Chest pain out-of-hours

Prospective studies on diagnostics and management in out-of-hours emergency primary health care in Norway

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Contents

1. Acknowledgements

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2. List of publications

This thesis is based on the following publications:

Paper I

Zakariassen E, Burman RA, Hunskaar S. The epidemiology of medical emergency contacts outside hospitals in Norway - a prospective population based study. Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine 2010, 18:9

Paper II

Burman RA, Zakariassen E, Hunskaar S. Acute chest pain – A prospective population based study of contacts to Norwegian emergency medical communication centres. BMC Emergency Medicine 2011, 11:9

Paper III

Burman RA, Zakariassen E, Hunskaar S. Management of chest pain – A prospective study from Norwegian out-of-hours primary care. BMC Family Practice 2014, 15:51

Paper IV

Burman RA, Zakariassen E, Hunskaar S. Chest pain out-of-hours - An interview study of primary care physicians' diagnostic approach, tolerance of risk and attitudes to hospital admission. BMC Family Practice 2014, 15:1127

In this thesis the four papers will be referred to by their Roman numbers, **Papers I-IV**

3. Definitions and abbreviations

This chapter contains an overview of terms and abbreviations often used in the thesis concerning the organisation of out-of-hours- and pre-hospital services, and clinical terms relevant for the management of patients out-of-hours in general and patients with chest pain specifically. The Norwegian word in square brackets.

Organisation of out-of-hours- and pre-hospital services:

Emergency medical communication centre (EMCC)[AMK-sentral]:

Patients in need of immediate medical assistance are advised to call the national three digits emergency number 113, whereas the call will be routed to the nearest EMCC. The EMCCs coordinate the pre-hospital emergency recourses, and based on the medical problem presented, the EMCCs will alarm the ambulances, physicians on-call and other resources if needed, e.g. the air ambulance service.

Local emergency communication centre (LEMC) [legevaktsentral]:

The LEMCs operate the local emergency number, and are often situated at the local casualty clinic. For each municipality it is mandatory to have a local emergency number that inhabitants can call when in need of urgent medical help. The LEMCs are often covering several municipalities during out-of-hours periods.

Casualty clinic [legevaktlokale]:

A medical office or surgery used in out-of-hours primary care. Often a dedicated surgery to out-of-hours work, but it can also some places be co-used as a GP surgery at daytime.

General practitioner (GP) [allmennlege]:

GPs are primary care physicians who normally work in a GP surgery/office, solo or in a group, who takes care of a wide variety of medical problems and may refer patients to specialists and hospitals in the secondary health care system if needed ("gate-keepers"). Regular GPs (rGPs) are GPs with a contract with the municipality, and thus responsible for a list of patients. Out-of-hours work is a mandatory part of the rGP's work in the municipality.

Norwegian Index of Medical Emergencies (Index) [Norsk indeks for medisinsk nødhjelp]:

The Index is a criteria-based decision tool used in the EMCCs to triage patients and decide the appropriate level of response. Red colour is defined as an "acute" response, with the highest priority. Yellow colour is defined as an "urgent" response, with a high, but lower priority, where the patient should be examined as soon as the physician-on call is available. Green colour is defined as a "non-urgent" response, with the lowest priority.

Triage [hastegradsvurdering]:

Triage is defined, in emergency medicine, as a process of sorting injured or sick people into different groups based on their individual need for immediate medical treatment. In this thesis the term "triage" is mostly used to describe the process in which the EMCCs or casualty clinics decide the appropriate level of response according to the Index.

Clinical terms

Ischaemic heart disease (IHD) [Iskemisk hjertesykdom]:

Disease caused by plaque building and partial or total occlusion of the coronary arteries of the heart. Also called coronary artery disease (CAD), and includes both stable angina, angina equivalents (such as dyspnoea on exertion) and acute coronary syndrome.

Acute coronary syndrome (ACS) [Akutt koronarsyndrom]:

Refers to acute onset IHD with one of three medical conditions; unstable angina, non-ST segment elevation myocardial infarction (NSTEMI) and ST segment elevation myocardial infarction (STEMI).

Electrocardiogram (ECG) [EKG]:

Diagnostic tool often used when diagnosing patients with chest pain, acute dyspnoea or palpitation. It measures electrical activity of the heart, and can be used to diagnose both arrhythmias and IHD.

Clinical decision rule/Clinical prediction rule [Klinisk beslutningsstøtteverktøy]:

Tools developed to assist clinicians in making diagnostic and/or therapeutic decisions “bedside”. They are often constructed in a manner where the clinicians, using sign and symptoms, end up with a score measured against a set cut-off.

4. Abstract

4.1 English summary

The main aim of this thesis was to explore primary care physicians' diagnostic measures, reasoning, and management of patients with chest pain in out-of-hours emergency primary care in Norway.

Chest pain is a common symptom in out-of-hours primary care, and still constitutes a considerable diagnostic challenge for the physicians on-call, with a limited set of diagnostic tools outside hospitals. There is still a lack of knowledge on the epidemiology of all medical emergencies outside hospitals in general, and patients with acute chest pain more specifically. It remains unclear to what extent the physicians follow current guidelines and evidence when diagnosing patients with chest pain, and how the physicians' tolerance of risk and attitudes to hospital admission influences the management of these patients.

The main objectives of this thesis were:

- To obtain representative data on the epidemiology of medical emergencies classified as "red response" by the emergency medical communication centres (EMCCs) in general, and patients with acute chest pain more specifically
- To investigate the use of diagnostic tools and treatment of choice in patients with chest pain out-of-hours in Norwegian primary care
- To gather knowledge about primary care physicians' diagnostic approach, tolerance of risk and attitudes to hospital admission in patients with chest pain out-of-hours in Norwegian primary care

This thesis is based on two studies, each with two corresponding papers. Study 1 is a prospective population-based observational study presented in **Paper I** and **Paper II**. Three emergency medical communication centres (EMCCs) gathered information on every situation that was triaged as a red response according to the Norwegian Index of Medical Emergencies (Index), during a three month period. Red response is defined as an "acute" response, with the highest priority, according to the Index. Records from ambulances and primary care doctors were subsequently collected. International Classification of Primary Care - 2 symptom codes were assigned retrospectively, as well as severity of illness scores measured with The National Committee on Aeronautics (NACA) System.

Paper I describes all medical emergencies classified as red response, with a total incidence of red response situations of 5 105 during three months, corresponding to a rate of 25.1 situations per 1 000 inhabitants per year. A total of 5 180 patients were registered in the study; 394 patients were involved in 138 accidents, and 181 situations were without patients. The study showed that 90% of the red responses were medical problems with a large variation of symptoms, the remainder being accidents. Analysing severity of illness; the study found that 70% of all patients were in a non-life-threatening situation and 50% of the patients in a potentially or definitely medical situation (NACA score 4-7) were above 70 years of age. Within the accident group, males accounted for 61%, and 35% were aged between 10 and 29 years, with a median age of 37 years. Chapter A10 "Chest pain" of the Index was the most common in use (22% of all situations), but few of the 39 chapters in the Index were used in total. ICPC-2 symptom codes showed that cardiovascular, syncope/coma, respiratory and neurological problems were the most common medical problems. The paper concludes that emergency medicine outside hospitals mainly consists of medical problems, in which most patients are not in a life-threatening situation. Further research should focus on triage at the EMCCs and how to best deal with "everyday" emergency problems outside hospitals.

Paper II gives a more detailed description of the 1 104 patients classified as a red response, with chest pain as their main complaint (Chapter A10 – "Chest pain"). Estimated rate was 5.4 chest pain cases per 1 000 inhabitants per year. Severity of illness scores (NACA) indicated that 26% of the patients were in a life threatening medical situation. Analysing prehospital response time; the study found a median response time of 13 minutes, with an ambulance reaching the patient in less than 10 minutes in 30% of the cases. Seventy-six per cent of the patients with chest pain were admitted to a hospital for further investigation, 14% received final treatment at a casualty clinic, while 10% had no further investigation by a doctor ("left at the scene"). **Paper II** concludes that the majority of patients with acute chest pain were admitted to a hospital for further investigation, but only a quarter of the patients were assessed prehospitally to have a severe illness. The findings highlight the challenges for the EMCCs in deciding the appropriate level of response in patients with acute chest pain. Overtriage is to some extent both expected and desirable to intercept all patients in need of immediate help, but it is also well known that overtriage might put an increased strain on the medical resources available.

Study 2 is a prospective, observational interview study presented in **Paper III** and **Paper IV**. Four Norwegian casualty clinics participated with collection of data, and the data were registered prospectively during a six month period. Data from structured telephone interviews with 100 physicians shortly after a consultation with a patient presenting at the casualty clinic with "chest pain" were analysed. The casualty clinics continued registration of patients until the predefined number of 100 unique physicians with 100 corresponding patients had been included, and each physician could only be interviewed once. The questionnaire used in the telephone interview had two parts, where the first part (presented in **Paper III**) consisted of questions related to the patient they just had treated, including diagnostic measures (use of ECG and laboratory analyses), severity of illness (NACA scores) and choice of treatment. The second part (presented in **Paper IV**) focused on the individual physician's approach to diagnosing patients with chest pain, tolerance of risk and attitudes to hospital admission for patients with chest pain in general. Tolerance of risk was

measured by the Pearson Risk Scale and the Tolerance of Risk Scale, the latter developed for this study.

As described in **Paper III,** 832 patients with chest pain were registered in Study 2. The predefined 100 interviews were carried out, leading to 100 corresponding doctor-patient pairs included in the study. The median age of included patients was 46 years, men constituted 58%. An ECG was taken in 92 of the patients, and ECG was by far the most common diagnostic tool in use. Analyses of severity of illness showed that of the 24 patients categorised to acute level of response, 15 had a NACA-score indicating a potentially or definitely life-threatening medical situation. Concerning management of the patients and probable cause; 50 of the patients were admitted to a hospital for further treatment, of which 43 were thought to have ischaemic heart disease. Musculoskeletal pain was the second most common cause of pain (n = 22). Otherwise the patients were thought to have a variety of conditions, most of them managed at a primary care level. **Paper III** concluded that less than half were admitted to hospital for probable acute coronary syndrome, and only a minority was given emergency treatment for acute coronary syndrome. A wide variety of other diagnoses were suggested as probable cause of the chest pain. Deciding the appropriate level of response for patients with chest pain is a difficult task, and both over- and under-triage probably occur in out-of-hours primary care.

Paper IV presented data from the same 100 structured interviews and doctor-patient pairs described in **Paper III**. Concerning diagnostic approach; "Patient history and symptoms" was considered the most important, and "negative ECG" and "effect of sublingual nitroglycerin" the least important aspects of the diagnostic process. Half of the physicians believed that the presence of chest-wall tenderness was of little importance. The study found no significant differences in length of experience or gender when testing "risk avoiders" against the rest. Analysing tolerance of risk; almost all physicians felt that their risk assessment out-of-hours was reasonably good, and felt reasonably safe, but only 50% agreed with the statement "I don't worry about my decisions after I've made them". Concerning chest pain patients only, 51% of the

physicians were worried about complaints being made about them, 75% agreed that admitting someone to hospital put patients in danger of being "over-tested", and 51% were more likely to admit the patient if the patient herself wanted to be admitted. **Paper IV** concluded that physicians working out-of-hours showed considerable differences in their diagnostic approach, and not all physicians diagnose patients with chest pain according to current guidelines and evidence. Further research and continuous medical education should focus on empowerment of physicians through training and emphasis on risk assessment and "tolerance of risk".

Main findings of this thesis:

- Emergency medicine outside hospitals mainly consists of medical problems, with acute chest pain the most common symptom. Most patients in a red response situation were not in a life-threatening situation
- The majority of patients with acute chest pain defined as a red response situations were admitted to a hospital for further investigation, but only a quarter of the patients were assessed prehospitally to have a severe illness
- In out-of-hours care; less than half of the patients with chest pain were admitted to hospital for probable acute ischaemic heart disease, and only a minority was given emergency treatment for acute coronary syndrome
- Physicians working out-of-hours showed considerable differences in their diagnostic approach, and not all physicians diagnose patients with chest pain according to current guidelines and evidence
- Differences in "tolerance of risk" have a substantial influence on how physicians decide to manage patients with chest pain out-of-hours, and the physicians vary considerably in what may influence their decision to admit a patient with chest pain to a hospital or not

4.2 Norwegian summary – norsk sammendrag

Hovedmålet med denne avhandlingen har vært å undersøke legers diagnostiske metoder og håndtering av pasienter med brystsmerte på legevakt i Norge.

Brystsmerte er et vanlig symptom i legevaktsammenheng, og symptomet utgjør fremdeles en betydelig diagnostisk utfordring for legene på vakt, med begrensede diagnostiske verktøy utenfor sykehus. Det mangler fremdeles kunnskap om epidemiologiske forhold knyttet til medisinske akuttsituasjoner utenfor sykehus i Norge generelt, og pasienter med akutte brystsmerter mer spesifikt. Det er fremdeles usikkerhet knyttet til hvilken grad legevaktleger følger gjeldende retningslinjer og ny kunnskap når de diagnostiserer pasienter med brystsmerte, og hvordan legenes «toleranse for risiko» og holdninger til sykehusinnleggelse påvirker håndteringen av nevnte pasienter.

Hovedmålene med denne avhandlingen har vært:

- Å innhente representative epidemiologiske data knyttet til medisinske akuttsituasjoner klassifisert som «rød respons» ved AMK-sentralene generelt, og pasienter med brystsmerter mer spesifikt
- Å undersøke bruk av diagnostiske verktøy og valg av behandling for pasienter med brystsmerte ved norske legevakter
- Å innhente ny kunnskap om legevaktlegers diagnostiske tilnærming, «toleranse for risiko» og holdninger til sykehusinnleggelse for pasienter med brystsmerter ved norske legevakter

Denne avhandlingen har bakgrunn i to studier, med to artikler publisert fra hver studie. Den første studien er en prospektiv, populasjonsbasert observasjonsstudie presentert i **artikkel I** og **artikkel II**. I denne studien samlet tre AMK-sentraler informasjon om alle medisinske hendelser klassifisert som «rød respons» etter Norsk Indeks for medisinsk nødhjelp (Indeks) i en tre måneders periode. «Rød respons» er etter Indeks definert som en akutt respons, med den høyeste prioriteringen. Det ble også innhentet journalnotater fra ambulansetjenesten og fastlegene/legevaktene. International Classification of Primary Care - 2 (ICPC-2) symptom koder ble gitt retrospektivt, på samme måte ble alvorlighetsgrad angitt hos hver pasient, gjennom et scoringsverktøy kalt The National Committee on Aeronautics (NACA) System.

Artikkel I beskriver alle de medisinske hendelsene klassifisert som «rød respons», med en insidens på 5 105 hendelser i løpet av tre måneder. Dette tilsvarer en rate på 25.1 hendelser per 1 000 innbyggere per år. Totalt 5 180 pasienter ble registrert i studien; 394 pasienter var involvert i 128 ulykker, og 181 hendelser var uten pasienter. **Artikkel I** viste at 90 % av de røde responsene var medisinske hendelser, med en stor variasjon i symptomer/plager, resten var ulykker. Analyser av pasientenes alvorlighetsgrad viste at 70 % var ikke i en livstruende situasjon, mens 50 % av pasientene som var potensielt eller definitivt livstruende syke eller skadde (NACA score 4-7) var over 70 år gamle. Innen ulykkesgruppen utgjorde menn 61 %, og 35% av disse var mellom 10 og 29 år, med median alder på 37 år. Kapittel A10 «Brystsmerte» i Indeks var det mest brukte kapitelet (22 % av alle hendelser), men få av de 39 kapitlene i Indeks ble brukt totalt. ICPC-2 symptom kodene viste at kardiovaskulære problemer, synkope/koma, respirasjons- og nevrologiske problemer var de vanligste medisinske utfordringene. Artikkelen konkluderer med at akuttsituasjoner utenfor sykehus hovedsakelig er medisinske, hvor få er livstruende syke. Fremtidig forskning bør fokusere på triagering ved AMK-sentralene og hvordan helsetjenestene best kan håndtere «hverdags-akuttmedisinen» utenfor sykehus.

Artikkel II gir en mer detaljert beskrivelse av de 1 104 pasientene klassifisert som «rød respons», hvor «brystsmerte» var hovedsymptomet (kapittel A10

«Brystsmerte»). Estimert rate var 5.4 brystsmertepasienter per 1 000 innbyggere per år. Alvorlighetsscore (NACA) indikerte at 26 % av pasientene var i en livstruende situasjon. Analyser av prehospital responstid viste en median responstid på 13 minutter, hvor ambulansen nådde pasienten innen 10 minutter i 30 % av tilfellene. 76 % av pasientene med brystsmerte ble innlagt på sykehus for videre utredning, 14 % fikk endelig behandling på legevakten, og hos 10 % var det ikke behov for legevurdering etter ambulansens første vurdering. **Artikkel II** konkluderer med at de fleste pasientene med akutte brystsmerter ble innlagt på sykehus, men kun en firedel av pasientene ble vurdert utenfor sykehus til å være alvorlig syke. Funnene kaster lys på de utfordringene AMK-sentralene har når det kommer til å bestemme riktig hastegrad for pasienter med akutte brystsmerter. Overtriagering er til en viss grad både forventet og ønsket, i det man ønsker å fange opp alle pasienter som trenger akutt hjelp, men det er også velkjent at overtriagering kan øke belastningen på de knappe ressursene som er tilgjengelig.

Studie 2 er en prospektiv, observasjonsbasert intervjustudie presentert i **artikkel III** og **artikkel IV**. Fire norske legevakter deltok med innhenting av data, og dataene ble registrert prospektivt i løpet av en seks måneders periode. Informasjon fra strukturerte telefonintervju med 100 legevaktleger kort tid etter en konsultasjon med en brystsmertepasient ble analysert. Legevaktene registrerte pasienter forløpende til det predefinerte antallet 100 unike leger med tilhørende pasienter var inkludert i studien. Hver lege kunne inkluderes kun én gang. Spørreskjemaet som ble brukt i telefonintervjuet hadde to deler. Den første delen (funnene presentert i **artikkel III**) besto av spørsmål knyttet til pasienten de nettopp hadde behandlet, inkludert diagnostiske verktøy (bruk av EKG og blodprøver), alvorlighetsgrad (NACA score) and valg av behandling. Den andre delen (funnene presentert i **artikkel IV**) fokuserte på de individuelle legenes diagnostiske tilnærming hos pasienter med brystsmerte, deres «toleranse for risiko» og holdninger til innleggelse av brystsmertepasienter generelt. «Toleranse for risiko» ble målt gjennom skalaene Pearson Risk Scale og Tolerance of Risk Scale, hvor av den siste skalaen ble utviklet til studie 2.

Artikkel III viste at 832 pasienter med brystsmerte ble registrert ved de fire legevaktene. Det predefinerte antallet med 100 intervjuer ble gjennomført, som førte til at 100 lege-pasient par ble inkludert i studien. Median alder på inkluderte pasienter var 46 år, menn utgjorde 58 %. EKG ble tatt hos 92 av pasientene, og EKG var det klart hyppigste diagnostiske verktøy i bruk. Analyser av alvorlighetsgrad viste at blant de 24 pasientene som ble klassifisert som akutt hastegrad («rød»), hadde 15 en NACA-score som indikerte en potensiell eller definitivt livstruende situasjon. Vedrørende håndtering av pasientene og legenes vurdering av mest sannsynlig årsak til brystsmertene viste studien at 50 pasienter ble innlagt for ytterligere behandling, av disse var det mistanke om iskemisk hjertesykdom hos 43. Muskel-/skjelettsmerte var nest hyppigste årsak (n=22). Utover dette ble det opplevd at pasientene hadde en relativt stor variasjon av lidelser, hvor de fleste ble ferdigbehandlet i primærhelsetjenesten. **Artikkel III** konkluderer med at under halvparten av pasientene ble innlagt med mistanke om akutt iskemisk hjertesykdom, og kun et fåtall ble gitt akuttbehandling for mistenkt akutt koronar syndrom. Legene oppga flere andre diagnoser som mulig årsak til pasientenes brystsmerte. Å bestemme riktig hastegradsnivå for pasienter med brystsmerte er utfordrende også i legevaktsammenheng, og det er sannsynlig at både over- og undertriage forekommer.

Artikkel IV presenterer data fra de samme 100 strukturerte intervjuene og lege-pasient parene beskrevet i **artikkel III**. Angående legenes diagnostiske tilnærming ble «sykehistorie og symptomer» vurdert som viktigste element, mens «negativ EKG» og «effekt av sublingual nitroglycerin» ble vurdert som minst viktigst i den diagnostiske prosessen. Halvparten av legene mente «ømhet i brystveggen» var lite viktig. Studien fant ingen signifikante forskjeller ved legenes erfaring eller alder da de «risiko motvillige» ble testet mot resten. Analyser av «toleranse for risiko» viste at alle legene følte at deres risikovurdering var rimelig god og følte seg rimelig trygg på legevakt, men kun 50 % var enig i uttalelsen «jeg bekymrer meg ikke for avgjørelser etter jeg har tatt dem». Ved spørsmål som kun omhandlet brystsmertepasienter, svarte 51 % av legene at de bekymret seg for å få klager på seg, 75 % var enige i at innleggelse i sykehus kunne medføre at pasienter ble «over-testet», og 51 % mente det

var mer sannsynlig at de ville legge inn pasienten hvis pasient selv ønsket det. **Artikkel IV** konkluderer med at legevaktlegene viste betydelige forskjeller i deres diagnostiske tilnærming, og ikke alle leger diagnostiserer pasienter i tråd med gjeldende retningslinjer og ny kunnskap. Fremtidig forskning og utdannelse bør fokusere på å styrke legenes beslutningskompetanse gjennom undervisning og fokus på risikovurdering og «toleranse for risiko».

Hovedfunn i denne avhandlingen:

- Akutte situasjoner utenfor sykehus omhandler hovedsakelig medisinske problemer, hvor brystsmerte er det vanligste symptomet. De fleste pasienter klassifisert som «rød respons» var ikke i en livstruende situasjon

- De fleste pasienter med akutte brystsmerter klassifisert som "rød respons", ble innlagt på sykehus for ytterligere utredning, men kun en firedel av pasientene ble utenfor sykehus vurdert til å være alvorlig syke

- Under halvparten pasientene med brystsmerte vurdert på legevakt ble innlagt med mistanke om akutt iskemisk hjertesykom, og kun et fåtall ble gitt akuttbehandling for mistenkt akutt koronar syndrom

- Legevaktlegene viste betydelige forskjeller i deres diagnostiske tilnærming, og ikke alle leger diagnostiserer pasienter i tråd med gjeldende retningslinjer og ny kunnskap

- Forskjeller i "toleranse for risiko" har en stor innvirkning på hvordan legevaktlegene håndterer pasienter med brystsmerte, og legene varierer betydelig i hva som påvirker deres valg om pasientene skal innlegges eller ikke

5. Introduction

The symptom “chest pain” still seems to constitute a somewhat “magical” term for health personnel, patients and next-of-kin alike. By this, I believe that the symptom tends to awake a “spinal reflex” in many physicians and other health personnel, in which we tend to quickly think that the symptom constitutes a life-threatening illness, often ischaemic heart disease. We see the same pattern in patients and their next-of-kin, which is helpful by leading the patients to seek rapid help, but may also be troubling because it might induce unnecessary anxiety in some patients and lead to more frequent consultations with the risk of the patient being “over-diagnosed” .

This thesis aims to give new insight on how physicians diagnose and manage patients with chest pain in out-of-hours primary care. The thesis will document the epidemiology of medical emergency contacts outside hospitals in Norway, and show that “chest pain” constituted the most frequent occurring symptom. My studies will also demonstrate how serious ill the patients were, and at what level of care they ended up being treated. Until now, little has been known about how patients with chest pain have been diagnosed and managed out-of-hours. My thesis will give new insight on the use of diagnostic tools, the physicians’ diagnostic approach and how “tolerance of risk” might influence how physicians manage patients with chest pain.

When starting my doctoral work, I wanted to explore why the symptom “chest pain” seem to have this special standing, compared with for instance abdominal pain or back pain, which seem to not awake the same before mentioned “spinal reflex”, even though it is well known that both these symptoms can represent serious and potential life-threatening illnesses.

My path into medical research started as a student in medical school, working with two cardiologists at the University hospital of Stavanger, doing research on the impact of the “2007 ESC-ACC-AHA-WHF Universal definition on the incidence and classification of acute myocardial infarction”. This research led to my first international publication as a co-author, and motivated me for further research in the

field (1). However, as my heart and mind was gradually preparing for a clinical and academic life in family medicine, it soon became evident that I wanted to focus my research in the field of family medicine in general, and out-of-hours medicine specifically.

Chest pain is an important and frequently occurring symptom out-of-hours, and both diagnostics and management of the symptom deserve more research and attention. In family medicine, the patients seldom present with ready-made diagnoses. I wanted to explore and gain new insight on how physicians *currently* diagnose and manage patients with the *symptom* chest pain, independent of the probable cause, and what could be done better in the future. My research and this thesis will hopefully be used in continuous medical education to focus on the diagnostic approach in patients with chest pain in primary care and empowerment of physicians through emphasis on risk assessment and "tolerance of risk" out-of-hours.

6. Background

Investigating the possible cause and management of "chest pain" have interested and fascinated physicians for hundreds of years, with the first descriptions of the symptom dating back to 600 BC. The Indian surgeon Sushruta described a symptom called "hritshoola", which literally means "heart pain", and according to him "hritshoola" is a chest pain which is "precordial, temporary, exertional, emotional, burning like and relieved by rest" (2). The ancient Greek physician Hippocrates (460 to 375 BC) is also considered to be among the first to describe coronary artery disease, with terms like "sharp pains, irradiating soon towards the clavicle and towards the back are fatal" (from *Coan Prognostics)* (3). The term "angina pectoris" is also Greek, and translates to "strangulation of the chest". In 1772, the English physician William Heberden, in his paper "Some account of a disorder of the breast", was the first to introduce a new method of a "proper taking and recording of a medical history about chest pain" (4).

Discovery of the electrocardiogram (ECG) by Willem Einthoven in 1901 was an important breakthrough concerning the diagnostics of many cardiovascular diseases, and Einthoven early on detected many of the electrocardiographic features still used today (5). Further development in the field of diagnosing the cause of chest pain was aided by the discovery of "cardiac biomarkers", historically referred to as "cardiac enzymes" because most of them in fact were enzymes. Aspartat transaminase (AST, also called glutamic-oxaloacetic transaminase) was one of the first biomarkers in use, but this enzyme is not specific for myocardial damage (6). The introduction of creatine kinase MB (CK-MB) and troponin tests have revolutionised how we diagnose patients with chest pain in the hospitals, and detection of a rise and/or fall of troponin (alternatively CK-MB) is now a mandatory part of the criteria used bedside to diagnose a myocardial infarction (7). We have also recently seen a development introducing troponin testing in primary care, aiming to "rule out" ischaemic heart disease when examined in primary care.

Patients with acute chest pain outside hospitals are mainly investigated for acute heart disease, hoping to confirm or "rule out" this diagnosis. However, this "one-sided" focus on the possibility of ischaemic heart disease, supported by the introduction of high sensitive troponin tests, might misguide the physician to overlook other, and more probable, causes of chest pain, especially in primary care ("low prevalence setting" for suspected acute ischaemic heart disease).

