



Original Article

Inpatient versus outpatient onsets of acute myocardial infarction[☆]

Paul Erne^{a,b}, Osmund Bertel^c, Philip Urban^d, Giovanni Pedrazzini^e, Thomas F. Lüscher^f,
Dragana Radovanovic^{g,*}, on behalf of the AMIS Plus Investigators

^a AMIS Plus, Hirschengraben 84, CH-8001 Zurich, Switzerland

^b Department of Cardiology, Cardiology Clinic, University Hospital Zurich, Rämistrasse 100, CH-8091 Zurich, Switzerland

^c Cardiology Center, Klinik im Park, Seestrasse 220, CH-8027 Zurich, Switzerland

^d Cardiovascular Department, La Tour Hospital, 3, avenue J.-D. Maillard, CH-1217 Geneva, Switzerland

^e Division of Cardiology, Cardiocentro Ticino, Via Tesserete 48, CH-6900 Lugano, Switzerland

^f University Heart Center, Department of Cardiology, University Hospital Zurich, Rämistrasse 100, CH-8091 Zurich, Switzerland

^g AMIS Plus Data Center, Epidemiology, Biostatistics and Prevention Institute, University of Zurich, Hirschengraben 84, CH-8001 Zurich, Switzerland

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ABSTRACT

Background: There are few studies on patients suffering acute myocardial infarction (AMI) when already in hospital for other reasons; therefore, this study aimed to compare patients with in-hospital-onset AMI admitted for either medical or surgical reasons versus patients with outpatient-onset AMI.

Methods: Patients enrolled in the AMIS Plus registry from 2002 to 2014 were analyzed. The main endpoint was in-hospital mortality.

Results: Among 35,394 AMI patients, 356 (1%) had inpatient-onset AMI following hospital admission due to other pathologies (surgical 175, non-surgical 181). These patients were older (74 vs. 66 years; $P < 0.001$), more often female (35% vs. 27%; $P < 0.001$), had less frequently ST-elevation myocardial infarction (35.5% vs. 55.5%; $P < 0.001$), but higher risk profiles: hypertension (83% vs. 62%; $P < 0.001$), diabetes (28% vs. 20%; $P = 0.001$), known coronary artery disease (54% vs. 35%; $P < 0.001$), and more comorbidities (Charlson Comorbidity Index above 1 in 51% vs. 22%; $P < 0.001$) than those with outpatient-onset AMI. Percutaneous coronary intervention was less frequently applied (OR 0.45; 95% CI 0.36–0.57), and they were less likely to be treated with aspirin (OR 0.43; 95% CI 0.37–0.59), P2Y12 blockers (OR 0.42; 0.34–0.52) or statins (OR 0.51; 95% CI 0.41–0.63). Crude mortality was higher (14.3% vs. 5.5%; $P < 0.001$) and inpatient-onset AMI was an independent predictor of in-hospital mortality (OR 2.35; 95% CI 1.63–3.39; $P < 0.001$).

Conclusions: Patients with in-hospital-onset AMI were at greater risk of death than those with outpatient-onset AMI. More work is needed to improve the identification of hospitalized patients at risk of AMI in order to provide the appropriate management.

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1. Introduction

There are very few studies on patients suffering acute myocardial infarction (AMI) when already hospitalized for other reasons [1,2]. In particular, prospective data are lacking in this patient population, and the magnitude of the problem has not been appropriately examined.

Of the studies available, the majority come from the surgical field. Annually, more than 200 million patients undergo surgical procedures [1], and for such patients, AMI is the most common major perioperative vascular complication [3]. Of the patients undergoing non-cardiac, non-neurological surgery, 0.24% developed Q-wave AMI within 30 days post surgery [4]. A cohort study of 8351 patients who underwent non-cardiac surgery in 190 centers of 23 countries noted an AMI incidence of

5.0% within 30 days [5]. However, patients experiencing an AMI after non-cardiac surgery have a hospital mortality rate of 15%–25% [6].

