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Title: Norwegian Index for Emergency Medical Assistance
Studies on the Use and Precision of the Emergency Medical Dispatch Guidelines in Norway

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Scientific environment

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Preface

Handling an emergency medical situation by phone, and phone only, requires multiple simultaneous tasks: get a rapid overview of the situation and patient, determine the problem and dispatch an adequate response, alert prehospital doctors on call, casualty clinics or hospital, and instruct the caller on how to perform first aid. All while keeping cool.

The Norwegian Index for Emergency Medical Assistance (Index) provides the guidelines supporting the emergency medical dispatcher during an emergency 113 call handling. The Index was developed in 1994, and is used by all the 19 Emergency medical communication centres in Norway. It has also been translated, adapted and implemented in several European countries.

However, the Index has never been validated, and there has been no knowledge about its ability to identify the true patients and to provide these with the proper resources. It was considered well-functioning, and all complaints made to the authorities regarding dispatch issues were rejected as long as Index had been used during the call. Meanwhile, the actual use of the guidelines was never measured.

Medical triaging by phone is difficult. Nonetheless, it is of utmost importance for both the individual patient and the society as a whole that the triage is as expedient as possible. The acutely ill or severely injured patient needs acute response, highly-skilled resources and transport directly to regionalized hospitals for treatment, while the moderately ill patient may receive good care at the local casualty clinic. The prehospital resources are limited and need to be utilized properly.

This project was initiated to obtain the necessary data to clarify the use of the Index and start a validation process of its ability as dispatch guidelines.

Abbreviations and terminology

113	The medical emergency telephone number. Toll free, and the public's access point to acute medical care. Answered by the EMCCs.
116 117	The medical urgency telephone number. Toll free, and the public's access point to urgent medical care. Answered by the LEMCs.
AMIS	The software program used by the EMCC to register and keep record of all contacts. Contains information on patient/situation, location, caller phone number, Index criteria code, urgency, response, resources utilized and time events.
Ambulance-/GP-alarm	Simultaneous notification of both ambulance and GP on call. Should be released as a rule for all acute responses.
Casualty clinic (Legevaktlokale)	The actual premise of the out-of-hours services.
CBD	Criteria based dispatch. An emergency medical dispatch system using lists of criteria/prompts to determine a response. As a contrast to algorithmic dispatch systems.
Dispatch	1. Term used specifically about sending out an ambulance, or other resources.

	2. Term used in general for the whole process of receiving emergency call, triage, deciding upon a response, and then dispatching adequate resource.
EMCC (AMK-sentral)	Emergency medical communication centre (Akuttmedisinsk kommunikasjonssentral). Receives and handles emergency medical 113 calls from the public, health line calls from prehospital emergency primary health care. Coordinate and dispatch the ambulance fleet. Manned by operators and resource coordinators.
EMD	Emergency medical dispatch. Term used to describe the dispatch process.
EMD response interval (AMK reaksjonstid)	Term used to describe the time interval between answering the call and dispatching the adequate resource.
EMS	Emergency medical services. Term used to describe the system providing rapid and appropriate medical care to victims of sudden illness or injuries. Includes both prehospital and in-hospital resources.
GP (Fastlege)	General practitioner. The term used for physicians working at primary care level. Work on contract with the municipality as regular GPs in office hours, and take shifts on call in the out-of-hours services.
Health trusts	The central government owns the secondary health care services through four regional health trusts; North, Middle, West and South-East.

HEMS	Helicopter emergency medical services. Norway has six rescue helicopters and 13 ambulance helicopters, all staffed by anesthesiologists. Each helicopter base also has an emergency car for missions when use of helicopter is inappropriate: incident in close proximity to the base, poor weather conditions, no flight time left. HEMS is part of the secondary health care system, alongside the ambulance service.
ICD-10	International classification of diseases. A classification of diseases and other health problems, mainly used by the secondary health care system in Norway. Provided by the World Health Organization and last revised 1990.
Index	The Norwegian Index for Emergency Medical Assistance (Norsk indeks for medisinsk nødhjelp). The dispatch guidelines used in Norway since 1994. Revised in 2009, 3rd edition.
LEMC (Legevaktsentral)	Local emergency medical communication centre. Receives and handles urgent medical 116 117 calls from the public. Usually co-localized with a casualty clinic.
NPV	Negative predictive value. The proportion of true negatives among all test negatives.
Operator	The person answering and handling the 113 call at the EMCC. Usually a registered nurse with extra EMCC training.
OR	Odds ratio. The ratio of the odds of an event occuring in

	one group to the odds of it occuring in another group.
OOH (Legevakttjenesten)	Term used for organized out-of-hours emergency primary care service in the municipalities. Staffed by nurses and GPs on call. Handles the majority of the urgent and non-urgent patients.
PPV	Positive predictive value. The proportion of true positives among all positives test outcomes.
Resource coordinator	The person coordinating and dispatching the ambulance fleet at the EMCC. Also handling health lines from prehospital emergency primary care services. Usually an ambulance worker with extra EMCC training.
Response	Each Index criteria code has a pre-determined recommended response which includes urgency and resource: Acute response = Red response (Akutt). Presumably life-threatening situation. GP on call is to be notified and ambulance dispatched immediately. Ambulance may drive with lights and sirens. Consider notifying HEMS. Urgent response = Yellow response (Haster). Potentially life-threatening situation. Cooperation with LEMC. Consider ambulance dispatch. Non-urgent response = Green response (Vanlig). Transfer to LEMC.

Sensitivity	The likelihood of a condition positive being identified as a positive in a test for the condition.
Specificity	The likelihood of a condition negative being identified as a negative in a test for the condition.

Summary

The main aim of this thesis was to initiate a validation process of the Norwegian Index for Emergency Medical Assistance (Index). Before we could do that, however, we had to explore to which extent the Index actually is used by the Norwegian emergency medical communication centres (EMCCs).

The Index is the emergency medical dispatch guidelines used by operators at EMCC when they receive and handle calls at the emergency medical line. In Norway, 113 is the specific toll-free line for medical emergencies. The Index was developed in 1994, and is now available in the 3rd edition (2009). All EMCCs and a majority of the local emergency medical communication centres (LEMCs) in Norway claim to use the Index upon receipt of 113 calls. In 2010, knowledge on the epidemiology of 113 calls was non-existing.

Criteria-based dispatch guidelines are designed to be used in close cooperation with experienced health educated EMCC operators, and the operators are intended to bring their knowledge, experience and skill into the assessment process. This has complicated past research, as it is difficult to determine whether the determined criteria code or dispatched response is due to the guidelines themselves, the operator's own assessment or a combination of both. In addition, the Index is still paper-based, so that its use remains unable to track.

After the initial mapping of the place, situation and the patient's vital functions found on the start page, the rest of the Index criteria cards are symptom-based. This makes it challenging to compare specific Index criteria codes with specific discharge diagnoses from hospitals, as a measure on Index validity. Criteria card "27 Altered levels of consciousness – paralysis", specifically the criteria codes A. 27.03–06, was considered comparable to the diagnosis of stroke, including intracerebral haemorrhage, acute ischemic stroke and transient ischemic attack.

The objectives of the individual studies were to gain more knowledge about:

- The 113 epidemiology in Norway
- Use of the Index by the EMCCs
- The Index's validity in identification and prediction of stroke

Study 1 was a cross-sectional survey of all 113-enquiries to the 19 EMCCs during a 72-hour period in August 2011. The final material consisted of 2 298 printouts from the electronic EMCC records, Emergency medical information system (AMIS), and contained information about time, caller, patient, Index criteria code, response and resources allocation. The national mean 113 contact rate was 56/1 000 population per year, but the variation among the different EMCCs was from 33 to 114. The acute contact rate was 21/1 000 per year, with a variation of 5 to 31. Urgency distribution showed 37% acute, 34% urgent and 27% non-urgent contacts. The most frequently used Index criteria card was "06 Unclear problem", which was used in 20% of the contacts, with a variation of 10 to 42% among the EMCCs.

Study 2 was a national questionnaire study to all EMCC operators, to explore self-reported use of the Index. The questionnaire contained questions about use of the Index, education, EMCC experience, and training in, and repetition on the use of the Index at their workplace. Response rate was 63.4%, and the typical operator among the respondents was a female registered nurse with six years of EMCC experience, who worked in rotation with either the emergency department or ambulance. Mean self-reported use of the Index was calculated to be 3.95, corresponding to the response format 4 = "often, > 75%". Rotation with ambulance reduced use of the Index, while experienced focus on use of the Index at workplace increased the use. The operators checked whether the patient was conscious or not in 93% of the calls, but claimed to use the start page in only 47%. Availability of the electronic AMIS was the most frequent stated reason for not using the start page or the Index as a whole.

Study 3 was a review of the audio logs from the same time period as **Study 1**, to assess use of the Index in an objective manner, and then see if the guideline adherence

affected the emergency medical dispatch (EMD) response interval. Seven EMCCs participated, with a total of 299 randomized calls, 174 acute and 125 urgent. The EMCC selection was strategic, based on variation in size, geographical location, various health trusts, and the EMCCs' mean self-reported use of the Index from **Study 2**. The listening form measured whether and how fast the operator got various indicators on use of the Index confirmed. The indicators "location", "consciousness" and "criteria compliance" were combined in an overall guideline adherence variable, where 0 indicated no guideline adherence and 3 the maximum guideline adherence. Mean guideline adherence was 2.41, equivalent to 80% of the maximum score. EMD response interval increased with decreased guideline adherence score.

Study 4 was a retrospective registry study comparing patients with EMCC stroke suspect criteria codes and patients with hospital stroke diagnoses. The material consisted of AMIS-printouts from Bergen EMCC, and patient data from Haukeland University Hospital, Haraldsplass Diaconal Hospital and Voss Hospital. Less than half of the confirmed stroke patients' initial EMCC contact was via 113 line, 52% of the patients were in contact with the primary health care services first. By combining patient data from the stroke database at Haukeland University Hospital and the 113-data from Bergen EMCC, we calculated sensitivity for stroke identification at EMCC contact of 57.9%, specificity of 99.1%, positive predictive value (PPV) of 45.7% and negative predictive value (NPV) of 99.4%. Stroke patients whom initial EMCC contact was via the 113 line had a higher proportion of acute responses and stroke suspect criteria codes. Although the majority of stroke patients who came in contact with the EMCC via primary health care services did not receive stroke suspect criteria codes, 85% of these calls had free-text notes addressing stroke suspicion.

Main findings:

- The national mean 113 contact rate was 56/1 000 a year, but the individual contact rates for the different EMCCs varied between 33 and 114. The urgency distribution was 37% acute, 34% urgent and 27% non-urgent contacts. Index criteria card “06 Unclear problem” was the most frequently used, used in between 10 and 42% of the contacts among the different EMCCs.
- Self-reported use of the Index by the operators was > 75%. Working in rotation, with shifts at both the EMCC and the ambulance service, was associated with reduced use of the Index, while focus on use of the Index at the EMCC increased use. AMIS was the most frequent stated reason for not using the Index.
- Measured mean guideline adherence was 80% of the maximum score. Low guideline adherence score correlated with longer EMD response interval.
- The Index’s ability to identify or predict stroke patients is modest, with a sensitivity of 57.9%, specificity of 99.1%, PPV of 45.7% and NPV of 99.4%. More than half of the stroke patients initially contacted primary health care services instead of 113.

Norwegian summary – Sammendrag

Hovedmålet med avhandlingen var å sette i gang en valideringsprosess av Norsk indeks for medisinsk nødhjelp. For å kunne gjøre det måtte vi imidlertid først undersøke i hvilken grad Indeks brukes ved norske AMK-sentraler.

Norsk indeks for medisinsk nødhjelp (Indeks) er det beslutningsstøtteverktøyet operatørene ved AMK-sentralen støtter seg til når de mottar og håndterer medisinske nødsamtaler på 113. Indeks ble tatt i bruk i 1994, og foreligger nå i 3de utgave (2009). Samtlige AMK-sentraler og en majoritet av legevaktsentralene i Norge oppgir å bruke Indeks ved mottak av 113 henvendelser. I 2010 var kunnskap om 113 epidemiologien nasjonalt ikke-eksisterende.

