Optimizing the early treatment of a threatening myocardial infarction

Annica Ravn-Fischer, M.D.

Department of Molecular and Clinical Medicine
Institute of Medicine at Sahlgrenska Academy
University of Gothenburg

Sweden

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Cover illustration: “The Heart” from Elin Ravn-Fischer

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annica.ravn-fischer@vgregion.se

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Knowledge is power.

Sir Francis Bacon,
English author, courtier, & philosopher (1561 - 1626)

ABSTRACT

Acute myocardial infarction is the single most common cause of death for both women and men in Sweden. Great efforts have, over the years, been made to improve immediate treatment and care of acute coronary syndromes. Through fast and efficient chest pain care we know that we can minimize myocardial damage and improve outcome and prognosis.

In this thesis we have focused on the early chain of care in patients with a threatening myocardial infarction. In five papers we describe chest pain care in our community with regard to the gender-, the foreign-, the age and the co-morbidity perspective. We have also investigated predictors of direct admittance to a coronary care unit and predictors of mortality.

Regarding the gender perspective, women with chest pain were older as compared to men. Women were not admitted to a coronary care unit as often as men and there were longer delays to the right level of care and to performance of coronary angiography among women. However, a final acute coronary syndrome diagnosis was more common in the male group. Among women, who actually had an acute coronary syndrome and were admitted to a coronary care unit, gender differences were minor or even non-existent.

In non-Swedish speaking chest pain patients we found a higher prevalence of diabetes and previous stroke, placing them at increased risk also for coronary heart disease. Poorer language proficiency was associated with longer delay time from arrival in hospital to admission to a coronary care unit or catheterization laboratory. Maybe this prolonged delay is due to

communication difficulties and there could be room for improvements by increased use of interpreters.

The strongest predictor for admittance to a coronary care unit was a prehospital ECG suggesting acute occlusion of a coronary vessel. Interestingly, these patients had lower 1-year mortality. The future challenge is to improve early cardiac care for the large infarction-group with poor prognosis but without such alarming ECG signs.

In the municipality of Gothenburg there are three hospitals offering emergency care for chest pain patients. In our studies we found differences between these hospitals especially with regard to delays to coronary angiography in presumed acute coronary syndrome patients. Our data highlight logistical problems that our health care system has to deal with in order to improve chest pain care and to follow current guidelines.

Hopefully our findings will improve the early treatment of a threatening myocardial infarction and hopefully other communities can learn from our experience. Our goal is an efficient and equitable chest pain care despite age, gender, ethnicity and geographical belongings.

Keywords: chest pain, acute coronary syndrome, coronary care unit, gender,

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SAMMANFATTNING PÅ SVENSKA

Akut hjärtinfarkt är den enskilt vanligaste dödsorsaken för både kvinnor och män i Sverige. Genom ett snabbt och effektivt omhändertagande vid en hotande hjärtinfarkt kan skador på hjärtmuskeln minimeras och prognosen förbättras.

I 5 delarbeten beskriver vi den tidiga vårdkedjan hos patienter med hotande hjärtinfarkt i Göteborg. Vi har speciellt intresserat oss för könsskillnader och skillnader i hjärtsjukvård hos svensktalande respektive icke svensktalande samhällsmedborgare. Vi har även studerat faktorer som predisponerar för direktinläggning på en hjärtintensivavdelning och prediktorer för dödlighet.

Med utgångspunkt från könsperspektivet såg vi att kvinnor som söker vård på grund av bröstsmärta var äldre än män. Kvinnor blev inte lika ofta direktinlagda på en hjärtintensivavdelning. Vidare fann vi längre fördröjningstider till behandling med acetylsalicylsyra och längre väntan på kranskärlsröntgen för kvinnor. Männen hade dock en högre frekvens av akuta koronara syndrom. För de kvinnor som verkligen hade ett akut koronart syndrom och som vårdades på en hjärtintensivavdelning sågs endast små skillnader mellan könen.

Hos de icke svensktalande patienterna med bröstsmärta fann vi en ökad förekomst av diabetes och tidigare stroke. Dessa riskmarkörer medför en ökad risk även för kranskärlssjukdom. Sämre språkförståelse var associerat med längre väntan på att få komma till en vårdavdelning och längre fördröjning till kranskärlsröntgen. Denna fördröjning kan bero på

kommunikationssvårigheter och ett ökat utnyttjande av tolk kan eventuellt minska fördröjningen.

Den tyngsta prediktorn för direktinläggning på en hjärtintensivavdelning var ett ambulans-EKG som visade tecken på en akut tilltäppning av ett kranskärl. Vår uppföljning visar dock att just dessa patienter är yngre, tidigare friskare och har bättre 1-års överlevnad än andra patienter. Utmaningen framöver blir att förbättra det tidiga omhändertagandet av den andra stora hjärtinfarkt-populationen utan sådana alarmerade EKG-tecken. Denna grupp är äldre, oftare multisjuk och har sannolikt nytta av att vårdas på en hjärtavdelning.

I stor-Göteborg finns 3 sjukhus som erbjuder akutsjukvård för patienter med hotande hjärtinfarkter. Våra studier visar att det finns skillnader mellan sjukhusen framför allt vad det gäller fördröjningstider till kranskärlröntgen. Resultaten antyder logistiska problem i vårdkedjan för patienter med akuta koronara syndrom. För att förbättra vården vid hotande hjärtinfarkt och för att följa aktuella riktlinjer (guidelines) måste sjukvården åtgärda dessa problem.

Vi hoppas att våra resultat kan leda till förbättringar i det tidiga omhändertagandet av patienter med hotande hjärtinfarkter. Förhoppningsvis kan även andra utanför Göteborg lära av våra erfarenheter. Vårt mål är en bättre fungerande hjärtsjukvård som är jämlik och rättvis oavsett ålder, kön, etnicitet eller geografisk tillhörighet.

LIST OF PAPERS

This thesis is based on the following studies, referred to in the text by their Roman numerals.

I. **Ravn-Fischer, A**. Caidahl, K. Hartford, M. Karlsson, T. Kihlgren, S. Perers, E. Rashed, H. Johanson, P. Herlitz, J. Community-based gender perspective of triage and treatment in suspected myocardial infarction. Int J Cardiol 2012 Apr 19;156(2):139-43. (E-pub 2010 Nov 27)

II. **Ravn-Fischer, A**. Karlsson, T. Santos, M. Bergman, B. Johanson, P. Herlitz, J. Chain of care in chest pain – Differences between three hospitals in an urban area. Int J Cardiol 2011 Nov 24 (E-pub ahead of print)

III. **Ravn-Fischer, A**. Karlsson, T. Santos, M. Bergman, B. Herlitz, J. Johanson, P. Inequalities in the early treatment of women and men with acute chest pain? Am J Emerg Med 2012 Oct; 30(8): 1515–21 (E-pub 2012 Mar 3)

IV. Santos, M. **Ravn-Fischer, A**. Herlitz, J. Bergman, B. Is the early treatment of acute chest pain provided sooner to patients who speak the national language? Submitted

V. **Ravn-Fischer, A**. Karlsson, T. Johanson, P. Herlitz, J. Prehospital ECG signs of acute coronary occlusion are associated with reduced one-year mortality. Submitted

CONTENT

ABBREVIATIONS

ACS	Acute coronary syndrome
AMI	Acute myocardial infarction
BMI	Body mass index
CABG	Coronary artery bypass grafting
Cath.lab	Catheterization laboratory
CI	Confidence interval
CCU	Coronary care unit
CVD	Cardiovascular disease
ECG	Electrocardiogram
ED	Emergency department
EF	Ejection fraction
EMS	Emergency medical system
GRACE	The Global registry of acute coronary events
LBBB	Left bundle branch block
MI	Myocardial infarction
NSS	Non-Swedish-speaking
NSTEMI	Non-ST-elevation myocardial infarction
OECD	Organisation for economic co-operation and development
OR	Odds ratio
PCI	Percutaneous coronary intervention
SCB	Statistiska centralbyrån
SS	Swedish-speaking
STEMI	ST-elevation myocardial infarction
SU	Sahlgrenska University Hospital
SWEDEHEART	Swedish web system for enhancement and development of evidence-based care in heart disease evaluated according to recommended therapies.
UAP	Unstable angina pectoris
VD	Vessel disease
WHO	World Health Organization

DEFINITIONS IN SHORT

ACUTE MYOCARDIAL INFARCTION

The definition of acute myocardial infarction (AMI) was based on the following diagnostic criteria; 1) Laboratory parameters (minimum one troponin value, I or T, above the upper reference level and another troponin value 6 hours later indicating dynamic changes) and at least one of the two conditions 2a) symptoms raising suspicion of myocardial infarction such as; pain or discomfort in chest, arms, neck, jaw, back or abdomen; dyspnea; nausea; cold sweat or 2b) Electrocardiogram (ECG)-findings suggesting ischemia: ST-segment elevation/ depression in at least two contiguous leads (ST-segment elevation of $\geq$0.1 mV in leads aVL, aVF, I, II, III, V_5-V_6 or $\geq$0.2 mV in leads V_1-V_4, ST-segment depression of $\geq$0.1 mV) or Left Bundle Branch Block (LBBB).

ACUTE CORONARY SYNDROMES

The definition of acute coronary syndrome (ACS) is a diagnosis of either AMI, including ST-Elevation Myocardial Infarction (STEMI), Non-ST-Elevation Myocardial Infarction (NSTEMI) or Unstable Angina Pectoris (UAP).

1 BACKGROUND

Cardiovascular disease (CVD) is a major cause of death worldwide. Fortunately, in industrial countries, mortality rates during the last decades have declined. However, for low- and middle- income countries cardiovascular deaths have increased with a remarkable rate. (1) The increase of CVDs in developing countries is a consequence of lifestyle changes linked to urbanization and industrialization. Inequities of education, power, money and resources have impact on health status and development of CVD. (2) When average length of life is increasing, people are more exposed to CVD risk factors such as, smoking, unhealthy diets and physical inactivity, i.e. factors that promote heart disease and stroke. (3) According to the World Health Organization (WHO) more than 3 million CVD deaths occur before the age of 60. CVD deaths affect individuals in their peak midlife and have financial impact both at the family level and for national economy. WHO estimates that 17.3 million people died from CVDs in 2008 and over 80% of these deaths took place in low-and middle-income countries. Prognostic calculations from the WHO also estimate that almost 23.6 million people will die from CVDs in 2030. Undoubtedly, this will mean that great efforts are needed to reduce the global incidence of CVD in the future. (1)

In Sweden, and in many other industrial countries, the incidence of myocardial infarction (MI) is decreasing over time. The last decade, despite new definitions of MI and despite new sensitive biomarkers, the age standardized incidence of MI has been reduced by almost 25% for both men and women. In 2010 the incidence of MI in Sweden was 571/100 000 for men and 379/100 000 for women (4) and according to the SWEDEHEART registry the mean age for patients who gets an MI is 76 year for women and 70 year for men. (5) Along with the decreasing incidence of MI, mortality

rates have also decreased considerably during the last decade. The 28-day mortality rate is now reduced to 13% for hospitalized patients. (4) This pleasant progress is presumably depending on both primary preventive factors and improved adherence to guidelines for interventions, acute treatment and secondary prevention factors. (6, 7) Annual reports concerning mortality rates, prevalence and incidence of ACS is compiled by; the National cause of death registry, the Swedish Social Board and the SWEDEHEART/RIKS-HIA organization. The RIKS-HIA registry, which is a part of the SWEDEHEART organization, started in 1995 and since 2008, all 74 hospitals who handle ACS-patients in Sweden are connected. The majority of patients with suspected ACS, seeking care at some of the 74 hospitals, are included in this large database. The registry is a national quality database where compilations concerning quality of care or other healthcare issues between hospitals and geographical areas could be performed. (5) These types of systematic compilations is rather unique for Sweden and results in a good overview of the ACS-field and are good prospects for research. The data in the registry is available for both the health care system and for the public/media.

