Acute disease or injury - whom to call?

Patients contacting the Danish out-of-hours health care services

Breinholt Søvsø, Morten

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DISSERTATION SUBMITTED 2020

AALBORG UNIVERSITY
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Morten Breinholt Søvsø

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PhD supervisor: Clinical professor Erika Frischknecht Christensen
Centre for Prehospital and Emergency Research
Department of Clinical Medicine, Aalborg University

Assistant PhD supervisors: Senior researcher Morten Bondo Christensen
Research Unit for General Practice
Department of Public Health, Aarhus University

Senior researcher Linda Huibers
Research Unit for General Practice

Associate professor Bodil Hammer Bech
Section for Epidemiology
Department of Public Health, Aarhus University

PhD committee: Clinical Professor Kirsten Fonager (chairman)
Aalborg University

Erik Zakariassen, Associate Professor
University of Bergen

Clinical Professor Christian Backer Mogensen
University of Southern Denmark

PhD Series: Faculty of Medicine, Aalborg University

Department: Department of Clinical Medicine

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ENGLISH SUMMARY

In the majority of Western countries including Denmark, acute out-of-hours (OOH) health care is organized in a bilateral manner with emergency medical services (EMS) working parallel with predominately OOH primary care services (OOH-PC). In Denmark, EMS work in similar fashions throughout the country, whereas the OOH-PC is organized differently in one region compared to remaining four regions. The OOH services are the access points for health care outside normal working hours. Although there are organizational differences, the OOH services all use some form of telephone triage and calling one of these services is mandatory prior to further access to health care such as emergency departments. Deciding to call either OOH-PC or EMS may seem as a simple choice, but for the public, navigating the acute health care system can be a challenge, since the boundaries between services are unclear and cooperation and information sharing between EMS and OOH-PC vary greatly. Additionally, the intended aims of OOH-PC and EMS differ as does the triage systems, call waiting time and call-handler training. In life or limb threatening situations with high urgency, patients are prompted to call EMS, while OOH-PC care is intended for less acute injuries and disease.

With this dissertation, our overall aim was to investigate if patients choose the OOH health care service most relevant for their condition. This aim was approached in three studies. First, we investigated patients with three different time-critical conditions in **study I**. We expected that these patients would call EMS, but wanted to explore if patient outcome depended on choice of entrance. Secondly, we compared hospitalized patients with an EMS and/or OOH-PC contact in **study II**, expecting to find differences in prevalence of hospitalization and diagnoses patterns. Third and last in **study III**, we explored which sociodemographic factors were related to contacting OOH care and whether different factors were associated with choosing EMS or OOH-PC.

We found a substantial overlap between EMS and OOH-PC services as contacts with time-critical conditions were almost equally divided between the two services. Yet, in the most severe cases, patients seem to contact EMS, supported by a higher mortality, risk of ICU stay and proportion of longer hospital stays among EMS patients compared to OOH-PC patients. We also found substantial overlap in terms of hospital diagnoses at chapter level, but EMS patients had higher prevalence of

potentially severe conditions, higher proportions of hospital contacts and admissions. Patients contacting EMS were a socially vulnerable group with low socioeconomic status compared to OOH-PC patients. Lastly, we identified a group of patients who contacted both EMS and OOH-PC with an increased risk of poor outcome.

The overlap in patient populations between OOH services may be due to patients having difficulty in navigating these health care services, but additional qualitative research is needed to understand the reasons behind the patients' choice of service, especially patients contacting both EMS and OOH-PC. Here audits of medical record could also be helpful. Ideally, we should adjust our OOH services to better match patient behavior and needs. Adjustments could include improved collaboration between OOH services in terms of more patient information shared, compatible telephone systems and perhaps co-location of OOH-PC and EMS, but the benefits and drawbacks of such adjustments needs to be evaluated.

DANSK RESUME

I Danmark og i hovedparten af andre vestlige lande, har man organiseret de akutte sundhedstilbud uden for egen læges åbningstid i præhospitale organisationer (1-1-2) og lægevagten eller lignende primære akutte sundhedstilbud. De præhospitale organisationer i Danmark ligner hinanden, mens der er forskel på det primære akutte sundhedstilbud i Region Hovedstaden (Akuttelefonen 1813 (1813)) og de resterende regioner (lægevagt). Adgangen til det akutte sundhedsvæsen er gennem de akutte sundhedstilbud, der visiterer patienthenvendelser i telefonen. Det er et krav, at man ringer til et af de akutte sundhedstilbud før man kan komme på sygehuset. Det kan virke nemt at vælge mellem 1-1-2 eller lægevagten/1813, men for den generelle befolkning er det svært at navigere i det akutte sundhedsvæsen, da grænserne mellem de akutte sundhedstilbud ikke er helt klare og samarbejdet og delingen af informationer mellem 1-1-2 og lægevagten/1813 varierer meget. Desuden er der forskel på organiseringen, visiteringsmåden, ventetiden i telefonen og hvem der visiterer. Endelig er der også forskel på formålene med 1-1-2 og lægevagten/1813. I livstruende situationer eller ved alvorlig tilskadekomst, opfordres patienter til at ringe 1-1-2, hvorimod lægevagten/1813 er henvendt til patienter med mindre akutte skader og sygdom.

Formålet med denne afhandling er at undersøge om patienterne vælger det akutte sundhedstilbud, der er mest relevant for deres helbredsproblem. Vi gennemførte tre studier for at svare på dette. I studie I undersøgte vi patienter med tre forskellige tidskritiske tilstande. Selvom vi forventede, at disse patienter ville ringe 1-1-2, undersøgte vi hvilket akut sundhedstilbud de ringede til og om valget påvirkede, hvordan det gik dem. Derefter undersøgte vi patienter med kontakt til 1-1-2 eller lægevagt/1813 og en efterfølgende hospitalskontakt (studie II). Her forventede vi at finde forskelle i prævalensen af hospitalskontakter og diagnosemønstre. I det sidste studie III undersøgte vi hvilke sociodemografiske faktorer, der var associeret til at kontakte et akut sundhedstilbud og om forskellige faktorer var associeret til at kontakte henholdsvis 1-1-2 og lægevagt/1813.

Vi fandt et betydeligt overlap imellem de akutte sundhedstilbud, når det drejede sig om tidskritiske tilstande. Her var kontakterne næsten ligeligt fordelt mellem 1-1-2 og lægevagten/1813. Ikke desto mindre, fandt vi, at patienterne kontaktede 1-1-2 i de mest alvorlige tilfælde. Det blev understøttet af en højere dødelighed, højere risiko for indlæggelse på en intensiv afdeling og en større andel af lange indlæggelser

blandt 1-1-2 patienter. Vi fandt også et betydelig overlap af hospitalsdiagnoser, men 1-1-2 patienter havde en større forekomst af potentielt alvorlige tilstande, en større andel hospitalskontakter og indlæggelser. Ydermere fandt vi, at patienter der kontakter 1-1-2 er en socialt udsat gruppe med lav socioøkonomisk status sammenlignet med patienter, der kontakter lægevagten/1813. Som det sidste fandt vi, at patienter der kontakter både 1-1-2 of lægevagten/1813 er en gruppe med øget risiko for et dårligt udfald.

Det overlap vi fandt imellem de akutte sundhedstilbud kan måske skyldes, at patienter har svært ved at navigere i det akutte sundhedsvæsen og de akutte sundhedstilbud. Vi har dog brug for yderligere kvalitative undersøgelser til at forstå årsagerne bag patienters valg af akutte sundhedstilbud. Særligt også når patienter kontakter både 1-1-2 og lægevagten/1813. I sådanne tilfælde kunne det være givtigt at gennemgå patienternes journaler. Det er muligt, at vi bør tilpasse vores akutte sundhedstilbud mere til patienterne og deres behov. Sådanne tilpasninger kunne være et øget samarbejde mellem de akutte sundhedstilbud med mere deling af patient information, kompatible telefonsystemer og måske fælles lokalisation. Vi bør dog først undersøge fordele og ulemper ved de foreslåede tilpasninger.

PAPERS

The thesis is based on the following papers:

1. Søvsø, M.B., Christensen, M.B., Bech, B.H., Christensen, H.C., Christensen, E.F., Huibers, L. Contacting out-of-hours primary care or emergency medical services for time-critical conditions - impact on patient outcomes. BMC Health Serv Res 19, 813 (2019) doi:10.1186/s12913-019-4674-0

2. Søvsø, M.B., Huibers, L., Bech, B.H., Christensen, H.C., Christensen, M.B., Christensen, E.F. Acute care pathways for patients calling the out-of-hours services. Resubmitted

3. Søvsø, M.B., Bech, B.H., Christensen, H.C., Huibers, L., Christensen, E.F., Christensen, M.B. Sociodemographic characteristics associated with contacts to emergency medical services and out-of-hours primary care. An observational study of 2.3 million citizens. Under review

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During the first part of my GP training, I had several employments at various departments and general practices, all of relatively short duration. Although shifting workplace and routines often is part of becoming a generalist, it was a challenge and made me want to dive into a specific subject for a longer period of time. While studying I was part of a couple of research projects, but I never really had the time needed to dedicate myself to the projects. This thesis has allowed me to do so and first and foremost I would like to thank my main supervisor Erika Frischknecht Christensen and my assistant supervisor Morten Bondo Christensen for thinking outside the box and coming up with the collaboration that made my employment and research project possible.

Erika, your experience, fun and uplifting spirit and encouragement has been a great part of what gradually got me hooked on research and, as you know, now I am not letting go. Thank you for always been accessible and for giving me the chance to do this project and hopefully many more to come.

Morten, thank you for enduring my many emails asking to find out if there was any possibility of me doing a research project at your unit and of course for giving me the chance at last. Your frank, warm, fun and pragmatic way of being definitely carried this project at lot of the way.

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It's been very interesting and at times extremely frustrating to be part of two different research units, but I am very thankful for the experience and I have learned much more than just how to conduct research properly because of it. From the

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I look forward to continue working with all of you.

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I would like to thank my family for being part of this and everything else. In the years that have passed, while working with this thesis, life kept hitting me in the face, worst of all when my dear mother passed away. I know that she would have loved to experience the last part of this journey. Thankfully, amazing things also happened, as my wife and I had our son Johan. Becoming a parent puts everything into perspective and laughing and playing with my son just fixes everything.

My extraordinary wife Didde deserves the biggest thanks of all. You have been my rock, endlessly giving me time and space, especially in tough times and during the last part of writing this thesis. You are my favorite partner in crime, awesome co-parent and the best friend anyone could ever ask for. I look forward to whatever life brings as long as it is with you.

TABLE OF CONTENTS

ABBREVIATIONS

OOH	out-of-hours
EMS	emergency medical services
OOH-PC	out-of-hours primary care
AMI	acute myocardial infarction
GP	general practitioner
ED	emergency department
MPDS	medical priority dispatch system
CBD	criteria-based dispatch
GPC	general practitioner cooperatives
CDSS	computerized decision support systems
MH-1813	medical helpline 1813
EMCC	emergency medical coordination centre
PMR	prehospital medical record
ICU	intensive care unit
ICD-10	International Statistical Classification of Diseases, 10th Edition
PIN	personal identification number
OR	odds ratio
HR	hazard ratio
IRR	incidence rate ratio
CI	confidence intervals
SD	standard deviation
STEMI	ST-elevation myocardial infarction

1 INTRODUCTION

In the majority of Western countries, acute out-of-hours (OOH) health care is organized in a bilateral manner with emergency medical services (EMS) working parallel with other forms of acute care providers – predominately OOH primary care services (OOH-PC). In life or limb threatening situations with high urgency, patients are prompted to call EMS, while OOH-PC care is intended for less acute injuries and disease. The cooperation between EMS and OOH-PC varies greatly; from a minimum of cooperation to co-location of EMS and OOH-PC services with a high degree of shared information.

Choosing which service to contact can be difficult – especially for persons without professional training.[1–8] In recent years, a number of information campaigns directed at the Danish general public have been launched to address this issue.[9,10] Most of the campaigns have aimed at directing patient calls to the most relevant service. Either by diverting non-urgent calls from EMS to primary care or by ensuring that patients with symptoms of time-critical conditions such as acute myocardial infarction (AMI) or stroke call EMS as fast as possible. Information campaigns have good intentions, but more advice does not necessarily reduce the difficulty of health care navigation for patients; it is still the patient or bystander that makes the initial choice of which health care service to contact.

Therefore, this thesis aims to explore if patients choose the most relevant service outside office hours, where the choice of services is limited in Denmark. First by investigating patients with time-critical conditions, where we would expect patients to contact EMS. Secondly, by investigating and comparing diagnostic patterns of patients with contacts to different OOH services, who were hospitalized on the same date. Thirdly, by investigating the influence of patients' sociodemographic characteristics on contacting OOH health care and choosing a specific type of OOH service.

2 BACKGROUND

2.1 WESTERN OUT-OF-HOURS HEALTH CARE ORGANISATION

In relation to primary health care, the term 'out-of-hours' originates from describing the health care available to patients outside the normal working hours of their regular general practitioner (GP).[11] Today the term OOH health care encompasses all types of services available around the clock such as EMS and other acute care providers such as emergency departments (EDs).[12] Yet, in most Western countries, the organization of OOH health care is differentiated into OOH-PC and EMS functioning as two parallel strings.[13–16]

In recent years, EMS have undergone major changes with more and more advanced treatment made possible in the prehospital setting with higher levels of training of ambulance personnel, the addition of prehospital physicians (in some countries) and the introduction of helicopter-based EMS.[13,16–20] Another organizational change of great importance, was the development of a systematic telephone triage system, the Medical Priority Dispatch System (MPDS), in 1978 in the Salt Lake City, Utah, USA.[21] In the 1990s, a different dispatch system, the Criteria-Based Dispatch (CBD) protocol was developed and later implemented in King County, Washington, USA.[22] The overall purpose of both systems is to assess which patients are in need of help and the level of urgency with which to send help through a systematic approach. In the MPDS, the dispatcher asks the caller key questions and the answer determines the next question. The call is categorized by chief complaint and an urgency level is assigned.[21] The CBD is guided by a number of medical criteria for different conditions (25 in the original protocol) and through the description of the symptoms and complaints of the patient, the call-handler chooses an urgency level and a corresponding response e.g. ambulance with lights and sirens.[22,23] Both systems have been continuously modified and translated from English to other languages and are still used, making telephone triage and medical dispatch an essential part of present day prehospital care.[24,25]

In many countries, GPs were responsible for the patients registered to their practice outside normal working hours, during weekends and public holidays. However, in the 1980s and 1990s, various OOH deputizing services, GP rotas or GP cooperatives (GPC) gradually emerged, adopting the patient responsibility during OOH.[11] As the

reason for this structural change, some studies suggest that the OOH workload increased (i.e. more patient contacts during OOH), whereas other studies suggest factors such as decreased personal involvement by the GPs.[11,26] As a consequence of the change in structure, OOH-PC also consists of different organizational models across Europe and in several countries more than one model of OOH care exist (for instance EDs alongside GPC, telephone hotlines, walk-in clinics).[27,28] Access to OOH-PC is either unrestricted or through telephone triage. Telephone triage is predominately carried out by registered nurses with only few exceptions such as in Denmark. Nurse telephone triage differ across countries and models, but may include additional triage training, various clinical algorithms or computerized decision support systems (CDSS). Much like in EMS, the OOH-PC telephone triage aims at assessing a relevant type of health care and level of urgency.[25,29–33]

2.2 DANISH OUT-OF-HOURS HEALTH CARE NOW

Denmark is divided into five health administrative regions, with each region being responsible for the health care services within that region, including hospitals and OOH care services (i.e. EMS and OOH-PC).[34] Danish health care is free of charge for all citizens (including OOH services) and financed through taxes. The OOH services are the access points for health care outside normal working hours. They all use telephone triage and calling one of the OOH services is mandatory prior to further access to health care (i.e. EDs and other forms secondary care in hospital), although some patients still show up at the EDs on their own accord. Prior to 2014, all regions had very similar organizations of OOH care with GPC and EMS working alongside each other. In 2014, the Capital Region of Copenhagen introduced the Medical Helpline 1813 (MH-1813) as OOH-PC service and the GPC in this region discontinued. The remaining four regions have all maintained largely similar GPC organization. Thus, Danish OOH-PC is now comprised of two types of services, whereas EMS organizations are similar nationwide (**figure 1**).[13,26,35–39]

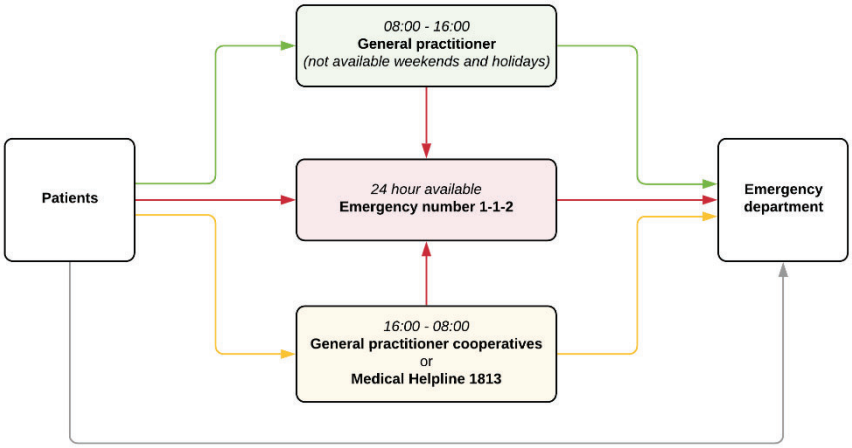


Figure 1. Medical service accesses. Modified figure from Lindskou TA, Mikkelsen S, Christensen EF, et al. The Danish prehospital emergency healthcare system and research possibilities. *Scand J Trauma Resusc Emerg Med*. 2019;27(1):100. doi:10.1186/s13049-019-0676-5.[13]

2.3 OUT-OF-HOURS PRIMARY CARE

2.3.1 GENERAL PRACTITIONER COOPERATIVES

Danish GPCs are large-scale regional cooperatives of GPs responsible for OOH-PC within the region. They are located strategically in each region, most often at hospitals (**figure 2**) and are organized in teams of GPs; one team responsible for telephone triage, one for clinic consultations at the GPC and one for home visits.[26,39] The GPCs in Denmark handle approximately 2.2 million calls annually, with around 50-60% of calls being handled as telephone consultations only.[39,40] All calls to the GPC are answered by GPs (or GP trainees in the final part of their training), who perform triage and assess the patient's symptoms and complaints to choose a relevant response; telephone consultation, clinic consultation at the GPC, home visit or direct referral to hospital.[29] In the Zealand Region, patients with injuries are prompted to call a different telephone number maned by nurses, whereas all other (non-injury) calls are answered by GPs.[39,41] With the aforementioned exception, nurses are not used for telephone triage at the GPCs, which is different from other countries comparable with Denmark. In the larger GPC locations nurses perform

various supportive functions for the GPs in relation to patient consultations. Home visits are most often carried out in cases, where the patient cannot attend the GPC clinic and an on-site clinical examination is needed to assess the patient.[26,42,43] All patient contacts are registered and documented in an electronic medical record available to the patients' regular GP (after patient consent) and to the GPC personnel. Only referrals to the hospital are available to hospital staff and no records are shared with the EMS.

