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Temporal trends in the treatment and outcomes of elderly patients with acute coronary syndrome

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Aims To determine whether treatment and outcomes of older acute coronary syndrome (ACS) patients changed over time.

Methods and results We analysed the use of guideline-recommended therapies and in-hospital outcomes of 13 662 ACS patients ≥70 years enrolled in the prospective Acute Myocardial Infarction in Switzerland (AMIS) cohort between 2001 and 2012 according to 4-year periods (2001–2004, 2005–2008, and 2009–2012). Between first and last 4-year period, percutaneous coronary intervention (PCI) use increased from 43.8 to 69.6% of older ACS patients ($P < 0.001$). Use of guideline-recommended drugs as well increased. At the same time, in-hospital mortality of the overall population decreased from 11.6% in the first to 10.0% in the last 4-year period ($P = 0.020$), and in-hospital major adverse cardiac and cerebrovascular events from 14.4 to 11.3% ($P < 0.001$). Percutaneous coronary intervention was used in increasingly older and co-morbid patients over time (mean age of patients treated with PCI 76.2 years in 2001–2004 and 78.1 years in 2009–2012, $P < 0.001$; Charlson score ≥2 was found for 27.6% of patients treated with PCI in 2001–2004 and for 32.1% in 2009–2012, $P = 0.003$). Percutaneous coronary intervention use was associated with similar odds ratios (ORs) of in-hospital mortality over time (adjusted OR 0.29, 95% confidence interval, CI, 0.22–0.40, in 2001–2004; and, adjusted OR 0.26, 95% CI 0.20–0.35, in 2009–2012).

Conclusion Use of guideline-recommended therapies for ACS increased and in-hospital outcomes improved over the observed 12-year period. Though PCI was used in increasingly older and co-morbid patients, PCI use was associated with similar ORs of in-hospital mortality over time. This study suggests that increasing use of guideline-recommended therapies was appropriate.

Trial registration ClinicalTrials.gov Identifier: NCT01305785.

Keywords Cohort studies • Myocardial ischaemia • Elderly • Aged 80 and over • Coronary angiography

Introduction

Mortality rates from coronary heart disease declined during the last decades in many developed countries, even among the growing demographic of older people with high cardiovascular disease burden.[1–4] Improved prevention helped to reduce disease incidence rates, and improved adherence to guideline-recommended treatment contributed to reduce case-fatality ratios.[2–5] Nevertheless, older patients with acute coronary syndrome (ACS) continue to have a higher risk of dying, suffering complications, and experiencing functional decline than younger patients.[3,6–13] Some of the studies on management and outcomes of ACS in older patients suggested that worse outcomes in older vs. younger patients were at least partially attributable to a decreased adherence to guideline-recommended therapies.[8–13] Current guidelines recommend the use of modern therapies for ACS independent of age, but acknowledge that withholding therapies may be justified in older patients with high co-morbidity burden and reduced life expectancy.[6,14–16]

Considering the observable decrease in the use of guideline-recommended therapies with increasing age, the question arises whether this decrease is justified by co-morbidities and reduced life expectancy. None of the studies so far was able to definitely

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answer this question, though some studies suggested that use of guideline-recommended therapies was less even among elderly individuals likely to benefit.[8,12] We hypothesized that a study evaluating use of guideline-recommended therapies and outcomes in older patients over time would add to current evidence in this field. We therefore analysed temporal trends in the treatment and outcomes of older patients with ACS, and evaluated whether treatment effectiveness on short-term mortality changed over time using data from the AMIS Plus project.

Methods

Study setting

The AMIS Plus project is a prospective cohort of ACS patients admitted to one of the participating hospitals in Switzerland (www.amis-plus.ch).[8,17–21] Hospitals participated on a voluntary basis. Since 1997, 82 hospitals ranging from community-level institutions to large tertiary facilities have temporarily or continuously collected data for the AMIS Plus project. Participating hospitals either had a facility for performing PCI or had a contract with another hospital providing PCI. In Switzerland, PCI access is ensured within a maximum of 1.5 h for all ACS patients.

