Implementation of Guidelines for the Treatment of Acute ST-Elevation Myocardial Infarction – the Cologne Infarction Model (KIM) Registry

1 Markus Flesch, M.D., M.Sc., 1Jens Hagemeister, M.D., 2 Hans-Joerg Berger, M.D.,
3 Annett Schiefer, 1Sylke Schynkowski, 1Martin Klein, 3 Sasan Sahebdjami,
3 Stephan vom Dahl, M.D., 4 Wolfgang Fehske, M.D., 5 Rudolf Mies, M.D.,
6 Michael von Eiff, M.D., 7 Holger Pfaff, M.D., 8 Peter Frommolt, M.Sc.
and 1 Hans-Wilhelm Hoepp, M.D.

1 Klinik III für Innere Medizin, Universitäet zu Köln
2 Krankenhaus Merheim, Lehrstuhl II für Innere Medizin, Universitäet zu Köln
3 St. Franziskus Krankenhaus, Köln
4 St. Vinzenz-Hospital, Köln
5 St. Antonius-Krankenhaus, Köln
6 Malteser-Krankenhaus St. Hildegardis, Köln
7 Zentrum für Versorgungsforschung der Universitäet zu Köln
8 Institut für Medizinische Statistik, Informatik und Epidemiologie der Universitäet zu Köln

Please send correspondence to:
Markus Flesch, M.D., M.Sc.,
Klinik III für Innere Medizin der Universitäet zu Köln,
Kerpener Strasse 62, 50937 Cologne, Germany

Tel. +49 221 478 4155, Fax +49 221 478 3163
e-mail: markus.flesch@uni-koeln.de
Abstract

Background: Aim of the Cologne Infarction Model (KIM) is to examine the feasibility of obligatory treatment of STEMI by first line percutaneous coronary intervention.

Methods: The study was performed in Cologne with >1 million citizens, 5 coronary intervention centres and 11 primary care hospitals. 12-lead ECG is available for all EMS teams. Partners guaranteed direct transfer of STEMI patients to a catheterization laboratory.

Methods and Results: In 2006, 519 patients were included. 24% presented at a primary care hospital, 11% directly at a coronary intervention centre, 5% were transferred by EMS to primary care hospitals, 60% were directly transferred by EMS to a catheterization laboratory. In 91% of cases, the catheterization laboratory was notified of the patient’s arrival in advance. False positive ECG diagnosis of STEMI by EMS accounted for 6%. Median treatment times were: begin of symptoms to first medical contact 120 minutes, phone-to-balloon 70 minutes, and door-to-balloon 49 minutes. 93% of all patients underwent angiography. 409 patients were treated by coronary intervention, 24 underwent emergency CABG. TIMI 3 flow was obtained in 89%. In hospital, deaths and new myocardial infarctions were observed in 12.1 % and in 1.9 % of all patients, respectively.

Conclusion: KIM provides evidence for the feasibility of obligatory treatment of STEMI by primary coronary intervention in a metropolitan setting. Acceptance of treatment pathways allowed nearly all STEMI patients to undergo coronary angiography. ECG competence of EMS was excellent. Treatment times were within postulated limits. Results including mortality were within a high quality range.

Key Words:
STEMI – guideline adherent treatment – primary percutaneous coronary intervention
Introduction

Primary percutaneous intervention (PCI) has been shown to be superior to fibrinolytic therapy in patients with ST-segment-elevation myocardial infarction (STEMI). The benefit of PCI is most pronounced when it is performed early after the onset of symptoms and close to the patient’s first contact with medical professionals. 1, 2 This evidence has been reflected in recent guidelines for the treatment of acute myocardial infarction, 3, 4 recommending PCI as first line therapy provided that the time between first medical contact and first balloon inflation or the time between entering the hospital and the first balloon inflation is less than 90 minutes and the delay between the potential start of fibrinolytic therapy and the percutaneous coronary intervention is not more than 60 minutes.