This thesis is focused on delivery of care to patients with suspected ACS. All studies are conducted in the Swedish health care system. In Sweden we have a government and parliamentary regulated health care, which is operatively run by 21 counties and 290 municipalities, and health care has a total annual expenditure of nearly 9.9 % of the Swedish gross domestic product. (8) The health care is highly decentralized and consists of a three-level system with university hospitals, regional hospitals and county hospitals. It is mostly the secondary or tertiary hospitals that have PCI- or CABG- facilities.

Despite a reduction in MI-incidence, chest pain patients still are very common in the emergency departments (EDs). Only in the municipality of Gothenburg approximately 10 000 patients with chest pain seek emergency care every year. (9) There are many possible causes of chest pain and they vary from non-serious to life threatening conditions. In order to handle such large volumes of patients, and to detect and treat life-threatening conditions as fast as possible, a well optimized triage system is necessary. The whole chain of care, including the dispatch centre, the emergency medical system (EMS), the EDs, the coronary care units (CCUs) and the catheterization laboratories (cath.labs) must be optimized for the best outcome. Optimizing the chest pain care is not only important for the individual patient, it is also important from the health care- and economical- perspectives. Later on in this thesis these issues will be extensively discussed.

1.1 PATHOGENESIS

Coronary atherosclerosis in human vessels starts early in life and atherosclerotic plaques are common in young adults in western countries. (10, 11) Atherosclerotic plaques are often located in the inner layer, the intimae, of the coronary vessels. Proliferation of smooth muscle cells and lipid accumulation makes the arterial lumen gradually narrower. (12) The narrowing process is usually slow and can continue for many years before symptoms appear. Different inflammatory processes in combination with endothelial dysfunction can cause instability in the atherosclerotic plaques making them more vulnerable. (13) Erosion or disruption of a plaque will generate response from both platelets and the coagulation system, and will trigger a thrombosis formation. A thrombus in a coronary vessel can, if not treated, be occlusive and thereby lead to an MI. (14)

Preventing atherosclerosis is difficult and risk factors such as family history, gender or age are immutable. However important risk factors such as tobacco use, unhealthy diets, obesity, physical inactivity, hypertension, diabetes and dyslipidemia are modifiable and by lifestyle changes we can get the atherosclerosis process to slow down. (3) Primary prevention efforts are necessary already from childhood to reduce manifestations of ACS and stroke later on in life. (15)

1.2 DEFINITION OF MYOCARDIAL INFARCTION

Acute myocardial infarction (AMI) is defined as myocardial necrosis due to an interruption of coronary blood supply (which decrease the delivery of oxygen and nutrients) and/or as a result of increased metabolic demand. (16) An interruption in the supply of myocardial oxygen and nutrients occurs when a thrombus is superimposed on an ulcerated or unstable atherosclerotic plaque and results in coronary occlusion. Ischemic myocardial cell injury can be either reversible or irreversible. (17) Stunning and hibernation of the myocardium are forms of reversible myocardial damage often associated with shorter time of ischemia or with reperfusion injury. When the myocardium is exposed to longer periods of ischemia (20-30 min) histological cell death occurs. (17-19) Complete necrosis of myocardial cells at risk requires at least 2-4 h of ischemia, or longer, depending on the presence of collateral circulation to the ischemic zone, persistent or intermittent coronary artery occlusion, the sensitivity of the myocytes to ischemia, preconditioning and individual demand for oxygen and nutrients. (16) Usually it takes several weeks or even months for a myocardial infarction to heal, sometimes with a scar of fibrosis and heart failure as a consequence. (20)

Myocardial infarction can be subcategorized on the basis of anatomic, morphologic, and diagnostic clinical information. The clinical diagnosis of an MI is based on the triad: 1. Symptoms of ACS; 2. ECG findings suggesting ischemia; and 3. Presence of elevated biochemical markers indicating myocardial damage. (16) In countries with limited financial resources, cardiac biomarkers and imaging techniques may not be available except in a few centers, and even the option of ECG recordings may be lacking. In these countries the MI definitions must be more flexible and more based on clinical symptoms.

Early in the myocardial injury process it is possible to detect heart specific biomarkers such as cardiac troponin I or T and CKMB. These biomarkers only indicate necrosis of myocytes, but not the underlying mechanisms. (21) Myocardial injuries with elevations of cardiac troponins are seen in a variety of conditions as presented below.

Causes of cardiac troponin elevation

PRIMARY MYOCARDIAL ISCHEMIA	**INJURY NOT RELATED TO ISCHEMIA**
Plaque rupture	Contusion, surgery, ablation, pacing
Thrombus formation	Myocarditis and cardiotoxic agents
SUPPLY/DEMAND IMBALANCE	**MULTIFACTORIAL**
Arrhythmias	
Aortic dissection	Heart failure
Hypovolem or septic shock	Stress (Takotsubo) cardiomyopathy
Severe respiratory failure	Pulmonary embolism
Severe anemia	Renal failure
Coronary spasm	Neurological diseases
Coronary embolism	Infiltrative disease (e.g. amyloidosis, sarcoidosis)
Severe hypertension	Strenuous exercise

In my work I have focused on myocardial injury due to interruption of blood flow in coronary vessels including UAP, NSTEMI and STEMI. In order to reduce myocardial damage in ACS, early revascularization therapy is important. In this thesis I will discuss how to optimize time to pharmaceutical interventions and revascularization for ACS patients.

1.3 ACS IN WOMEN

CVD is one of the most common causes of death in the world and it affects both sexes. Whereas the cardiovascular death rates are declining in men, they remain constant in women. (22) In the USA, 42 million women are estimated to live with CVDs and more than 200 000 women die each year from a myocardial infarction. This means that about 5 times as many women die from an MI than from breast cancer. (23)

From previous research we know that sex discrepancies in patients with MI do exist. Women are 4-10 years older when having their first MI. (24, 25) Women more often have a history of hypertension and diabetes, but are less likely to have a history of a previous MI or any revascularization as compared to men. (25) Female coronary arteries seem to have smaller dimensions and the atherosclerosis is often more diffuse than in men. (26, 27) Furthermore, chest pain due to spasm in the coronary arteries and cardiac syndrome X tend to be more common in women, as is stress-induced (or Takotsubo) cardiomyopathy. (28, 29) There are also discrepancies in type and localization of symptoms. Women more frequently report nausea, vomiting and dyspnea and the pain is more often located in the neck, back and abdomen, when compared to men. (30-32) Maybe this different pain perception, or the belief that coronary artery disease is predominately a male

disease, can explain why women with ACS call later for professional help. (22) Use of the ECG as the first line diagnostic tool in ACS may be less reliable in females presenting to emergency rooms. In women there are less frequent ST elevation and higher rates of ST depression and T-wave inversions, as well as nonspecific alterations. (22) Also during myocardial ischemia, women seem to have less pronounced ST changes as compared to men, which could possibly explain why women do not receive as much active treatment as men. (33) Cardiac specific biochemical markers seem to be a good tool, independent of gender, in identifying patients at risk. (22, 34) However, women with chest pain undergoing a coronary angiography seem to have a higher probability of a normal angiogram and they are less likely to develop an AMI as compared to men. (35)

Women have a higher rate of drug side effects probably due to the fact that most CVD-pharmaceuticals are developed for, and tested in, men. The pharmacokinetics of the drugs is then extrapolated from males to females and the drug doses are not adjusted to the smaller body of a woman. Furthermore, women have a greater risk of both complications and death after revascularization procedures than men. (36)

1.4 THE FOREIGN POPULATION

From extensive previous research we know that the overall health situation is worse in the foreign born population as compared to native born. Especially psychiatric diseases such as depression and anxiety disorders, post traumatic stress disorder and sleep disorder are more common in the foreign group. (37) This could be explained by compulsory transfers, traumatic experiences and by being forced into a new environment. Despite poorer health in the foreign

population they more often avoid to seek help in the healthcare system than the natives. (38) There have been speculations that low confidence in our health care systems, accessibility problems, economical reasons or ethnical or religious causes may be the cause of this health care avoiding behavior. (39)

During the last decades, migration from native countries through the world has increased and this migration of people creates language barriers. Communication difficulty is a growing problem worldwide. In healthcare it is especially important to be able to communicate with the patient in order to reach the right diagnosis and choose the right treatment. We know from former studies that language barriers are associated with negative impact on access to healthcare services; these patients have fewer physician visits and receive fewer preventive services. (40) Even when these patients have access to care they often have poorer adherence to treatment and medications and they also have decreased comprehension of their diagnoses. (40) Language barriers also have negative impact on delay-times to treatments and investigations, quality of care, patient satisfaction and costs. (41) The use of interpreter services can lower the costs by decreasing the use of diagnostic testing, lowering the probability of hospital admission and re-visits at the ED. (40, 42)

The foreign population is also a socio-economically vulnerable group. From previous studies, we know that there is a relationship between socioeconomic status and cardiovascular disease. Low socioeconomic status, particularly in women, predisposes for an increased risk of cardiovascular disease. (43, 44) The education level, independent of place of birth, has impact on the incidence of MI where low educated people have higher risk for developing an MI and poorer outcome. (45) This is probably due to unhealthier lifestyle

factors in the low educated group. Low education is linked to low socio-economic status and both are risk markers for CVD.

1.5 DEVELOPMENT OF THE CCU

A coronary care unit (CCU) or cardiac intensive care unit (CICU) is a hospital ward specialized in care of patients with different kinds of heart diseases which require continuous invasive or non-invasive monitoring and treatment. The CCUs developed in the 1960s when it became clear that monitoring patients with heart problems by specially trained nurses and physicians could reduce mortality. (46) In 1967 there were studies published that revealed that patients suffering from heart problems observed in a CCU had better outcomes compared to those who were not. (47, 48) When Killip and Kimball reported a nearly 20% reduction in mortality associated with CCU care, the rapid proliferation of CCUs across the world promptly ensued. (49, 50) Within some years, CCU treatment of AMI became the standard of care worldwide. (51) Moreover, in the 1970s, research in Sweden showed that larger CCUs at teaching hospitals had not only significantly lower age-adjusted mortality rates, but also greater productivity and efficiency. (52) However, since the 1970s, the clientele at the CCUs have changed and older patients with non-cardiovascular disease seems to be more common. (50) From previous studies we know that the CCU care is rather expensive and that costs have increased considerably. (53) In order to optimize the critical heart care and increase efficiency and improve cost-effectiveness it is important to better define the role of the CCU.

1.6 THE PREHOSPITAL CARE AND TELEMEDICINE

Ambulance originates from the latin word “ambulare” that could be translated “walk around” and was originally meant “a movable hospital”. Transportation systems for patients with different illnesses have been used since ancient times. In 1899 the first motor powered ambulance was brought into service in Chicago in the USA and in 1902 Stockholm received its first ambulance automobile. Since then there have been a remarkable evolution not only of the vehicles but also of the prehospital care. Ambulances are certainly not only transport systems, they are an important link in the chain of care in patients with threatening MIs.