Study population

The AMIS Plus cohort includes patients who are admitted to one of the participating hospitals for one of the following final diagnoses: ST-elevation myocardial infarction (STEMI), non-ST-elevation myocardial infarction (NSTEMI), or unstable angina. Diagnoses were based on symptoms, electrocardiogram, and/or cardiac biomarkers, and conformed to prevailing guidelines in use at the time of inclusion.[22] The study population of our present analysis comprised all patients aged 70 years or more enrolled in the AMIS Plus cohort between 1 January 2001 and 31 December 2012. The Above-Regional Ethics Committee for Clinical Studies, the Swiss Board for Data Security, and all Cantonal Ethic Commissions approved the study.

Data collection

The coordinator of each participating hospital provided anonymised data for each patient by filling in a standardized web- or paper-based questionnaire. The questionnaire collected detailed information on previous medical history, clinical presentation at hospital admission, in-hospital management, and in-hospital outcome. The AMIS Plus data centre gathered all questionnaires and checked them for consistency and plausibility. Incomplete or implausible questionnaires were returned to the enrolling centres for completion and/or correction. This standard procedure ensured a low percentage of missing data. Internal validation by an independent physician who reviewed hospital case records on a random sample of 20 patients demonstrated good agreement with data obtained from questionnaires (κ scores >0.8 for baseline data and therapeutic interventions). The error rate was 0–0.9% for baseline characteristics, and 0% for therapeutic interventions. External monitoring has been carried out regularly since 2010 in randomly selected hospitals and randomly selected patients.

Measurements for the evaluation of therapy use

For the evaluation of therapy use, we selected seven therapies that were recommended by guidelines during the entire study period and irrespective of age.[14–16] The therapies evaluated were: (i) use of acetylsalicylic acid in combination with either a P2Y12 blocker or a glycoprotein IIb/IIIa inhibitor, (ii) use of heparins (unfractionated or low-molecular-weight heparins), (iii) use of β-blockers, (iv) use of angiotensin converting enzyme inhibitors (ACEIs) and/or angiotensin receptor blockers (ARBs), (v) use of statins, (vi) use of PCI during the index hospitalization, and (vii) use of a primary PCI in STEMI patients. Pertaining to drugs, only drug therapy provided within 48 h after symptom onset or within 24 h after hospital admission was considered. Primary PCI was defined as PCI performed within the first 24 h after hospital admission. It was evaluated in the subgroup of STEMI patients, because primary PCI is the therapy of choice in these patients.

Measurements for the evaluation of in-hospital outcomes

We evaluated four in-hospital outcomes: first, in-hospital mortality which was defined as death from any cause during the index hospitalization; second, in-hospital major adverse cardiac and cerebrovascular events (MACCE) which was a combined endpoint of in-hospital mortality, non-fatal myocardial infarction or non-fatal stroke; third, the duration of the in-hospital stay in days; and fourth, the discharge destination (i.e. discharge to home or nursing home, to other hospital, or to rehabilitation facility).

Statistical analysis

We first descriptively analysed baseline characteristics according to three age groups (septua-, octo-, and nonagenarians). Twelve centenarians in the cohort were assigned to the group of nonagenarians. We then analysed the use of guideline-recommended therapies separate for each of the three age groups according to three 4-year periods (2001–2004, 2005–2008, and 2009–2012). Third, we performed a descriptive analysis of in-hospital outcomes according to the three 4-year periods for the overall study population as well as separate for each of the three age groups. We finally evaluated associations between PCI use and in-hospital mortality separate for the three 4-year periods. For this purpose, we used logistic regression to give odds ratios (ORs) and 95% confidence intervals (CIs), with corresponding *P*-values to measure the effect. Logistic regression analyses were performed unadjusted and adjusted for age, sex, Charlson score, Killip class ≥ 3, and the presence of STEMI. These variables were chosen for their well-known influence on treatment decisions and prognosis in older patients. No adjustment was done for further factors influencing treatment and prognosis that were already covered by the Charlson score (e.g. renal failure).[23] We did not analyse the associations with in-hospital mortality for other guideline-recommended therapies than PCI, because these therapies are less debated in old ACS patients.