Figure 2. Sign from Aalborg University Hospital, Thisted showing the direction to the GPC (*Lægevagten*) located within hospital grounds.

2.3.2 MEDICAL HELPLINE 1813

The MH-1813 is available in the Capital Region of Copenhagen only and handles close to 1 million calls annually, of which 50% are telephone consulations.[38,44] The helpline call-center is co-located with the EMS in the region and they use similar software systems for patient records which are accessible for both services. As with the GPC, records are not shared with the hospital unless for referrals, but the MH-1813 have access to regional hospital medical records.[45] Both nurses and physicians are employed at the MH-1813. Nurses far outnumber physicians and the vast majority of calls to the MH-1813 are answered by nurses.[38,39,44] The original idea was to have nurses answering the telephone, with backup from GPs. However, initially and during our study period, the physicians were of various medical specialties (few GPs). In the last years, more GPs have been employed. Nurses at the MH-1813 use a locally developed CDSS to guide them in performing telephone triage and to decide if telephone advice, consultation, home visit or direct referral to hospital is needed.[29,46] Home visits are performed by physicians, whereas clinic consultations take place in

various emergency departments by hospital clinicians of different specialties. Clinic consultations are therefore registered as hospital contacts. The level of home visits is very low after the introduction of MH-1813.[44,47]

2.4 EMERGENCY MEDICAL SERVICES

Denmark has a joint national emergency number (1-1-2) for police, fire and medical emergencies.[48] Emergency calls are answered by police and then forwarded to a regional Emergency Medical Coordination Centre (EMCC), which is part of the EMS, if of medical nature. Redirected calls from the national emergency number to Danish EMS amounts to approximately 0.3 million annually.[49] For the most part nurses answer the calls, but paramedics are also employed as call-handlers (**figure 3**).[13] Danish EMS use the CBD protocol Danish Index for Emergency Care, a translated and adjusted version of the Norwegian Index for Medical Emergency Assistance, which in turn is based on the original CBD protocol from King County.[23] In the process, additional criteria have been added and local adjustments made, resulting in 37 main symptom groups, each divided into five levels of emergency, ranging from *life-threatening or potentially life-threatening condition (A)* to *no ambulance dispatched, advice/other service (E)*.[36,49] After determining the main symptom and level of urgency, the call-handler relays this information to the technical dispatch personnel present at the EMCC, who in turn dispatches the emergency vehicle(s). Danish EMS is comprised of ambulances staffed with two ambulance professionals of which at least one is at paramedic level, rapid response vehicles with paramedics with special competencies and mobile emergency care units or helicopters with prehospital anesthesiologists.[13,24]

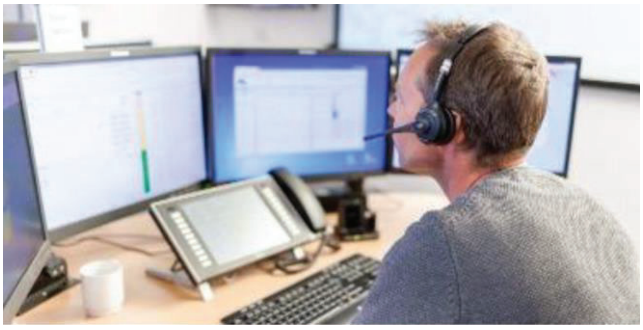


Figure 3. Call-handler at the EMCC in the North Denmark Region.

2.5 CHOOSING OOH-PC OR EMS IN A DANISH CONTEXT

As outlined above, accessing OOH health care requires a telephone call either to OOH-PC or EMS, which may seem as a simple choice, but for the general public, navigating the acute health care system can be a challenge and the boundaries between services are unclear.[8,50] The intended aims of OOH-PC and EMS are publicly available and often stated alongside the telephone number for the services. Existing literature concerning the OOH services have also described the aims as;
1) OOH-PC is intended for non-life threatening acute disease or injury that cannot wait till the following workday and 2) EMS is intended for life or limb threatening disease or major accidents.[5,9,13,39,44,48,51]

The patient's choice of OOH service could impact patient outcome, since the model of triage used, the call waiting time and the type of call-handler differs. Only a small number of studies have addressed this issue, most of them focusing on delay in patient treatment, when contacting primary care.[15,52] Even fewer studies, often limited in size, have included clinical outcome measures such as severity of disease or mortality.[14,53] Investigating patients with time-critical conditions, could allow for assessing the impact of OOH service choice, more than in conditions where time is of less importance.[54]

Moreover, owing to the limitations of telephone triage (e.g. risk of over- or under triage due to no clinical examination) as well as patient help seeking behaviour, overlaps in patient populations of OOH services may occur; patients in need of urgent care contact OOH-PC and patients with less urgent medical problems contact EMS.[6,55,56] Contacts deemed medically inappropriate or non-urgent have been extensively investigated, while studies on overlap in patient populations of OOH services have not.[2,4,5,57] Quantifying such overlap based on in-hospital diagnostic patterns and proportion of hospital contacts following different OOH service contacts could clarify if the intended differences in aims regarding urgency or severity of the services are reflected in hospital diagnoses.

Patient help-seeking behavior also entails several factors other than the perception of the urgency of the acute health problem experienced by the patient, such as sociodemographic characteristics.[6,58] Although much of the focus has been on inappropriate or recurrent use, previous studies suggest that characteristics such as low education, ethnicity and older age are associated with seeking help, but no large-scale cohort studies have investigated differences in these characteristics for

patients contacting EMS and OOH-PC.[1,2,6,59–63] Such insight could contribute to the understanding of patient utilization of OOH health care services and identify vulnerable patient groups in need of increased focus.

3 OBJECTIVES

When patients experience acute disease or injury outside normal working hours in Denmark, they are presented with the choice of calling either EMS or OOH-PC for help. This dissertation aimed to investigate whether patients choose the OOH health care service most relevant for their condition. This aim was approached in three steps. First, we investigated patients with three different time-critical conditions. We expected that these patients would call EMS, but wanted to explore if patient outcome depended on choice of entrance. Secondly, we compared hospitalized patients with an EMS and/or OOH-PC contact, expecting to find differences in prevalence of hospitalization and diagnoses patterns. Third and last, we explored which sociodemographic factors were related to contacting OOH care and whether different factors were associated with choosing EMS or OOH-PC.

Study I: Patients with time-critical conditions – who did they call and did it affect their outcome?

Aim: to investigate the association between choice of entrance (OOH-PC or/and EMS) and mortality (1 and 30-day), intensive care unit (ICU) stay and length of hospital stay for patients with AMI, stroke or sepsis.

Study II: Patient care pathways outside office hours

Aim: to investigate contacts to EMS and/or OOH-PC services in Denmark regarding differences in prevalence of contacts, subsequent hospital contacts and age-related pattern of hospital diagnoses.

Study III: Do patient sociodemographic factors play a role when calling for help?

Aim: to explore sociodemographic patient characteristics and their association with contact to OOH health care and with choosing a specific type of OOH service (EMS or OOH-PC.

4 METHODS

4.1 STUDY DESIGN

All studies were population-based observational cohort studies carried out in the North Denmark Region and Capital Region of Copenhagen between January 1st and December 31st 2016. Included participants were as follows:

Study I

Adult patients (≥18 years) with an EMS and/or OOH-PC service contact on the same date as a hospital contact for acute myocardial infarction, stroke or sepsis.

Study II

All patients with an EMS and/or OOH-PC contact with or without a hospital contact on the same date.

Study III

All inhabitants in the North Denmark Region and Capital Region of Copenhagen with or without an EMS or OOH-PC contact.

4.2 SETTING

All studies were carried out in the North Denmark Region and Capital Region of Copenhagen. The North Denmark Region is a rural-urban region with 586,000 inhabitants representing approximately 10% of the Danish population. In contrast, the Capital Region of Copenhagen is a densely populated urban region with 1,789,000 inhabitants corresponding to 30% of the Danish population.[64] We chose these two regions to include a patient population representative of the entire sociodemographic profile, variations in population density and most importantly all types of OOH health care services in Denmark.[65,66] The overall OOH health care setup as well as regional differences has been described previously in this thesis. All studies were based on contacts to OOH services outside office hours, which was defined as weekends, public holidays and 4 P.M to 8 A.M on normal workdays.[13,66,67]

4.3 SELECTION OF PARTICIPANTS

In **study I**, we first identified adult patients (≥18 years) admitted to a hospital during 2016 with AMI, stroke or sepsis diagnoses according to the International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10) and as defined in **table 1**. We then subsequently identified the patients, who called one or more OOH services (GPC, MH-1813 and/or EMS) on the same date as their hospital contact began and included them in the study. If patients had multiple contacts during the study period, we included them by their first contact.[68]

Diagnosis	ICD-10 codes included in study population
Acute myocardial infarction	Acute myocardial infarction **I210** (I210A, I210B, I211, I211A, I211B, I213, I214, I219) Other acute ischaemic heart diseases **I240** (I240A, I241, I248, I248A, I249)
Stroke (incl. hemorrhagic stroke)	Subarachnoid haemorrhage **I600** (I601, I602, I603, I604, I605, I606, I606A, I606B, I606C, I607, I607A, I608, I609, I609A) Intracerebral haemorrhage **I610** (I611, I611A, I611B, I6612, I613, I614, I615, I616, I618, I619) Other non-traumatic intracranial haemorrhage **I620** (I621, I629) Cerebral infarction **I630** (I631, I632, I633, I634. I635, I636, I638, I639) Stroke, not specified as haemorrhage or infarction **I640** (I649)
Sepsis	Salmonella sepsis **A021** Septicaemic plague **A207** Anthrax sepsis **A227** Erysipelothrix sepsis **A267** Extraintestinal yersiniosis **A282B** Listerial sepsis **A327** Acute meningococcaemia **A392** (A392A) Meningococcaemia, unspecified **A394** Streptococcal sepsis **A400** (A401, A402, A403, A408, A409) Other sepsis **A410** (A411, A411A, A412, A413, A414, A415, A415A, A418, A419, A19B, A419C, A4127) Bacteraemia, not otherwise specified **A499A** Gonoccocal sepsis **A548G** Candidal sepsis **B377** Fungaemia, not otherwise specified **B499A**

Table 1. A list of ICD-10 codes used to identify which patients to include in the population of **study I**.[68]

For **study II** we identified all patients with contacts to GPC, MH-1813 and/or EMS in 2016. If hospital contacts on the same date as an OOH service contact were present, these were then identified. If patients had multiple contacts, they were included for each one.[67]

In **study III** we included all inhabitants in the North Denmark Region and Capital Region of Copenhagen and subsequently identified if they had an OOH service contact and if so, which type. Patients were included by their first service contact.[66]

All studies only included patients with valid personal identification number (PIN) and residence in the same region as the OOH service contacted.[66–69]

4.4 DATA SOURCES

The Danish Civil Registration System (studies I-III)

The Civil Registration System contains individual information on each citizen in Denmark.[69,70] The variables of greatest interest for our studies were: the unique personal identification number (PIN), gender, place of residence, date of birth, ethnicity, citizenship and continuously updated information on vital status (dead or alive). Most importantly, the PIN allows for linkage to a vast number of other registries.[66–68]

Prehospital databases of EMS, North Denmark Region and Copenhagen (studies I-III)

For all the patients included in the three studies, contacts to the EMS were identified by PIN in the dispatch data included in the prehospital medical record (PMR) (**figure 3**) and in the separate logistics data.[71] We only included EMS contacts that were redirected from the national emergency number 1-1-2 and only outside office hours, thus excluding daytime contacts and interhospital transport as well as ambulances requested from GPs. The data used in all studies were primarily dates or more specific timestamps for each EMS contact. However, these databases also include data such as the main symptom of the patient at the time of the emergency call (according to Danish Index for Emergency Care), time of ambulance dispatch, initial assessment of the patient by the ambulance personnel, therapy performed during transport and vital parameters registered.[72]

Figure 4. Ambulance personnel showing a tablet with the electronic prehospital medical record used nationwide in Danish EMS.

Data concerning contacts to MH-1813 were stored in the prehospital database of the EMS Copenhagen as MH-1813 and EMS use similar software solutions and are physically co-located. The database contains information such as time and date of call, description of patient symptoms, triage outcome (EMS referral, referral to hospital, home visit, telephone advice, see own GP on the following day etc.). All contacts to MH-1813 outside office hours were included.[66–68]

The National Health Service Registry (studies I-III)

The National Health Service Registry contains data regarding all contacts of Danish citizens with a valid PIN to GPs during normal working hours and to the GPC outside office hours.[73] This included timestamps for the contact, codes on type of contact (i.e. email consultation, telephone consultation, consultation and home visit and codes regarding procedures carried out such as laboratory tests, annual controls of chronic diseases). The registry also contained a variable determining if the contact took place during daytime or outside office hours. We only included OOH contacts.

The Danish National Patient Registry (studies I-II)

The registry includes information on PIN, date and time of hospital admissions and discharges, hospital and department of the admissions, all diagnosis codes during

admissions according to ICD-10 as well as information on surgical procedures and ICU stay.[74,75]

Statistics Denmark (studies I & III)

Statistics Denmark is state institution and the central authority on Danish statistics, collecting, compiling and publishing statistics on the Danish society.[76] It contains a vast amount of information on Danish citizens and certain registers are derived from this information such as Danish registers on personal labour market affiliation, Danish registers on personal income and transfer payments and Danish education registers.[66,68,77–79] The socioeconomic variables that were used in two of the studies in this thesis (i.e. highest completed education, personal income and labor market affiliation) were all obtained from such derived registers.

4.4.1 DATA MANAGEMENT

All the above information was anonymized by and uploaded to Statistics Denmark. Through remote access to a project database on a secure server, we were able to link the relevant information by PIN for each of the three studies and subsequently perform our analyses.