In Germany, a number of hospitals provide a 24 hour coronary catheterization laboratory and organized networks exist to guide the patient with an acute STEMI into the catheterization laboratory without any delay. 5 However, precise data concerning the clinical results of these efforts remain sparse. For the US, it has been reported that less than one third of patients with STEMI receive primary PCI and that fewer than 40% are treated within 1.5 hours. 2, 6-8 This holds true despite the fact that in several regions both triage and transfer protocols for PCI in patients with STEMI have been developed. 2 Thus, there is no broad evidence in the literature proving the feasibility of PCI as first line therapy in patients with STEMI.

Cologne is a German city with >1 million citizens. Within the city, there are five cardiology departments with a cardiac catheterization facility equally distributed throughout the city and 11 primary care hospitals without catheterization facility. The emergency medical service (EMS) is centrally organized and 12-lead ECG is available for all EMS teams. Thus, Cologne provides ideal conditions for the implementation of STEMI treatment guidelines. For more than ten years, PCI has been offered as first line therapy for myocardial infarction by some cardiology departments. However, it took until autumn 2005 that the efforts of the central emergency service and of all hospitals within the city were coordinated in order to provide treatment of patients with ST-elevation myocardial infarction according to the guidelines. The Köln (Cologne) Infarction Model (KIM) was founded, establishing a
triage and a transfer protocol guiding STEMI patients to a catheterization laboratory the fastest way possible. The efforts of the network were accompanied by a registry documenting all important treatment steps, serving as quality management as well as scientific evaluation. This report is the first presentation of the registry data, providing evidence that, at least in an ideal urban setting, the requests of the recent European and US American guidelines can be fulfilled. The very new aspect of this registry is that the complete medical system including all hospitals within a city can be involved and can adhere to a strict quality management. KIM is self-financed and works independent from health insurances and political health administrations.
Methods

Patient Population
The data reflect 519 patients treated within KIM between January and December 2006. The aim of KIM was to collect data of patients with a STEMI treated within the medical system of Cologne regardless whether they were treated in a catheterization laboratory or otherwise. Inclusion of patients in the KIM registry occurred after initial diagnosis of STEMI regardless whether this was done by the emergency physician outside a hospital, by a physician in a hospital without a catheterization laboratory or in a cardiology unit with a catheterization laboratory. Inclusion was based on the 12-lead ECG criteria: ST-segment elevation of ≥ 0.1 mV in two or more depending extremity leads, ST-segment elevation of ≥ 0.2 mV in at least two neighbouring chest leads or left bundle branch block in combination with typical symptoms.

Transfer triage and treatment protocol
Prior to the start of KIM, the metropolitan emergency medical service, all 11 hospitals without and all 5 centres with a catheterization unit agreed that patients diagnosed with STEMI should no longer be transferred to the responsible district hospital. Instead, they should be transferred directly to a cardiology unit with catheterization facility. The cardiology units were obliged to provide a catheterization laboratory and an emergency care unit available seven days a week for 24 hours. Activation of the catheterization lab and its staff had to be started after the diagnosis of STEMI by first medical contact. Thus, the mobilization of catheterization laboratory staff occurred immediately after announcement of a patient’s transfer to the catheterizing hospital or after patient’s arrival at this site. EMS physicians diagnosing a STEMI were asked to inform the responsible catheterization laboratory by phone and to deliver the patient directly to this facility. Admitting physicians in non catheterizing hospitals diagnosing a STEMI were also asked to inform the cooperating cardiology unit and to transfer the patient to its catheterization laboratory without any delay. Patients presenting at the emergency department of a hospital with a catheterization laboratory had to be transferred directly for coronary angiography and interventional treatment. The proposed patient pathway is shown in figure 1.
In order to ensure ECG competence of the EMS doctors who were all medical doctors but only some of them were internal medicine doctors or cardiologists, the start of KIM was accompanied by a special ECG teaching campaign for the emergency medical service staff. Also, all EMS teams and all co-operators within KIM were supplied with a specific handbook summarizing the actual recommendations for STEMI diagnosis and therapy as well as standard operating procedures reflecting the special situation in Cologne.

Initial treatment of the patient either by the emergency medical service or the first admitting hospital included intravenous heparin (5000 IE), aspirin (500 mg), clopidogrel (600 mg) and oxygen inflation. Depending on the patient’s pain and stress opioids and diazepam could be given. Hemodynamically stable patients were allowed to be treated with 2.5 – 5 mg metoprolol or an equivalent dose of another beta-blocker. In case of hypertension and left ventricular decompensation treatment with nitroglycerol (0.8 mg s.l.) was recommended. In case of hemodynamically stable ventricular tachycardia, it was recommended that patients were treated with amiodarone. Resuscitation occurred according to international standards, if necessary.