6.1 Organisation of emergency primary care services in Norway

In Norway, there exists a strong "gate keeping" tradition, with a well-defined structural border between primary and secondary health care services (figure 1, page 24). No patient can contact or meet directly at the emergency departments (ED) at the hospitals (so-called "self-referrals"). Only a physician, usually in primary care, can admit patients. However, exceptions are made when ambulance personnel believe a patient is in a life-threatening medical situation, in which the patient normally will be taken directly to the ED. The decision to bring a patient directly to the ED or not, is often based on a triage tool, such as RETTS (Rapid Emergency Triage and Treatment System), developed in Sweden (8, 9) or SATS (South Africa Trauma Scale) (10). The last couple of years we have seen a shift in pre-hospital practice with a tendency of more patients being brought directly to the hospitals, bypassing the out-of-hours services and primary care physician on-call.

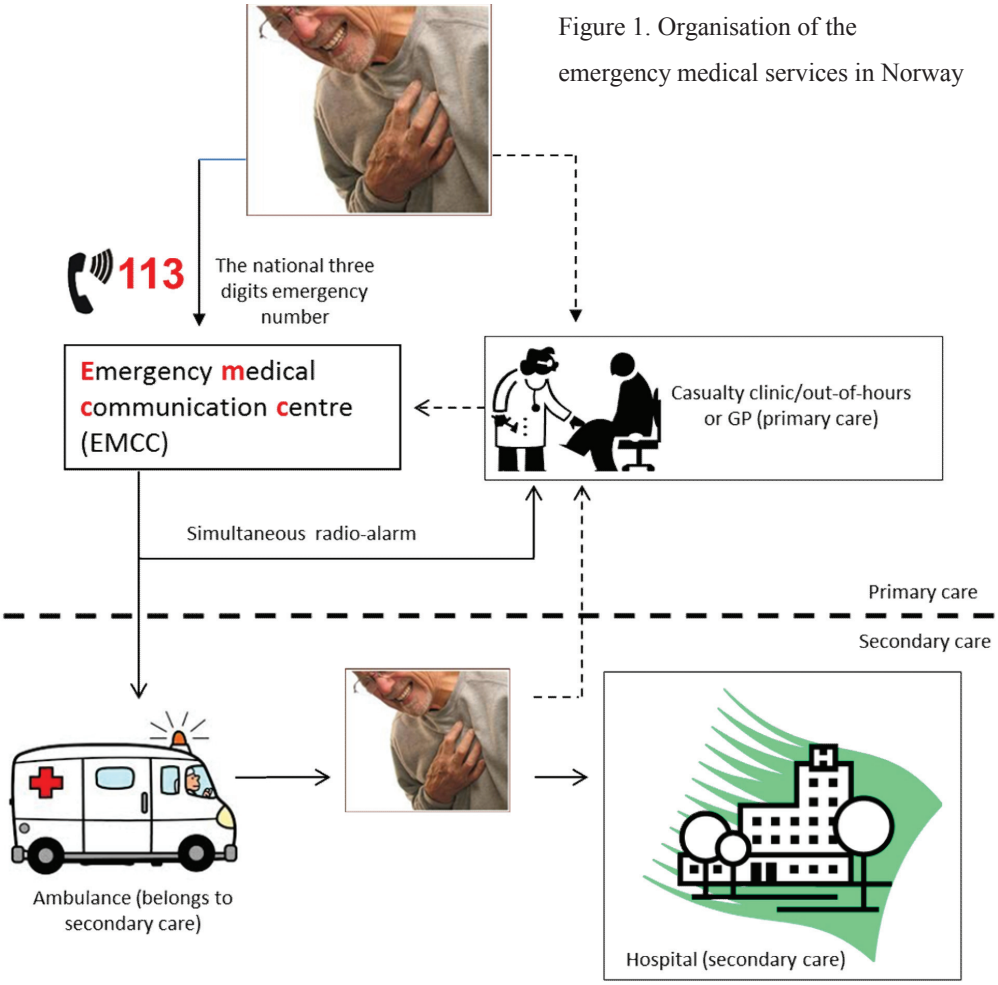

Figure 1. Organisation of the emergency medical services in Norway

6.1.1 General practitioner (GP) list system

Norway has a general practitioner list system, in which regular GPs (rGPs) work as family medicine physicians based on a contract with the municipality. Thus they are responsible for a list of patients, typically between 1 000 and 1 500 patients, with a maximum of 2500 patients allowed on each list, and a mean number of patients of around 1200 (11). Out-of-hours work is a mandatory part of the rGP's work in the municipality. The rGPs are also responsible for the emergency primary care services in the municipality during office hours, but there exists a considerable variation in how each GP-surgery and municipality organise these daytime services.

6.1.2 Out-of-hours services, casualty clinics, local emergency communication centres and triage

After office hours, patients in need of urgent medical care will need to contact the primary care out-of-hours services (OOH-services). These services are typically located at a casualty clinic, and co-situated with the local emergency communication centre (LEMC). The LEMCs are responsible for the local emergency number that inhabitants can call if they are in need of urgent medical assistance. During out-of-hours periods, the LEMCs are often covering several municipalities, and one casualty clinic can also serve more than one municipality. Even though the OOH-services initially were organised to handle urgent medical matters after office hours (evening, nights and weekends), studies have shown that as many as 75% of the contacts to the OOH-services concern a non-urgent medical matter, so-called "green response" (12).

To decide how urgent the medical problem is, nurses at the casualty clinic or the LEMC use the Norwegian Index of Medical Emergencies to decide the appropriate "level of response" (13). The Index categorises clinical symptoms, findings and incidents into a red, yellow and green criteria based section, correlating to the appropriate level of response (figure 2). Red colour is defined as an "acute" response; yellow colour an "urgent" response, where the patient should be examined as soon as the physician on-call is available. Green colour is defined as a "non-urgent" response, with the lowest priority. Figure 3 (page 26) shows chapter 10 – "chest pain" as an example.

Figure 2. The three levels of response in the Index with colour chart

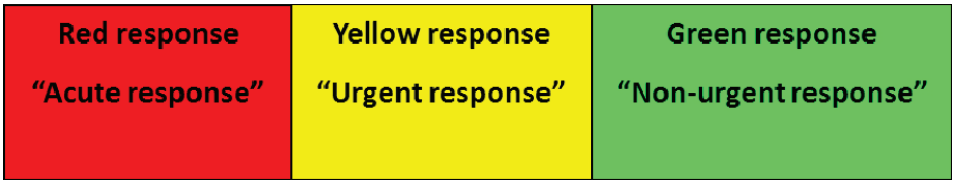

Figure 3. Example of chapter from the Index, here the symptom «chest pain» is shown

10 Brystsmerter - hjertesykdom

1

		KRITERIER	RÅD
RØD - akutt	A.10.01	Reagerer ikke på tilrop og risting.	3
	A.10.02	Vondt i brystet og holder på å besvime.	1.2.3.4.6.7
	A.10.03	Sterke smerter midt i bryststet i mer enn 5 min.	1.2.3.4.5.6.7
		Brystsmerter eller ubehag i brystet	
	A.10.04	- og pustevansker	1.2.3.4.5.6.7
	A.10.05	- og uvel, kvalm	1.2.3.4.5.6.7
	A.10.06	- og blek, klam hud	1.2.3.4.5.6.7
	A.10.07	- og utstråling av smertene til kjeve/skulder/arm/rygg	1.2.3.4.5.6.7
	A.10.08	- og plutselig kraftløs i armene	1.2.3.4.5.6.7
	A.10.09	- og EKG som viser hjerteinfarkt (STEMI)	1.2.3.4.5.6.7
	A.10.10	- og bare forbigående virkning av nitroglycerin	1.2.3.4.5.6.7
	A.10.11	Mulig alvorlig hjerteproblem med uklare symptomer.	1.2.3.4.5.6.7
	A.10.12	Har fått støt av innoperert hjertestarter og føler seg uvel.	1.2.3.4.5.6.
	A.10.13	Har fått mer enn 4-5 støt av innoperert hjertestarter.	1.2.3.4.5.6.
GUL - haster	H.10.01	Smertene er ikke spesielt sterke, og pas. føler seg OK.	2.6
	H.10.02	Vedvarende god virkning av 1-4 nitroglycerintabletter/ spraydoser.	2.6
	H.10.03	Smertene/ubehaget sitter i siden av brystkassen.	2.6
	H.10.04	Plutselig hjertebank og føler seg uvel.	2.6
	H.10.05	Har fått et par støt av innoperert hjertestarter, men er helt OK nå.	2.6.8
GRØNN - vanlig	V.10.01	Smerter bare ved dyp innånding eller ved bevegelse.	2
	V.10.02	Føler at hjertet slår uregelmessig.	2
	V.10.03	Plutselig hjertebank, men føler seg ellers OK.	2
	V.10.04	Korte stikk av smerte i brystet.	
	V.10.05	Engstelig for hjertesykdom.	1.2
	V.10.06	Har fått ett støt av innoperert hjertestarter, men er helt OK nå.	2.8

6.1.3 Emergency medical communication centres and ambulance services

The emergency medical communication centres (EMCCs) and ambulance services are both situated organisationally in the secondary health care system, operated by four regional health authorities (RHA). There are 19 EMCCs (2014), and the main responsibilities of the EMCCs include coordination of the emergency medical services outside hospitals, and operating the national three digits emergency telephone number "113". When a patient, or someone on the patient's behalf, calls the emergency number 113, the call is routed to the nearest EMCC. Based on the decision tool Index, the nurses at the EMCC will classify the medical problem into one of three possible responses; red, yellow or green, using the same protocol as the LEMCs (chapter 6.1.2). In case of a red response, defined as an "acute" response, with the highest priority, the EMCC will trigger the transmission of a simultaneous radio alarm to both the primary care physician on-call and the local ambulance service. The intention of this simultaneous radio alarm is to actively involve the primary care physicians in emergency medical situations outside hospitals, alongside the ambulance services, functioning as a "backbone" of the out-of-hospital emergency system in Norway.

The ambulance services in Norway use different triage-systems, dependent on which RHA they belong to. Furthermore, the emergency departments often use other triage systems than the local ambulance service, so there is an apparent lack of coherence between the emergency services. However, measures have been taken to rectify this problem, and there are currently ongoing projects exploring the possibility of unifying the services concerning triage (14).

There exists only scarce literature on the possible effects of using different triage-systems, but some research is currently underway, including a ph.d.-project on the validation of the Norwegian Index for Medical Emergencies (15). Recently there has been published several papers on the role of primary care doctors in out-of-hospital emergency medicine, focusing on medical situations with "red response" (16, 17). However, there is still a lack of knowledge on the epidemiology of all medical emergencies classified as "red response" by the emergency medical communication centres (EMCCs) in general, and patients with acute chest pain more specifically.

6.2 Diagnosing the cause of chest pain in primary care

When diagnosing the cause of a patient's chest pain, the physicians will use similar approaches in primary and secondary care. However, there are some important differences, mainly concerning the prevalence setting and the availability of more advanced diagnostic tools in secondary care.

6.2.1 Chest pain in primary care and secondary care – same, but different?

Patients with chest pain account for approximately 1-2% of all contacts in primary care (table 1, page 29) (18-22). It is well documented that less serious conditions frequently occur in primary care, with myalgia and chest wall syndromes making up almost half of the patients (18, 20, 21, 23, 24). Other frequently occurring causes include psychogenic disorders, lung diseases and dyspepsia. Studies have shown that ischaemic heart disease (IHD) account for approximately 5-15% of patients with chest pain in primary care (18, 20, 21, 23, 24). One study from Sweden reported a diagnose of IHD in 8% of 554 patients complaining of a new episode of chest pain (18), while a study from Belgium comparing chest pain in general practice with the hospital

emergency department found a final diagnosis of "serious cardiovascular disorder" in 4.8% of 320 patients in general practice (24).

Table 1. Studies describing incidence/prevalence (**A**) and probable cause (**B**) of chest pain in primary care

A. Studies describing incidence/ prevalence of chest pain	**Incidence/prevalence of chest pain (setting)**
Nilsson et al. Br J Gen Pract 2003.	1.5 % (general practice, incidence)
Cayley WE. Am Fam Physician 2005.	1 - 2 % (primary care unspecified, incidence)
Bosner et al. Eur J Gen Pract 2009.	0.7 % (general practice, prevalence)
Verdon et al. Swiss med wkly 2008.	2.7 % (general practice, incidence)
Sandvik et al. National centre for emergency primary health care 2014.	1.4 % (out-of-hours, incidence)
B. Studies describing probable cause of chest pain	**Most common cause vs ischaemic heart disease**
Svavarsdottir et al. Can Fam Physician 1996.	Musc.skel (49 %) vs 2.1 %/15.8 % (AMI/AP)
Buntix et al. Fam Pract 2001.	Musc.skel (58 %) vs 4.8 %/8.4% ("serious heart"/AP)
Nilsson et al. Br J Gen Pract 2003.	Musc.skel (47 %) vs 8 % (new episode IHD)
Verdon et al. Swiss med wkly 2008.	Musc.skel (49 %) vs 1.5 %/11.2 % (ACS/stable AP)
Bosner et al. Eur J Gen Pract 2009.	Musc.skel (29 %) vs 3.6 %/11.1 % (ACS/stable IHD)

In Norway, most studies on "chest pain" in recent years have concerned non-cardiac chest pain in relation to psychogenic disorders (25-27). One of these studies found that in 160 patients referred to a cardiac outpatient unit for evaluation for chest pain or palpitations, 4% were diagnosed with coronary heart disease, while 39% had a psychiatric disorder (25). Recently another paper from Norway was published on the prevalence and prognosis of non-specific chest pain among patients hospitalised for suspected acute coronary syndrome (28). The study concluded that "patients with non-specific chest pain represent a large, heterogeneous and important group… but their average one-year mortality rate was almost six times lower than those with acute

coronary syndrome". Other studies from Norway have mostly focused on the diagnosis and treatment of acute coronary syndrome in a hospital setting (1, 29-34).

Examining the hospital setting closer, extensive research has shown that IHD account for approximately 25-50% of patients presenting with chest pain, depending on inclusion criteria and definition of diagnosis. A study from 16 hospitals in Denmark showed that out of 6254 patients presenting with chest pain or other symptoms suggestive of acute myocardial infraction (AMI), 25% were diagnosed with an AMI during the hospital visit (the incidence of unstable angina was not examined in this study) (35). The study from Belgium comparing general practice with hospital emergency department (ED) found that in the ED approximately 50% had a serious cardiovascular disorder or unstable angina, 12% with a diagnose of lung disease, 10% with psychopathology/neurosis and 6% had musculoskeletal disorders (24).

A major challenge when comparing the prevalence of chest pain and IHD from different studies in both primary and secondary care is the considerable variation in inclusion criteria and definitions. However, as shown, there exists strong evidence supporting the notion that concerning the diagnosis of IHD in patients with chest pain; primary care should be considered a "low prevalence setting" opposed to a "high prevalence setting" in hospital care. This aspect has important clinical implications knowing that the prevalence of IHD functions as a pre-test probability of the diagnosis, and thus will influence how physicians in the different prevalence settings should interpret findings in the diagnostic tests performed. With a relatively low prevalence of acute IHD in primary care, the physicians must be aware of the possibilities of false positive findings, although in the case of IHD most physicians would worry more about the possibility of a false negative diagnosis, i.e. falsely "ruling out" IHD in a patient. This highlights the importance of epidemiological and clinical studies on chest pain in primary care, and the need for primary care physicians to have a basic understanding of the sensitivity and specificity of different signs, symptoms and tests relevant when diagnosing patients with chest pain. A diagnostic meta-analysis from Belgium examined all diagnostic accuracy studies on symptoms

and signs in diagnosing acute coronary syndrome (ACS) (36). A main finding from this study was that presence of chest-wall tenderness on palpation would to a great extent "rule out" ACS in a low prevalence setting. They found a likelihood ratio of 0.23 (LR-) for the absence of chest-wall tenderness, so a "negative" test result (meaning presence of tenderness), gave a post-test probability for ACS of 1% in a low prevalence setting like primary care (the pre-test probability used was 5%). Another study from Germany examined the accuracy of symptoms and signs for IHD assessed in primary care (37). This study concluded that the individual criteria were not conclusive used alone, but a combination could help the physician to decide the appropriate management of patients with chest pain in primary care.

6.2.2 Availability of diagnostic tools for chest pain outside hospitals

In a hospital setting, more advanced diagnostic tools such as cardiac biomarkers and echocardiography are readily available, and some hospitals can offer angiography as both a diagnostic tool and as a treatment for partial or total occlusion of coronary arteries with percutaneous intervention (PCI).

Electrocardiography (ECG)

In primary care, the most important diagnostic tool is still the electrocardiograph (ECG). Previous studies have shown that Norwegian out-of-hours services are generally well-equipped with diagnostic tools and laboratory services, but adapted to a primary care setting (38, 39). One study showed that 99% of all casualty clinics were equipped with an ECG-device, while only 6% could measure d-dimer and/or troponin locally (39). The availability of an ECG-device in primary care is thought to vary considerably between different countries, and should be judged in the context of how the health care system is organised in the specific country examined. In countries where it is common with self-referrals to the hospital emergency department (ED),

one should expect that most patients with chest pain would contact the ED directly, with less need of ECG as a diagnostic tool for the primary care physician. In Norway, with a strong gate-keeping tradition, and a decentralised out-of-hours organisation, it is expected that the primary care physician will take care of most patients with chest pain initially, and subsequently almost every primary care physician will have access to an ECG-device. One study from Switzerland, a country with a similar decentralised out-of-hours organisation, found that 98% of all GPs had an ECG-device available out-of-hours (40). Belgium is on the other hand an example of a country in which self-referrals to the ED is common, and one study from Belgium examining how GPs refer patients with chest pain, showed that an ECG was recorded in 29% of the patients (41). This study also showed that nearly 40% of the patients with chest pain in primary care were referred urgently to the ED or non-urgently to a cardiologist, a number which is considerably higher than comparable studies from primary care (18, 23).

ECG is still a diagnostic tool with limited sensitivity (42), and it is of pivotal significance that the physicians possess an overview of the test's diagnostic accuracy, including sensitivity and specificity. The National Institute for Health and Care Excellence (NICE) in the UK published in 2010 new guidelines for "chest pain of recent onset – assessment and diagnosis of recent onset chest pain or discomfort of suspected cardiac origin" (43). The "full guideline version" gives a thorough description of the methods and evidence used to develop the guidance, including a review on current evidence concerning the use of 12 lead resting ECG when diagnosing chest pain. Four systematic reviews were examined and together they showed that the test has acceptable specificity used in clinical practice, meaning that the results could be trusted to "rule in" the diagnosis of acute myocardial infarction (AMI) (42, 44-46). ST-segment elevation was the most discriminating factor, but also Q-waves and ST- segment depression showed reasonable discrimination. A normal ECG was reasonably helpful at "ruling out" an AMI, but the suboptimal sensitivity of the test indicated that physicians should not "rule out" ACS based on a normal ECG

alone. Interpreting the results from an ECG-test in a reliable way also requires comprehensive knowledge by the physician.

Cardiac biomarkers

The development of new high-sensitive troponin assays for "point-of-care"-testing (POC) is thought to revolutionise how primary care physicians diagnose patients with chest pain outside hospitals (47-51). Some countries have already introduced POC-testing of troponin routinely in patients with chest pain outside hospitals, while others are on the brink of introducing the test for routine use soon (40, 52). A study from 2009 reported that 12 out of 209 (6%) Norwegian casualty clinics (out-of-hours services) had troponin analyses available locally, and 2% CK-MB (39). No research exists on the use of troponin in general practice in Norway, but information from the Norwegian Quality Improvement of Primary Care Laboratories (Norwegian abbreviation NOKLUS) (53), suggests that POC-testing of troponin is rarely done in Norwegian primary care (personal correspondence with Svein Ivar Fylkesnes, NOKLUS). A Swiss study from 2012 reported that 76% of the 471 GPs examined in one region of Switzerland had troponin assays available locally (40). Nilsson et al have recently examined the diagnostic accuracy and clinical benefits of POC Troponin T testing in patients with chest pain in Swedish primary care (52). This study concludes: "The use of POCT-TnT may reduce emergency referrals but probably at the cost of an increased risk to miss patients with AMI or UA. Swedish physicians at PHC centres do not seem to need the aid of POCT-TnT analysis to improve the chance of finding patients with AMI or UA".

To date, there exists only scare literature on the use of POC-testing of troponin in primary care, and the potential clinical benefits of such use. The new high-sensitive troponin assays are not yet thoroughly tested in a primary care setting and more research is needed to give definitive guidance on the implementation of POC-testing of troponin outside hospitals.

Other diagnostic tools

Chapter 6.2.1 describes the broad spectrum of causes for chest pain in primary care, supporting the need for primary care physicians to be armed with suitable diagnostic tools. Most GP surgeries and out-of-hours services in Europe will be expected to have blood pressure meters (sphygmomanometers) readily available, but scarce literature exists on the availability of other relevant diagnostic tools for patients with chest pain in primary care, such as C-reactive protein (CRP), d-dimer, and so-called "multi-monitors". In a recent study, Howick et al examined current and future use of point-of-care tests in primary care in Australia, Belgium, The Netherlands, the UK and the USA (54). Results showed that local availability of CRP-testing had great variation, from 3% in Australia and Belgium, to 48% in the Netherlands. The study also showed that D-dimer, troponin and CRP were all among the most desired POC-tests for the future. Rebnord et al found in their study from Norwegian out-of-hours services in 2009 that 42% of the services had a heart monitor system, 99% could measure CRP locally, and 6% had available d-dimer POC-tests (39).

6.2.3 Overview of guidelines and clinical decision rules for use in primary care

Norway does not have a specific set of guidelines concerning diagnostics and management of patients with chest pain in primary care. However, most physicians daily use clinical "handbooks" or "manuals" functioning as guidelines for clinical practice (55, 56). The "handbooks" most common in use (55, 56) both contain chapters on the symptom "chest pain". The clinical text book on family medicine most common in use in Norway also contains a separate chapter on "chest pain", with a broad clinical approach (57).

The before mentioned NICE-guideline on "chest pain of recent onset – assessment and diagnosis of recent onset chest pain or discomfort of suspected cardiac origin" should also be seen as an important new contribution to the knowledge on how

primary care physicians in all countries best could diagnose and manage patients with chest pain (43).

Concerning guidelines on how to diagnose patients with acute myocardial infarction (AMI), most countries will use the third universal definition of myocardial infarction, stated by the joint task force from the European Society of Cardiology, American College of Cardiology Foundation, American Heart Association and World Heart Federation (7). These guidelines are also recognised by the Norwegian Society of Cardiology and recommended implemented in Norway (58). However, these guidelines are mostly relevant in a hospital setting, partly because the definition includes a mandatory criterion on the use of a cardiac biomarker, but also because most patients will get the final diagnosis of an AMI in relation to a hospital admission.

Several papers have described the development, use and validation of clinical decision rules (CDRs) or prediction rules in diagnosing patients with chest pain, but most CDRs have been developed to be used in the emergency departments (59-63). Many countries have also established "rapid access chest pain clinics" in connection with the ED, where the aim is to help physicians to rapidly confirm or rule-out acute coronary syndrome (64, 65). A recent systematic review examined the diagnostic accuracy of CDRs to exclude ACS in the emergency department setting (66). This review concluded that the current CDRs have substantial methodological limitations, they are not successfully implemented in a clinical setting, and that more research is needed before the CDRs can safely guide clinical practice.

There exists only scarce literature on the use of CDRs to rule out ACS in primary care. Grijseels et al have described the development and implementation of a pre-hospital decision rule for patients with suspected myocardial infarction in Dutch general practice (67, 68). This CDR consisted of a structured questionnaire and ECG-analyses. Implementation of their CDR resulted in a reduction of patients admitted to the ED for further examination, and use of the CDR proved to be safe. In a more recently published paper, also from the Netherlands, Bruins Slot et al used the same

clinical items as Grijseels et al to develop a new CDR, and compared the diagnostic accuracy of this CDR with the risk estimates for ACS of the attending GPs (69). This study concluded that GPs more adequately classified patients as with or without ACS than the CDR. Adding ECG-analysis to the CDR led to cases in which ACS was ruled in, cases where the GP would have missed an ACS judged by the clinical items alone.

In Switzerland, Gencer et al have also recently developed a clinical prediction score for ruling out coronary heart disease in primary care patients (70). This score is based only on history and physical examination, eight variables in total. The prediction score was externally validated using data from a German cohort (20), but the authors conclude that more research on the prediction score and evaluation of implementation is needed before the prediction score could be used in all primary care settings.

Ronga et al have developed and validated a clinical prediction rule for patients with suspected chest wall syndrome in primary care (71). Musculoskeletal disease is the most common cause of chest pain in primary care, and the authors conclude in their paper that the prediction rule might function as an important additional tool in diagnosing patients with chest pain outside hospitals, and a high positive score may help physicians to avoid further testing.

A research group based at the University of Marburg, Germany, have recently published several papers on the development and validation of a new CDR for ruling out coronary heart disease in primary care, called the Marburg Heart Score (72, 73). The Marburg Heart Score is a simple prediction score, including five findings from the patients' medical history and physical examination. The Marburg Heart Score is both internally and externally validated. The sensitivity and the negative predictive value were shown to be stable, and the primary care physician can largely rely on a negative result (72). Because of the score's accuracy and generalizability, the researchers believe the score is ready for use in clinical practice.

Haasenritter et al have also published a study protocol for a systematic review on the accuracy of medical history and physical findings in patients with chest pain (74). The

systematic review will include studies from primary care across Europe, and plans to validate existing CDRs from each of the included studies.

Status 2014 – Diagnosing the cause of chest pain in primary care

As we have seen, diagnosing the cause of chest pain has a long history, and there have been considerable advances the last 20 years, especially with the introduction of biomarkers more specific of cardiac ischaemia. Yet, it remains unclear what role the new high-sensitive Troponin assays will have in primary care, and to what extent clinical decision rules truly will aid the physicians in their difficult task of correctly diagnosing the cause of chest pain, and safely “”rule-out” ischaemic heart disease. There is still a need for research on the use of diagnostic tools and treatment of choice in patients with acute chest pain out-of-hours in Norwegian primary care.

6.3 Management of patients with chest pain out-of-hours

Management of patients with chest pain in primary care largely depends on the probable cause of symptoms, and the risk estimation of possible acute coronary syndrome. The following chapter will present an overview of current knowledge on the management of chest pain in primary care, including what determines level of care, and how the physicians’ tolerance of risk might influence choice of treatment.

6.3.1 Management - Overview of current knowledge and level of care

There exists comprehensive guidelines for the management of chest pain of suspected cardiac origin, or ACS, and these guidelines are mostly relevant both in primary care and in a hospital setting. In Europe, most countries will follow the guidelines from the European Society of Cardiology, and there are two separate guidelines depending on

the patient presents with ST-segment elevation (STEMI) or not on the ECG (75). These two guidelines are also recognised to be used in Norway by the Norwegian Society of Cardiology (34, 76). The NICE-guideline on "chest pain of recent onset" described in chapter 6.2.4 is also a highly relevant guideline for use in primary care (43).

The acute management of ACS outside hospitals, meaning GP surgery, casualty clinic or ambulance services, should be based on the following components (43, 75):

- Anti-ischaemic therapy: Nitrates to relieve angina. Beta-blockers, especially in patients with left ventricle dysfunction, may be indicated in cases with long transportation time (NB: contraindicated in patients with inferior wall AMIs)
- Anti-platelet treatment: Aspirin should be administered to all patients with medium to high probability of ACS. Consider adding a P2Y-inhibitor, eg. Clopidogrel, to patients with high probability of ACS unless there are contraindications
- Anticoagulation: The use of heparin should be discussed with the attending cardiologist/internist at the hospital, especially in cases of STEMI
- Fibrinolytic therapy versus primary percutaneous intervention (PCI): In patients with STEMI or new left bundle branch block (LBBB), primary PCI is recommended over fibrinolysis if performed within 120 minutes of first medical contact and within 12 hours of symptom onset. If possible, fibrinolysis should start in the pre-hospital setting
- The treatment of ACS will also often include oxygen and morphine.