4.5 ANALYSIS

Study I

We described the baseline characteristics of the study population (i.e. age, gender, ethnicity, income level (quantiles), employment status, education length and comorbidity) and reported the distribution of contacts to the OOH services (i.e. OOH-PC and/or EMS). We created income level quantiles based on the income levels of the entire population and divided education level in three groups based on education length (≤10, >10-15 and ≥15 years). Comorbidity was determined according to the Charlson Comorbidity Index using diagnoses from past five years from the Danish National Patient Registry. As a measure for the degree of comorbidity, we created three categories (i.e. 0, 1-2, ≥3 comorbidities).[80,81]

For each included time-critical condition, we computed Kaplan-Meier survival curves to show the differences in mortality in relation to the OOH service contacted, calculated odds ratios (ORs) with 95% confidence intervals (CI) for mortality (1- and 30-day) using logistic regression analyses and the likelihood (hazard ratio (HR)) of having an ICU stay while hospitalized using cox regression analyses. Both crude and adjusted regression analyses were performed, the latter adjusted for the baseline characteristics. We also performed a sensitivity analysis including the patients by their last contact in the study period. Finally, we reported length of hospital stay as proportions for each time-critical condition in relation to the OOH service contacted.[68]

Study II

We reported the frequency of contacts to each OOH service and frequency of subsequent hospital contacts in relation to regional background populations (contacts per 1,000 inhabitants). For comparison of OOH service contact rates, we calculated incidence rate ratio estimates (IRR) with 95%CIs. Based on length of hospital stay, we divided hospital contacts into short hospital contacts (<24 hours) or hospital admissions (≥24 hours). For each OOH service, we calculated the distribution of the two hospital contact types in percent. Cases with an EMS and OOH-PC contact on the same date as the hospital contact were reported separately.

For subsequent hospital contacts, we included the last ICD-10 diagnosis that was reported during the hospital stay. We calculated the proportions of the ICD-10 chapters for both short hospital contacts and hospital admissions in percent and showed the distribution of chapters between OOH services. Finally, we visualized the diagnostic pattern based on ICD-10 chapters of short contacts and admissions stratified by the OOH service contacted prior, with frequency per patient age at the time of contact. We test differences in age across OOH service groups by performing Wilcoxon rank sum test.[67]

Study III

We identified the first OOH service contact (OOH-PC or EMS) for each citizen during the study period and assigned this citizen to this service. We did so because each citizen may have had contact to more than one OOH service during the study period. We then reported the prevalence of sociodemographic characteristics (i.e. age, sex, ethnicity, income level (quantiles), education length (≤10, >10-15 and ≥15 years) and

socioeconomic classification) by region and by assigned service (OOH-PC, EMS or no contact).

We evaluated the association between the sociodemographic characteristics and OOH health care utilization by performing negative binomial regression analysis. For this analysis, we included a measure for contact rate by including all contacts to the OOH service, the patient was assigned to (e.g. if the first OOH service contacted was OOH-PC, all contacts to OOH-PC were included). Consequently, the regression analysis resulted in IRR, for instance ratio of contacts for low income with high income as the reference. All IRRs were then combined in a Forest plot.

We also performed logistic regression analyses to assess the association between sociodemographic characteristics and the likelihood of contact (reported as OR) to EMS or OOH-PC as outcome. In this analysis, we also used the OOH service first contacted. The OR estimates where then combined in a Forest plot. We adjusted for age and sex in all regression analyses. If missing values were present for characteristics, analyses only included citizens with the information of interest.[66]

All statistical analyses were performed with Stata V.15.0/MP (Stata Corporation, College Station, Texas, USA).

4.6 ETHICS

All studies were approved by the Danish Data Protection Agency (North Denmark Region record number 2008-58-0028 and project identification number 2017-171). Due to the possible urgency and severity of the patients' conditions as well as the population size, consent for accessing prehospital medical records could not be obtained through individual patient consent. Thus, access to prehospital patient medical records was approved by the Danish Patient Safety Authority on behalf of the included patients (record number 3-3013-2315/1).

5 RESULTS

5.1 PATIENTS WITH TIME-CRITICAL CONDITIONS – WHO DID THEY CALL AND DID IT AFFECT THEIR OUTCOME?

In **study I**, we included 6,826 adult patients, who contacted EMS, OOH-PC or both and were hospitalized with AMI, stroke or sepsis on the same date. The patients were elderly with a mean age of 70.2 (95%CI: 69.7-70.8) years for OOH-PC, 70.8 (95%CI: 70.3-71.3) for EMS and 71.6 (95%CI: 70.3-72.8) years for patients who contacted both services. The majority were men (56.9%, 58.0% and 59.8%, respectively) (**table 2**).[68]

	OOH-PC	EMS	OOH-PC & EMS
Number (%)	3,401 (49.8)	2,903 (42.5)	522 (7.6)
Age, mean, (95%CI)	70.2 (69.7-70.8)	70.8 (70.3-71.3)	71.6 (70.3-72.8)
Female sex	1,464 (43.1)	1,220 (42.0)	210 (40.2)
Employment status			
Employed	743 (21.9)	579 (19.9)	91 (17.4)
Unemployed (retired, on benefits, under education etc.)	2,658 (78.2)	2,324 (80.1)	431 (82.6)
Ethnicity			
Danish	3,110 (91.4)	2,642 (91.0)	488 (93.5)
Western countries	101 (3.0)	91 (3.1)	14 (2.7)
Non-western countries	190 (5.6)	170 (5.9)	20 (3.8)
Education length*			
<=10 years	1,404 (41.3)	1,180 (40.6)	237 (45.4)
>10-≤15 years	1,380 (40.6)	1,250 (43.1)	214 (41.0)
>15 years	617 (18.1)	473 (16.3)	71 (13.6)
Income level (quantiles)			
1 (low)	727 (21.4)	739 (25.5)	127 (24.3)
2	922 (27.1)	815 (28.1)	156 (29.9)
3	849 (25.0)	693 (23.9)	148 (28.4)
4 (high)	903 (26.6)	656 (22.6)	91 (17.4)
Charlson Comorbidity Index (CCI)			
CCI 0	1,824 (53.6)	1,624 (55.9)	282 (54.0)
CCI 1-2	1,121 (33.0)	916 (31.6)	178 (34.1)
CCI >=3	456 (13.4)	363 (12.5)	62 (11.9)

*<=10 years (primary school), >10 - 15 years (vocational educations, gymnasium, short-cycle higher education), >15 years (medium-cycle higher education, long-cycle higher education, university).

Table 2. Baseline characteristics of patient population in **study I** (N=6,826) (n, (%)).[68]

Distribution of contacts

A large number of patients hospitalized with AMI (39.2%), stroke (39.9%) and the majority of sepsis patients (66.9%) contacted OOH-PC (**figure 5**). In the stroke group, EMS was contacted for 65.3% of patients with hemorrhagic stroke compared to 51.1% of patients with ischemic stroke. Patients hospitalized with sepsis were also

the largest patient group, comprising 37.5% of our population. Few patients contacted both EMS and OOH-PC (7.6%) (**table 2**).

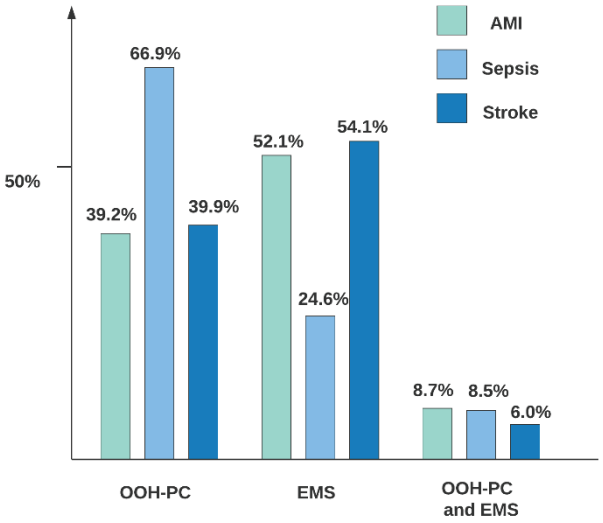


Figure 5. Distribution of the OOH service contacted for each time-critical condition.[68]

Mortality

Patients hospitalized with sepsis were severely ill and had the highest number of cumulative deaths on day 30 followed by stroke patients. Most sepsis patients contacted OOH-PC, but we found a significantly higher likelihood of both 1- and 1-30-day mortality for sepsis and stroke patients contacting EMS alone or contacting both OOH-PC and EMS, when compared to solely contacting OOH-PC. Of the three included conditions, patients with AMI had the lowest mortality. No statistically significant differences in likelihood of mortality for AMI patients were found in relation OOH service (**table 3** and **figure 6**).[68]

Diagnosis	Service	1-day mortality		1-30-day mortality		Intensive care unit stay	
	N	N (%)	OR (95%CI)	N (%)	OR (95%CI)	N (%)	HR (95%CI)
AMI (N=1,734)	OOH-PC (679)	12 (1.77)	ref	51 (7.51)	ref	12 (1.77)	ref
	EMS (904)	19 (2.10)	1.29 (0.58-2.48)	54 (5.97)	0.78 (0.53-1.16)	29 (3.21)	1.66 (0.85-3.27)
	OOH-PC and EMS (151)	<5 (NR*)	1.51 (0.48-4.76)	13 (8.61)	1.16 (0.61-2.19)	<5 (NR*)	1.44 (0.46-4.49)
Sepsis (N=2,561)	OOH-PC (1713)	43 (2.51)	ref	308 (17.98)	ref	42 (2.45)	ref
	EMS (629)	34 (5.41)	2.22 (1.40-3.51)	136 (21.62)	1.26 (1.00-1.58)	39 (6.20)	1.56 (0.99-2.46)
	OOH-PC and EMS (219)	15 (6.85)	2.86 (1.56-5.23)	54 (24.66)	1.49 (1.07-2.08)	8 (3.65)	1.14 (0.53-2.43)
Stroke (N=2,531)	OOH-PC (1,009)	11 (1.09)	ref	68 (6.74)	ref	23 (2.28)	ref
	EMS (1,370)	76 (5.55)	5.33 (2.82-10.08)	214 (15.62)	2.56 (1.92-3.41)	110 (8.03)	2.38 (1.51-3.75)
	OOH-PC and EMS (152)	5 (3.29)	3.09 (1.06-9.01)	21 (13.82)	2.22 (1.32-3.74)	7 (4.61)	1.94 (0.83-4.53)

* NR= not reported due to too few observations.

Table 3. Association between OOH service contacted and mortality and risk of ICU stay (crude OR and HR with 95%CI)(N=6,826).[68]

Adjusting for patient baseline characteristics, did not change the results notably as shown in **table 4**.

Diagnosis	Service	1-day mortality		30-day mortality		Intensive care unit stay	
		N (%)	OR* (95%CI)	N (%)	OR*(95%CI)	N (%)	HR* (95%CI)
AMI	OOH-PC (N=679)	12 (1.77)	ref	51 (7.51)	ref	12 (1.77)	ref
(N=1,734)	EMS (N=904)	19 (2.10)	1.01 (0.48-2.14)	54 (5.97)	0.68 (0.45-1.03)	29 (3.21)	1.83 (0.92-3.68)
	OOH-PC and EMS (N=151)	<5 (NR)	1.34 (0.41-4.37)	13 (8.61)	1.05 (0.53-2.08)	<5 (NR)	2.04 (0.64-6.51)
Sepsis	OOH-PC (N=1,713)	43 (2.51)	ref	308 (17.98)	ref	42 (2.45)	ref
(N=2,561)	EMS (N=629)	34 (5.41)	2.09 (1.31-3.33)	136 (21.62)	1.17 (0.92-1.48)	39 (6.20)	1.52 (0.96-2.41)
	OOH-PC and EMS (N=219)	15 (6.85)	2.53 (1.37-4.68)	54 (24.66)	1.31 (0.93-1.85)	8 (3.65)	1.19 (0.55-2.56)
Stroke	OOH-PC (N=1,009)	11 (1.09)	ref	68 (6.74)	ref	23 (2.28)	ref
(N=2,531)	EMS (N=1,370)	76 (5.55)	5.29 (2.79-10.03)	214 (15.62)	2.63 (1.96-3.53)	110 (8.03)	2.37 (1.50-3.74)
	OOH-PC and EMS (N=152)	5 (3.29)	3.26 (1.11 -9.60)	21 (13.82)	2.51 (1.45-4.33)	7 (4.61)	1.65 (0.69-3.94)

Table 4. Association between OOH service contacted and mortality and risk of ICU stay (adjusted OR and HR with 95%CI)(N=6,826).[68]

We performed a sensitivity analysis using the patients' last contact rather than their first, which did not lead to substantial changes in the results (**table 5**).

Diagnosis	Service	1-day mortality	30-day mortality	Intensive care unit stay
	N	OR (95%CI)	OR (95%CI)	HR (95%CI)
AMI	OOH-PC (684)	ref	ref	ref
(N=1,727)	EMS (894)	1.28 (0.62-2.64)	0.80 (0.54-1.18)	1.71 (0.87-3.36)
	OOH-PC and EMS (149)	1.55 (0.49-4.87)	1.24 (0.67-2.29)	1.50 (0.48-4.66)
Sepsis	OOH-PC (1,741)	ref	ref	ref
(N=2,587)	EMS (633)	2.15 (1.37-3.77)	1.28 (1.03-1.60)	1.60 (1.02-2.50)
	OOH-PC and EMS (213)	2.99 (1.66-5.39)	1.71 (1.24-2.36)	1.19 (0.56-2.55)
Stroke	OOH-PC (1,003)	ref	ref	ref
(N=2,512)	EMS (1,356)	5.58 (2.95-10.54)	2.65 (1.99-3.52)	2.28 (1.47-3.53)
	OOH-PC and EMS (153)	3.05 (1.04-8.90)	2.19 (1.30-3.69)	1.76 (0.76-4.08)

Table 5. Association between OOH service contacted and mortality and risk of ICU stay (crude OR and HR with 95%CI). Sensitivity analysis using the patients' last hospital contact during the study period (N=6,826).[68]

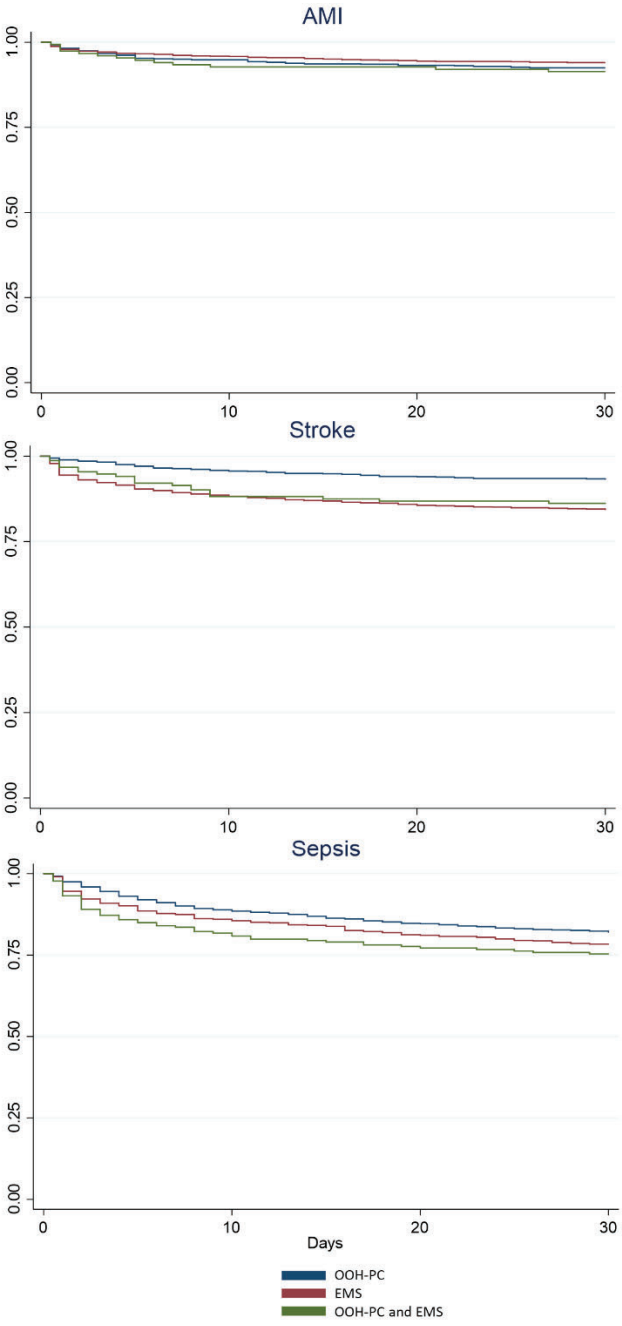


Figure 6. Kaplan-Meier survival curves for each time-critical condition with each different line color representing the different OOH services (N=6,826).[68]

ICU stay and length of stay

Stroke patients were most often admitted to the ICU (**table 3**) and we found a significantly higher risk of ICU stay for stroke patients contacting EMS compared to those contacting OOH-PC or OOH-PC and EMS. A non-significant tendency of increased risk of ICU stay was also observed for AMI and sepsis patients contacting EMS compared to patients contacting OOH-PC.