Treatment of the patients within the catheterization laboratory occurred according to international standards. Facilitated acute PCI was not recommended. Bare metal stents were regarded as standard, and drug eluting stents were available but not favoured. The use of GpIIb/IIIA antagonists was not excluded, but was also not specifically enforced as standard.

Data collection and quality management
Each patient included into the KIM treatment regimen was accompanied by a file consisting of seven separate protocol forms for each potential treatment step: check list of first medical contact, EMS treatment, admitting hospital without catheterization laboratory, catheterization laboratory intervention centre, discharging hospital without catheterization laboratory and, in addition, follow up questionnaire for general practitioners being addressed 3 months and 12 months after hospital discharge. These forms guaranteed collection of important patient information throughout the complex medical system. Doctors treating the patient at the individual steps were
asked to complete the forms, the time necessary for this procedure being less than 2
minutes. Missing data were added by a secondary study of the patient’s hospital files.
All data were transferred to an electronic data base blinded for patient’s names and
personal data.

Central parameters for the evaluation of KIM were:
- quality of data documentation
- adherence to treatment pathways
- correctness of primary diagnosis
- reaction times:
  - time between first symptoms and first medical contact
    (symptom-to-contact)
  - time between first medical contact and intracoronary balloon inflation
    (contact-to-balloon)
  - time between first announcement of patient at the catheterizing hospital
    and intracoronary balloon inflation (phone to balloon)
  - time between arrival at catheterizing hospital and puncture of femoral artery
    (door-to-needle)
  - time between arrival at coronary intervention hospital and intracoronary
    balloon inflation (door-to-balloon)
  - angiography and intervention rate / results of interventional treatment (TIMI III)
  - in-hospital major adverse cardiovascular events
  - secondary preventive medication at discharge and follow-up (3 und 12 months
    post MI)

Retrospective analysis of treatment parameters prior to the start of KIM
In order to provide comparable quality parameters for the time period before the start
of KIM, a retrospective analysis of STEMI patients’ data at two intervention centres
during the six months prior to the start of KIM was performed. Altogether, the files of
308 patients were analyzed. Because of STEMI, these patients were treated at the
two biggest coronary intervention centres in Cologne, the University Hospital and the
St. Vincenz Hospital, before the start of KIM from January to June 2005. Parameters
of interest were treatment times and mortality.
Statistics
The software package SPSS, version 12 (SPSS Inc., Chicago, USA) was used for all statistical analyses. Prior to the statistical analyses, Kolmogorov-Smirnov tests for normality were performed and the respective variables were analyzed accordingly. Descriptive data are given as median with interquartile range (IQR) or mean +/- standard deviation if appropriate. Plausibility check was performed for each individual parameter variable with the authors having access to the original patient treatment file. Statistical comparison of the treatment times between interventional centres and over time was based on Kruskal-Wallis tests (figure 2), whereas chi-square tests were performed for comparison of mortalities (figure 3 and table 3). The trend test used in figure 3 was based on a weighted linear regression of the mortalities on a score defined by the age groups.

Statement of Responsibility
The authors had full access to and take full responsibility for the integrity of the data. All authors have read and agree to the manuscript as written.

Funding Resources
This research has been funded exclusively by membership fees of the KIM (Cologne Infarction Model) Association, a non profit collaboration of all Cologne hospitals and the Cologne EMS.

Conflict of Interest Disclosures
None.

Acknowledgments
The authors acknowledge the statistical assistance of Andrea Pfeiffer, Zentrum für Klinische Studien Köln, and the editorial assistance of Ursula Fradera, B.Sc.
Results

Patient Characteristics

Between Jan 1, 2006 and Dec 31, 2006, 519 patients were included into KIM. The number of participating patients was equally distributed throughout the whole year. The smallest number of individuals included into KIM was 36 in September, the maximum number was 51 in February.