Kriteriebaserte beslutningsstøtteverktøy er laget for å brukes i tett samarbeid med helsefaglært AMK-operatør, og operatøren er ment å skulle bruke sin erfaring og kunnskap inn i vurderingsprosessen. Dette har komplisert tidligere validitetsforskning, da det er vanskelig å si om hastegrad og respons utløst skyldes selve verktøyet eller operatørens egen vurdering. I tillegg er Indeks fortsatt papirbasert, slik at bruken ikke kan spores digitalt.

Etter den initiale kartleggingen av sted, situasjon og pasientens vitale funksjoner på Startkortet, er resten av Indeks oppslagene symptombasert. Det gjør det utfordrende å sammenligne spesifikke Indeks kriteriekoder med spesifikke utskrivelsesdiagnoser fra sykehusene, som et mål på hvor god validiteten til Indeks er. Oppslag ”27 Nedsatt bevissthet – lammelser”, nærmere bestemt kriteriekode A.27.03 – A.27.06 ble vurdert å kunne måles opp mot diagnosen hjerneslag, inkludert hjerneblødning, hjerneinfarkt og drypp.

Målet med de enkelte studiene var å få mer kunnskap om:

- 113 epidemiologien i Norge
- bruken av Indeks ved AMK
- Indeks' validitet med tanke på å identifisere og predikere hjerneslag

Studie 1 var en tverrsnittsundersøkelse av alle 113-henvendelser til samtlige 19 AMK-sentraler gjennom en 72 timers periode i august 2011. Det endelige materialet bestod av 2 298 utskrifter fra det elektroniske journalsystemet ved AMK, Akuttmedisinsk Informasjonssystem (AMIS), og inneholdt informasjon om tid, innringer, pasient, Indeks kriteriekode, hastegrad og involverte ressurser. Samlet 113 kontaktrate var 56 /1 000 innbyggere per år, men variasjonen for de ulike AMK-sentralene var fra 33 til 114. Den akutte kontaktraten var 21/1 000 per år, med variasjon 5 til 31. Hastegradsfordelingen viste 37% akutte, 34% haster og 27% vanlige henvendelser. Det hyppigst brukte oppslaget var "6 – Uavklart problem", som ble brukt i 20% av henvendelsene, med en variasjon på 10 til 42% mellom AMK-sentralene.

Studie 2 var en nasjonal spørreskjemastudie til operatørene ved samtlige 19 AMK-sentraler, for å kartlegge selvrapportert bruk av Indeks. Spørreskjemaet inneholdt spørsmål om bruk av Indeks, utdanning, AMK-erfaring, og opplæring i og repetisjon av bruk av Indeks ved sentralen. Svarprosenten var 63.4%, og den typiske operatøren var en kvinnelig sykepleier med seks års AMK-erfaring, og jobbet i rotasjon med enten akuttmottak eller ambulanse. Bruk av Indeks ble kalkulert til å være 3.95, svarende til responsformatet 4 = "ofte, > 75%". Det å jobbe både ved AMK og i ambulansetjenesten reduserte bruk av Indeks, mens opplevd fokus på bruk av Indeks ved arbeidsplassen økte bruken. Operatørene oppga å undersøke om pasienten var bevisst i 93% av henvendelsene, men brukte Startkortet i kun 47%. Bruk av AMIS var hyppigste oppgitte årsak til ikke å bruke Startkortet eller Indeks som helhet.

Studie 3 var en strukturert gjennomgang av lydlogger fra samme tidsperiode som studie 1, for å måle bruk av Indeks objektivt, og deretter se om bruk av Indeks påvirket AMK-reaksjonstid. Syv strategisk utvalgte AMK-sentraler deltok, med tilsammen 299

randomiserte akutte og hastehenvendelser, 174 akutte og 125 haster. Utvelgelsen av sentraler var basert på spredning i størrelse, geografisk lokalisasjon, ulike helseforetak, og sentralenes gjennomsnittlige selvrapporterte bruk av Indeks fra studie 2. Det ble utarbeidet et lytteskjema som målte om og hvor raskt operatøren fikk bekreftet ulike indikatorer på bruk av Indeks. Indikatorene lokalisasjon, bevissthet og strukturert gjennomgangen av kriterier på valgt oppslag ble satt sammen til en variabel, der 0 var minsteskår og 3 maksskår. Gjennomsnittlig bruk av Indeks var 2.41, svarende til 80% av maksskår. AMK-reaksjonstid økte med over 2 minutter for de henvendelsene med minsteskår på bruk av Indeks, sammenlignet med de med maksskår.

Studie 4 var en retrospektiv registerstudie som sammenlignet pasienter med slagsuspekte kriteriekoder fra AMK med pasienter med hjerneslagsdiagnoser fra sykehus. Materialet bestod av AMIS-utskrifter fra Bergen AMK, og pasientdata fra Haukeland Universitetssykehus, Haraldsplass diakonale sykehus og Voss sykehus. Mindre enn halvparten av de bekreftede slagpasientene kom i kontakt med AMK via 113, 52% var i kontakt med primærhelsetjenesten først. Ved å kombinere pasientdataene fra slagdatabasen ved Haukeland Universitetssykehus med 113-data fra Bergen AMK kalkulerte vi sensitivitet for å oppdage slagpasienter ved inital kontakt med AMK på 57.9%, spesifisitet på 99.1%, positiv prediktiv verdi (PPV) på 45.7% og negativ prediktiv verdi (NPV) på 99.4%. Slagpasientene som kom i kontakt med AMK via 113 hadde høyere andel akutte hastegrader og slagsuspekte kriteriekoder enn de som først var i kontakt med primærhelsetjenesten. Selv om majoriteten av slagpasientene som gikk via primærhelsetjenesten ikke fikk slagsuspekte kriteriekoder, hadde 85% av disse et fritekstnotat om mistanke om slag.

Hovedfunn:

- Den nasjonale kontaktrate for 113 var 56/1 000 per år, men varierte fra 33 til 114 mellom de ulike AMK-sentralene. Hastegradene fordelte seg med 37% akutte, 34% haster og 27% vanlige henvendelser. Det hyppigst brukte oppslaget var ”6 Uavklart problem”, som ble brukt i mellom 10 og 42% av henvendelsene ved de ulike AMK-sentralene.
- Selvrapportert bruk av Indeks blant operatørene var > 75%. Jobbrotasjon mellom AMK-sentral og ambulanse var assosiert med redusert bruk av Indeks, mens opplevd fokus på bruk av Indeks ved sentralen økte bruken. AMIS var den hyppigst oppgitte årsaken for ikke å bruke Indeks.
- Målt bruk av Indeks var 80% av maksimalskåren. Det var en sammenheng mellom lav bruk av Indeks og lengre AMK-reaksjonstid.
- Indeks’ evne til å identifisere eller predikere slagpasienter var beskjeden, med sensitivitet på 57.9%, spesifisitet på 99.1%, PPV på 45.7% og NPV på 99.4% . Over halvparten av slagpasientene kontakter primærhelsetjenesten i stedet for 113 direkte.

List of publications

The thesis is based on three papers, from four studies:

Study 1 and 2

Paper I: **Variations in contact patterns and dispatch guideline adherence between Norwegian emergency medical communication centres – a cross-sectional study.**
Ellensen EN, Hunskaar S, Wisborg T, Zakariassen E
Scand J Trauma Resusc Emerg Med. 2014;22:2.
doi: 10.1186/1757-7241-22-2

Study 3

Paper II: **Dispatch guideline adherence and response interval – a study of emergency medical calls in Norway.**
Ellensen EN, Wisborg T, Hunskaar S, Zakariassen E
BMC Emerg Med 2016;16:40. *doi: 10.1186/s12873-016-0105-2*

Study 4

Paper III: **Stroke identification by criteria-based dispatch.**
Ellensen EN, Naess H, Wisborg T, Hunskaar S, Zakariassen E
Submitted December 2016

The studies are referred to as **Studies 1-4**, and the papers as **Papers I-III** throughout the thesis. The papers are included in full text in the appendices. Reprints were made with permissions from Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine and BMC Emergency Medicine.

Contents

1 Background

1.1 Prehospital emergency medical services

Emergency medical service (EMS) has been defined as a system which provides effective, coordinated and timely delivery of health care services to victims of sudden illness or injuries (1). Historically, prehospital EMS strategies have been described as dichotomous; basic level service versus advanced level service, or in other words "scoop and run" versus "stay and stabilize". The "scoop and run" strategy aimed to bring the patient to the hospital as fast as possible, and was used to a great extent in EMS systems with open access to the emergency ward. The ambulance services were typically ground-based, and considered part of the public safety system, alongside fire and police departments. The "stay and stabilize" strategy aimed to bring the hospital to the patient, and utilized physician or paramedic-staffed vehicles, both cars and helicopters, with more advanced equipment, alongside regular ambulances (1-3).

The organization of EMS systems varies substantially throughout the world, as summarized in a series on EMS organization worldwide published in Resuscitation 2003–2009, utilizing a diversity of combinations of ambulance workers, paramedics, specialized nurses, general practitioners, anaesthesiologists, emergency physicians and physicians in residency (2-12). More recent publications on EMS organization are sparse, but there are reasons to believe that most EMSs today use a combination of both the "scoop and run" and the "stay and stabilize" strategy, depending on acuity, patient need, location and resources available.

This heterogeneity in EMS systems, together with lack of uniform data collections, often results in small and non-generalizable studies where the isolated outcome effect of the prehospital interventions can be difficult to measure (13).
A qualitative study published in 2014 found multiple key barriers for conducting prehospital clinical studies: funding, ethical approval, data collection, protocol training and compliance, randomizing and blinding interventions, obtaining patient outcomes,

adequate study staffing and EMS partnering (14). A meta-analysis of randomized trials published in a high impact factor emergency medicine journal revealed that only 8% of the studies were from the prehospital field (15). Overall, prehospital emergency medicine has been a neglected area of research for many years compared to in-hospital medical fields (13). A PubMed search reveal that although there is a 7.4 times increase in number of publications involving “prehospital” and “emergency medicine” from 1996–2000 to 2011–2015, the number of medical publications as a whole rises by 9.2 during the same period (16).

1.2 Prehospital emergency medicine in Norway

The health care system in Norway is twofold, with a primary care level and a specialist/hospital care level. A general referral system serves as a strict gatekeeper towards the second level: the hospital emergency department can only be attended by patients admitted by physicians, or acute patients brought in directly by ambulances.

Although the majority of the 5 million population lives in urban areas, there are rural settlements along the entire coastline of 25 000 km. Scattered population, fjords, mountains, seasonal climate changes and poor road quality many places provide challenging conditions for the rescue and transport of patients (7).

1.2.1 Emergency primary health care system

The principle that all issues should be dealt with at the lowest effective level of health care means that the large quantity of patients in need of non-urgent or urgent medical assistance are handled by the emergency primary health care system: GPs and the out-of-hours (OOH) service. The regular GPs are obligated to provide emergency medical assistance for their own patients during office hours. The out-of-hours medical assistance is provided by LEMCs and casualty clinics, manned by nurses and

physicians. In addition to regular GPs taking out-of-hours shifts on call, physicians in internship, hospital physicians and foreign stand-in physicians have played an important role in manning the casualty clinics, accounting for almost half of the shifts (17). In 2015, a new regulation on emergency medicine stated that the physician on call at the casualty clinics should be a GP (18). Besides handling urgent and non-urgent patients at the casualty clinics, the GPs on call are also supposed to be notified about all acute patients prehospital but choose themselves whether to attend the situation or not. Both notification and involvement of GPs with acute patients have proved to vary geographically (19,20).

The municipalities are responsible for the primary health care system, including the medical emergency parts. The number of casualty clinics is decreasing, indicating increasing inter-municipal cooperation. In 2014, 58% of the casualty clinics were inter-municipal and 42% municipal (21). The emergency primary health care system handled close to 1 950 000 contacts in 2015 (17).

1.2.2 Emergency secondary health care system

The patients in need of acute medical assistance are mainly handled by the secondary health services: the ambulance service and EMCCs (7,22), but GPs on call are supposed to be alarmed and assist if necessary. The ambulance service include cars, boats, planes and helicopters. Cars are staffed by two ambulance workers, planes by specialized nurses and helicopters by anaesthesiologists and rescuers (18). Each helicopter base also has an emergency car for missions when use of helicopter is inappropriate: close proximity to the base or poor weather conditions.

