart failure in the hospital or at discharge compared with the younger group and more of the very elderly dying of these causes experienced angina pectoris during the early follow-up period. Thus, selected patients >75 years of age might also be candidates for coronary angiography according to recently described criteria (33), provided that their overall health status does not preclude possible revascularization.

Conservative diagnostic and therapeutic techniques are traditionally recommended for elderly persons and tended to be followed in our very elderly patients (Table 2). Treadmill exercise testing may be safely performed in the elderly patient and is one method by which the high risk patient might be identified (34). No deaths or significant complications were reported by Saunamaki (35) in a series of 62 patients >70 years undergoing treadmill testing soon after myocardial infarction. Similarly Deckers et al. (36) performed exercise tests in 111 patients >64 years old after myocardial infarction without complications. However, in these studies (35,36), <50% of the patients were able to perform an exercise test, emphasizing the need for additional diagnostic procedures such as dipyridamole thallium perfusion or coronary angiography. Recurrent angina pectoris, especially while on medical therapy, should also identify the higher risk patient who should be considered for coronary angiography (37).

Therapeutic approaches in the elderly. Many trials (16–24) involving new treatment strategies for acute myocardial infarction have excluded the elderly. Thus, little information exists concerning the efficacy of thrombolytic agents, beta-adrenergic blockers, calcium antagonists or angiotensin-converting enzyme inhibitors in the elderly. In our study, fewer patients aged >75 years than younger patients received beta-blocker therapy and more received digitalis, diuretic drugs and antiarrhythmic agents (Table 2). Whether the evidence for a deleterious effect of digitalis (38) is more or less pronounced in the elderly has not been investigated.

It has been recommended (39) that intravenous streptokinase therapy not be used in patients ≥75 years of age, especially in women, because of a higher incidence of major hemorrhagic complications, and in our very elderly patients, proportionately more women were encountered. In the Gruppo Italiano per lo Studio della Streptochinasi nell'Infarto Miocardico (GISSI) study (40), no benefit was reported for streptokinase given to patients >75 years old. However, in the Second International Study of Infarct Survival (ISIS-2) (41), patients >70 years old exhibited benefit from streptokinase alone or in combination with aspirin. Also, the older patients did not experience an increased rate of complications due to therapy. Thus, the role of thrombolytic therapy in the elderly remains controversial.

Mechanical reperfusion with coronary angioplasty (42) or coronary artery bypass grafting (43–45) can be performed safely in elderly patients. Dorros et al. (42) reported an 86% success rate in 242 consecutive patients with chronic coronary heart disease undergoing elective coronary angioplasty at a mean age of 74.2 years (range 70 to 88). The overall actuarial survival rate at 72 months was 92% and was not adversely affected by gender (90% survival for men versus 95% for women). Although definitive long-term follow-up studies are not yet available for elderly patients undergoing coronary angioplasty, these results suggest that it might have a beneficial impact in preventing increased mortality in selected postinfarction patients.

The findings of Rahimtoola et al. (43) indicate that the immediate and long-term results of selective coronary artery bypass graft surgery in patients >65 years old are similar to those in a younger patient group. The operative mortality rate was 3% for a group 75 to 84 years of age and the 7 year survival rate in that group was 65%. Recently, Edmunds et al. (44) published their experience in 100 consecutive patients ≥80 years of age and reported a 65% survival rate over a mean follow-up period of 40 months (range 12 to 142) in 41 patients undergoing coronary artery bypass surgery. Loop et al. (45) noted a higher 8 year survival rate (65%) for their patients >75 years old who underwent coronary artery bypass grafting compared with the general population matched for age and gender; however, female gender and left ventricular impairment were predictors for a higher operative mortality rate in this group. Because our elderly patient group contains a high proportion of women and patients with congestive heart failure, these findings suggest that coronary bypass grafting may be appropriate for relatively few very elderly patients after acute myocardial infarction.

Conclusions. As the population of elderly patients continues to increase, it is clear that strategies for their management after myocardial infarction should be established. The results of our analyses of patients between 65 and 75 years of age indicate that this patient group was not at such high risk (12% 1 year cardiac mortality rate) and many of these patients could probably benefit from further diagnostic and therapeutic approaches. In very elderly patients (>75 years old), the high proportion of deaths that are sudden or due to a new myocardial infarction rather than to congestive heart failure suggests a role for increased use of diagnostic evaluation with procedures such as treadmill exercise testing or coronary angiography, or both, before 90 days postinfarction (in those without other severe health problems) in an attempt to identify patients in this group for potential intervention.

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