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Impact of contemporary emergency percutaneous coronary angioplasty for acute myocardial infarction on length of hospital stay

B.A. Schaer[a], *S. Osswald*[a], *M. J. Zellweger, S. Jegge, C. Sticherling, M. Pfisterer*

Clinic for Cardiology, University Hospital, Basel, Switzerland

Summary

Questions under study: Compared to thrombolysis, acute percutaneous coronary intervention (PCI) in patients with acute myocardial infarction (AMI) allows both immediate revascularisation and identification of additional relevant stenosis, so that subsequently no further risk stratification should be necessary and hospital stay shortened. Our aim was to evaluate the impact of PCI on outcome and length of hospital stay after MI compared to that in the thrombolysis era.

Methods: Retrospective evaluation in a Swiss tertiary referral centre of 105 patients with AMI undergoing emergency PCI, who initially were neither in cardiogenic shock nor transferred to another primary or secondary care hospital for further treatment. Main outcome measurement was length of overall hospital stay. Additional measurements included mortality, left ventricular function, and time point of the last major adverse cardiac event (MACE).

Results: Overall hospitalisation time was 11.1 ± 6.8 days, thus being only 1.5 days shorter than in the thrombolysis era. Age above 70 or type of infarction did not influence hospitalisation time, but age below 60 years did. In-hospital mortality was 1%. Left-ventricular function was considerably impaired (<35%) in 6 patients. After the sixth hospital day, 97% of MACE had occurred.

According to a validated risk score, 92% of patients belonged to a low risk group with a 30-day mortality risk of 1.4% or less and could have been discharged not later than day 6.

Conclusions: Our data suggest that an early discharge strategy, although safe in low risk patients is not followed at the present time. This approach could further reduce costs without jeopardizing outcome.

Key words: acute myocardial infarction; emergency percutaneous coronary intervention; hospital stay; discharge; outcome; risk assessment

Introduction

Definition and treatment of acute myocardial infarction (STEMI and NSTEMI) have undergone major changes over the last decades. Twenty years ago, most patients were treated with aspirin and bed rest, had risk stratification before discharge and only a minority of patients underwent coronary angiography. Hospitalisation time was between two and three weeks or even longer. Introduction of thrombolytic therapy in the mid-eighties altered the management of patients, which resulted both in an important reduction in infarct mortality [1] and in a decrease of hospitalisation time to an average of 10 to 12 days [2, 3]. Contemporary studies demonstrated the advantage of acute PCI as compared to thrombolysis [4–6] so that now a majority of patients undergo acute PCI instead of thrombolysis. However, even though the vessel status of patients after PCI is known and mobilisation could start early after the event without fear of further myocardium at risk, the influence of acute PCI on a further reduction in hospital stay is not clear.

We therefore conducted a retrospective analysis in order to analyze the length of hospital stay and to identify patients who could have been discharged earlier than is current practice.

Abbreviations

AMI	acute myocardial infarction
MI	myocardial infarction
PCI	percutaneous coronary intervention
STEMI	ST elevation myocardial infarction
NSTEMI	Non-ST elevation myocardial infarction
CCU	Coronary care unit
ICD	Implantable cardioverter defibrillator
MACE	Major adverse cardiac events
DRG	Diagnosis related groups

[a] equal contribution

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Methods

We included all patients hospitalised on the cardiac care unit (CCU) in our hospital, who had a myocardial infarction and underwent emergency PCI within 24 hours after symptom onset. Eligible patients had to have acute chest pain lasting at least 20 minutes, new dynamic ECG changes and elevated serum troponin T and CK/CK-MB levels. Patients with acute coronary syndrome (ECG changes without elevated CK/CK-MB levels) were not considered. Patients hospitalised on the intensive care unit in cardiogenic shock or who needed respiratory or circulatory support were excluded. The reason for this exclusion was that these patients constitute a high-risk population in whom an early-discharge strategy would not be feasible. Finally, patients who were transferred to another hospital after PCI were excluded, since data in these patients could not be assessed properly.

Hospitalisation time on the CCU (in hours) and overall hospitalisation time were assessed. Patients were usually transferred to the regular ward about 48 hours after symptom onset or later in case of complications. Any medical reason explaining a prolonged hospitalisation was classified as either cardiac or non-cardiac. All further cardiac tests during follow-up were monitored and the exact hospitalisation day, when the last of these tests took place, was determined. All drug changes and dosage modifications were registered and again the exact day of the last modification was specified. The following events were classified as major cardiac events (MACE): death, MI, unstable angina, acute stent thrombosis, recurrent PCI, development of congestive heart failure and ventricular arrhythmias.