In contrast to GPs being notified of all acute patients, the criteria for notifying helicopter emergency medical services (HEMS) are rather unspecific: “If appropriate, consider sending the nearest otherwise occupied ambulance; notifying nearest doctor not on call; notifying HEMS; recommend private patient transport.” Geographical

access, shortened transfer time and advanced prehospital critical care interventions have been found to be the three main benefits of primary prehospital HEMS (23-25), and HEMS availability has been used as a factor mitigating centralization of trauma care and specialized health services. This is based on the assumption that the EMCCs are able to dispatch HEMS to the patients who need it, and avoid unnecessary use for patients with minor injuries or no other indication for HEMS. Once notified by EMCC, the HEMS anaesthesiologist accepts or declines the mission based on medical indication (26,27), and the EMCC thus have no authority to dispatch the helicopter, in contrast to the rest of the ambulance fleet. In Western Norway more than one third of the HEMS dispatches from the EMCC were declined or aborted by the HEMS crew, due to diminished medical indication, bad weather conditions or competing missions (27).

The regional trusts are responsible for the secondary health care system, and all contacts are made through the EMCCs. In 2015 the EMCCs handled close to 850 000 contacts (26).

1.3 The emergency medical communication system

When in need of acute medical assistance, the public has access to both primary and secondary health care level through the two toll-free emergency telephone numbers: The 116 117 line, to be used in an urgent medical emergency situation; and the 113 line when there is an acute, life-threatening situation.

The 116 117 line is answered by the nearest LEMC. They assist the caller with medical advice and referral to GPs and casualty clinics. If necessary, they can also request an ambulance through the EMCC. During the last decade, there has been a desired shift towards increased use of LEMC as the public's access point during out-of-hours, but some casualty clinics still allow direct attendance without calling beforehand. This is especially common in the larger cities.

The 113 line is answered by the nearest EMCC, which also coordinates and dispatches the ambulance fleet when needed. If deemed appropriate, the EMCC can transfer an obviously non-urgent call to LEMC, and vice versa.

In addition to assisting the public in need of acute medical help, the emergency medical communication system (113, EMCC and LEMC) also facilitates radio and telephone communication between all the different participants in the chain of pre-hospital emergency medical care; ambulance personnel, GPs on-call, casualty clinics and in-hospital specialists (18,28). From 2015, the emergency health services , police and fire and rescue services have used Nødnett, a separate radio network for inter-agency public safety communication during rescue missions, accidents and major situations (29).

1.4 The Emergency Medical Communication Centres

The EMCCs and the ambulance service are part of the secondary health care system, administered through four regional health trusts. There are now 16 EMCCs in Norway (2017); 4 in North, 4 in Middle, 4 in West, and 5 in South-East (30). They differ in size, with regard to the corresponding population (65 000–1 165 000 in 2011) (31), tasks and staffing. The EMCCs are normally located at the nearest hospital, although co-localization with the other emergency services, fire brigade and police, also exists. In addition to the public 113 line, the centres also receive direct lines from casualty clinics, in-hospital emergency lines, ambulance booking line, and admission lines from GPs. Some EMCCs are co-located with the nearby LEMC.

Although the personnel requirements of the regulations have been unspecified, most EMCCs are manned by registered nurses and ambulance workers with specific EMCC training (18). The EMCC operators, usually nurses, traditionally answer and triage phone calls made to the 113 line, and assist the caller with medical advice if necessary. The resource coordinators, usually ambulance workers, handle health lines and

dispatch and coordinate the entire ambulance fleet including cars, boats, planes and helicopters. At the smaller EMCCs these tasks can be handled by the same person.

National EMCC data has been available to some extent from 2012 (26,30,32,33).

1.4.1 Acute Medical Information System

The software program Acute Medical Information System (AMIS) is used by all EMCCs to register and document each contact. AMIS records contain information on patient identity, location, caller, time of all events, Index criteria, urgency level, response dispatched, and resources involved. It is a local record system for the EMCC alone, and not integrated with the hospitals' record systems.

1.4.2 Audio log recordings

Prior to the regulation of 2015 (18) there was no time limit for storage of audio log recordings. After the new regulation, all calls are taped and stored for a minimum of three years, then they are deleted. There is an exemption for deletion if the log has served as evidence or documentation in a complaint, case supervision or other case management.

1.5 Emergency medical dispatch

Emergency medical dispatch is an important key in the prehospital chain of survival. Identification of patients in potential life-threatening situations is the vital first step toward providing them rapid and appropriate help. In the 1980s two different dispatch systems developed in the United States of America; the Medical Priority Dispatch System (MPDS) and the Criteria Based Dispatch (CBD) system. The MPDS is an

algorithm-based protocol, digitalized and used by non-health educated personnel with special MPDS training. The system has the advantage of easy monitoring on protocol compliance and other quality markers (34). This facilitates research in general and in particular validity studies (35).

The CBD guidelines use symptoms and prompts to determine the nature of the medical condition, the urgency and hence the appropriate level of response. It is supposed to be used by an experienced health-educated operator with special EMCC training. This allows for a dynamic approach to the situation at hand, but also complicates research on CBD (34,36). The complex interaction between the supporting guidelines and the operator introduces an unknown variance when studying guideline adherence and validity (37,38). The skill, knowledge and experience of the individual operator will interfere with how the guidelines are interpreted and modified to the situation at hand. This will influence the criteria set, and hence the urgency and response dispatched. Another factor complicating CBD research is the symptom-based approach, which makes comparison between initial dispatch criteria and final hospital discharge diagnoses as a measure of validity difficult.

A 2013 systematic review on adherence to prehospital guidelines and protocols failed to identify any eligible study in the field of emergency medical dispatch, neither CPD, nor MPDS-based (39). Nevertheless, a Norwegian study from 2005, evaluating dispatch in drug-related emergencies, found an operator guideline compliance of 99%, based on a multiple choice questionnaire, and a 64% compliance when going through log recordings (40). Research on CBD compliance internationally has been sparse, but in 2014 a study on cardiac arrest calls compared an American MPDS protocol to the Norwegian CBD guidelines (Index) and found both to have equally high levels of consciousness clarification (100% for MPDS and 97% for CBD) and detection of respiratory distress (100% and 98%, respectively) (41).

The flip-over Index in use by an operator at the EMCC (Photo: VS Ellensen).

1.6 The Norwegian Index for Emergency Medical Assistance

The Index comprises the criteria-based medical dispatch guidelines used in Norway (28). It was introduced in 1994, developed from the original American CBD guidelines (42). As the EMCC holds a key role in resource allocation in the prehospital setting, implementation of the Index at all EMCCs should secure a comprehensive and equitable service for all citizens regardless of location. In addition to being used by all the EMCCs when receiving medical emergency phone calls (113), it is also used by a majority of the LEMCs when receiving out-of-hours phone calls (116 117) (21).

It is designed to be used by health educated operators with special training, and aims to assist the operator throughout the dispatch process; initial survey of the situation at hand, dispatch of the adequate resources, and finally, provision of medical advice and instructions on first aid and care for the caller. Despite its many years in service, and

several exports abroad, Denmark and Croatia most recently (43,44), there was no knowledge in 2010 of how and to which degree it was used or how well it performed.

In 2016, the Index still exists as a flip-over in large paper format in Norway. It consists of a start page and 40 criteria cards (Appendix 1).

1.6.1 Start page

The start page is algorithmic and clarifies vital information like location, phone number, vital functions of the patient and a brief questioning on the problem at hand (Appendix 2). The operator then decides if there is an immediate need of an ambulance, life-saving instructions, or if the time allows; moving on to the proper criteria card to explore the situation further.

1.6.2 Criteria cards

The first three criteria cards are mainly instructional ("01 Unconscious [lifeless] adult", "02 Unconscious [lifeless] child" and "03 Choking / foreign body in throat"), with a focus on cardiopulmonary resuscitation. There are five cards of a more administrative order ("04 Disaster – major accident", "05 Transport reservations", "24 Help in crisis", "31 Cooperation with others" and "40 About Index") and 32 cards based on symptoms and situations.

A symptom card is a list of criteria prompts in decreasing severity, and the operators start at the top and move downwards until one criterion is met. Each criterion has a predefined urgency and a recommended dispatch. The cards also include additional questions, caller advice and supporting instructions for health personnel on scene. "27 Altered levels of consciousness – paralysis" is enclosed as a criteria card example in appendix 3.

The administrative criteria card “05 Transport reservations” is used for a variety of ambulance transports, including primary responses, secondary transfers and return of patients. It includes all urgencies, and is used for both pre-planned and acute incidents. If the caller is a physician or another health personnel calling in to order an ambulance, the operator can choose between using criteria card 5 or using a more specific symptom card according to the patient at hand.

Criteria card “06 Unclear problem” is a collection of criteria covering mainly unclear situations, where the operator is unable to provide enough information to designate a proper criteria card. It also contains some more specific criteria that don’t fit into any other criteria card.

1.6.3 Urgency and responses

The Index divides the responses into three urgency categories: acute (red), urgent (yellow) and non-urgent (green). Acute responses are when the situation is acute and life-threatening, and there is a need for immediate acute ambulance dispatch and alarm of the GP on-call. Urgent responses are potentially life-threatening situations where an ambulance is normally dispatched but without lights and sirens, and the need for the GP on-call is assessed. In non-urgent responses, there is no life-threatening situation and the patients are usually referred to the primary level of emergency care, the casualty clinics, unless there is an obvious need for ambulance transport.

1.7 Criteria card “27 Altered levels of consciousness – paralysis and stroke”

The criteria card “27 Altered levels of consciousness – paralysis” is one of very few Index cards corresponding closely to a medical diagnosis, or diagnoses group, namely stroke (Appendix 3). Over the past decade, stroke has entered prehospital emergency medicine as a time-critical event in need of acute response, on the same acute level as heart attack and severe trauma. Current stroke treatment gives better outcomes, both in terms of survival and dependency, but the therapeutic window is time-limited. The benefits decrease proportionally with increasing time between symptom onset and treatment, disappearing between 4.5 and 6 hours (45,46).

Time from symptom onset to treatment relies on many factors: patient’s or bystander’s awareness of stroke symptoms and urgency for seeking medical assistance; dispatch recognition of stroke symptoms; prehospital time, including time to scene, on-scene and transport to hospital; and in-hospital time, including diagnostics (47,48). Identification of stroke at EMCC can reduce both prehospital and in-hospital time, through acute responses and pre-arrival notification of the hospital (49-51).

Although beneficial for the acute ischemic stroke (AIS), thrombolysis is potentially lethal to patients suffering from haemorrhagic stroke. Imaging diagnostics is therefore essential prior to treatment. Mobile stroke units, ambulances equipped with computed tomography (CT) scanners, are now emerging in the prehospital field (52-55), aiming to reduce time to treatment by eliminating in-hospital time spent on diagnostics. In the future, thrombolysis might be given prehospital as well, reducing the time from symptom onset to treatment substantially. But, this presupposes a valid stroke dispatch.

Studies on different dispatch protocols have found a sensitivity for stroke identification ranging from 41% to 83% (56-60). The ability of Index and criteria card “27 Altered levels of consciousness – paralysis” to identify stroke patients is unknown.

1.8 Summary of background

Internationally the organization of emergency medical systems is diverse, both within countries, and between countries. In Norway, the emergency medical health care system is twofold: The emergency primary health care system includes the GPs, the casualty clinics and the LEMCs, with the public urgent emergency medical telephone line 116 117. The secondary level includes the ambulance service and the EMCCs with the public acute emergency medical telephone line 113.

The EMCCs are manned by operators handling the 113 calls, and resource coordinators dispatching and administering the ambulance fleet. Since 1994, all Norwegian EMCCs use the same CBD guidelines, the Index, but both validity of the guidelines and the actual use of it remained unknown.

Emergency medical dispatch is a key element in the chain of prehospital emergency medical care. The nature of CBD calls for close interaction between the operator and the guidelines, and prior CBD research has been sparse due to the difficulties of addressing these tangled factors. The criteria cards are symptom-based, which challenges the matching of initial dispatch criteria code and patient outcome. Criteria card “27 Altered levels of consciousness – paralysis” and stroke diagnosis are considered to be the closest match possible. Stroke is a highly time critical situation, as the treatment is time-dependent. Valid dispatch of the timely and appropriate resources is a presumption for proper prehospital resource allocation.