Concerning management of chest pain outside hospitals in Norway, Rebnord et al found, while studying the available equipment in 209 Norwegian out-of-hours services (OOH), that most services had available an oxygen apparatus (95%), a

bag/mask for ventilation (95%), an emergency bag (89%; often containing medication like morphine) and a defibrillator (88%) (39). Even though not examined, most OOH –services also have available treatment options for respiratory tract infections (antibiotics), panic attacks (benzodiazepines), dyspepsia (antacida) and ACS (morphine/nitrates). Fibrinolytic therapy is still an essential treatment option outside hospitals for many patients with STEMI in Norway, especially in rural districts. Physicians working in Norwegian out-of-hours primary care services are expected to have a basic knowledge on the use of fibrinolytic therapy outside hospitals. A clinical handbook specially designed for out-of-hours work offers guidance and a check-list for patients where fibrinolysis might be the treatment of choice (56).

In 2012 the Norwegian Myocardial Infarction Registry was established, and recently a paper was published with the first data from the registry (77). Results showed that 11% of the 3658 STEMI patients (n=418) in 2013 were given primary thrombolytic treatment and approximately half of them prior to hospitalisation. Patients in Northern Norway with STEMI, a part of Norway with typically large, rural districts, accounted for almost half of the patients who received thrombolytic therapy.

The advances in invasive management of ACS, especially patients with STEMI, have led to the evolvement of “fast-track” protocols for all patients with chest pain of suspected cardiac origin in some countries (78, 79). These protocols are developed to ensure that all patients with a possible AMI get adequate treatment as soon as possible, and within the “golden hour” in patients with STEMI. To my knowledge, after searching PubMed, there are no relevant studies on the possible downside of such protocols. The protocols are not set up to distinguish between “harmless” causes of chest pain (eg. Musculoskeletal pain) and potentially life threatening causes like a STEMI. This might subsequently lead to many patients being admitted to the hospital with non-serious illnesses. In Norway, there are no national guidelines recommending “fast-track” protocols for all patients with chest pain outside hospitals. However, many regional health authorities and hospitals have examined the possibility of implementing such protocols. More research should be done to explore the possible

downsides of admitting all patients with chest pain to hospitals based on "fast-track" protocols.

Concerning management and level of care, a recent study from Belgium has examined the initial diagnosis and referral rates in patients with chest pain in primary care (41). In this study, nearly 40% of the patients received "heart disease" (26% "serious" and 11% "other") as the initial diagnosis, while muscular disease accounted for 30% and somatoform disease 10%. Approximately 40% of all patients (811 out of 1996) with chest pain were referred urgently to the ED (37%, n=297) or non-urgently to a specialist or the hospital (out-patient clinic) (63%, n=514). In a study from Iceland, Svavarsdottir et al found that patients with musculoskeletal disease accounted for 49%, while 18% were diagnosed with heart disease (23). The study setting was a primary care health centre, with no gatekeeping system towards secondary care. One of the 93 patients with musculoskeletal disease was admitted to the hospital, while 2 patients were referred non-urgently to a specialist. Among the 34 patients with heart disease, 12 were admitted to the hospital, while six were referred non-urgently. In total; 42% of the 190 patients were held for observation, in 39% medication was ordered (not specified what), 9% were admitted to hospital and 8% were referred to a specialist non-urgently.

6.3.2 The role of physicians' tolerance of risk and attitudes to hospital admission

Diagnosing patients with chest pain is often a complex task. Physicians, both in primary care and in the EDs, will strive to primarily base their decisions on management, including whether the patient should be admitted for further testing or not, on the patient's medical condition and the probability of serious illness. Still, some studies have indicated a correlation between the physicians' personality traits, such as "tolerance of risk" and "gut feeling", and admission rates (80, 81).

The “Risk-taking Scale” was developed in 1995 by Pearson et al for use in triage decisions for emergency department patients with chest pain (80). In their study, using the “Risk-taking Scale”, physician risk attitudes correlated significantly with admission rates for patients with acute chest pain. The “risk-seeking” physicians admitted only 31% of the patients with chest pain, compared with 53% for the physicians with low risk–taking scores (“risk-avoiders”). Also in 1995, Green and Becker performed a study on “physician decision making and variation in hospital admission rates for suspected acute cardiac ischemia”. They found a high rate of “low probability” (of acute ischaemia) admissions, and recommended improving physicians’ probabilistic judgements (82).

Bruyninckx et al have performed a qualitative study exploring GPs’ reasons for referral of patients with chest pain (81). The authors conclude that in addition to “classical” signs and symptoms, other important aspects of their decision-making include “background knowledge about the patient, GPs’ personal ideas and gut feeling”.

In a study from the UK, Ingram et al examined risk taking in general practice by exploring GP out-of-hours referrals to hospital (83). They found that female GPs and GPs with “low tolerance of risk” were more likely to refer patients to the hospital out-of-hours, but the female GPs referred more because they were more inclined to be “risk averse”. In 2007, Rossdale et al also found that female GPs referred more patients out-of-hours, and that length of work experience did not influence referral rates (84). A qualitative study from the UK found that GPs who were high referrers out-of-hours typically are more cautious and would admit more often if in doubt (85).

Status 2014 – Management of patients with chest pain out-of-hours

Management of chest pain of suspected cardiac origin follow detailed guidelines, and most physicians in primary care will be fully competent to follow these guidelines, sometimes in cooperation with internists/cardiologists. However, there are still

considerable challenges when it comes to the management of patients with chest pain of more uncertain aetiology, and research presented earlier in this chapter have shown that physicians also are influenced by their personality traits and other factors than the patient's medical history and condition.

There is a lack of knowledge on the management of patients with chest pain in out-of-hours primary care, including consequences of possible differences in physicians' tolerance of risk and attitudes to hospital admission.

7. Aims of the studies included in the thesis

The overall aim of this thesis was to examine diagnostics and management of patients with chest pain in out-of-hours primary care. The results have been published in four peer-reviewed articles (**paper I – IV**). **Paper I** and **Paper II** were based on data from an existing study ("red response"-study), while **Paper III** and **Paper IV** were based on a new study developed to answer the remaining aims of the thesis.

Aims of the two studies with corresponding papers:

Study 1 ("Red response"-study):

Paper I: The aim was to obtain representative data on the epidemiology of medical emergencies classified as "red response" by the emergency medical communication centres (EMCCs).

Paper II: The aim was to obtain representative data on the epidemiology of acute chest pain outside the hospitals in Norway, by a more detailed investigation of the data from the EMCC study.

Study 2 (Clinical out-of-hours study):

Paper III: The aim was to investigate the use of diagnostic tools and treatment of choice in patients with chest pain out-of-hours in Norwegian primary care.

Paper IV: The aim was to investigate primary care physicians' diagnostic approach, tolerance of risk and attitudes to hospital admission in patients with chest pain out-of-hours in Norwegian primary care.

8. Materials, methods and results of the individual studies

This chapter includes a brief overview of material, methods and results from the four papers presented. The first study (**Paper I** and **Paper II**) was a prospective population-based observational study, and the second study (**Paper III** and **Paper IV**) was a prospective, observational interview study.

8.1 Materials, methods and results of Study 1 – **Paper I** and **Paper II**

The materials and methods from the first two papers will be described together as the data came from the same study. The results from the two papers will be described separately.

Materials and methods

The first study was a prospective population-based longitudinal study designed to investigate and obtain representative data on the epidemiology of medical emergencies classified as "red responses" in Norway. **Paper I** concerns the epidemiology of all medical emergencies, while **Paper II** describes a more detailed investigation of patients with "chest pain" from the same material.

A strategic sample of three emergency medical dispatch centres (EMCCs) were chosen as catchment areas for data collection, with the areas covering 816 000 inhabitants (18% of Norway's population). The three EMCCs cover the areas of Innlandet, Stavanger and Haugesund. Information on every incident triaged as a red response, according to The Norwegian Index of Medical Emergencies (Index), was gathered during a three month period in 2007 from the cooperating EMCCs.

The Index is a triage tool that categorises clinical symptoms, findings and situations into 39 chapters. Each chapter is subdivided into a red, yellow and green criteria based section, correlating to the appropriate level of response. Red colour is defined as an "acute" response, with the highest priority, and warrants immediate response. Yellow colour is defined as an "urgent" response, with a high priority. Green colour is defined as a "non-urgent" response, with the lowest priority.

The EMCCs use software called "Acute Medical Information System" (AMIS). The AMIS-form contains basic information about the red response incident, including the patient(s), all available logistics (date, time registration for incoming alarm and all alarms and electronic messages sent to the different prehospital resources, who responded and when), and to where the patients were transported (left at scene, home, casualty clinic, hospital). The three EMCCs sent AMIS forms on every red response incident during the three months period together with records from ground, boat and air ambulances. Records from the primary care doctors involved were also subsequently collected. A meeting with the participating EMCCs was held prior to project start, to secure a uniform recording of the variables in the AMIS program.

Based on information from the AMIS forms and medical records, all red response incidents were classified according to the International Classification of Primary Care - 2 (ICPC -2). The analyses in Study 1 (**Paper I** and **Paper II**) were based on codes from the "symptom component" of the ICPC- 2 solely, and each patient was given one code only (e.g. A11 for "chest pain" or N07 for "convulsions"). ICPC-2 codes were already classified in the medical records from the physician on-call. All other ICPC-2 codes were classified retrospectively by two members of the research team with experience in emergency medicine.

Severity of the medical problem ("severity of illness") was classified using the National Committee on Aeronautics (NACA) Score. This classification was done retrospectively based on all available information gathered from the EMCCs and medical records, except in the patients transported with air ambulances, in which the NACA score was given prospectively "bedside". In the NACA score system, the

patient's status is classified from 0 to 7, zero indicating no disease or injury, while seven indicates the patient being dead.

Results ***Paper I***

The EMCCs collected 5738 AMIS-forms for the study, of which 633 were excluded, and the total incidence of red response situations was 5 105 during the three month period. This corresponds to a rate of 25.1 (24.4-25.7) situations per 1 000 inhabitants per year. There were 394 patients involved in 138 accidents, and 181 situations were without patients, resulting in a total of 5 180 patients included in the study (rate of 25.5 patients per 1 000 inhabitants per year).

The patients' age ranged from 0 to 107 years, with a median age of 57. Gender distribution showed 55% men with median age 55, and 45% women with median age 58. A10 – "chest pain" was the most used Index category for both genders. 90% of the red responses were medical problems with a large variation of symptoms, the remainder being accidents (Index categories A34 and A35). In the accident group; males accounted for 61%, and 35% were aged between 10 and 29 years, with a median age of 37 years.

Analyses of NACA-scores showed that 70% of all patients were in a non-life-threatening situation; 81% within the accident group alone. Males constituted 68% of the 246 patients with NACA 6-7, meaning acute cardiac/respiratory arrest or dead. Half of all patients in a life-threatening medical situation (NACA score 4-7) were over 70 years of age. There were no statistically significant differences in NACA score distribution between the three EMCC districts.

Analysing the patients' whereabouts, we found that 58% were residing at home or at private facilities; one fourth were in public areas and 12% at primary health care services (casualty clinics, GP surgeries or nursing homes). 70% of the patients were brought to a hospital, either via the casualty clinic (11%) or directly with (35%) or

without (24%) being examined by a physician first. Patients who remained on site accounted for 11% of the patients.

ICPC-2 symptom codes were registered in 99% of the patients. Analyses of the ICPC-2 codes showed that 89% had medical symptoms, leaving 11% with injuries/traumas. Cardiovascular problems were most common among the medical symptoms (28%), while loss of consciousness was second in place (19%).

Results ***Paper II***

Of the 5180 patients involved in red response incidents, 1 104 (21%) patients had chest pain as their main symptom (Index category A10). This corresponds to an estimated rate of 5.4 chest pain cases per 1 000 inhabitants per year.

The patients' age ranged from 4 to 97 years (median age 65). There were 56% males with median age 61 and 44% females with median age 70. The males were significantly younger than the females ($p < 0.0001$), and the females constituted the majority (54%) in the age group over 70 years.

The primary care physician on-call was alerted by radio alarm in 36% of the cases, of which the doctor responded with an emergency call out in about a third. The caller to the EMCC was a next-of-kin in 38% of the incidents, in 16% the patient herself made the call, and a layperson in 6% of the calls. A physician called directly to the EMCC for assistance in 11% of the cases, while the call came from other health personnel in 29%.

Over 90% of the patients were reached by an ambulance in less than 30 minutes and median pre-hospital response time was 13 minutes (95% CI 9-20). Analysing severity of illness, we found that 9% were given NACA-score 0 or 1, indicating no illness or an illness not requiring medical attention. Overall, the female patients were given lower NACA-scores than the male patients, indicating less severe symptoms ($p < 0.001$). Males dominated among the patients given NACA 4-6 (67% of the 163

patients, $p < 0.001$). Among the 10 patients with NACA 7 (patient dead), nine were male ($p < 0.05$). Severity of illness did not correlate with whether or not the doctor was alerted by radio alarm, but the doctors' call out rate generally increased with the patients' severity of illness, with a call out in one of five patients with NACA 0-1, compared to 43% of the patients with NACA 4-6. Air ambulance was alerted by the EMCCs in 6% of the cases, and a helicopter with an anaesthetist was actually sent to assist in 3% of the patients with chest pain.

A total of 76% of the patients were admitted to a hospital for further investigation and/or treatment, either via the casualty clinic (12%) or directly with (39%) or without (25%) being examined by a physician. Of the 24% who were not admitted, about half received final treatment at the casualty clinic, while a third of the patients were not brought to a doctor for further investigation or treatment.

8.2 Materials, methods and results of Study 2 – **Paper III** and **Paper IV**

The materials and methods from **Paper III** and **Paper IV** will also be described together as the data came from the same study. The results from the two papers will be described separately.

Materials and methods

The second study was a prospective interview study designed to investigate diagnostics and management of patients with chest pain in Norwegian out-of-hours primary care. **Paper III** focuses on diagnostic tools and actual management of the patients, while **Paper IV** investigates the physicians' diagnostic approach, tolerance of risk and attitudes to hospital admission.

Four casualty clinics were chosen for cooperation, according to strategic sampling, to cover rural, suburban and urban districts, and to include both smaller and larger casualty clinics. The four casualty clinics were located at Sotra, Haugesund, Drammen and Kristiansand. Data were collected from February to July 2012.

We performed structured telephone interviews with 100 physicians shortly after a consultation with a patient presenting at the casualty clinic with "chest pain" as the main symptom. The patients were registered prospectively by the nurses, and registration continued until the predefined number of 100 unique physicians with 100 corresponding patients had been included. Each physician could only be interviewed once, and if a physician could not be reached by telephone within 2 days of the consultation, she was excluded from the study.

Patient inclusion criteria were "chest pain" or equivalent symptoms, independent of the probable cause of complaint, and only patients with symptoms suggestive of mastitis were excluded. Equivalent symptoms included "retrosternal pain", "chest discomfort" and "tightness in chest". The nurses recorded the following variables for each patient; consultation date and time, name, birth date, sex, age of the patient, and response level. The Norwegian Index of Medical Emergencies (Index) was used by the nurses to set "level of response". The Index categorises the patients with their symptoms into one of three responses; red, yellow and green. The Index is described in more detail under Study 1.

The questionnaire used in the structured telephone interview with the physicians had two parts. The first part was made up by questions related to the patient they just had treated, including use of diagnostic tools, management, and severity of illness. Severity status was set by the physicians using The National Committee on Aeronautics (NACA) Score System, described earlier under Study 1. Part I also included the physicians stating the most probable cause of the patient's chest pain, and finally, if the patient was admitted to a hospital; got final treatment at the casualty clinic or was referred to their GP or a specialist in an out-patient clinic.

Part two of the questionnaire consisted of questions related to the individual physician's approach to diagnosing patients with chest pain, the physician's "tolerance of risk", and attitudes to hospital admission. To measure the physicians' diagnostic approach we used a five-point Likert scale where the different aspects of the diagnostic process were graded by their importance. "Tolerance of risk" was measured using the Pearson Risk Scale, which was developed by Pearson et al in 1995 for triage decisions in patients with chest pain. We also developed a new Tolerance of Risk Scale for our study, by using the seven first items of a questionnaire from a previously published article (Ingram et al 2009) (83). The Ingram-questionnaire consists of four dimension, measuring "tolerance of risk and uncertainty" (dimension A), "fear of complaints" (dimension B) and "attitudes to hospital admission" (dimension C and D).

Results from part one of the questionnaire, focusing on diagnostic measures and management of the study patients, are presented in **Paper III**. Results from part two of the questionnaire, concerning the physicians' diagnostic approach, tolerance of risk and attitudes to hospital admission, are described in **Paper IV**.

Results ***Paper III***

The casualty clinics registered a total of 832 patients with chest pain, and included the first 100 patients and physicians that met the inclusion criteria with corresponding structured interviews. The study patients' age ranged from 18 to 92 years (median age 46 years), 58% males with a median age of 45 years, and 42% females with median age 51 years. The included patients were about 5 years younger ($p < 0.05$) than the patients not included ($n = 732$), but did not differ statistically in any other variable.

Red response level ("acute") was set in 24 patients, 66 were given yellow response ("urgent"), and in the remainder 10 a green response was set ("non-urgent"). An ECG was taken in 92 of the patients, and in half of these patients (52%) the ECG was

ordered by the nurse at the casualty clinic. Other diagnostic tests were taken in 57%, with oxygen saturation (n = 44) and C-reactive protein (CRP) (n = 29) most often used. D-dimer (n = 3) and other blood tests were rarely in use.

15 of the patients with a NACA-score indicating a potentially or definitely life-threatening medical situation (NACA 4–6) were categorised to "red response", the remaining 11 patients were given a lower response level (yellow or green). Nine of the ten patients with "green response" were not in a life-threatening situation; the last one had a NACA-score of 4, indicating immediate need of help.

Medication was given to 43 patients with chest pain, most often sublingual nitro-glycerine (n = 29) and acetylsalicylic acid (ASA) (n = 27). In nine patients morphine was administered, two patients were given antacida, and one patient a benzodiazepine.

Half of the patients were admitted to hospital for further testing and treatment, in which the physician suspected ischaemic heart disease in 86% of the admitted patients. Musculoskeletal pain was suspected as cause in 22 patients, and of these 21 (95%) were managed in primary care (physician on-call at casualty clinic or referred to GP). The remaining patients had a variety of conditions, most of them managed at a primary care level; twelve patients with psychiatric disease, five with pulmonary disease, five had dyspepsia, three had other gastrointestinal discomfort and the last three other diagnoses. 24 of the 43 patients admitted with suspected ischaemic heart disease had NACA-scores between 4 and 6, indicating a potentially or definitely life-threatening illness.

Results ***Paper IV***

The characteristics of the included patients are described under "*Results* ***Paper III***". Of the 100 included physicians, 60 were men, and GPs constituted 67%, the rest were interns or physicians with their main employment in secondary care.

All but one of the physicians believed that the patient's symptoms and history was a fairly (19%) or very important (80%) aspect of the diagnostic process. "Positive" ECG-findings were important for all physicians; for 10% fairly and 90% very important (mean 4.9 of 5). "Negative ECG-findings" (mean 2.8 of 5) and "effect of sublingual nitro-glycerine" (mean 3.0 of 5) were least important.

Analysing "physician risk attitudes" from the Pearson Risk Scale, there was no significant difference in the length of work experience between male and female physicians (p=0.072). The "middle-scoring" group from the Pearson Risk Scale made out 66 of the 100 physicians, while both the "risk-avoider" group and the "risk-seekers" counted 17 physicians each. There were no significant differences in length of experience (p=0.155) or gender (p=0.913) when analysing the "risk-avoiders" against the rest.

"Tolerance of risk and uncertainty" was measured using dimension A of the "Ingram-questionnaire". We found the strongest agreement in the statement "I think my risk assessment is reasonably good, and I'm reasonably safe", in which 94% agreed to the statement (67% a little; 27% strongly; mean 4.2 of 5).

Half of the physicians (51%, mean 3.0 of 5) worried about complaints being made about them, but few let fear of complaints from the Board of Health Supervision influence their practice (16%, mean 2.1 of 5) (Both statements from dimension B). In dimension C and D, examining attitudes to hospital admission, 69% (mean 3.6 of 5) agreed that admitting someone to hospital enables them to get a second opinion, but 75% (mean 3.7 of 5) were also concerned that admitting someone to hospital put patients in danger of being "over-tested". Almost all of the physicians believed that the patient's clinical status was the most important factor (96% agreed, mean 4.6 of 5) in deciding to admit a patient or not. 51% agreed (mean 3.2 of 5) with the statement that they were more likely to admit the patient if the patient himself wanted to be admitted, and 46% (mean 3.1 of 5) if a family member wanted the patient to be admitted.

We performed an analysis comparing overall mean scores from items in the four dimensions with mean scores within the three risk groups derived from the Pearson Risk Scale (table 2, pages 54-55). In dimension A, we found a significant difference between the risk groups in the statement “When it comes to OOH-medicine I’m quite cautious” ($p=0.024$), and a trend in most items that the “risk-avoiders” differed from the rest. Analysing dimension B, there was a significant difference in the statement “I don’t worry about a complaint being made about me” ($p=0.006$), while there were no significant differences between the risk groups in dimension C. In the last dimension (D), we found significant differences in three of the statements; “I am more likely to admit a person if they want to be admitted” ($p=0.039$), “If members of the family say there’s nobody to look after someone, I see that as a problem for the family rather than the doctor” ($p=0.034$) and “I am more likely to admit someone if they live alone” ($p=0.008$).

Table 2 - Cross-table comparing overall mean scores from items in the four dimensions with mean scores within the three risk groups derived from the Pearson risk scale

	Pearson Risk Scale				
	Mean value all	Risk avoiders	Middle scorers	Risk seekers	P- value[§]
A. Tolerance of risk and uncertainty – all patients out-of-hours (OOH)					
1. When it comes to OOH-medicine I'm quite cautious	3.5	4.0	3.5	3.1	0.024*
2. As an OOH-physician you think that you can deal with most things most of the time	3.8	3.5	3.9	4.1	0.18
3. I think my risk assessment is reasonably good, and I'm reasonably safe	4.2	4.1	4.3	4.2	0.49
4. All OOH-physicians take risks; it's risk assessment OOH all the time (**n=99**)	3.3	3.0	3.3	3.7	0.22
5. OOH-physicians are good at living with uncertainty and risk	3.5	3.2	3.5	3.8	0.18
6. I don't worry about my decisions after I've made them	3.1	2.7	3.2	3.1	0.10
7. I sometimes go back and check on the patient's outcome after a shift finished	3.1	3.5	3.0	3.3	0.12
B. Complaints by patients or relatives - only patients with chest pain					
1. I don't worry about a complaint being made about me	3.0	2.2	3.2	3.1	0.006*
2. I have had complaints made against me	1.1	1.1	1.1	1.1	0.84
3. Fear of complaints from the Board of Health Supervision influences my practice	2.1	1.7	2.2	2.0	0.25

C. Attitudes to hospital admission – only patients with chest pain					
1. A benefit of admission is that it reduces the risk of being sued	2.4	2.5	2.4	2.3	0.70
2. It's easier to send somebody in and get the hospital to check them out than to leave them at home	3.3	3.7	3.2	3.3	0.09
3. Admitting someone to hospital enables me to get a second opinion	3.6	3.9	3.5	3.8	0.33
4. Admitting someone to hospital means I can speed up urgent tests	3.3	3.4	3.2	3.5	0.62
5. Admitting someone to hospital puts them in danger of being "over-tested"	3.7	3.8	3.6	4.1	0.77
D. Patient-related factors - only patients with chest pain					
1. The most important factor in my decision to admit is the patient's clinical status	4.6	4.7	4.6	4.4	0.37
2. I am more likely to admit a person if they want to be admitted	3.2	3.7	3.2	3.1	0.039*
3. If a family wants me to admit their relative I would be more inclined to admit them	3.1	3.5	3.0	3.2	0.13
4. I see myself as a negotiator, 'selling' my decision (whatever that is) to family and carers	3.3	3.4	3.3	3.1	0.66
5. If members of the family say there's nobody to look after someone, I see that as a problem for the family rather than the doctor	2.8	2.4	2.9	3.0	0.034*
6. I am more likely to admit someone if they live alone	3.7	4.2	3.5	3.9	0.008*
7. I am more likely to admit someone if they are poorly housed	3.6	3.9	3.5	3.6	0.09

§ "Risk avoiders" tested against the rest using the Mann-Whitney U test. *P-value <0.05 considered significant.

8.3 Statistical analyses

Statistical analyses were performed using IBM Statistical Package for the Social Sciences (SPSS version 15 for **Paper I** and **Paper II** and version 20 for **Paper III** and **Paper IV**). Standard univariate statistics were used to describe the material, including mean and median. Skewed distributed data are presented as median with 25–75 % percentiles. Rates are presented as numbers of red responses per 1 000 inhabitants per year with a 95%-confidence interval (CI) (**Paper I** and **Paper II**).

Mann-Whitney U test was used for comparing age between males and females in **Paper II** and for comparison between the items from the Ingram-questionnaire and the Pearson Risk Scale in **Paper IV**. Student's t-test was used to compare mean age between all registered patients and the included study patients in **Paper III**. For other comparisons the Pearson Chi-Square test was used. A p-value of < 0.05 was considered statistically significant.

8.4 Ethical considerations

In Study 1, patient characteristics and their medical records were collected, without patient consent. Ideally, consent should have been collected in all included patients, but because of the large number of patients, this was difficult to carry out. Approval of Study 1 (**Paper I** and **Paper II**) was given by the Data Protection Official for Research (privacy ombudsman, reference number 16876) (86), Regional Committee for Medical and Health Research Ethics (REC West, reference number 07/7179-106.07/ars) (87), and the Norwegian Directorate of Health (reference number 07/2561) (88) , the latter giving the project manager exemption from professional secrecy.

In Study 2, the project manager had daily contact with the four casualty clinics, gathering data on all registered patients and variables, excluding patient name and date of birth to achieve anonymous data collection. Oral consent was obtained from the physicians at the beginning of the interview. To ensure anonymous data collection, the physicians were explicitly asked to not disclose the patient's name and/or date of birth. Study 2 (**Paper III** and **Paper IV**) was given approval by the Regional Committee for Medical and Health Research Ethics (REC West) (87) before inclusion started (reference number 2010/1499-10).

9. Discussion

9.1 Methodological considerations

This thesis is based on two separate studies, each presented with two papers. A survey design was used in both studies. Survey design is an efficient way of gathering data from populations with the possibility to collect a vast set of variables. However, the challenge will often be making sure the data are reliable, representative and with valid measures.

The first study (**Paper I** and **Paper II**) was a prospective longitudinal observational study, while the second study (**Paper III** and **Paper IV**) was a prospective, observational interview study based on structured telephone interviews with a questionnaire. The advantages and disadvantages of the study design and methods of the two studies will be discussed separately.

The methodological considerations will mainly focus on the two studies' internal and external validity. Validity of a survey study can be defined as whether or not the data from the study represents what it intends and claims to represent. Internal validity refers to what extent the results extracted from the sample actually represents the concept one sets out to measure. External validity concerns to what extent the results of a study can be generalised to other populations (89, 90). Poor internal validity will threaten the external validity of the study.

