# Age-Related Differences in the Use of Guideline-Recommended Medical and Interventional Therapies for Acute Coronary Syndromes: A Cohort Study

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**OBJECTIVES:** To compare the use of guideline-recommended medical and interventional therapies in older and younger patients with acute coronary syndromes (ACSs).

**DESIGN:** Prospective cohort study.

**SETTING:** Fifty-five hospitals in Switzerland.

**PARTICIPANTS:** Eleven thousand nine hundred thirty-two patients with ACS enrolled between March 1, 2001, and June 30, 2006. ACS definition included ST-segment elevation myocardial infarction (STEMI), non-ST-segment elevation myocardial infarction (NSTEMI), and unstable angina pectoris (UA).

**MEASUREMENTS:** Use of medical and interventional therapies was determined after exclusion of patients with contraindications and after adjustment for comorbidities. Multivariate logistic regression models were used to calculate odds ratios (ORs) per year increase in age.

**RESULTS:** Elderly patients were less likely to receive acetylsalicylic acid (OR = 0.976, 95% confidence interval (CI) = 0.969–0.980) or beta-blockers (OR = 0.985, 95% CI = 0.981–0.989). No age-dependent difference was found for heparin use. Elderly patients with STEMI were less likely to receive percutaneous coronary intervention (PCI) or thrombolysis (OR = 0.955, 95% CI = 0.949–0.961). Elderly patients with NSTEMI or UA less often underwent PCI (OR = 0.943, 95% CI = 0.937–0.949).

**CONCLUSION:** Elderly patients across the whole spectrum of ACS were less likely to receive guideline-recommended therapies, even after adequate adjustment for comorbidities. Prognosis of elderly patients with ACS may be improved by increasing adherence to guideline-recommended medical and interventional therapies. **J Am Geriatr Soc 56:510–516, 2008.**

**Key words: cohort studies; myocardial ischemia; elderly; aged 80 and over; coronary angiography**

The American College of Cardiology (ACC) and the American Heart Association (AHA) periodically release guidelines for the management of patients across the spectrum of acute coronary syndromes (ACS). Early guidelines from the 1990s did not detail recommendations for older persons because of a lack of data on the elderly from clinical trials. During the late 1990s, evidence increased that older persons benefited from medical and interventional therapies for ACS. For the first time, the 1999 ACC/AHA guideline for the management of ST-segment elevation myocardial infarction (STEMI)[1] and the 2000 ACC/AHA guideline for the management of unstable angina pectoris (UA) and non-ST-segment elevation myocardial infarction (NSTEMI)[2] explicitly recommended early medical and interventional therapies for older persons to improve their worse prognosis than that of younger patients.[3–6]

Previous studies showed that elderly patients with ACS are less likely to receive guideline-recommended therapies.[7–13] Most of the previous studies documenting inappropriate therapy use in elderly patients enrolled patients before the release of the 1999 and 2000 ACC/AHA guidelines.[7–12] Only two of these studies from the 1990s adequately considered comorbidities beyond the cardiovascular risk profile, although noncardiovascular comorbidities may substantially

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DOI: 10.1111/j.1532-5415.2007.01589.x



0002-8614/08/$15.00

and justly influence treatment decisions of physicians.[10,12] This study sought to determine whether older patients with ACS receive the same guideline-recommended medical and interventional therapies as younger patients in a population adjusted for comorbidities.

## METHODS

### Study Population

The Acute Myocardial Infarction in Switzerland (AMIS) Plus project is a prospective cohort study of patients admitted with ACS to 55 participating hospitals in Switzerland.[14–16] All participating hospitals were required to have a facility to perform percutaneous coronary intervention (PCI) (12 hospitals) or a contract with a nearby hospital guaranteeing access to PCI within a maximum of 1.5 hours for all patients (43 hospitals). In 2003, 106 Swiss hospitals conformed to these requirements. Participating and nonparticipating hospitals were not statistically different with regard to size, available skills, or quality grading.[17]

For inclusion in the cohort, patients had to conform to one of the following final diagnoses: STEMI, NSTEMI, or UA. Definition of STEMI required ST-segment elevation or new left bundle branch block on initial electrocardiogram (ECG) and elevated cardiac enzymes (total creatinine kinase (CK) or CK, muscle and brain, at least twice the upper limit of normal range). NSTEMI was diagnosed according to the presence of symptoms, ECG changes compatible with ACS, or both and elevated cardiac enzymes, but without criteria for STEMI being fulfilled. Diagnosis of UA required symptoms, ECG changes compatible with ACS, or both and normal cardiac enzymes. The study population comprised all patients enrolled in the AMIS Plus registry between March 1, 2001, and June 30, 2006. The Above-Regional Ethics Committee for Clinical Studies and the Swiss Board for Data Security approved the study.