The first ECG from human heart was recorded in 1887. However, it was Willem Einthoven, who developed the ECG technique in the early 20th century resulting in the Nobel Prize in 1924. (54)

Possibilities to record ECGs prehospitally and then telemedically transmit them to hospital, have resulted in reduced delay-times and have allowed faster triage in critical cardiac cases. (55, 56) Approximately 50% of all ACS-patients use ambulance transports for hospital admission. (57) These patients can benefit from an early prehospital triage and thus a reduced time to reperfusion, by prehospital administration of thrombolytic therapy, or by being “fast-tracked” into the cath.lab. According to a meta-analysis of randomized trials, administration of thrombolytic therapies prehospitally in STEMI patients can reduce time to thrombolysis with around one hour compared to in hospital administration of thrombolytic drugs. (58) We know from other studies that “time is heart muscle” and that every minute is important in the ischemic heart. (17, 19)

1.7 REPERFUSION THERAPY

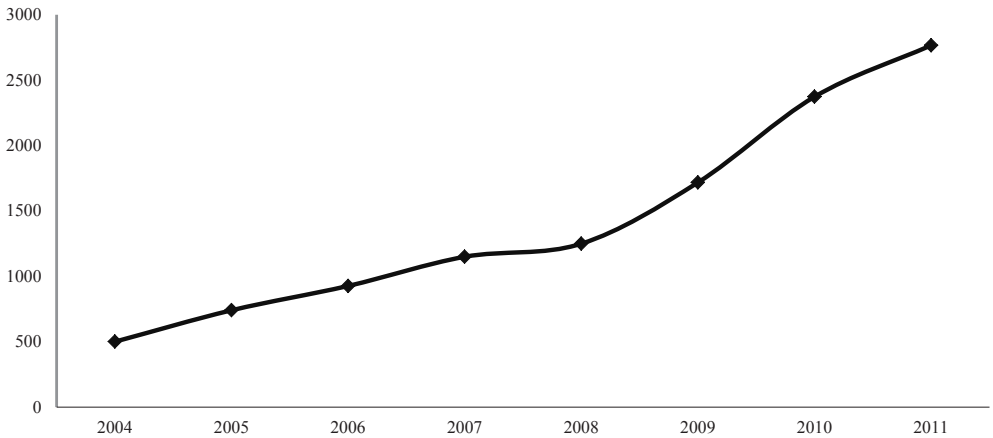
The chest pain patient with suspected AMI and an ECG presenting either STEMI or new LBBB is presumed to have an occlusive thrombosis in a coronary artery. According to national (59) and international (60) guidelines they are therefore candidates for immediate reperfusion therapy either with thrombolytic therapy, percutaneous coronary intervention (PCI) or coronary artery bypass grafting (CABG). Reperfusion therapy should be started as early as possible in the coronary event without unnecessary delays and this treatment is indicated for up to 12 hours after symptom onset (sometimes up to 24 hours with ongoing symptoms). According to guidelines, the STEMI-patient considered for primary PCI as reperfusion therapy, should be transported to, and preferably reach a cath.lab within 90 minutes from first medical contact. If a longer transport delay is expected, thrombolytic therapy should be considered, preferably already in the ambulance.(59) The use of thrombolytic therapies is, according to this time limit, more common in rural areas. According to SWEDEHEART data there is only one county in Sweden that meets the requirements of 90 minutes from first ECG recorded to reperfusion therapy for the whole population in the county. (5) This indicates that Sweden has great potential for improvements and that further research on how to optimize chest pain care is needed.

In order to minimize delay-times to reperfusion, direct admission from ambulance to the CCU or Cath.lab is preferable. Direct admission to a CCU requires adequate prehospital triage-methods and telemedical connections between the ambulance crew and the CCU.

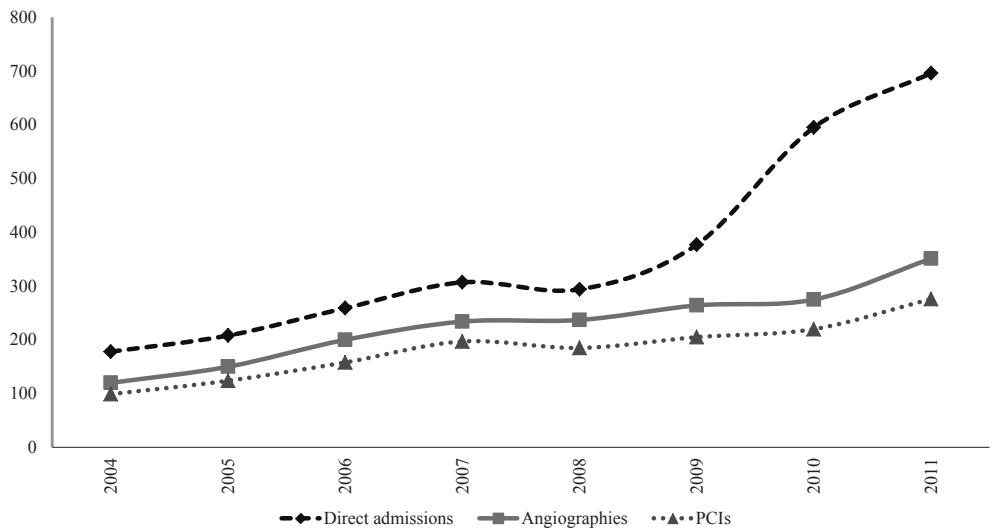
The two figures below show the numbers of contacts between the EMS organization and the tertiary CCU at Sahlgrenska University Hospital in 2004-2011. It also shows investigations and treatments in the direct admitted

group which includes, not only ACS-patients, but also other patients with severe heart diseases.

Numbers of contacts between EMS organization and the tertiary CCU at Sahlgrenska University Hospital 2004-2011

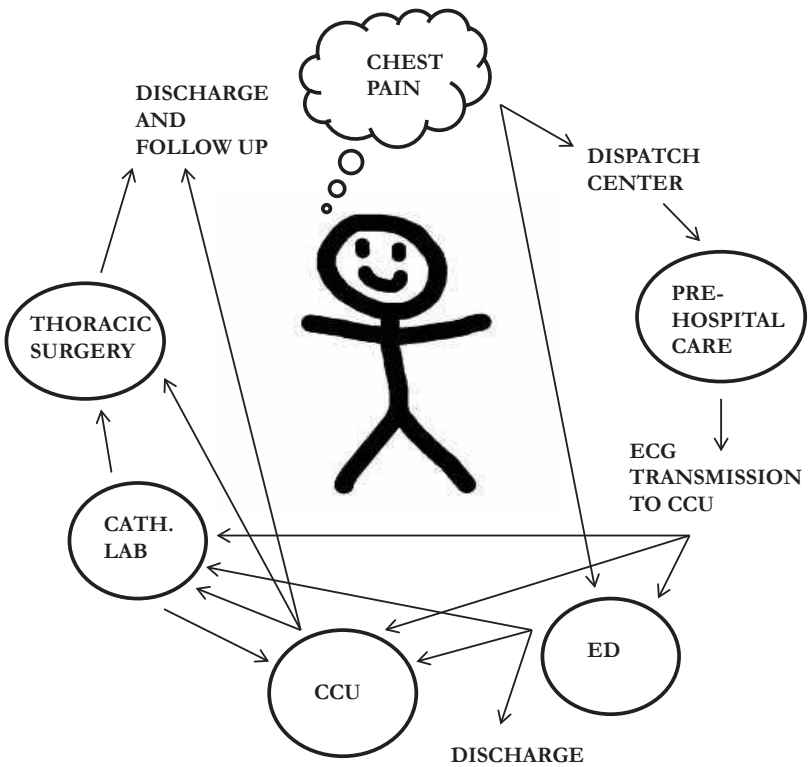


Numbers of direct admissions, coronary angiographies and PCIs at the tertiary CCU.



1.8 THE CHAIN OF CARE AND LOGISTICS

To optimize the early treatment of a threatening MI we have to consider a long chain of events. Every link in this chain is important to take into account. It is often easier to influence processes in your own department and most of the efficiency-work is done at this level. To interact and cooperate with systems outside your own clinic is far more difficult. The problem is multifarious and includes leadership, working culture, prestige and last but certainly not least economic interests and resources. To get every link to communicate with the others will be necessary if we want the chain of care in chest pain patients to improve in the future.



Chest pain flowchart, Sahlgrenska University Hospital 2012

1.8.1 MANAGEMENT OF VARIATION

The healthcare system and other government services have to deal with the problem of variation. Many processes in healthcare are unpredictable as for example the influx of patients to a CCU at a given point of time. Unjustified variations often lead to poor quality of care and increasing costs. Due to the complexity in our organization, ill defined processes, large amount of employees and heterogeneous customers it is far from trivial to avoid unjustified variation. Former research even indicates that different hospital traditions can influence long-term survival in patients with AMI. (61) Moreover there is seasonal variation, variations over days of the week and variations of the time of day. However, this time-related variation is often easier for the health care system to handle and to be prepared for due to compilations from past years. In the literature, the terms standardization and customization are used, meaning that health care has to consider both to have standardized processes but also to treat every patient like an individual with customized medical procedures. (62) Standardization and customization processes could be seen as polar opposites of each other and are not always easy to optimize at the same time. This is a challenge for healthcare now and in the future.

1.8.2 IMPORTANCE OF LOGISTICS

Optimized logistic processes are needed when the chest pain patient calls the dispatch center or seeks care in the ED. We know that about 50% of patients with ACS use the EMS system to transport themselves to a hospital (57). Cooperation and communication with the EMS staff is essential for impact on outcome in this patient group. In patients with STEMI, shorter delay-times to hospital admission and reperfusion therapy will reduce infarction size and fortunately prevent complications. (63)

In the health care system, centralization of medical facilities is common. In Gothenburg, and probably in many other cities, there is more than one hospital taking care of ACS patients but only one tertiary centre with facilities for coronary angiography, PCI or thoracic surgery 24h a day. The tertiary centre is responsible for reperfusion therapy in STEMI patients in the whole municipality of Gothenburg. Unstable angina pectoris and NSTEMI patients are usually directed to their nearest hospital. This type of organization is not unusual and such a subdivision of resources results in considerable demands in logistics for the EMS organization as well as for the three EDs. Despite our intentions to help the chest pain patient in the best and most rapid way, there is a risk that centralization leads to an unfair and unequal care that is based on geographical belongings instead of medical priorities.

However, sometimes centralization can be beneficial due to larger volumes associated with economies of scale and enhanced quality of care but it is also a risk that this centralization will lead to delay to treatment and investigations. A good logistic process will improve quality of care and will probably reduce costs.

1.8.3 ACCESSIBILITY OF HOSPITAL BEDS

Over time, the number of hospital beds per capita in Sweden has been reduced to a level of 2.8 per 1000 inhabitants, leaving us at the lower end when comparing with other OECD countries. (64) The reason for reduction of hospital beds usually is economical, although shortage of beds creates long queues, obstructs efficient care and leads to expensive delays. A constant deficit of hospital beds makes the EDs crowded and contributes to longer delays to admission to hospital wards and longer delays to investigations and treatments. Shortage of beds might even become a threat to quality of care.

Despite this, Swedish healthcare seems to have a good reputation and compares well on the international scale and is considerably cheaper than in many other countries. (64) However, the Swedish system is dependent on an efficient primary care. By treating the patients in general practices and thereby avoiding expensive hospital admissions we could probably hold the expenditures at a low level.

1.9 THE ECONOMY PERSPECTIVE

Health is important for the wellbeing of individuals and society, but a healthy population is also a prerequisite for economic productivity, prosperity and a key factor for economic growth. Health expenditure can be seen as an economic burden but spending on health is not just a cost, it is an investment. (65)

Sweden and other industrial countries spend an enormous amount of money on healthcare. In Sweden nearly 10% of the gross domestic product is spent on healthcare compared with over 15% in the USA for example. (8) Sweden is a country with a health care system that is tax-based and heavily-funded and operated by the government (single-payer). This type of system seems to spend less money on healthcare, compared with systems operated by insurance-companies (multiple-payers). The county councils and municipalities are the main providers of health care, with only about 10% of all health services delivered by private providers. (66) According to Swedish Association of Local Authorities and Regions (SALAR) the health services in Sweden perform well concerning access to care, quality of care and medical outcomes compared to other countries. The good outcomes are achieved with moderate costs, indicating an overall efficiency of our health services. (66)

In our system, and probably in many others, there is an insatiable need of care but the resources are limited. Healthcare and other government services have optimizing difficulties because they are large organizations with built-in inertia. Every hospital assigns money and divides the money to the different departments. Every department makes its own budget independently of the other departments. At the department level we are fairly good in our own, local economical optimization. However, we do not take responsibility of the totality or greater perspective. This often results in sub-optimizations both economically and in quality of care. The solution, at least partly, could be to cooperate and consider our neighbour´s problems as well. An efficient chain of care with the patient in focus will result in quality benefits and these improvements very often go hand in hand with savings in costs.

Another, very appealing aspect on saving costs would be to prevent illnesses. In Europe, 97 % of the health care budget is spent on investigations and treatments in already established diseases and only 3% on preventing illnesses. (65) This is despite that CVD and other chronically illness, at least partly, can be prevented. To prevent CVDs we have to work hard with primary prevention activities at a national level. To implement healthy living habits such as increased physical activity, healthy diets and to get people to stop smoking and cut down on alcohol most likely will prevent CVD´s and save costs. Healthy living habits must be implemented early in life perhaps already in childhood or adolescence.