356 patients were male, 163 were female. The mean age of the patients was 63.4 ± 13.9 years. 37.6 % of the patients were between 65 and 79 years of age. 13.3 % of the patients were eighty years or older.

At primary contact with the medical system, 15.2 % of the patients presented with signs of cardiogenic shock, defined as either cardiac arrest (6.5%) or severe inotropic failure (8.7%). In all these patients, ECG diagnosis of STEMI was confirmed by a qualified cardiologist. In addition, 74 % of these patients revealed a significant increase in creatinine kinase. The remaining 22 patients died early in the catheterization lab and no blood samples had been taken at all prior to death. In 13.3 % of all patients, resuscitation was performed by the EMS team and in 14.7 % of all patients, intubation and ventilation was necessary prior to the transfer to the intervention centre. 8% of all patients revealed a positive shock index with systolic blood pressure < 100 mm Hg and pulse rate > 100 beats/minute. 16.6 % of the patients received catecholamines during the EMS transport to the intervention centre and 5.6 % of the patients had to be resuscitated during this transport. On admission at the intervention centre, 15.2 % of the patients depended on catecholamines, 13.0 % were ventilated and 6.9 % had to be resuscitated. Patient characteristics are summarized in table 1.

Patient pathways through the medical system

122 (24%) of all patients primarily presented at a hospital without a catheterization facility and secondarily were transferred to a coronary intervention centre. 55 (11%) presented themselves at a coronary intervention centre. 25 (5%) of all patients were contacted first by an EMS team which transferred the patient to a district hospital without a catheterization laboratory. 315 (60 %) patients were first seen by an EMS
team and transferred directly to a coronary intervention centre. In order to activate the catheterization laboratory team, the coronary intervention centre was notified by phone in 428 of 466 patients (91%) being transferred to a coronary intervention centre either by EMS team or from another hospital prior to admission.

Correctness of diagnosis
False positive inclusions were defined as diagnosis of STEMI by EMS doctor or admitting physician at a non coronary intervention hospital and exclusion of STEMI by the specialist in the admitting coronary intervention centre. False positive ECG-interpretation and patients’ inclusion into KIM by EMS doctors occurred in 6% and by admitting physicians in non coronary intervention hospitals in 5% of their patients, respectively.

Reaction times
Reaction times are given in table 2. The main time delay for most patients was the interval between onset of symptoms and first contact within the medical system with a median symptom to contact time of 120 minutes.

Once the patient had been seen by a medical professional, median treatment times were all within the time limits as recommended by international guidelines. Especially, median phone-to-balloon time and door-to-balloon time were within the 90 minutes range, which has been suggested as discrimination criterion between primary interventional therapy and primary fibrinolysis by most guidelines. The achievement becomes evident when treatment times within KIM are compared with treatment times prior to its start. In 308 patients treated in the two biggest coronary care units in Cologne from January to June 2005, median door-to-needle time was 43 (IQR 49) minutes and median door-to-balloon time was 72 (IQR 65) minutes. For the patients treated in this particular coronary care units between January and June 2006, thus after the start of KIM, median door-to-needle time was 20 (IQR 22) minutes and median door-to-balloon time was 42 (IQR 33) minutes. It has to be noted that there were a number of cases in which this time goal for interventional treatment within 90 minutes was not achieved. However, 74.4 % of the patients were treated within a phone-to-balloon time and 79.8 % were treated within a door-to-balloon time below 90 minutes, respectively.
When treatment times of the five intervention centres were compared, there were minor differences with all centres lying within the requested time limits (figure 2a, p<0.001). There were no significant differences in treatment times when the time periods within 2006 and by the end of 2005 were compared (figure 2b, p=0.33; figure 2c, p=0.12).

**Intervention Rate und Results**

As intended, coronary angiography rate was high. 516 patients were admitted at a coronary intervention centre and 479 (92.8 %) of all patients underwent coronary angiography. 409 of these 479 patients (85%) had an indication for immediate coronary angioplasty. The major infarction vessels are given in table 1. 91.1% (n=407) of the patients presented with infarction related stenoses (>80%) in one vessel, 6.8% (n=30) with stenoses in two vessels and 1.1% (n=5) with stenoses in three vessels. 50 patients required a second intervention either at their infarction vessels (n=16), 34 in another vessel.