### Data Collection

Participating centers provided anonymized data for each patient through a standardized Internet or paper-based questionnaire. The standardized questionnaire comprised 140 items for each patient and was filled in by the coordinator of each institution. It sought information regarding previous medical history, clinical presentation at hospital admission, in-hospital management, and in-hospital prognosis. In-hospital management included the use of medical and interventional therapies. The questionnaire allowed determining the degree of comorbidity using the Charlson Comorbidity Index (CCI).[18] The CCI was shown to predict mortality in patients with coronary artery disease.[19]

All data were centralized at the Institute of Social and Preventive Medicine at the University of Zurich, where data were checked for plausibility and consistency. Incomplete questionnaires were returned to the enrollment centers for completion. In 2003, 19% of questionnaires were returned to the enrollment center, in most cases due to one implausible or incomplete variable. This procedure ensured a low percentage of missing data, markedly below 1% for all therapies and age groups. In December 2004, an independent physician reviewed hospital case records on a random sample of 20 patients for internal validation; the sample demonstrated good agreement with data obtained from questionnaires ($\kappa$ scores $>0.8$ for baseline data and therapeutic interventions). The error rate was 0% for therapeutic interventions, 0% to 0.9% for baseline characteristics, and 1.2% for time variables (e.g., time of symptom onset, time of PCI).

### Measurements

The use of early in-hospital medical therapy, defined as the medical therapy provided within 48 hours after symptom onset or within 24 hours after hospital admission, was measured. The following drugs were selected: acetylsalicylic acid, clopidogrel, heparin (including unfractionated heparin and low molecular weight heparin), beta-blockers, and nitrates (including oral, transdermal, and intravenous nitrates). According to the 1999 and 2000 ACC/AHA guidelines, acetylsalicylic acid, heparin, and nitrates should be given to patients with STEMI and NSTEMI or UA who have no contraindications to these medications.[1,2] Clopidogrel is recommended if there is an allergy to acetylsalicylic acid or if a PCI with stent implantation is planned. Beta-blockers should be administered in the absence of contraindications if there is ongoing chest pain. Contraindications for acetylsalicylic acid, clopidogrel, and heparin were active bleeding, recent surgery, uncontrolled hypertension, a recent cerebral event, or current use of anticoagulants. Contraindications for beta-blockers included heart rate less than 50 per minute, systolic blood pressure less than 90 mmHg, or history of congestive heart failure. The analysis was performed after exclusion of patients with these contraindications.

Interventional therapies constituted a further measurement. For the analysis of interventional therapies, patients in the cohort were divided in two subgroups according to the differentiation in the 1999 and 2000 ACC/AHA guidelines.[1,2] The first subgroup included patients with STEMI, the second patients with NSTEMI or UA. For the subgroup of patients with STEMI amenable to primary reperfusion therapy, primary PCI (defined as PCI within the first 24 hours of the index hospitalization), any PCI during the index hospitalization (defined as primary, elective, or rescue PCI), and thrombolysis were analyzed. For patients with NSTEMI or UA, the assessment of interventional therapy included the use of primary PCI and the use of any PCI during the index hospitalization. According to the 1999 and 2000 ACC/AHA guidelines, primary PCI or thrombolysis should be performed in patients with STEMI who have no contraindications to these therapies. Primary PCI should also be performed in patients with NSTEMI or UA who are at high risk. Advanced age as a marker of high risk should favor PCI in older patients. Contraindications to PCI use included moderate to severe renal failure (serum creatinine $>160\,\mu$mol/L). Contraindications for thrombolysis included active bleeding, noncompressible puncture site, recent surgery, uncontrolled hypertension, recent cerebral event, and current use of anticoagulants. The analysis was performed after exclusion of patients with these contraindications.