Patients with AMI contacting OOH-PC had the highest proportion of one day hospital stays (**figure 7**). More EMS patients with stroke had stay of seven days or more compared to OOH-PC or OOH-PC and EMS contacts. In addition, more sepsis patients with EMS or OOH-PC and EMS contacts had stays of seven days or more, when compared to OOH-PC contacts.[68]

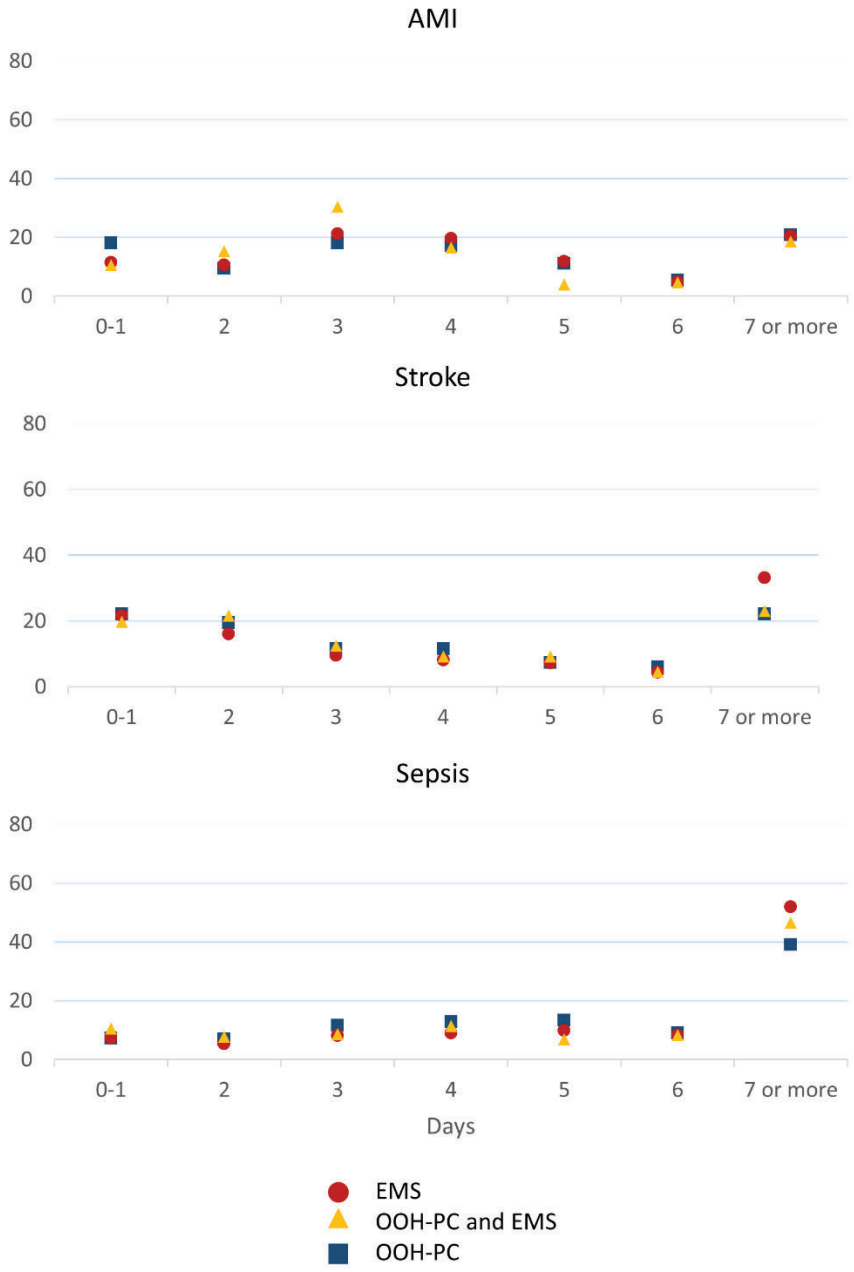


Figure 7. Length of hospital stay (percentage of all OOH contacts within each service) for the included conditions with line color representing the different OOH services (N=6,826).[68]

5.2 PATIENT CARE PATHWAYS OUTSIDE OFFICE HOURS

Prevalence of contacts

We identified 1,219,963 OOH patient contacts with valid PIN to EMS or OOH-PC services in **study II** (**figure 8**). The highest prevalence of contacts were to OOH-PC, corresponding to more than 90% of all contacts (**table 6**).[67]

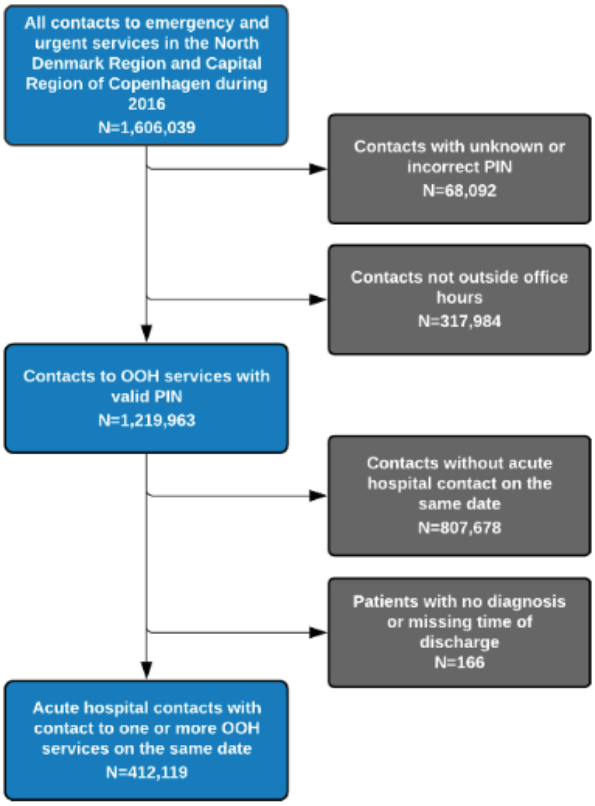


Figure 8. Flow chart of inclusion process for **study II**.[67]

Patient pathways

The rate of hospitalization differed between OOH services. We found that between 46% and 54% of patients contacting EMS had a subsequent hospital contact, closely followed by MH-1813 with 41% subsequent hospital contacts. Patients contacting the GPC had the fewest hospital contacts (9%) (**table 6**). Additionally, we identified

7,197 hospital contacts by patients who had called both EMS and OOH-PC on the same date as hospitalization.[67]

Type of hospital contact

For EMS patients, hospital contacts of short duration (defined as <24 hours) amounted to 10 per 1,000 inhabitants (IRR=0.93 (95%CI: 0.90-0.96)) and hospital admissions (defined as ≥24 hours) to 11-13 per 1,000 inhabitants (IRR=0.89 (95%CI: 0.87-0.92)), yielding admission rates of 26%-30% for all EMS contacts (**table 6**).

The number of short contacts for OOH-PC patients showed substantial regional differences being five times as frequent for MH-1813 (144 per 1,000 inhabitants) compared to GPC (29 per 1000 inhabitants) (IRR=5.02 (95%CI: 4.94-5.10). Admissions were also less frequent for GPC compared to MH-1813 (23 vs. 34 per 1,000 – corresponding to 4%-8% of all OOH-PC contacts (IRR=1.44 (95%CI=1.34-1.56))).

Both short contacts and admissions for patients contacting both EMS and OOH-PC were few in numbers; short contacts (1-2 per 1,000), admissions (2-3 per 1,000). However, of those hospital contacts, the proportion of admissions was higher than that of EMS or OOH-PC patients (**figure 9**).[67]

	EMS		OOH-PC		
Healthcare service	**North**	**Copenhagen**	**GPC**	**MH-1813**	**Total**
All activities, all hours[1]	102 (59,880)	173 (310,907)	560 (328,151)	507 (907,101)	(1,606,309)
Valid PIN, all hours	90 (53,123)	156 (279,393)	560 (328,151)	490 (877,280)	(1,537,947)
Out-of-hours[2]	39 (22,592)	50 (90,074)	560 (328,151)	435 (779,146)	(1,219,963)
Subsequent hospital contacts[3]	21 (12,544)	23 (41,993)	52 (30,307)	178 (319,358)	(404,202)
- **Short hospital contacts**	10 (5,679)	10 (18,618)	29 (16,867)	144 (258,392)	(299,556)
- **Admissions**	11 (6,865)	13 (23,375)	23 (13,440)	34 (60,966)	(104,646)

[1]Activities during all hours including OOH shown. [2]Only including EMS contacts related to emergency (1-1-2) calls. [3]Not including patients with multiple contacts.

Table 6. Prevalence of contacts per 1,000 inhabitants stratified by OOH service.[67]

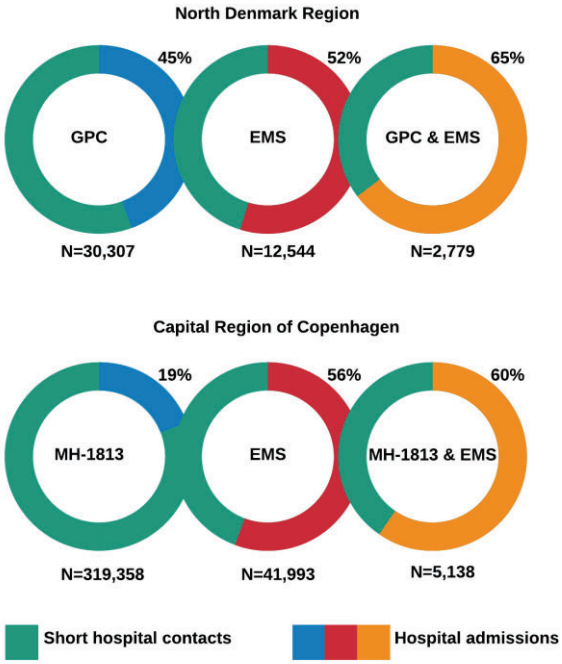


Figure 9. For OOH service contacts with a subsequent hospital contact, the proportion of short contacts and hospital admissions is shown for each service in the two regions (N=412,119).[67]

Pattern of diagnoses

In our population, the majority of patients were hospitalized with injury or poisoning or non-specific diagnoses (comprised of the ICD-10 chapters symptoms and signs and other factors) (**table 7-8, figure 10a-b, 11a-b**).

Short hospital contacts

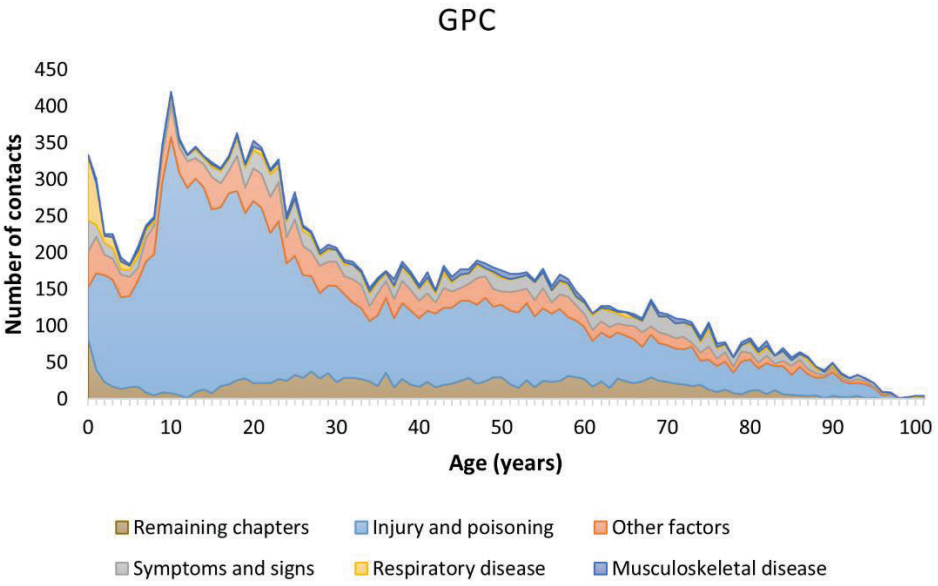
In short hospital contacts, especially injury and poisoning differed with a much larger proportion of these diagnoses among GPC patients. Similarly, for patients contacting MH-1813 the proportion of respiratory diseases was much larger. Additionally, the patients contacting EMS were diagnosed with non-specific diagnoses twice as often (36.8%-44.9%) as patients contacting OOH-PC (19.8%-22.2%). Looking at the less frequent diagnoses, we saw that patients contacting MH-1813 differed in diagnostic pattern compared to patients contacting EMS or GPC with a much higher frequency of for instance infections and genitourinary disease (**table 7**). Patients with

circulatory disease were most frequent in EMS contacts, while patients with digestive disease were most frequent in OOH-PC contacts.

ICD-10 chapter	All	EMS		OOH-PC	
	% N=299,556	North N=5,679	Copenhagen N=18,618	GPC N=16,867	MH-1813 N=258,392
Injury and poisoning	33.9	33.7	37.0	62.6	31.8
Respiratory disease	14.0	2.4	4.4	2.3	15.7
Symptoms and signs	11.4	29.6	22.1	8.8	10.4
Other factors	10.1	15.3	14.7	13.4	9.4
Infections	7.3	0.5	1.4	1.2	8.2
Genitourinary disease	4.9	1.2	1.9	1.2	5.4
Musculoskeletal disease	3.7	2.5	2.6	2.1	3.9
Skin disease	3.2	0.2	0.4	0.8	3.6
Ear disease	3.0	0.3	0.4	0.3	3.4
Eye disease	2.8	0.2	0.2	1.9	3.1
Digestive disease	2.5	1.2	2.3	1.5	2.6
Circulatory disease	1.1	3.4	3.6	1.7	0.9
Remaining chapters	2.1	9.9	9.0	2.2	1.6
Total	100	100	100	100	100

Table 7. Distribution of ICD-10 diagnostic chapters in short hospital contacts ranked by frequency of chapters in all contacts and stratified by OOH service (N=299,556).[67]

Patients contacting EMS or GPC showed some similarities in age pattern, although EMS patients were more often elderly ($p<0.00$). In contrast, MH-1813 patients were often children of 4 years and younger (**figure 10a-b**). Patients contacting both EMS and OOH-PC (not in table) often received non-specific diagnoses (35.8%-56.6%) followed by injury diagnoses (18.3%-27.8%).



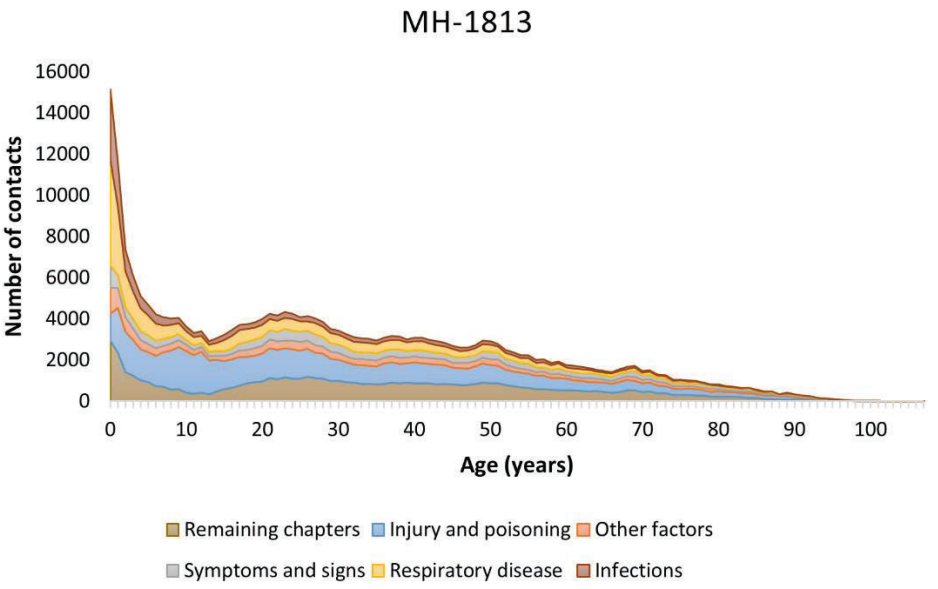
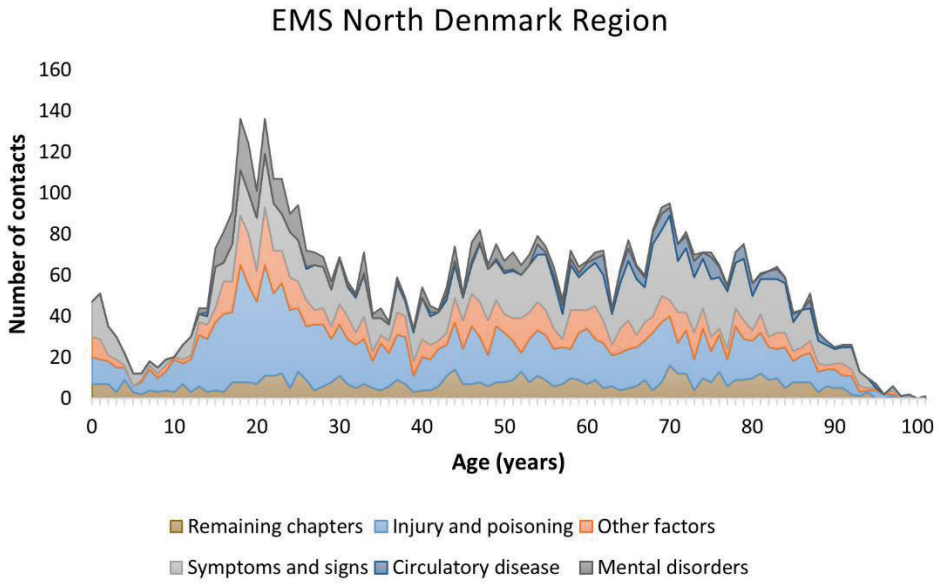