1.10 NEW CHALLENGES

In Sweden, as well as in many other countries, there is a remarkable population growth the last century. In 1901 there were approximately 5.2 million inhabitants compared to 9.5 million inhabitants in 2011. (67) Birth rate exceeds death rate and there is a positive net migration rate.

Approximately 85 % of the population is urbanized (2010) and there is a positive trend for movement in to the cities. Life expectancy at birth is 79.1 years for men and 83.2 for women. (67) This demographic development requires increased access to healthcare. In a time with limited economic resources, the healthcare system needs to prioritize among different patient groups. This priority process is not easy and requires decisions at many levels; from the government level down to the department level at our hospitals. To facilitate the priority processes the Swedish Social Board have compiled national guidelines with health-economic perspectives for different kinds of investigations and treatments. (68) This is a support for the physicians but not always useful in treatments of the individual patient. New and more expensive treatment recommendations, a growing and ageing population and limited resources will be a difficult puzzle to solve in the future.

1.10.1 NSTEMI AND GRACE SCORE

For the STEMI patient the recommendation of immediate reperfusion therapy have been clear and unquestionable for a long time. (60) For the NSTEMI patient the recommendations have not been that clear. In Sweden, the national guidelines have been based on the FRISC II-study, telling that NSTEMI patients ought to undergo coronary angiography and revascularization within 4-7 days. (69) Current guidelines, however, recommend that a major proportion of the NSTEMI patients should be treated earlier with an invasive strategy. (70) Signs of instability, such as refractory angina or heart failure should result in an urgent angiography. Furthermore, even stable NSTEMI patients at high risk as assessed by for instance the GRACE-score should undergo a coronary angiography within 24 hours in order to reduce mortality, MI or stroke. (70, 71)

The NSTEMI patient is a common visitor at our hospitals and with this new knowledge we have to do something about the long delay-times to our

cath.labs. Directing NSTEMI patients to hospitals without facilities for coronary angiographies may preclude such early intervention. Another dilemma is that patients with NSTEMI sometimes are directed to medical wards instead of CCUs. The NSTEMI group is older, have more co-morbidities and more often multi-vessel disease than the STEMI group. (72) The NSTEMI patients would probably benefit from immediate evaluation by a cardiologist and then be directed to a CCU. The timing of angiography should be based on the patients risk profile regardless of gender or geographical belongings. How do we handle this large group at our cath.labs and CCUs in the future?

2 AIMS OF THIS THESIS

I. To explore the triage- and treatment- processes in ACS-patients, in a community, in relation to gender.

II. To describe differences in treatments and delay-times, in acute chest pain patients, at three hospitals in Gothenburg, Sweden.

III. To identify sex differences in the early chain of care for patients with chest pain.

IV. To identify differences in the early treatment of chest pain patients with regard to the language proficiency and to identify opportunities for improving and for enhancing equity in cardiac care.

V. To investigate prehospitally triaged patients with suspected ACS, especially with regard to predictors of direct admittance to a CCU/cath.lab and predictors of mortality.

3 PATIENTS AND METHODS

3.1 ETHICS

The five studies that together form this thesis and all data collection from medical records have been approved by the local Ethics Committee at the University of Gothenburg.

3.2 DESIGN

From 1995-2008 we retrospectively have collected data from chest pain patients in the greater Gothenburg area. During this 14-year period data has been collected in 5 different databases comprising approximately 9900 patients. There have already been published studies on this material and we now wanted to analyze the most recent data from 2004-2008 in order to get an updated picture of chest pain care in Gothenburg. The result from our data collection was two large databases including 2757 patients (paper I,V) and 2393 patients (paper II-IV) respectively.

3.3 STUDY POPULATION

In **paper I** we wanted to compare the data from patients with suspected ACS with data from three earlier studies previously published (73-75), with focus on a gender perspective. In order to do so we collected data from all patient visits (n=3224) due to suspected ACS, in whom an ECG was prehospitally recorded and telemedically sent to the CCU, at the Sahlgrenska University Hospital in 2004-2007. There were no exclusion criteria and the patients were included regardless of being directly admitted to the CCU/Cath.lab or

referred to the ED. This material was later reanalyzed and discussed in **paper V** when we had 1-year follow up and mortality data.

In **paper II-IV** we retrospectively collected data from all patients admitted to one of the three EDs or directly admitted to a CCU in the municipality of Gothenburg, due to chest pain, during a three-month period in 2008. The data represent one fourth of the annual population of patients with acute chest pain in Gothenburg. Chest pain or discomfort in the chest was the only inclusion criteria and there were no exclusion criteria. This database included 2588 visits made by 2393 patients.

3.4 DATA COLLECTION

In **paper I and V** data was collected from medical records, ECG-, echocardiography and laboratory databases. A point of care contact sheet comprising variables such as age, gender, time for onset of symptoms, localization and intensity of symptoms, blood pressure, heart rate, oxygen-saturation and ECG pattern were filled in by the CCU nurse for each telemedically received ECG before the patient arrived at the hospital. (see contact sheet, chapter 9, appendix) This information was given by telephone from the paramedics in the ambulance. For supplementary information such as previous history of illness, smoking habits, BMI, laboratory parameters, investigations, final diagnosis at discharge and in hospital mortality another more extensive data form was used. All data from these two forms was entered into a database for subsequent statistical analyses. For ACS patients being treated at the CCU, data was also collected from the Swedish national quality registry, SWEDEHEART. The supplementary data sampling was performed by two research nurses, a medical student and a cardiologist, all clearly instructed how to record data. For each variable that was assessed

there were strict definitions. Uniformity in data collection was enabled by regular meetings within the research group.

In **paper II-IV** data was collected from ambulance- and medical records, ECG-, echocardiography and laboratory databases in the same way as in paper I and V. An extensive data form comprising over 200 variables was developed and used for collecting data. The abstract form used for data collection was pilot-tested and revised before the main sampling started. The variables were the same as in paper I and V with additional data concerning; need of interpreter, language proficiency, alcohol habits, time to treatments and investigations, medication- and follow up after discharge. The data sampling was performed by different coworkers, and all the collaborators were clearly instructed how to record data and there were strict definitions for each variable that was assessed. All ECGs were evaluated by an independent cardiologist. Uniformity in data collection was enabled by regular meetings within the research group. Dates of death and survival confirmation were obtained from Swedish National Population Registry.

3.5 STATISTICS

In all papers the Mann-Whitney U test (**paper I, III, IV & V**) or Kruskal-Wallis test (**paper II**) were used for age comparisons between groups, except for survey 3 in **paper I**, where Fisher's non-parametric permutation test was used.

Age-adjusted p-values for differences between groups regarding proportions were calculated using logistic regression (**paper I & V**) or Cochran-Mantel-Haenszel statistic (**paper II, III & IV**) and regarding continous/ordered variables a stratum adjusted Kruskal-Wallis test were used in all papers.

Logistic regression was also used for other multivariate analyses, i.e. analysis of gender as a predictor of direct admission in **paper I**, differences between men and women in **paper III** and between Swedish-speaking and non-Swedish-speaking patients in **paper IV** regarding delay times (dichotomized by the median), when adjusting for potential confounders, and also to identify independent predictors of admittance to the CCU and 1-year mortality in **paper V**.

In **paper II** the Kaplan-Meier method was used to estimate mortality rates and Cox's proportional hazards model was used for calculation of age-adjusted p-values regarding mortality.

All proportions/means/medians are presented as crude results, i.e. not adjusted for age.

In paper I, II, III & IV all cases were used in the analyses (in the latter, excluding those where information regarding Swedish-speaking ability was unavailable), except for mortality analysis, where only the first visit was included for those with multiple visits. For those patients with multiple cases in **paper V** one was chosen by random.

All tests are two-sided and considered statistically significant if below 0.05 in paper **I & IV** and if below 0.01 in **paper II, III & V**. No additional adjustment was made for multiple testing.

All analyses were performed using SAS for Windows, versions 9.1 and 9.2.

3.6 METHODOLOGICAL CONSIDERATIONS

Our studies are all retrospective and therefore there is some amount of missing data due to the design. In paper I, there was a large time span over 12

years and the four survey-samples during this period were not uniform. The definitions of ACS and MI have changed over time and the new highly sensitive troponin-biomarkers have resulted in an increased numbers of MI´s. The quality of the data that was collected depends on the quality of the data existing in the medical records. Due to few observations/patients in some of the groups a few parameters are not reliable. In paper IV the number of NSS was small and lack of statistical significance should be interpreted with caution as differences between NSS and SS may exist in reality, although they passed unnoticed in this study with limited power. The registration of times is often associated with difficulties and delays are sometimes not registered in the medical records, resulting in missing data. The data-sampling were performed by different coworkers. Although all collaborators were clearly instructed in how to perform the sampling in a standardized manner, we cannot entirely rule out the possibility of any data collection bias. No measures were implemented in order to compare or increase the inter-data collector validity. Our studies comprise a large amount of tests which raise the risk for false statistical significances, even though the lower p value of 0.01 was used as a significance level in paper II,III and V.

3.7 CONTRIBUTIONS

The thesis includes five databases, three of them collected before my PhD-project started. The most recent data from 2004-2008 including a total of 5150 patients was collected into two databases of which I was involved from the start.

Out of the five manuscripts in this thesis, I´m the main author of four (Paper I,II,III,V). In these papers I´m responsible for study design, developing data forms, interpretation of results and writing. In the fourth paper I was the second author and my contribution to this manuscript included; being

involved in study design, the development of abstract form used for data collection and in writing the manuscript. The statistical analyses in all the five papers were performed by my co-author Thomas Karlsson. My supervisors have contributed greatly with very constructive advises at all levels in this thesis.

3.8 FOUNDATIONS – THE VINNVÅRD RESEARCH PROGRAM

Vinnvård started in 1996 and is a research program with four collaborators; VINNOVA, Vårdalsstiftelsen, Socialdepartementet and Sveriges Kommuner och Landsting. The purpose of the Vinnvård research program was to support research projects that engage in research about, and improve the possibilities for, implementing and taking advantage of research results in everyday health- and social care practice. One clear aim was to achieve more patient and citizen centric healthcare, including building of lasting learning structures to support sustainable improvements in healthcare. Vinnvård hopefully will improve quality and efficacy in health- and social care and the ambition is that Vinnvård contributes with research which can fill the gap between: What we know and what we do. Vinnvård includes 20 projects running from 2007-2012 and has a total budget of 150 million SEK. Our part in Vinnvård is to improve the process for treating patients with acute chest pain. (76) The Vinnvård project has been the main founder of paper II-IV.

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4 RESULTS

4.1 PAPER I

Since large national registers and large-scale clinical trials normally only collect data from ACS patients admitted to a CCU, our aim in this study was to investigate also those ACS patients who did not reach a CCU especially in a gender perspective. This study describes the triage and treatment processes from a community-based gender perspective in patients with suspected myocardial infarction in 1995-2007. In our practice setting there appear to be a difference in the priority given to women and men with ACS prior to eventual CCU-admission but not thereafter.

Women were significantly older when having a suspected ACS and there were differences in previous history of illness, symptoms and ECG-pattern between women and men. The delay from hospital admission to arrival at a hospital ward was twice as long in women as compared to men. Women were not directly admitted to the CCU as often as men were but they were also not diagnosed as having an ACS or an MI as often as men were. As a consequence of this, PCI or CABG were more common in the male group. In-hospital mortality and 30-day mortality were higher for women but, when age adjusted, no differences in mortality were seen.