SPSS software (SPSS Inc., Chicago, IL, USA) for Windows XP (version 20.0) was used for all analyses. Results for discrete variables are presented as percentages. In case of missing data, we preferred providing *n*/*N* (= number of patients with a characteristic/number of patients with available data) instead of an imputation procedure. Results for continuous variables are provided as either means ± SD or medians with interquartile range (IQR) depending on distribution. Hypothesis testing for descriptive results was done using the unpaired Student's *t*-test or the χ^2 test. For trends, we used the Mantel–Haenszel linear-by-linear association χ^2 test with 1 degree of freedom. A *P*-value of <0.05 was considered to indicate statistical significance for all tests.

Results

Study population

We enrolled 32 500 patients with ACS in AMIS Plus between 1 January 2001, and 31 December 2012 from 73 hospitals. Of these, 13 662 patients (42.0%) were 70 years or older and included in the

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Table 1 Baseline characteristics

Characteristic	2001–2004 (*N* = 3919)	2005–2008 (*N* = 5734)	2009–2012 (*N* = 4009)	*P*-value (for trend)
Age, mean (SD) (years)	78.6 (5.7)	79.3 (6.0)	79.6 (6.0)	<0.001
Male sex, *n* (%)	2340 (59.7)	3456 (60.3)	2440 (60.9)	0.294
Presentation at admission				
Symptoms at admission				
Pain, *n*/*N*[a] (%)	2833/3832 (73.9)	4315/5476 (78.8)	3183/3801 (83.6)	<0.001
Dyspnoea, *n*/*N*[a] (%)	1311/3816 (34.4)	1945/5206 (37.4)	1524/3450 (44.2)	<0.001
Atrial fibrillation at admission, *n*/*N*[a] (%)	343/3836 (8.9)	538/5638 (9.5)	370/3944 (9.4)	0.509
Diagnosis of STEMI, *n* (%)	2099 (53.6)	2851 (49.7)	1927 (48.1)	<0.001
Killip class 3 or 4, *n*/*N*[a] (%)	422/3894 (10.8)	500/5604 (8.9)	418/3932 (10.6)	0.769
Characteristics prior to admission				
Delay symptom onset to admission, median (IQR) (min)	283 (130, 765)	250 (120, 680)	240 (120, 637)	<0.001
Cardiopulmonary resuscitation prior to admission, *n*/*N*[a] (%)	96/3668 (2.6)	129/5590 (2.3)	106/3946 (2.7)	0.824
Cardiovascular risk factors				
Hypertension, *n*/*N*[a] (%)	2646/3772 (70.1)	4107/5422 (75.7)	3012/3793 (79.4)	<0.001
Dyslipidaemia, *n*/*N*[a] (%)	1977/3456 (57.2)	2570/4798 (53.6)	1912/3412 (56.0)	0.324
Smoking, *n*/*N*[a] (%)	633/3572 (17.7)	765/4931 (15.5)	472/3186 (14.8)	0.001
Diabetes, *n*/*N*[a] (%)	970/3801 (25.5)	1376/5432 (25.3)	968/3824 (25.3)	0.837
Medical history and previously diagnosed comorbidities				
Previous acute MI, *n*/*N*[a] (%)	791/3270 (24.2)	1274/5543 (23.0)	922/3841 (24.0)	0.916
Cerebrovascular disease, *n*/*N*[a] (%)	376/3270 (11.5)	534/5638 (9.5)	397/3890 (10.2)	0.098
Peripheral arterial disease, *n*/*N*[a] (%)	280/3270 (8.6)	509/5638 (9.0)	337/3890 (8.7)	0.918
Moderate-to-severe renal disease, *n*/*N*[a] (%)	330/3270 (10.1)	786/5638 (13.9)	623/3890 (16.0)	<0.001
Dementia, *n*/*N*[a] (%)	128/3270 (3.9)	225/5543 (4.1)	200/3827 (5.2)	0.006
Charlson score ≥2, *n*/*N*[a] (%)	1230/3270 (37.6)	2123/5543 (38.3)	1514/3827 (39.6)	0.089
Medication prior to admission				
Acetylsalicylic acid, *n*/*N*[a] (%)	1930/3837 (50.3)	2803/5578 (50.3)	1986/3852 (51.6)	0.270
β-Blocker, *n*/*N*[a] (%)	1351/3824 (35.3)	2272/5527 (41.1)	1588/3804 (41.7)	<0.001
ACEI or ARB, *n*/*N*[a] (%)	1447/3824 (37.8)	2588/5542 (46.7)	2004/3822 (52.4)	<0.001
Statin, *n*/*N*[a] (%)	956/3815 (25.1)	1768/5528 (32.0)	1463/3798 (38.5)	<0.001