76 % of the patients with coronary angiography required stent implantation. 10% underwent coronary angioplasty without stent implantation. 5% were transferred to CABG surgery, either directly or after coronary angioplasty. In those undergoing coronary angioplasty, the success rate - defined as achievement of TIMI III flow - was 89 %.

**Death and Re-Myocardial Infarction**

Mortality was 12.1 % with two patients dying in their district hospital without transfer to an intervention centre and 61 patients dying after admission to a coronary intervention centre. 10 (1.9 %) patients experienced a re-infarction. For the 479 patients undergoing coronary angiography, mortality was 11.9 %. For comparison, mortality rate was analyzed for patients treated at the two biggest intervention centres of Cologne between January and June 2005, prior to the start of KIM. Mortality rate among 308 patients treated at the two major coronary intervention centres in Cologne was 10.4%. One year later, between January and June 2006, after the start of KIM, mortality rate was 7.6% in these two centres.
Major determinants of mortality were old age and circulatory stage at primary contact or admission to the intervention centre. There was a significant trend of mortality increasing with age ($p<0.001$), with the mortality for patients at age 80 years and older being six times higher than for patients below 50 years of age (figure 3). Also, mortality was significantly increased in patients with cardiogenic shock. Patients being in shock (defined as either inotropic failure or cardiac arrest) at first medical contact had a mortality of 50%, whereas patients not being in shock had a mortality of 4.72%. Patients with inotropic failure (systolic blood pressure < 100 mm Hg) had a mortality of 36.1%. Within this group, those without need for resuscitation had a mortality of 16.9%, those with need for resuscitation had a mortality of 59.2%. Patients with cardiac arrest (documented ventricular fibrillation) had a mortality of 55.9%. Risk factors for increased mortality are given in table 3.

**Secondary preventive medication at discharge and follow up**

Secondary preventive medication was defined as prescription of beta-blocker, ACE-inhibitor, aspirin and statins at the time of hospital discharge. The criterion was met by 82.4% of patients being directly discharged from a hospital with coronary intervention unit and was met by 79.2% of patients being discharged from a hospital without coronary intervention unit.
Discussion

KIM is the first attempt to implement PCI as obligatory therapy for all patients presenting with an acute STEMI within a metropolitan European setting. The data of the KIM registry presented in this study provide evidence for the feasibility of recent US American and European guidelines recommending PCI as first line therapy for acute STEMI. The major findings are:

- Combined efforts of a metropolitan EMS, district hospitals and specialized cardiology units and implementation of coordinated standard operating procedures allow treatment of nearly all STEMI patients in a city with 1 million citizens by primary PCI within a phone-to-balloon time < 90 minutes, respectively.
- ECG training and use of 12-lead ECG by the EMS provide sufficient competence for diagnosis of STEMI and initiation of treatment pathways.
- Despite all efforts, overall mortality remains high but is due to a high number of patients being treated by PCI despite very old age and unstable circulatory state.

The present data go beyond a recent report presenting results of the Viennese STEMI Registry. In Vienna, the metropolitan ambulance system cooperated with five interventional cardiology departments guaranteeing that a catheterization laboratory was available 24 hours a day in at least two alternating places. The primary triage of patients to either thrombolysis or PCI was performed by the EMS physicians. Guideline implementation led to a marked increase in the percentage of patients receiving PCI as first line therapy, finally leading to a drop in in-hospital mortality from 16% to 9.5%. The aim of KIM was to guarantee PCI in time as primary therapy for all STEMI patients within a city of 1 million citizens. As consequence, the Cologne EMS, all coronary intervention centres and all regular hospitals within Cologne agreed to provide an infrastructure guaranteeing a contact-to-balloon and phone-to-balloon time of less than 90 minutes during 24 hours to every patient presenting with STEMI. Only 2 out of 591 patients with a STEMI were not transferred into a coronary intervention centre; the majority of patients underwent coronary angiography and angioplasty. This supports the finding that the prevalence of normal coronary angiography in acute STEMI is below 3%. As in Vienna, also in KIM delay times...
were within the time limits requested by AHA, ESC and national guidelines. \textsuperscript{11, 12} Thus, the consequent guideline implementation in a metropolitan area enables PCI as obligatory first line therapy for STEMI. \textsuperscript{13, 14}