Figure 10a. Most frequent (top five) ICD-10 diagnosis chapters in short hospital contacts following contact to each OOH service, with number of contacts for patient age (N=299,556).[67]



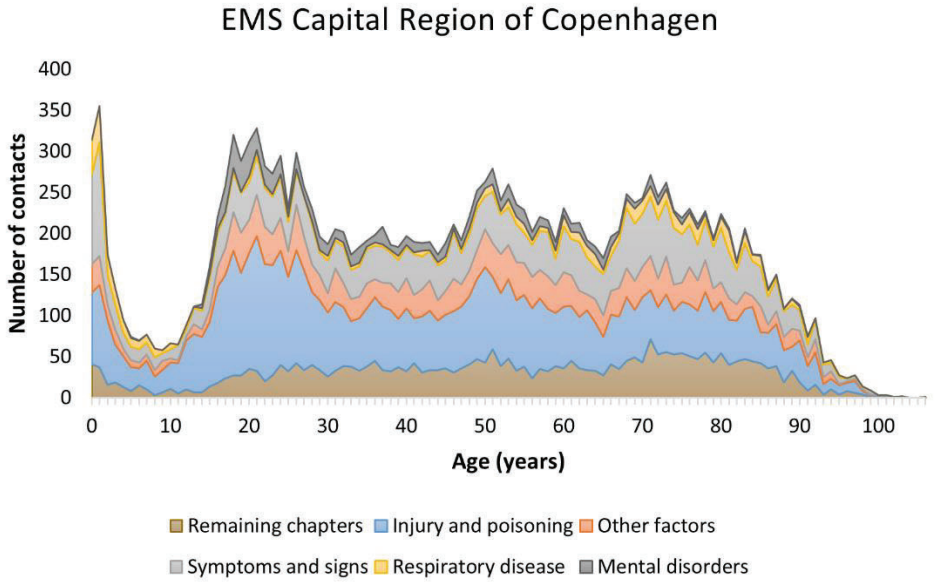


Figure 10b. Most frequent (top five) ICD-10 diagnosis chapters in short hospital contacts following contact to each OOH service, with number of contacts for patient age (N=299,556).[67]

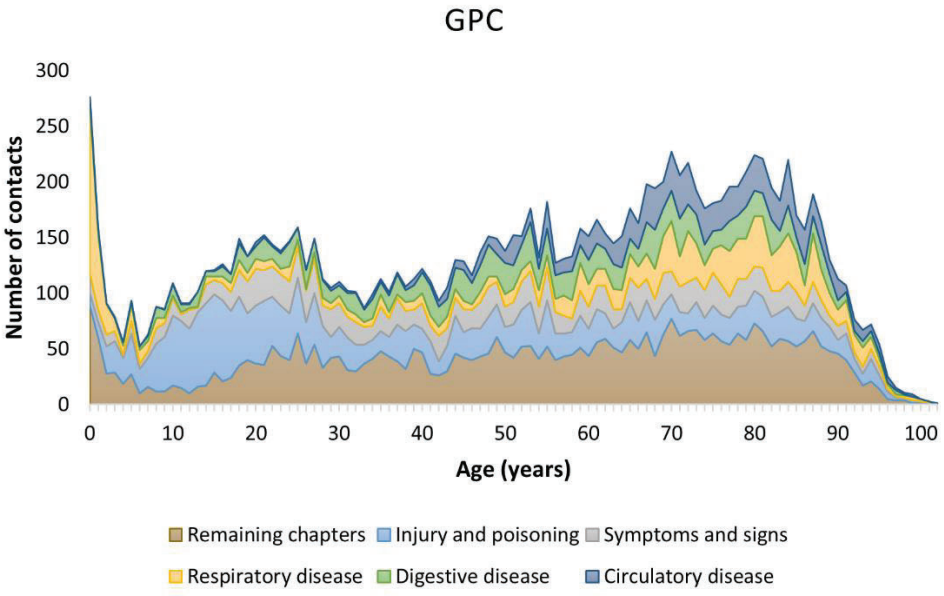
Hospital admissions

Patients contacting EMS or OOH-PC were often admitted to hospital with non-specific or injury diagnoses as well as respiratory diseases (**table 8, figure 11a-b**). For EMS patients, circulatory disease, neurological disease and mental disorders were twice as frequent as for OOH-PC patients, while the opposite was the case for infections, digestive and genitourinary disease.

More elderly patients were admitted for all types of OOH service contacts (p<0.00). Still, children 4 years and below often contacted MH-1813 (**figure 11a-b**). Circulatory and respiratory diseases were prominent among patients who contacted both EMS and OOH-PC (not in table).[67]

	All	EMS		OOH-PC	
ICD-10 chapter	% N=104,646	North N=6,865	Copenhagen N=23,375	GPC N=13,440	MH-1813 N=60,966
Injury and poisoning	17.2	21.6	19.8	22.2	14.7
Symptoms and signs	15.9	17.1	15.3	13.7	16.5
Respiratory disease	13.1	10.7	12.1	12.8	13.9
Other factors	11.4	9.8	11.5	7.4	12.4
Circulatory disease	9.0	16.8	13.2	8.7	6.6
Digestive disease	8.6	5.6	5.4	11.7	9.4
Infections	5.3	2.6	3.0	5.1	6.5
Genitourinary disease	4.6	2.4	2.5	5.0	5.6
Neurological disease	2.8	3.7	4.6	1.9	2.1
Musculoskeletal disease	2.7	1.4	1.6	2.3	3.3
Endocrine disease	2.6	1.9	2.7	2.9	2.6
Mental disorders	2.1	3.5	4.0	1.6	1.3
Skin disease	1.4	0.2	0.3	1.2	1.9
Pregnancy & childbirth	1.1	0.6	1.9	0.9	0.8
Remaining chapters	2.2	2.1	2.1	2.6	2.1
Total	100	100	100	100	100

Table 8. Distribution of ICD-10 diagnostic chapters in admissions ranked by frequency of chapters in all contacts and stratified by OOH service (N=104,646).[67]



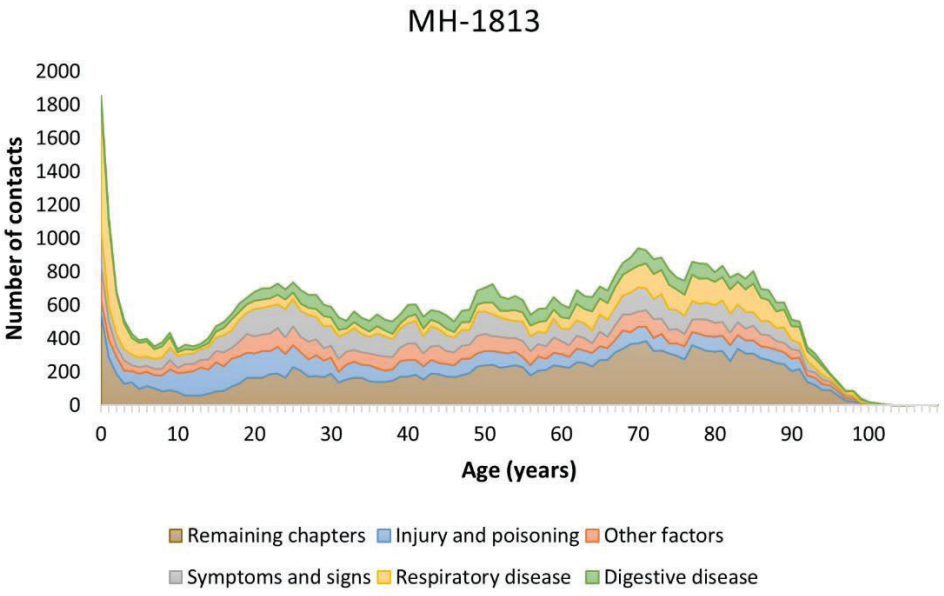
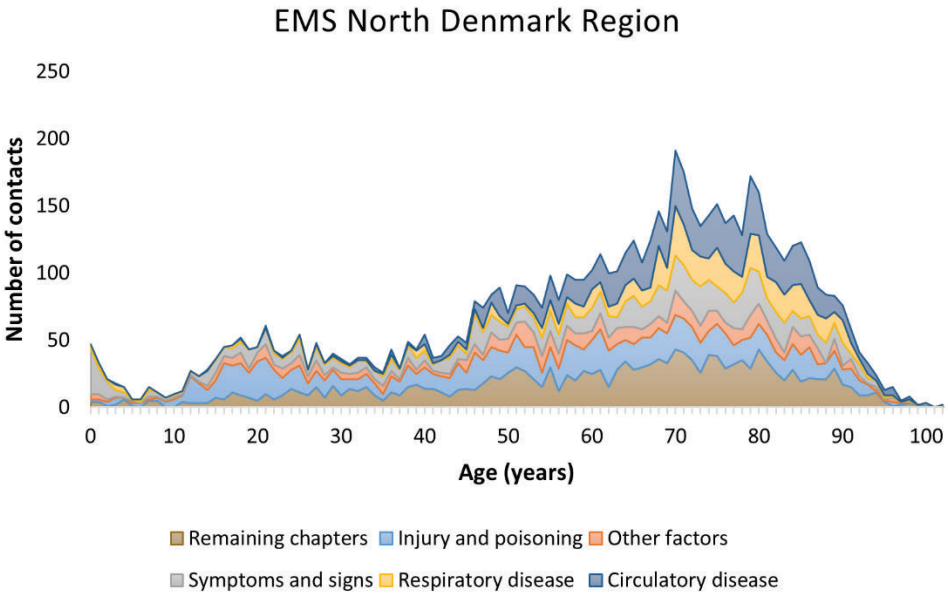


Figure 11a. Most frequent (top five) ICD-10 diagnosis chapters in hospital admissions following contact to each OOH service, with number of contacts for patient age (N=104,646).[67]



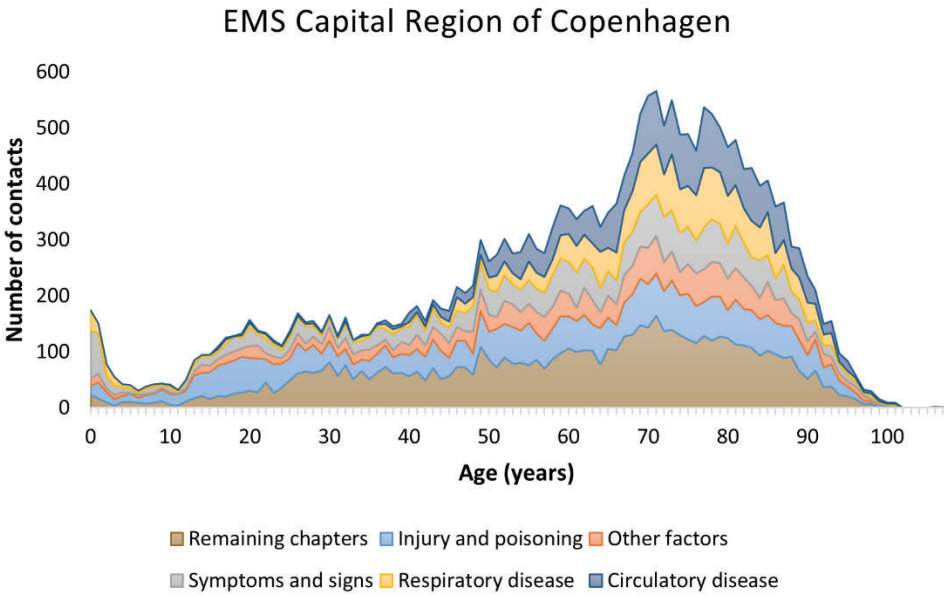


Figure 11b. Most frequent (top five) ICD-10 diagnosis chapters in hospital admissions following contact to each OOH service, with number of contacts for patient age (N=104,646).[67]

5.3 DO SOCIODEMOGRAPHIC FACTORS PLAY A ROLE WHEN CALLING FOR HELP?

In **study III**, our study population consisted of the populations in the North Denmark Region and Capital Region of Copenhagen (2,374,673 inhabitants). Among these, 26% (619,857) had one or more OOH service contact(s) and OOH-PC handled the vast majority of these contacts (89.3%).[66]

Comparison of citizens with or without an OOH service contact

Patients with contact to any type of OOH service were identified and included by their first OOH service contact and the number of subsequent contacts to that particular service. For each sociodemographic characteristic, we chose a reference value and investigated the association between that characteristic and having a contact to an OOH service (**figure 12**).

The highest IRRs were observed for the age groups 0-18 years (IRR=1.94 (95%CI: 1.92-1.95)) and 81+ years (IRR=2.56 (95%CI: 2.52-2.60)) with 31-65 years as reference. Among the socioeconomic classifications, disability pensioners (IRR=3.15 (95%CI: 3.07-3.24)), old-age pensioners (IRR=2.88 (95%CI: 2.83-2.93)), citizens on cash benefits (IRR=2.25 (95%CI: 2.19-2.31)) and sick/leave pay (IRR=1.64 (95%CI: 1.59-1.70)) had the highest IRR with employees as the reference. Inhabitants in the 3rd (IRR=1.76 (95%CI: 1.74-1.78)) and 4th (IRR= 1.70 (95%CI: 1.68-1.71)) (lowest) income quantiles also had a higher likelihood of an OOH service contact compared to citizens in the highest income quantile). Contacts to OOH care were less likely to occur for highly educated patients: education level >15 years (IRR=0.54 (95%CI: 0.54-0.55)) with lowest education level as the reference.[66]

Comparison of EMS patients and OOH-PC patients

Among patients identified with an OOH service contact, we investigated the likelihood of contacting EMS or OOH-PC for each sociodemographic characteristic (**figure 13**).

We found the highest ORs for contacting EMS in the age groups 66-80 years (OR=2.78 (95%CI: 2.72-2.84)) and 81+ years (OR=3.21 (95%CI: 3.13-3.30)) compared to the age group 31-65 years, while an EMS contact for 0-18 years was not likely (OR=0.3 (95%CI: 0.29-0.31)), corresponding to a high likelihood of OOH-PC contact. High odds for contacting EMS were also found for persons with the socioeconomic classifications cash benefits (OR=2.45 (95%CI: 2.36-2.54)), disability pension (OR=2.28 (95%CI: 2.20-2.37), other (OR=1.90 (95%CI: 1.81-2.00)) and old-age

pension (OR=1.89 (95%CI: 1.83-1.96)) with employees as the reference. Lowest income level was also associated with higher odds of contacting EMS (OR=1.76 (95%CI: 1.72-1.81)) with highest income level as reference. All the investigated sociodemographic characteristics are displayed in **figure 13**.[66]

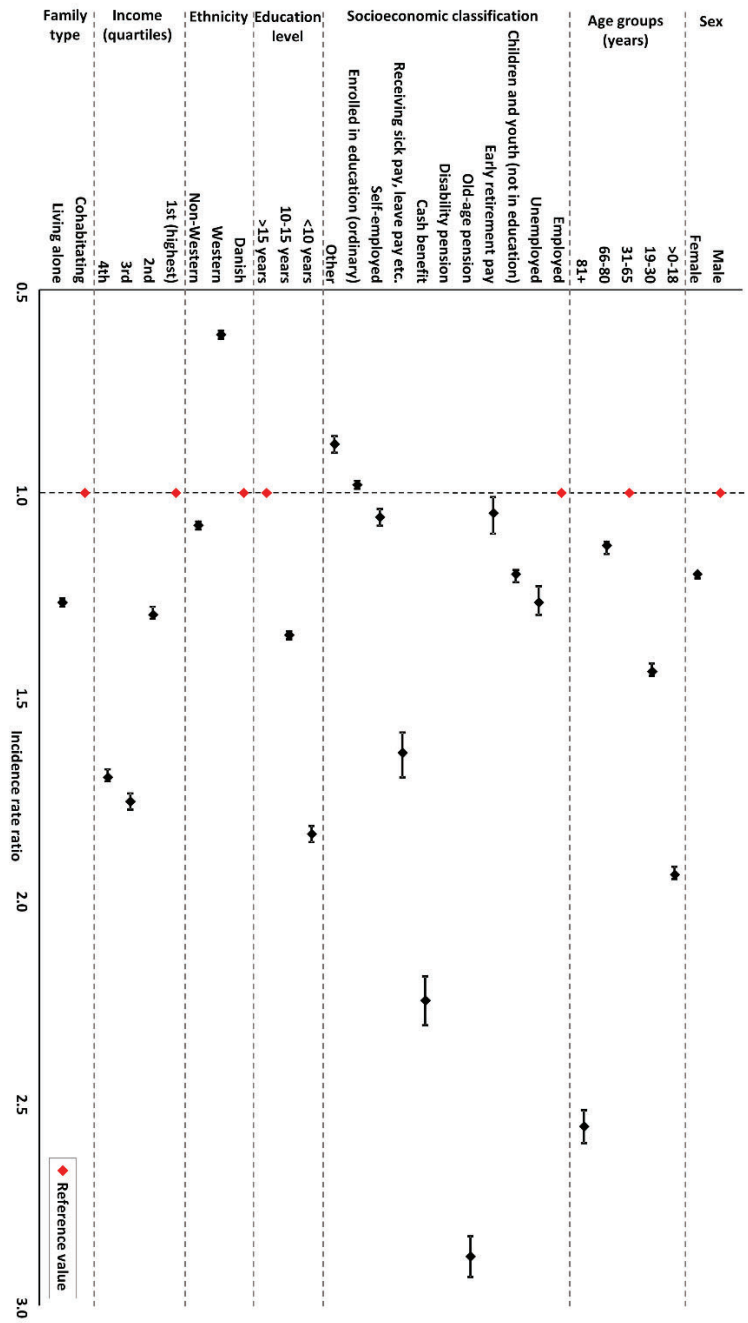


Figure 12. Associations between sociodemographic characteristics and adjusted incidence rate ratios with 95%CI (N=2,374,673).[66]