### Statistical Analyses

SPSS software (version 14.0, SPSS Inc., Chicago, IL) was used for all statistical analyses. A $P$-value $<.05$ was considered significant. For baseline characteristics, data are presented as percentages for discrete variables and as means ± standard deviations or medians for continuous variables after stratification into five age groups (≤50, 51–60, 61–70, 71–80, and ≥81 years). Age groups comprised the 1-year interval before the corresponding birthday. Differences in baseline characteristics between age groups were compared using the unpaired $t$ test and chi-square test. For descriptive statistical analysis of medical and interventional therapies, data are given as percentages after stratification into the five age groups. For the analysis of guideline-recommended therapy use, odds ratios (ORs) with 95% confidence intervals (CIs) per year increase in age were calculated using multivariate logistic regression models. All models were done with and without adjustment for other variables that may have influenced treatment decisions. Models for the analysis of medical therapies were adjusted for sex, CCI, and Killip class (Class I = no clinical signs of heart failure, Class II = rales in the lungs, Class III = frank pulmonary edema, Class IV = cardiogenic shock).[20] Models for interventional therapies were adjusted for sex, CCI, Killip class, catheter laboratory availability in hospital, and severity of ACS (CK). Because guidelines require time to be implemented in clinical practice, an additional analysis was performed of the subgroup of patients included between January 1, 2004, and June 30, 2006.

## RESULTS

### Baseline Characteristics

Between March 1, 2001, and June 30, 2006, the participating centers enrolled 11,932 patients in the AMIS plus registry. Clinical characteristics of enrolled patients are presented in Table 1 according to age group.

The proportion of women was 11.3% in the youngest patients (≤50) and 49.7% in the oldest patients (≥81 years). Pain was the most frequent symptom at hospital admission in all age groups. Dyspnea was present in 14.9% of the youngest age group and increased markedly to 41.6% in the oldest age group ($P<.001$). Accordingly, the proportion of patients with Killip Class I decreased with age, whereas the proportion of patients with clinical signs of heart failure (Killip Classes II and III) increased with age ($P<.001$). Heart failure has to be recognized as an important primary symptom of ACS in elderly people in order not to delay hospital admission and adequate treatment.

The proportion of patients with a prior myocardial infarction increased with age (Table 1). The most prevalent cardiovascular risk factors in the youngest age group were smoking (70.8%) and dyslipidemia (64.9%); hypertension was present in 31.3% of patients. In the oldest age group, hypertension (70.7%) and dyslipidemia (46.6%) were most prevalent. The prevalence of diabetes mellitus increased to 25.2% in the oldest patients ($P<.001$). The CCI increased from 0.42 in the youngest age group to 1.84 in patients aged 81 and older ($P<.001$).

### Use of Guideline-Recommended Medical Therapy

The proportion of patients receiving medical therapy in a specific age group is shown in Table 2 (unadjusted analysis). The proportion of patients receiving acetylsalicylic acid, clopidogrel, heparin, or beta-blockers decreased significantly with age ($P<.001$ for all). An increase of nitrate use was observed in older patients ($P<.001$).

ORs of the multivariate logistic regression are shown in Table 3. The use of acetylsalicylic acid, clopidogrel, and beta-blockers significantly decreased with increasing age ($P<.001$ for both), even after exclusion of patients with potential contraindications for these therapies and after adjustment for the number of comorbidities using the CCI.

### Use of Guideline-Recommended Interventional Therapies

There were 6,713 patients with STEMI and 5,185 patients with NSTEMI or UA. Thirty-four patients with missing initial ECG were excluded from the subsequent analysis. The proportion of patients receiving a PCI during the course of the index hospitalization decreased significantly with age ($P<.001$ for all) (Table 2). In patients with STEMI, primary PCI was performed in 74.8% of the youngest age group and 24.6% of the oldest age group. In patients with NSTEMI or UA, the proportion of patients receiving primary PCI decreased from 59.6% in the youngest age group to 11.9% in the oldest. A similar decrease regarding the use of any PCI during the index hospitalization was seen in patients with STEMI or NSTEMI or UA (Table 2). The proportion of patients treated using thrombolysis also decreased with increasing age, although it was less commonly used overall. The use of coronary artery bypass graft surgery did not explain why patients were not treated using PCI (Table 2).

ORs of the multivariate logistic regression are shown in Table 4. Elderly patients were less likely to undergo PCI (primary or any PCI) even after exclusion of patients with potential contraindications for these therapies and adjustment for factors that may have influenced treatment decisions, including the number of comorbidities. The use of thrombolysis significantly decreased with increasing age ($P<.001$) (Table 4).