Only recently, activation of the catheterization laboratory by EMS while the patient is on its way and staff arriving at the catheterization facility within 20 minutes after being paged, have been named as major strategies leading to a decrease in treatment delay. \textsuperscript{15} Data of the KIM registry confirm that this approach leads to short delay times and prompt coronary interventions. One of the most important innovations was triage responsibility of the EMS physician. KIM proves that activation of the catheterization team by EMS staff does only rarely lead to “false alarm”. Nearly all patients (93 \%) who were transferred into a coronary intervention centre had an indication for emergency coronary angiography and intervention. Thus, EMS doctors equipped with a 12-lead ECG develop sufficient diagnostic competence for handling the therapeutic triage in STEMI patients. The specificity of diagnosis based on pre-hospital 12-lead ECG as observed in this study is similar to that in an assessment of the US American Agency for Healthcare Research and Quality, which calculated the specificity of pre-hospital 12-lead ECG based diagnosis being 97\%. \textsuperscript{16} It was even higher than in a recent report from San Diego in which specificity of ECG based diagnosis was 78\% in the hands of paramedics and 96\%, if ECG was interpreted by physicians after electronic transfer. \textsuperscript{17}

The number of patients included into KIM within 12 months was lower than expected. Based on data of the MONICA trial obtained in the region around Augsburg, a city in southern Germany, it can be expected that there are 1800 patients with a STEMI per 1 million citizens per year. \textsuperscript{18} Since the intention of the KIM organizers was to include every patient with a new STEMI, the achieved number of 561 patients included in 2006 appears to be too low. Possible explanations are: 1) The incidence of STEMI is lower than estimated. 2) Many patients with STEMI do not show up in the medical system. 3) Despite the agreement for cooperation, a number of patients are not included into KIM and are not transferred from their primary hospitals to a coronary intervention centre.
The hypothesis that patients might not reach a hospital or might not even get in touch with a medical professional is reflected by the threatening observation that the median time between onset of symptoms and first medical contact is 120 minutes. The impact of time delay until first medical contact on the increase in mortality has been characterized very well. The long symptom-to-contact-time is another argument in favour of PCI because thrombolysis is mainly efficient within the first two hours after the onset of symptoms.

KIM did not lead to a major reduction in mortality. As a matter of fact, a mortality of 12.1% is higher than in many other trials comparing thrombolysis and PCI for the STEMI therapy. One explanation is that a high number of patients presented with cardiogenic shock, defined as either patients who primarily survived cardiac arrest or with inotropic failure. These patients had a tenfold increased risk of death compared to patients without shock, which was similar to a 25 fold increase in the risk of death for patients with cardiogenic shock in the Vienna STEMI registry. More precisely, mortality rate in patients with cardiac arrest was 56%. In patients with inotropic failure mortality was 39%. In contrast, in patients without cardiac arrest or inotropic failure mortality was 5%. This confirms earlier data collected by a group of German hospital cardiology in 4815 STEMI-patients who demonstrated that cardiogenic shock led to an increase in in-hospital mortality from 4% to 40% and was a more important determinant of mortality than in-hospital treatment time. Another reason might be the high percentage of patients of high age in the KIM registry. In the MITRA PLUS registry comparing the effects of thrombolysis and PCI in STEMI patients being older than 70 years, mortalities were 17.8% and 12.5%, respectively. In KIM, mortality for patients being 80 years and older was 24.6% in contrast to a mortality of 10.2% for patients younger than 80. The number of patients presenting with cardiogenic shock or at very old age increased between the period before KIM and after initiation of KIM. E.g., in the two major coronary intervention centres, 8% of the patients were 80 years and older and 9.7% of all patients presented in cardiogenic shock prior to the start of KIM from January to June 2005. In contrast, in the first half of 2006, 13% of the patients were 80 years and older and 15.2% arrived in cardiogenic shock. In this context, it can be speculated whether the triage rules in KIM allow more circulatory unstable patients to arrive and to be treated in a catheterization laboratory. This might lead to an increase in mortality. On the
other hand, it is the high risk patient who benefits most from PCI vs. thrombolytic therapy. In this context, a retrospective analysis of the DANAMI-2 trial showed that in high risk STEMI patients with a TIMI risk score $\geq 5$, PCI lead to a reduction in mortality to 25.3% compared to 36.2% in patients receiving thrombolysis.\textsuperscript{26}