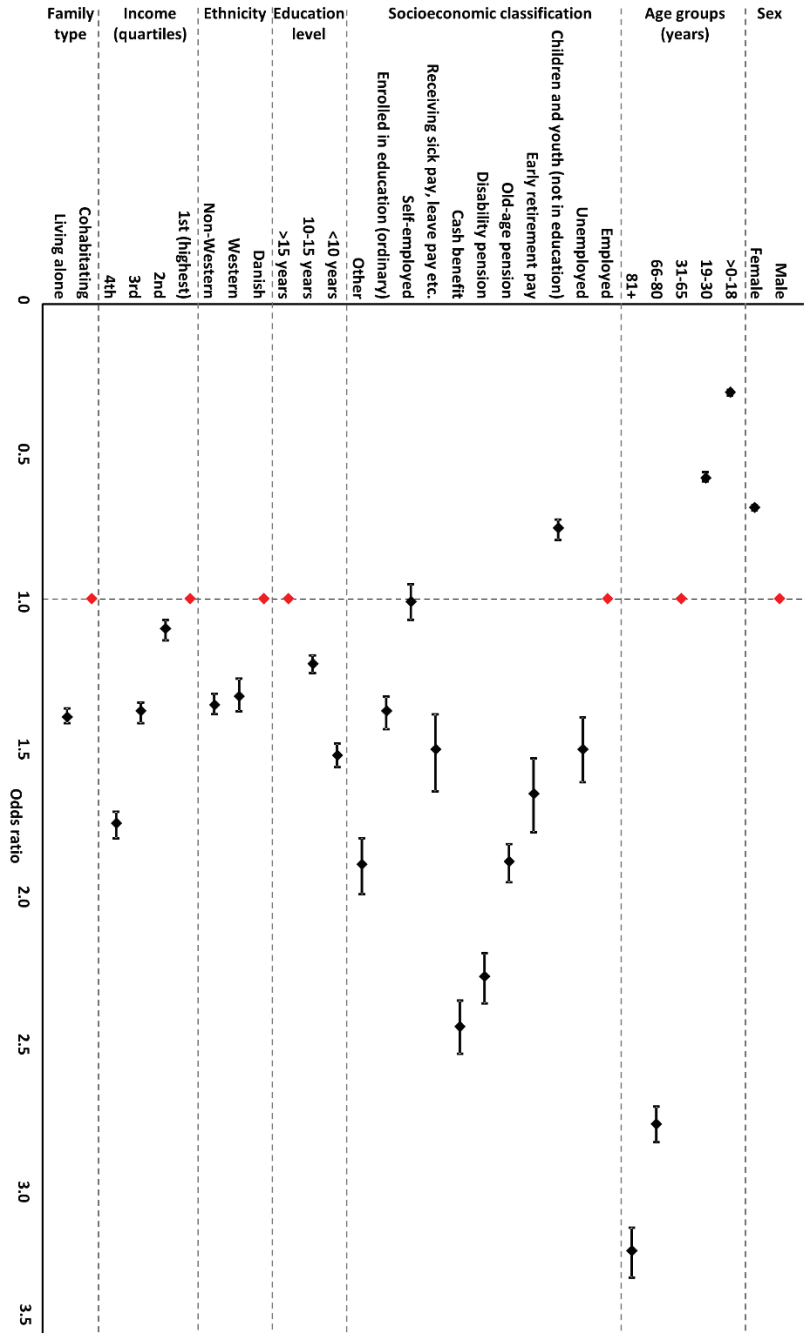


Figure 13. Adjusted odds ratios with 95%CI of EMS or OOH-PC contact for each sociodemographic characteristics (N=619,857).[66]

5.4 PATIENTS CONTACTING BOTH EMS AND OOH-PC

In this thesis, we identified a small group of patients who contacted both EMS and OOH-PC on the same date as they had a hospital contact. They comprised 7.6% and 1.9% of the hospitalized population in **studies I** and **II**, respectively. In **study I**, we observed that these patients were the oldest, had the highest percentage of unemployment and the highest proportion of short education (**table 2**). Furthermore, their 30-day (and in the case of sepsis also 1-day) mortality surpassed that of patients contacting EMS or OOH-PC, when hospitalized with AMI or sepsis (**table 3**). When hospitalized with stroke, both 1- and 30-day mortality surpassed OOH-PC patients, but not EMS patients. The proportion of patients with ICU stay was also higher than OOH-PC patients, but not than EMS patients. In **study II**, patients contacting both EMS and OOH-PC with a subsequent hospital contact also had a higher proportion of admissions than EMS or OOH-PC patients and were older (**figure 9, table 9**)**.** In hospital admissions, the three most frequent diagnostic chapters were respiratory disease, symptoms and signs and circulatory disease (**table 10**).

	Short hospital contact	Admission
EMS		
North Denmark Region	47.0 (24.8)	60.1 (22.6)
Capital Region of Copenhagen	46.8 (25.4)	60.5 (22.7)
All	**46.8 (25.3)***	**60.4 (22.7)*†**
OOH-PC		
GPC	34.2 (24.1)	51.5 (26.9)
MH-1813	30.1 (23.5)	49.1 (27.6)
All	**30.3 (23.5)***	**49.5 (27.5)*†**
Multiple contacts		
EMS & GPC	51.4 (24.3)	62.6 (21.0)
EMS & MH-1813	47.4 (26.5)	64.3 (23.2)
All	**48.7 (25.7)***	**63.7 (22.5)*†**

*comparison of age between overall groups (EMS, OOH-PC and multiple contacts), p<0.00
†comparison of age in short hospital contacts and admissions, p<0.00

Table 9. Mean age (SD) of hospitalized patients with a hospital contact (N=412,119).[67]

ICD-10 chapter	All N=7,917	Short contacts N=3,058	Admissions N=4,859
Symptoms and signs	19.9	27.1	15.4
Injury and poisoning	15.5	24.8	9.7
Respiratory disease	12.3	6.4	16.1
Other factors	12.1	15.4	9.9
Circulatory disease	9.4	3.7	13.0
Digestive disease	7.5	4.1	9.6
Remaining chapters	23.3	18.5	26.3
Total	100	100	100

Table 10. Diagnostic chapters of patients contacting both EMS and OOH-PC with a subsequent short hospital contact or admission. Chapters comprising ≥5% of all contacts shown (N=7,917).

6 DISCUSSION

6.1 MAIN FINDINGS

The overall objective of this thesis was to investigate if patients choose the most relevant OOH service to handle their condition. We addressed this question through three objectives and found the following results:

Study I: Patients with time-critical conditions – who did they call and did it affect their outcome?

Patients hospitalized with AMI or stroke contacted OOH-PC in 40% of all contacts, while two-thirds of sepsis patients contacted OOH-PC. Few patients (7.6%) contacted both EMS and OOH-PC on the date of hospitalization.

Stroke and sepsis patients contacting the EMS or contacting both EMS and OOH-PC had a higher mortality rate (1- and 1-30 days) compared to patients with a preceding OOH-PC contact, while no such difference was found for patients with AMI. Contacting EMS was significantly associated with a higher risk of an ICU stay for stroke patients. A similar tendency was observed for patients with sepsis and AMI. Patients hospitalized with stroke or sepsis who had a preceding EMS contact more often had longer stays.

Study II: Patient care pathways outside office hours

OOH-PC services (i.e. GPC and MH-1813) handled 90% of all contacts outside office hours. Around half of EMS patients, 41% of MH-1813 patients and 9% of GPC patients had a subsequent hospital contact. For MH-1813, patients referred to face-to-face consultations at hospital were included in short hospital contacts. A small group of patients (1.9%) contacted both OOH-PC and EMS on the date of hospitalization. Among all patients with hospital contacts, the proportion of admissions was highest for patients contacting both EMS and OOH-PC, followed by EMS, GPC and lastly MH-1813 patients.

Patients with short hospital contacts were younger than admitted patients. Patients contacting EMS or OOH-PC with short hospital contacts often concerned injuries. EMS patients received non-specific diagnoses in 30% of short hospital contacts and among all short hospital contacts non-specific diagnoses comprised 20%. MH-1813

contacts frequently concerned children ≤4 years and respiratory diseases. Admitted patients with preceding contacts to either EMS or OOH-PC were older than patients with short hospital contacts and had similar diagnoses, often concerning respiratory disease, injuries and non-specific symptoms. Circulatory disease was twice as frequent for EMS patients compared to OOH-PC patients. Patients contacting both EMS and OOH-PC were frequently admitted, often due to circulatory or respiratory disease.

Study III: Do sociodemographic factors play a role when calling for help?

Compared to the background population, patients contacting any OOH service were more often of young or very old age, receiving disability pension, old-age pension, cash benefits, with low education or low income. Other characteristics significantly associated with an OOH service contact were female sex, non-Western ethnicity and living alone.

Among patients calling an OOH service, old age, having a low income, living alone, receiving cash benefits, disability pension or old-age pension was associated with calling EMS rather than OOH-PC compared to the reference groups. The opposite was the case for younger age groups and highly educated patients.

Coherence between the studies

The results of **study I** showed that patients contacting EMS were more severely ill than those contacting OOH-PC. The results were not significant for AMI patients, but the sample was also the smallest of the three included conditions. Our sample size seems plausible since the annual incidence of AMI in Denmark is around 8,200 and we included 40% of the Danish population, but only AMI patients contacting OOH services outside office hours.[82] Based on our results, we expect that with a larger sample, AMI patients contacting EMS would most likely also have a higher mortality than those contacting OOH-PC. Sepsis patients displayed the highest mortality of the three time-critical conditions studied, and very interestingly, the majority contacted OOH-PC. This could be due to the possible vague initial symptomatology of sepsis, which can mimic various other less severe infections compared to cases where the patients is evidently ill and EMS is contacted.[83] In the same study, stroke patients showed the strongest association between choice of OOH service and 1-30-day mortality (OR=2.56 (95%CI: 1.92-3.41 for patients contacting EMS). Our stroke group included both hemorrhagic and ischemic stroke, which may partially explain our findings. Patients with hemorrhagic stroke have a significantly worse prognosis with

a higher mortality and often rapid deterioration than ischemic stroke.[84] Thus, hemorrhagic stroke is more likely to lead to EMS contact, which we also found in **study I**, where 65% of patients with hemorrhagic stroke contacted EMS.

In **study II**, we used hospitalization (i.e. a short hospital contact or a hospital admission) as a measure for severity, but due to organizational differences and in particular the amount of MH-1813 patients with a short hospital contact due to face-to-face consultations carried out at the hospital, we changed focus more towards admissions as a measure for severity. The majority of hospital contacts by MH-1813 patients were short contacts (81%), followed by GPC patients (55%) and surprisingly 44%-48% of contacts by EMS patients. Overall, admissions occurred most often for EMS patients closely followed by MH-1813 patients and lastly GPC patients. These findings support those of **study I**, as EMS patients were more often admitted than OOH-PC patients, indicating a higher degree of severity.

Injuries and non-specific diagnoses comprised close to half of all hospitalizations, regardless the length of stay, and they were frequent for all OOH service types.
In short hospital contacts, patients contacting the MH-1813 differed in diagnostic pattern compared to patients contacting EMS or GPC with a much higher frequency of for instance infections and genitourinary disease. In both short hospital contacts and admissions, patients with circulatory disease (including potentially time-critical conditions as AMI or stroke) were most frequent in EMS contacts, while patients with digestive disease were most frequent in OOH-PC contacts, which could indicate more severe disease among EMS patients.

In **study III**, we explored which sociodemographic characteristics were associated with choice of OOH service type. Patients who contacted EMS were more likely to be older, living alone, receiving cash benefits, disability or old-age pension and to have low income and low education when compared to patients with an OOH-PC contact. These findings seem to indicate social vulnerability and could be associated with physical vulnerability such as comorbidity or frailty.[85] In that way, the results of **study III** support those of **studies I** and **II**.

Across **studies I** and **II**, patients contacting both EMS and OOH-PC were identified as having the highest 1-30-day (and in the case of sepsis also 1-day) mortality when hospitalized with AMI or sepsis**.** For this patient group, the proportion of ICU stay was also higher than for OOH-PC patients, but not EMS patients. Additionally, they had the highest percentage of admissions compared to patients solely contacting EMS or OOH-PC, often with respiratory disease, symptoms and signs and circulatory

disease. In **study I**, we observed that these patients were the oldest, had the highest percentage of unemployment and the highest proportion of short education, characteristics that we found to be associated with contacting EMS in **study III**. Our findings indicate that patients contacting both EMS and OOH-PC require specific attention as they are at risk of poor outcome.

6.2 METHODOLOGICAL CONSIDERATIONS

For each of the studies in this thesis, we have reported the individual strengths and limitations thoroughly in the appurtenant papers, however there are some common and additional issues which have been addressed below.

6.2.1 INTERNAL VALIDITY

Selection bias

The studies in this thesis all used population-based designs, which means that they included either all OOH service contacts (as Danish health care is freely accessible for all) or all citizens in the two regions during the study period.[66–68] The population-based design reduces this risk of selection bias and increases the cohort size – both major strengths. However, all three studies had missing data, both missing patient PINs and missing data on patient characteristics. The studies were all based on the possibility of linking PINs from the OOH service contact data to a number of other registries an without PIN we could not link OOH service contacts to hospital contacts, but the registration of PINs in contacts to MH-1813 and especially to EMS was not complete. So far, no studies have reported the number of missing PINs in MH-1813 contacts, but in our data it amounted to 3%.[67] Missing registration of PINs at the EMS most often occur in calls of the lowest urgency, which comprise around 15-20%.[24,86] Other studies have shown that missing PINs in EMS contact data may amount to 18% of all calls and close to half of the least urgent calls.[4,87] We found around 10% missing or incorrect PINs in our EMS data.[67] These missing patients may have introduced selection bias if they represent a group of patients with specific characteristics, outcomes or diagnostic patterns differing from the included patients. We expect that the majority of missings concern the least urgent calls. They are probably also least likely to have a hospital contact and may differ in sociodemographic characteristics

from the included contacts.[4] Moreover, the implementation of a new electronic medical record in hospitals in the Capital Region of Copenhagen also led to fewer hospital contacts being registered. This missing registration was a general problem, most likely unrelated to specific OOH service contacts. As a consequence, we may have underestimated the prevalence of hospital contacts.

In **studies I** and **II**, we linked OOH service contacts and hospital contacts by PIN and date. Linking by date meant that contacts to OOH services before midnight with a hospital contact after midnight were not linked. Thus, fewer patients with hospital contacts were included and fewer patients with a time-critical condition were identified as having a prior OOH service contact. Contacts to OOH services occur mostly in afternoon and early evening, so the loss of included patients is most likely a minor one.[86,88] Not only population size may have been affected, as diagnostic pattern during night time may differ from daytime.[89–91]

In **study I**, we relied on the Danish National Patient Registry, when including patients by diagnoses. The AMI and stroke diagnoses in this registry have high validity, while the validity of sepsis varies greatly.[67,68,75] We did not obtain any other data (such as hospital medical records) to further verify the diagnoses used, but for sepsis we included ICD-10 codes based on an earlier study to include as many relevant diagnoses as possible.[92] Nevertheless, the same study found that sepsis is underreported in Danish registries and yet another study showed that sepsis registration increased with disease severity.[93] This may have introduced a selection bias; we have included too few sepsis cases, but with a high degree of severity. Two-thirds of sepsis patients contacted OOH-PC and patients with less severe sepsis would probably also contact OOH-PC, therefore our message in **study I** would remain unchanged.[68]

If patients in **study I** had more than one hospital contact, we included them by their first contact in the study period and for patients with several contacts during the study period, doing so may have resulted in an underestimation of mortality, since we would expect patients with many contacts for time-critical conditions to be more severely ill. We therefore performed a sensitivity analysis using the patients' last contact, which did not change our results.[68]

Similarly, in **study III** we identified the OOH service contacted first by the patient during the study period and assigned the patient to that service. The remaining contacts to that service were included in the study as a measure for workload i.e. contact rate. Using the first contact could have introduced a bias in the population

included if the first contacts differ from the remaining contacts in the study period. For instance if a patient had the first contact with the GPC and then the five contacts with the EMS the rest of the year, this patient would be assigned to the GPC.