In order to estimate the individual risk after MI we determined the Zwolle risk score [7] in every patient. This validated score was designed to estimate mortality risk in patients with PCI for acute MI based upon 6 factors (Killip class, TIMI flow after PCI, age below/above 60 years, presence or absence of 3-vessel disease, presence of anterior infarction, and ischaemia time less or more than 4 hours). The last factor was not assessed in our study, but taken as positive in every patient so as to slightly overestimate the risk than to underestimate it.

Vital status was assessed one year after myocardial infarction. If a patient had died, the family doctor was asked for the mode of death (cardiac or non-cardiac).

Statistical analysis

Data are presented as mean ± one standard deviation. Continuous variables were compared with Student's t-test and categorical variables by the Fisher's exact test. A p-value <0.05 was considered statistically significant. Statistical analysis was done with the StatView software package version 5.0 (SAS Institute Inc., Cary, NC/USA).

Results

Over a period of 14 months (4/2002–6/2003), 105 consecutive patients met the inclusion criteria. Seventy-nine percent were male; age was 59 ± 11.5 years with a range of 34 to 81. Baseline characteristics are shown in Table 1. PCI was successful in all but one patient, who later underwent bypass surgery. The majority of patients stayed on the CCU for three calendar days (n = 82), 19 patients stayed for 4 days, 3 for 2 days and there was one prolonged hospitalisation of 12 days. This patient had an AMI complicated by the development of complete AV block in need of temporary pacing in addition to severe gastrointestinal bleeding. In 9 of the 12 patients remaining on the unit for 4 days, the main reason was lack of an available bed on the regular ward. The other three patients required an extended stay due to heart failure (1 patient) and ventricular arrhythmias (2 patients), respectively. Hospitalisation time on the CCU was 52 ± 15 hours, a 10/90 percentile range from 40 to 63 hours.

Table 1

Baseline characteristics of patients.

Interval between onset of pain and PCI <12 hours	82%
Interval between onset of pain and PCI 12–24 hours	18%
Infarct related vessel:	
left anterior descending artery	44%
left circumflex artery	21%
right coronary artery	35%
Risk factors:	
smoking	63%
elevated cholesterol	62%
hypertension	50%
family history of CAD	38%
diabetes	18%
history of CABG/PCI	16%

Echocardiography (on day 5.3 ± 2.7) for determination of left ventricular function was performed in 82 patients (78%). An ejection fraction of 35% or less, indicating the need of further arrhythmia risk stratification, was found in only 6 of these patients (7%). Ejection fraction was between 35% and 50% in 40% of patients and higher than 50% in the remainder. A treadmill test was obtained in 19 patients, usually the day before discharge or on the discharge day itself. Holter monitoring was done in 7 patients. An ICD was implanted in 4 patients (3 according to the MUSTT criteria [8], 1 according to the MADIT-2 criteria [9]). In 16 patients an additional PCI of a non-infarct-related artery was performed between day 5 and 12.

At discharge, drug therapy was well established. 100% of patients were on clopidogrel/aspirin, 97% on a beta-blocker, 76% on an ACE inhibitor or an AT-2-receptor antagonist, and 97% on a statin.

Overall hospitalisation time was 11.1 ± 6.8 days with a range of 4 to 60 days. After excluding 4 patients, whose prolonged hospitalisation time (21/22/22/23 days) was mainly due to strictly non-cardiac causes, it decreased to 10.7 ± 6.6 days. Only

Figure 1

Estimated mortality risk according to the Zwolle score (7)
The x axis gives the Zwolle score above, then the corresponding 30-days mortality rate in the Zwolle population and then below the mortality rate in our study.
The y axis gives the number of patients in every group.