TABLE 1
Paper 1 - Survey 4 - Baseline characteristics

	Women (n=1281)	Men (n=1943)	p#
AGE (years); median (25^{th},75^{th} percentile)	77 (66,84)	68 (57,78)	<0.0001
ONGOING SYMPTOMS (%) (28/27)*	83	83	0.29
LOCALISATION (of pain/discomfort)			
Chest (22/33)	73	76	0.50
Neck (23/39)	9	8	0.02
Arms (24/39)	21	22	0.44
Back (24/41)	12	6	<0.0001
Abdomen (26/40)	6	5	0.12
OTHER SYMPTOMS (%)			
Dyspnea (33/52)	23	19	0.07
Cold sweat (31/48)	16	25	<0.0001
Nausea (35/49)	19	15	0.001
Vomiting (33/51)	6	6	0.47
Vertigo (33/47)	9	8	0.67
Syncope (32/47)	4	6	0.007
Arrhythmia (31/45)	4	4	0.61
Cardiac arrest (33/48)	0.6	0.8	0.77
Cardiogenic shock (34/50)	0.3	0.8	0.04
ECG PATTERN (%)			
ST-elevation (94/118)	25	33	0.004
ST-depression** (267/442)	23	16	0.008
Left bundle branch block (96/128)	14	12	0.37
Pacemaker (95/129)	3	3	0.49
DECISION BY NURSE (%) (102/169)	48	44	0.006

age adjusted (except for age) ; * number of patients with missing data in the two groups, respectively
** not available for 2004

4.2 PAPER II

This paper describes differences in the chain of care in chest pain patients between three hospitals in the same urban area, in 2008. In the study there were 2393 patients included. There was a minor deviation in age between the hospitals but the percentage of women did not differ and was about 50% in all hospitals. The overall proportion of hospitalized chest pain patients was highest at the hospital with the highest need for an interpreter. At the tertiary centre the patients more often had a previous history of PCI or CABG and they more often had severe symptoms and ST-segment changes on ECG. Among ACS patients there was a difference between the three hospitals in performing a coronary angiography with a range from 57%-66%-83%. There were longer delay-times to coronary angiography and PCI for patients with presumed ACS, who were not directly admitted to the tertiary centre. However, there was no statistically significant difference in mortality when the three hospitals were compared. Our data in this study highlight logistical problems and deviations in treatment efficacy between different hospitals in a community.

TABLE 2

Paper 2 - Baseline characteristics in all patients

	SU/S (n=1253)	SU/Ö (n=853)	SU/M (n=482)	p*
AGE; years (mean±sd)	60±19	59±19	61±20	0.02
FEMALES (%)	47	49	50	0.65
PREVIOUS HISTORY (%)				
Diabetes	14 [2]	15 [1]	11	0.07
Hypertension	38 [2]	34 [1]	32	0.01
Heart failure	9 [2]	12 [2]	7	<0.0001
Myocardial infarction	22 [2]	22 [1]	18	0.03
Angina pectoris	20 [2]	27 [1]	16	<0.0001
PCI	15 [2]	10 [1]	8	0.0005
CABG	10 [2]	8 [1]	6	0.04
Stroke	8 [2]	8 [1]	6	0.26
Peripheral vascular disease	2 [2]	2 [1]	<1	0.13
COPD	6 [2]	5 [1]	4	0.11
Malignancy	9 [2]	7 [1]	3	<0.0001
Depression/psychic disease	10 [2]	21 [2]	5	<0.0001
Renal disease	3 [2]	4 [2]	1	0.03
Current smoker	23 [3]	28 [3]	20 [3]	0.11
NEED FOR INTERPRETER (%)	7	12	4	<0.0001
ADMITTED TO HOSPITAL VIA (%)				
Emergency award	94	>99	93	<0.0001
Directly to CCU	4	0	1	<0.0001
Already hospitalised**	3	<1	5	<0.0001
TRANSPORTED BY AMBULANCE (%)	42	40	35	0.002
HOSPITALISED (%)	50	63	51	<0.0001

* Age adjusted (except for age) ; ** Also from other hospitals

[1] 5-10% missing [2] 10-25% missing [3] 25-50% missing

4.3 PAPER III

In this study we investigated inequalities in the early treatment of women and men with acute chest pain, in 2008. In the study there were 2588 visits included and of these 48 % were women. Of all visits 42% of women and 38% of men were transported by the EMS. On average, women were 4 years older than men. There were differences in baseline characteristics, where women had a higher prevalence of hypertension and psychiatric disease as compared to men. Men had, on the other hand, a higher prevalence of previous heart failure, MI, angina and former PCI- and CABG-procedures. Furthermore, men had more frequently ST-elevation on the first ECG recorded as compared to women.

When adjusting for baseline variables, female sex was significantly associated with a prolonged delay time between admission to hospital and admission to a hospital ward. Median delay was 36 minutes longer for women. Furthermore, female gender was associated with a prolonged delay time from admission to hospital to performance of coronary angiography, and from first physical contact until the first dose of Aspirin as compared to men. The difference in median delays was 20 hours and 78 minutes respectively. Delay time to first ECG recording did not differ significantly between women and men.

Among all hospitalized patients with chest pain, a final diagnosis of MI was more common in men as compared to women. Coronary angiographies and echocardiographies were more often performed in the male group. Among all ACS-patients we could not identify any difference in medication therapy between sexes and there were generally a high prescription of aspirin, clopidogrel, β-blockers, ACE-inhibitors/A2-blockers and lipid-lowering drugs.

TABLE 3

Paper 3 - Diagnosis, findings and secondary preventive activities in hospitalized patients

	Women (n=629)	Men (n=721)	p*
FIRST POSITION FINAL DIAGNOSIS (%)			
Acute myocardial infarction	11	18	<0.0001
ST-elevation AMI	5	8	0.01
Non-ST-elevation AMI	6	11	0.0002
Unstable angina pectoris	3	5	0.09
FINAL DIAGNOSIS, ANY POSITION (%)			
Acute myocardial infarction	12	19	<0.0001
Unstable angina pectoris	4	6	0.05
FINDINGS (%)			
Coronary angiography performed	13	23	<0.0001
Main stem stenosis **	5	9	0.14
Triple vessel disease **	28	30	0.25
Two vessel disease **	30	35	0.36
One vessel disease **	19	26	0.35
No coronary artery disease **	24	9	<0.0001
Echocardiography performed	25	36	<0.0001
EF <50% ***	15	27	<0.0001
EF <30% ***	2	5	0.03
SECONDARY PREVENTIVE ACTIVITIES (%) #			
Lipid analysis <24 hours after onset of symptoms	55 [1]	49	0.05
DISCHARGED ALIVE FROM HOSPITAL (%) #	94	95	0.58

* age adjusted ; ** of those where angiography was performed ; *** of those where echocardiography was performed

only patients with ACS as first final diagnosis ; [1] 5-10% missing

4.4 PAPER IV

This study was based on the same database as in paper II-III concerning patients who seek care due to chest pain in one of our three hospitals in Gothenburg, in 2008. The aim was to evaluate whether treatment was provided sooner to patients who speak the national language. An interpreter service was deemed necessary in 209 visits (8%). The most frequently spoken languages in the NSS-group were Bosnian/Croatian/Serbian (17%), Arabic (13%), Persian (13%), Kurdish (11%), Somali (7%) and Turkish (6%). In comparison to SS patients, the NSS were younger. For several diseases there were statistical significant differences in previous history between SS and NSS. Thus, NSS had a previous history of diabetes, hypertension, MI, PCI and stroke more often than SS. The rate of hospitalization differed greatly between SS and NSS. In the SS group the hospitalization rate was 54% compared to the NSS group where the hospitalization rate was 64%. There were only minor differences in delay-time to treatments and investigations after hospital admission and the two groups were treated in a similar way.

TABLE 4
PAPER 4 - Baseline characteristics.

	Swedish Speaking (n=2334)	Non-Swedish Speaking (n=209)	p*
AGE; years (mean±sd)	60±19	58±16	0.03
FEMALES (%)	48	51	0.23
PREVIOUS HISTORY (%)			
Diabetes	13 [1]	22 [2]	<0.0001
Hypertension	35 [1]	41 [2]	0.01
Heart failure	10 [1]	9 [2]	0.32
Myocardial infarction	21 [1]	26 [2]	0.01
Angina pectoris	22 [1]	22 [2]	0.33
PCI	11 [1]	17 [1]	0.03
CABG	8 [1]	9 [1]	0.48
Stroke	7 [1]	11 [1]	0.002
Peripheral vascular disease	2 [1]	<1 [1]	0.31
Depression/psychiatric disease	12 [1]	14 [2]	0.53
ADMITTED TO HOSPITAL VIA (%)			
Emergency Ward	96	94	0.41
Directly to CCU	2	2	0.55
Already hospitalized**	3	3	0.57
TRANSPORTED BY AMBULANCE (%)	40	41	0.19
HOSPITALIZED (%)	54	64	0.0007
ECG (%)			
ST-changes	6.3	4.1 [1]	0.28
ST-elevation	3.2	3.0 [1]	0.54
ST-depression	3.9	1.5 [1]	0.17

* age adjusted (except for age)
** including those transferred from another hospital, family doctor, nursing home etc
[1] 5-10% missing ; [2] 10-25% missing

4.5 PAPER V

This paper is based on patients, in whom an ECG was recorded prehospitally due to a suspicion of ACS, and sent to a CCU at a tertiary centre. In this paper the aim was to compare patients directly admitted to a CCU/cath.lab with those referred to the ED in order to explore predictors of direct admittance and predictors of death. In all 2757 patients were included and out of these 858 (31%) were directly admitted to the CCU or Cath.lab. Of all patients directly admitted to a CCU, 31% were women. Patient directly admitted to the CCU were younger than those who were not. Predictors for direct admission to a CCU were ST-elevation on the initial ECG, LBBB, ongoing symptoms, current smoking and ST-segment depression. It was much more common with a STEMI-diagnosis in the direct admission group and subsequently reperfusion therapy was more common and there were shorter delays to treatment in this group. Independent predictors for 1-year mortality were cardiogenic shock, increasing age, diabetes and chronic heart failure. Interestingly, ST-segment elevation on the initial ECG was associated with a lower 1-year mortality rate. Consequently STEMI on ECG was an independent predictor for a reduced risk of death!

TABLE 5a
PAPER V – Predictors for direct admission to the CCU

	OR	(95% c.i.)	p
ONGOING SYMPTOMS	2.90	(1.74,4.83)	<0.0001
PAIN LOCALIZATION			
Chest	1.84	(1.24,2.72)	0.002
Arms	1.61	(1.13,2.29)	0.009
OTHER SYMPTOMS			
Cold sweat	2.33	(1.66,3.28)	<0.0001
ECG-PATTERN			
ST-segment elevation	46.11	(32.34,65.74)	<0.0001
ST- segment depression	2.05	(1.36,3.08)	0.0006
Left bundle branch block	3.30	(2.06,5.26)	<0.0001
PREVIOUS HISTORY			
Smoking (ongoing)	2.18	(1.55,3.06)	<0.0001

Table 5b
PAPER V – Predictors of 1-year mortality

	OR	(95% c.i.)	p
AGE (per year)	1.082	(1.066,1.097)	<0.0001
ECG-PATTERN			
ST-segment elevation	0.52	(0.36,0.76)	0.0006
STATUS ON ADMISSION			
Systolic blood pressure (per mmHg)	0.988	(0.983,0.993)	<0.0001
Rales of the lungs (Killip III)	2.87	(1.57,5.23)	0.0006
Cardiogenic shock (Killip IV)	14.40	(3.24,63.96)	0.0005
PREVIOUS HISTORY			
Diabetes	2.09	(1.52,2.86)	<0.0001
Chronical heart failure	1.67	(1.22,2.28)	0.001

5 DISCUSSION

The overall aim for Swedish healthcare is formulated in the Health Care Law (77) and to literally quote the second paragraph (§2);

The goal of health care is a good health and care on equal conditions for the entire population. (Act 1982:783)