ACEI, angiotensin converting enzyme inhibitor; ARB, angiotensin receptor blocker; BP, blood pressure; IQR, interquartile range; MI, myocardial infarction; STEMI, ST-elevation myocardial infarction.
[a]In case of missing data *N* = number of patients with available data and *n*/*N* = number of patients with a characteristic/number of patients with available data.

present analysis. These patients divided into three age groups: 7974 septuagenarians (58.4%), 5009 octogenarians (36.7%), and 679 nonagenarians (5.0%).

Table 1 shows the baseline characteristics for the overall study population according to the three 4-year periods. Patients' age increased by 1 year over the three 4-year periods. Patients more often had co-morbidities such as hypertension, renal disease, or dementia in the last 4-year period when compared with the preceding periods, whereas smoking prevalence decreased. Use of cardiovascular drugs prior to admission, such as ACEIs/ARBs, β-blockers, and statins, increased across the three 4-year periods. The delay from symptom onset to hospital admission as well as STEMI prevalence at hospital admission decreased.

Temporal trends in the use of guideline-recommended therapies

Table 2 shows the temporal trends in the use of guideline-recommended therapies separate for septua-, octo-, and nonagenarians. The use of drug therapies increased across the three 4-year periods in all age groups, except for β-blockers in septua- and octogenarians where its use decreased along with the declining importance of β-blockers for acute treatment of ACS. In contrast, use of β-blockers increased in nonagenarians, but the proportion of nonagenarians receiving β-blockers during the first 4-year period was markedly lower than that of septua- or octogenarians. For PCI use, marked increases were found (*Table 2* and *Figure 1*). Overall, PCI was performed in 43.8% of older ACS patients during

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Table 2 Temporal trends in the use of guideline-recommended therapies for septua-, octo-, and nonagenarians

