Processes and outcomes for acute myocardial infarction patients

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Abstract

Purpose – The purpose of this paper is to determine whether process quality indicators for acute myocardial infarction (AMI) one associated with outcome indicators (hospital mortality and early readmission).

Design/methodology/approach – A retrospective cohort study was conducted among patients discharged from three Swiss university hospitals with a primary or secondary International Classification of Diseases, 10th revision (ICD-10) AMI code in 1999. A total of 1,129 patients' records were abstructed. Demographic characteristics and risk factors at admission were recorded. The main ECG and laboratory findings were further abstracted as well as hospital and discharge management and treatment. The main outcome measure was process quality indicators derived from evidence-based guidelines, and hospital mortality and early readmissions.

Findings – After exclusions, 577 patients with AMI were eligible for this study. The mean (SD) age was 68.2 (13.9). In the assessment of quality indicators patients with potential contra-indications were excluded. Among cohorts of "ideal candidates" for specific interventions, aspirin was not prescribed within 24 hours after admission in 33 (6.2 percent) patients. Among those, 17 (51.5 percent) died ($p < 0.0001$). The adjusted OR for no aspirin after admission was 3.61 (95 percent CI 1.11-11.77) for hospital mortality. Further, 78 (19.5 percent) patients did not receive β-blockers at discharge. Among them nine (11.5 percent) were readmitted ($p = 0.133$). The adjusted OR for no β-blockers at discharge was 2.15 (95 percent CI 0.86-5.41) for readmissions. Among patients with AMI, not prescribing aspirin within 24 hours after admission was associated with hospital mortality. However, process indicators derived from evidence-based guidelines were not related to early readmission in this study.

Originality/value – The paper stresses the importance of clinicians confronting their decisions with recommendations of evidence-based guidelines for the management and treatment of AMI patients.

Keywords Cardiovascular diseases, Patient care, Quality indicators, Switzerland, Hospitals

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Introduction

Acute myocardial infarction (AMI) is a major cause of morbidity and mortality worldwide. In Western Europe, the ten-year coronary heart disease death rate among men, ranged from 2 percent in Spain to 11 percent in Finland (Conroy *et al.*, 2003). In

Switzerland, ischemic diseases are responsible for 17 percent of death in men and 16 percent in women (Wietlisbach, 2004). Because of its burden in term of prevalence and mortality, AMI has been a topic of intense scientific and clinical interest. Therefore, several professional groups have issued clinical practical guidelines to optimize the diagnosis and management of AMI (Antman *et al.*, 2004; Van de Werf *et al.*, 2003).

Furthermore, studies have shown that if patients with AMI are not treated according to evidence-based clinical guidelines, worth outcomes will be observed. We have previously shown the same pattern for heart failure patients (Luthi, 2002, 2003, 2004), but in this study, we focus on AMI. Process and outcomes have been reported in previous studies (Burwen *et al.*, 2003; Baker *et al.*, 2004; Urban *et al.*, 2000; Wei *et al.*, 2002), some of which have shown improvement in process and outcomes of care after interventions (Marciniak *et al.*, 1998; Beck *et al.*, 2003) and some after having reported quality rating publicly (Krumholz *et al.*, 2002; Baker *et al.*, 2002). In one study including Medicare beneficiaries from all acute care hospital in the US in 1994 and 1995, Krumholz *et al.* (1999) observed that patients who received β-blockers had lower hospital mortality than patients who did not receive the drug (Krumholz *et al.*, 1999). In another study conducted in the US between 1988 and 1994, patients who received thrombolytic therapy or angioplasty or coronary surgery during the index hospitalization were less frequently rehospitalized (Maynard *et al.*, 1997). The purpose of this study was to determine whether process quality indicators for AMI patients were associated with hospital mortality and early readmission.

Methods

Setting and patients

We conducted a retrospective cohort study of adult patients hospitalized for AMI in three Swiss academic medical centers. These hospitals were urban, public university hospitals, the major tertiary care centers for their respective areas and participated voluntarily in the study. Patients included in the study were discharged from these hospitals from January 1 to December 31, 1999, with a primary or a secondary diagnosis of AMI (International Classification of Disease, 10th revision (ICD-10) codes I21.0-I21.9, I22.0-I22.9, and I23.0-I23.8).