2 Aim and objectives

The overall aim of this thesis is to contribute to increased knowledge and awareness about how and to which degree the Index is used, and to test its ability to identify stroke patients.

The four studies had the following specific objectives:

1. To investigate the epidemiology of 113 calls, focusing on possible differences among the EMCCs in urgency levels, Index criteria use and contact rates.

2. To determine self-reported use of the Index among operators, and explore possible factors influencing this use.

3. To measure guideline adherence in an objective manner, and explore a possible effect on response interval.

4. To explore sensitivity, specificity and predictive values of stroke identification at initial EMCC contact, and to evaluate possible factors associated with stroke identification and prediction.

3 Methods and material

AMIS records from the EMCCs were collected as a data basis for all four studies. The operators' self-reported use of the Index and measured guideline adherence were obtained through questionnaires and audio log recordings. In the last study, we compared AMIS data on Index criteria codes at dispatch with hospital data on diagnoses at submission.

The studies were performed 2011–2013. The first two studies were national, including all EMCCs in Norway. The third study included a strategic selection of EMCCs (7 out of 19), and the last study focused on one EMCC in particular.

During the study period, there were 19 EMCCs in Norway; 5 in the North, 4 in the Middle, 4 in the West and 6 in the South-East health trusts. They differed in size, with populations ranging from 65 000 to 1 165 000, calculated by the end of 2011 (31). All EMCCs officially used the Index as their only tool to prioritize and handle 113 calls, and the software program AMIS to register and document each contact.

We conducted a total of four studies (**Studies 1-4**), contributing to a total of three papers (**Papers I-III**). Findings from the first study were mainly reported in **Paper I**, but the material was also used in **Paper II**.

3.1 Study 1 – 113 epidemiology (Paper I)

This was a national cross-sectional population-based epidemiologic study on 113 calls. The study period was 72 hours during late August 2011, including both weekdays and weekend. The purpose of the study was to investigate the epidemiology of 113 calls among the different EMCCs, with regards to urgency levels, Index criteria use and population contact rates.

3.1.1 Method and data collection

All 19 EMCCs contributed with AMIS data for every medical emergency contact made to 113 during the study period, 2 298 in total. Calls from other direct lines (fire department, police and LEMCs), incidents with too little information (missing three or more of the following; gender, age, Index criteria, urgency or response), duplicates, maculated incidents and misdialling were excluded.

3.1.2 AMIS printouts

The AMIS records were collected as printouts. They contained information on date, time, caller role, patient gender and age, set Index criteria, set urgency, response, and involvement of resources like ambulances, air ambulances, GPs and others.

3.2 Study 2 – Self-reported use of the Index (Paper I)

This was a national questionnaire-based survey on the use of the Index and associated factors. All 19 EMCCs participated. The purpose of the study was to determine use of the Index as perceived by the operators themselves, and explore possible factors influencing their use.

3.2.1 Method and data collection

A questionnaire on the use of the Index was sent to all 429 EMCC operators in Norway, distributed through EMCC management and returned directly to the research facility to secure anonymity for the individual respondent. Operators were defined as personnel whose primary occupation was to answer the 113 calls. Resource coordinators were defined as personnel whose primary occupation was to dispatch

resources and coordinate the ambulance fleet. Only answers from operators were included in the study.

3.2.2 Questionnaire

The questionnaire was developed in cooperation with Bergen EMCC and tested on their operators to avoid misinterpretations. It included different sections on individual use of the Index, education, EMCC work experience, and initial training and repetitions on use of the Index. It is enclosed in Appendix 4.

The eleven questions on the operators use of the Index were arranged as a Likert scale of five symmetric response formats: never, seldom (<25%), sometimes, often (>75%) and always. Each question was expressed in the same form: "During a real emergency call, how often do you…?" and covered different parts of the Index. In earlier editions of the Index, the question "Does the patient breathe?" was part of the start page. This was changed to "Is the patient able to talk?"in the 2009 3rd edition (28). This switch was used in the study to reveal whether the operator actually used the present start page, or if they used their own mental version of the former vital questions, by picking questions directly from the start page, like "… Check if the patient is awake," and "… Is the patient able to talk?" It was possible to add explanations or points of view at the end of the questionnaire.

3.3 Study 3 – Guideline adherence (Paper II)

This was an observational cross-sectional study of acute and urgent 113 calls during the same 72-hour study period utilized in **Study 1**. The purpose of the study was to measure guideline adherence by listening through audio log recordings of real emergency calls, and to explore whether guideline adherence affects emergency medical dispatch (EMD) response interval.

3.3.1 Study sample

A strategic selection of nine EMCCs was invited to participate, and seven accepted. The selection was based on diversity in geographic area (all health regions represented), EMCC size, population density (5–210 inhabitants per km^2), and findings from the first paper; contact rates (36–75 contacts per 1 000 inhabitants a year) and self-reported use of the Index at EMCC level (3.3–4.4). The EMCCs constituting the study sample were: Tromsø, Harstad, Trondheim, Bergen, Sørlandet, Buskerud and Oslo og Akershus.

In order to verify the sample validity, contact rates and mean self-reported use of the Index in the EMCC study sample were compared to the national findings reported in **Paper I** (61). The study sample had a contact rate of 57/1 000 inhabitants a year, corresponding to the national rate of 56/1 000 inhabitants a year. The mean self-reported use of the Index in the sample was slightly below the national findings, 3.86 (*SD* 0.40) and 3.95 (*SD* 0.39) respectively, but both corresponded to the response format "often, > 75%" (=4).

3.3.2 Randomization of calls

A random sample of 300 acute and urgent calls from the study period were included in the study. The five largest EMCCs contributed 50 calls each, while the two smallest EMCCs in the study sample, Tromsø and Harstad, did not have 50 acute or urgent calls during the study period, and hence contributed 30 and 20 calls instead. Guideline adherence during the call was evaluated using the developed listening form. The randomization of the calls was achieved through a number generator (www.random.org). Corresponding AMIS records for each call provided information on event times, set criteria and set urgency. One call was excluded due to missing AMIS data, resulting in 299 included calls.

3.3.3 Data collection

The call listening and evaluation sessions on Index adherence were done locally at each EMCC by the primary researcher personally.

3.3.4 Listening form

The listening form used in the study was based on an internal quality control form used by Bergen EMCC, but modified to fit our study. The form is enclosed in Appendix 5. Both information given spontaneously by the caller and information specifically asked for by the operator were registered separately, but later merged for analyses.

Each form measured six different indicators. Indicators 1–4 were derived from the start page and measured vital information: (1) confirmation of caller phone number, (2) location, (3) patient consciousness, (4) patient responsiveness. These were categorized into “within 1 minute”, “within 2 minutes” or “not at all”. Information gained after 2 minutes was interpreted as negative.

Indicator 5, criteria compliance, measured the number of criteria above the set criterion that were not accounted for during the call, either spontaneously or asked for by the operator. Hence an increasing criteria compliance value means the operator has overlooked some more urgent or vital criteria. The indicator was grouped in 0, 1 and 2 and more.

Indicator 6, communication problems, was registered positive if the operator failed to understand what the caller was trying to communicate, as assessed by the researcher.

3.3.5 Variables and outcome measures

The three variables confirmation of location, confirmation of consciousness and criteria compliance were combined to compose the main outcome variable "Overall guideline adherence". Each variable was dichotomized, and information gained within 1 minute for the two first variables, and zero or one unchecked criteria above the set criterion were interpreted as positive. Information gained after 2 minutes and 2 and more criteria above set unchecked were both interpreted as negative. All three variables were weighted equally, composing a measured guideline adherence score of 0 (no positive) to 3 (all positive).

3.4 Study 4 – Stroke identification (Paper III)

This was a retrospective register-based study. The data period was 1st January 2011–31st January 2012. The purpose of the study was to explore the Index's ability to identify and predict stroke at initial EMCC contact, and to explore possible factors associated with stroke identification and prediction.

3.4.1 Method

The data collection for this study was stepwise:
First step:

a. Identify all criteria code 27 patients from Bergen EMCC.
b. Identify all confirmed stroke patients at Haukeland University Hospital

Second step:

a. Code 27 patients hospitalized at Haraldsplass Diaconal Hospital and Voss Hospital – stroke diagnoses or not?
b. Confirmed stroke patients with no code 27 – which EMCC code?

A stroke suspect was defined as a patient receiving dispatch code A.27.03 – Sudden facial drooping, A.27.04 – Sudden impaired strength in an arm or a foot, A.27.05 – Sudden speech difficulties or A.27.06 – Increasing confusion/bluntness – suspicious for stroke at initial EMCC contact. These codes were chosen because they are marked in Index as stroke-suspicious, asking the operator to consider actions facilitating thrombolysis. Criteria card 27 is enclosed in the appendices (App 4).

A stroke patient was defined as a patient with a diagnosis of intracerebral haemorrhage (I61), acute ischemic stroke (I63), unspecified stroke (I64) or transient ischemic attack (G45) at hospital discharge, according to International Classification of Diseases, Tenth Revision (ICD-10).

3.4.2 Data collection

AMIS records were collected from Bergen EMCC; data on stroke patients were retrieved from the Bergen study part of the Norwegian stroke registry (NORSTROKE) at Haukeland University Hospital. Supplementary diagnostic data on stroke suspects admitted elsewhere were retrieved from Haraldsplass Diaconal Hospital and Voss Hospital.

Cases were merged based on the unique civil registration numbers and date of EMCC contact/hospital admission.

3.4.3 Material

During the study period, there were 549 patients with confirmed stroke at Haukeland University Hospital. In the same period, there were 94 606 medical calls to Bergen EMCC, and 1 013 patients received a 27 criteria dispatch code. Of these, there were 709 patients with a stroke-suspect dispatch code of A.27.03–06, and 568 of these were hospitalized. In Step two, we collected dispatch codes for the stroke patients without a code 27, and diagnoses on the code 27 patients sent to Haraldsplass Diaconal Hospital or Voss Hospital. The material is illustrated in Figure 3.4.3 a and b.

Figure 3.4.3a Flow chart of stroke patients at Haukeland University Hospital and their initial EMCC contact line.