9.1.1 Study 1 (**Paper I** and **Paper II**)

This study was a comprehensive, prospective observational study with a large set of variables measured, and the complete collection of every red response situation during the study period gave reliable date. However, some specific elements of the study design and methods need to be addressed, mainly concerning the issue of validity.

Convenience sample, Index and sample size

Three EMCCs were chosen for cooperation and data collection. All 19 EMCCs use the Index as a triage tool, but one most expect that there exist differences in the use of Index between the EMCCs and between the individual operators. A recent study from all of the 19 EMCCs examined to what extent the Index was used, and how it was used (91). The study concluded that there was a large variation between the EMCCs with regards to the use of Index, both on individual operator and EMCC level. It is uncertain to what extent the three chosen EMCCs are representative for all EMCCs, and this could represent a sample bias and reduced internal and external validity.

The three EMCCs cover one fifth of Norway's land area and the catchment areas of the cooperating EMCCs cover 816 000 inhabitants (18% of Norway's population). The incidence of the different medical situations and accidents, including the rates of red responses, should be representative for the total Norwegian population. The study managed to include all red response situations during the study period, a fact that strengthens the results' external validity.

Accuracy of scoring

The NACA score system was chosen to measure "severity of illness/injury" because the score system is easy to use retrospectively, and the severity score was mainly set based on records from the ambulances and physicians on-call at the casualty clinics. The exception was the physicians in the air ambulance service who register NACA-scores "bedside" in real-time. However, the validity of the NACA score system has never been examined thoroughly. One study described low accuracy concerning precise severity ratings (92), another showed differences between experienced and less experienced emergency physicians when scoring the same patient group (93). A recent study from Norway, examining if anaesthesiologists reliably predict mortality using the NACA severity score, concluded that: "[NACA is]…useful as a tool to measure overall severity of the patient population in this kind of emergency medicine system" (94). The fact that the scoring was mainly done retrospectively, and the NACA score system not being sufficiently validated, could reduce the internal validity of the "severity of illness" score in Study I, and thus the external validity. The study aimed to give an overview of the severity of patients in all medical emergencies outside hospitals defined as a "red response", not to describe exact severity score in each patient. Only two persons scored the patients according to the NACA system retrospectively (except for the patients handled by the air ambulance service), giving consistent NACA scores and strengthening the study. Concerning patients with chest pain specifically (**Paper II**), severity assessment can be difficult from medical records alone, but the records included the patients' symptoms and clinical findings, making it possible to achieve reliable registrations.

ICPC-2 symptom codes were given retrospectively in all patients based on the received medical records from the EMCCs, except in patients where the physician on-call already had given an ICPC-2 symptom code in the patient's medical record. To increase internal validity, it was decided to only use the "symptom"-section of the ICPC-2 framework, as the "diagnose"-section would yield a larger degree of uncertainty and probably less accurate scoring. Concerning the ICPC-coding, it is a

strength that all ICPC-coding done retrospectively were carried out by only two persons, obtaining consistent and coherent symptom coding.

Red response cases and patients with "chest pain"

The study aimed to include only "true" red response cases, based on what the EMCCs triaged as a red response. It is not based on clinical knowledge of the patients adjudged by the researchers retrospectively.

5 105 AMIS-forms with 5 180 patients (each form could include more than one patient) were included in the study, from a total of 5 738 forms collected. AMIS-forms in which the exact level of response could not be identified, or more than one level of response was set (eg. both yellow and red) were excluded to make sure the study only included "true" cases. This would increase the content validity of included red response cases, and thus increase both the internal and external validity.

Of the 5 180 patients, a total of 1 104 (21%) patients were given the Index code A10 – "chest pain", these patients are described separately in **Paper II**. **Paper I** showed that 1 389 of the 5 180 patients (27%) were given the ICPC-2 codes A11 "Chest pain" (n=808) or K1 "Heart pain" (n=513). The combined percentage of A11 and K1 might be higher than the Index incidence because patients with K01 "Heart pain" may have presented with other symptoms indicative of heart disease. Still, by comparing two different symptom code-systems, and showing that the incidence is similar for the most common symptom ("chest pain"), the results strengthen the study's internal validity.

9.1.2 Study 2 (**Paper III** and **Paper IV**)

This study was a prospective, observational interview study based on structured telephone interviews with a questionnaire. This study design has some clear advantages, but also has some important limitations, which is discussed more in detail in the following paragraphs.

Sample

Four casualty clinics (CCs) were chosen for cooperation and data collection according to strategic sampling theory. The CCs, located at Sotra, Haugesund, Kristiansand and Drammen, were chosen to cover both smaller and larger CCs, and the four CCs together cover rural, suburban and urban districts. However, it is uncertain to what extent the four CCs are representative for all CCs, and this could imply a possible sample bias, with impact on internal and external validity.

Sample size

The study design, which planned for structured telephone interviews with the first 100 physicians who had treated a patient meeting the inclusion criteria, limited the number of physicians and patients possible to include in the study. We chose to include 100 unique physicians with 100 corresponding patients. This allowed us to perform sub-group analyses on several variables, but the number may have limited the inclusion of more seldom diagnoses. The number is an important limitation of the study, and could reduce especially the external validity.

Included patients and physicians

The participating physicians from the four CCs included both women and men, and inexperienced and experienced physicians. A strength of the study is the prospective registration of all patients with chest pain at the collaborating casualty clinics during the study period (3 months). The included patients (n = 100) were about 5 years younger ($p < 0.05$) than the patients not included (n = 732), but did not differ statistically in any other variable. To avoid dependency and an unbalanced weighting of the data, it was decided that each patient and physician could only be included once.

Telephone interviews and questionnaire

Using telephone interviews to collect answers to the questionnaire enabled the interviewer to give precise instructions, including how to interpret the different questions and the context of the questions. We aimed to reduce recall bias by reaching the physicians shortly after the consultation, and we decided to exclude the physician if he or she could not be interviewed within two days. However, some recall bias will be expected when interviewing a physician about a specific patient one or two days after an out-of-hours shift, and this might threaten the internal validity of the results related to questions about the specific patient ("study patient") (**Paper III**). Telephone interviews enabled the interviewer to collect a complete set of data from the 100 physicians, with no missing data from the questionnaires. An interview approach also reduced the risk of a low response rate one would expect if the questionnaire was sent by mail.

The questionnaire consisted of two parts, in which the first part was related to the patient just treated by the included physician ("study patient", results described in **Paper III**). This part had standardised questions with little chance of observer subjectivity, except the questions on "severity of illness" and appraisal of the most probable cause of the patient's chest pain (see *Accuracy of scoring* below). Part two

of the questionnaire concerned the diagnostic approach and management of patients with chest pain in general. The questions on diagnostic approach were designed by the research team as a method to standardise the measurement of how the physicians rate the importance of the different aspects of the diagnostic process. "Tolerance of risk" and attitudes to hospital admission were measured by the Pearson Risk Scale (80) and a slightly adapted questionnaire from a recently published paper (83). Using a questionnaire with standardised questions would contribute to a high degree of reliability, but standardisation also has disadvantages; some questions may not have been appropriate for all respondents, decreasing the internal validity. Using the Pearson Risk Scale and a questionnaire used in another study (83), enabled the possibility of comparisons with existing literature, but neither are sufficiently validated, and this could have impact on the validity of Study 2 (**Paper IV**, see also *Accuracy of scoring* below).

Accuracy of scoring

"Severity of illness" was in Study 2 also measured using the NACA score system (**Paper III**. See *Accuracy of scoring*, Study 1, for discussion concerning validity of the NACA score). In Study 2, the physicians were asked to give their patient a NACA-score based on the consultation at the casualty clinic. All of the included physicians were briefed on how to use the NACA-score during the interview, but only few were familiar with the scoring system before the interview, thus one must expect a certain degree of observer subjectivity. This could impact the study's reliability and internal validity.

"Level of response" was set by the nurses at the casualty clinic according to the Index. A recent study examined nurses' decision on priority grade according to the Index in seven Norwegian casualty clinics (95). Classification was measured in a set of twenty validated cases, and the total mean correct classification was nearly 80%. This could

indicate a high degree of reliability and validity of the variable "level of response" in Study 2 (**Paper III**).

Appraisal of the most probable cause of the patient's chest pain will also to a certain extent depend on observer subjectivity, but this will not be avoidable when examining a physician's "initial diagnosis" of many symptoms in primary care.

The Pearson Risk Scale was developed by Pearson et al in 1995, and use of the scale has shown internal consistency and reliability (80). A study comparing three different scales to measure risk tolerance in physicians dealing with chest pain patients in the EDs, showed that only the Pearson Risk Scale was associated with the decision to admit or to use supporting diagnostic tools such as CT coronary angiogram or cardiac markers (96). Study 2 did not have a design that allowed comparison between "tolerance of risk" and admission rates, but previous research has documented that the Pearson Risk Scale is a valid scale when testing risk tolerance in physicians dealing with chest pain patients.

Tolerance of Risk was also measured using a questionnaire from a previously published study, and the questionnaire measured attitudes to hospital admission as well (83). Most of the questions in the original questionnaire by Ingram et al were derived from a qualitative study (85), and the validity of the questions has not been evaluated thoroughly. This would impact the internal and external validity in Study 2 (**Paper IV**).

9.2 Discussion of the results

9.2.1 Epidemiology of medical emergencies outside hospitals (**Paper I**)

Results from **Paper I** showed an estimated rate of 25 per 1 000 inhabitants per year involved in a red response situation, but with considerable differences in rates between the three EMCC districts. EMCC Innlandet, with a rate of 30 per 1 000 inhabitants, had a rate that was 50% higher than EMCC Stavanger. NACA score distribution between the three EMCCs was not significant, so the differences cannot be explained by a higher degree of accuracy or more appropriate triage at EMCC Innlandet. A previous paper from the same study has shown pronounced differences between the three EMCCs with respect to alerting physicians on-call in a red response situation, with EMCC Innlandet also here the stand out case (16). EMCC Innlandet alerted the physicians in a fifth of all red responses, while the physicians were alerted in three out of four incidents at EMCC Stavanger and Haugesund. This sheds light on how local customs and practice at the EMCCs might influence their procedures, and the subsequent possibility of considerable differences in how the EMCCs triage patients according to the Index. A recent study examined to what extent the Index was used, and how it was used, in all 19 EMCCs in Norway. A publication from that study concluded that there was a large variation between the EMCCs with regards to the use of Index, both on individual operator level and EMCC level (91).

Paper I also showed that relatively few of the 39 chapters of the Index were regularly in use, and two of the chapters most often used were A05 “Ordered mission” (medical problem already known) and A06 “Inconclusive problem”, in which the medical problem could not be identified. A throughout evaluation of the Index is needed, and hopefully an ongoing ph.d.-project on the validation of the Norwegian Index for Medical Emergencies will bring important new evidence and insight (15).

Examining the variation of symptoms in the 5 180 patients using the ICPC symptom codes, we found that cardiovascular symptoms were most common (28%), respiratory symptoms accounted for 10%, and psychiatry 6%. This distribution is comparable to a recent study (Rørtveit and Hunskaar 2009) from a single municipality in Norway involving 240 patients requiring urgent medical care (97). In this study, the ICPC code distribution showed that cardiovascular symptoms accounted for 25% and respiratory symptoms 11%. The frequency of medical emergencies with a rate of 27 per 1 000 inhabitants per year was also nearly identical to the rate found in our study, but in this study the medical emergencies were not defined by the Index alone, and the rates are thus not directly comparable. Rørtveit and Hunskaar also found that injuries/accidents accounted for 16% of all incidents; our corresponding number was 11%.

Analyses of "severity of illness" showed that more than two thirds of the patients were given a NACA score indicating non-life-threatening situations. As described earlier, appropriate triage in the EMCCs is of vital importance, but it has also shown to be difficult for the different EMCCs to perform triage according to the Index without a considerable level of operator subjectivity (91). Overtriage in dispatch centres is well known and demanding on the resources involved (98, 99). Most districts in Norway are covered by a casualty clinic with only one physician on-call (100) and overtriage by the EMCCs could lead to incidents in which the physician are forced to deal with "simultaneity conflicts" which might have been avoidable.

70% of the patients were admitted to a hospital for further testing and treatment. Another publication from the same data material have previously shown that in medical situations where the primary care physicians on-call were *not* alerted, direct transports to the hospitals with ambulance were doubled compared to situations where physicians were alerted (16). More primary care physicians on site could possibly contribute to a reduction in hospital admissions, and points to the fact that the emergency primary healthcare services also have an important gate-keeping function.

Another important finding in **Paper I** is the age distribution of the patients included. Patients above 50 years of age made out over 60% of all red responses, while patients in the group older than 70 accounted for 31% alone. A study from the US found that the rate of ambulance use among older patients (65 years or older) was four times higher than among younger patients, all levels of responses included (101). With an increasingly older population, one must expect a considerable increased pressure on the emergency systems both inside and outside hospitals. The responsible governments must ensure that the future emergency services are prepared for the upcoming challenges, including capacity issues, formal qualifications in the services and clarification regarding the division of labour between primary and secondary care.

9.2.2 Acute chest pain and "red response" outside hospitals (**Paper II**)

Paper II described a rate of 5.4 acute chest pain cases involved in a red response per 1 000 inhabitants per year. More than a fifth of all contacts to the EMCCs ending in a red response involved chest pain as the main symptom. Our rate of acute chest pain patients is similar to reported rates in two other studies from Norway; one study from primary care reported a rate of 4.8 (97), another from the ambulance services showed a rate of 5.4, identical to the rate of our study (102). The findings from **Paper II** confirm that chest pain is a frequent and important symptom in out-of-hours primary care.

Men constituted the majority of the patients, and they were significantly younger than their female counterparts in our study. It is well known that men are significantly younger than women when they suffer from a myocardial infarction (77, 103). A recent study from Norway examining gender-specific ambulance priority and delays to primary percutaneous coronary intervention showed a median age of 62 among the men versus 67 years among the women (104). However, the study did not show any differences in symptoms and clinical findings between the genders in patients suffering from ST-elevation myocardial infarctions (STEMI). Previous research has

also shown that similar differences in age are valid for all chest pain patients as well, irrespective of probable cause (41, 105). Analysis of "severity of illness" in **Paper II** showed that only a fourth of the patients were given a NACA score indicating a potentially or definitely life-threatening medical situation (NACA ≥ 4). As all patients in the study were triaged by the EMCCs to the highest priority grade, these findings point to a considerable degree of overtriage. As many as 10% were not brought to a physician for further investigation or treatment. This indicates that the patient's medical condition was not as severe as initially assessed. Overtriage is to a certain extent both expected and desirable to intercept all patients in need of immediate help, but the findings also highlight the challenges for the EMCCs in deciding the appropriate level of response in patients with chest pain. This may partly be explained by the weaknesses of the Index discussed earlier, but may also reflect a lack of knowledge on the variation of causes shown for patients with chest pain outside hospitals (18, 20, 21, 23, 24), and a possible "one-sided" focus on catching patients with life-threatening ischaemic heart disease. Concerning triage at the EMCCs, and use of Index, Melberg et al have recently published a paper from Norway examining ambulance priority in the EMCCs and delays to primary percutaneous coronary intervention (104). They found that even though men and women presented with similar symptoms, the women were significantly more often given a lower priority level (yellow versus red) indicating a possible gender bias. The study also showed that the Index was not used regularly by all EMCC-operators, and the dispatch time delay was significantly shorter when the Index was used. A Swedish study examining characteristics and outcome among women and men transported by ambulance with symptoms suggestive of ACS, also showed that women were less frequently assigned the highest priority grade (106). However, this difference in priority grade between the genders was not present when they analyzed the patients with confirmed ACS separately.

Both Norwegian health authorities and cardiologists have stressed the importance of the patients themselves or their next-of-kin calling the national three digits emergency number "113" (EMCC) directly when patients experience chest pain of sudden onset.

Still, our study showed that in almost half of the calls to the EMCC, the call was made by health personnel. This could indicate a considerable, and possibly dangerous, "patient delay" for the patients with chest pain of cardiac origin in need of immediate diagnosis and treatment. Melberg et al found in their study that only a third of the patients with STEMI called the emergency number"113" directly and another third contacted their GP or casualty clinic first when experiencing their symptoms (104). The patients that called "113" directly did not differ significantly from the rest of the patients with regards to age and gender. Two other studies from the Nordic countries have also shown considerable patient related delays in patients with symptoms suggestive of ischaemic heart disease (107, 108). In the Swedish study, Johansson et al found that a frequent reason for patient delay after onset of symptoms was that they did not know that a short delay could have important implications (108). In a recent study from primary care in the Netherlands, examining gender differences in pre-hospital time delay in patients suspected of ACS, Bruins et al found that there were no differences in patient delay between the genders (103). However, they found that doctor delay, defined as time from call to GP consultation, was longer in women than in men. Findings from the three Nordic studies (104, 107, 108), combined with the similar findings in **Paper II**, highlight the need for continuous campaigns towards the public on how to respond when experiencing chest pain of sudden onset.

Examining where the patients were brought, **Paper II** showed that more than three quarters of the patients were admitted to a hospital for further investigation and treatment. The NACA-scores still indicate that most patients with chest pain were not in need of immediate hospital care, and with the knowledge of the broad spectrum of causes in patients with chest pain in primary care; the physicians on-call out-of-hours should still play an important role after the first contact with the EMCC. Primary care physicians working out-of-hours in Norway are usually experienced in separating severe from non-severe illness, and they hold a clinical background well suited to manage patients with chest pain outside hospitals.

9.2.3 Management of chest pain in out-of-hours care (**Paper III**)

Results from **Paper III** showed that men constituted the majority, and the included male patients were about six years younger (median age men 45 versus women 51). Both the male majority, and the fact that they as a group were younger than the women, is in accordance with previous research, including **Paper II** (103-105).

Concerning the use of diagnostic tools; an ECG was taken in 92% of the patients, and other laboratory tests in approximately half. A recent study from Norway has shown that 99% of all casualty clinics are equipped with an ECG-device (39). Another study from Switzerland, a country with a similar decentralised out-of-hours organization as Norway, found that 98% of all GPs had an ECG-device available out-of-hours (40). These findings would indicate that ECG is seen as an important diagnostic tool in primary care. However, a study from Belgium, examining the initial diagnosis and referral rates in patients with chest pain in primary care, Bruyninckx et al reported that an ECG was recorded in only 29% of the patients (41). This rather low rate of ECG-testing might be explained by the fact that Belgium is an example of a country in which self-referrals to the ED is common, while both Norway and Switzerland have a stronger "gatekeeping" tradition. Primary care physicians in Norway and Switzerland are thus expected to see a broader spectrum of patients, including patients with potentially life-threatening disease, like acute chest pain. The high rate of ECG-testing shown in **Paper III** might be explained by the fact that an ECG often is taken as a routine test in patients with chest pain before they are examined by the treating physician. It is desirable and important with early ECG-testing in patients suspicious of ischaemic heart disease, but it is also well known that over-testing, including use of ECG, can be unfortunate for patients suffering from anxiety or panic attacks. Thus, early testing with ECG in *all* patients with chest pain in primary care might come with a price. ECG is also a diagnostic tool with limited sensitivity, and the test demands comprehensive knowledge in order to interpret the results in a reliable way. A more detailed discussion of the strengths and weaknesses of ECG as a diagnostic tool, as

well as how the physicians use ECG in their diagnostic approach, can be found in the discussion of **Paper IV** (chapter 9.2.4).

The use of blood tests as supplementary diagnostic tests were rarely done and only CRP was tested in more than a few (29% of the patients, **Paper III**). None of the participating four casualty clinics had troponin assays available, and in only three patients, d-dimer was measured. Rebnord et al found in 2009 that 6% of Norwegian casualty clinics could measure troponin locally, while 2% could measure CK-MB (39). Tandjung et al found in their study from Switzerland that 76% of the 471 GPs examined in one region of Switzerland had troponin assays available locally (40). The development and introduction of new high-sensitive troponin assays for "point-of-care"-testing (POC) is thought to have a major impact on how primary care physicians diagnose patients with chest pain outside hospitals (47-51). In some countries, POC-testing with "traditional" (not high-sensitive) troponin assays has been introduced routinely in patients with chest pain outside hospitals, like several GP-surgeries in Sweden and Switzerland (40, 52). Nilsson et al have recently investigated the diagnostic accuracy and clinical benefit of POC-testing of troponin in Swedish primary care (52). They conclude that Swedish primary care physicians do not need POC troponin analysis to improve the chance of finding patients with acute coronary syndrome. In another recent publication from the same data material, Nilsson et al found that POC troponin testing in primary care may be cost saving but at the expense of missed cases of acute coronary syndrome (109). Bruins Slot et al published in 2013 a systematic review of point-of-care tests in patients with suspected acute myocardial infarction (110). In this study, they found that an ideal POC test for the diagnosis of AMI within 6 hours after the onset of symptoms does not yet exist, and the evaluated tests reported too many false negatives to be considered safe to use. It is still unclear if the new, high-sensitive troponin assays could bridge the gap for patients in primary care with recent onset of symptoms (within 6 hours), and more research is needed to give definitive guidance on the implementation of POC-testing of troponin outside hospitals. It is also important to bear in mind that an increased level of high-sensitive troponin concentration alone does not give the diagnosis of acute myocardial

infarction (7), and that a possible introduction of new cardiac biomarkers in primary care should never replace a comprehensive diagnostic approach with focus on other causes than ACS as well.

Appraisal of the most probable cause, or "initial diagnosis", showed an incidence of "ischaemic heart disease" of 50% (**Paper III**), while musculoskeletal pain was second most common with 22%. Heart disease as the initial diagnosis was more common in our study than comparable studies from primary care reporting incidences from 5 to 15% (18, 20, 21, 23, 24). The same five studies all reported musculoskeletal pain as the probable cause in around half of the patients. Our findings may partly be explained by the study setting, where patients at the casualty clinic are expected to have more acute and severe disease and higher occurrence of acute heart disease than patients during daytime GP surgery hours. However, only few of the patients received full "MONA-treatment" (morphine, oxygen, nitroglycerin and ASA), the preferred treatment in patients with suspected acute coronary syndrome, and just about half of the patients with "heart disease" as initial diagnosis received ASA only. This might suggest a low probability of ischaemic heart disease in many of the patients. Knowing that 43 of the 50 patients with "heart disease" were admitted to hospital for further testing, one can suspect that the initial diagnosis of "heart disease" in some patients was used to "justify" why they admitted the patient. Half of the 100 patients in the study were admitted to a hospital for further testing and treatment. A detailed discussion of the primary care physicians' attitudes to hospital admission, including the influence of "tolerance of risk", can be found in the discussion of **Paper IV** (chapter 9.2.4).

Examining "severity of illness", the results from **Paper III** showed that 26% of the patients were in a life-threatening medical situation, defined as NACA score ≥ 4. This number is equal to the number found in **Paper II**, but in that study only patients with the highest priority were included. These findings would indicate that patients with chest pain assigned with priority level "red" by the EMCCs do not have a higher "severity of illness" than the patients examined at the casualty clinics with all three

priority levels. This is a surprise finding, because it is thought that patients handled by the EMCCs to a greater extent are in need of immediate care. However, previous research has shown that patients with chest pain do not always know where to call or who they should contact when they are in need of medical help (104, 108). As discussed earlier, this increases the risk of patient related delay.

As discussed in **Paper II**, deciding the appropriate level of response can be a difficult task in patients with chest pain. In **Paper III** we found that 63% of the patients assigned with the highest priority level (red response) had a NACA-score indicating a potentially or definitely life-threatening medical situation, pointing to a certain degree of "over-triage". The downfalls of over-triage are discussed earlier in chapter 9.2.1 (discussion of **Paper I**). On the other hand, as many as 11 of the 76 patients (14%) who were given a yellow or green response level were also in need of rapid diagnostics and/or treatment (NACA ≥ 4), indicating possible "under-triage". Under-triage is medically more worrying than over-triage, and represents a potentially harmful underestimation of the patients' severity of illness. The results concerning over- and under-triage at the EMCCs and casualty clinics from **Papers I, II,** and **III** highlight the need for a thorough evaluation of the use of triage tools in the emergency service for all patients in general and specifically when used in patients with chest pain.

9.2.4 Diagnostic approach, tolerance of risk and attitudes to hospital admission in patients with chest pain in out-of-hours care (**Paper IV**)

The results from **Paper IV** concerning the physicians' diagnostic approach showed that Norwegian physicians working out-of-hours only to a certain degree diagnose patients with chest pain according to current guidelines and evidence. Although previous studies from primary care have highlighted the broad spectrum of causes for patients with chest pain; ruling out or confirming ischaemic heart disease (IHD) still seem to constitute the most important diagnostic challenge.

In **Paper IV** we found that almost all physicians believed a patient's symptoms/history and possible "positive ECG"-findings were fairly or very important in the diagnostic approach. The vast majority also regarded "negative ECG"-findings to be of less importance, however almost a fourth still considered negative findings to be important when diagnosing patients with possible IHD. Nearly half of the physicians believed that the effect of nitroglycerin was important and over half believed that the presence of chest-wall tenderness was of little importance.

In the last decade, we have seen an increasing interest and focus on research concerning the diagnostic process of patients with chest pain in primary care. A meta-analysis published in 2008, from a Belgium research group in primary care, examined the accuracy of symptoms and signs in diagnosing coronary heart disease (36). They found that patient history with symptoms is clinically important, but no *symptom itself* had a major impact on the post-test probability of IHD in a low-prevalence setting, such as general practice. However, an important finding from this meta-analysis was that the presence of chest-wall tenderness in principle ruled out IHD, with a post-test probability of only 1%. A German research team has also recently published a cross-sectional diagnostic study on the accuracy of symptoms and signs for coronary heart disease assessed in primary care (37). They found that "known vascular disease", "pain worse on exercise", and "patient assuming cardiac origin of pain" were all strongly associated with coronary heart disease, while "cough present" and "pain reproducible on palpation" showed a negative association.

The patient's response to nitroglycerin with alleviation of chest pain or discomfort has historically been seen as a relevant part of the diagnostic process (111-114). The British National Institute for Health and Care Excellence (NICE) has recently published guidelines concerning chest pain of recent onset, and in the making of the guideline, use of nitrates in the diagnosis of chest pain has been examined (43). Based on three prospective cohort studies and one retrospective cohort study, the guidelines conclude that nitrates are of no diagnostic value in patients with acute chest pain (111-114).

The electrocardiogram (ECG) is still considered one of the most important diagnostic tools when diagnosing patients with chest pain. Extensive research has been published on the usefulness of ECG in the diagnostic process, including several systematic reviews (42, 44-46). They all found that ECG is a diagnostic tool with relatively high specificity, and positive ECG findings can be trusted as indicative of IHD. As suspected, ECGs showing ST-segment elevation had the greatest diagnostic utility for the detection of acute IHD, but present Q-waves and ST-segment depression also showed to have good predictive value. Several of the studies showed that a normal resting ECG was reasonably useful at ruling out IHD, but not definitive, and the existing evidence seems to be unison in stating that a normal ECG alone should not be used to rule out IHD in patients with chest pain suspicious of cardiac origin (42, 43, 115).