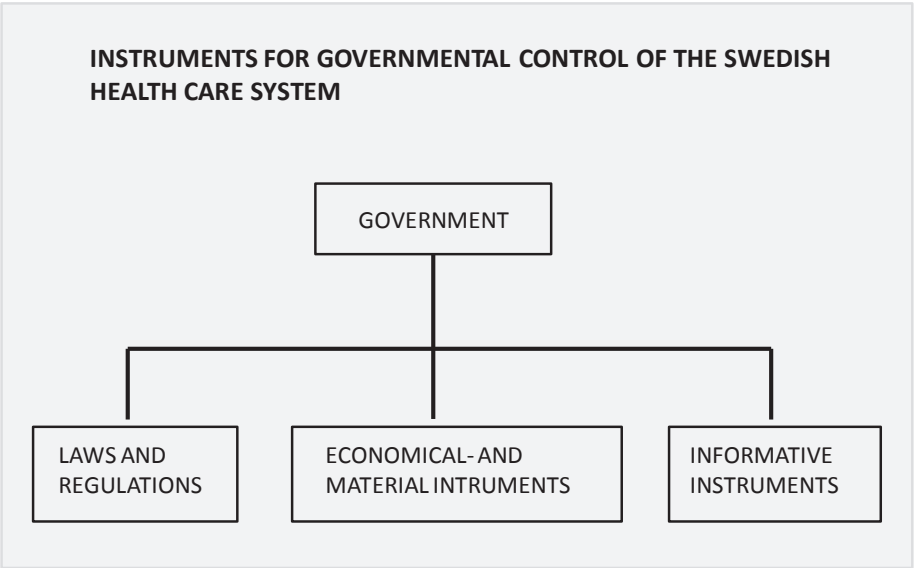
Care shall be provided with respect for the equal worth and human dignity. Those who have the greatest need for health care shall be given priority to health care (Act 1997:142)

5.1 THE CHAIN OF CARE PERSPECTIVE

In Sweden we have a vertical organization structure with strong departmentalization of responsibilities. (78) The Government has three possible instruments to control the Swedish health care system. These instruments are; laws and regulations, economical and material resources and informative guidelines. (See figure on next page)

Unclear definitions of responsibilities between the medical profession and the departments can cause an inefficient healthcare. (79) Health care providers tend to focus specifically on the particular patients they themselves are treating and are often not able to consider the general health care goals. Sometimes the providers do not even know the overall purpose at their own departments. To create a chain of care can be a way to engage health care providers with different knowledge and experience at different departments, and thereby merge focus on a common issue. Through such participation, communication and cooperation, the care system will hopefully improve.

Thus, the most important reason for developing chains of care is to improve quality of care. Another reason to make up chains of care is to turn health care more patient-focused. (79)



Origin: Vedung 1998

In the municipality of Gothenburg a chain of care, as described above, has been built up for caretaking of chest pain patients. The chain includes the dispatch center, the EMS, the EDs, the CCUs, the cath.labs and the medical wards. This organization constitutes three hospitals and handle, as reported in papers II-IV, just over 10 000 patients with chest pain, per year. Approximately 50% of these patients will be hospitalized due to their symptoms. This large amount of patients creates great demands on the prehospital- and in-hospital- organization. For optimal use of hospital beds and economic resources and for optimal quality of care, it is of greatest importance to triage and risk-stratify the patients as early as possible in order to send them to right level of care. In our organization we try to triage the

chest pain patient prehospitally, if an ambulance is used, and otherwise as soon as possible at the ED.

Since the 1980-ies we have known that early revascularization therapy in STEMI patients is important and this is extensively described in the literature. (80, 81) Therefore, for STEMI-patients or patients with cardiogenic shock there have been clear instructions for a long time. These patients should, regardless of geographical belongings, immediately be transferred to the CCU or cath.lab at the tertiary centre for further investigations and treatments. Because some facilities, such as immediate coronary angiography and thoracic surgery, only exist at the tertiary centre this has been uncontroversial. For the NSTEMI patients or patients with severe arrhythmias or severe heart failure (with exception for cardiogenic shock) the instructions are however not that clear. For these patients there are no agreements or local guidelines where to direct the ambulances.

For chest pain patients transported by the EMS organization there almost always is a prehospital ECG recorded and transmitted to the CCU at the tertiary center. Then, for each of these patients, there is often a requirement for a pragmatic immediate solution suggesting; If there are empty hospital beds at the tertiary CCU, the patient with either ACS, severe arrhythmias or severe heart failure can be directly admitted here. Otherwise the patient is referred to one of the EDs often resulting in admission to a CCU at the other two hospitals, or a medical ward at the tertiary center. When logistical problems such as a crowded tertiary CCU and matters of chance for a free bed, instead of medical priorities, determine where each patient is admitted, the result most probably will not be a high quality of care. Medical priorities should always be superior and logistical problems must be solved. Efficient

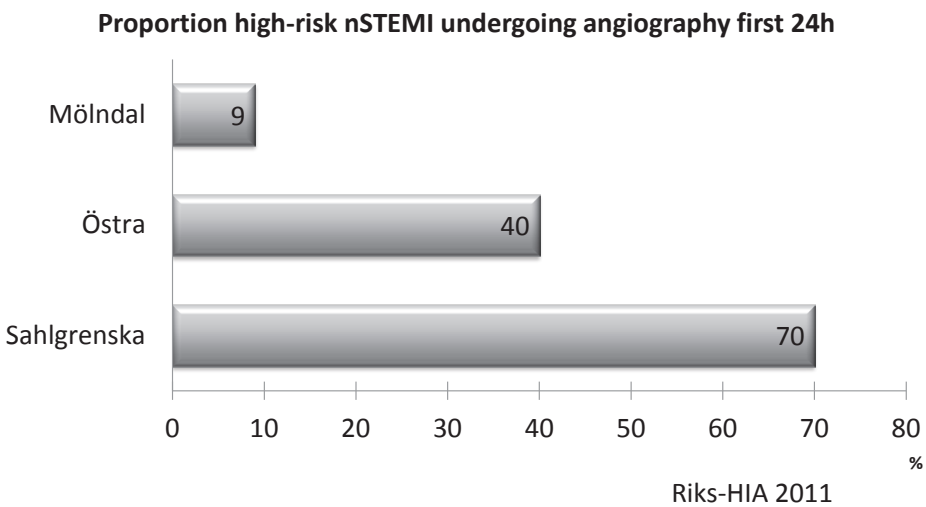
use of the beds and resources at the tertiary CCU requires a high turnover and good aftercare alternatives.

In paper II we compared chest pain care at the three hospitals in the municipality of Gothenburg in order to get an updated picture of the quality of care concerning patients with heart problems. There were interesting findings in baseline characteristics. For example, a previous history of depression or psychiatric disease was more common at the hospital with the most frequent need for interpreters, and in this hospital we also found the highest percentage of hospitalized patients. These findings indicate that communication problems may result in increased hospitalization and that non-Swedish-speaking patients (NSS) may be overrepresented with psychiatric illnesses. Probably there is an under-use of interpreters at the ED´s and it could be cost-saving to use interpreters to avoid unnecessary investigations and hospitalizations. (82, 83)

The three hospitals represent different geographical areas and the study population presents heterogeneities in the socio-economic status. From previous studies, we know that there is a relationship between socio-economic status and CVD, where low socio-economic status, particularly in women, predisposes for an increased risk of CVDs. (43, 44) For immigrant-dense areas it is important to take this knowledge into account and be extra careful with good follow up, both concerning the CVD but also with regard to extended problems with mental illness and communication difficulties.

Concerning delay-times to treatments and investigations of the patients with suspected ACS, we saw statistically significant differences between the hospitals, especially with regard to delay to coronary angiography. Among all hospitalized chest pain patients the delays to coronary angiography were 20 h at the tertiary center. For the other two hospitals this delay was 50 h and 70 h

respectively. Thus, there was a 2.5 and 3.5 times extra delay for patients not admitted to the tertiary center. According to guidelines a high fraction of these patients ought to be investigated with a coronary angiography within 24 hours. (70) According to our data, this seems however only achievable for patients admitted to the tertiary center. Recent data from the SWEDEHEART/ RIKS-HIA registry confirm our findings concerning delay-times to coronary angiography in NSTEMI patients in the three hospitals in our community. (5) The figure below shows the proportion of *high-risk* NSTEMI patients actually undergoing coronary angiography during the first 24 hours (which is recommended in the guidelines). Thus, in 2011 we can still conclude that there are unjustified differences between hospitals.



These findings indicate severe logistical problems: Long delay-times to investigations and treatments predispose in an ineffective use of hospital beds, which in turn leads to increased over-all costs. The other aspect is that depending on which geographical area you live in, there are differences in

emergency heart care. An unequal chest pain care in the same municipality is not consistent with The Health Care Law and these deviations must be corrected. However, in our study, this extra delay had no significant impact on the observed 30-days or 1-year mortality. On the other hand, our study was too small to correctly investigate mortality differences.

The centralization of medical facilities and therapies is cost-effective and probably will improve quality in the patients with severe heart disease. It is well known that larger volumes are associated with economies of scale and enhanced quality. (84, 85) However, there is also a risk that this kind of centralization will lead to an unfair and unequal care system with delay to treatments and investigations, as shown above, for patients with UAP or NSTEMI waiting for a coronary angiography. For the population in the geographical area belonging to the tertiary center there were much shorter waiting-times to the cath.lab as compared to the situation in the other two hospitals. In a community like ours, with small distances between hospitals, there ought to be a better cooperation and coordination in the chain of care. The medical needs of the patient based upon severity of symptoms, ECG-findings and hemodynamic parameters etc should be used for medical decision support rather than geographical belongings, in order to direct each individual patient to the right level of care and to the hospital with the most optimized facilities and resources.

These logistical problems we probably share with each and every city that has more than one hospital and where these hospitals have different profiles or facilities. Strangely, reports focusing on this area are scarce and not reported from other communities. Hopefully our findings could improve the effectiveness and efficiency of the chain of care for chest pain patients in our area as well as in other communities.

5.2 THE GENDER PERSPECTIVE

Chest pain patients are common visitors at our EDs. Only in Gothenburg nearly 10 000 patients per year seek emergency care due to chest pain. Scantily half of this population is female (48%). In an era when there is focus on equal care and equality between genders we wanted to explore this area. In two of our papers (I,III) we investigate gender perspectives in the chest pain care. In these studies there appears to be a difference in the priority given to women and men with suspicion of ACS prior to eventual admission to a CCU but only minor differences thereafter. Our data suggests that when the patients are treated at a CCU and when a final diagnosis of ACS is established, the differences in treatment of women and men might be minor. The problem is that patients with ACS and MI are treated not only at CCUs but also at medical wards, stroke departments, in the geriatric wards and so on. In two of our studies (paper I & III) and also according to others' experiences, women are less frequently admitted to a CCU as compared to men. (74, 86) A number of mechanisms might explain the phenomenon of a gender bias outside the CCU, with women continuing to be given a lower priority than men. Women suffering from ACS sometimes have more diffuse symptoms, including more pain in the neck, back and abdomen than men.(30-32) Women also appear to be less inclined to believe that their symptoms actually come from a threatening MI (87) and therefore perhaps explain their symptoms less clearly than men. These symptom differences in ACS and MI patients are confirmed by both us and in the literature. (30-32). We also know that patients without chest pain/ discomfort in the chest tend to present later, are treated less aggressively, and have almost twice the short-term mortality compared with those presenting with more typical symptoms of MI. (88). A recent report based on 1 million patients hospitalized with MI suggests that 4 out of 10 women do not suffer from chest pain as compared