There are a number of limitations of this study. Some concerns have been mentioned already: There is no control for false negative diagnoses leading to an exclusion of patients because of ECG misdiagnosis. Thus, there is no evaluation how many patients with STEMI were missed despite getting in touch with the medical system. Also, so far, there have been no regular audits of the participating hospitals controlling for patients diagnosed as suffering from STEMI but not included into KIM. However, comparing the KIM data of two randomly chosen KIM hospitals with their own ICD statistics makes us believe that the presented data do reflect the reality in Cologne in 2006. Treatment data were provided by the treating EMS and hospital physicians, and there might have been a trend to artificially improve the own treatment results. Finally, the comparison between treatment parameters before and after initiation of KIM is difficult, because data for the time before KIM have been generated retrospectively.

In conclusion, KIM demonstrates that PCI can be offered as preferred and obligatory therapy for patients with acute STEMI. KIM proves that if recent recommendations for the organization of a STEMI network are put into practice - especially the implementation of pre-hospital ECG-diagnosis, direct transfer to a coronary intervention centre and activation of the catheterization lab staff by the EMS physician – treatment times are within the limits requested in the actual guidelines for the primary use of PCI in the treatment of myocardial infarction. The wide-spread use of primary PCI leads to favourable treatment results for a majority of patients.
References


11. Cannon CP, Gibson CM, Lambrew CT, Shoultz DA, Levy D, French WJ, Gore JM, Weaver WD, Rogers WJ, Tiefenbrunn AJ. Relationship of symptom-onset-


Figure Legends:

**Figure 1:**
Triage for patients with a STEMI in KIM.

**Figure 2:**
Reaction times in KIM in the 1st to 4th quarter of 2006 and in a pre-test phase from September to December 2005. This four month pre-test phase was used to educate all KIM partners concerning the patient pathways and standard operation procedures. A gives the mean door to balloon-times in the five participating centres. B gives the time between the onset of symptoms and the first medical contact (symptom-to-contact time). In C, the time between arrival at the coronary intervention centre and balloon inflation (door-to–balloon time) are shown. All data are given as median ± standard error.

**Figure 3:**
Mortality in KIM patients in 2006. A shows age-dependent mortality. B shows age-dependent mortality in patients presenting at first medical contact with and without cardiogenic shock. C shows mortality depending on the presence or the absence of cardiogenic shock at the time point of first medical contact and depending on gender.
### Table 1: Patient Demographics

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>519</td>
</tr>
<tr>
<td>Men / Women (%)</td>
<td>69 / 31</td>
</tr>
<tr>
<td>Age y (mean ± SD)</td>
<td>63.4 ± 13.9</td>
</tr>
<tr>
<td>Age between 65 and 79 years [%]</td>
<td>67.6</td>
</tr>
<tr>
<td>Age 80 years and older [%]</td>
<td>13.3</td>
</tr>
<tr>
<td>Cardiogenic Shock [%]</td>
<td>14.8</td>
</tr>
<tr>
<td>Major infarction vessel [%]</td>
<td></td>
</tr>
<tr>
<td>LAD</td>
<td>36.8 (n=174)</td>
</tr>
<tr>
<td>RD</td>
<td>3.2 (n=15)</td>
</tr>
<tr>
<td>LCX</td>
<td>13.3 (n=63)</td>
</tr>
<tr>
<td>RPLS</td>
<td>3.6 (n=17)</td>
</tr>
<tr>
<td>RCA</td>
<td>41.4 (n=195)</td>
</tr>
<tr>
<td>venous bypass graft</td>
<td>1.7 (n=7)</td>
</tr>
</tbody>
</table>

LAD = left anterior descending artery, RD = ramus diagonalis, LCX = left circumflex artery, RPLS = ramus posterolateralis sinister, RCA = right coronary artery. A lesion was regarded as significant when the stenosis occluded the vessel diameter by more than 70%.
Table 2: Reaction Times