Our results from examining the physicians' appraisal of the importance of different aspects of the diagnostic process showed that when it comes to patient history/symptoms and positive ECG-findings, the physicians act in concordance with current evidence. Almost a fourth considered negative findings to be important when diagnosing patients with possible IHD, this view has some support in the evidence presented, but in our study we could not determine if the physicians regarded a negative ECG important enough to rule out IHD. 4 out of 10 physicians believed that the effect of nitrates is fairly of very important, and this should be considered an important finding as evidence suggest that nitrate effect on chest pain relief should not be used in the diagnostic process. Only approximately half of the physicians thought that "chest wall tenderness" was important, even though presented evidence suggest that presence of chest wall tenderness largely rules out IHD in patients with chest pain in "low-prevalence" settings.

Several studies have been published on the development, use and validation of clinical decision rules (CDRs) or prediction rules in diagnosing patients with chest pain, but most studies have been carried out in the emergency departments/secondary care (59-63). A recent systematic review that examined the diagnostic accuracy of

CDRs for chest pain patients in emergency departments also concluded that the current CDRs have substantial methodological limitations, and are not successfully implemented in a clinical setting (66). In recent years, we have seen several examples of the development of CDRs to be used in primary care to rule out IHD/ACS (67-70, 72, 73). The most promising CDR to be used in primary care seems to be the Marburg Heart Score, developed by a German research team from the University of Marburg (72, 73). This CDR is a simple prediction score, including five findings from the patients' medical history and physical examination. The prediction score has been both internally and externally validated, and has shown promising results when used in a clinical setting. The development of reliable and validated CDRs, like the Marburg Heart Score, might lead to a considerable change in how we diagnose patients with chest pain outside hospitals in the near future.

Tolerance of risk and attitudes to hospital admission was in **Paper IV** measured through the Pearson Risk Scale and a questionnaire derived from a previously published paper slightly adapted to a Norwegian out-of-hours-setting (83).

The results showed no significant differences in length of experience or gender when testing "risk avoiders" against the rest, neither when using the Pearson Risk Scale nor the Tolerance of Risk Scale. Concerning out-of-hours work, almost all physicians felt that their risk assessment was reasonably good, and felt reasonably safe, but only half agreed with the statement "I don't worry about my decisions after I've made them". Examining the dimensions concerning chest pain patients only, we found that half of the physicians worried about complaints, most agreed that hospital admissions come with the risk of patients being "over-tested" and about half of the physicians were more likely to admit a patient if they wanted to be admitted.

Ingram et al published in 2009 a paper on risk taking in general practice, with focus on GPs out-of-hours referrals to hospital (83). From this paper we derived our questionnaire used in **Paper IV**. A main finding from this paper was that GPs with "low tolerance of risk" and female GPs were more likely to refer patients to the hospital out-of-hours, but the difference between the genders could be explained by

the fact that the female GPs were more inclined to be "risk averse". Rossdale et al also found in a study from 2007 that female GPs referred more patients out-of-hours than their male counterparts, and that length of work experience as GP did not influence referral rates (84). Calnan et al have previously found in a qualitative study that GPs that most often refer patients out-of-hours typically are more cautious and would admit more often if in doubt (85). Pearson et al developed a new scale in 1995 for use in triage decisions for emergency department patients with chest pain, naming it the "Risk-taking scale" (80). In their paper from 1995, they found that physician risk attitudes correlated significantly with admission rates for patients with acute chest pain. The findings from these four studies all suggest that referral rates are strongly linked with the physicians' "tolerance of risk", and that any difference between the genders could be explained by underlying differences in how "risk averse" the physicians are.

The study design of **Paper IV** did not allow comparison between "tolerance of risk" and referral/admission rates. However, the results did show that physicians vary in their "tolerance of risk" in out-of-hours work, and **Paper IV** also showed that physicians vary considerably in what influences their decision to admit a patient with chest pain to a hospital or not. Viewed in the light of the previously described studies (80, 83-85), the findings in **Paper IV** showing that "tolerance of risk" was not dependent on gender or length of experience seem to be in concordance with existing research. This statement seems also valid concerning the results showing considerable variation on what influences the decision to admit or not.

The findings on differences in the diagnostic approach in **Paper IV**, and challenges in management of chest pain outside hospitals described in **Paper III** both highlight the need for continuous education of GPs on diagnosing chest pain in primary care. A significant number of physicians do not comply with current evidence and guidelines concerning the diagnostic approach of patients with chest pain of suspected cardiac origin. Furthermore, findings from **Paper III** and **Paper IV**, along with extensive research presented earlier, support the notion that focus should be more on diagnosing

the probable cause, with appropriate management, and less on "ruling out" ischaemic heart disease alone.

It is considered well known from research and clinical practice that physicians vary considerably in attitude and confidence, and this variation is also thought to affect patient management strategies and attitudes to hospital admissions/referrals. The findings on "tolerance of risk" and "reasons for hospital admission" in **Paper IV** support the need to empower primary care physicians in decision-making and confidence. Even though attitude and confidence to some extent must be seen as inherent personality traits in many physicians, one must believe that specific education on topics like risk-stratification and pre-test probabilities of important medical conditions, in different health care settings, will contribute to the right decision being made, with less influence from the physician's attitude and tolerance of risk. Empowerment of the physicians through training and focus on the physicians' risk assessment out-of-hours and decisions on treatment and right level of care is pivotal in countries where primary care physicians function as "gatekeepers", like Norway. Such empowerment will hopefully and probably lead to more appropriate referrals and better management of all patients out-of-hours in general, and chest pain patients specifically.

10. Conclusions

Main conclusions of this thesis:

- Emergency medicine outside hospitals mainly consists of medical problems, where the majority of the patients have a non-life-threatening situation. Future focus should be on the skill of triage and the organisation of dispatch. Such focus is needed to secure knowledge based decisions for the future organisation of the emergency system

- Chest pain is the most common medical problem in patients with the highest priority level outside hospitals. The majority of patients with acute chest pain were admitted to a hospital for further investigation, but only a quarter of the patients were assessed prehospitally to have a severe illness. The EMCCs have considerable challenges in deciding the appropriate level of response in patients with acute chest pain. Overtriage is to some extent both expected and desirable to intercept all patients in need of immediate help. But overtriage is also resource demanding and may lead to unnecessary "simultaneity conflicts" for the primary care physician on-call

- Patients with chest pain presenting at out-of-hours services in Norway are investigated for acute heart disease, but less than half are admitted to hospital for probable acute coronary syndrome, and only a minority is given emergency treatment for acute coronary syndrome. A wide variety of other diagnoses are suggested by the physicians for patients presenting with chest pain. Deciding the appropriate level of response for such patients is a difficult task, and both over- and under-triage probably occur in out-of-hours primary care

- Physicians working out-of-hours showed considerable differences in their diagnostic approach, and not all physicians diagnose patients with chest pain according to current guidelines and evidence. Differences in "tolerance of risk" have a substantial influence on how physicians decide to manage patients with

chest pain out-of-hours, and the physicians vary considerably in what may influence their decision to admit a patient with chest pain to a hospital or not. There were no significant differences in length of experience or gender when testing “risk avoiders” against the other physicians, suggesting that “risk tolerance” mainly is a personality trait that varies between physicians. Continuous medical education must focus on the diagnostic approach in patients with chest pain in primary care and empowerment of physicians through training and emphasis on risk assessment and “tolerance of risk”.

11. Implications and recommendations for future research

This thesis sheds light on some important issues concerning the future organisation of the emergency services outside hospitals, including the EMCCs and the out-of-hours services. The main issue concerns the use of triage tools at the EMCCs and casualty clinics, for all patients in general, and patients with chest pain specifically. Both over- and undertriage occur, and current triage tools do not seem to function as well as one should expect. Future research should focus on the medical skill of triage at both the EMCCs and the out-of-hours services. We must expect a considerable increased pressure on the emergency systems both inside and outside hospitals during the next decades. The responsible governments must ensure that the future emergency services are prepared for the upcoming challenges, including capacity issues, formal qualifications in the services and clarification regarding the division of labour between primary and secondary care.

The thesis has confirmed that chest pain is a common symptom out-of-hours, with a broad spectrum of causes. Future research should focus on the introduction of new diagnostic tools in primary care, such as high-sensitive troponin assays, and what implications such introduction might have on how primary care physicians diagnose and manage patients with chest pain. More research should also be performed on the patients with chest pain who do get admitted to the hospital, including the correlation between “first” and “final” diagnosis and to what extent the admission was appropriate or needed.

Education in medical school and vocational training in family medicine should focus on empowerment of physicians through training and emphasis on risk assessment and “tolerance of risk”. It is believed that specific education on risk-stratification and pre-test probabilities of important medical conditions, like chest pain, will contribute to

the right decision being made, with less influence from the physicians' attitude and tolerance of risk. New research is needed to examine if such empowerment leads to more appropriate referrals and better management of patients out-of-hours, specifically in patients with chest pain as their main symptom.

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The epidemiology of medical emergency contacts outside hospitals in Norway - a prospective population based study

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Abstract

Introduction: There is a lack of epidemiological knowledge on medical emergencies outside hospitals in Norway. The aim of the present study was to obtain representative data on the epidemiology of medical emergencies classified as "red responses" in Norway.

Method: Three emergency medical dispatch centres (EMCCs) were chosen as catchment areas, covering 816 000 inhabitants. During a three month period in 2007 the EMCCs gathered information on every situation that was triaged as a red response, according to The Norwegian Index of Medical Emergencies (Index). Records from ground ambulances, air ambulances, and the primary care doctors were subsequently collected. International Classification of Primary Care - 2 symptom codes (ICPC-2) and The National Committee on Aeronautics (NACA) Score System were given retrospectively.

Results: Total incidence of red response situations was 5 105 during the three month period. 394 patients were involved in 138 accidents, and 181 situations were without patients, resulting in a total of 5 180 patients. The patients' age ranged from 0 to 107 years, with a median age of 57, and 55% were male. 90% of the red responses were medical problems with a large variation of symptoms, the remainder being accidents. 70% of the patients were in a non-life-threatening situation. Within the accident group, males accounted for 61%, and 35% were aged between 10 and 29 years, with a median age of 37 years. Few of the 39 chapters in the Index were used, A10 "Chest pain" was the most common one (22% of all situations). ICPC-2 symptom codes showed that cardiovascular, syncope/coma, respiratory and neurological problems were most common. 50% of all patients in a sever situation (NACA score 4-7) were > 70 years of age.

Conclusions: The results show that emergency medicine based on 816 000 Norwegians mainly consists of medical problems, where the majority of the patients have a non-life-threatening situation. More focus on the emergency system outside hospitals, including triage and dispatch, and how to best deal with "everyday" emergency problems is needed to secure knowledge based decisions for the future organization of the emergency system.

Introduction

Persons in need of acute medical assistance are supposed to come in contact with the emergency care system by calling a three digits emergency number (113) to an emergency medical dispatch centre (EMCC). The 19 EMCCs are responsible for alarming the out-of-hospitals emergency resources like ambulances services (ground and air) and primary care doctors on-call.

For all calls to an EMCC, trained nurses use The Norwegian Index of Medical Emergencies (Index) [1] to classify the medical problem into one of three different levels of response; green, yellow and red, the latter indicating immediate need of help (potentially or a manifest life-threatening situation). When an emergency situation is classified as red, there will be transmitted a simultaneous radio alarm from the EMCC to doctors on-call and the ambulances in the relevant area.

Even though emergency medicine is considered an important part of the health care system, little is known about the incidence and management of medical

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emergencies outside hospitals in Norway. Emergency medicine is not a formal speciality for doctors in Norway. Still, treatment of critically ill or injured people is defined as emergency medicine. Earlier white papers and plans concerning the organisation of the emergency services underscore the lack of national statistics and scarce epidemiological knowledge [2-4]. It has for long been anticipated a rate of about 10 red responses per 1 000 inhabitants per year, but this figure has not been supported by valid statistics or scientific studies [3]. Data from a representative sample of Norwegian out-of-hours districts showed a rate of 9 red responses per 1 000 inhabitants per year, but this number was based on data from local emergency communication centres, not EMCCs [5,6]. A recent study from a single island municipality with approximately 4 000 inhabitants found an incidence of 27 medical emergencies per 1 000 inhabitants per year [7]. However, the definition of an emergency was wider in this study than the classification of a red response based on the Index of Medical emergencies from EMCCs.

There seems to be a scarce literature with broad epidemiological approach to pre-hospital emergencies in general. Most studies deal with specific emergency problems like cardiac arrest, chest pain or trauma [8-14]. One study in Norway has a wider epidemiological scope [7]. More epidemiological knowledge is needed to make the right decisions for policy makers and leaders of the health care services.

To obtain representative data on the epidemiology of medical emergencies classified as "red response" by the EMCCs, we performed a large prospective population based study.

Materials and methods

For data collection we chose and cooperated with a strategic sample of three EMCCs, located at Haugesund, Stavanger and Innlandet hospitals, covering Rogaland, southern part of Hordaland, Hedmark, and Oppland counties, covering a total of 69 581 km^2 (21% of the total area ofNorway) and 816 000 inhabitants (18% of the total population). Data registration was performed prospectively during a period of three months, from October 1st to December 31st 2007.

Variables

All EMCCs use a software system called Acute Medical Information System (AMIS) to record all incoming situations. Usage of the AMIS system results in an electronic form with registration of each incident (not the individual patient). The AMIS form contains basic information about the situation, the patient(s), all available logistics (date, time registration for incoming alarm and all alarms and electronic messages sent to the different prehospital resources, who responded and when), and to where the patients are transported (left at scene, home, casualty clinic, hospital).

Based on the immediate available information, the EMCC operator (usually a specially trained nurse) gives the situation a clinical criteria code with a response level based on the Index [1]. The Index is based on ideas from the Criteria Based Dispatch system in the US [15], and was first published in 1994. Clinical symptoms, findings and situations are categorised into 39 chapters. Each chapter is subdivided into a red, yellow and green criteria based section, correlating to the appropriate level of response. Red colour is defined as an "acute" response, with the highest priority. Yellow colour is defined as an "urgent" response, with a high, but lower priority. Green colour is defined as a "non-urgent" response, with the lowest priority.

Copies of all AMIS forms involving situations classified as red responses were sent the project manager every second week throughout the study. The EMCCs also sent copies of ambulance records from all red responses which involved ground or boat ambulances. In situations where doctors on-call or air ambulances had been involved, copies of medical records were requested by mail from the project manager directly to the person or agency involved. Several reminders were needed during collection of medical records from different parts of the health care system and continued until October 2008. To secure a uniform recording of the variables in the AMIS program, a meeting between the persons in charge of the participating EMCCs was held.

Based on information from all AMIS forms and medical records we classified the situations according to the International Classification of Primary Care - 2 (ICPC - 2) [16]. The ICPC-2 is structured into 7 components and 17 chapters from A to Z depending on the body system to which the problem belongs (table 1).

Component 1 (codes -01 to -29) provides codes for symptoms and complaints. The analyses in this study were based on codes from the symptom component solely. Each patient was given one code only (e.g. D01 for abdominal pain or N07 for convulsions). For further analyses the symptom-codes were aggregated into clinically connected and appropriate groups based on the chapters from A to Z. ICPC codes were classified in medical records from the doctors on-call. All other ICPC codes were classified by two members of the research team with experience in emergency medicine. Main symptom was used for ICPC coding

Based on all available information according to The National Committee on Aeronautics (NACA) Score System [17], the severity of the medical problem was classified (table 2).

The NACA score system was chosen because it is easy to use retrospectively and the air ambulances use

Table 1 International Classification of Primary Care (ICPC)

ICPC	Body system
A	General and unspecified
B	Blood, blood-forming organs, lymphatic, spleen
D	Digestive
F	Eye
H	Ear
K	Circulatory
L	Musculoskeletal
N	Neurological
P	Psychological
R	Respiratory
S	Skin
T	Endocrine, metabolic and nutritional
U	Urology
W	Pregnancy, childbearing, family planning
X	Female genital system
Y	Male genital system
Z	Social problems

Table 2 National Committee on Aeronautics (NACA)

Score level	Patient status
NACA 0	No injury or illness
NACA 1	Not acute life-threatening disease or injury
NACA 2	Acute intervention not necessary; further diagnostic studies needed
NACA 3	Severe but not life threatening disease or injury; acute intervention necessary
NACA 4	Development of vital (life threatening) danger possible
NACA 5	Acute vital (life threatening) danger
NACA 6	Acute cardiac or respiratory arrest
NACA 7	Death

NACA score as a routine for their patients. The patient's status is classified from 0 to 7, zero indicating no disease or injury, while seven indicates the patient being dead. NACA score was in the analyses categorised as NACA 0-1, indicating a patient either with no symptoms/injuries or in no need of medical treatment, NACA 2-3, indicating need of medical help where value 3 indicates need of hospitalisation, but still not a life-threatening situation. NACA 4-6 indicates potentially (4) and definitely life-threatening medical situations (5 and 6) and NACA 7 is a dead person. NACA scores were classified prospectively in patients transported by air ambulance, and the scores were found in the medical records. All other NACA scores were classified by two members of the research team with experience in emergency medicine. In case of multi-patient accidents the most severely injured patient was included from each situation.

Statistical analyses

The statistical analyses were performed using Statistical Package for the Social Sciences (SPSS version 15). Standard univariate statistics were used to characterise the sample. Skewed distributed data are presented as median with 25-75% percentiles. Rate is presented as numbers of red responses per 1 000 inhabitants per year with a 95% confidence interval (CI). A p-value of < 0.05 was considered significant. Index categories were merged into the five most used (A01/A02 "Unconscious", A05 "Ordered mission", A06 "Inconclusive problem", A10 "Chest pain" and A34/A35 "Accidents") and one category containing the rest, called "All Other" in the analyses. In the analysis of diurnal variations, NACA scores were dichotomised to non life-threatening or life-threatening situations. In 64 patients we were not able to extract information on gender, patients' whereabouts in 82 situations and where patients where brought to in 50 situations. In 435 situations it was not possible to decide NACA score and in 39 situations ICPC symptoms score.

Ethics and approvals

Approval of the study was given by the Privacy Ombudsman for Research, Regional Committee for Medical Research Ethics, and the Norwegian Directorate of Health.

Results

The three participating EMCC-districts collected 5 738 AMIS forms for the study, of which 633 were excluded, due to e.g. situations not being red responses and duplicates (fig 1).

Total incidence of red response situations was then 5 105 during the three month period corresponding to a rate of 25.1 (24.4-25.7) situations per 1 000 inhabitants per year. Innlandet had a rate of 30.6 (29.4-31.8), Stavanger 20.0 (19.0-21.0) and Haugesund 22.9 (21.4-24.3) Differences in rates between the three EMCC areas was all statistically significant ($p < 0.000$). In 104 situations the mission was aborted (no patients), six situations concerned allocation of ambulance resources (no patients) and 71 situations were support to other emergency units (fire and police departments, no patients). 394 patients were involved in 138 accidents, resulting in 256 more patients than situations in which 77 situations had 2 patients, 30 situations had 3 patients, and 16, 9 and 6 situations had 4, 5 and 6 or more patients, respectively. The total number of patients was 5 180 which corresponds to a rate of 25.5 (24.7-26.1) patients per 1 000 inhabitants per year. Of the 256 extra patients from the accidents, 98% had a NACA score of 3 or lower, one was dead. The 256 extra patients, all interrupted missions, allocations of ambulances, and support to

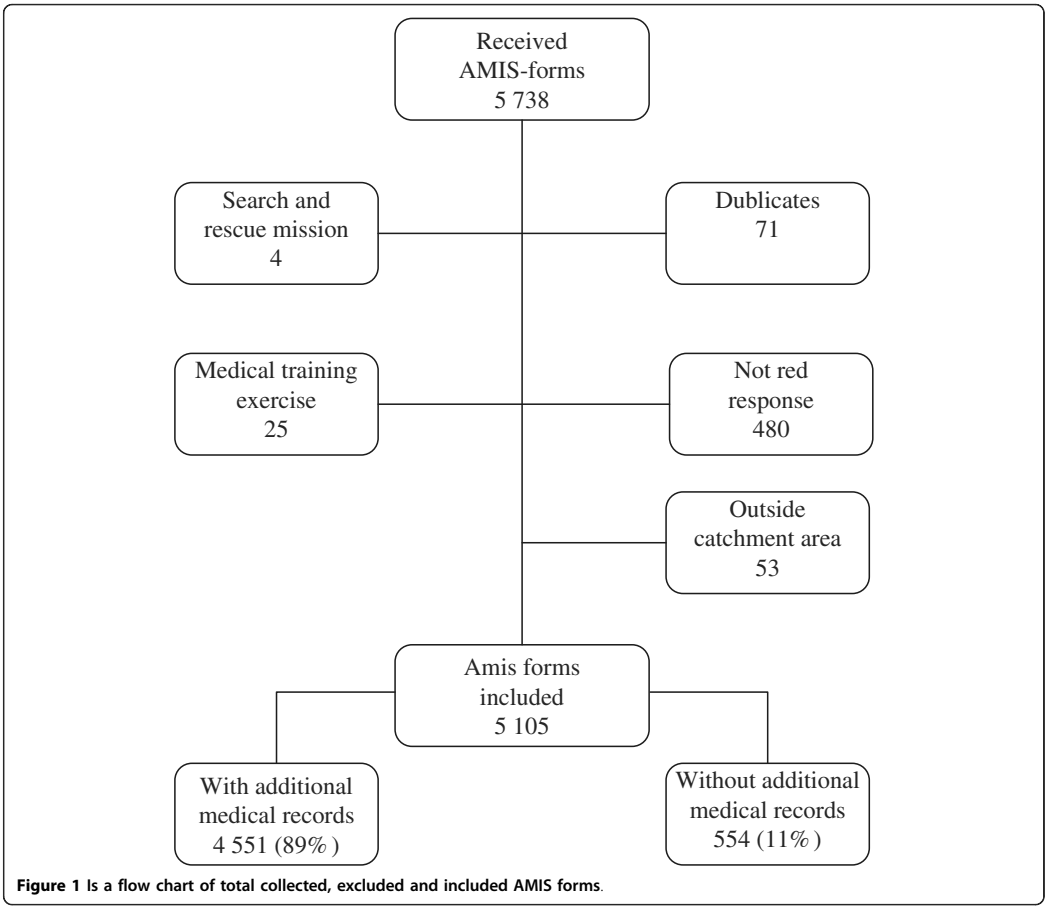

Figure 1 Is a flow chart of total collected, excluded and included AMIS forms.

other emergency units were excluded from further statistical analyses, and the material thus consists of the remaining 4 924 red response situations with the same number of patients.

Demography and Index categories

The patients' age ranged from 0 to 107 years, with a median age of 57 (33-75). The gender distribution showed 55% men with median age 55, and 45% women with median age 58. Table 3 shows the five most common Index categories. The mostly used Index category was A10 "Chest pain" for both genders, and more than 80% of the patients with chest pain were over the age of 50. Index category A34/A35 "Accidents" constituted 12%, where 35% of the patients were between 10 and 29 years, and males accounted for 61%.

The incidence of red responses was higher during daytime (0800-1529) compared to night time (2300-0759) for most of the Index categories, except for category "all other" which had only minor skewness around the clock (table 4). A34/A35 "Accidents" showed the highest incidence during daytime with a proportion of 45% (table 4).

A29 "Breathing difficulties" was the most used Index-category in the "all other" group with nearly 5% of the total. Approximately half of all patients in the youngest age group had "all other" medical problems and convulsions (A23) was the most common Index category with 14% of the situations. Seven Index categories were each used five times or less and six were not used at all.

Severity of injury and illness

NACA-score could be set in 4 489 (91%) of the 4 924 situations with patients (table 4). Males constituted

Table 3 The most frequent used Index categories by patients' gender, age, whereabouts and to where the patients were brought.

	A01/02 Unconscious		A05 Ordered mission*		A06 Inconclusive problem		A10 Chest pain		A34/35 Accidents		All other categories		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Patients	410	8	864	18	707	14	1 098	22	565	12	1 280	26	4 924	100
Male														
0-9 years	11	6	44	24	24	14	2	1	15	8	85	47	181	100
10-29 years	34	8	55	14	58	14	13	3	119	30	123	31	402	100
30-49 years	38	7	80	15	70	13	111	21	97	19	128	25	524	100
50-69 years	62	7	133	16	132	16	275	33	70	9	158	19	830	100
> 70 years	81	11	126	18	131	18	211	29	32	5	139	19	720	100
Total	226	9	438	16	415	16	612	23	333	12	633	24	2 657	100
Female														
0-9 years	20	16	20	16	11	10	1	1	8	6	63	51	123	100
10-29 years	28	8	56	16	39	11	12	3	76	21	151	42	362	100
30-49 years	29	7	80	19	55	13	67	16	50	12	152	35	433	100
50-69 years	23	5	81	17	75	15	156	32	45	9	110	23	490	100
> 70 years	77	10	171	21	110	14	249	31	31	4	157	20	795	100
Total	177	8	408	19	290	13	485	22	210	9	633	29	2 203	100
Patients' whereabouts														
At home	243	9	349	12	416	15	833	30	87	3	882	31	2 810	100
Casualty clinic	4	3	115	77	3	2	17	11	1	1	10	6	150	100
Doctor's surgery	2	1	105	54	4	2	62	32	4	2	19	9	199	100
Public area	113	9	65	6	221	19	94	8	442	37	249	21	1 184	100
Hospitals	0	0	137	87	0	0	9	6	0	0	11	7	157	100
Nursing home	22	9	64	27	34	15	51	22	2	1	60	26	233	100
Other	13	12	12	11	21	19	20	18	15	14	29	26	110	100
Total	397	8	849	18	699	15	1 086	22	551	11	1 260	26	4 842	100
Patients brought to														
Casualty clinic	57	8	76	10	151	21	155	21	105	14	187	26	731	100
Hospital via casualty clinic	27	5	76	15	100	19	127	24	52	10	138	27	520	100
Directly hospital, doctor involved	107	6	544	32	145	8	424	25	159	9	337	20	1 716	100
Directly hospital, doctor not involved	102	9	87	7	175	15	274	23	175	15	364	31	1 177	100
Remained on site	42	8	55	11	82	16	100	19	43	8	200	38	522	100
Deceased	64	38	12	7	37	22	10	6	14	9	30	18	167	100
Taken care of by other	5	12	3	7	11	27	2	5	8	20	12	29	41	100
Total	404	8	853	18	701	15	1 092	22	556	11	1 268	26	4 874	100

The variables have some missing data and the total may not add up to 4 924 for all groups.

* Mission ordered by health personnel or other emergency units, i.e. transport directly to hospital or ambulance assistance to other emergency

68% of the 246 patients with NACA 6-7. Patients >70 years accounted for 50% of the 1 280 patients with potentially/manifest life-threatening medical situations pronounced dead (NACA 4 and higher). Median age of the dead patients was 69 (53-81).

More than 60% of the patients were in category NACA 2-3. Also a large majority of the accidents (81%) were given NACA-score 0-3, indicating non-life threatening situations. Considering the 166 patients that were pronounced dead on arrival or resuscitated without return of spontaneous circulation (NACA 7), 64 (39%) were given the code A01/A02 "Unconscious", 37 (22%) A06 "Inconclusive problem", 14 (8%) A34/A35 "Accidents", and 10 (6%) A10 "Chest pain". The percentage of patients with non life-threatening conditions increased from 70% at daytime to 74% at night, while life-threatening conditions

Table 4 The most frequent used Index categories by time of day and NACA-score.