### Additional Analysis

In the subgroup of 6,879 patients enrolled between January 1, 2004, and June 30, 2006, elderly patients still received less medical and interventional therapies. In multivariate logistic regression, the use of acetylsalicylic acid, beta-blockers, and primary PCI decreased with increasing age ($P<.001$ for all).

## DISCUSSION

This analysis of a contemporary cohort study in 11,932 patients with ACS primarily shows that elderly patients received fewer guideline-recommended medical and interventional therapies. An increasing underuse of acetylsalicylic acid, clopidogrel, beta-blockers, and PCI was found with increasing age even after allowing for contraindications and controlling for comorbidities.

Previous studies reported similar age-dependent results,[7–13] although many previous studies on this topic were published before the release of the 1999 and 2000 ACC/AHA guidelines.[10] Some of the recent publications

**Table 1. Baseline Characteristics of 11,932 Patients with Acute Coronary Syndromes According to Age Group**

| Characteristic | Age | | | | | *P* (for Trend) |
|---|---|---|---|---|---|---|
| | ≤50 (n = 1,727) | 51–60 (n = 2,515) | 61–70 (n = 2,875) | 71–80 (n = 3,134) | ≥81 (n = 1,681) | |
| Age, mean ± standard deviation | 44.7 ± 4.9 | 55.8 ± 2.9 | 65.6 ± 2.9 | 75.5 ± 2.9 | 85.6 ± 3.7 | <.001 |
| Men, % | 88.7 | 83.3 | 77.0 | 62.6 | 50.3 | <.001 |
| Admission symptoms and electrocardiogram | | | | | | |
| Time between onset of symptoms and hospital admission, minutes, median | 194 | 218 | 250 | 270 | 260 | .64 |
| Pain, % | 80.8 | 78.8 | 77.0 | 73.0 | 71.7 | <.001 |
| Dyspnea, % | 14.9 | 16.1 | 19.4 | 29.6 | 41.6 | <.001 |
| Killip class, %* | | | | | | <.001 |
| I | 92.1 | 88.3 | 82.6 | 70.8 | 52.7 | |
| II | 5.1 | 7.7 | 12.3 | 20.5 | 34.7 | |
| III | 0.6 | 1.2 | 2.4 | 5.7 | 9.6 | |
| IV | 1.8 | 2.3 | 2.3 | 2.3 | 2.3 | |
| ST-segment elevation myocardial infarction, % | 64.4 | 60.8 | 54.4 | 52.1 | 52.0 | <.001 |
| Past medical history, % | | | | | | |
| Prior myocardial infarction | 11.1 | 14.0 | 17.9 | 23.6 | 27.5 | <.001 |
| Prior heart failure | 0.9 | 1.3 | 2.9 | 7.0 | 12.1 | <.001 |
| Prior cerebrovascular disease | 1.2 | 2.9 | 5.2 | 10.3 | 11.9 | <.001 |
| Hypertension | 31.3 | 47.8 | 59.1 | 67.9 | 70.7 | <.001 |
| Dyslipidemia | 64.9 | 67.4 | 65.3 | 61.4 | 46.6 | <.001 |
| Diabetes mellitus | 9.6 | 16.7 | 22.3 | 25.4 | 25.2 | <.001 |
| Diabetes mellitus with target organ damage | 1.6 | 1.7 | 4.8 | 6.0 | 6.1 | <.001 |
| Current smoking | 70.8 | 54.5 | 35.1 | 19.8 | 9.0 | <.001 |
| Chronic lung disease | 2.7 | 3.9 | 6.4 | 9.5 | 9.7 | <.001 |
| Obesity (body mass index ≥30 kg/m$^2$) | 18.8 | 20.2 | 18.2 | 14.7 | 8.6 | <.001 |
| Moderate to severe renal disease (serum creatinine >160 μmol/L) | 1.7 | 1.7 | 4.3 | 8.8 | 16.9 | <.001 |
| Dementia | 0.1 | 0.1 | 0.4 | 2.8 | 6.8 | <.001 |
| Malignant neoplasm | 0.8 | 2.2 | 4.3 | 6.3 | 9.0 | <.001 |
| Charlson Comorbidity Index, mean (95% confidence interval for mean)† | 0.42 (0.37–0.47) | 0.60 (0.56–0.65) | 0.94 (0.88–0.99) | 1.46 (1.39–1.52) | 1.84 (1.74–1.93) | <.001 |
| Outcome | | | | | | |
| In-hospital mortality on first day after admission | 0.8 | 0.8 | 1.0 | 2.5 | 5.4 | <.001 |