Treatment	2001–2004	2005–2008	2009–2012	*P*-value (for trend)
Septuagenarians	$N = 2447$	$N = 3279$	$N = 2248$	
ASA and P2Y12 blocker or ASA and GPI, n/N^a (%)	1108/2438 (45.4)	2380/3210 (74.1)	1845/2196 (84.0)	<0.001
Heparins, n/N^a (%)	2110/2437 (86.6)	2756/3199 (86.2)	1860/2176 (85.5)	0.28
β-Blocker, n/N^a (%)	1726/2434 (70.9)	2151/3190 (67.4)	1230/2174 (56.6)	<0.001
ACEI and/or ARB, n/N^a (%)	1093/2403 (45.5)	1857/3187 (58.3)	1215/2180 (55.7)	<0.001
Statin, n/N^a (%)	1475/2173 (67.9)	2450/3194 (76.7)	1659/2188 (75.8)	<0.001
Any PCI[b], n/N^a (%)	1390/2444 (56.9)	2509/3176 (79.0)	1701/2024 (84.0)	<0.001
Primary PCI[c] in STEMI, n/N^a (%)	567/1311 (43.2)	1191/1600 (74.4)	821/1082 (75.9)	<0.001
Octogenarians	$N = 1310$	$N = 2155$	$N = 1544$	
ASA and P2Y12 blocker or ASA and GPI, n/N^a (%)	396/1309 (30.3)	1188/2085 (57.0)	1020/1505 (67.8)	<0.001
Heparins, n/N^a (%)	1111/1309 (84.9)	1739/2087 (83.3)	1223/1504 (81.3)	0.012
β-Blocker, n/N^a (%)	789/1305 (60.5)	1353/2079 (65.1)	795/1496 (53.1)	<0.001
ACEI and/or ARB, n/N^a (%)	594/1292 (45.9)	1141/2082 (54.8)	784/1498 (52.3)	0.001
Statin, n/N^a (%)	580/1191 (48.7)	1314/2076 (63.3)	950/1498 (63.4)	<0.001
Any PCI[b], n/N^a (%)	315/1309 (24.1)	946/2106 (44.9)	836/1462 (57.2)	<0.001
Primary PCI[c] in STEMI, n/N^a (%)	160/691 (23.2)	490/1063 (46.1)	410/730 (56.2)	<0.001
Nonagenarians	$N = 162$	$N = 300$	$N = 217$	
ASA and P2Y12 blocker or ASA and GPI, n/N^a (%)	16/162 (9.9)	75/289 (26.0)	99/213 (46.5)	<0.001
Heparins, n/N^a (%)	125/161 (77.6)	227/291 (78.0)	170/212 (80.2)	0.53
β-Blocker, n/N^a (%)	75/161 (46.6)	133/291 (45.7)	123/212 (58.0)	0.019
ACEI and/or ARB, n/N^a (%)	57/161 (35.4)	138/290 (47.6)	107/211 (50.7)	0.004
Statin, n/N^a (%)	28/148 (18.9)	87/290 (30.0)	95/211 (45.0)	<0.001
Any PCI[b], n/N^a (%)	10/162 (6.2)	27/298 (9.1)	39/215 (18.1)	<0.001
Primary PCI[c] in STEMI, n/N^a (%)	8/97 (8.2)	15/147 (10.2)	28/96 (29.2)	<0.001

ACEI, angiotensin converting enzyme inhibitor; ARB, angiotensin receptor blocker; ASA, acetylsalicylic acid; GPI, glycoprotein IIb/IIIa inhibitor; PCI, percutaneous coronary intervention; STEMI, ST-elevation myocardial infarction.
[a]In case of missing data N = number of patients with available data and n/N = number of patients with a characteristic/number of patients with available data.
[b]Any percutaneous coronary intervention performed during the index hospitalization.
[c]Percutaneous coronary intervention in STEMI patients performed within the first 24 h after hospital admission.

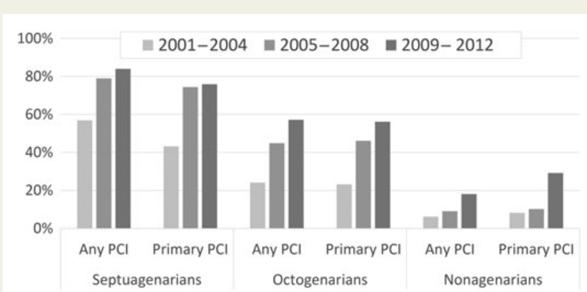

Figure 1 Temporal trends in the use of percutaneous coronary intervention. Use of any percutaneous coronary intervention during the index hospitalization in all study patients and use of primary percutaneous coronary intervention (defined as percutaneous coronary intervention performed within 24 h after hospital admission) in the subgroup of patients with ST-elevation myocardial infarction are displayed separate for septua-, octo-, and nonagenarians.

the first, and in 69.6% during the last 4-year period ($P < 0.001$). The highest relative increase was found for primary PCI use among nonagenarians with STEMI (3.6-fold increase between the first and the third 4-year period) (*Table 2*). The increase in nonagenarians was most pronounced between the second and third 4-year period, whereas in septuagenarians a marked increase was observed earlier and thereafter plateaued (*Table 2*).

Between first and third 4-year period, PCI was used in increasingly older and co-morbid patients. The mean age of patients treated with PCI was 76.2 ± 4.4 years from 2001 to 2004 and 78.1 ± 5.2 years from 2009 to 2012 ($P < 0.001$). A Charlson score ≥2 was found for 27.6% of patients treated with PCI from 2001 to 2004 and for 32.1% from 2009 to 2012 ($P = 0.003$). A Killip class 3 or 4 was found for 5.0% of patients treated with PCI from 2001 to 2004 and for 8.7% from 2009 to 2012 ($P < 0.001$).