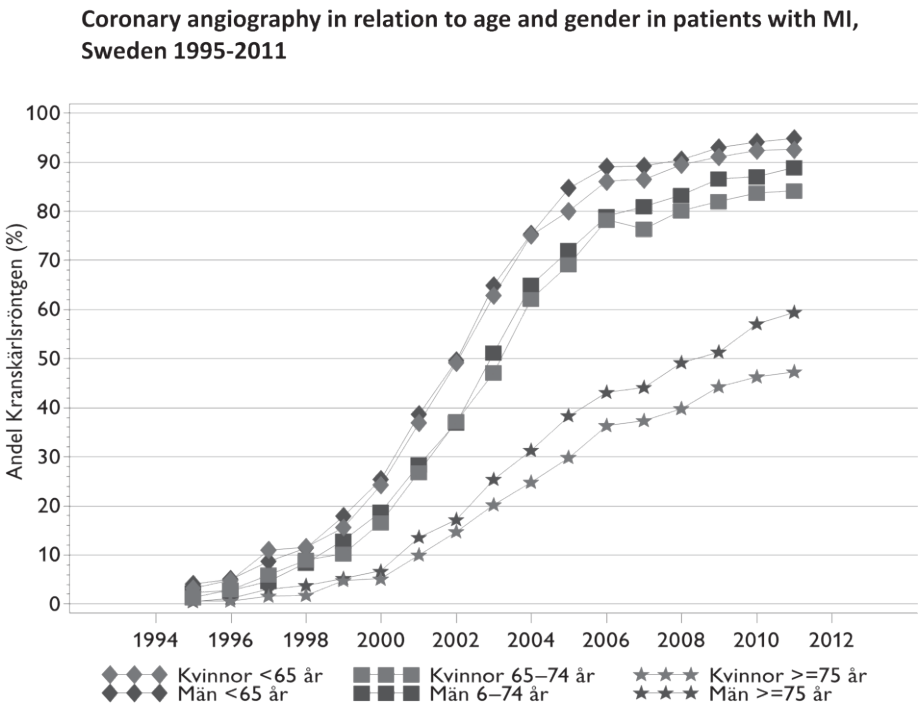
with 3 out of 10 men. (89) The fact that women with MI were more likely to present without chest pain could contribute to why the dispatch centre or the health care providers at the ED give women with symptoms of ACS lower priority than men and that missed diagnoses of acute cardiac ischemia is more common in women.(75, 90) In the CCU, cardiologists are responsible for the patients care, and cardiologists are probably more familiar with the diagnostic difficulties in women with ACS. Physicians working outside the CCU have various backgrounds and might be less familiar with the "women dilemma" and not as alert to the possibility of MI among women with atypical symptoms. Here, we still need to educate the medical profession to approach women with acute chest pain as aggressively as men despite that the likelihood of myocardial damage is less in women. It is also important to include patients with chest pain treated outside a CCU in future studies, in order to compare and improve quality of care especially with regard to sex.

Whereas a number of studies have described delay to admission to hospital in a gender perspective (91, 92) research on sex differences concerning delay times to treatment and investigations in ACS-patients is scant. Particularly in paper III (but also in paper I) this was investigated. In both studies there was an overall longer delay between hospital admission and arrival at a ward/cath.lab in women than in men. There were in general long delays at the ED´s before reaching a ward and for both sexes this delay exceeded 3 hours (median time). In women the admission to a ward took an additional 36 minutes without any feasible explanation. There were also statistically significant sex differences in delay times to administration of aspirin and delay times to coronary angiography. To minimize the risk of excessive myocardial damage and subsequent complications in patients with ACS, it is important to speed up treatments and investigations in both females and

males. Concerning medical therapy at hospital discharge there were no significant differences between genders and both groups were medically treated in consistence with guidelines.

In our studies and in former studies, women with chest pain undergoing a coronary angiography, seem to have a higher probability of an angiogram without a significant stenosis as compared to men. (93) In addition we know from our studies and from previous research that women with chest pain are less likely to develop an MI as compared with men. (35) In paper III, among hospitalized chest pain patients, only 12 % of women developed an MI as compared to 19% among men. In relation to these findings- maybe it is right to perform less coronary angiographies in women? However, despite this, it is of course important to properly examine, investigate, risk stratify and finally treat women with suspicion of an ACS.

In a recent Swedish study on a large cohort of patients with NSTEMI, both genders tended to have a better outcome associated with an early invasive strategy. (94) Our findings do indicate a lower use of diagnostic tools such as coronary angiography and echocardiography as well as lower access to a CCU among women. These findings are confirmed by the national quality registry, RIKS-HIA. The figure below shows the frequency of coronary angiographies in MI-patients, discharged from hospital alive, in relation to age and gender in Sweden 1995-2011.There was a lower use of coronary angiography among women as compared to men, for all ages. The differences seem to be greatest in the group above 75 years of age, indicating that the elderly females are not as extensively investigated as men. However, no adjustment for differences in age within the age groups was performed.



Recent figures from 2011 at our cardiology department state that, women constitute 36% of all hospital care days (17588 care days in total for both genders). The average length of stay is 2.6 days and did not differ between genders. Women were older than men (mean age 67 years compared to 64 years) and women were given a final ACS diagnosis less often than men. Only 26% of women admitted to the tertiary CCU had a final ACS diagnosis compared to 35% among men. This is in congruence with data from papers I and III. Of all coronary angiographies only 47% resulted in a PCI among women compared to 59% in the male group indicating, as in previous reports and in paper III, that women more often have a normal angiogram. (93)

In summary, early in the triage system there seems to be differences between genders but when a final diagnosis of ACS is established the differences between women and men are minor. An obvious goal must be to make chest

pain triage and early care as equal as possible despite the gender of the patient.

5.3 THE FOREIGN PERSPECTIVE

In Sweden, at turn of the year 2009/2010, the foreign-born population represented 14.3% of the people living in Sweden. (95) According to statistics of Sweden (SCB) an immigrant by definition is a person with an intention to stay in our country for at least 1 year, who has a residence permit, and who has registered himself as an inhabitant. (67) For 2011, there were approximately 185 different citizenships represented among immigrants. Returning Swedish citizens constituted the lion part of the immigrants.

For people seeking asylum, health care rights are formulated in "The Law on health care for asylum seekers and others" (2008:344) telling that asylum seekers (≥18 years) are entitled free *emergency* health care and *emergency* dental service. This means that immediate revascularization therapy when having an MI is free for asylum seeking adults but not a planned PCI, CABG-operation or heart valve surgery. This means that we, according to the law, cannot treat every human in Sweden in an equal way despite their life threatening conditions and this will of course lead to frustration among health care providers. Children (<18 years) seeking asylum have the same rights to health care and dental services as Swedish children.

We know from previous research that CVD is a common cause of morbidity and mortality in the foreign born group as well as in Swedish born persons. The overall trends for male foreigners show a slight decrease in the incidence of CVD over time, but for foreign-born women there is an unchanged or slightly increasing trend. (96) In our study (paper IV) NSS patients had a previous history of diabetes, hypertension, MI, PCI and stroke more often

than SS patients. This could explain an increased risk for CVDs in the foreign group compared to the native born. We know from previous research that, foreign-born people are at an increased risk for new CVD compared to Swedish born persons, even when levels of education and employment status are taken into account. (97) Probably there is a multi-factorial genesis that might explain the over-risk in these groups. Example of such over-risk factors are; different genetic predisposition, differences in smoking habits or other lifestyle factors, psychological or cultural differences or maybe effects of stress during migration. It is very important to health care providers to be aware of a possible risk of unhealthy behaviors and risk factors for coronary disease in the immigrant group. (97, 98) Language factors have been found to be associated with disparate health care delivery and worse outcomes. (40) Moreover, non-native speaking persons often have poorer adherence to medical treatment and follow up. (38) Recent figures for Gothenburg (2011) show that it is more common among foreigners to be absent from work as compared to the Swedish population (36.4 absent days per year in the foreign group compared to 26.8 absent days in the whole Swedish population) (67).

It is also important for health care providers to consider the language barrier problem and to use interpreters when this is needed. In our study an interpreter service was deemed necessary in 8 % of the visits due to chest pain. The hospitalization rate in the chest pain patients differed between NSS and SS groups (64% vs 54 %) and language barriers could probably, at least partly, explain this. Further, the presumption of immigrants and their "over-risk" for CVD could also explain higher admission rates. Altogether, communication problems probably result in a higher frequency of hospital admissions, since the physician would not risk ignoring a possible serious illness. One could argue that "unnecessary" hospital admissions must be much more expensive than the use of an interpreter to facilitate

communication at the ED. In the population investigated in our study, interpreter service might be underused and our hypothesis is that it will be cost-saving to use interpreters when it is necessary to avoid such unnecessary hospitalizations.

Poorer language proficiency was associated with longer delay time from arrival in hospital to admission to the CCU or the cath.lab. Maybe this prolonged delay is due to communication difficulties and there could be room for improvements by increased use of interpreters. No statistically significant differences were however found between NSS and SS patients in final diagnoses or coronary angiography- and echocardiographic findings and only minor differences regarding delay-times to other treatments and investigations were found. Furthermore there were no differences in mortality during hospital stay but the study was underpowered to address these questions appropriately.

Our findings indicate that it is possible that the largest differences between NSS and SS patients may lie outside hospital care. Either before, in primary care, or after, in rehabilitation or secondary prevention, there could be factors that substantially explain the inferior health or well-being of NSS. Thus, place of birth ought to be considered as a risk factor to develop CVD (99) and all health care providers, taking care of chest pain patients, should be aware of and consider this problem. Maybe health care in immigrant-dense geographical areas should be provided with more education and economical resources to improve primary care and secondary prevention among CVD patients. From the hospital perspective, cardiologists certainly could get better at initiating follow up in primary care and we could be better in supporting physicians in general practices with advices concerning CVD-patients.

5.4 THE AGEING PATIENT AND MULTIPLE ILLNESS PERSPECTIVE

It is important to discuss the age and multiple illness perspectives in the chain of care for patients with suspected ACS. The Swedish population is ageing and according to SCB the elderly population >65 years will grow from 1.5 million inhabitants in 2003 to estimated 2.5 millions in 2050. (67) An ageing population requires more health care and we must be prepared for larger volumes of patients at our hospitals in the future. This will be afflicted with costs and when the resources are limited, care of the elderly must be discussed from a political/economical perspective as well as from an ethical perspective: How much can our health care system afford to do for the elderly?

We know that older patients are less likely to be admitted to the CCU, a cardiology ward, and be under the care of a consultant cardiologist. (100) At the same time, we know that the elderly are a high risk group with more significant treatment benefits than younger ACS patients. (100, 101) Later in the text these age inequalities in ACS care will be discussed and according to our data there seems to be opportunity for improvements in age-related ACS care.

Previous research has showed that NSTEMI patients are older, have more co-morbidities and multi-vessel disease than the STEMI group. (72) According to SWEDEHEART data in 2011, the NSTEMI group dominates over the STEMI/LBBB group and, if looking in the mirror, it was the opposite 17 years ago, when the registry started. (5) In 2011, out of all MIs, the STEMI group amounted 30% compared to 6 % LBBB and 64% NSTEMI. (5)

Our findings indicate (paper V), somewhat surprising, that many chest pain patients without ST-elevation but with severe illness and high long-term

mortality are not admitted to a CCU, although this group probably would benefit from a higher, instead of lower, attention. This is in congruence with data from the annual SWEDEHEART report from 2011, showing that patients with ACS and diabetes or renal failure less often are treated invasively with PCI or CAGB. In our study, and in other studies, patients with diabetes, as compared to non-diabetics, have a substantially increased mortality rate when having a suspected ACS. (99) The elderly, "non-terminal" patients with severe illnesses must not be down-prioritized for CCU-care just because they lack an indication for immediate cath.lab care. According to SWEDEHEART data, patients with co-morbidities are also non-optimally treated pharmacologically when compared to ACS patients without co-morbidities. (5)

We know from previous research that a CCU, with cardiologists and heart specialized nurses, offers the best evaluation for ischemic heart disease and that treatment in a CCU has been associated with lower 30-day mortality. (102, 103) Why then are NSTEMI patients, diabetics and patients with acute heart failure not directly admitted to a CCU/cath.lab as often as the younger and "healthier" STEMI-group is? Our study (paper V) indicates a higher age-adjusted mortality in the chest-pain group without ST-elevation, as compared to the STEMI group. Even stable NSTEMI patients at high risk as assessed by the GRACE-score should undergo a coronary angiography within 24 hours with the aim to reduce mortality. (70, 71) It is essential to spread the information about the importance of early treatment also among the elderly. From previous research we know that patients' delay to hospital admission is longer for the group of elderly as compared to the younger group. (104) Therefore, we need to educate also the elderly that "time is heart muscle".