	A01/02 Unconscious		A05 Ordered mission		A06 Inconclusive problem		A10 Chest pain		A34/35 Accidents		All other categories		Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Time of day														
0800-1529	170	41	367	43	275	39	393	36	256	45	439	34	1 897	39
1530-2259	137	34	292	34	266	38	368	34	211	38	447	35	1 721	35
2300-0759	103	25	199	23	160	23	332	30	97	17	388	31	1 279	26
Total	410	100	858	100	701	100	1 093	100	561	100	1 274	100	4 897	100
NACA-score														
0-1	38	10	44	6	95	15	87	9	101	19	86	7	451	10
2-3	163	43	465	59	418	65	631	65	326	62	747	63	2 750	61
4-6	117	30	265	34	96	15	243	25	83	16	318	27	1 122	25
7	64	17	11	1	37	5	10	1	14	3	30	3	166	4
Total	382	100	785	100	646	100	971	100	524	100	1 118	100	4 489	100

Due to some missing data total numbers will not add up to 4 924 for all groups.

decreased from 30% at daytime to 26% at night. Differences in NACA distribution between the districts were not statistical significant ($p > 0.05$).

Patients' whereabouts and final level of care

Table 3 also describes the patients' whereabouts and where the patients were brought, by Index categories. Overall, 58% of the 4 924 patients were residing at home or at private facilities, while one fourth were in public areas. The primary health care services (casualty clinics, doctors' surgeries and nursing homes) constituted 12% of the patients' whereabouts. 77% of the situations with A10 "Chest pain" were in private homes and 80% of the situations with A34/A35 "Accidents" were in public places.

A total of 3 413 (70%) patients were brought to a hospital, either via the casualty clinic (11%) or directly with (35%) or without (24%) being examined by a doctor first. Patients who remained on site accounted for 11% of the patients. The table also shows that in 26% of the situations, the casualty clinics were directly involved in patient care, either as final place of treatment or by examination and subsequent referrals to hospital. Considering the accidents alone, 28% of the 556 patients were brought to a casualty clinic. Among the 77 patients with diabetes as the main cause of contact with the EMCC, 73% remained on site after treatment.

ICPC symptom score

In 4 551 (92%) patients we retrieved one or more medical record, and in 99% of all patients a symptom-code was registered. Table 5 shows the symptom distribution where 89% had medical symptoms, while injuries/traumas accounted for 11% of the patients. Cardiovascular symptoms was the most common symptom group (N = 1 389, 28%), and loss of consciousness second, accounting for 945 of the situations (19%). Chest pain or pain related to the heart dominated the cardiovascular patients with 95%. Of the 465 patients categorised under "Other", 23% had a problem related to pregnancy or labour.

Most of the symptom groups were more or less equally gender distributed for all ages, except for traumas/injuries with a large male majority (63% of the 521 situations). Cardiovascular symptoms were common among the men over the age of 30, with a peak incidence in the age group "50-69 years" (N= 346; 42%), while the female patients with cardiovascular symptoms tended to be older with a peak incidence in the age group "> 70 years" (N = 329; 42%). Traumas were most common in the age group 10-29 years, dominated by young males with 29% of the 399 situations in this group. In the youngest age group (0-9 years), neurological symptoms dominated in both genders, with 32% of the 180 situations among the boys, and 43% of the 123 situations among the girls.

Table S1; additional file 1 shows the Index categories A05 "Ordered mission" and A06 "Inconclusive problem" by gender, age and the patients' whereabouts. More than a third of the patients with code A05 had cardiovascular symptoms, while the symptom "Injury/trauma" (6%) was used the least. For gender there were only minor differences between the symptom groups.

Discussion

Based on our comprehensive, prospective and population based study, estimated rate of red response patients was about 25 per 1 000 inhabitants per year in Norway. However, differences in rates between the three districts

Table 5 Patient distribution according to the ICPC-2 classification system with frequencies, rate and national estimate per year

ICPC symptoms	ICPC-code (n)	N	%	Rate per 1000/year	National estimate/year
Cardiovascular		1 389	28	6.8	31 100
Chest/heart pain	A11 (808) K01 (513)				
Other cardiovascular symptoms	K29 (68)				
Loss of consciousness		945	19	4.6	21 200
Syncope/coma	A06/07 (945)				
Respiratory		472	10	2.3	10 600
Dyspnoea/breathing problems	R02/04 (430)				
Other respiratory symptoms	R29 (42)				
Neurological		592	11	2.9	13 300
Convulsion	N07 (324)				
Other neurological symptoms	N29 (268)				
Digestive		195	4	1.0	4 400
Abdominal pain/cramps	D01 (113)				
Other digestive symptoms	D29 (82)				
Psychiatric		296	6	1.5	6 600
Acute alcohol abuse	P16 (113)				
Other psychiatric symptoms	P29 (182)				
Injury/trauma		531	11	2.6	11 900
Laceration/cut, skin	S18 (101)				
Other skin symptoms other	S29 (34)				
Other musculoskeletal symptoms	L29 (396)				
Other		465	10	2.3	10 400
Endocrine/metabolic symptoms	T29 (11)				
Urinary/male genital symptoms	U29 (7) Y29 (5)				
Pregnancy/female genital symptoms	W29 (106) X29 (1)				
Assault/harmful event/problem	Z25 (12)				
General symptoms	A29 (317)				
Eye symptoms	F29 (6)				
Not classified		39	1	0.2	
Subtotal		4 924	100	24.2	110 000
Excluded patients		256		1.3	
Total		5 180		25.5	116 000

were pronounced. Index category A10 "Chest pain" was the most used category (22%), while A34/A35 "Accidents" accounted for 12% of the total. More than 70% of all red responses were found to be non life-threatening situations with NACA score = 3. Nearly 60% of the patients were at home or other private facilities. 70% of the patients were brought to hospitals, 24% of them without being examined by a doctor beforehand. One fourth of the patients were brought to a casualty clinic.

The strengths of our study include its completeness, representativity, and number of variables included. In the course of a three month period we were able to prospectively collect a complete material of more than 5 000 red responses based on a population close to 820 000 inhabitants, about 20% of the Norwegian population. In nearly 90% of all situations we retrieved records from ground and air ambulances, casualty clinics, general practitioners and doctors on-call. Together with the complete set of AMIS forms, this yields a comprehensive material for analysis of the objectives of the study. There are some limitations of the study. Severity score (NACA) on patients was assessed retrospectively based on medical records and may therefore have lower accuracy (except for situations where the air ambulances had been involved and their medical records were retrieved). The presented results are based on the EMCCs' definition of an emergency based on the Index. Undertriaged patients are thus not included.

Rate of red responses in Innlandet was higher then the rates in Stavanger and Haugesund. We see no obvious explanation for this. If the percentage of NACA 4 and above was higher in Stavanger and Haugesund compared to Innlandet, it could indicate higher accuracy and a lower level of "overtriage". This was not the fact and differences in NACA distribution between the districts were not significant. The study was not designed to investigate possible differences in triage pattern between the EMCCs.

A comparable study from Norway based on 4 400 inhabitants demonstrate mainly the same distribution between the different ICPC scores. For instance, cardiovascular problems were most common with 32%, respiratory diseases 11% and psychiatric problems constituted 5% of the situations [7]. Accidents accounted for 16% of the situations [7] which is higher percentage than in our study where accidents accounted for 11%.

Patients in the age group 50 and older represented nearly 60% of all red response situations, and persons older than 70 constituted 31%. This places emphasis on some of the upcoming challenges in emergency care, both in the primary and the secondary health care system, namely an increasingly older population and therefore more pressure on the emergency systems both inside and outside hospitals. A recently published white paper emphasised this as an important challenge for the capacity and organization of the health care system in Norway [18]. In the US, the rate of ambulance use among older patients (65 years or older) was found to be four times higher than among younger patients, all levels of responses included [19].

Medical symptoms constituted 90% of all red response situations and A10 "Chest pain" was the most used Index category for a red response. Of all 39 chapters in the Index only five were used more than 8%, in which two of those represent situations where the problem was already known (A05 "Ordered mission") or the problem could not be disclosed (A06 "Inconclusive problem"). Seven of the chapters were hardly ever used and six were not used at all. A12 "Drowning" was probably not used due to season variation. To the best of our knowledge a throughout evaluation of the Index has never been performed in Norway. The necessity of 39 chapters and the content of the chapters should be evaluated. The large majority of the red responses were given a NACA score indicating non life-threatening situations. Overtriage in dispatch centres is well known and demanding on the resources involved [20-22].

ICPC-2 coding of the symptoms resulted in a large variation of symptoms where 90% were medical problems, with cardiovascular problems as the most common one. In the category A05 "Ordered mission" cardiovascular symptoms were most common, and in A06 "Inconclusive problem" loss of consciousness was the most common symptom. The latter was probably mainly due to patients with syncope where the obvious reason for loss of consciousness was regarded as unknown.

The results show that patients involved in emergency medical situations have of a large variety of medical problems, where the majority of the patients have a non life-threatening situation. The large variation of medical symptoms stands in contrast to a narrow use of the Index as a decision tool in the EMCCs. More focus towards the emergency system outside hospitals, including triage and dispatch, and how to best deal with "everyday" emergency problems is needed in Norway. The large variety of symptoms and conditions may for instance indicate a need for more diagnostic competence at the scene of the patients. Doctors on-call in the emergency primary care services has to be more involved in emergency situations. More clinical assessment up front may lead to better medical care and to more relevant transportation routes. This challenge is addressed in a plan of action for the future emergency primary health care service in Norway [23].

Additional file 1: Table S1: Shows the Index categories A05 Ordered mission and A06 Inconclusive problem distributed by ICPC-2 symptom categories.
Click here for file
[http://www.biomedcentral.com/content/supplementary/1757-7241-18-9-S1.DOC]

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Authors' contributions
EZ and SH planned and established the project, including the procedures for data collection, and designed the paper. EZ and RAB performed the analyses and drafted the first manuscript. All authors took part in rewriting and approved the final manuscript.

Competing interests
The authors declare that they have no competing interests.

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RESEARCH ARTICLE Open Access

Acute chest pain - A prospective population based study of contacts to Norwegian emergency medical communication centres

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Abstract

Background: Acute chest pain is a frequently occurring symptom in patients with medical emergencies and imposes potentially life threatening situations outside hospitals. Little is known about the epidemiology of patients with acute chest pain in a primary care setting in Norway, and we aimed to obtain more representative data on such patients using data from emergency medical communication centres (EMCCs).

Methods: Data were collected prospectively during three months in 2007 from three EMCCs, covering 816 000 inhabitants. The EMCCs gathered information on every situation that was triaged as a red response (defined as an "acute" response, with the highest priority), according to the Norwegian Index of Medical Emergencies. Records from ambulances and primary care doctors were subsequently collected. International Classification of Primary Care - 2 symptom codes and The National Committee on Aeronautics (NACA) System scores were assigned retrospectively. Only chest pain patients were included in the study.

Results: 5 180 patients were involved in red response situations, of which 21% had chest pain. Estimated rate was 5.4 chest pain cases per 1000 inhabitants per year. NACA-scores indicated that 26% of the patients were in a life-threatening medical situation. Median prehospital response time was 13 minutes; an ambulance reached the patient in less than 10 minutes in 30% of the cases. Seventy-six per cent of the patients with chest pain were admitted to a hospital for further investigation, 14% received final treatment at a casualty clinic, while 10% had no further investigation by a doctor ("left at the scene").

Conclusions: The majority of patients with acute chest pain were admitted to a hospital for further investigation, but only a quarter of the patients were assessed prehospitally to have a severe illness. This sheds light on the challenges for the EMCCs in deciding the appropriate level of response in patients with acute chest pain. Overtriage is to some extent both expected and desirable to intercept all patients in need of immediate help, but it is also well known that overtriage is resource demanding. Further research is needed to elucidate the challenges in the diagnosis and management of chest pain outside hospitals.

Keywords: Chest pain, After-hours care, Emergency medical services, Emergencies

Background

Acute chest pain is an important and frequently occurring symptom in patients with medical emergencies outside hospitals [1-3]. Chest pain is often a sign of ischaemic heart disease, although gender, age and comorbidity may modify how acute coronary heart disease presents itself within the individual patient. Acute chest pain may indicate a potentially life threatening situation, but it is also commonly acknowledged that a wide variety of differential diagnosis exists, many with lower health impact and less serious potential [4,5].

In Norway, patients in need of acute medical assistance are recommended to come in contact with the emergency health care system by calling the health specific national three digits emergency number 113, thereby reaching the nearest emergency medical communication

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centre (EMCC). Similar three digits emergency numbers also exist for the fire department (110) and the police (112). When a call reaches the EMCC, trained nurses use a decision tool, the Norwegian Index of Medical Emergencies [6], to classify the actual medical problem into one of three levels of response, each indicated by a colour code. "Red response" indicates an immediate need of help (potentially or manifest life threatening situation), and will trigger the transmission of a simultaneous radio alarm from the EMCC to both the primary care doctor on-call and the ambulance service in the relevant area.

Little is known about the epidemiology of acute chest pain outside hospitals in Norway. A recent study from a single island municipality documented an incidence of 27 medical emergencies per 1 000 inhabitants per year, with an incidence rate of acute chest pain and suspected myocardial infarction of about 4.8 patients per 1 000 inhabitants per year [7]. Another study examined prehospital diagnosis and treatment of acute myocardial infarction in a single county in Norway [8]. An incidence rate of 5.4 per 1 000 inhabitants per year of acutely ill patients with chest pain or suspected acute myocardial infarction was found.

In a previous study [1] we presented data from three EMCCs after gathering information on every situation that was triaged as a red response, according to the Norwegian Index of Medical Emergencies. The study showed that 90% of the red responses were medical problems with a large variation of symptoms, the remainder being accidents. Severity of illness was classified retrospectively, and showed that 70% of the patients were not in a life-threatening situation.

The aim of the present analyses was to obtain representative data on the epidemiology of acute chest pain outside the hospitals in Norway, by a more detailed investigation of the data from our EMCC study.

Methods

Three EMCCs, located at Haugesund, Stavanger and Innlandet hospitals, were involved in the study, with the three corresponding districts covering 816 000 inhabitants (18% of the total Norwegian population). Data were collected prospectively from October 1 to December 31 2007.

Variables

All 19 EMCCs in Norway use a software system called Acute Medical Information System (AMIS) to record all incoming cases. Usage of the AMIS results in an electronic form with registration of each incident (*not* the individual patient). The AMIS form contains information about the incident, the patient (or patients, if more than one patient is involved in the incident) and all available logistics, including date, time of day, and to where the patients are transported ("left at scene", home, casualty clinic, hospital). Prehospital response time is also registered, defined as the time period from when the caller calls 113 until the nearest available ambulance reaches the patient [9,10].

Based on the immediate available information, the EMCC operator (usually a specially trained nurse) gives the incident one clinical criteria code and one response level according to the Index [6]. The Index is based on ideas from the Criteria Based Dispatch system in the US [11], and was first published in 1994. It categorises clinical symptoms, findings and incidents into 39 chapters, and each chapter is subdivided into a red, yellow and green criteria based section, correlating to the appropriate level of response. Red colour is defined as an "acute" response, with the highest priority, and will trigger the transmission of a radio alarm to both the primary care doctor on-call and the ambulance service. Yellow colour is defined as an "urgent" response, with a high, but lower priority, where the patient should be examined as soon as the doctor-on-call is available. Green colour is defined as a "non-urgent" response, with the lowest priority. Chapter 10 in the Index covers the symptom "Chest pain", and usage of the red response section will result in the code A10 - Chest pain (A for "acute"). An example of a criterion leading to a red response will be "chest pain with breathing difficulties", while "pain not particular strong, and the patient feels fine" is defined as a yellow criterion, leading to an urgent response, but with lower priority than red response.

Copies of all AMIS forms involving incidents classified as red response were sent to the project manager every other week throughout the study. The EMCCs also sent copies of ambulance records from all red responses which involved ground or boat ambulances. In cases where doctors on-call, casualty clinics, primary care doctors or air ambulances had been involved, copies of medical records were requested and collected separately. This collection of medical records continued also after the study period, until October 2008. To secure a uniform use of the variables in the AMIS program, a meeting was held between the persons in charge of the participating EMCCs.

The severity of the medical problem was classified using The National Committee on Aeronautics (NACA) Score System based on all available information [12]. In the NACA system, the patient's status is classified from 0 to 7, zero indicating no disease or injury, while seven indicates the patient being dead. NACA score was categorised in the analyses as NACA 0-1 (patient with either no symptoms/injuries or in no need of medical treatment), NACA 2-3 (patient in need of medical help, where value 3 indicates need of hospitalisation, but still not a life-threatening situation), NACA 4-6 (4 is a potentially, and 5 and 6 are definitely, life-threatening medical situations) and NACA 7 (dead person).

Based on information from all available forms and medical records the cases were also classified into symptom groups according to the International Classification of Primary Care - 2 (ICPC - 2) [13]. The analyses presented in the results-section are based on the patients who were given the code A10 - Chest pain. Results on all the clinical categories and symptom groups, are published in a previous article [1].

Statistical analyses

The statistical analyses were performed using Statistical Package for the Social Sciences (SPSS version 15). Standard univariate statistics, including median and percentiles, were used to characterise the sample. Median, with 25th-75th percentiles, was used to analyse data where normal distribution was not present. Rates are presented as numbers of red responses per 1 000 inhabitants per year with a 95%-confidence interval (CI). Mann-Whitney U test was used for comparing age between males and females, for other comparisons the Pearson Chi-Square test was used. A P-value of < 0.05 was considered statistically significant.

Ethics and approvals

Approval of the study was given by the Privacy Ombudsman for Research, Regional Committee for Medical Research Ethics, and the Norwegian Directorate of Health.

Results

A total of 5 738 AMIS-forms were collected from the three participating EMCC-districts during the three month period, of which 5 105 AMIS-forms with 5 180 patients (each form could include more than one patient) were included in the study (Figure 1). 1 104 of the patients (21%) were assigned the code A10 - Chest pain according to the Index, corresponding to a rate of 5.4 (95% CI 5.3-5.6) chest pain cases reported to the EMCCs per 1000 inhabitants per year. Further analyses are based on the 1 104 patients with code A10 - Chest pain.

The patients' age ranged from 4 to 97 years (median (25^{th}-75^{th} percentile): 65 (53-79)), 56% males with a median age of 61 (25^{th}-75^{th} percentile: 52-75), and 44% females with median age 70 (25^{th}-75^{th} percentile: 56-82). The males were significantly younger than the females ($p < 0.0001$), and males dominated the age group 30-69 years with 63%, while the females constituted the majority (54%) in the age group > 70 years (Figure 2). There were only minor differences in the distribution of patients around-the-clock.

The primary care doctor on-call was alerted by radio alarm in 351 (36%) of the cases, of which the doctor responded with an emergency call out in about a third. The doctors' responses and choices of action are shown in Table 1. In 417 (38%) of the medical emergencies with chest pain as the main symptom, the caller to the EMCC was a next-of-kin, in 173 (16%) the patient, and a layperson made the call in 61 (6%). A physician called directly to the EMCC for assistance in 108 (11%) of the cases, while the call came from other health personnel in 314 (29%) of the cases.

Median prehospital response time was 13 minutes (95% CI 9-20), and over 90% of the patients were reached by an ambulance in less than 30 minutes. Figure 3 shows the number of patients reached per minute (Figure 3a) and cumulative by percentage (Figure 3b).

NACA-score could be classified in 971 (88%) of the patients (table 1), with 87 (9%) given NACA-score 0 or 1, indicating no illness or an illness not requiring medical attention. Overall, the female patients were given lower NACA-scores than the male patients, indicating less severe symptoms ($p < 0.001$), and in the group NACA 1, females constituted 59% of the patients ($p < 0.01$). Males dominated among the patients given NACA 4-6 (67% of the 163 patients, $p < 0.001$). Among the 10 patients who were dead, nine were male ($p < 0.05$). Figure 4 shows severity of illness (NACA-scores) in study patients, by gender.

Table 1 also describes the patients' severity of illness, represented by NACA-score stratified by whether the doctor was alerted by radio, doctor's response to the alarm, prehospital response time and involvement of air ambulance services. Severity of illness did not seem to affect whether or not the doctor was alerted by radio alarm, but the doctors' call out rate generally increased with the patients' severity of illness, with a call out in one of five patients with NACA 0-1, compared to 43% of the patients with NACA 4-6. Increasing NACA-score showed a tendency towards shorter prehospital response time, but the association between increasing NACA-score and shorter prehospital response time was not significant ($p = 0,07$).

Air ambulance was alerted in 56 (6%) of the cases, and a helicopter with an anaesthetist was sent to assist in 34 (3%) of the patients. Air ambulance service was not requested in any patients with NACA 0-1. In the group with potentially or definitely critically ill patients (NACA 4-6), a helicopter was requested in 16% of the cases, and actually sent to assist in 10%.

Analyses of the patients' whereabouts revealed that the large majority of the patients with acute chest pain categorised as "red response" were residing at home or at private facilities, 9% were in public areas and 6% at their general practitioner's surgery when the red response was triggered (table 1). The vast majority of the patients were admitted to a hospital for further investigation and/or treatment (N = 825, 76%), either via the casualty

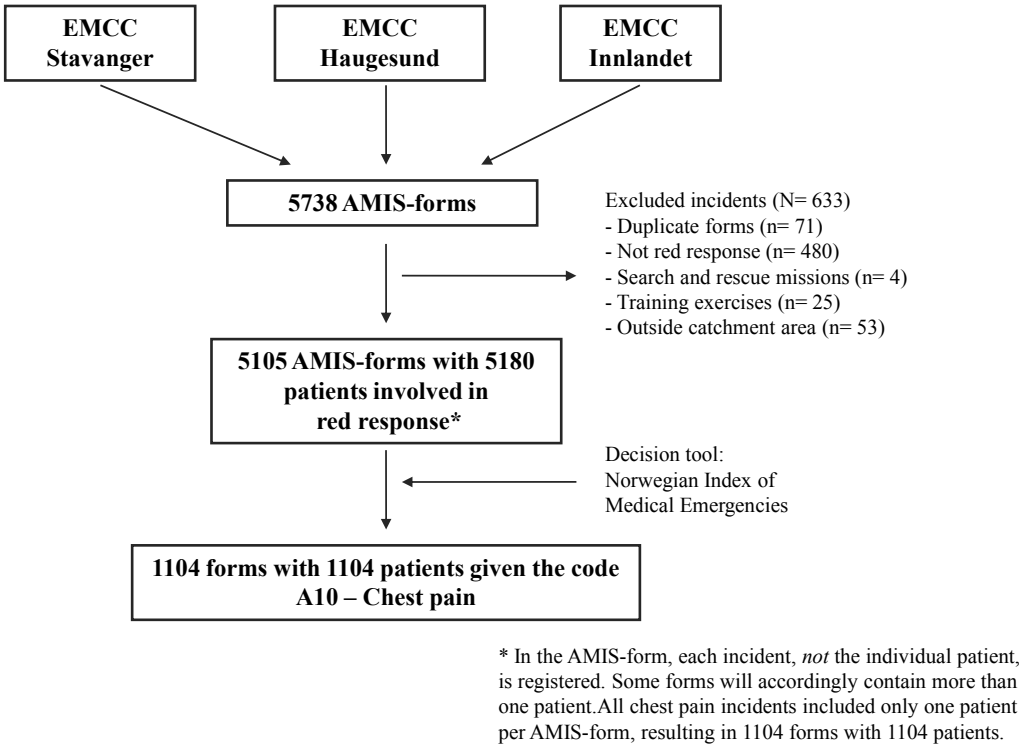

Figure 1 Flow chart of AMIS forms received for registration, with both excluded and included incidents.

clinic (12%) or directly with (39%) or without (25%) being examined by a doctor. Of the 267 patients who were not admitted, 155 (58%) received final treatment at the casualty clinic, while 100 (37%) patients were not brought to a doctor for further investigation or treatment.

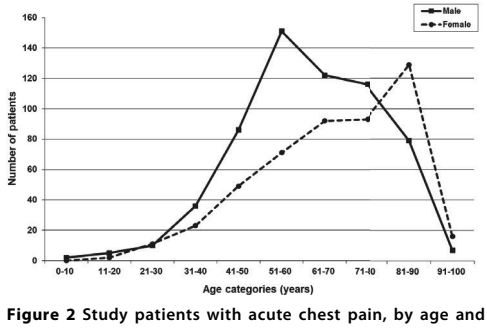

Figure 2 Study patients with acute chest pain, by age and gender.

The cases were also classified with an ICPC-2 code, with the codes A11 "Chest pain" (56%) and K01 "Heart pain" (32%) constituting the vast majority. The remainder 12% were spread over 35 different ICPC-2 codes, with A06 "Fainting/syncope" accounting for 3% of the cases, and R02/R04 "Dyspnoea/Breathing problem" 2%. An ICPC-2 code from the psychiatry-chapter (P01-P29) was used in 1%.

Discussion

Summary of main findings

This prospective population based study showed an estimated rate of 5.4 acute chest pain cases involved in a red response per 1000 inhabitants per year. This corresponds to approximately 10 patients with acute chest pain in need of immediate medical help each week in an out-of-hours district covering 100.000 inhabitants. Over 20% of all contacts to the EMCCs ending in a red response involved chest pain as the main symptom. Males

Table 1 Alerting of doctors with their response, prehospital response time, air ambulance involvement and to where the patients were brought by NACA-score

			NACA Scores							
	Total		0-1		2-3		4-6		7	
	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)
Doctor was the caller	108	(11)	4	(5)	65	(10)	39	(16)	0	(0)
Doctors alerted	351	(36)	36	(41)	214	(34)	95	(39)	6	(60)
Doctors neither caller or alerted	512	(53)	47	(54)	352	(56)	109	(45)	4	(40)
Total	971	(100)	87	(100)	631	(100)	243	(100)	10	(100)
Doctors' response when alerted										
Call out	109	(33)	7	(21)	57	(29)	39	(43)	6	(100
Awaiting further notice	138	(42)	16	(47)	90	(46)	32	(36)	0	(0)
Occupied with other patient(s)	2	(1)	0	(0)	2	(1)	0	(0)	0	(0)
No contact/response from doctor	9	(3)	1	(3)	3	(1)	5	(6)	0	(0)
Consultation with hospital	69	(21)	10	(29)	45	(23)	14	15)	0	(0)
Total	327	(100)	34	(100)	197	(100)	90	(100)	6	(100)
Prehospital response time										
0-9 minutes	276	(30)	20	(23)	176	(29)	76	(33)	4	(57)
10-19 minutes	413	(45)	38	(44)	287	(47)	86	(38)	2	(29)
> 20 minutes	237	(25)	28	(33)	143	(24)	65	(29)	1	(14)
Total	926	(100)	86	(100)	606	(100)	227	(100)	7	(100)
Air ambulance requested										
Yes	56	(6)	0	0)	13	(2)	39	(16)	4	(40)
No	915	(94)	87	(100)	618	(98)	204	(84)	6	(60)
Total	971	(100)	87	(100)	631	(100)	243	(100)	10	(100)
Air ambulance response										
Helicopter with anaesthetist sent	34	(69)	0	(0)	5	(45)	25	(74)	4	(100)
Ground vehicle with anaesthetist sent	9	(18)	0	(0)	5	(45)	4	(12)	0	(0)
Awaiting further notice	1	(2)	0	(0)	1	(9)	0	(0)	0	(0)
No flight due to weather condition	4	(8)	0	(0)	0	(0)	4	(12)	0	(0)
No flight due to technical problem	1	(2)	0	(0)	0	(0)	1	(3)	0	(0)
Total	49	(100)	0	(0)	11	(100)	34	(100)	4	(100)
Patients brought to										
Casualty clinic	143	(15)	46	(53)	95	(15)	2	(1)	0	(0)
Hospital via casualty clinic	121	(13)	0	(0)	108	(17)	13	(5)	0	(0)
Directly hospital, doctor involved	373	(39)	0	(0)	216	(34)	157	(65)	0	(0)
Directly hospital, doctor not involved	230	(24)	0	(0)	161	(26)	69	(29)	0	(0)
Patient remained on site	87	(9)	38	(44)	49	(8)	0	(0)	0	(0)
Deceased	10	(1)	0	(0)	0	(0)	0	(0)	10	(100)
Taken care of by other	2	(~0)	2	(2)	0	(0)	0	(0)	0	(0)
Total	966	(100)	86	(100)	629	(100)	241	(100)	10	(100)

constituted a majority of the patients, and were significantly younger than the females. NACA-scores indicated that only a fourth of the patients were in a potentially or definitely life-threatening medical situation (NACA ≥ 4), but more than three quarters were admitted to a hospital for further investigation and treatment.