We found respectively 553, 380 and 196 eligible patients in these three hospitals (total: 1129). We excluded 236 patients discharged to another acute care facility, three patients who left the hospital against medical advice, four with inconsistent date of discharge, 97 not hospitalized for AMI but erroneously coded as such, and 70 patients with an incomplete or missing chart. We further excluded 142 cases because the episode did not match the clinical definition of AMI, using the definition described in the consensus document of the Joint European Society of Cardiology/American College of Cardiology Committee for the Redefinition of Myocardial Infarction (Anonymous, 2000). This definition includes typical rises or gradual falls (Troponin) or more rapid rises or falls (CK-MB) of biochemical markers of myocardial necrosis with at least one of the following:

- ischemic symptoms;
- development of pathologic Q-waves on the ECG; and
- ECG-changes as indicative of ischemia (ST-segment elevation or depression).

The final sample size was 577.

Data

Data abstraction was conducted by trained medical doctors or medical record specialists. In two hospitals, the entire medical charts were available for data abstraction. In the third one, only the electronic medical records, which included the discharge letter, laboratory results, and all cardiological procedures, were obtained. Variables abstracted from the charts included age, sex, smoking status, hypertension, diabetes, hyperlipemia, history of heart failure, stroke, angina pectoris, or myocardial infarction. Clinical information included a measure of chest pain, syncope, dyspnea and cardiogenic shock. We also recorded ECG findings and laboratory values, as well as, if available, the ejection fraction or a narrative description of the ejection fraction on an echocardiography, angiography or ventriculography. We also abstracted medications at admission (including thrombolytics), during hospitalization and at discharge as well as specific procedures such as percutaneous transluminal coronary angioplasty (PTCA) and coronary artery bypass surgery. The Charlson co-morbidity index, a weighted average of selected co-morbidities, was computed at the index hospitalization for each patient as a measure of severity of illness, using the Deyo *et al.* (1992) modification. Information on hospital mortality and readmissions within 30 days were identified at using administrative data sets from hospitals.

Quality indicators

Quality indicators were developed from evidence-based guidelines. They were derived from the US Cooperative Cardiovascular Project (Jencks *et al.*, 2003), and used in many studies. The development of these performance measures for AMI was based on the reliability and validity of the indicator and on the evidence of a process-outcome link (Spertus *et al.*, 2003). They were adapted locally with key clinicians. The first quality indicator (QI) was the measure of a timely reperfusion within 12 hours of admission by use of thrombolytics or percutaneous transluminal coronary angioplasty. Patients who were treated only with thrombolytics (no percutaneous transluminal coronary angioplasty) were excluded if they had a contraindication to thrombolytics. We abstracted the time in minutes between the admission and the procedure. The second and third QI were the prescription of aspirin, respectively within 24 hours after admission, and at discharge. We excluded patients with contra-indications to aspirin. For all QI related to a prescription or counseling at discharge, we excluded patients who died at the hospital. The fourth QI was the prescription of β-blockers at discharge. All β-blockers prescribed at discharge were recorded and patients with contra-indication were excluded. The fifth QI was prescription of angiotensin converting enzyme inhibitors at discharge in patients with left ventricular systolic dysfunction, which was defined as a value of the ejection fraction ≤ 40 percent documented in the chart from the current hospitalization. If no quantified information was found in the chart, a patient was classified as having left ventricular systolic dysfunction based on narrative terms describing the ejection fraction. Angiotensin converting enzyme inhibitors were identified in the medical charts through generic or trade name. We excluded from the study patients who experienced any of the listed contraindication to angiotensin converting enzyme inhibitors. Finally, we assessed smoking cessation counselling with the information available in the medical record.

Statistical analysis

First, bivariate analyses were conducted using, when appropriate, chi-square tests, Fisher's exact-tests and *T*-tests. Then, we performed a multivariate analysis using logistic regression. Considering the relatively small sample size and the large number of potential confounders, we used *a priori* considerations and bivariate results to initially select potential confounders. After having defined the starting model that included all selected potential confounders, we eliminated, by backward elimination, those potential confounders. Starting with the least significant covariate, we assessed whether the OR changed by more than 10 percent compared to the OR for the starting model. If the OR changed by more than 10 percent, the variable was retained, otherwise it was dropped. After this process the resulting model became the "final" model (Kleinbaum and Klein, 2000). None of the models showed evidence of collinearity problems. All analyses were conducted with the SAS-software, version 8.02 (SAS institute Inc., Cary, NC, USA).

Results

Of the 577 eligible patients, the mean (SD) age of the entire sample was 68.2 (13.9), 65.2 percent were males, 12.6 percent had a previous history of heart failure, 35.5 percent a previous AMI or history of angina, 6.5 percent a previous stroke, 55.2 percent hypertension, 67.8 percent hyperlipidemia, 22.8 percent diabetes, and 31.5 percent were current smokers.