Temporal trends of in-hospital outcomes

Temporal trends of in-hospital outcomes in the overall study population and in the subgroups of septua-, octo-, and nonagenarians are shown in *Table 3*. In-hospital mortality decreased from 11.6% in the first to 10.0% in the last 4-year period in the overall study population ($P = 0.020$). The highest relative decrease of in-hospital mortality (22.7%) between first and last 4-year period was observed among octogenarians. The rate of MACCE and the duration of in-hospital

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Table 3 Temporal trends of in-hospital outcomes in the overall study population as well as separate for septua-, octo-, and nonagenarians

Outcome Overall study population	2001–2004 N = 3919	2005–2008 N = 5734	2009–2012 N = 4009	P-value (for trend)
In-hospital mortality, n (%)				
All patients, n (%)	454 (11.6)	584 (10.2)	400 (10.0)	0.020
Subgroup of patients who underwent PCI, n/N[a] (%)	78/1715 (4.5)	206/3482 (5.9)	148/2576 (5.7)	0.140
In-hospital MACCE[b], n/N[c] (%)	542/3764 (14.4)	641/5596 (11.5)	447/3943 (11.3)	<0.001
Duration of in-hospital stay, median (IQR), days	8 (3, 13)	7 (3, 12)	6 (2, 10)	<0.001
Discharged to				
Home, n/N[c] (%)	1818/3305 (55.0)	2368/4952 (47.8)	1518/3450 (44.0)	0.206
Nursing home, n/N[c] (%)	137/3305 (4.1)	335/4952 (6.8)	228/3450 (6.6)	
Other hospital, n/N[c] (%)	654/3305 (19.8)	934/4952 (18.9)	779/3450 (22.6)	
Rehabilitation, n/N[c] (%)	696/3305 (21.1)	1315/4952 (26.6)	925/3450 (26.8)	
Septuagenarians	N = 2447	N = 3279	N = 2248	
In-hospital mortality, n (%)	198 (8.1)	231 (7.0)	156 (6.9)	0.130
In-hospital MACCE[b], n/N[c] (%)	258/2348 (11.0)	268/3206 (8.4)	177/2211 (8.0)	<0.001
Duration of in-hospital stay, median (IQR) (days)	7 (3, 12)	6 (2, 11)	5 (2, 9)	<0.001
Discharged to nursing home, n/N[c] (%)	31/2249 (1.4)	64/3048 (2.1)	31/2096 (1.5)	0.75
Octogenarians	N = 1310	N = 2155	N = 1544	
In-hospital mortality, n (%)	213 (16.3)	279 (12.9)	194 (12.6)	0.005
In-hospital MACCE[b], n/N[c] (%)	239/1262 (18.9)	297/2104 (14.1)	215/1518 (14.2)	0.001
Duration of in-hospital stay, median (IQR) (days)	9 (5, 14)	8 (4, 13)	6 (2, 11)	0.022
Discharged to nursing home, n/N[c] (%)	83/1097 (7.6)	198/1876 (10.6)	154/1350 (11.4)	0.002
Nonagenarians	N = 162	N = 300	N = 217	
In-hospital mortality, n (%)	43 (26.5)	74 (24.7)	50 (23.0)	0.430
In-hospital MACCE[b], n/N[c] (%)	45/154 (29.2)	76/286 (26.6)	55/214 (25.7)	0.470
Duration of in-hospital stay, median (IQR) (days)	9 (4, 15)	9 (4, 14)	7 (3, 12)	0.085
Discharged to nursing home, n/N[c] (%)	23/119 (19.3)	73/226 (32.3)	43/167 (25.7)	0.35

MACCE, major adverse cardiac and cerebrovascular events; PCI, percutaneous coronary intervention.
[a]Number of patients who died (n) and number of patients who underwent PCI (N).
[b]Combined endpoint of in-hospital mortality, non-fatal myocardial infarction, or non-fatal stroke.
[c]In case of missing data N = number of patients with available data and n/N = number of patients with a characteristic/number of patients with available data.

stay significantly decreased over the three 4-year periods in the overall study population, particularly due to significant decreases among septua- and octogenarians. Among nonagenarians, no statistically significant changes of in-hospital outcomes were observed, but numbers of within-group patients were low. The pattern of discharge destinations after the in-hospital stay did not significantly change over the three 4-year periods in the overall study population.