*Killip classes: Class I, no clinical signs of heart failure; Class II, rales in the lungs; Class III, frank pulmonary edema; Class IV, cardiogenic shock.[20]
†Higher values indicate greater number of comorbidities.[18]

enrolled patients when these guidelines were not yet available.[7–9,11,12] Furthermore, many investigations focused on patients with STEMI or patients with NSTEMI or UA.[9–13] It is therefore likely that these data add to the literature in showing that contemporary elderly patients across the whole spectrum of ACS still receive less guideline-recommended treatment.

The question arises as to why older adults continue to receive less guideline-recommended treatment. First, this finding might be attributable to the increasing number of comorbidities with age.[1,2] In the current study, increasing age was independently and significantly associated with less treatment use even after adjustment for CCI. Therefore, this study clearly demonstrates an age-related effect. Only two previous studies adequately considered comorbidities.[10,12] Therefore, because most previous studies did not allow for a measure of comorbidity, they probably failed to truly separate age- and comorbidity-related effects. Second, the question may arise as to whether older patients died faster and did not have a chance to get treated, but the mortality rates on the first day after hospital admission (Table 1) do not explain the increasing underuse of guideline-recommended therapies. Third, patient refusal might have led to this underuse. However, most elderly patients are willing to consider interventional therapy if recommended by their physician.[21] It is therefore likely that the underuse of guideline-recommended treatment in older adults points to physicians' attitudes toward withholding treatment in older adults because of their age. The increasing use of nitrates in older patients might reinforce this hypothesis, because this was most probably due to a primarily symptomatic initial therapeutic strategy in older patients.

This study exhibits several potential limitations. First, it is conceivable that unmeasured factors may have influenced the study findings, despite the prospective and multicentric character of the study. In particular, this could

**Table 2. Proportion of Patients Receiving Therapy**

| Therapy | Age ≤50 n/N*(%) | | Age 51–60 n/N*(%) | | Age 61–70 n/N*(%) | | Age 71–80 n/N*(%) | | Age ≥81 n/N*(%) | | *P*-Value (for Trend) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Medical therapy | | | | | | | | | | | |
| Acetylsalicylic acid | 1,664/1,721 | 96.7 | 2,418/2,509 | 96.4 | 2,709/2,871 | 94.4 | 2,868/3,122 | 91.9 | 1,459/1,674 | 87.2 | <.001 |
| Clopidogrel | 1,235/1,719 | 71.8 | 1,754/2,503 | 70.1 | 1,848/2,858 | 64.7 | 1,741/3,115 | 55.9 | 612/1,655 | 37.0 | <.001 |
| Acetylsalicylic acid, clopidogrel, or both | 1,689/1,722 | 98.1 | 2,453/2,509 | 97.8 | 2,765/2,872 | 96.3 | 2,939/3,126 | 94.0 | 1,504/1,677 | 89.7 | <.001 |
| Heparin | 1,490/1,718 | 86.7 | 2,207/2,506 | 88.1 | 2,500/2,868 | 87.2 | 2,667/3,123 | 85.4 | 1,376/1,668 | 82.5 | <.001 |
| Beta-blocker | 1,345/1,714 | 78.5 | 1,971/2,496 | 79.0 | 2,155/2,864 | 75.2 | 2,186/3,116 | 70.2 | 1,001/1,667 | 60.0 | <.001 |
| Nitrates | 908/1,710 | 53.1 | 1,382/2,493 | 55.4 | 1,588/2,849 | 55.7 | 1,836/3,106 | 59.1 | 1,074/1,664 | 64.5 | <.001 |
| Interventional therapy | | | | | | | | | | | |
| Primary PCI† | | | | | | | | | | | |
| Patients with STEMI | 827/1,105 | 74.8 | 1,072/1,521 | 70.5 | 1,015/1,557 | 65.2 | 861/1,629 | 52.9 | 214/870 | 24.6 | <.001 |
| Patients with NSTEMI or UA | 358/601 | 59.6 | 511/974 | 62.5 | 590/1,292 | 45.7 | 469/1,483 | 31.6 | 95/799 | 11.9 | <.001 |
| Any PCI† | | | | | | | | | | | |
| Patients with STEMI | 1,005/1,112 | 90.4 | 1,353/1,529 | 88.5 | 1,309/1,564 | 83.7 | 1,111/1,633 | 68.0 | 270/874 | 30.9 | <.001 |
| Patients with NSTEMI or UA | 501/608 | 82.4 | 773/981 | 78.8 | 953/1,302 | 73.2 | 818/1,493 | 54.8 | 164/800 | 20.5 | <.001 |
| Thrombolysis | | | | | | | | | | | |
| Patients with STEMI | 154/1,112 | 13.8 | 241/1,528 | 15.8 | 231/1,564 | 14.8 | 205/1,633 | 12.6 | 62/874 | 7.1 | <.001 |
| Coronary artery bypass graft surgery performed‡ | 31/1,675 | 1.9 | 67/2,433 | 2.8 | 96/2,787 | 3.4 | 109/3,035 | 3.6 | 16/1,633 | 1.0 | <.001 |