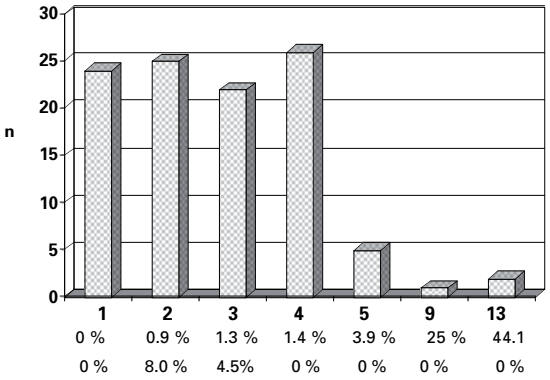
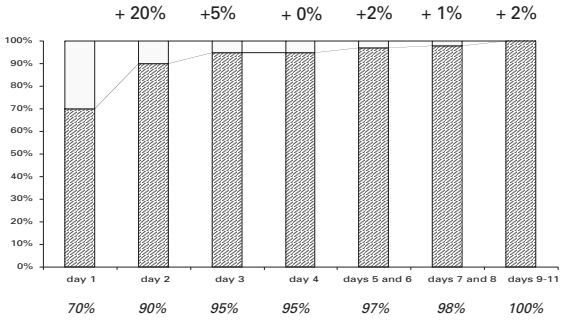


Figure 2

Percentages of the last major event that occurred until the given hospital day.
The rate above the graph indicates the increment compared to the day before, i.e. that e.g. the rate of MACE that had occurred until day three was 95%, 5% higher than at day two.



12% of patients were discharged within 6 days. Women were hospitalised significantly longer than men (14.0 days versus 10.4, p <0.003), which still remained significant (p <0.01) after exclusion of the outliers.

Patients younger than 60 years were discharged earlier than older ones (9.7 versus 12.7 days, p = 0.04). For patients above the age of 70, there was merely a trend to a prolonged hospitalisation (12.1 versus 10.6 days, p 0.17) compared to younger ones. There were no significant differences of hospitalisation time regarding type of infarction (NSTEMI versus STEMI) or infarct related artery. When comparing patients who stayed longer than the median hospitalisation time of 9 days to those staying a shorter time, gender and type of infarction did not differ. However, patients were significantly older (61.0 ± 13 vs. 57.5 ± 10 years), had a lower ejection fraction (50% ± 8 vs. 55% ± 11) and a higher Zwolle risk score (2.5 ± 2.5 vs. 1.4 ± 1.1), all p values <0.001.

The number of patients in the different Zwolle risk groups is depicted in figure 1. Overall, 92% of patients were in the low risk group with an estimated 30-day mortality rate of 1.4% or less.

Four major complications were observed during further hospitalisation on the regular ward. One patient died suddenly of suspected pulmonary embolism on day 11, 1 patient had severe post-infarct angina and received additional PCI on day 7, and 2 patients had an acute stent thrombosis on days 5 and 9, respectively. Figure 2 depicts all major events that occurred during follow-up. The vast majority of major events had occurred at day 3 and the incremental benefit of the hospitalisation beyond day 6 was only 3% of all events.

Follow-up (550 ± 125 days) was uneventful in 82 patients (78%). Two patients, both aged 79 years, died, one of pulmonary embolism and one of sudden cardiac death. One patient suffered reinfarction due to acute stent thrombosis 2 days after regular discharge on day 9. Two further patients suffered myocardial infarctions, 11 underwent elective PCIs, 6 bypass surgery and in 2 additional patients an ICD was implanted.

Thus, mortality in the hospital and during the 1.5 years of follow-up was 2.9% (3/105), 1% in hospital and 1.9% during follow-up. The 3 patients who died had a risk score of 3 (2 patients) and 2 (1 patient).

Discussion

Our study shows that acute PCI for myocardial infarction in patients without cardiogenic shock at presentation has an excellent short and long-term outcome. Quality of drug therapy at discharge was good and conformed well to current guidelines. In the vast majority of patients left-ventricular function was preserved. However, hospitalisation times were long with a mean of 11.1 days. As 97% of all MACE had occurred by day 6, our data suggest that patients could have been discharged safely at this point in time.

Even though all patients underwent emergency PCI for acute myocardial infarction, neither the hospitalisation time nor the percentage of patients discharged early, altered considerably in comparison to a survey [2] done in Switzerland in 1998. At that time, less than 38% of patients underwent thrombolysis and only 5% had acute PCI. Despite the fact that in our study acute PCI was performed in all patients, hospitalisation time was only reduced by 1.5 days and there was a mere 4% increase in the number of patients discharged within 6 days. The recommended medication at discharge (antithrombotic therapy, beta blockers, statins) was in place in almost 100%. This is much higher than in an earlier study performed at our institution in 1998 [10].