Information bias

We based all three studies on the assumption that if patients had a contact to an OOH service on the same date as they were hospitalized, the two events were related, which may not have been the case. This is a potential misclassification error present in all studies.[66–68] If present, it is probably most likely that contacts to OOH-PC are misclassified since contacts to OOH-PC are generally low in urgency and can concern a number of health issues unrelated to having a hospital contact. EMS contacts are less likely to be misclassified, but it may still occur – in particular for the low urgency contacts without ambulance dispatch. For instance, patients who called EMS and received telephone advice only, could drive to the ED and have a hospital contact and be incorrectly classified as an EMS contact using our methodology. Such misclassification may have led to an overestimation of the number of hospital contacts as well as the importance of OOH service choice. Since calling either EMS or OOH-PC is mandatory prior to hospital contact, this misclassification issue is most likely a minor one.

Linking the patients' OOH service contacts and hospital contacts by date rather than by time-intervals (hours) may have led to another misclassification error, since patients with OOH service contacts close to midnight and a hospital contact just after midnight will be (mis)classified as having no hospital contact, underestimating cohort size. A similar risk of misclassification applies to whether patients had contacts to both EMS and OOH-PC on the same date, possible underestimating the size of this particular group.

In **study I**, we also reported length of stay in relation to choice of OOH service as a secondary outcome. Such outcome measure may be subject to competing risk resulting in misclassification i.e. if patients died shortly after admission, they would be classified as having a short hospital stay, which we considered less severe than a longer hospital stay, but in fact they were perhaps the most severely ill patients with imminent risk of death. The length of stay reported could potentially be severely bias, since the included conditions all have high mortality rates.

In **study II**, we reported diagnoses at chapter level, which may be a potential misclassification problem, since diagnostic chapters include many diagnoses of

varying severity. For instance, we found a higher proportion of circulatory diseases among EMS patients, which we interpreted as an indicator of more severe disease in this patient group. However, our interpretation is supported by earlier studies in similar settings that identified the chapter circulatory disease as having one of the highest mortality rates.[87,94]

Confounding

In **study I,** there were a number of possible confounders in the association between OOH service choice and patient outcome. We addressed those closely related to the patient such as age, sex, comorbidity. However, other variables (e.g. ED crowding, hospital characteristics (regional hospital or university hospital)) remained unaddressed in our regression model and the association between choice of OOH service and outcome may have been overestimated as a result of this residual confounding.[68,95–97] In **study III**, we explored the association between sociodemographic characteristics and having any OOH service contacts and also the likelihood of contacting EMS rather than OOH-PC. Other variables or patient characteristics may also have been associated to having an OOH service contact such as comorbidity, psychiatric disease, health literacy and availability of daytime primary health care. However, our aim was not to investigate why there might be differences in sociodemographic characteristics between those with or without OOH service contacts, but to ascertain if there were.

6.2.2 EXTERNAL VALIDITY

OOH health care services have gradually been organized in a similar fashion in many Western countries in recent years and especially OOH-PC now are somewhat comparable within European countries and within the Scandinavian countries, EMS have more similarities than differences.[16,98] However, major differences still persists such as direct access to ED or private specialist care, nurse-led telephone triage only and fees for patients. Applying the findings of this thesis to other countries may therefore only be feasible when cautiously evaluating each country's OOH service organization and population characteristics.

6.3 COMPARISON WITH LITERATURE

Study I: Patients with time-critical conditions – who did they call and did it affect their outcome?

Navigating the OOH health care services when having a time-critical conditions has been sparsely investigated, with studies from Western countries that mostly cover reasons for delayed treatment and predominately focus on patients with AMI followed by stroke and sepsis.[99–101] However, a number of studies did investigate the patient pathway in terms of first medical contact for acute coronary syndrome/ST-elevation myocardial infarction (STEMI) and/or stroke.[14,15,52,102–105] For acute coronary syndrome/STEMI patients the first medical contacts was primary care (not exclusively OOH) in between 14% and 47.5% of the included cases[15,52,102] In a Swedish study of 445 patients, of which 14% contacted their primary health care provider, compared to 39.2% in our study. The discrepancy could be explained by the other options freely available in the Swedish setting, since 21% called a telephone hotline and 14% went directly to the freely accessible ED.[52] Similarly, in stroke patients the proportion ranged from 36.1% to 49.4%, which is in good agreement with our results of 39.9%.[14,15,105] These studies predominately arrived at the conclusion that if patients contacted some form of primary care, the delay from symptom onset to arrival at the hospital (the prehospital delay) increased.[14,15,103] Faiz et al. also showed, that the delay from symptom onset to health care contact (patient delay) was often longer among patients contacting primary care compared to those contacting EMS.[14]

Few studies reported clinical patient outcome in relation to the choice OOH service, but a Norwegian study on 299 stroke patients by Faiz et al. observed milder neurologic deficits among patients contacting primary care compared to patients contacting EMS, but did not provide information regarding mortality.[103] On the distribution of contacts to OOH services for patients with sepsis, limited literature was found. One Dutch study included 440 ED patients with infections or suspected infections, of which 83% were referred from GPs and the remaining were EMS patients.[53] GP-referred patients were less frequently triaged with high urgency, admitted to hospital or ICU than EMS patients. No statistically significant differences in mortality were reported, but only few patients included. Another Dutch study of ICU admitted sepsis patients, reported that 48.3% of the patients had a preceding GP contact. Overall mortality rates did not differ between patients with and without a GP contact, but the sample was of limited size (263 patients).[106] In **study I** we found that patients contacting the EMS were more severely ill (i.e. higher mortality and risk

of ICU stay) than those with an OOH-PC contact, even though a substantial proportion of the patients with AMI and stroke contacted OOH-PC. Conditions such as AMI and stroke are likely to present with recognizable or alarming symptoms and we would expect patients with such symptoms to contact EMS.[107,108] Calling OOH-PC could be a result of poor ability to navigate health care services or perhaps patients with less severe symptoms performed some form of self-triage, which may also have been the case in the Norwegian stroke study by Faiz et al.[14]

Study II: Patient care pathways outside office hours

In **study II**, we investigated patient pathways from OOH services to the hospital and expected major differences in prevalence of contacts to EMS and OOH-PC as well as subsequent hospital contacts. We did, however, find substantial differences within the two OOH-PC services, since patients who contacted the MH-1813 and are triaged to clinic consultation, receive this consultation at the hospital since no OOH GP consultation is possible. Consequently, clinic consultations are registered as hospital contacts, explaining the larger proportion of short hospital contacts for MH-1813 patients. In addition, the CDSS used by nurses performing telephone triage at the MH-1813, may lead to an increased number of face-to-face consultations compared to GP telephone triage as suggested by a Danish study.[40]

The pattern of diagnoses reported in this study were contacts outside office hours and may differ from daytime contacts, since differences in the prevalence of diseases and admission rates have previously been reported.[89–91] Two studies reported pattern of diagnoses, but did not report if the patients had an EMS or OOH-PC contact prior to hospital contact.[94,109] One study on admissions to a medical ward found a comparable pattern of the top-five most frequent diagnostic chapters; circulatory disease (19.3%), other factors (16.9%), infections (15.5%), symptoms and signs (11.8%) and injury and poisoning (6.3%). The ward did not include surgical specialties, explaining the very low proportion of injuries.[109] In a previous study from the North Denmark Region, we also reported the pattern of diagnoses for contacts to an ED and the findings of that study are in good agreement with the present findings; injuries and poisoning (38.3%), symptoms and signs (16.1%), other factors (14.5%), circulatory diseases (5.7%) and respiratory diseases (5.4%).[94]

Other studies have investigated the pattern of diagnoses of EMS patients brought to the hospital, finding a broad range of diagnoses including a large proportion of non-urgent and/or non-specific diagnoses.[87,110,111] Furthermore, patients with critical

conditions such as AMI or stroke also contact primary care (both during daytime and outside office hours), perhaps indicating an overlap between EMS and OOH-PC patient populations.[14,15,52,103] A recent study investigated who referred the patient to hospital (GP, OOH doctor, outpatient clinic/private specialist and direct admission) and the diagnostic pattern of admissions. The most frequent diagnostic chapters used for admissions in the study were injuries and poisoning, circulatory disease, symptoms and signs, respiratory disease and digestive disease, in good agreement with our results for hospital admissions. The chapter other factors was excluded from the study.[91]

Study III: Do sociodemographic factors play a role when calling for help?

The association between sociodemographic patient characteristics and contact to different types of OOH service has received limited attention. Yet, a survey study investigated OOH help-seeking through hypothetical case scenarios with the intended patient behavior as outcome: not contacting OOH care vs contacting OOH care (=EMS, OOH-PC or ED). Older age, female sex, ethnicity, low education and low income were associated with an intended OOH care contact, findings that are supported by our results.[59] The results of an international survey study that investigated the propensity to seek health care (GP during daytime) were also in accordance with some of our findings as this study reported that older age, female sex, ethnicity (first generation migrants) were predisposing factors for seeking health care.[60] Additionally, we found that low income, education and socioeconomic status were associated with contacting OOH services. We found one Dutch cohort study with 12,276 patient contacts investigating factors associated with contacting EMS versus OOH-PC (GPC). In this study, male sex and higher age was more frequent among EMS users, which we also found.[12] Other studies solely focusing on patients using EMS, emphasized male gender, older age and low income and low socioeconomic status as important factors related to contacting EMS.[112,113] The same factors were associated with contacting EMS rather than OOH-PC in our study, which could partially be explained by the observed differences in diagnostic pattern and severity in **study II**. Here we found that EMS patients were more often admitted to hospital and more often with circulatory diseases representing conditions with high mortality rates. In addition, EMS patients with time-critical conditions were more severely ill compared to OOH-PC as shown in **study I**. Thus, the sociodemographic factors associated with contacting EMS may be closely related to disease burden or severity of disease.

7 CONCLUSIONS AND PERSPECTIVES

Overall conclusions

With this thesis we covered patients contacting EMS and/or OOH-PC services focusing on the overall question: can patients navigate the OOH services and choose the service most relevant for handling their condition?

We found a substantial overlap between EMS and OOH-PC services as contacts with time-critical conditions were almost equally divided between the two services. Yet, in the most severe cases, patients seem to contact EMS, supported by a higher mortality, risk of ICU stay and proportion of longer hospital stays among EMS patients compared to OOH-PC patients. We also found substantial overlap in terms of hospital diagnoses at chapter level, but EMS patients had higher prevalence of potentially severe conditions, higher proportions of hospital contacts and admissions. Patients contacting EMS were a socially vulnerable group with low socioeconomic status compared to OOH-PC patients. Lastly, we identified a group of patients who contacted both EMS and OOH-PC with an increased risk of poor outcome.

Perspectives

We have identified several interesting aspects concerning patient utilization of the OOH services with this thesis.

First and foremost, there seems to be a large overlap in the patient populations between services, since almost half of patients with time-critical conditions contacted OOH-PC. Patients with such conditions contacting OOH-PC were less severely ill than those contacting EMS, but they still represent a patient group with potential high fatality and should be prompted to contact EMS. Many campaigns have targeted symptoms of time-critical conditions and the ideel way of handling these, yet our results suggest that there is still room for improvement. Moreover, we found that patients with contact to any OOH service, and even more so for contact with EMS, were often socially vulnerable and therefore perhaps difficult to reach with such campaigns.

Ideally, we should adjust our OOH services to better match patient behavior and needs instead. Such adjustments could include improved collaboration between OOH services in terms of

- Compatible telephone systems
- Shared medical record accessible to both OOH-PC and EMS
- Co-location of call centers for OOH-PC and EMS

The need for better collaboration is emphasized by the group of patients contacting both EMS and OOH-PC on the same date, identified in this thesis. They appear to have an increased risk of poor outcome, supported by high mortality and the highest proportion of admissions. Thus, a higher degree of shared information between OOH services could contribute to earlier identification of this patient group and in this way improve patient outcome by making sure they are cared for.

The patients identified as socially vulnerable in this thesis may also benefit from an improved collaboration between OOH-PC and EMS, since it is very likely that the prevalence of comorbidity/chronic disease is also substantial in this group. Improving collaboration with OOH-PC may allow for information of a patient contact to reach the patients' own GP and thus potential for preventive interventions could be enhanced.

Lastly, we found that OOH-PC handled 90% of all contacts outside office hours. Consequently, any organizational changes made to OOH-PC services have great impact on patient flow and access to hospital. The changes implemented with MH-1813 have resulted in more short hospital contacts, when comparing to GPC, meaning that more primary care patients are seen at hospital by hospital personnel, which should be considered when planning future OOH-PC services

In the future, a number of studies could aid in understanding patient utilization of OOH services as well as in improving OOH service organization to the benefit of the patients. With this thesis, we applied quantities methods in our studies. Yet, these methods have their limits when we want to understand the patients' behavior in relation to OOH service use and qualitative studies investigating the patients' choice of OOH service and the reasons behind would indeed complement our findings. In line the adjustments suggested for improved collaboration between OOH services, it would be highly relevant to look at ways of sharing more patient information perhaps as an intervention study. A study like that might also improve the identification of patients contacting both EMS and OOH-PC, which we found to be a

patient group at risk. We need to know more about this group in terms of audits of patient medical records to determine the reason for contacting both services and to explore if these patients are a risk group when they do not have hospital contacts.
Our study on sociodemographics and OOH service contact may benefit from additional research on the degree of comorbidity and daytime primary care access as possible explanatory factors among patients with and without OOH service contact. Finally, it could be of interest to investigate how the organisational changes within the OOH-PC in the Capital Region of Denmark with more patients seen at hospital may affect cost of primary care outside office hours.

8 LITERATURE LIST

Bibliography

1. Carret MLV. Inappropriate use of emergency services : a systematic review of prevalence and associated factors. *Cad Saude Publica*. 2009;25(1):7-28. doi:10.1590/S0102-311X2009000100002

2. Nørøxe KB, Huibers L, Moth G, Vedsted P. Medical appropriateness of adult calls to Danish out-of-hours primary care : a questionnaire-based survey. *BMC Fam Pract*. 2017:1-9. doi:10.1186/s12875-017-0617-1

3. Booker MJ, Simmonds RL, Purdy S. Patients who call emergency ambulances for primary care problems: a qualitative study of the decision-making process. *Emerg Med J*. 2014;31(6):448-452. doi:http://dx.doi.org/10.1136/emermed-2012-202124

4. Lehm KK, Andersen MS, Riddervold IS. Non-urgent Emergency Callers: Characteristics and Prognosis. *Prehospital Emerg Care*. 2017;21(2):166-173. doi:10.1080/10903127.2016.1218981

5. Keizer E, Smits M, Peters Y, Huibers L, Giesen P, Wensing M. Contacts with out-of-hours primary care for nonurgent problems: patients' beliefs or deficiencies in healthcare? *BMC Fam Pract*. 2015;16(1):157. doi:10.1186/s12875-015-0376-9

6. Huibers L, Keizer E, Carlsen AH, et al. Help-seeking behaviour outside office hours in Denmark, the Netherlands and Switzerland: A questionnaire study exploring responses to hypothetical cases. *BMJ Open*. 2018;8(10):1-9. doi:10.1136/bmjopen-2017-019295

7. Lowthian JA, Cameron PA, Stoelwinder JU, et al. Increasing utilisation of emergency ambulances. *Aust Heal Rev*. 2011;35(1):63. doi:10.1071/AH09866

8. Tiley CG. Patients are often unaware of how to access medical help out of hours. *Br J Gen Pract*. 2014;64(625):389.2-389. doi:10.3399/bjgp14X680869

9. The North Denmark Region. ring-rigtigt @ rn.dk [Call the correct number (campaing)]. https://rn.dk/sundhed/patient-i-region-nordjylland/akut-sygdom/ring-rigtigt. Accessed January 5, 2020.

10. Danish Resuscitation Council. www.genoplivning.dk/straek-snak-smil/ [Stretch-talk-smile (campaign of recognicition of stroke)]. https://genoplivning.dk/straek-snak-smil/. Accessed January 5, 2020.