* Number of treated patients/number of patients without missing data.
† Primary percutaneous coronary intervention (PCI) was defined as PCI within the first 24 hours after hospital admission; any PCI was defined as any PCI during the course of the index hospitalization.
‡ Coronary artery bypass graft surgery performed during the course of the index hospitalization.
STEMI = ST-segment elevation myocardial infarction; NSTEMI = non-ST-segment elevation myocardial infarction; UA = unstable angina pectoris.

apply to patients' will, which was not assessed. Other potential factors play only a minor part in Switzerland; access to medical and interventional therapies is guaranteed for everyone regardless of age, insurance, income, or residency.[22] Second, this study may exhibit selection bias, although 55 hospitals participated in this study, representing more than half of the 106 hospitals treating ST-segment elevation ACS in Switzerland.[17] There was no statistically significant difference between participating and nonparticipating hospitals with regard to size, available skills, and quality grading.[17] Approximately 11,000 patients have an ACS treated in a Swiss hospital each year.[17] It is estimated that the cohort included 40% of all patients being treated for an ACS in the participating institutions and 20% of all patients being treated for an ACS in Switzerland during the investigated time period. It is therefore likely that the study

**Table 3. Odds Ratio for Guideline-Recommended Medical Therapies in Older Patients Compared with Younger Patients**

| Medical Therapy | Patients, n* | OR† (95% Confidence Interval) *P*-Value Unadjusted | | Adjusted‡ | |
|---|---|---|---|---|---|
| Acetylsalicylic acid§ | 11,805 | 0.960 (0.956–0.968) | <.001 | 0.976 (0.969–0.980) | <.001 |
| Clopidogrel§ | 11,759 | 0.965 (0.962–0.968) | <.001 | 0.975 (0.973–0.979) | <.001 |
| Acetylsalicylic acid, clopidogrel, or both§ | 11,906 | 0.954 (0.947–0.961) | <.001 | 0.969 (0.961–0.976) | <.001 |
| Heparin§ | 11,791 | 0.996 (0.996–0.997) | <.001 | 0.999 (0.994–1.003) | .63 |
| Beta-blocker§ | 10,359 | 0.979 (0.976–0.983) | <.001 | 0.985 (0.981–0.989) | <.001 |

* Number of patients suitable for analysis after exclusion of patients with contraindications or patients with missing values.
† Odds ratio (OR) for using a medical therapy per year increase in age.
‡ Adjusted for sex, Charlson Comorbidity Index,[18] and Killip class.[20]
§ Contraindications for acetylsalicylic acid, clopidogrel, and heparin included active bleeding, recent surgery, uncontrolled hypertension, recent cerebral event, or current use of anticoagulants; contraindications for beta-blockers included heart rate <50 per minute, systolic blood pressure <90 mmHg, or history of congestive heart failure.