Cardiovascular complications including AMI can occur during the acute phases of many diseases, during pregnancy [7], or during medical procedures, and little is known on the incidence and outcome of AMI developing during hospitalizations for other than surgical reasons. Therefore, the aim of this study was to compare the baseline characteristics, treatments, and outcomes of patients prospectively enrolled in the AMIS Plus registry with in-hospital-onset AMI admitted for either medical or surgical reasons versus those patients with outpatient-onset AMI.

2. Methods

The AMIS Plus project is an ongoing nationwide prospective registry of patients admitted with acute coronary syndromes (ACS) to hospitals in Switzerland. It was founded by the Swiss Societies of Cardiology,

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* Corresponding author. Tel.: +41 44 634 48 34; fax: +41 44 634 49 86.

E-mail address: dragana.radovanovic@uzh.ch (D. Radovanovic).

Internal Medicine and Intensive Care Medicine in 1997 with the goal to understand the transfer, use, and practicability of knowledge gained from randomized trials in the real world of daily clinical practice. Details have been previously published [8–12]. From 106 hospitals treating ACS in Switzerland, 82 hospitals temporarily or continuously enrolled patients in AMIS Plus. Participating centers, ranging from community institutions to large tertiary facilities, provided blinded data for each patient through standardized Internet- or paper-based questionnaires. All data were checked for completeness, plausibility, and consistency by the AMIS Plus Data Center in the Epidemiology, Biostatistics and Prevention Institute at the University of Zurich and treating physicians or study nurses were queried when necessary. External monitoring has been carried out regularly since 2010 in randomly selected hospitals using randomly selected cases. The registry was approved by the Supra-Regional Ethics Committee for Clinical Studies, the Swiss Board for Data Security, and the Cantonal Ethics Commissions.

The questionnaire comprised items addressing medical history, comorbidities, known cardiovascular risk factors, clinical presentation, out-of-hospital management, early in-hospital management, reperfusion therapy, hospital course, used or planned diagnostic tests, length of stay, discharge medication, and discharge destination. Patients were enrolled on the basis of their final discharge diagnosis.

Information on known risk factors was obtained from the patient's medical history. Dyslipidemia, arterial hypertension, and diabetes were considered if the patient had been previously treated for such a condition and/or diagnosed by a physician. Patients were defined as obese if the body mass index was ≥ 30 kg/m² and as smokers if the patient was smoking at the time of the cardiovascular event. Patient comorbidities were assessed using the Charlson Index [13,14]. Immediate drug therapy was defined if administered within 24 hours after admission. Bleeding complications were recorded if deemed clinically relevant by the individual physician caring for the patient, without the use of a classification system. Reinfarction was defined as clinical signs or symptoms of ischemia with ECG changes indicative of new ischemia (new ST-changes or new LBBB) and a re-rise of biomarkers following the initial infarction. A stroke was defined as any event due to ischemic, thrombotic, or hemorrhagic disturbances confirmed by a neurologist or imaging modality.

The primary outcome measure was in-hospital mortality. Secondary outcome measures were the rates of in-hospital major adverse cardiac or cerebrovascular events (MACCE) defined as a composite endpoint of mortality, reinfarction, and cerebrovascular events. An additional outcome measure in a subgroup of patients was 1-year mortality.

2.1. Patient selection

The present analysis included all patients enrolled in AMIS Plus between January 2002 and September 2014. AMI was defined by characteristic symptoms and/or ECG changes and cardiac marker elevation (creatinine kinase MB fraction at least twice the upper limit of normal or troponin I or T above individual hospital cut-off levels for AMI). Patients with unstable angina were excluded.

The patients with in-hospital-onset AMI were additionally divided into three groups according to the primary admission reasons: surgery, internal medicine diseases (including gastric, urological, pulmonary, neurological, oncological, dermatological, and ophthalmological diseases), and diagnostic procedures.