Strengths and weaknesses of the study

The main strength of our study is the large register of data collected, where we were able to prospectively collect a complete material of more than 5 000 red responses during the three month period, based on a population close to 820 000 inhabitants, about 20% of

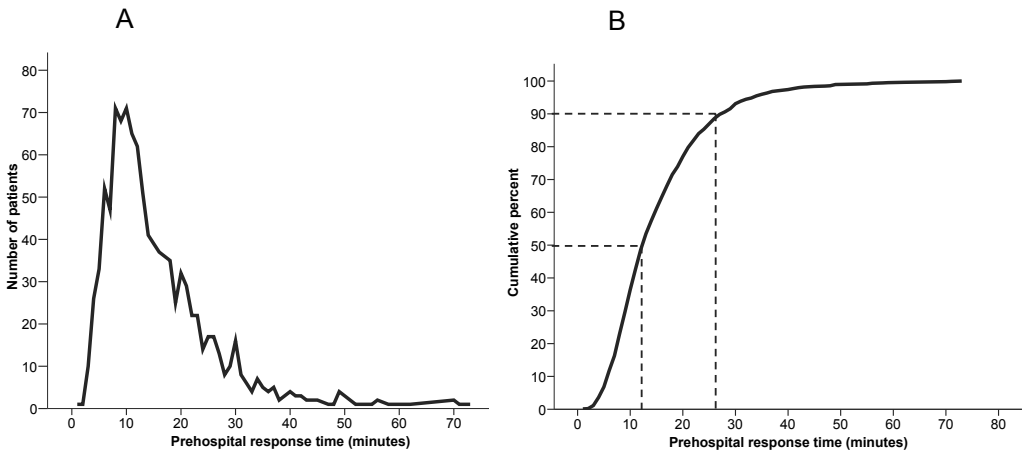

Figure 3 Prehospital response time, defined as the time period from the caller calls the emergency number 113 until the nearest available ambulance resource reaches the patient. a. Number of patients reached per minute b. Number of patients reached, cumulative percentage. Presented with 50- and 90-percentiles.

the Norwegian population. Limitations include NACA-scores in most of the cases being assessed retrospectively based on medical records, which might give a lower accuracy when registering the severity of the illness. Severity assessment in patients with chest pain can be difficult from medical records alone, but the records included the patients' symptoms and clinical findings, making it possible to achieve reliable registrations. Ideally the study would have included on-going clinical evaluation by the physicians on-site, in addition to results

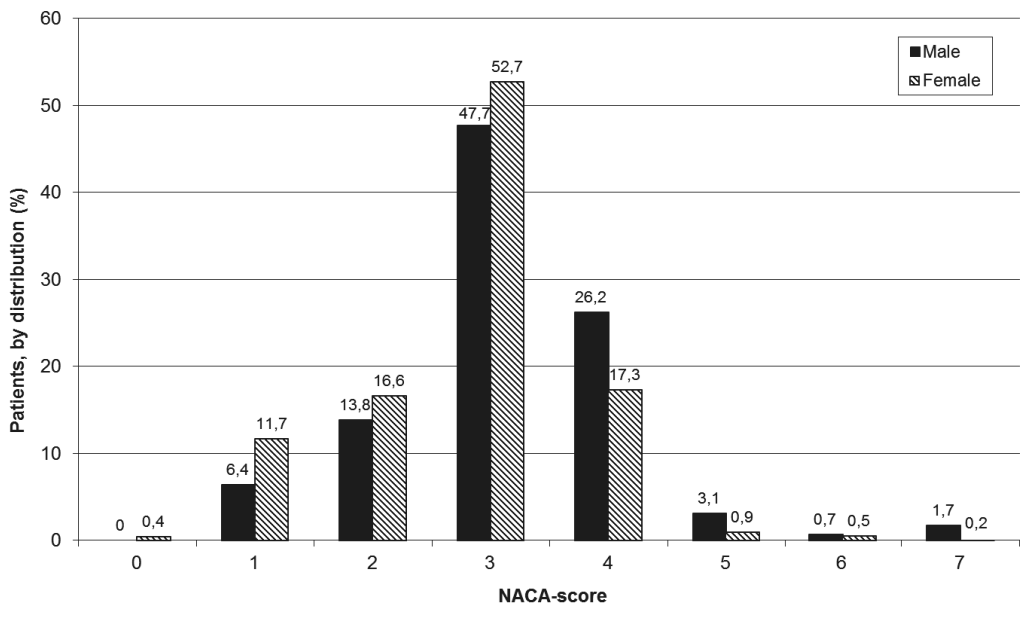

Figure 4 Severity of illness (NACA-scores) in study patients (distribution) with acute chest pain, by gender.

and diagnoses from the investigations for the patients admitted to the hospital. Our results are based solely on patients in an emergency situation defined by the EMCCs using the Index (red response), and thus undertriaged patients would not be included. Patients with chest pain assigned with a yellow response might be at risk of being undertriaged ("false negatives"), supporting the need for further studies on all patients with chest pain outside hospitals. The degree of urgency was set by trained nurses using the Norwegian Medical Index of Emergencies, but little is known about the validity of the Index and how the Index is used in the different EMCCs. A throughout evaluation and validation of the Index is needed.

Previous studies

The rate of acutely ill patients with chest pain in our study is similar to the findings in two other studies from Norway, reporting rates of 4.8 [7] and 5.4 [8]. The difference in median age between the genders, with the males being significantly younger, is in accordance with previous studies [14]. Recent studies from the UK [2,3] and the US [15] have shown that around 10% of calls to emergency medical dispatch systems involve acute chest pain. A Norwegian publication from 2009 [16] showed that 22% of all the calls to the emergency number 113 ended in a red response, and it is intended that most of the chest pain incidents will be classified as a red response. In our study this would indicate that approximately 5% of all calls to the EMCCs involved chest pain as the main complaint, given that all incidents with chest pain were classified as a red response.

Meaning of study

A substantial number of the patients were not in a life threatening medical situation. This sheds light on the challenges for the EMCCs in deciding the appropriate level of response in patients with acute chest pain. Overtriage is to some extent both expected and desirable to intercept all patients in need of immediate help, but it is also well known that overtriage is resource demanding. Almost 10% of the patients were not brought to a doctor for further investigation or treatment. This indicates that the patient's medical condition was not as severe as initially assessed, supported by our results showing that all of these patients were given a NACA-score of ≤ 3. Norwegian health authorities and cardiologists have called attention to the importance of patients calling the three digits emergency number "113" directly when experiencing acute chest pain. Our study shows that in almost half of the calls to EMCC the call was made from health personnel, representing a possible system delay for patients with chest pain of cardiac origin in need of immediate diagnosis and treatment. Still, as the vast majority of patients with acute chest pain seem not to be in need of immediate hospital care, the primary care doctor on-call at the casualty clinic should still play an important role after the first contact to the EMCC. Primary care doctors are usually experienced in differentiating between severe and non-severe illness. As a group, they also hold a clinical background and competence making them a valuable asset in the initial management of patients with acute chest pain outside hospitals.

A white paper concerning the organisation of the emergency services in Norway [17] have defined recommended minimum requirements for prehospital response times in red response missions. An ambulance should have reached 90% of the patients within 8 minutes in urban districts, and 25 minutes in rural districts. Our results show that 87% of all patients with acute chest pain are reached within 25 minutes, but only 23% within 8 minutes. This might partly be explained by the fact that a considerable number of patients from the study population live in rural districts. But it also sheds light on the reality in Norwegian prehospital emergency medicine, which shows that we are still quite far from meeting the political aims concerning minimum requirements for prehospital response time [18].

Conclusions

The majority of patients with acute chest pain were admitted to a hospital for further investigation, but only a quarter of the patients were assessed prehospitally to have a severe illness. Little is still known about the extent of patients with chest pain as their main symptom outside hospitals in Norway, including diagnostic measures, how they are treated and rates of admission to the hospital.

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Authors' contributions
EZ and SH planned and established the project, including the procedures for data collection. RAB designed the paper, performed the analyses and drafted the first manuscript. All authors took part in rewriting and approved the final manuscript.

Competing interests
The authors declare that they have no competing interests.

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III

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RESEARCH ARTICLE Open Access

Management of chest pain: a prospective study from Norwegian out-of-hours primary care

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Abstract

Background: Chest pain is a common diagnostic challenge in primary care and diagnostic measures are often aimed at confirming or ruling out acute ischaemic heart disease. The aim of this study was to investigate management of patients with chest pain out-of-hours, including the use of ECG and laboratory tests, assessment of severity of illness, and the physicians' decisions on treatment and admittance to hospital.

Methods: Data were registered prospectively from four Norwegian casualty clinics. Data from structured telephone interviews with 100 physicians shortly after a consultation with a patient presenting at the casualty clinic with "chest pain" were analysed.

Results: A total of 832 patients with chest pain were registered. The first 100 patients (corresponding doctor-patient pairs) were included in the study according to the predefined inclusion criteria. Median age of included patients was 46 years, men constituted 58%. An ECG was taken in 92 of the patients. Of the 24 patients categorised to acute level of response, 15 had a NACA-score indicating a potentially or definitely life-threatening medical situation. 50 of the patients were admitted to a hospital for further management, of which 43 were thought to have ischaemic heart disease. Musculoskeletal pain was the second most common cause of pain (n = 22). Otherwise the patients were thought to have a variety of conditions, most of them managed at a primary care level.

Conclusions: Patients with chest pain presenting at out-of-hours services in Norway are investigated for acute heart disease, but less than half are admitted to hospital for probable acute coronary syndrome, and only a minority is given emergency treatment for acute coronary syndrome. A wide variety of other diagnoses are suggested by the doctors for patients presenting with chest pain. Deciding the appropriate level of response for such patients is a difficult task, and both *over-* and *under*-triage probably occur in out-of-hours primary care.

Keywords: Chest pain, Primary care, Out-of-hours, ECG, Severity of illness

Background

Chest pain is a common diagnostic challenge in primary care for both general practitioners (GPs) during day time surgery hours and in casualty clinics out-of-hours [1-4]. Diagnostic measures are often aimed at confirming or ruling out acute ischaemic heart disease (IHD). However, in primary care less serious conditions frequently occur in patients with chest pain, such as musculoskeletal pain, dyspepsia and psychogenic disorders [5-8]. Previous research has shown that approximately only 5% of all patients with chest pain presenting in general practice have acute IHD; while as many as 50% may have myalgia and chest wall syndromes [7,9]. In emergency consultations out-of-hours, either at a casualty clinic or an urgent house call by a GP, the prevalence of acute IHD may still be as low as 15% [9].

In Norway, patients with chest pain in need of acute medical assistance are encouraged to call the national three digits emergency telephone number "113". Still, many patients with chest pain choose to contact their GP directly, or the local casualty clinic out-of-hours. A recent study from Norway showed that patients with chest pain constituted 21% of all medical emergencies outside hospitals. The study also revealed that most of the patients were not as ill as initially assessed at the

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emergency medical communication centres, pointing to the challenges in deciding the appropriate level of response in patients with chest pain outside hospitals [3].

Diagnosing chest pain in primary care is a complex task. Previous studies have confirmed the importance of a thorough patient history on sensation of pain (type, duration, localisation etc.) and concomitant symptoms when diagnosing acute IHD [8,9]. Still, without cardiac markers (i.e. troponin) and more advanced diagnostic tools, many patients will be admitted to a hospital for further testing and treatment. Electrocardiogram (ECG) is a crucial diagnostic tool for patients with chest pain, but although ECG is a diagnostic test with high specificity, the sensitivity of the test in clinical practice is low, making it difficult to rule out IHD based on ECG alone [10,11].

In a hospital setting, patients with chest pain of suspected cardiac origin are often diagnosed and treated according to specific guidelines and to some extent clinical decision rules. The pre-test probability of IHD is greater ("high prevalence setting") than in primary care ("low prevalence setting") and diagnostic tools are readily available to make more definitive diagnoses. Previous studies have shown that Norwegian out-of-hours services generally are well-equipped with laboratory and diagnostic tools, but the selection of tests are mainly adapted to a primary care setting [12,13]. One study reported that ECGs were taken in 4% of all consultations [12]. Another study showed that 99% of all Norwegian casualty clinics had an ECG-device, while only 6% of the casualty clinics could measure d-dimer and/or troponin locally [13].

Little is still known about the management of chest pain in Norwegian out-of-hours primary care. No research exists on the use of diagnostic tools; how patients with chest pain are treated; or how many patients that end up being admitted to a hospital.

The aim of this study was to investigate the use of diagnostic tools and treatment of choice in patients with acute chest pain out-of-hours in Norwegian primary care. We registered the use of ECG and other laboratory tests, assessed the severity of illness, and also the physicians' decisions on treatment and admittance strategies.

Methods

Four Norwegian casualty clinics, located at Sotra, Haugesund, Drammen and Kristiansand, were involved in the study. The casualty clinics were chosen according to strategic sampling to cover both rural, suburban and urban districts, and to include both larger and smaller casualty clinics. Data were collected prospectively from February to July 2012.

Data in the analyses come from structured telephone interviews with 100 physicians shortly after a consultation with a patient presenting at the casualty clinic with "chest pain" as his or her main symptom. Each physician could only be interviewed once, and the casualty clinics continued registration of patients until the predefined number of 100 unique physicians with 100 corresponding patients had been included. The number of included physicians and patients were chosen to ensure the possibility of interviewing all physicians shortly after the consultation, and to ensure a large enough sample to perform sub group analyses. The patients were registered prospectively by the nurses at the cooperating casualty clinics. All patients with "chest pain" or equivalent symptoms, independent of the probable cause of complaint, were registered with a unique identification number in a patient log. The variables recorded were consultation date and time, name, birth date, sex, age of the patient, response level and name and telephone number of the physician who treated the patient. Equivalent symptoms to chest pain included "tightness in chest", "retrosternal pain" and "chest discomfort". Patients with symptoms suggestive of mastitis were excluded. One of the authors (RAB) had daily contact with the four casualty clinics, gathering all registered patients and variables, excluding patient name and date of birth to achieve anonymous data collection. Before patient inclusion started, all nurses and physicians at the cooperating casualty clinics were informed of the study through information meetings and distribution of the inclusion criteria and the study protocol. Oral consent was obtained from the physicians at the beginning of the interview. To ensure anonymous data collection, the physicians were explicitly asked to not disclose the patient's name and/or date of birth. If a physician could not be reached by telephone, and interviewed, within 2 days after the consultation, he or she was excluded from participation, to reduce recall bias. The variable "level of response" was set by the nurses at the casualty clinic using the Norwegian Index of Medical Emergencies [14]. The Index categorises clinical symptoms, findings and incidents into a red, yellow and green criteria based section, correlating to the appropriate level of response. Red colour is defined as an "acute" response, with the highest priority. Yellow colour is defined as an "urgent" response, with a high, but lower priority, where the patient should be examined as soon as the doctor-on call is available. Green colour is defined as a "non-urgent" response, with the lowest priority.

The questionnaire used in the telephone interview had two parts, where the first part consisted of questions related to the patient they just had treated, including diagnostic measures (use of ECG and laboratory analyses) and choice of treatment. Severity of illness was set by the physicians using The National Committee on Aeronautics (NACA) Score System [15]. In the NACA system, the patient's status is classified from 0 to 7, zero indicating no disease or injury, while seven indicates the patient being dead (Table 1). NACA score was categorised in the analyses as NACA 0–1 (patient with either no symptoms/

Table 1 National committee on Aeronautics (NACA) score, used to decide severity of illness

Score level	Patient status
NACA 0	No injury or illness
NACA 1	Not acute life-threatening disease or injury
NACA 2	Acute intervention not necessary, further diagnostic studies needed
NACA 3	Severe, but not life threatening disease or injury; acute intervention necessary
NACA 4	Development of vital (life threatening) danger possible
NACA 5	Acute vital (life threatening) danger
NACA 6	Acute cardiac or respiratory arrest
NACA 7	Death

injuries or not in need of medical treatment), NACA 2–3 (patient in need of medical help, where value 3 indicates need of hospitalisation, but still not a life-threatening situation), NACA 4–6 (4 is a potentially, and 5 and 6 are definitely, life-threatening medical situations) and NACA 7 (dead person). The physicians were also asked to state what he or she judged to be the most probable cause of the symptoms. Finally, if the patient was admitted to a hospital, referred to a GP or a specialist, or got final treatment at the casualty clinic. The remainder of the questions focused on the individual physician's approach to diagnosing patients with chest pain and reasons for hospital admission in general. These data will be described elsewhere.

Statistics

IBM Statistical Package for the Social Sciences (IBM SPSS version 20) was used for statistical analyses. Standard univariate statistics were used to describe the material, including mean and median. Student's t-test was used to compare mean age between all registered patients and the included study patients. For other comparisons the Pearson Chi-Square test was used. A p-value of < 0.05 was considered statistically significant.

Ethics

The study was given approval by the Regional Committee for Medical and Health Research Ethics (REC West) before inclusion started (Reference number 2010/1499-10).

Results

A total of 832 patients with chest pain were registered at the four participating casualty clinics, of which 100 patients with corresponding structured telephone interviews with the physician on-call, were included in the study (Figure 1). All but one of the contacted physicians gave consent and wanted to participate in the study. The physicians included in the study were made up by 67 GPs and 33 other (11 interns in GP-practice, the rest hospital-based residents).

Table 2 shows a comparison between the registered patients not included (n = 732) and the included study patients (n = 100) with regard to mean age, age groups, sex and level of emergency response. In the study population (n = 100) the patient's age ranged from 18 to 92 years (median age 46 years), 58% males with a median age of 45 years, and 42% females with median age 51 years. The two groups did not differ in any of the variables stated, except mean age, the study patients were about 5 years younger ($p < 0.05$).

Table 3 describes the level of response set by the nurse using the Index compared to severity of illness (NACA score) judged by the physicians, and the use of supplemental diagnostic tools such as ECG and other laboratory tests. Red response was set in 24 patients, 66 were given yellow response, the remainder 10 green response. An ECG was taken in 92 of the patients. Of the eight patients where an ECG was not taken, four were given response level "yellow", and the last four "green response".

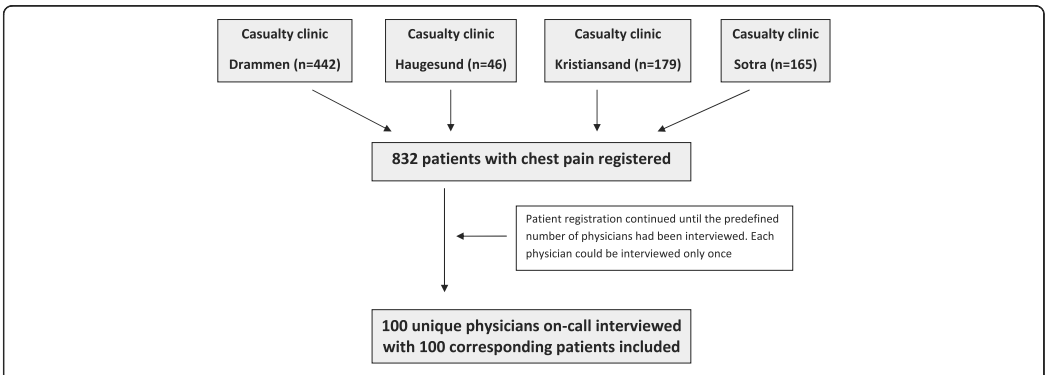

Figure 1 Flow chart of registration of patients and the inclusion process.

Table 2 Comparison between all registered patients and the included study patients

	Registered patients, not included (N = 732)	Included study patients (n = 100)	P-value
Age, years (mean)	55	50	*0.016*
Age categories, distribution			*0.086*
18-35 years	17%	23%	
36-50 years	26%	33%	
51-65 years	24%	23%	
66-80 years	21%	15%	
>80 years	12%	6%	
Sex (female)	46%	42%	*0.494*
Level of response, distribution			*0.451*
Red	19%	24%	
Yellow	68%	66%	
Green	13%	10%	

Level of response was set using the Norwegian Index of Medical Emergencies.

52% (n = 48) of the ECGs were ordered by the nurse at the casualty clinic, in 24% (n = 22) the physician ordered the test, and in 15% (n = 14) the ECG was taken in the ambulance. In 8% (n = 7) an ECG was taken both in the ambulance and at the casualty clinic. Other laboratory tests were taken in 57% of the patients. Oxygen-saturation (n = 44) and C-reactive protein (n = 29) were the tests most often used, while d-dimer (n = 3) and other blood tests (glucose and haematology) were rarely done. 63% (n = 15) of the patients with a NACA-score indicating a potentially or definitely life-threatening medical situation (NACA 4–6) were categorised to "red response", leaving 11 patients (37%) with a lower response level (yellow or green). Nine of the ten patients with "green response" were not in a life-threatening situation, leaving one patient with a NACA-score indicating immediate need of help.

Medication was prescribed or given at the casualty clinic in 43% of the patients. Of the 43 patients, sublingual nitro-glycerine (67%, n = 29) and acetylsalicylic acid (ASA) (63%, n = 27), were most often the treatments of choice. Nine patients were given morphine, two patients received antacida and one patient was given a benzodiazepine.

Table 4 shows the physicians' appraisal of the most probable cause of symptoms ("initial diagnosis"), and how they ended up treating the patient, including level of care. Half of the patients were admitted to hospital for further care, 86% (n = 43) because of suspected ischaemic heart disease. Musculoskeletal pain was the second most common cause of pain, managed in primary care (physician on-call or referred to GP) in 21 of the 22 patients (95%). Otherwise the patients were thought to have a variety of conditions, most of them managed at a primary care level. Of the 43 patients admitted to hospital with suspected ischaemic heart disease, 24 patients had NACA-scores between 4 and 6, indicating a severe illness.

Table 3 The use of diagnostic tools and severity of illness (NACA-score) by level of response (Norwegian Medical Index) for the included 100 patients

	Level of response			
	Red	Yellow	Green	Total
ECG taken?				
Yes	24	62	6	**92**
No	0	4	4	**8**
Total	24	66	10	**100**
Who ordered the ECG?				
Ambulance	9	5	0	**14**
Nurse at the casualty clinic	10	35	3	**48**
Physician at the casualty clinic	3	16	3	**22**
Both ambulance and casualty clinic	2	5	0	**7**
Unknown	0	1	0	**1**
Total	24	62	6	**92**
Any laboratory test taken?				
Yes	15	37	5	**57**
No	9	29	5	**43**
Total	24	66	10	**100**
Laboratory test (more than one possible)				
Oxygen-saturation	13	29	2	**44**
C-reactive protein	2	23	4	**29**
D-dimer	0	3	0	**3**
Other blood tests (glucose, haematology)	1	5	0	**6**
Severity of illness; 0 = no disease, 7 = dead				
NACA 0	1	0	0	**1**
NACA 1	1	18	5	**24**
NACA 2	4	18	3	**25**
NACA 3	3	20	1	**24**
NACA 4	10	9	1	**20**
NACA 5	4	1	0	**5**
NACA 6	1	0	0	**1**
NACA 7	0	0	0	**0**
Total	24	66	10	**100**

Discussion

We included 100 individual patients after interviews with 100 unique physicians, from a sample of 832 patients with chest pain. Median age of the included patients was 46 years, men constituted 58%. An ECG was taken in 92 of the patients, other laboratory tests in a

Table 4 Initial diagnosis and level of care for treatment or follow-up with GP or specialist

		Level of care for treatment or follow-up			
	Total	**Managed at casualty clinic**	**Referred to GP**	**Referred to specialist non-urgently**	**Admitted to hospital**
Appraisal of the most probable cause ("initial diagnosis")					
Ischaemic heart disease	**50**	2	3	2	43
Musculoskeletal pain	**22**	16	5	0	1
Psychiatric disease/anxiety	**12**	1	9	0	2
Pulmonary disease	**5**	3	1	0	1
Dyspepsia	**5**	1	4	0	0
Gastrointestinal disease, other than dyspepsia	**3**	1	0	0	2
Other diagnoses (arrhythmia, hypertensive crisis)	**3**	0	2	0	1
Total	**100**	**24**	**24**	**2**	**50**

majority. Of the 24 patients categorised to an acute level of response, two thirds had a NACA-score indicating a potentially or definitely life-threatening medical situation. Half of the patients had suspected ischaemic heart disease; the rest had a variety of conditions. Half of the patients were admitted to a hospital for further care, of which a large majority were thought to have heart disease.

A main strength of the study is the prospective registration of all patients with chest pain at the collaborating casualty clinics. To avoid dependency and an unbalanced weighting of the data; each patient and physician could only be included once. Answering of the questionnaire through telephone interviews enabled the interviewer to give precise instructions. We aimed to reduce recall bias by reaching the physicians shortly after the consultation, but some recall bias will be expected when interviewing a physician about a specific patient one or two days after an out-of-hour shift. The NACA-score has been widely used in studies concerning pre-hospital emergency medicine, and all included physicians were thoroughly explained how to use the scoring system. However, most of the interviewed physicians did not know the scoring system before the interview, and this might limit the reliability of its use. The data does not include the place of consultation (casualty clinic vs. ambulance), and the study design did not allow physician appraisal on how they decided the level of care for treatment. Due to resources available for interviews, the study was limited to 100 patients and doctors, a number that may limit the inclusion of more seldom diagnoses.

A recent study from Belgium [5] examined the initial diagnosis and referral rates in patients with chest pain in primary care. 37% of the patients received "heart disease" (26% "serious" and 11% "other") as the initial diagnosis, while muscular disease accounted for 30% and somatoform disease 10%. Our results are comparable to these numbers, and also to other studies of chest pain in primary care [1,2,6], except our higher rate of suspected heart disease. In the 26% with "serious heart disease" [5], nearly half was admitted urgently to the emergency department, while a third was referred non-urgently to a specialist or the hospital. Our study showed that 43 of the 50 patients with suspected heart disease were admitted to hospital. An ECG was recorded in only 29% of the patients in the study from Belgium, which is considerably lower than in our study (92%). A prospective study from Norway investigating 1100 patients with acute chest pain assigned an acute response level ("red"), showed that 26% of the patients were in a life-threatening medical situation [3]. This number is equal to our study (26% with NACA-score 4–7), but our study includes patients with all three levels of response.

Patients with chest pain account for approximately 1-2% [1-4] of all consultations in primary care. Our study confirmed that ECG is the most important diagnostic tool in primary care. The high rate of ECG-testing might be explained by the fact that an ECG often is taken as a routine in patients with chest pain before they are examined by the treating physician. ECG is also readily available in all Norwegian casualty clinics, and most GP surgeries. Early ECG-testing is important in patients with severe illness suspicious of ischaemic heart disease, but it is also well known that over-testing, including use of ECG, and hospital admissions for chest pain can be unfortunate for patients suffering from anxiety or panic attacks. ECG is also still a diagnostic tool with limited sensitivity [10], and the test demands comprehensive knowledge in order to interpret the results in a reliable way.