**Table 4. Odds Ratio for Guideline-Recommended Interventional Therapies in Older Patients Compared with Younger Patients**

| Interventional Therapy | Patients, n* | OR† (95% Confidence Interval) *P*-Value | | | |
|---|---|---|---|---|---|
| | | Unadjusted | | Adjusted‡ | |
| Primary PCI§ | | | | | |
| Patients with STEMI | 6,302 | 0.955 (0.951–0.959) | <.001 | 0.968 (0.964–0.973) | <.001 |
| Patients with NSTEMI or UA | 4,778 | 0.951 (0.946–0.956) | <.001 | 0.964 (0.959–0.969) | <.001 |
| Any PCI§ | | | | | |
| Patients with STEMI | 6,332 | 0.924 (0.919–0.930) | <.001 | 0.938 (0.932–0.944) | <.001 |
| Patients with NSTEMI or UA | 4,812 | 0.930 (0.925–0.935) | <.001 | 0.943 (0.937–0.949) | <.001 |
| Thrombolysis, patients with STEMI§ | 6,654 | 0.989 (0.983–0.994) | <.001 | 0.992 (0.986–0.999) | .02 |
| Primary PCI and thrombolysis combined, patients with STEMI§ | 6,288 | 0.935 (0.872–0.939) | <.001 | 0.955 (0.949–0.961) | <.001 |

* Number of patients suitable for analysis after exclusion of patients with contraindications or patients with missing values.

† Odds ratio (OR) for using an interventional therapy per year increase in age.

‡ After adjustment for sex, Charlson Comorbidity Index,[18] Killip class,[20] catheter laboratory availability within hospital, and creatinine kinase.

§ Primary percutaneous coronary intervention (PCI) was defined as PCI within the first 24 hours after hospital admission; any PCI was defined as any PCI during the course of the index hospitalization. Contraindications for PCI included moderate to severe renal failure (serum creatinine >160 μmol/L); contraindications for thrombolysis included active bleeding, noncompressible puncture site, recent surgery, uncontrolled hypertension, recent cerebral event, or current use of anticoagulants.

STEMI = ST-segment elevation myocardial infarction; NSTEMI = non-ST-segment elevation myocardial infarction; UA = unstable angina pectoris.

population was representative of the Swiss population. As a third limitation, this Swiss study may not accurately reflect the situation in other countries, thus limiting its generalizability, although overall, the results are concordant with those from other countries.[7–13] The results may probably be generalized to other similar countries.

This study has clinical implications. The medical and interventional therapies investigated in the study have been shown to improve prognosis in elderly patients with ACS.[23,24] Consequently, the underuse of these therapies results in a worse prognosis for elderly patients. Elderly patients are of particular interest regarding the increasing prevalence of ACS with age and the shifting population pyramid in developed countries. The findings suggest that better implementation of and adherence to guideline-recommended treatment could dramatically influence quality of care in the elderly.[24] Guidelines affect clinical practice and have improved care of patients with ACS in recent years.[25] Guideline implementation programs may help to improve implementation in the future.[26] Furthermore, monitoring the implementation of guidelines by the use of registries, allowing for the potential influence of comorbidities, contraindications, and patients' will, is recommended.

In summary, the Swiss AMIS Plus cohort study provided important information on the use of guideline-recommended therapies in adults with ACS. It showed that older adults are less likely to receive guideline-recommended therapies than younger adults even after exclusion of potential confounding by comorbidities. There may be important opportunities to improve outcomes of ACS care for older adults; further research is needed to better understand this important domain of care.