Patients' characteristics by outcomes

Among 577 eligible patients, 79 (13.7 percent) died in the hospital. The mean (SD) age was 74.4 (13.3) among those who died. Further, more patients with a previous history of heart failure, with a diagnosis of diabetes, syncope, dyspnea, and cardiogenic shock died in the hospital. We also noted in our sample that fewer patients with hyperlipemia and who were current smokers died in the hospital (Table I).

Among 497 patients who did not die in the index hospital and who were, therefore, eligible for readmission, the mean age of patients readmitted was slightly higher compared to patients not readmitted. We observed that patients with a previous AMI or angina, as well as patients with dyspnea and cardiogenic choc were more readmitted.

Table II presents hospital characteristics by outcomes. We noted that more patients with Q waves and anterior AMI on ECG died during the index hospitalization. However, none of the ECG findings were associated with early readmission.

Association between process and outcomes

In the assessment of quality indicators, we excluded patients with potential contra-indications to the interventions examined. Among cohort of "ideal candidates" for specific interventions, 49 (33.8 percent) did not receive re-perfusion within 12 hours after admission, neither with thrombolytics nor PTCA. Aspirin was not prescribed within 24 hours after admission by 33 (6.2 percent) patients and aspirin was not prescribed at discharge in 43 (9.0 percent).

Table III presents the bivariate association between hospital mortality, 30 days readmission, and process quality indicators. Our results showed that among patients

Table I. Demographic characteristics, cardiac risk factors, symptoms and clinical findings at admission of patients with acute myocardial infarction by outcomes, $n = 577$

	Hospital mortality $n = 577$					30-days readmissions $n = 497$				
Patients' characteristics	*N*	Mean (SD)	*N* dead (%)	Mean (SD)	*p*-value	*N*	Mean (SD)	*N* readmitted (%)	Mean (SD)	*p*-value
Total	577		79	(13.7)		497		41	(8.3)	
Mean age (SD)	68.2	(13.9)	74.4	(13.3)	< 0.0001	67.2	(13.7)	70.6	(13.5)	0.098
Sex					0.255					0.767
Male	376		47	(12.5)		329		28	(8.5)	
Female	201		32	(15.9)		168		13	(7.7)	
Previous history HF ($n = 538$)	68		16	(23.9)	0.003	52		7	(13.5)	0.100
Previous AMI or angina ($n = 564$)	200		30	(15.0)	0.281	170		21	(12.4)	0.020
Previous stroke ($n = 570$)	37		6	(16.2)	0.613	31		4	(12.9)	0.312
Hypertension ($n = 569$)	314		41	(13.1)	0.857	273		25	(9.2)	0.434
Hyperlipidemia ($n = 503$)	341		22	(6.5)	< 0.0001	318		20	(6.3)	0.021
Diabetes ($n = 570$)	130		28	(21.5)	0.001	102		12	(11.8)	0.161
Current smoker ($n = 569$)	179		9	(5.0)	0.0002	170		9	(5.3)	0.088
Clinical findings										
Chest pain ($n = 564$)	468		52	(11.1)	0.0007	415		34	(8.2)	0.650
Syncope ($n = 570$)	58		23	(39.7)	< 0.0001	35		3	(8.6)	1.00
Dyspnea ($n = 564$)	189		40	(21.2)	< 0.0001	149		19	(12.8)	0.032
Cardiogenic shock ($n = 568$)	67	49	(73.1)	0.0007	< 0.0001	18		4	(22.2)	0.054
Mean BMI $n = 330$	26.2	(4.5)	27.5	(6.5)	0.320	26.1	(4.3)	25.2	(3.7)	0.166
Hospital ($n = 577$)					0.0005					0.179
A	216		34	(15.7)		181		20	(11.1)	
B	270		23	(8.5)		247		15	(6.1)	
C	91		22	(24.2)		69		6	(8.7)	

Notes: HF: heart failure; AMI: acute myocardial infarction; BMI: body mass index; SD: standard deviation

Table II. Hospital characteristics of patients with acute myocardial infarction by outcomes, $n = 577$