In former studies, the NSTEMI patients treated in a CCU, with an early invasive strategy, had significantly shorter length of stay compared with patients treated in a general internal medicine ward. (105) Furthermore, it is of greatest importance that every ACS patient participates in secondary preventive activities for best outcome and there seems to be an under-utilization of cardiac rehabilitation especially among the elderly. (106, 107) ACS patients not admitted to the CCU unfortunately often miss rehab programs. Previous research has shown that exercise-based cardiac rehabilitation is effective in reducing total and cardiovascular mortality and hospital admissions. (108, 109) Other benefits include improvements in quality of life, functional capacity, and social support. (110) However, only a minority of post-MI patients actually participates in formal cardiac rehabilitation programs. This is probably due to several factors, including lack of structured programs, physician referrals, low patient motivation, noncompliance, and financial constraints. According to SWEDEHEART data 2011 only 40% of all patients with MI in Sweden take part in cardiac rehab programs. (5) For Sahlgrenska University Hospital the corresponding figure is 58% (111) but still there are groups of patients, for instance the elderly, who would benefit from increased rehab training.

Maybe the elderly would benefit from being treated by geriatrically orientated cardiologists when having acute heart problems? It is important that health care providers are familiar with geriatric problems. According to SWEDEHART data, patients older than 80 years have more co-morbidities, less chest pain and lower frequency of STEMI/LBBB compared to the younger group when having an MI. (5) Nevertheless, the effect of different kinds of treatment strategies in the elderly ACS-patients more often have higher impact on mortality and morbidity compared to younger patients even though the risk for complications and bleedings are higher. (100, 101)

Among the elderly with co-morbidities there is a lack of randomized, controlled trials to guide management and treatments since advanced age has been an exclusion criterion for the majority of studies. Consequently, there is a discrepancy between trial populations and the "real world" resulting in difficulties how to treat the growing population of patients at advanced age.

The trend the last decade (2002-2011) is that the clientele at our tertiary CCU is getting older. In the figure below, it is shown that in 2002 the patients aged >80 years amounted 11 % of all patients admitted to the CCU. Ten years later, patients above 80 years of age amounted 19 % of all patients. Even though the length of stay is short also among elderly, in average 3.3 days, the increasing elderly population will require great attention at the cardiology departments in the future. Perhaps the CCU capacity ought to expand to prepare for larger volumes of patients. This will, however, be afflicted with costs and must be related to other priorities in our health care system.

Number of patients and care days, in relation to age, at the tertiary CCU at Sahlgrenska University Hospital 2002 and 2011

		2002				2011			
AGE		**WOMEN**	**MEN**	**TOTAL**	**%, TOTAL**	**WOMEN**	**MEN**	**TOTAL**	**%, TOTAL**
<50	PTS	198	456	654	13	377	670	1047	15
	DAYS	457	1095	1552	12	866	1432	2298	13
50-59	PTS	277	818	1095	22	330	753	1083	16
	DAYS	719	1867	2586	19	615	1723	2338	13
60-69	PTS	379	933	1312	27	541	1294	1835	27
	DAYS	924	2584	3508	26	1261	3082	4343	25
70-79	PTS	436	883	1319	27	533	999	1532	23
	DAYS	1265	2737	4002	30	1407	2786	4193	24
80-89	PTS	232	266	498	10	527	594	1121	16
	DAYS	773	914	1687	13	1730	1872	3602	21
>90	PTS	18	18	36	1	140	66	206	3
	DAYS	58	55	113	1	514	300	814	5
MEAN AGE		65	63	63		67	64	65	

How do we solve the problem with a growing population of elderly patients with heart disease and multiple illnesses when the financial resources are limited and there is a constant shortage of hospital beds? The health care system will need clear directives from the Government and politicians how to act and what to prioritize. Otherwise there is a risk of frustration among caregivers and without directives there certainly is a risk for an unequal and unfair care system. How to prioritize among critically ill patients at a ward or the ED, at the individual level, is something every physician is educated and trained in. How to prioritize at a national level is a problem for politicians and they have to take their responsibility for a good future healthcare.

THOUGHTS OF IMPROVMENTS IN OUR CHEST PAIN CARE

C - Communication and co-operation
H - Help each other when overcrowded wards.
E - Economic perspective with good use of common resources
S - See our departments from a ”holistic” perspective
T - Teamwork between three hospitals with specific strenghts.

P - Patients' perspective
A - Adequate level of care directly
I - Increased effectiveness
N - No prestige

C - Common aims and strategies known by all co-workers
A - Avoid unnecessary movements of patients
R - Regularly quality controls
E - Equality despite age, gender, ethnicity or geographical belongings

6 CLINICAL IMPLICATIONS

Our studies suggest that there are some differences between women and men in the early chain of chest pain care. These differences indicate that we need to educate the medical profession to approach, investigate and triage women as thoroughly as men despite the likelihood of myocardial damage being less in women. For the non-Swedish speaking group, an increased use of interpreters could possibly minimize the delays to treatments and investigations. This foreign population seems to have an increased risk for CVD and we must adapt and optimize not only hospital care, but also primary and secondary preventive programs for these patients. Furthermore, if there is a suspicion of ACS we must focus more on the high-risk group, i.e. patients without ST-elevation on ECG and treat them in a faster and more invasive way according to the new guidelines.

Many larger cities have more than one hospital and when multiple centers are involved in the chest pain care there always occur logistical problems. By highlighting these problems we hope to optimize triage and treatment of patients with suspected myocardial infarction in the future. We also hope that other communities can learn from our experiences.

7 CONCLUSIONS

Concerning the chain of care in chest pain patients there certainly are room for improvements at many levels. Women with suspected ACS seem to be given lower priority prior to CCU admission and for women there were longer delay times to appropriate level of care, administration of aspirin and to performance of a coronary angiography. When a final diagnosis of ACS is established the difference in treatment between genders is minor.

Poorer language proficiency was associated with higher prevalence of diabetes and stroke and in the non-Swedish-speaking group there were longer delay-times from arrival in hospital to admission to cath.lab. The prolonged delays can be related to communication difficulties and the chain of care can possibly speed up with an increased use of interpreters.

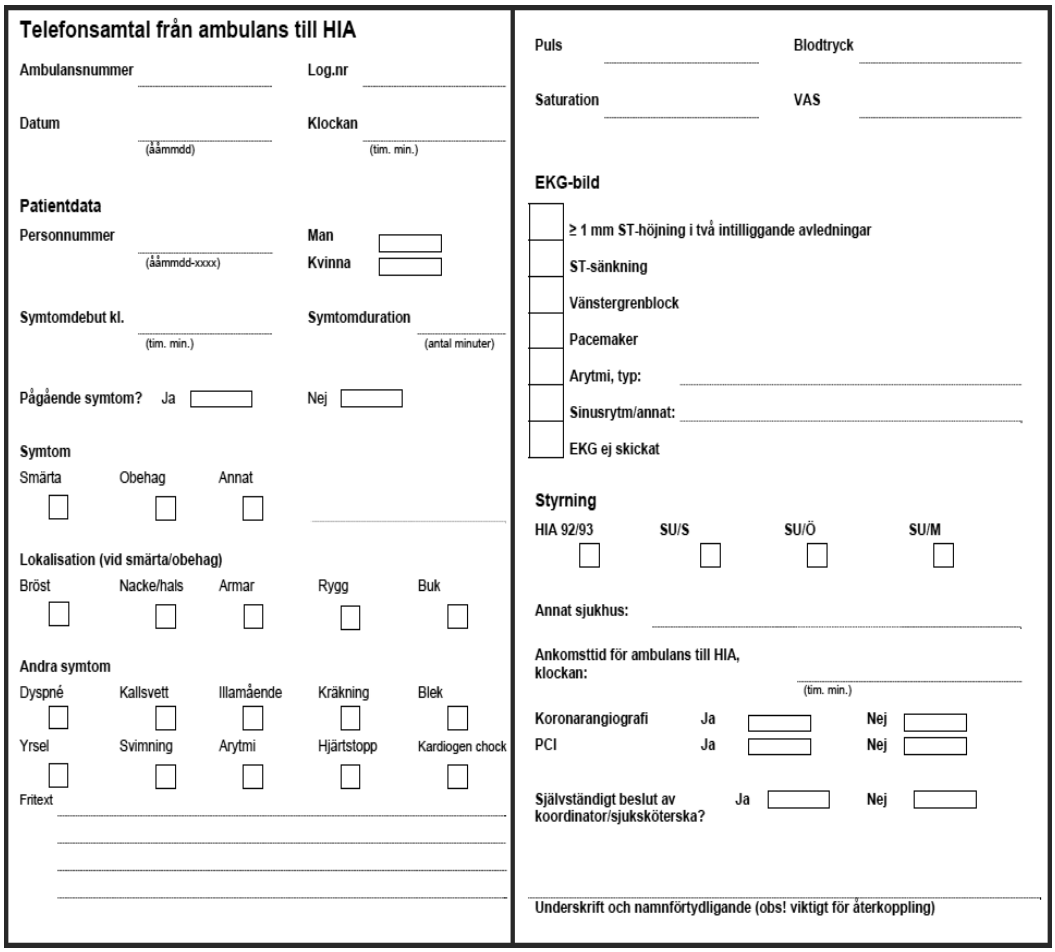
ST-segment elevation on the ECG was the strongest predictor and, should probably stay, the most important factor, for direct admittance to a CCU. As a consequence of such fast and efficient STEMI care, mortality was lower in the STEMI group as compared with other patients with suspected ACS. The time might have come to focus also on NSTEMI patients in order to find and treat the high-risk ones that otherwise would have a poor prognosis.

Our data also highlight logistical problems in the acute care. In the municipality of Gothenburg, there are significant differences between hospitals, especially with regard to delays to coronary angiography and PCI in presumed ACS-patients. The medical condition of the patient, not the geographical belonging, should decide the speed of investigations and treatments. Deviations like these are unacceptable at a time when equitable treatment for each patient ought to be an attainable and obvious goal or even a right conceded by law to all citizens.

8 FUTURE PERSPECTIVES

In this thesis we have focused on the early chain of care in patients with threatening myocardial infarctions. Here we have identified some deficiencies and it would be interesting to look deeper into them in future research. Even more interesting would be to study the population BEFORE they get their coronary event and AFTER hospital discharge. These fields are insufficiently explored and a well- functioning system for primary prevention as well as optimized secondary rehab programs certainly would improve outcome for CVD patients.

9 APPENDIX



Telefonsamtal från ambulans till HIA

Ambulansnummer ..... Log.nr .....

Datum ..... (ååmmdd) Klockan ..... (tim. min.)

Patientdata

Personnummer ..... (ååmmdd-xxxx) Man ☐ Kvinna ☐

Symtomdebut kl. ..... (tim. min.) Symtomduration ..... (antal minuter)

Pågående symtom? Ja ☐ Nej ☐

Symtom

Smärta ☐ Obehag ☐ Annat ☐

Lokalisation (vid smärta/obehag)

Bröst ☐ Nacke/hals ☐ Armar ☐ Rygg ☐ Buk ☐

Andra symtom

Dyspné ☐ Kallsvett ☐ Illamående ☐ Kräkning ☐ Blek ☐

Yrsel ☐ Svimning ☐ Arytmi ☐ Hjärtstopp ☐ Kardiogen chock ☐

Fritext .....

Puls ..... Blodtryck .....

Saturation ..... VAS .....

EKG-bild

☐ ≥ 1 mm ST-höjning i två intilliggande avledningar

☐ ST-sänkning

☐ Vänstergrenblock

☐ Pacemaker

☐ Arytmi, typ: .....

☐ Sinusrytm/annat: .....

☐ EKG ej skickat

Styrning

HIA 92/93 ☐ SU/S ☐ SU/Ö ☐ SU/M ☐

Annat sjukhus: .....

Ankomsttid för ambulans till HIA, klockan: ..... (tim. min.)

Koronarangiografi Ja ☐ Nej ☐

PCI Ja ☐ Nej ☐

Självständigt beslut av koordinator/sjuksköterska? Ja ☐ Nej ☐

Underskrift och namnförtydligande (obs! viktigt för återkoppling)

Contact sheet used by the nurses at the tertiary CCU at Sahlgrenska University Hospital. See chapter 3.4 for details.

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11 REFERENCES

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