Associations between percutaneous coronary intervention use and in-hospital mortality

Use of a PCI during the index hospitalization was associated with lower odds of in-hospital mortality and the unadjusted as well as the adjusted ORs did not markedly change between the first and the last 4-year period (unadjusted OR 0.23, 95% CI 0.18–0.30 and adjusted OR 0.29, 95% CI 0.22–0.40, from 2001 to 2004; unadjusted OR 0.24, 95% CI 0.19–0.30 and adjusted OR 0.26, 95% CI 0.20–0.35, from 2009 to 2012).

Discussion

This analysis in a contemporary cohort of 13 662 old ACS patients showed that the use of guideline-recommended therapies increased from 2001 to 2012 in septuagenarians, in octogenarians as well as in nonagenarians. At the same time, in-hospital outcomes of these patients improved despite the fact that patients admitted in the last 4-year period were older and had a higher burden of co-morbidities than in the preceding 4-year periods. This analysis also revealed that increasing PCI use was not associated with lower effectiveness to prevent in-hospital death, despite its use in increasingly older and co-morbid patients.

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Our observational data are in agreement with previous reports.[2–5] Along with the demographic and epidemiologic changes in developed countries, patients admitted for ACS were older and sicker in recent years. Use of guideline-recommended therapies for ACS increased over the past decades and outcomes at the same time improved. Our results indicate that, during the last 4-year period, about 64 in-hospital deaths and 121 in-hospital MACCE were prevented when compared with the first 4-year period. However, there is one shortcoming. Nursing home admissions increased among the oldest ACS patients. We therefore believe that future efforts to improve quality of care in these patients should also comprise elements of geriatric care and/or cardiac rehabilitation, which both are underutilized so far.[24–30]

The finding of an unaltered association between PCI use and in-hospital mortality from 2001 to 2012 is important. It shows that PCI effectiveness was preserved despite increasing use and despite the treatment of increasingly older patients with higher co-morbidity burden. Old ACS patients did benefit from more frequent PCI use, justifying its increasing utilization.[31] The question arises which patients should no longer be considered for an invasive treatment strategy.

The study has some limitations. First, generalizability of the observed temporal trends is limited by the fact that the study was performed in Switzerland. Switzerland is among the countries with a high healthcare expenditure per capita as well as in relation to gross domestic product.[32] Access to guideline-recommended therapies for ACS is granted to all patients regardless of age, insurance, income, or residency. Nevertheless, the situation in Switzerland is probably comparable with other developed countries and the finding of similar ORs across time is probably generalizable to other countries. Second, the duration of in-hospital stay decreased over the three 4-year periods. The duration of in-hospital stay is directly linked to the time available for the observation of in-hospital mortality and in-hospital MACCE. However, 67.7% of all deaths occurred during the first 5 days. Therefore, it is conceivable that the decreased duration of in-hospital stay did not relevantly influence mortality data. Moreover, according to the unchanged pattern of discharge destination, we believe that the decreased duration of in-hospital stay rather is an indicator of better quality of care than an indication that patients were referred to other institutions and died elsewhere. Third, our statistical approach of using regression modelling in a prospective cohort does not prove a causal relationship between use of therapy and outcome. However, there are not many other possible explanations, except for the reduced delay from symptom onset to hospital admission which also is an indicator of better quality of care. Fourth, ORs originating from regression modelling may overestimate the treatment effect.[33] Moreover, patients undergoing PCI had to survive long enough to have the procedure, thus creating a survival bias. Therefore, the ORs found for PCI use are not suited to estimate the treatment effect, but are well suited to compare treatment effectiveness between time periods. Fifth, the fact that the data originate from a registry may exhibit further limitations (e.g. selection bias). However, 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. Finally, frequency of ACS diagnosis may have increased over time due to the increasing use of sensitive cardiac troponins. This may also have an effect on outcomes.[34]