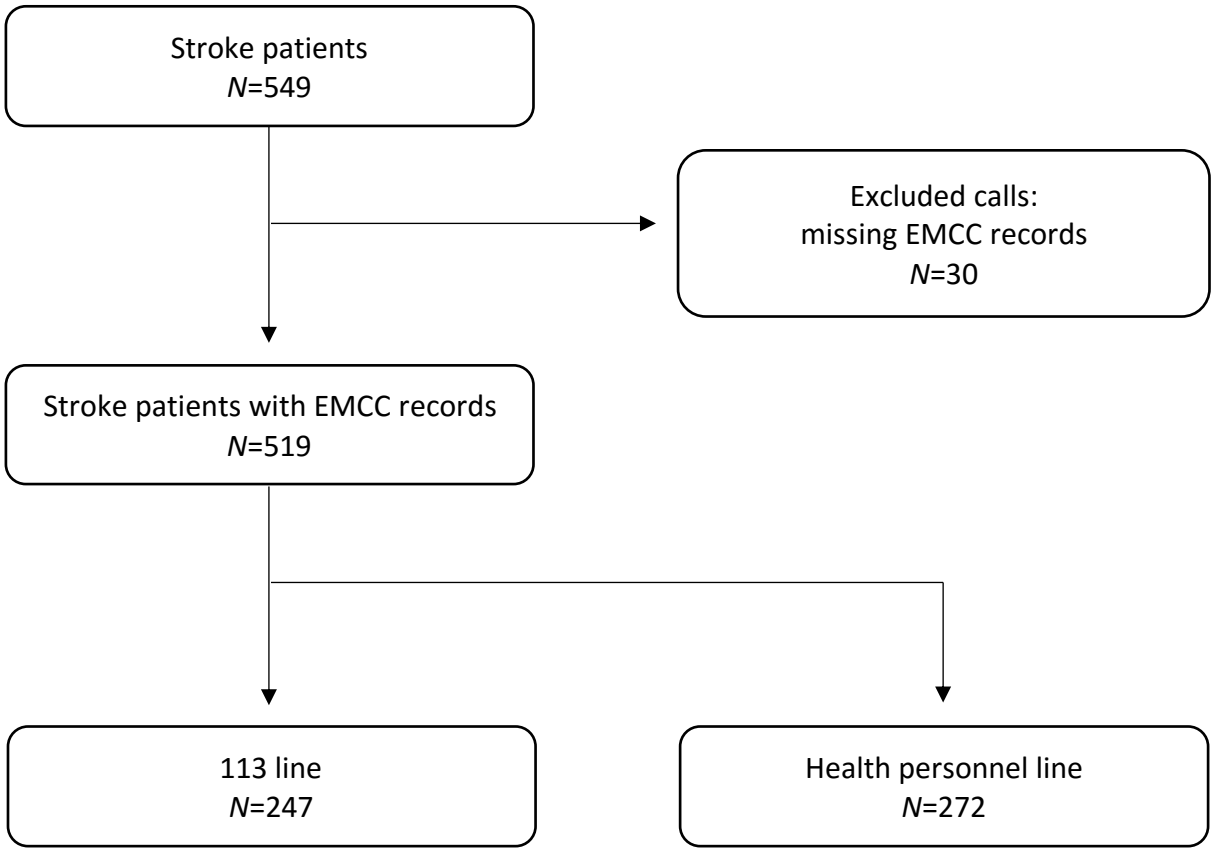
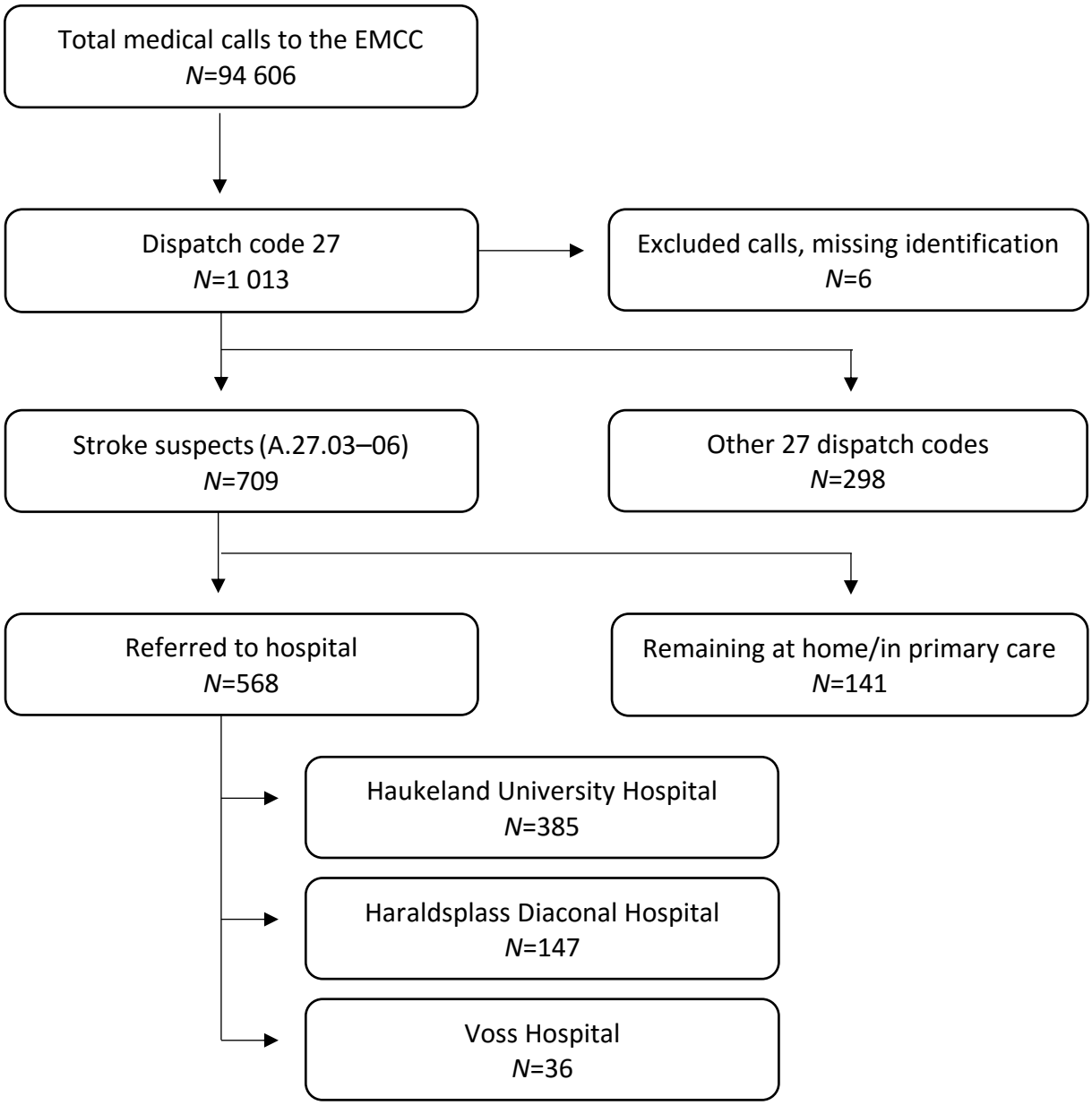


Figure 3.4.3b Flow chart of stroke suspects after initial contact with EMCC in the study period.



3.5 Statistical analyses

Results are presented in absolute numbers (*N*), percentages (%) and odds ratios (*OR*). Continuous data are presented as means (standard deviation) for symmetric data, and medians (interquartile range) for skewed data. Rates were calculated as contacts per 1 000 inhabitants per year. Response interval was analysed as a continuous variable (seconds). Standard error of the observed proportion was calculated using the normal approximation to the binominal distribution, providing 95% *CI* for sensitivity, specificity and predictive values (**Study 4**). Outcome variables were checked for normal distribution by Q-Q plots.

The Likert scale in **Study 2** was constituted from eleven questions and five response formats valued 1 to 5. The outcome variable "use of Index" was calculated for each operator as the mean Likert scale score. One-way analysis of variance (ANOVA) was used to compare the EMCCs with regards to variation in mean use of Index (**Study 2**) and guideline adherence (**Study 3**), while Mann –Whitney U test and Kruskal-Wallis tests were used to compare scores on response interval (**Study 3**). Different regression analyses were used to explore factors associated with use of Index (**Study 2**, univariate and multivariate linear), and with identification of Stroke (**Study 4**, binary logistic).

Statistical analyses were performed using Statistical Package for the Social Sciences (IBM SPSS version 20 for **Studies 1** and **2**, and version 23 for **Studies 3** and **4**) and STATA (Stata/IC 12.1 for **Studies 1** and **2**). *P*-values below 0.05 were considered statistically significant.

3.6 Ethical considerations

Asking patients and next of kin for consent can be difficult. Emergency medical situations are often particularly complex, as it may include both patient, caller and next of kin, complicating identifying all persons involved and collecting consent. The

situation can be dramatic and life-threatening, and many patients may no longer be alive at the time of the study. We applied for, and received, exemption of consent considering the importance of a complete material, the possible distress on patients and next of kin collecting consent, and that there was no intervention affecting the patients.

The first three studies were assessed by the Regional Committee for Medical and Health Research Ethics, and were deemed to be in no need of ethical approval (2011/756/REC West). The committee also exempted patients and EMCC operators' consent to pertaining to analysis of sensitive data. The studies were approved by the Data Protection Official for Research.

The fourth study was approved by the Regional Committee for Medical and Health Research Ethics (2013/982/REC West). The committee exempted patients' consent pertaining to analysis of sensitive data.

Studies 1 and **3** included AMIS records with identifiable patient information in the form of civil registration numbers and addresses. The AMIS printouts have been kept locked up in archive cabinets, behind both key-locked and electronically locked doors. The questionnaires in **Study 2** were collected anonymously. The log recordings in **Study 3** were never extracted from the EMCCs, only listened through locally. Although no directly identifiable patient information was noted on the listening form, the information was indirectly identifiable as AMIS identification numbers were used as a link to the corresponding AMIS. Hence, the listening forms were kept locked up together with the AMIS printouts. The data from Haukeland University Hospital in **Study 4** contained civil registration numbers to enable linkage with AMIS, and was kept on an encrypted USB-memory-stick and locked up.

4 Main findings

This chapter includes a brief overview on the main findings from the four studies.

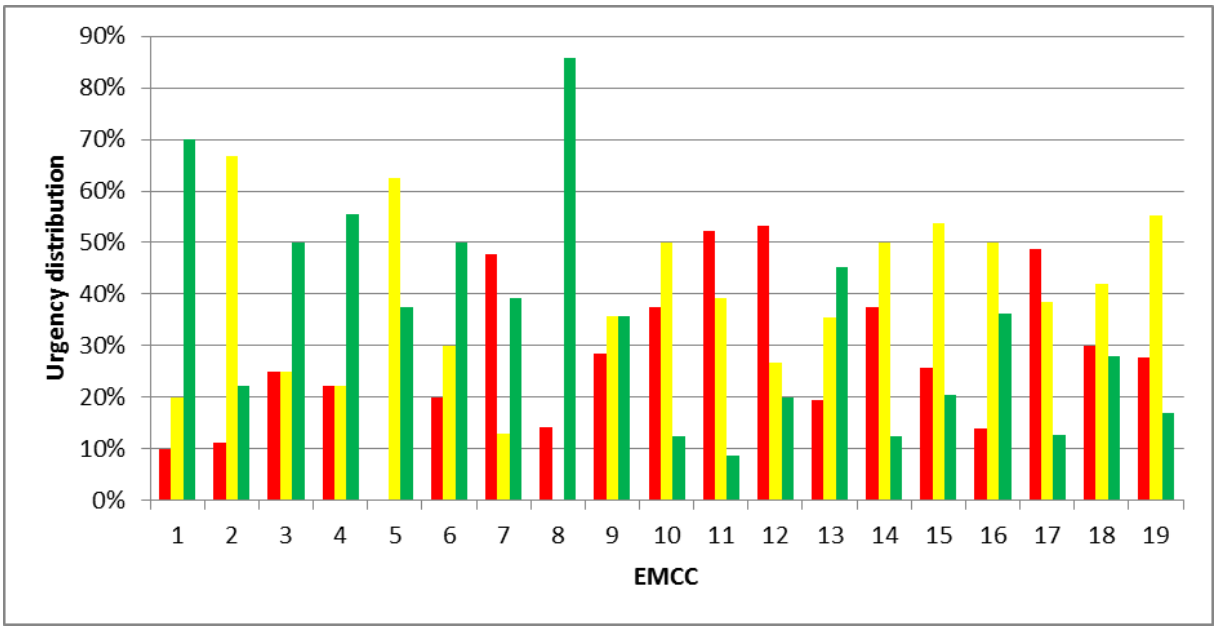
4.1 Study 1 – 113 epidemiology

These results were published in **Paper I**, together with the findings from **Study 2**.

The 72-hour study period yielded 3 294 AMIS records, of which 2 244 were included for analyses. The overall national 113 contact rate was 56/1 000 inhabitants per year (9 5% *CI* 53-57). Contact rates varied among the different EMCCs, from 33 (95% *CI* 21-45) to 114 (95% *CI* 87-141). There was variation in acute contact rates among the EMCCs, from 5 to 31/1 000 inhabitants per year, with an overall national acute contact rate of 21/1 000 per year. Assessment of the contact urgency category showed 37% acute, 34% urgent, and 27% non-urgent, while 1.5% of the contacts received no urgency assessment.

The most frequently used Index criterion, accounting for 20% of all contacts all over, was “6 – Unclear problem”. The variation in use of this criterion was 10–42%. Other criteria, like “5 – Ordered assignment” and “28 – Psychiatry – Suicide”, also varied much between different EMCCs, 0–22% and 0–19% respectively. Besides huge variation in frequency, the urgency assessments on Criteria 6 also differed between the EMCCs; acute 0–53%, urgent 0–67% and non-urgent 9–86% (Figure 4.1).

Figure 4.1 Variation in urgency assessment and use of Index criteria card "06 Unclear problem" among the EMCCs.



Red = Acute, yellow = urgent, green = non-urgent.