Thus, the ideal and most cost-effective time of discharge would appear to be that day on which a patient is fully revascularised, the risk of complications is minimised and education and rehabilitation are scheduled. So why does emergency PCI for acute MI not reduce hospitalisation time? There are obvious reasons why a patient can safely be discharged earlier. Due to early reperfusion therapy, infarct size is limited and left ventricular function more often preserved. As the most important factor towards an early discharge strategy, stenotic lesions in non-infarct-related arteries are identified and can be treated with PCI a few days later. All

these aspects should allow physicians to mobilise their patients earlier and to a higher physical level, and should consequently favour early discharge.

The mortality rate after MI is markedly influenced by the presence of initial risk factors, putting the patient in a low or high-risk situation. These factors always include the presence of cardiogenic shock, significant arrhythmias and a low ejection fraction [11–14]. In some studies an anterior infarction [11] or the presence of a left-bundle branch block [13] have been used additionally. During the further course of the discussion, only the subgroup of low-risk patients will be considered, as high-risk patients are not candidates for early discharge. Patients with acute MI and PCI therapy have a low in-hospital mortality rate of 0.7% to 1.6% and an additional 6 to 12 months mortality rate of 0% to 4.5%, according to initial risk presentation [12, 13, 15, 16]. Furthermore, at least five studies [7, 14–17] have demonstrated that the majority of severe complications occur during the first 3 to 4 hospitalisation days.

In contrast, factors that favour a longer hospitalisation time, in the era of acute PCI, are not evidence-based. They consist of a hospital-based, established mobilisation scheme with a slow increase in physical exercise under the supervision of a physiotherapist, the need for a step-up adjustment of drug therapy and the stipulated desire of the patient to slowly cope with his altered physical and psychological situation after myocardial infarction. It might also be speculated that the absence of a DRG system in our hospital does not encourage physicians to discharge patients earlier.

Several randomised studies have shown that discharge as early as day 3 after infarction is safe and cost-effective. As early as 1988 Topol et al. [18] demonstrated that patients, who in the majority had undergone reperfusion therapy, underwent stress testing without signs of ischaemia and were discharged on day 3, had a similar outcome to patients who stayed in hospital until day 10, with savings of more than 5,000 $ per patient. A post-hoc analysis of the GUSTO-1 data [17], showed that any further hospital day beyond day 3 has only a minimal impact on life-years saved (0.006 years) with incremental costs of 105,000 $. Since then, further prospective studies have been performed in patients with uncomplicated MI, randomising patients to early or standard discharge. Patients underwent stress testing on the third hospital day and were discharged, if they had no signs of residual ischaemia [13] or alternatively were discharged directly on day 3 after PCI for acute MI [12]. The two studies showed a similar outcome regarding the MACE rate at 6 months and the long-term psychosocial outcome in both groups. This latter aspect is of great importance, as a major argument against an earlier discharge might be that patients should be instructed regarding life style changes after myocardial infarction [19], which may as well be done during rehabilitation programs.

The two most important factors for long-term survival after MI are whether acute PCI is successful and whether the patient goes into cardiogenic shock [11, 20]. As cardiogenic shock was an exclusion criteria in our study and all but one patient had a successful PCI, these two limiting factors were virtually absent and do not explain the prolonged hospital stay.

Studies have focused on factors that might have a negative impact on an early discharge strategy. One of them, the ZWOLLE risk score study [7] was able to show a very low mortality of 0.2% and 1.3% 10 and 30 days respectively after an acute MI in patients with a score of ≤3. Such a score was present in 77% of patients in our study, again suggesting that a majority of the patients could have been discharged much earlier without an increase in mortality.

What would have happened to our patients if all of them had been discharged hypothetically on day 6? The mortality would have only increased from 1% to 2% at the most.

It may be argued that the results presented primarily reflect a poor performance in our particular hospital. However, mean hospital time in Switzerland after acute MI in non-selected patients is currently 9 days (data from the AMIS plus registry, personal communication).

In summary, our data as well as a review of the literature suggest that an early discharge strategy in low risk patients is presently not being implemented although it would be safe and that this approach could reduce costs without jeopardizing the outcome.

Correspondence:
Beat Schaer, MD
Clinic for Cardiology, University Hospital
CH-4031 Basel
Switzerland
E-Mail: bschaer@uhbs.ch

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