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptom-to-contact</td>
<td>120 (305) minutes</td>
<td></td>
</tr>
<tr>
<td>Contact-to-balloon</td>
<td>92 (46) minutes</td>
<td></td>
</tr>
<tr>
<td>Phone-to-balloon</td>
<td>70 (33) minutes</td>
<td></td>
</tr>
<tr>
<td>Door-to-needle</td>
<td>26 (26) minutes</td>
<td></td>
</tr>
<tr>
<td>Door-to-balloon</td>
<td>49 (30) minutes</td>
<td></td>
</tr>
</tbody>
</table>

Symptom-to-contact time means interval between onset of symptoms and first contact with a medical professional. Contact-to-balloon time means time between first contact with a medical profession and first coronary balloon inflation. Phone-to-balloon time is the interval between notification of the coronary intervention centre by the referring EMS doctor or by the referring district hospital and first coronary balloon inflation. Door-to-needle time is the time interval between arrival of a patient at the coronary intervention centre and puncture of the femoral artery. Door-to-balloon time is the time interval between arrival of the patient at the coronary intervention centre and first coronary balloon inflation. Reaction times are given as medians with the interquartile range in brackets ().
Table 3: Mortality in STEMI patients according to Risk Factors

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>11.5%</td>
<td>0.62</td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>13.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age &gt; 80 years</td>
<td>24.7%</td>
<td>10.2%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Cardiogenic Shock at Primary Contact</td>
<td>50.0%</td>
<td>5.3%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Resuscitation by EMS</td>
<td>56.1%</td>
<td>6.4%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Resuscitation at Admission in Coronary Intervention Centre</td>
<td>65.7%</td>
<td>7.7%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mechanical Ventilation at Admission in Coronary Intervention Centre</td>
<td>57.6%</td>
<td>5.1%</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

*Comparison of men and women*
Disclosures

All authors declare that there are no conflicts of interests and that there are no relationships to be declared. Especially, there are no relationships within the last 2 years that are relevant to the topic of the manuscript.
Patient with Angina pectoris

EMS Physician

12-Lead ECG

ST-elevation >0.1 mV in 2 or more neighbouring extremity leads and / or ST-elevation >0.2 mV in 2 or more neighbouring chest leads and / or new left bundle branch block plus typical signs of myocardial infarction

Emergency Room ECG Control

Non-Interventional Hospital (Responsible District Hospital)

Coronary Intervention Centre
Figure 3

A

Mortality [%]

< 50 50-64 65-79 > 80

Age [Years]

p < 0.001

All Patients

B

Mortality [%]

No Shock Shock

< 50 50-64 65-79 > 80

Age [Years]

p < 0.001

p < 0.001

p < 0.001

C

Mortality [%]

No Shock Shock

All Patients Male Female

p < 0.001

p < 0.001

p = 0.21

p < 0.001
Implementation of Guidelines for the Treatment of Acute ST-Elevation Myocardial Infarction –
the Cologne Infarction Model (KIM) Registry
Markus Flesch, Jens Hagemeister, Hans-Joerg Berger, Annett Schiefer, Sylke Schynkowski, Martin
Klein, Sassab Sahebdjani, Stephan vom Dahl, Wolfgang Fehske, Rudolf Mies, Michael von Eiff,
Holger Pfaff, Peter Frommolt and Hans-Wilhelm Hoepp

Circ Cardiovasc Interv. published online September 3, 2008;
Circulation: Cardiovascular Interventions is published by the American Heart Association, 7272 Greenville Avenue,
Dallas, TX 75231
Copyright © 2008 American Heart Association, Inc. All rights reserved.
Print ISSN: 1941-7640. Online ISSN: 1941-7632

The online version of this article, along with updated information and services, is located on the
World Wide Web at:
http://circinterventions.ahajournals.org/content/early/2008/09/03/CIRCINTERVENTIONS.108.768176

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in
Circulation: Cardiovascular Interventions can be obtained via RightsLink, a service of the Copyright Clearance
Center, not the Editorial Office. Once the online version of the published article for which permission is being
requested is located, click Request Permissions in the middle column of the Web page under Services. Further
information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Circulation: Cardiovascular Interventions is online at:
http://circinterventions.ahajournals.org/subscriptions/