4.2 Study 2 – Self-reported use of Index

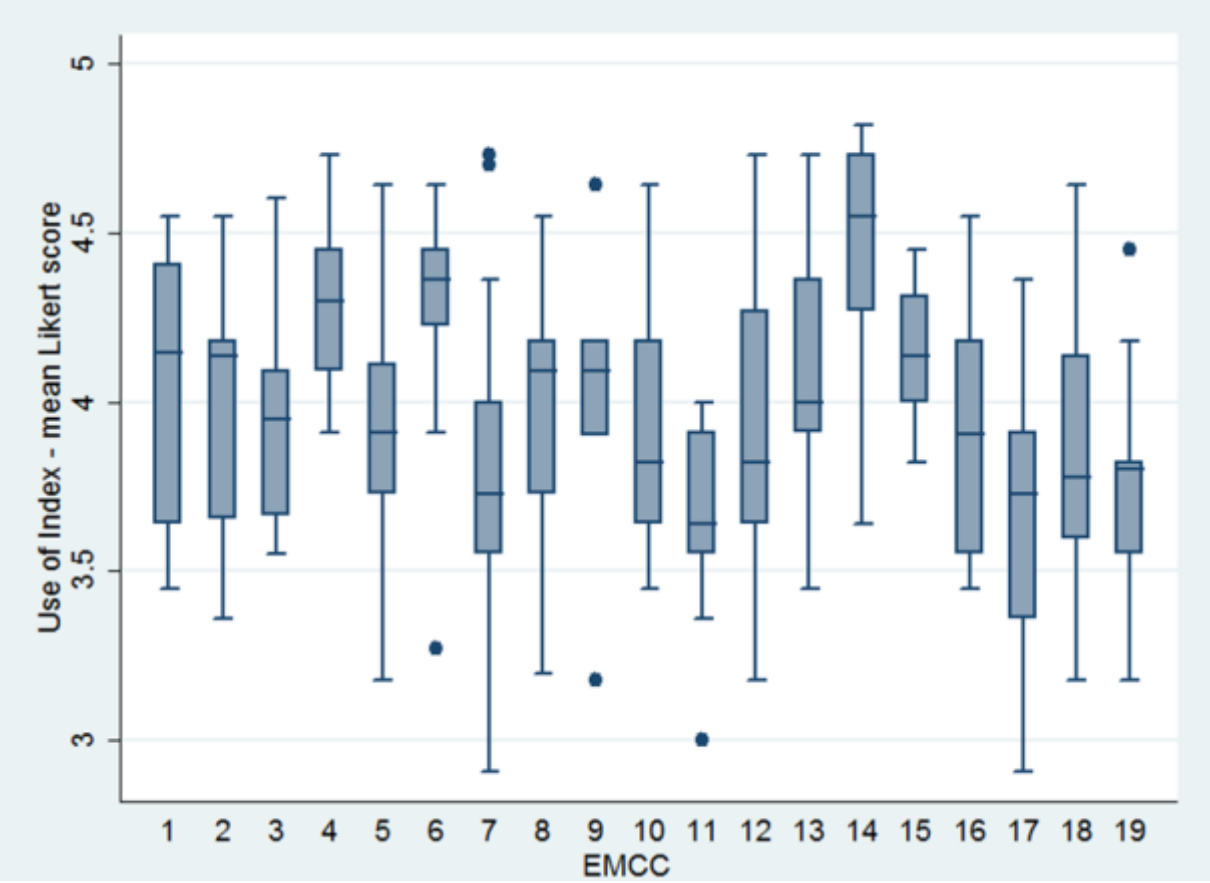
These results were published in **Paper I**, together with the findings from **Study 1**.

All 19 EMCCs were represented in the material, consisting of 272 questionnaires after three reminders, a response rate of 63.4%. The typical operator was female, a registered nurse and worked in rotation with either the emergency ward or ambulances. The majority received initial training in the use of the Index when starting at the EMCC, but repetitions later on were rare. The median EMCC work experience was six years (QI 3, 12).

Use of the Index ranged from 2.91 to 4.82, with an overall mean of 3.95 (*SD* 0.39) for all operators, corresponding closely to the questionnaire response format "often, > 75%" (=4). On the EMCC level, use of the Index varied from 3.7 (0.24) to 4.4 (0.39) (p<0.001) (Figure 4.2). When exploring possible factors associated with use of the

Index, rotation with ground ambulance, regular use of the Index and the perception of focus on use of the Index at the workplace all had a statistically significant effect on use of the Index (p<0.005). Adjusting for explanatory variables, only the negative effect of rotation with ambulances (β = -0.21, p<0.002) and the positive effect of focus on use of the Index at workplace (β = 0.46, p<0.001) were statistically significant.

Figure 4.2 Variations in mean use of the Index among the different EMCCs,



The start page was used often or always (> 75% of real emergency calls) by 47% of the operators, but 93% always checked if the patient was awake and 46% if he was able to talk. “I find what I need in AMIS”, “I know it”, and “It takes too long” were the main reasons for not using the Index at all. The main reasons for not using the start page were “I know it”, “I prefer to go straight to the proper card” and “I find what I need in AMIS”.

Free text note explanations or supplements did not add further information relevant on the questions addressed in the study, and were hence not analysed.

4.3 Study 3 – Guideline adherence

These findings were published in **Paper II**. There were 174 acute and 125 urgent contacts. An ambulance was dispatched in 99% of the acute contacts (*n*=173) and 87% of the urgent contacts (*n*=106).

Guideline adherence was calculated based on six measured indicators: caller's phone number confirmed, location confirmed, patient's consciousness, patient's responsiveness, criteria compliance and communication. The mean overall guideline adherence was 2.41 (0.73), 80% of the maximum value of 3. Although the individual EMCCs varied in guideline adherence (75 to 89%), this variation was not statistically significant (p=0.073).

Acute contacts had higher levels of overall guideline adherence, compared with urgent contacts (rho=0.27, p<0.0005), but there was no correlation between overall guideline adherence and self-reported use of the Index, EMCC contact rate or population density.

Urgent contacts had a median response interval of 4:10 minutes compared to acute contacts with 2:01 minutes. This increase of 2:09 minutes was statistically significant (p<0.0005). Increasing overall guideline adherence decreased EMD response interval (p<0.0005)

Criteria compliance was the only individual indicator with a statistically significant effect on EMD response (p=0.001), with increased EMD response in the group with more criteria unchecked. EMD response interval was not influenced by confirmation

of location, telephone number or consciousness status, or by any of the communication challenges (language difficulties, caller non-cooperation or caller not on the scene).

4.4 Study 4 - Stroke identification

These findings are submitted in **Paper III**.

Of the 519 stroke patients, 48% reached EMCC through the 113 line. Combining the population from Haukeland University Hospital and the 113 line criteria code A.27.03–06, we calculated a sensitivity for identifying a stroke patient at initial EMCC contact of 57.9% (95% *CI* 51.5, 64.1), a specificity of 99.1% (95% *CI* 98.9, 99.2), PPV of 45.7% (95% *CI* 40.1, 51.4) and a NPV of 99.4% (95% *CI* 99.3, 99.5) (Table 4.4). Figure 4.4 shows the overlap of stroke suspects, stroke patients, 113 line and health lines.

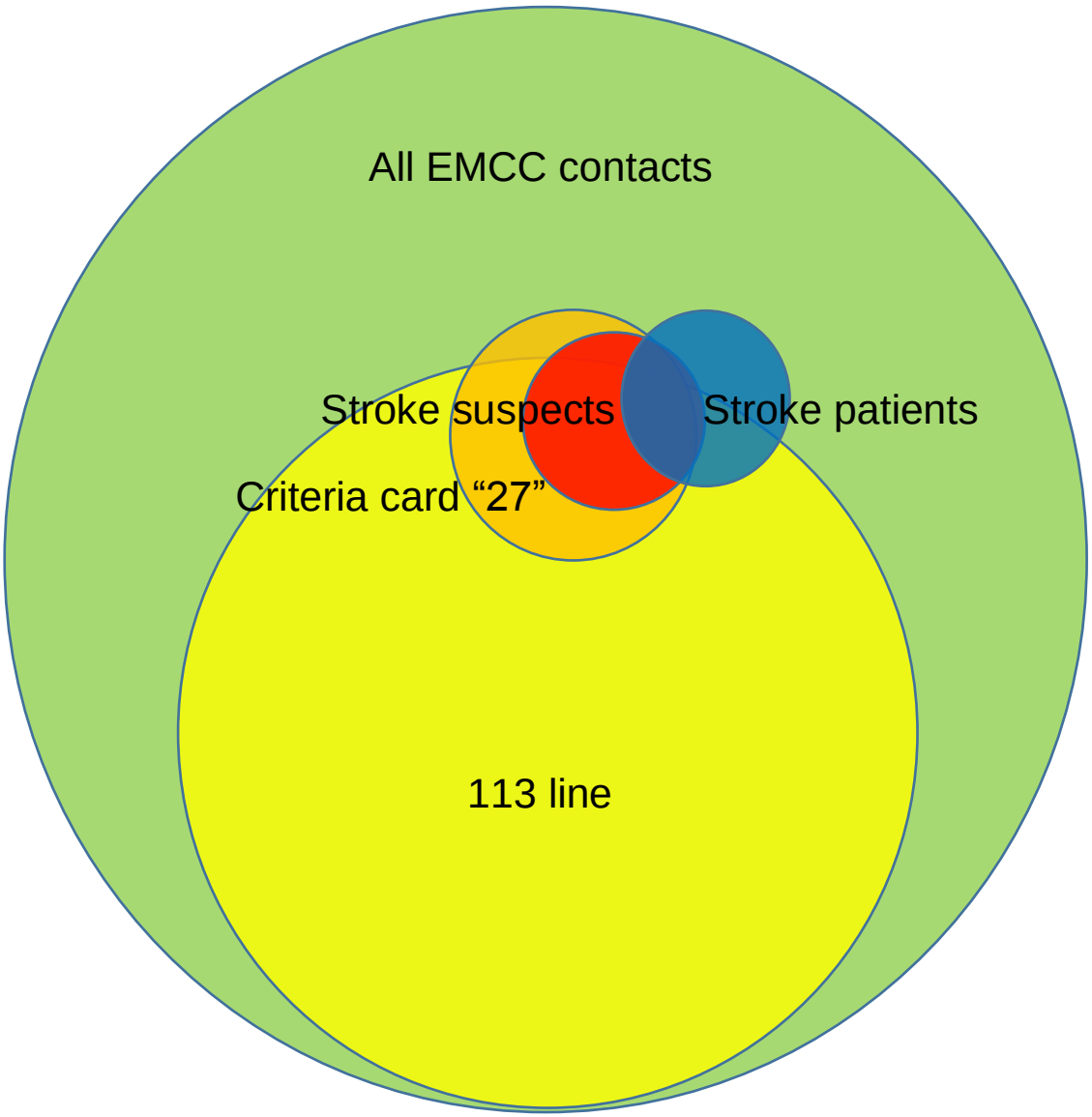
Table 4.4 Cross tabulation of the 113 line: Patients with Index dispatch criteria code A.27.03–06 (stroke suspects) versus confirmed stroke diagnoses (stroke patients).

		Stroke patients[1]		
		Yes	No	Total
Stroke suspects[2]	Yes	143	170	313
	No	104	17 987	18 091
	Total	247	18 157	18 404

[1] True stroke condition: Confirmed stroke diagnoses at hospital discharge.

[2] Predicted stroke condition: Index dispatch criteria code A.27.03–06 at first EMCC contact.

Figure 4.4 Illustration of the match between stroke suspects and stroke patients, 113 line and health lines.



4.4.1 Stroke identification

Table 4.4.1 shows an overview of the Haukeland University Hospital stroke patients and their line of initial EMCC contact. The 113 line contacts are characterized by a high proportion of acute responses (84%) and stroke suspect dispatch codes (58%). The differences between the two populations were statistically significant with regards to urgency, dispatch codes and age groups ($p<0.0005$, $p<0.0005$ and $p=0.005$, respectively.

Table 4.4.1 Stroke patients and line of initial EMCC contact.