Patients' characteristics	Hospital mortality $n = 577$					30-days readmissions $n = 497$				
	N	Mean (SD)	*N* dead (%)	Mean (SD)	*p*-value	*N*	Mean (SD)	*N* readmitted (%)	Mean (SD)	*p*-value
Total	577		79	(13.7)		497		41	(8.3)	
Q wave ($n = 529$)	154		28	(18.2)	0.040	126		8	(6.4)	0.353
ST up ($n = 518$)	319		48	(15.1)	0.196	270		22	(8.2)	0.594
ST down ($n = 517$)	196		30	(15.3)	0.359	166		17	(10.2)	0.389
Left bundle block ($n = 544$)	31		5	(16.1)	0.579	26		4	(15.4)	0.257
Anterior AMI ($n = 545$)	226		40	(17.7)	0.033	186		14	(7.6)	0.733
Mean (SD) cholesterol in mmol/l ($n = 506$)	5.8	(1.6)	6.3	(2.0)	0.048	5.7	(1.5)	5.5	(1.4)	0.358
Mean (SD) HDL in mmol/l ($n = 369$)	1.1	(0.3)	1.1	(0.4)	0.970	1.1	(0.3)	1.2	(0.4)	0.751
Mean ejection fraction in % ($n = 383$)	46.9	(14.3)	35.3	(13.8)	< 0.0001	47.9	(13.9)	39.2	(13.8)	0.0007
Mean (SD) Charlson comorbidity index ($n = 577$)	1.6	(1.4)	1.6	(1.5)	0.868	1.6	(1.4)	1.9	(1.6)	0.201
Mean (SD) Length of stay ($n = 577$)	12.9	(12.7)	5.9	(7.4)	< 0.0001	13.9	(13.0)	19.2	(19.1)	0.065

Notes: AMI: acute myocardial infarction; HDL: high density lipoprotein; SD: standard deviation

Table III.
Association between process quality indicators and outcomes, bivariate analysis, $n = 577$

Quality indicators	Hospital mortality $n = 577$ N	N dead (%)		p-value	30 days readmissions $n = 497$ N	N readmitted (%)		p-value
Total	577	79	(13.7)		497	41	(8.3)	
No receipt of reperfusion within 12 hours either with thrombolytics or primary PTCA ($n = 145$)	49	3	(6.1)	0.545	46	4	(8.7)	0.719
No aspirin within 24 hours ($n = 532$)	33	17	(51.5)	< 0.0001	16	1	(6.3)	0.797
No aspirin at discharge ($n = 477$)	NA	NA		NA	43	3	(7.0)	0.802
No β-blockers at discharge ($n = 399$)	NA	NA		NA	78	9	(11.5)	0.133
No ACEI at discharge if LVSD ($n = 154$)	NA	NA		NA	32	5	(15.6)	0.535
No smoking cessation advice ($n = 158$)	NA	NA		NA	90	6	(6.7)	0.240

Notes: PTCA: percutaneous transluminal coronary angioplasty; ACEI: angiotensin converting enzyme inhibitors; LVSD: left ventricular systolic dysfunction. NA: not applicable because relates only to patients discharged alive who did not receive aspirin within 24 hours after admission, 17 (51.5 percent) died ($p < 0.0001$).

The results of the multivariate analysis controlling for potential confounding factors are presented in Table IV. The adjusted odds ratio (OR) for no reperfusion was 1.78 (95 percent confidence interval (CI) 0.15-21.29) for hospital mortality and 0.80 (95 percent CI 0.15-4.23) for 30 days readmission. The risk of dying during the hospital stay was 3.61 times higher in patients who were not prescribed aspirin within 24 hours after admission ($p = 0.033$). Among patients with no contra-indications to β-blockers, the adjusted OR for readmission was 2.15 (95 percent CI 0.86-5.41). Finally, none of the association between readmission and process quality indicators were statistically significant in the multivariate analyses.

Discussion

The first main finding of our study is that not prescribing aspirin within 24 hours after admission was associated with higher hospital mortality. These results showed occurrence of worse outcomes when patients are not treated according to evidence based-guidelines. Similar findings of higher hospital death rates among AMI patients not receiving appropriate process of care has been described in previous studies. One study investigating time delays related to AMI treatment showed that in a cohort of more than 27,000 patients treated with primary angioplasty, door-to-balloon time longer than two hours was an important factor associated with hospital mortality (Canon *et al.*, 2000). In another study, including Medicare beneficiaries, patients who were prescribed early β-blocker therapy had significant lower mortality rates than those who did not (Krumholz *et al.*, 1999). Increasing the use of β-blockers for these patients would have provided an excellent opportunity to improve their care and outcomes. In another study conducted in the context of the Swiss AMIS PLUS project that included more than 7,000 patients between 1997 and 2002, early prescription of aspirin was shown to reduce the risk of hospital death (adjusted odd ratio: 0.63) (Erne *et al.*, 2003). Results of the AMIS PLUS project showed as well that early use of β-blockers and ACE inhibitors had a beneficial effect on hospital mortality (Erne *et al.*, 2003).