Our study confirms that acute chest pain is a common diagnostic challenge in a primary care setting [1,2,5,6], and reflects much more than acute cardiac disease. However, the incidence of "heart disease" as the initial diagnosis in our study (50%) is higher than comparable studies. This may partly be explained by the study setting; patients at the casualty clinic are expected to have more acute and severe disease and higher prevalence of IHD than patients

during daytime GP surgery hours [9]. On the other side, only 27 patients were given ASA, even though as many as 43 of the 50 patients with suspected heart disease, were admitted to a hospital. This suggests a lower probability of IHD in many of the patients, and few were given full "MONA"-treatment (morphine, oxygen, nitro-glycerine and ASA). The 50 patients with suspected IHD constituted most of the patients with a NACA-score ≥ 4. Still, even among the 43 patients with suspected IHD admitted to the hospital, almost half (19 of 43) had a NACA-score not indicative of a serious illness. In Norway, patients with chest pain in need of acute medical assistance are encouraged to call the national three digits emergency telephone number ″113″. A recent study from Norway [3], showed that in patients with chest pain handled by the emergency medical communication centres (EMCCs, responding to the ″113″ calls), 24% were brought directly to the hospital and managed by the ambulance staff alone, without involving the primary care physician on-call. Most ambulances in Norway can transmit an ECG to the hospital through telemedicine, and in many patients with acute chest pain the EMCC will "bypass" the casualty clinics. This might explain the low prevalence of patients given "MONA"-treatment at the casualty clinics in our study, but the 24% patients brought directly did nevertheless not have a NACA-score indicating a more severe illness [3].

The introduction of high-sensitivity (hs) troponin-tests, also in primary care, might change how GPs diagnose patients with acute chest pain in the near future. But it is important to bear in mind that an increased level of hs-troponin concentration alone does not give the diagnosis of acute myocardial infarction, according to recent guidelines [16]. Diagnosing chest pain in primary care is still a complex task because of the broad spectrum of causes, and it is important that a possible introduction of hs-troponin in primary care does not replace a comprehensive diagnostic approach.

Deciding the appropriate level of response can also be a difficult task, especially in patients with chest pain [3]. Our study showed that 63% of the patients with red response had a NACA-score indicating a potentially or definitely life-threatening medical situation, pointing to a certain degree of "*over*-triage", well known to be resource demanding. On the other hand, 11 of the 76 patients (14%) given a yellow or green response level were also in need of rapid diagnostics and/or treatment (NACA ≥ 4), indicating possible "*under*-triage" and a potentially harmful underestimation of the patients' severity of illness.

Half of the 100 patients in the study were admitted to hospital, and as many as 86% of the patients with an initial diagnosis of heart disease were admitted urgently. A recent study from the UK [17] showed that GPs in out-of-hours work with low "tolerance of risk" were more likely to admit patients to the hospital. Little is known about *how* physicians' diagnose patients with chest pain in out-of-hours primary care and their reasons for deciding if the patient should be admitted to the hospital or not. More research is needed to elucidate this important part of GPs out-of-hours work.

Conclusions

Patients with chest pain presenting at out-of-hours services in Norway are investigated for acute heart disease, but less than half are admitted to hospital for probable acute coronary syndrome, and only a minority is given emergency treatment for acute coronary syndrome. A wide variety of other diagnoses are suggested by the doctors for patients presenting with chest pain. Deciding the appropriate level of response for such patients is a difficult task, and both *over*- and *under*-triage probably occur in out-of-hours primary care.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

RAB, EZ and SH planned and established the project, including the procedures for data collection, and designed the paper. RAB performed the analyses and drafted the first manuscript. All authors took part in rewriting and approved the final manuscript. All authors read and approved the final manuscript.

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IV

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RESEARCH ARTICLE Open Access

Chest pain out-of-hours an interview study of primary care physicians diagnostic approach, tolerance of risk and attitudes to hospital admission

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Abstract

Background: Acute chest pain constitutes a considerable diagnostic challenge outside hospitals. This will often lead to uncertainty in choosing the right management, and the physicians approach may be influenced by their knowledge of diagnostic measures and their tolerance of risk. The aim of this study was to investigate primary care physicians diagnostic approach, tolerance of risk and attitudes to hospital admission in patients with acute chest pain out-of-hours in Norwegian primary care.

Methods: Data were registered prospectively from four Norwegian casualty clinics. Data from structured telephone interviews with 100 physicians shortly after a consultation with a patient presenting at the casualty clinic with chest pain were analysed. Tolerance of risk was measured by the Pearson Risk Scale and the Tolerance of Risk Scale, the latter developed for this study.

Results: Patient history and symptoms was considered the most important, and negative ECG and effect of sublingual nitroglycerine the least important aspects in the diagnostic approach. There were no significant differences in length of experience or gender when testing risk avoiders against the rest. Almost all physicians felt that their risk assessment out-of-hours was reasonably good, and felt reasonably safe, but only 50% agreed with the statement I don t worry about my decisions after I ve made them . Concerning chest pain patients only, 51% of the physicians were worried about complaints being made about them, 75% agreed that admitting someone to hospital put patients in danger of being over-tested , and 51% were more likely to admit the patient if the patient herself wanted to be admitted.

Conclusions: Physicians working out-of-hours showed considerable differences in their diagnostic approach, and not all physicians diagnose patients with chest pain according to current guidelines and evidence. Continuous medical education must focus on the diagnostic approach in patients with chest pain in primary care and empowerment of physicians through training and emphasis on risk assessment and tolerance of risk .

Keywords: Chest pain, Primary care, Out-of-hours, Diagnostic approach, Clinical decision rules, Tolerance of risk

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Background

Acute chest pain still constitutes a considerable diagnostic challenge outside hospitals, especially when it comes to separating potential life-threatening illnesses (e.g. acute coronary syndrome) from less serious conditions (e.g. thoracic myalgia or dyspepsia) [1-4]. Attempts have been made to develop valid clinical decision rules for patients with acute chest pain in primary care, but extensive research have shown that determining the cause of chest pain, without cardiac markers (ie. troponin) and more advanced diagnostic tools, is a difficult task [5-9]. It is still unclear if clinical decision rules are suitable for such a complex diagnostic situation.

In Norway, many patients with acute chest pain choose to contact their general practitioner directly, or the local casualty clinic out-of-hours, instead of calling the national emergency three digits number 113 . Previous research has shown that chest pain is one of the most common complaints in out-of-hours primary care [10], and we have recently published a paper describing the challenges in managing chest pain outside hospitals [11].

Challenging diagnostics will often lead to uncertainty in choosing the right treatment and level of care for the patient. In primary care, especially the decision to admit a patient with chest pain to a hospital or not can be demanding. Deciding the appropriate management of patients with chest pain, including the decision to admit urgently to a hospital or not, may also be influenced by the physician s tolerance of risk, and the preferences of both the patient himself and his family. Previous studies have indicated a correlation between physicians tolerance of risk and admission rates, both for patients in general and patients with chest pain specifically [12-15].

There exists only scarce literature about primary care physicians attitudes to admitting patients with chest pain to a hospital. The aim of this study was to investigate primary care physicians diagnostic approach, tolerance of risk and attitudes to hospital admission in patients with acute chest pain out-of-hours in Norwegian primary care.

Methods

Four Norwegian casualty clinics were chosen for cooperation and collection of data, according to strategic sampling. The casualty clinics cover both rural, suburban and urban districts, and include both larger and smaller clinics. Data were collected prospectively from February to July 2012.

The analysed data consist of structured telephone interviews with 100 physicians (each physician interviewed only once) shortly after a consultation with a patient meeting the inclusion criteria. Registration of patients continued until 100 unique physicians with 100 corresponding patients had been included. All patients with chest pain or equivalent symptoms as their main symptom, independent of the probable cause of complaint, were registered by nurses at the four casualty clinics. Equivalent symptoms included tightness in chest , retrosternal pain and chest discomfort . Patients with symptoms clearly suggestive of mastitis were excluded. If a physician could not be reached by telephone, and interviewed, within 2 days after the consultation, he or she was excluded from participation, in order to reduce recall bias. The interviewer was a general practitioner with experience in out-of-hours work (author RAB).

The questionnaire used in the telephone interview was divided in to two parts, where the first part consisted of questions related to the patient they just had treated, including level of response , diagnostic measures (use of ECG and laboratory analyses), severity of illness, appraisal of most probable cause of symptoms and choice of treatment and level of care.

The results from the first part of the questionnaire, and a more detailed description of the methods of the study, are described elsewhere in a recently published paper [11]. Analyses showed that the study population (n = 100) did not differ from all registered chest pain patients (n = 832) in any of the variables stated, except mean age, the study patients were about 5 years younger [11].

Analyses from part two of the questionnaire are presented in this article. This part of the questionnaire focused on the individual physician s approach to diagnosing patients with chest pain, the physician s tolerance of risk , and attitudes to hospital admission. Diagnostic approach was measured using a five-point Likert scale where the physicians graded the importance of different aspects of the diagnostic process.

Tolerance of risk was measured using the Pearson Risk Scale, and a new Tolerance of Risk Scale, developed for this study.

Pearson risk scale

The Pearson Risk Scale was developed for triage decisions in patients with chest pain [15]. This scale consists of six items with questions answered along a six-point Likert scale from strongly agree to strongly disagree (Table 1). The scale divides physicians into one of three categories based on summation of the scores; high scorers (risk-seeking) scored one standard deviation or more above the mean, middle-scorers scored midrange, and low scorers scored more than one standard deviation below the mean (risk-avoiders).

Tolerance of risk scale

To develop the Tolerance of Risk Scale, we used the seven first items of a questionnaire from a previously

Table 1 Pearson risk scale*- Physician risk attitudes

1.	I enjoy taking risks
2.	I try to avoid situations that have uncertain outcomes
3.	Taking risks does not bother me if the gains involved are high
4.	I consider security an important element in every aspect of my life
5.	People have told me that I seem to enjoy taking chances
6.	I rarely, if ever, take risks when there is another alternative

*All questions were asked on a six-point Likert scale from "strongly agree to strongly disagree".

published article (Ingram-questionnaire) [12], slightly adapted to a Norwegian out-of-hours-setting. This questionnaire consists of statements where the physicians should select the appropriate level of agreement according to a five-point Likert scale from agree strongly to disagree strongly . Furthermore, we used a similar approach to how the Pearson Risk Scale was constructed, dividing the physicians into one of three risk groups , naming it the Tolerance of Risk Scale .

The Pearson Risk Scale measures physician risk attitudes in general, while the newly developed Tolerance of Risk Scale specifically measures risk attitudes working in an out-of-hours-setting.

Attitudes to hospital admission

Attitudes to hospital admission were measured using 15 items from three dimensions (B - D) of the Ingram-questionnaire [12].

Statistics

IBM Statistical Package for the Social Sciences (IBM SPSS version 20) was used for statistical analyses. Standard univariate statistics were used to describe the material, including mean and median. Mann Whitney U test was used for comparison between the items from the Ingram-questionnaire and the Pearson Risk Scale. For other comparisons Chi-Square tests were used. A P-value of < 0.05 was considered statistically significant.

Ethics

The study was given approval by the Regional Committee for Medical and Health Research Ethics (REC West) before inclusion started (Reference number 2010/1499-10).

Results

The four participating casualty clinics registered a total of 832 patients with chest pain as their main symptom, of which the first 100 unique patient and physician pairs, with completed structured telephone interviews, were included in the study.

The included patients (n = 100) age ranged from 18 to 92 years (median age 46 years), 58% males with a median age of 45 years, and 42% females with median age 51 years. The study included 60 male physicians and 40 female physicians. GPs constituted 67%, the rest were interns in general practice (11%) or hospital-based physicians (22%).

Table 2 describes the physicians approach to diagnosing patients with chest pain by registering the selected importance of different aspects of the diagnostic process. 99% believed that the patient s symptoms and history was fairly (19%) or very important (80%) (mean 4.8/5 on Likert scale), while all of the physicians stated that a positive ECG-finding was fairly (10%) or very important (90%) (mean 4.9). Negative ECG-findings (mean 2.8) and effect of sublingual nitro-glycerine (mean 3.0) were considered to be the least important aspects.

Figure 1a and b show the risk score sums from the Pearson Risk Scale (Figure 1a) and Tolerance of Risk Scale (Figure 1b). Both scales divide the physicians into three groups; risk-avoiding , middle-scorers and risk-seeking .

Table 2 Physicians appraisal of the importance of different aspects of the diagnostic process along a five-point Likert scale (n = 100)

Aspects of the diagnostic process	Degree of importance					Mean value
	Very important (5)	Fairly important (4)	Neither important nor unimportant (3)	A little important (2)	Very little important (1)	
Patient's symptoms/history	80	19	1	0	0	4.8
"Negative" ECG findings	3	25	23	46	3	2.8
Effect of sublingual nitroglycerine	5	36	22	29	8	3.0
Chest wall tenderness	3	44	26	25	2	3.2
"Positive" ECG findings	90	10	0	0	0	4.9
Clinical examination	22	50	17	11	0	3.8

Analytic value in brackets.

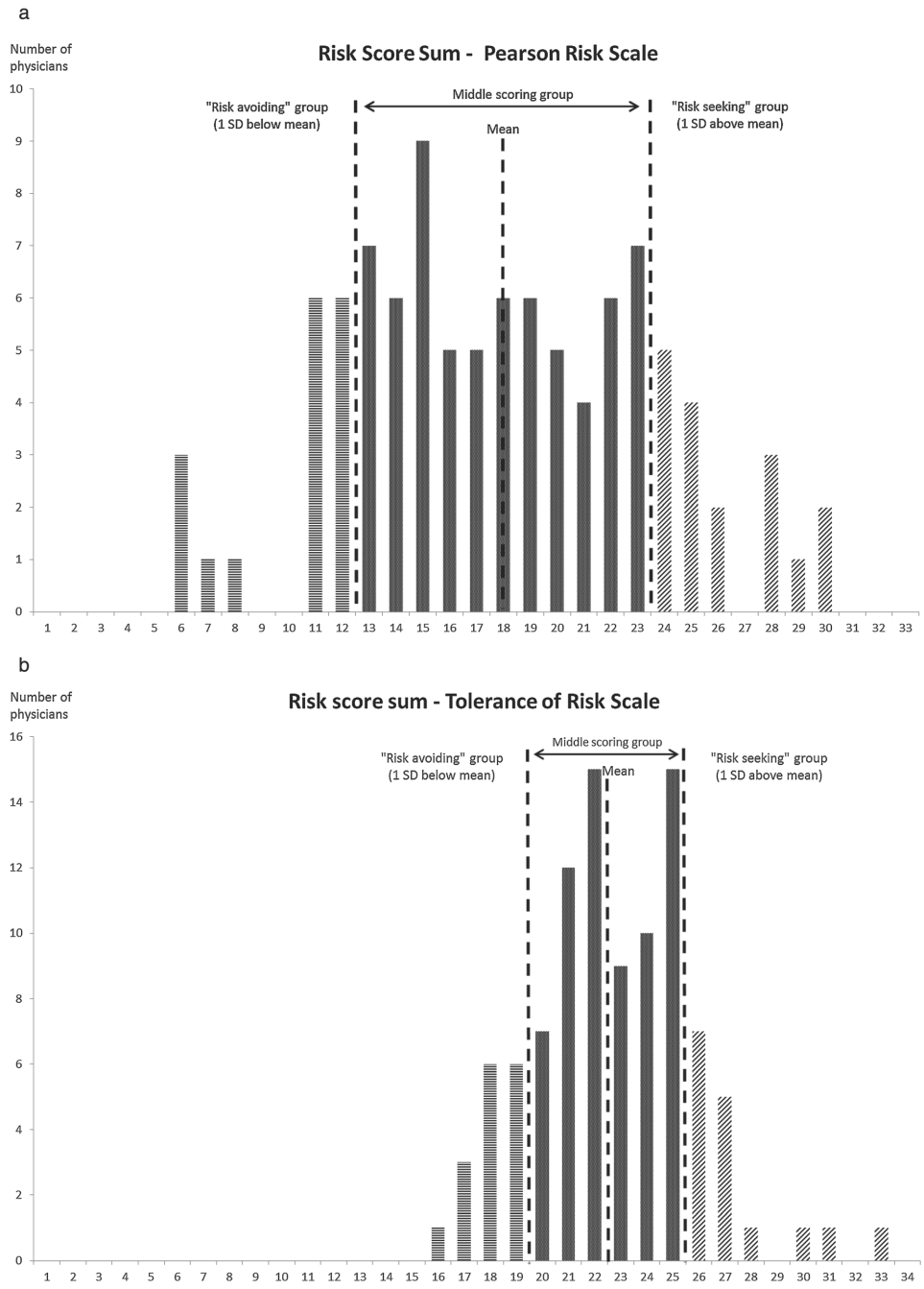

Figure 1 Risk score sums, dividing the physicians into one of the three groups. a. Pearson risk scale **b**. tolerance of risk scale.

Table 3 presents physician risk attitudes derived from the Pearson Risk Scale. There was no significant difference in the length of work experience between male and female physicians (p = 0.072). The middle-scoring group constituted two thirds (66 of 100), while the groups risk-avoiders and risk-seekers were equally divided with 17 physicians each. When analysing risk-avoiders against the rest, we found no significant differences in length of experience (p = 0.155) or gender (p = 0.913). Analysing risk-avoiders against the rest using the Tolerance of Risk scale also showed no significant differences (length of experience p = 0.085; gender p = 0.148).

Table 4 describes the physicians tolerance of risk and uncertainty (dimension A) and concerned all patients out-of-hours. The strongest agreement in dimension A was found in the statement I think my risk assessment is reasonably good, and I m reasonably safe , in which 94% agreed to the statement (67% a little; 27% strongly; mean 4.2). We found the weakest agreement in the statement I don t worry about my decisions after I ve made them , 46% disagreed (5% strongly; 41% a little), while 50 % agreed (42% a little; 8% strongly).

The other three dimensions (B-D) concerned chest pain patients only. Dimensions B D measured attitudes to hospital admission, including patient related and relative related influence on decision making.

In dimension B, we found that half of the physicians (51%, mean 3.0) worry about complaints being made about them, but few let fear of complaints from the Board of Health Supervision influence their practice (16%, mean 2.1).

Dimension C examined attitudes to hospital admission. 69% (mean 3.6) agreed that admitting someone to hospital enables them to get a second opinion, but 75% (mean 3.7) also agreed that admitting someone to hospital put patients in danger of being over-tested .

The last dimension (D) concerned patient-related factors. There was a strong agreement that the patient s clinical status was the most important factor (96% agreed, mean 4.6) in deciding to admit a patient or not. Half of the physicians were more likely to admit the patient if the patient himself wanted to be admitted (51% agreed, mean 3.2), or if a family member wanted the patient to be admitted (46% agreed, mean 3.1).

Overall mean scores from all items in the four dimensions were also compared with mean scores within the three risk groups derived from the Pearson Risk Scale. In dimension A, concerning all patients out-of-hours, there is a clear trend in most items that the risk avoiders differ from the rest, and there is a significant difference in the statement When it comes to OOH-medicine I m quite cautious (p = 0.024). In dimension B, we found a significant difference in the statement I don t worry about a complaint being made about me (p = 0.006), where the group risk avoiders had a mean score of 2.2 versus the mean score of 3.2 for the rest of the physicians. There were no significant differences when testing the risk avoiders against the rest in each of the five items in dimension C. In the last dimension (D), we found significant differences in the statements I am more likely to admit a person if they want to be admitted (p = 0.039), If members of the family say there s nobody to look after someone, I see that as a problem for the family rather than the doctor (p = 0.034) and I am more likely to admit someone if they live alone (p = 0.008).

Table 3 Physicians risk attitudes divided in to three groups, by gender and length of work experience

	Physicians risk attitudes Pearson risk scale			Total
	Risk-avoiding	Middle-scoring	Risk-seekers	
Male physicians				
Experience 0 5 years	5	17	3	25
Experience more than 5 years	5	25	5	35
Total	10	42	8	60
Female physicians				
Experience 0 5 years	6	11	7	24
Experience more than 5 years	1	13	2	16
Total	7	24	9	40
Total, all physicians	17	66	17	100

Discussion

Patient history and symptoms was by far the most important aspect in the diagnostic process, while negative ECG and effect of sublingual nitroglycerine was considered least important. We found no significant differences in length of experience or gender when testing risk avoiders (neither Pearson Risk Scale nor Tolerance of Risk Scale) against the rest. Almost all physicians felt that their risk assessment out-of-hours was reasonably good, and felt reasonably safe, but only half of them agreed with the statement I don t worry about my decisions after I ve made them . Concerning chest pain patients only (dimension B-D), about half of the physicians worried about complaints being made about them, the vast majority agreed that admitting someone to hospital put patients in danger of being over-tested , and about half of the physicians were more likely to admit the patient if they wanted to be admitted.

Main strengths of the study include the prospective study design with the use of telephone interviews shortly after a consultation, to gather data. This allowed the

Table 4 Tolerance of risk and uncertainty, dimension A

	Level of agreement					
	Agree strongly	Agree a little	Neither agree nor disagree	Disagree a little	Disagree strongly	Mean value
	(5)	(4)	(3)	(2)	(1)	
Tolerance of risk and uncertainty all patients out-of-hours (OOH)*						
1. When it comes to OOH-medicine I m quite cautious	13	51	12	22	2	3.5
2. As an OOH-physician you think that you can deal with most things most of the time	18	63	6	11	2	3.8
3. I think my risk assessment is reasonably good, and I m reasonably safe	27	67	4	2	0	4.2
4. All OOH-physicians take risks; it s risk assessment OOH all the time (n = 99)	17	29	21	31	1	3.3
5. OOH-physicians are good at living with uncertainty and risk	9	48	31	11	1	3.5
6. I don t worry about my decisions after I ve made them	8	42	4	41	5	3.1
7. I sometimes go back and check on the patient s outcome after a shift has finished	10	41	12	26	11	3.1

Five-point Likert scale (n = 100, unless otherwise stated).
(*Dimension A of the questionnaire. The seven items were used to create the Tolerance of Risk scale).

interviewer to give precise instructions and guidance. Some of the questions concerned the patient they recently had treated, and we aimed to reduce recall bias by reaching the physician shortly after the consultation (with a maximum of 2 days). An important limitation of the study is the number of included patients and physicians (n = 100), because of limited resources available for interviews.

Ruling out or confirming acute ischaemic heart disease (IHD) is widely considered the most important aspect when dealing with chest pain outside hospitals. A meta-analysis from 2008 on the accuracy of symptoms and signs in diagnosing coronary heart disease [5] confirmed that patient history with symptoms is clinically important, but no symptom itself had a major impact on the post-test probability of IHD in a low-prevalence setting (i.e. general practice). However, the presence of chest-wall tenderness largely ruled out IHD, with a post-test probability of only 1%. Similar results were found by Bsner et al. in 2010 [6]. Recently published guidelines from the British National Institute for Health and Care Excellence (NICE) concerning chest pain of recent onset recommend that physicians should not use the patient s response to sublingual nitroglycerine when diagnosing patients with chest pain [16]. Extensive research has shown that ECG is a diagnostic tool with relatively high specificity, but with limited sensitivity [17,18] and physicians should be careful ruling out IHD on the basis of a normal resting ECG alone. Our study showed that almost all physicians regarded a patient s symptoms/history and possible positive ECG -findings as fairly or very important in the diagnostic approach. These results concur with current evidence. The vast majority also adjudged negative ECG -findings to be less important, but almost a fourth considered negative findings to be important. As many as 40% believed that the effect of nitroglycerine was important and over half believed that the presence of chest-wall tenderness was of little importance. A research group in Germany has recently developed and externally validated a clinical decision rule for ruling out coronary heart disease in primary care (Marburg Heart Score) [19,20]. The Marburg Heart Score has shown promising results, and might lead to a breakthrough in the use of clinical decision rules in patients with chest pain outside hospitals.

The parts of our questionnaire containing four dimensions on tolerance of risk and attitudes to hospital admission were derived from a questionnaire previously published in an article by Ingram et al. in 2009 [12]. A main finding from that study was that GPs with low tolerance of risk and female GPs were more likely to refer patients to the hospital out-of-hours, but the female GPs referred more because they were more inclined to be risk averse . In 2007, Rossdale et al. also found that female GPs referred more patients out-of-hours than their male counterparts, and that length of work experience as GP did not influence referral rates [13]. Calnan et al. found in a qualitative study that high referring GPs out-of-hours typically are more cautious and would admit more often if in doubt [14].

Pearson et al. developed the Risk-taking Scale in 1995 for use in triage decisions for emergency department patients with chest pain [15]. They found that physician risk attitudes correlated significantly with admission rates for patients with acute chest pain. The risk-seeking physicians admitted only 31% of the patients with chest pain, compared with 53% for the physicians with low risk taking scores (risk-avoiders).

Our study did not have a design that allowed comparison between tolerance of risk and referral/admission

rates. However, we did show that physicians vary in their tolerance of risk in out-of-hours work. This variation was not dependent on gender or length of experience. We also showed that physicians vary considerably in what influences their decision to admit a patient with chest pain to a hospital or not.

The differences in diagnostic approach found in our study highlight the need for continuous education of GPs on diagnosing chest pain in primary care. A recently published article from another part of our study also revealed the challenges in management of chest pain outside hospitals [11]. Most patients were investigated for ischaemic heart disease, but less than half were admitted to hospital for suspected heart disease, and few were actually given emergency treatment for acute coronary syndrome at the casualty clinics [11]. This sheds light on the fact that patients with chest pain in primary care most often do not suffer from acute ischaemic heart disease. Focus should be more on diagnosing the probable cause, with appropriate management, and less on ruling out ischaemic heart disease alone.

Our findings on tolerance of risk and reasons for hospital admission also support the need for educational programmes to empower primary care physicians on decision-making and confidence. It is well known that physicians vary considerably in attitude and confidence. However, we believe that specific education on risk-stratification and pre-test probabilities of important medical conditions, in different settings, will contribute to the right decision being made, with less influence from the physicians attitude and tolerance of risk. Continuous medical education should also to a greater extent focus on what influence the physicians risk assessment out-of-hours and decisions on treatment and right level of care. In countries where primary care physicians function as gatekeepers , like Norway, empowerment of the physicians through training and focus on tolerance of risk , will probably lead to more appropriate referrals and better management of patients out-of-hours.

Conclusions

Physicians working out-of-hours showed considerable differences in their diagnostic approach, and not all physicians diagnose patients with chest pain according to current guidelines and evidence. Differences in tolerance of risk have a substantial influence on how physicians decide to manage patients with chest pain out-of-hours, and the physicians vary considerably in what may influence their decision to admit a patient with chest pain to a hospital or not. Continuous medical education must focus on the diagnostic approach in patients with chest pain in primary care and empowerment of physicians through training and emphasis on risk assessment and tolerance of risk .

Consent

Written informed consent was not obtained from the patients for this paper because in all collected data the patients were anonymous. This was approved by the Regional Committee for Medical and Health Research Ethics (REC West) before inclusion started.

Abbreviations

ECG: Electrocardiography; GP: General practitioner; OOH: Out-of-hours; IHD: Ischaemic heart disease.

Competing interests

The authors declare that they have no competing interests.

Authors contributions

RAB, EZ and SH planned and established the project, including the procedures for data collection, and designed the paper. RAB performed the analyses and drafted the first manuscript. All authors took part in rewriting and approved the final manuscript. All authors read and approved the final manuscript.

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