Subgroup analyses for 1-year mortality after discharge were performed using patients enrolled from 2006 to 2014, who had signed an informed consent form for follow-up participation.

2.2. Statistical analysis

The results are presented as percentages for categorical variables and analyzed using the non-parametric Pearson chi-square test or Fisher's exact test as appropriate. Continuous normally distributed

variables are expressed as means $\pm$ 1 standard deviation (SD) and compared using the Student's two-tailed unpaired t-test. Continuous non-normally distributed variables are expressed as median and interquartile ranges and analyzed using the Mann–Whitney *U* test. The differences in immediate and discharge therapies between the groups, the odd ratios (OR) were additionally adjusted for age and gender. A univariate analysis was carried out using all available variables and calculated only for patients with no missing variables. To determine in-hospital independent mortality predictors, a multivariate logistic regression model was applied for the same population using the following variables: inpatient-onset AMI, age, sex, Killip class >2 , the risk factors dyslipidemia, hypertension, and diabetes as well as a Charlson comorbidity weighted index >1 . The results of logistic regression are reported as OR with a 95% confidence interval (95% CI). A probability value of $P < 0.05$ was considered significant. SPSS software (version 22, SPSS Inc, Chicago, Illinois, USA) was used for all other statistical analyses.

3. Results

Between 2002 and 2014, 35,394 patients with AMI from 68 Swiss hospitals were enrolled in the AMIS Plus Registry. From these, 356 (1%) suffered in-hospital-onset AMI: 121 patients (34%) were hospitalized for various internal medicine diseases, such as gastric (6.7%), pulmonary (5.1%), urological (6.7%), neurological (6.2%), oncological (3.7%), or other medical disorders (ophthalmological or dermatological conditions, infections or delivery; 3.9%), 175 (49.2%) for surgery (orthopedic, visceral, or vascular), and 60 (16.9%) patients were hospitalized for diagnostic procedures.

Inpatient-onset AMI patients were older, more often female, hypertensive or diabetic with more moderate to severe comorbidities than those with outpatient-onset AMI. Chest pain was less frequently the leading symptom for AMI in patients admitted for other indications (Table 1).

Patients who suffered in-hospital-onset AMI underwent less frequently percutaneous coronary interventions, and if performed then considerably later with a median of 24 hours after symptom onset. These patients were less likely to immediately receive drugs such as aspirin, P2Y12 blockers, or statins even after adjusting for gender and age (Table 2).

Table 1
Baseline characteristics of patients according to AMI-onset location.

	Outpatient-onset AMI	Inpatient-onset AMI	P value
Number of patients	35,038	356	
Sex female	9406/35,038 (26.8)	123/356 (34.6)	0.001
Age in years, mean (SD)	66.1 (13.3)	74.0 (10.6)	<0.001
Symptoms			
Pain	28,597/33,264 (86.0)	207/308 (67.2)	<0.001
Dyspnea	9329/30,895 (30.2)	104/303 (34.3)	0.13
ST-elevation myocardial infarction	19,359/34,875 (55.5)	126/355 (35.5)	<0.001
Killip classes 3/4 at presentation	2426/34,837 (7.0)	51/351 (14.5)	<0.001
Risk factors			
Smoking	12,145/31,623 (38.4)	84/287 (29.3)	0.002
Dyslipidemia	17,878/30,796 (58.1)	211/312 (67.6)	0.001
Hypertension	20,460/33,132 (61.8)	278/336 (82.7)	<0.001
Obesity (BMI ≥ 30)	6243/29,751 (21.0)	62/311 (19.9)	0.72
Diabetes	6753/33,513 (20.2)	95/344 (27.6)	0.001
Coronary artery disease	11891/34,448 (34.5)	188/347 (54.2)	<0.001
Charlson Comorbidity Index >1	7723/35,038 (22.0)	182/356 (51.1)	<0.001

n/N (%)

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