## ACKNOWLEDGMENTS

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**Participating Centers**

The following hospitals participated from 2001 to 2006 in the AMIS project on which this report is based (in alphabetical order): Affoltern am Albis, Bezirksspital (F. Hess); Altdorf, Kantonsspital (R. Simon); Altstätten, Kantonales Spital (P.-J. Hangartner/M. Rhyner); Baden, Kantonsspital (M. Neuhaus); Basel, Kantonsspital (P. Hunziker); Basel, St. Claraspital (C. Grädel); Bern, Inselspital (B. Meier/S. Windecker); Biel, Spitalzentrum (H. Schläpfer); Brig-Glis, Oberwalliser Kreisspital (D. Evéquoz); Bülach, Spital (R. Pampaluchi/A. Ciurea-Löchel/M. Kruhl); Davos Platz, Spital (G. Niedermaier); Dornach, Spital (A. Koelz); Flawil, Kantonales Spital (T. Langenegger); Frauenfeld, Kantonsspital (H.-P. Schmid); Fribourg, Hôpital cantonal (B. Quartenoud); Frutigen, Spital (S. Moser/Kuengolt Bietenhard); Genève, Hôpitaux universitaires de Genève (J.-M. Gaspoz); Glarus, Kantonsspital (W. Wojtyna); Grenchen, Spital (P. Schlup/A. Oestmann); Herisau, Kantonales Spital (P. Staub/M. Schmidli); Interlaken, Spital (P. Sula/E.-M. Weiss); Lachen, Regionalsspital (I. Poepping/C. Steffen); Langnau im Emmental, Regionalspital Emmental (J. Sollberger); Lugano, Cardiocentro Ticino (G. Pedrazzini); Laufenburg, Gesundheitszentrum Fricktal (E. Koltai); Luzern, Kantonsspital (P. Erne); Mendrisio, Opitale regionale (A. Pagnamenta); Männedorf, Kreisspital (J. von Meyenburg/T. Luterbacher); Meyrin, Hôpital de la Tour (P. Urban); Münsingen, Regionales Spital Zentrum (F. Repond); Münsterlingen, Kantonsspital (F. Widmer); Muri, Kreisspital für das Freiamt (A. Spillmann/F. Scheibe/K. Rudaz-Schwaller); Rheinfelden, Gesundheitszentrum Fricktal Regionalspital (H.-U. Iselin); Rorschach, Kantonales Spital (M. Pfister); Samedan, Spital Oberengadin (P. Egger); Sarnen, Kantonsspital Obwalden (T. Kaeslin); Schaffhausen, Kantonsspital (R. Frey); Schlieren, Spital Limmattal (B. Risti/V. Stojanovic/T. Herren); Schwyz,

Spital (P. Eichhorn); Scuol, Ospidal d'Engiadina Bassa (G. Flury/C. Neumeier); Solothurn, Bürgerspital (P. Hilti); St. Gallen, Kantonsspital (W. Angehrn/H. Rickli); Thun, Spital (U. Stoller); Uster, Spital (D. Maurer/J. Muntwyler); Uznach, Kantonales Spital (A. Weber); Wädenswil, Schwerpunktspital Zimmerberg-Horgen (G. Garzoli/B. Kälin); Walenstadt, Kantonales Spital (H. Matter/D. Schiesser); Wetzikon, GZO (M. Graber); Winterthur, Kantonsspital (A. Haller); Wolhusen, Kantonales Spital (M. Peter); Zofingen, Spital (H. J. Vonesch/H. J. Meier/S. Gasser); Zollikerberg, Spital (P. Siegrist/R. Fatio); Zürich, Universitätsspital (F. Eberli/M. Maggiorini); Zürich, Stadtspital Triemli (O. Bertel); Zürich, Stadtspital Waid (M. Brabetz/S. Christen).

**Conflict of Interest:** The editor in chief has reviewed the conflict of interest checklists provided by the author and has determined that none of the authors have any financial or any other kind of personal conflicts with this paper.

**Funding Sources:** The AMIS Plus registry is funded by unrestricted grants from the Swiss Heart Foundation and from Abbott, Astra-Zeneca, Biotronik, Boehringer Ingelheim, Boston Scientific, Bristol-Myers Squibb, Essex/MSD, GlaxoSmithKline, Guidant, INVATEC, Johnson&Johnson—Cordis Division, A. Menarini, Medtronic, Mepha Pharma, Merck Sharp & Dohme-Chibret, Novartis, Pfizer, Sanofi-Aventis, Schering, Servier, SPSS, St. Jude Medical, and Takeda Pharma, all in Switzerland. Andreas W. Schoenenberger is supported by a grant from the Robert Bosch Foundation (Stuttgart, Germany).

**Author Contributions:** Study concept and design: Erne, Schoenenberger. Acquisition of data: Erne, Radovanovic. Analysis and interpretation of data: Erne, Radovanovic, Schoenenberger, Stuck, Urban, Stauffer, Gutzwiller, Eberli, Windecker. Drafting the article: Erne, Schoenenberger, Radovanovic, Stuck. Revision of the article: Erne, Schoenenberger, Radovanovic, Stuck, Urban, Stauffer, Gutzwiller, Eberli, Windecker. Final approval: Erne, Schoenenberger, Radovanovic, Urban, Stauffer, Stuck, Gutzwiller, Eberli, Windecker. The corresponding author affirms that everyone who contributed significantly is listed.

**Sponsor's Role:** The funding organizations did not have any role in the design or conduct of the study; in the methods, subject recruitment, data collection, analysis and interpretation of the data; or in the preparation, review, or approval of the manuscript.

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