The second main finding of our study was that we did not find an association between early readmission and process quality indicators. We have already observed the absence of such relationship among the same University hospitals, in heart failure patients (Luthi *et al.*, 2004). However, the present study was not entirely negative. We cannot rule out an association since the power was not very high and because some OR were > 1, especially the OR for β-blockers. Therefore, even if process quality indicators for AMI patients were not associated with early readmission in our data, there is considerable evidence that recommendations documented in evidence-based clinical guidelines for the management and treatment of AMI patients improve outcomes (Beck *et al.*, 2003; Meehan *et al.*, 1995; Krumholz *et al.*, 2003). Methods for measuring process quality indicators for AMI patients have clearly been established (Jencks *et al.*, 2003; Spertus *et al.*, 2003). Measuring outcomes, especially readmission is more difficult and more controversial. Some authors have found an association between process of care and readmission. In a meta-analysis, Ashton *et al.* found an association between early readmission and quality indicators and quality of care (Ashton *et al.*, 1997). In another study, Maynard *et al.* showed that patients who

Table IV. Association between process quality indicators and outcomes, multivariate analysis, $n = 577$

Quality indicators	Hospital mortality $n = 577$ N	Adjusted OR (95 percent CI)	p-value	30 days readmissions $n = 497$ N	Adjusted OR (95 percent CI)	p-value
No receipt of reperfusion within 12 hours either with thrombolytics or primary PTCA	144	1.78* (0.15-21.29)	0.643	132	0.80** (0.15-4.23)	0.790
No aspirin within 24 hours	523	3.61** (1.11-11.77)	0.033	402	0.64*** (0.08-5.19)	0.679
No aspirin at discharge	NA	NA	NA	412	0.89**** (0.24-3.30)	0.857
No β-blockers at discharge	NA	NA	NA	354	2.15**** (0.86-5.41)	0.103
No ACEI at discharge if LVSD	NA	NA	NA	124	1.08***** (0.26-4.52)	0.916
No smoking cessation advice	NA	NA	NA	157	3.25****** (0.35-30.09)	0.299

Notes: PTCA: percutaneous transluminal coronary angioplasty; ACEI: angiotensin converting enzyme inhibitors; LVSD: left ventricular systolic dysfunction; AMI: acute myocardial infarction. NA: not applicable because relates only to patients discharged alive. *Controlling for age, syncope, cardiogenic shock and dyspnea; **Controlling for age and cardiogenic shock; ***Controlling for previous AMI or angor, hyperlipidemia, dyspnea and cardiogenic shock; ****Controlling for hospitals, age, previous AMI or angor, hyperlipidemia, dyspnea and cardiogenic shock; *****Controlling for hospitals, previous AMI or angina, hyperlipidemia, dyspnea and cardiogenic shock; ******Controlling for previous AMI or angina received thrombolytic therapy or coronary angioplasty were less frequently readmitted (Maynard *et al.*, 1997). However, the link between quality of care and early readmission has not been clearly established. There is especially a lack of appropriate adjustment methods. This pushed the AMI working group of the American Heart Association/American College of Cardiology First Scientific Forum on Quality of Care and Outcome Research in Cardiovascular Diseases and Stroke to recommend not using readmission as outcome measure for comparing hospital at this stage (Spertus *et al.*, 2003).

Several limitations may have biased our results. First, in Switzerland administrative discharge data have been mandatory records since 1998. The quality of data has improved but is still very heterogeneous across providers. In particular, only 196 eligible AMI patients were identified through ICD-10 codes in one hospital, which is about the same size as the two others included in the study where twice the number of patients were recorded. A selection bias may have occurred because of this lower figure in the identification of AMI patients in one hospital. Another limitation is related to the chart abstraction process, which was conducted in each hospital by a different person with various educational backgrounds, although training, abstraction and reporting procedures were similar across hospitals. Another limitation reflects the voluntary participation of hospitals in this study. Representativeness could differ considerably between these voluntary hospitals and other hospitals, making the generalization of these results questionable.

In conclusion, our results suggest that early aspirin use by patients with acute myocardial infarction was associated with reduced in hospital mortality, but that readmission was not associated with process quality indicators in our data. However, even if we found controversial results regarding readmissions, it is important that clinicians confront their decisions with the recommendations of evidence-based guidelines for the management and treatment of AMI patients.

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