Our study has clinical and research implications. In comparison with reports from other developed countries, we document high percentages of guideline-recommended therapy use for old ACS patients in Switzerland.[3,4] Our results might therefore be encouraging to promote use of guideline-recommended therapies in many countries. However, to recommend increases in the use of guideline-recommended therapies, it would be desirable to have information on further important outcomes in older ACS patients. For example, functional outcomes should be assessed in future research in addition to mortality and MACCE.[7,35]

Our study, in conclusion, documents that older ACS patients have experienced considerable improvements in in-hospital outcomes from 2001 to 2012 and that these improvements were accompanied by increases in the use of guideline-recommended therapies. Our study also documents that PCI use was associated with similar ORs of in-hospital mortality between first and last 4-year period, though it was used in increasingly older and co-morbid patients. This study therefore suggests that increasing use of guideline-recommended therapies was appropriate.

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Acute myocardial infarction in Switzerland plus participants 2001–2012

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INTERACTIVE CARDIOVASCULAR FLASHLIGHT

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A young woman with shortness of breath

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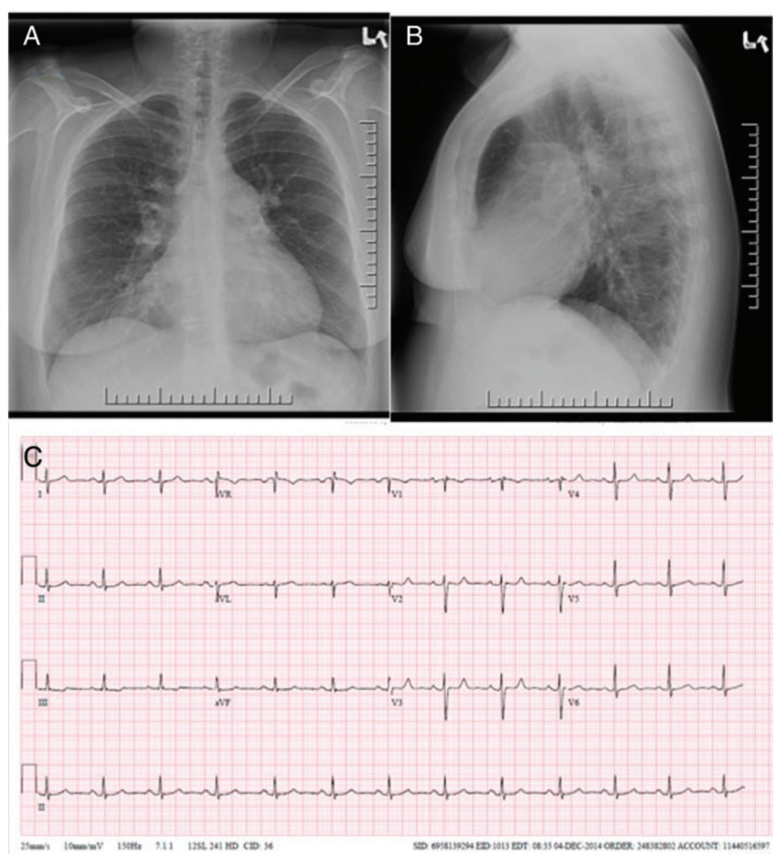
A previously well 21-year-old woman presents to her family physician with worsening dyspnoea on exertion and palpitations over the last 6 months. She describes her palpitations as regular, rapid, and occurring once a week. Her precordial examination reveals a right ventricular heave and a soft systolic murmur at the left upper sternal border. Her electrocardiogram (ECG) and chest radiograph are shown below (*Panels A–C*). This case describes the evaluation and management of a young patient with a congenital cardiac defect.

Explore full case on ESC website, case-based learning section, http://www.escardio.org/Guidelines-&-Education/E–learning/Clinical-cases.

Primary media (for abridged case): *Panels A* and *B* and chest radiograph of PA and lateral views. (*C*) Patient's 12-lead electrocardiogram.



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