	Total	113 line		Health lines	
	N	*N*	%	*N*	%
Total	519	247	48	272	52
Urgency					
Acute		207	84	77	28
Urgent		31	13	73	27
Non-urgent		9	4	122	45
Dispatch code					
Stroke suspect		143	58	30	11
None		8	3	111	41
Dispatch code 5		25	10	113	42
Others		71	29	18	7
Sex					
Female		112	45	126	46
Male		135	55	146	54
Stroke type					
Infarction		192	78	224	82
Haemorrhage		36	15	22	8
TIA		19	8	26	10
Age group					
< 60		40	16	67	25
60–74		66	27	90	33
75–84		76	31	68	25
85 <		65	26	47	17

Further analyses of the 113 population showed that patients with haemorrhagic stroke were less likely to receive a stroke suspect code at initial EMCC contact, *OR* 0,4 (95% *CI* 0.2, 0.9, p=0.029), while TIA patients were more likely to receive a stroke suspect code, *OR* 3.7 (95% *CI* 1.1, 13.2, p=0.042).

In 85% of the 272 health line calls, there was a free text note mentioning stroke suspicion. The presence of stroke suspicion notes was associated with the dispatch code given; 97% of the stroke-suspect dispatch codes, 87% of the no dispatch codes, 86% of the "05 Transport reservations" dispatch codes and 44% of the other dispatch codes had free text notes mentioning stroke suspicion (p<0.0005). Urgency was not associated with stroke suspicion notes.

4.4.2 Stroke prediction

Of the 1 013 dispatch code 27 patients, 314 were true stroke patients, and 87.9% of these had received a stroke suspect code. The proportion of stroke patients among these four stroke suspect dispatch codes, A.27.03–07, ranged from 27.6 to 42.7%. Dispatch code A.27.04–"Sudden impaired strength in an arm or a foot" and admission to Voss hospital gave the highest *OR* for stroke in the multivariate regression analyses, 2.6 (95% *CI* 1.5, 4.5, p=0.001) and 2.7 (95% *CI* 1.3, 5.8, p=0.011) respectively. Age below 60 years had a reduced probability for stroke, *OR* 0.3 (95% *CI* 0.2, 0.5, p<0.0005).

5 Discussion

5.1 Summary of main findings

The overall findings are that Index was used to a high degree by the operators, but that its ability to identify stroke patients was suboptimal.

The 113-epidemiology study showed a wide variation between the 19 EMCCs with regards to contact rates, specific acute rates and use of different Index criteria cards. The operators reported that they use the Index in more than 75% of the 113 calls, but there are variations in how the start page and other criteria cards are used between the EMCCs. The measured mean guideline adherence in the audio log study was 80%. Time to dispatch of resources decreased with higher levels of guideline adherence. In the stroke dispatch study criteria card 27 was tested for its ability to identify stroke patients: sensitivity of 57.9%, specificity of 98.7%, PPV of 37.1% and NPV of 99.4%. Only 48% of the stroke patients accessed emergency medical help through the 113 line.

5.2 Methodological considerations

The major methodological concern in the beginning of this project was the close interaction between the operator and the Index, and whether it was possible to distinguish the contribution of these two factors when looking at the dispatch outcome. As a criteria-based dispatch guideline rather than an algorithmic protocol, the Index was never meant to stand alone, so when **Studies 2** and **3** confirmed that the operators use the Index to a high degree, it supported the idea of considering the operator and the Index as a unity through the last study on its ability to identify and predict stroke.

5.2.1 Prehospital EMS research

Most medical research faces challenges regarding patient ethics, but research on prehospital emergency medical services is complicated by yet another number of factors: critical time intervals, challenging environment, many different participants and lack of data conformity. The patients might be unconscious or suffering from supposedly life-threatening injuries or conditions, complicating patient consent to participate in studies. Time is critical, and data collection and interventions naturally receive less priority than patient care. Every situation provides different indoor and outdoor settings, and weather challenges, and a typical prehospital incident might include patient, next of kin, bystanders, GP on call, ambulance workers, rescuer and anaesthesiologist from HEMS. There is also a lack of uniformity, both in data collected and reported, but also in software solutions. This complicates not only the patient follow-through from initial location to final hospital discharge, but also comparison among different participants of the service.

5.2.2 AMIS as data source

As the Index is a paper-based table fold-up generating no data on its use, AMIS data was used as a surrogate. **Studies 2** and **3** gave some conflicting views on the reliability of this data source as a surrogate on Index use. The Index criteria dispatch codes are all available directly in the AMIS display in a scroll-down menu, and this was stated to be the primary excuse when the Index was not used in **Study 2**. **Study 3**, on the other hand, found that the operators actually used the Index and its prompts to a high degree during the calls.

During registration of the AMIS entries, initially trying to log to which degree the GP on call had been involved in each case, it became clear that each EMCC uses AMIS coding differently.

In 2010 there was no national registry of AMIS data, 113 calls, Index criteria used or urgencies. Although these data were registered locally, extracting data electronically from the 19 different EMCCs seemed impossible for an external researcher. The resulting material of AMIS printouts collected for the epidemiology study (**Study 1**) was manually registered in an SPSS file, creating a local database with all information needed for the research project. This database later served as a background for the log recordings in **Study 3**.

A report on national 2012 EMCC data was published in 2013, providing overall data on population, contacts and response time, but no Index criteria data or urgency distributions for the 113 line separately (33). The 2013 report provided overall numbers on Index criteria cards and various presentations on 113 line calls, including urgency distribution (32). The Norwegian Directorate of Health has since then provided an interactive web page on EMCC activity, accessible for all to generate overall data extractions (26).

5.2.3 Questionnaire and listening form

The questionnaire and listening form were both developed specifically for these studies (Appendices). The questionnaire was pretested among a small group of operators in an attempt to clarify possible misunderstandings, but not validated prior to the study. The main reason for this was the small overall operator population, and a desire to include all in the national study. The questionnaire study was vulnerable to recollection bias, asking the operators to recollect what they usually do. The "eagerness to please" bias, as the operators are expected to use the Index, was attempted minimalized by providing anonymous return of the forms, directly to the researcher. All information and the reminders were distributed through the EMCC management, and this could be one of the reasons for the response rate of only 63.4%. This relatively low response rate opens for the possibility of a selection bias with regards to repliers versus non-repliers.

The listening form was developed from the quality control form used by Bergen EMCC, by simplifying the questions down to those necessary for the objectives of **Study 3**. Due to capacity issues, only one researcher visited the EMCCs participating in the study and listened to the included 113 calls. This could be regarded as both a strength, as all calls were assessed by the same investigator, and a weakness, as the assessments were not double-checked. This bias was presumed avoided by keeping the listening form simple, with yes/no/unnecessary and a time frame for each question, leaving little uncertainty about the findings. Whenever in doubt, a second researcher was asked for a second opinion.

5.2.4 Strategic selection of EMCCs

The invited EMCCs for **Study 3** were selected strategically in order to ensure that the findings would reflect the rest of the EMCCs. The selection was based on variation in size, geographic location, urban/rural, reputation and interest. All four health trusts were represented. The original idea was 6 centres with 50 calls each, acute and urgent. The AMIS material from **Study 1** was used as background data for the calls, and limited the number of acute and urgent calls available for selection. None of the EMCCs in the North health trust had 50 acute or urgent calls from this 72-hour period; hence two centres were included with 20 and 30 calls.

5.2.5 Criteria cards

The two most used criteria cards were “06 Unclear problem” and “05 Transport reservations”. From a researcher’s point of view, they are both deeply troublesome by providing material disturbances diminishing the validity of the data. To make things more complicated, the EMCCs don’t use the card similarly, as presented in **Study 4** on stroke patients. Some received dispatch codes from card 5, some from card 27.

Card 5 is used for organized ambulance transports, whether it's a planned non-urgent transport or an acute ride from a casualty clinic to the hospital. It's an administrative card, dealing with resource distribution alone in the form of orders.
Card 6 covers a whole range of different situations, from chaotic and unclear situations with too little information for the operator to designate a proper card, to well-defined situations where there just is no other criteria card that fits the situation. As shown in **Study 1**, the different EMCCs use this card very differently; 10–42% variation in frequency, and while some EMCCs use the acute criteria codes from this card most frequently, others use the non-urgent codes. The card seems to function as an easy solution if the operator doesn't solve the situation otherwise.

Criteria card 27 was selected for the validation study because it was the one card in the Index most closely associated to a diagnosis or diagnosis group. But, as the main card includes symptoms beyond those associated with stroke alone, the four dispatch codes A.27.03–06 were selected for the purpose of measuring stroke identification ability.

5.2.6 Missing data

Missing data is never a good thing in research, as it reduces the validity of the findings. In connection with the Norwegian Directorate of Health undertaking the responsibility for reporting on national EMCC data in 2013, a manual for registration of EMCC data was developed (62). The intention was to secure homogeneous and comparable data, resulting in registration of urgency and criteria dispatch code becoming mandatory for all incidents registered in AMIS.

5.3 Discussion of the results

5.3.1 Use of the Index

The variation in 113 contact rates among the different EMCCs, from 33 to 114 calls/1 000 inhabitants a year, indicates that the population uses 113 differently in the different regions. Possible reasons for this could be varying thresholds for what is regarded as acute and what is urgent, or local preferences related to availability of the casualty clinic and LEMC. The overall 113 urgency distribution: acute 37%, urgent 34% and non-urgent 27%, taken together with the findings of a primary emergency health care study: acute 2.3%, urgent 21.1% and non-urgent 76.6%, show that the population as a whole knows which level to address depending on the degree of medical emergency (22).

The epidemiology study also reported differences in acute contact rates, which, assuming that the distribution of acute illnesses and accidents are equally spread nationwide, means that the EMCCs differ in determining urgency. The mean acute contact rate of 21/1 000 inhabitants a year can compare to the annual rate of 25, found among three Norwegian EMCCs in 2007 (19), and of 17 on a national level in Denmark (43). The Danish study also found a difference among their included areas: 13–21 acute ambulance dispatches a year.

There is also a large difference among the EMCCs in the use of criteria card “06 Unclear problem”, both with regards to the total use of this card and the variation of urgencies it was used with. This was the single most frequently used criteria card in 113 calls, as problematized in methodological considerations, used in 20% of the contacts. The same result was found in Copenhagen in 2013, with “Unclear problem” accounting for 19% of the calls (63). The criteria card covers a whole range of different situations, from unclear situations with little information to well-defined situations where no other criteria card fit.

The mean self-reported use of Index value, 3.95 corresponded closely to the response format "> 75% of the cases", meaning the operators use the Index in a majority of the emergency calls. The variations were large also here, both on an individual operator level and on an EMCC level. The explanatory factors we investigated accounted for only 23% of this variation. The main factor associated with increased use of the Index was the perception by the operator that their EMCC focused on use of the Index. This increased use of the Index by 0.5 (10%). Although not significantly affecting use of the Index, the 19% reporting that their EMCC performed regular repetition on use of the Index was discouraging.

It was expected that use of the Index would diminish with experience, but this effect was unexpectedly small with only a 0.01 decrease in use of the Index per year working at the EMCC. Equally unexpected was the negligible effect the EMCC had on use of the Index, as this was thought to be the natural explanation for the variation found in the use of the Index.

The main factor associated with decreased use of the Index was rotational work at ground ambulance, reducing use of the Index by 0.2. This could be explained by these operators tending to use their own experience over the Index more often than operators without recent prehospital experience.

The > 75% use of Index found in **Study 2** corresponds well with the 80% guideline adherence found in **Study 3**. A prior Norwegian Index study from 2005 reported a self-reported Index compliance of 99% and a measured compliance of 64% (40). The consistency of our findings, and the fact that they both lay between the two 2005 findings, could indicate that our measures on guideline adherence are realistic. The reversed findings of our results, that the measured use is higher than the self-reported, could also indicate a positive development towards both higher actual use of the Index, and a more realistic reflection on own use. As CBD guidelines are developed to assist health care personnel in the decision process rather than to define the next step of action, the score on overall guideline adherence can never reach 100%. The optimal

level of guideline adherence is unknown, and the studies addressing CBD compliance internationally are non-existing.

Although the algorithmic dispatch systems facilitate high protocol compliance through electronic systems developed to monitor and increase compliance and other quality markers (38,56,64-67), less than 3% of the MPDS were Accredited Centers of Excellence in 2013 (68), which among other quality measurements require a minimum of 90–95% protocol compliance.

Less than half of the operators reported using the start page often or always. The reasons given for not using it were that they knew it by heart, and that they could find the key words they needed through AMIS. The low percentage of operators reporting actually asking if the patient is awake and able to talk, confirms that neither memory nor AMIS equals the start page. This question was changed from "awake and can breathe" to "awake and able to talk" in the 2009 revision of the Index (28). Confidence in AMIS providing the necessary key words to assess the situation was also the main reason for not using the Index as a whole. This raises concerns, as AMIS does not provide support in the decision making or give advice for the public or health personnel at scene. Discarding the guidelines completely in favour of memory, personal skills and experience constitutes a potential hazard of getting sidetracked or losing vital information due to unstructured call handling. This is one of the main risks highlighted by critics of CBD (34,65). Another given reason for not using the Index was the constant and cumbersome switching of hands and eyes between the electronic AMIS and the paper-based Index.

The relationship between clinical outcome and guidelines is known to be an important motivational factor for guideline adherence (39). Ambulance personnel arriving on scene can give the EMCC feedback on the patients, providing the operator the opportunity to adjust his/her perception of the situation initially formed by 113 call. The operators never receive information on the actual patient outcome though. This means that they have no possibility to adjust personal dispatch manners according to

patient outcome, unless the mistake is of such a fatal character that it ends up as a formal complaint.

Although an acceptable level of overall dispatch guideline adherence is unknown, it is not difficult to agree that start page compliance, including confirmation of patient location and consciousness, should be 100% in an emergency medical call. Despite the low reported use of start page, more than 90% of the operators in **Study 2** reported that they check if the patient is awake. **Study 3** found that the operators clarified consciousness within 1 minute in 83% of the cases. A 2014 study comparing an American MPDS with our CBD Index in cardiac arrest patients, reported a guideline adherence of 97% for successful clarifying level of consciousness (41). This difference can be explained partly by their material including cardiac arrest patients only, where the patients' loss of consciousness probably is the major reason for the caller to access 113 in the first place. Another explanation could be the wide variety between our EMCCs, ranging from 73 to 92%, when it comes to confirming consciousness. Although this variety was statistically insignificant in our study, the EMCC with the highest score corresponds to the EMCC participating in the 2014 study. Larger EMCCs allow for higher call processing rates, which is shown to increase dispatch performance: Operators processing more cardiac arrest calls recognized the cardiac arrest faster, dispatched first responding units faster, gave advice on cardiopulmonary resuscitation more often, and received bystander cooperation more often than operators processing few cardiac arrest calls (69). This supports the idea of fewer and larger EMCC units.

Consciousness and responsiveness is vital information for detecting possible life-threatening situations like cardiac arrest or breathing difficulties. These are situations where awareness and instructions from the operator might influence the outcome significantly. Failure to recognize cardiac arrest during the emergency call delayed both ambulance dispatch and arrival on the scene, and decreased three-month survival from 14 to 5% in the Netherlands (70). The Dutch dispatchers were supposed to clarify location, phone number, patient consciousness and breathing, and the study found

failure to ask whether and how the patient was breathing to be the primary reason for not recognizing the cardiac arrest.

Balancing over-triage and under-triage is vital with regards to resource allocation. A certain over-triage is generally accepted in the prehospital EMS, especially in dispatch where there are restricted possibilities to explore and assess the situation properly. Under-triage on the other hand, holds a potential risk for unnecessary time loss and suboptimal level of care, and is less accepted; especially for time-critical conditions like cardiac arrest, respiratory failure, trauma, acute coronary syndromes or stroke (the first hour quintet) (71). Low criteria compliance is a risk factor for under-triage, because important information might remain unrevealed. Experiences from Norwegian GPs participating in prehospital emergency situations show that the GPs downgrade 42% and upgrade 11% of the patients when triaging them on the scene compared to the initial EMCC dispatch (72). Acute abdominal cases were at highest risk of initial under-triage.

Patients initially coded as non-urgent ending up as fatalities have been reported in both Italy and Denmark (73,74). The Italian study found that these calls were predominantly made by next of kin reporting no life-threatening symptoms, but they were also shorter than other emergency calls and characterized by inadequate collection of vital information by the operators. The Danish under-triage study found that 152 (0.16% of the low-acuity) patients died the same day as the 112 call, and 12% of these were considered potentially preventable if the call had been assessed as acute. A Swedish study comparing CBD-based priority codes from the dispatch centre, with triage by the ambulance on scene, found that 4.8% of the patients were under-triaged (75). A similar finding of 4.6% under-triaged patients was recently found in Switzerland (76).

While the importance of not missing out on vital information is undebatable, the dispatch guidelines effect on time has been debated for years, with supporters claiming it saves time and critics claiming that it adds time to the dispatch process. The findings

from **Study 3** support that the Index could save time if used properly. Criteria compliance was the only Index indicator out of six explored in **Study 3** that had a statistically significant effect on response interval. The main effect on the response interval occurred between 1 and 2 unconfirmed criteria, with an increase of 1 minute and 31 seconds from 0 unconfirmed criteria to 2+ unconfirmed criteria. This indicates that the margins are small. The combined outcome variable "overall guideline adherence" showed an increase response interval of 2 minutes and 16 seconds between the lowest and highest value group.

5.3.2 Stroke identification

Ideally, all patients experiencing a stroke should get in contact with 113 as soon as possible, and be identified at the EMCC as a stroke patient. Figure 4.4 shows that in reality, this is not the case.

Although validation studies of CBD guidelines have been problematized due to the unknown factor of operator–guideline interaction, several studies have aimed to assess stroke dispatch validity in CBD guidelines recent years. In Sweden, sensitivity for stroke recognition was measured to be 64% (59), while a Danish study found a sensitivity of 66.2% and a PPV of 30.2% (60). These results are comparable to our findings, except from our sensitivity being somewhat lower. As our dispatch guidelines are quite similar, in particular the Norwegian and Danish Index, this difference might reflect a difference in use of guidelines, confirming concerns raised earlier about the CBD being vulnerable to individual EMDs and EMCCs (37,38).

Training operators in stroke recognition has been shown to raise the proportion of identified stroke patients in algorithmic dispatch protocol systems (77). Such training could be expected to be even more effective in the CBD, as this dispatch system utilizes the operator's individual skills and competence to a wider extent than the algorithmic systems. With regards to Index, increased stroke awareness may lead the

operator to criteria card 27 earlier, and hence decrease EMD response time further as well as potentially identifying more stroke patients.

The importance of a valid stroke dispatch is twofold. First and foremost, stroke recognition leads to a faster dispatch response and improves time to hospital arrival (49-51,78). This is confirmed in our findings; 91.9% of the patients dispatched as stroke suspects received an acute response, while the stroke patients with other dispatch codes received acute responses in 55.1% and urgent responses in 39.2%.

Secondly, an increasing focus on earlier prehospital diagnostics, and in the future maybe even prehospital thrombolysis, through dedicated stroke ambulances equipped with computed tomography scanners (52-54), presupposes a valid stroke dispatch.

The four dispatch codes selected for **Study 4**, A.27.03–06, are closely associated with the FAST stroke symptoms. The 2015 study on stroke patients from Sweden found that FAST symptoms were presented in 80% of the calls dispatched as stroke, compared to only 35% in those with other dispatch codes (49). Studies from the United Kingdom and Australia found quite opposite numbers, with FAST symptoms reported in less than 5% of the calls in the UK (79) and FAST symptoms reported spontaneously in 11% (facial droop) to 41 % (speech problems) in Australia (48). Our findings of nearly 90% identification of the stroke patients by these four dispatch codes compares to the Swedish numbers. Direct comparison with the other studies is difficult, as the dispatch systems are different. Fall is not mentioned as a criterion in Index, but is reported in the literature to be a known predictor of stroke (17–38%), as well as the word “stroke” mentioned by the caller (20–49%) (48,59,79-82).

Study 4 revealed that less than half of the stroke patients accessed the EMCC through the public emergency medical 113 line. Similar results was found in a Dutch study on different prehospital paths where almost half of the stroke patients contacted their GP initially (47). In the Netherlands, GP involvement increased the median time between seeking medical advice and arrival at hospital, compared to ambulance involvement

alone. Whether the same result would be found in Norway, where GP involvement also includes GP call-outs to the patient scene, is unknown. Also in the UK, a majority of the stroke patients' first medical access point was a general practitioner (83). GPs have also been found to have lower precision level of stroke prediction than paramedics and emergency physicians (84,85), indicating that GPs might represent a potential delay to treatment for stroke patients. The majority of public stroke warning campaigns report positive intervention effects, but are generally limited by methodological weaknesses (86). A Japanese study of a two year long stroke education campaign, found an increased association between knowledge on stroke symptoms and intention to call an ambulance (87). There is generally no tradition for studying the effect of public awareness campaigns in Norway, and stroke awareness campaigns are no exemption.

The majority of the stroke patients whose initial EMCC contact was through primary care personnel received either criteria card "05 Transport reservations" dispatch codes, or no dispatch codes at all. The assessments of a GP or out-of-hours doctor on scene with the patient are rarely overturned by the operator, thus the Index is not used as it would have been the with a 113 call. A free text note mentioning stroke suspicion was listed in 85% of these cases, giving the GPs a far better prediction level than previously reported from other countries (84,85). The majority of these patients received urgent or non-urgent response, assumedly due to a time delay beyond the thrombolysis treatment window of four hours from symptom onset.

Studies on patient behaviour as a reason for the delays reveal that although there is a good awareness of stroke of the commonest symptoms and the need for emergency response, only half the patients recognize it themselves, according to a 2010 systematic review (83). Severity of the symptoms, along with the support of family and bystanders both affect patient delay, which can vary from an hour to several days (88). A recent British qualitative study on TIA patients and how primary health care services contributed to time delay, found two factors associated with delay in general: availability of same day appointments and the role of the receptionist in identifying

urgent cases (89). Whether the delay in Norway is due to an initial patient delay, or to accessing the wrong level of emergency medical care is yet unknown. Most likely, it is a combination of both.

6 Conclusions

This thesis has contributed to increased knowledge about the use of the Norwegian Index for Emergency Medical Assistance, and about the precision level of one of the criteria cards. We were able to answer our aim and objectives:

1. There was a large variation between the EMCCs with regard to both contact patterns and use of the Index.

2. Self-reported use of the Index was relatively high, but there were large individual differences. A clear focus on use of Index at the EMCC was associated with increased use.

3. Measured guideline adherence was higher than self-reported use of the Index. Low overall guideline adherence increased the EMD response intervals.

4. The ability of the Index to identify or predict stroke patients was modest. The 113 line was the primary EMCC access point for less than half of the stroke patients.

7 Future aspects

7.1 Implications of the findings

It seems that the criteria-based model of dispatch guidelines works well with the EMCC operators, allowing them to utilize their education, experience and skills yet still use the Index. The finding that focus at the workplace is a factor for improved use of the Index, might encourage management and personnel at the EMCCs to focus further on the use of Index through repetition, case reviews and other reminders.

AMIS was identified as a factor decreasing use of the Index, as it provides easy access to the criteria codes without having to manually look them up in the paper-based Index version. An obvious and necessary improvement of the Index in the future is the electronic version that has been "just around the corner" since 2010. This will not only simplify the work flow for the individual operators, but also secure valid data on how the Index is actually used and enable larger validity studies of higher quality. It is likely to believe that this will improve use of the Index as well.

There is an upcoming revision of the Index, which includes changes to both the start page and criteria card 27, among others. Ability of the present Index to identify stroke patients is suboptimal, and it is of great importance that the new version of the Index is evaluated with regards to how it identifies these patients. Increased stroke awareness among the operators might lower the threshold for using criteria card 27.

The studies have shown that there is an overall and immediate need for improved data quality. Work has already been done during the last couple of years to homogenize the use of AMIS codes, and determining urgency and dispatch code has been made mandatory. Both steps will strengthen future EMCC-based research.

The national stroke registry was implemented in 2013, the cardiac arrest registry in 2015, and the national trauma registry commenced data registration as of January 2015. Use of such databases will provide easier access to data and enable larger studies.

7.2 Future research

Future research should strive to utilize registry resources and explore the effect of the imminent Index changes; complete numbers on urgencies and dispatch codes, a revised Index and hopefully in the near future, an electronic version.

Our stroke study was only the beginning of an Index validation process. With the use of electronic Index data and diagnosis registries, it would be possible to validate the Index as a whole.

Some interesting questions raised by this project, but not within its scope, are why the majority of stroke patients or their next of kin choose not to access the 113 line directly, and the time delays of different prehospital paths for stroke patients in Norway.

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