11. Hallam L. Primary medical care outside normal working hours: Review of published work. *BMJ*. 1994. doi:10.1136/bmj.308.6923.249

12. Moll Van Charante EP, Van Steenwijk-Opdam PCE, Bindels PJE. Out-of-hours demand for GP care and emergency services: Patients' choices and referrals by general practitioners and ambulance services. *BMC Fam Pract*. 2007;8:1-9. doi:10.1186/1471-2296-8-46

13. Lindskou TA, Mikkelsen S, Christensen EF, et al. The Danish prehospital emergency healthcare system and research possibilities. *Scand J Trauma Resusc Emerg Med*. 2019;27(1):100. doi:10.1186/s13049-019-0676-5

14. Faiz KW, Sundseth A, Thommessen B, Rønning OM. Prehospital path in acute stroke. *Tidsskr Den Nor Laegeforening Tidsskr Prakt Med Ny Raekke*. 2017;137(11):798-802. doi:10.4045/tidsskr.16.0512

15. Doggen CJM, Zwerink M, Droste HM, et al. Prehospital paths and hospital arrival time of patients with acute coronary syndrome or stroke, a prospective observational study. *BMC Emerg Med*. 2016;16:3. doi:https://dx.doi.org/10.1186/s12873-015-0065-y

16. Langhelle A, Lossius HM, Silfvast T, et al. International EMS Systems: The Nordic countries. *Resuscitation*. 2004;61(1):9-21. doi:10.1016/j.resuscitation.2003.12.008

17. Lyon RM, Nelson MJ. Helicopter emergency medical services (HEMS) response to out-of-hospital cardiac arrest. *Scand J Trauma Resusc Emerg Med*. 2013. doi:10.1186/1757-7241-21-1

18. Ketelaars R, Hoogerwerf N, Scheffer GJ. Prehospital chest ultrasound by a dutch helicopter emergency medical service. *J Emerg Med*. 2013. doi:10.1016/j.jemermed.2012.07.085

19. Nicholl JP, Brazier JE, Snooks HA. Effects of London helicopter emergency medical service on survival after trauma. *BMJ*. 1995. doi:10.1136/bmj.311.6999.217

20. Bøtker MT, Bakke SA, Christensen EF. A systematic review of controlled studies: do physicians increase survival with prehospital treatment? *Scand J Trauma Resusc Emerg Med*. 2009. doi:10.1186/1757-7241-17-12

21. Zachariah B., Pepe P. The development of emergency medical dispatch in the USA: a historical perspective. *Eur J Emerg Med*. 1995;2:109-112. https://www.emergencydispatch.org/articles/ScientificStudies/SS13_EMD in USA a Historical Perspective.pdf.

22. Culley LL, Henwood DK, Clark JJ, Eisenberg MS, Horton C. Increasing the efficiency of emergency medical services by using criteria based dispatch. *Ann Emerg Med*. 1994. doi:10.1016/S0196-0644(54)00223-5

23. Ellensen EN, Wisborg T, Hunskaar S, Zakariassen E. Dispatch guideline adherence and response interval-a study of emergency medical calls in Norway. *BMC Emerg Med*. 2016;16(1):40. doi:10.1186/s12873-016-0105-2

24. Andersen MS, Johnsen SP, Sørensen JN, Jepsen SB, Hansen JB, Christensen EF. Implementing a nationwide criteria-based emergency medical dispatch system: A register-based follow-up study. *Scand J Trauma Resusc Emerg Med*. 2013;21(1):53. doi:10.1186/1757-7241-21-53

25. Clawson J, Olola C, Heward A, Patterson B, Scott G. Ability of the medical priority dispatch system protocol to predict the acuity of "unknown problem" dispatch response levels. *Prehospital Emerg Care*. 2008;12(3):290-296. doi:10.1080/10903120802100787

26. Olesen F, Jolleys J V. Out of hours service: the Danish solution examined. *BMJ*. 1994;309(6969):1624-1626. doi:10.1136/bmj.309.6969.1624

27. Berchet C, Nader C. *The Organisation of Out-Of-Hours Primary Care in OECD Countries*.; 2016. doi:10.1787/5jlr3czbqw23-en

28. Huibers L, Giesen P, Wensing M, Grol R. Out-of-hours care in western countries: Assessment of different organizational models. *BMC Health Serv Res*. 2009;9:1-8. doi:10.1186/1472-6963-9-105

29. Graversen DS, Pedersen AF, Carlsen AH, Bro F, Huibers L, Christensen MB. Quality of out-of-hours telephone triage by general practitioners and nurses: development and testing of the AQTT–an assessment tool measuring communication, patient safety and efficiency. *Scand J Prim Health Care*. 2019;37(1):18-29. doi:10.1080/02813432.2019.1568712

30. Wahlberg AC, Cedersund E, Wredling R. Telephone nurses' experience of problems with telephone advice in Sweden. *J Clin Nurs*. 2003. doi:10.1046/j.1365-2702.2003.00702.x

31. Wahlberg AC, Cedersund E, Wredling R. Bases for assessments made by

telephone advice nurses. *J Telemed Telecare*. 2005. doi:10.1258/135763305775013581

32. Huibers L, Keizer E, Giesen P, Grol R, Keizer E, Wensing M. Nurse telephone triage: Good quality associated with appropriate decisions. *Fam Pract*. 2012;29(5):547-552. doi:10.1093/fampra/cms005

33. Anderson A, Roland M. Potential for advice from doctors to reduce the number of patients referred to emergency departments by NHS 111 call handlers: Observational study. *BMJ Open*. 2015;5(11):1-4. doi:10.1136/bmjopen-2015-009444

34. Schmidt M, Schmidt SAJ, Adelborg K, et al. The Danish health care system and epidemiological research : from health care contacts to database records. *Clin Epidemiol*. 2019;11:563–591. doi:10.2147/CLEP.S179083

35. Olejaz M, Juul Nielsen A, Rudkjøbing A, Okkels Birk H, Krasnik A, Hernández-Quevedo C. Denmark health system review. *Health Syst Transit*. 2012;14(2):i-xxii, 1-192. http://www.euro.who.int/__data/assets/pdf_file/0004/160519/e96442.pdf.

36. Danske Regioner. Dansk Indeks for Akuthjælp [Danish Index for Emergency Care]. 2014.

37. Danish Regions. in-english @ www.regioner.dk. https://www.regioner.dk/services/in-english. Accessed January 7, 2020.

38. Ebert JF, Huibers L, Christensen B, Lippert FK, Christensen MB. Giving callers the option to bypass the telephone waiting line in out-of-hours services: a comparative intervention study. *Scand J Prim Health Care*. 2019;37(1):120-127. doi:10.1080/02813432.2019.1569427

39. VIVE – The Danish Center of Social Science Research. *Regionale Lægevagter Og Akuttelefonen 1813 – En Kortlægning Med Fokus På Organisering, Aktivitet Og Økonomi [Regional out-of-Hours General Practitioner and and the Medical Helpline 1813 - A Survey Focusing on Organization, Activity and Finances]*.; 2018. https://pure.vive.dk/ws/files/2302345/11422_regionale_laegevagter_og_akuttelefonen_1813.pdf.

40. Moth G, Huibers L, Vedsted P. From Doctor to Nurse Triage in the Danish Out-of-Hours Primary Care Service: Simulated Effects on Costs. *Int J Family Med*. 2013;2013:1-5. doi:10.1155/2013/987834

41. Region Zealand. Default @ Www.Regionsjaelland.Dk. http://www.regionsjaelland.dk/Kampagner/broen-til-bedre-sundhed/broen-til-bedre-sundhed/sammenomminvejfagprofessionelle/Sider/default.aspx. Accessed January 7, 2020.

42. Huibers L, Moth G, Carlsen AH, Christensen MB, Vedsted P. Telephone triage by GPS in out-of-hours primary care in Denmark: A prospective observational study of efficiency and relevance. *Br J Gen Pract*. 2016;66(650):e667-e673. doi:10.3399/bjgp16X686545

43. Christensen MB, Olesen F. Out of hours service in Denmark: Evaluation five years after reform. *Br Med J*. 1998. doi:10.1136/bmj.316.7143.1502

44. Blakoe M, Gamst-Jensen H, von Euler-Chelpin M, Collatz Christensen H, Møller T. Sociodemographic and health-related determinants for making repeated calls to a medical helpline: a prospective cohort study. *BMJ Open*. 2019;9(7):e030173. doi:10.1136/bmjopen-2019-030173

45. The Capital Region of Denmark. Akuttelefonen-1813-kan-nu-slaa-op-i-Sundhedsplatformen-det-oeger-borgernes-tryghed [Medical Helpline 1813 now able to access regional hospital medical records - increasing citizens' comfort and safety]. https://www.regionh.dk/presse-og-nyt/pressemeddelelser-og-nyheder/Sider/Akuttelefonen-1813-kan-nu-slaa-op-i-Sundhedsplatformen-det-oeger-borgernes-tryghed1.aspx. Accessed January 9, 2020.

46. Region Hovedstaden. *Afrapportering Af Akut Og Præhospital Indsats i Region Hovedstaden [Report on Acute and Prehospital Efforts in the Capital Region]*.; 2013. https://www.regionh.dk/om-region-hovedstaden/Den-Praehospitale-Virksomhed/om-akutberedskabet/publikationer/Documents/Aarsrapport 2013_April 2014_Endelig.pdf.

47. The Capital Region of Denmark. *Årsrapportdata - 2018 [Activity Report 2018]*.; 2018. https://www.regionh.dk/om-region-hovedstaden/akutberedskabet/akutberedskabets-aktivitetsdata/Documents/Aktivitet for 2017 og 2018.pdf.

48. Danish Police. alarm-112 @ politi.dk. https://politi.dk/kontakt-politiet/alarm-112. Accessed January 7, 2020.

49. Regionernes Kliniske Kvalitetsudviklingsprogram. *Præhospitaldatabasen [The Prehospital Database (Part of The Danish Clinical Quality Program–National Clinical Registries]*.; 2019.

https://www.sundhed.dk/content/cms/56/101656_aarsrapport_praehospitaldatabasen_2017_-5_endelig_udgave_til_offentliggoerelse.pdf.

50. Pope C, McKenna G, Turnbull J, Prichard J, Rogers A. Navigating and making sense of urgent and emergency care processes and provision. *Heal Expect*. 2019;22(3):435-443. doi:10.1111/hex.12866

51. Region Hovedstaden. 1813 - Akuttelefonen [Medical Helpline 1813]. https://www.regionh.dk/akuttelefon. Accessed January 14, 2020.

52. Thylén I, Ericsson M, Hellström Ängerud K, Isaksson RM, Sederholm Lawesson S. First medical contact in patients with STEMI and its impact on time to diagnosis; an explorative cross-sectional study. *BMJ Open*. 2015;5(4):1-7. doi:10.1136/bmjopen-2014-007059

53. Latten GHP, Claassen L, Jonk M, Cals JWL, Muris JWM, Stassen PM. Characteristics of the prehospital phase of adult emergency department patients with an infection: A prospective pilot study. *PLoS One*. 2019;14(2):1-10. doi:10.1371/journal.pone.0212181

54. Dumont F, Lorgis L, Yeguiayan JM, et al. Impact of diverting general practitioner's after-hour calls to emergency medical dispatch centers in patients with acute myocardial infarction. *Eur J Emerg Med*. 2013;20(3):197-204. doi:10.1097/MEJ.0b013e328353d8ff

55. Keizer E, Smits M, Peters Y, Huibers L, Giesen P, Wensing M. Contacts with out-of-hours primary care for nonurgent problems: patients' beliefs or deficiencies in healthcare? *BMC Fam Pract*. 2015;16:157. doi:10.1186/s12875-015-0376-9

56. Huibers L, Smits M, Renaud V, Giesen P, Wensing M. Safety of telephone triage in out-of-hours care: a systematic review. *Scand J Prim Health Care*. 2011;29(4):198-209. doi:10.3109/02813432.2011.629150

57. Plat FM, Peters YAS, Loots FJ, et al. Ambulance dispatch versus general practitioner home visit for highly urgent out-of-hours primary care. *Fam Pract*. 2018;35(4):440-445. doi:10.1093/fampra/cmx121

58. Andersen R, Newman JF. Societal and individual determinants of medical care utilization in the United States. *Milbank Mem Fund Q Health Soc*. 1973;51(1):95-124. http://www.ncbi.nlm.nih.gov/pubmed/4198894.

59. Keizer E, Christensen MB, Carlsen AH, et al. Factors related to out-of-hours help-seeking for acute health problems: A survey study using case scenarios

11 Medical and Health Sciences 1117 Public Health and Health Services. *BMC Public Health*. 2019;19(1):1-12. doi:10.1186/s12889-018-6332-6

60. Van Loenen T, Van Den Berg MJ, Faber MJ, Westert GP. Propensity to seek healthcare in different healthcare systems: Analysis of patient data in 34 countries. *BMC Health Serv Res*. 2015;15(1):1-10. doi:10.1186/s12913-015-1119-2

61. Søvsø MB, Kløjgaard TA, Hansen PA, Christensen EF. Repeated ambulance use is associated with chronic diseases - A population-based historic cohort study of patients' symptoms and diagnoses. *Scand J Trauma Resusc Emerg Med*. 2019. doi:10.1186/s13049-019-0624-4

62. Caplan SE, Straus JH, S.E. C. Strategies for reducing inappropriate after-hours telephone calls. *Clin Pediatr (Phila)*. 1988;27(5):236-239. http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=emed4&NEWS=N&AN=18135858.

63. Scott J, Strickland AP, Warner K, Dawson P. Frequent callers to and users of emergency medical systems: a systematic review. *Emerg Med J*. 2014;31(8):684-691. doi:10.1136/emermed-2013-202545

64. Statistics Denmark. Danmarks Statistik [Statistics Denmark]. http://www.statistikbanken.dk/statbank5a/default.asp?w=1440. Accessed January 14, 2020.

65. Henriksen DP, Rasmussen L, Hansen MR, Hallas J, Pottegård A. Comparison of the five Danish regions regarding demographic characteristics, healthcare utilization, and medication use - A descriptive cross-sectional study. *PLoS One*. 2015. doi:10.1371/journal.pone.0140197

66. Søvsø MB, Bech BH, Christensen HC, Huibers L, Christensen EF, Christensen MB. Sociodemographic characteristics associated with contacts to emergency medical services and out-of-hours primary care. An observational study of 2.3 million citizens. UNDER REVIEW January 2020. *Clin Epidemiol*.

67. Søvsø MB, Huibers L, Bech BH, Christensen, Helle Collatz Christensen, Morten Bondo Christensen EF. Acute care pathways for patients calling the out-of-hours services. UNDER REVIEW January 2020. *BMC Health Serv Res*.

68. Søvsø MB, Christensen MB, Bech BH, Christensen HC, Christensen EF, Huibers L. Contacting out-of-hours primary care or emergency medical services for time-critical conditions - Impact on patient outcomes. *BMC Health Serv Res*. 2019. doi:10.1186/s12913-019-4674-0

69. Pedersen CB. The Danish Civil Registration System. *Scand J Public Health*. 2011;39(7 suppl):22-25. doi:10.1177/1403494810387965

70. Schmidt M, Pedersen L, Sørensen HT. The Danish Civil Registration System as a tool in epidemiology. *Eur J Epidemiol*. 2014. doi:10.1007/s10654-014-9930-3

71. Judex A/S. projects @ judex.dk. http://judex.dk/projects#Amphi. Accessed January 12, 2020.

72. Christensen EF, Berlac PA, Nielsen H, Christiansen CF. The Danish quality database for prehospital emergency medical services. *Clin Epidemiol*. 2016. doi:10.2147/CLEP.S100919

73. Andersen JS, Olivarius NDF, Krasnik A. The Danish National Health Service Register. *Scand J Public Health*. 2011;39(7 Suppl):34-37. doi:10.1177/1403494810394718

74. Lynge E, Sandegaard JL, Rebolj M. The Danish National Patient Register. *ScandJPublic Heal*. 2011;39(7 Suppl):30-33. doi:10.1177/1403494811401482

75. Schmidt M, Schmidt SAJ, Sandegaard JL, Ehrenstein V, Pedersen L, Sørensen HT. The Danish National Patient Registry: a review of content, data quality, and research potential. *Clin Epidemiol*. 2015;7:449. doi:10.2147/CLEP.S91125

76. Statistics Denmark. About us @ www.dst.dk. https://www.dst.dk/en/OmDS. Accessed January 14, 2020.

77. Jensen VM, Rasmussen AW. Danish education registers. *Scand J Public Health*. 2011;39(7_suppl):91-94. doi:10.1177/1403494810394715

78. Baadsgaard M, Quitzau J. Danish registers on personal income and transfer payments. *Scand J Public Health*. 2011;39(7_suppl):103-105. doi:10.1177/1403494811405098

79. Petersson F, Baadsgaard M, Thygesen LC. Danish registers on personal labour market affiliation. *Scand J Public Health*. 2011;39(7_suppl):95-98. doi:10.1177/1403494811408483

80. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: Development and validation. *J Chronic Dis*. 1987. doi:10.1016/0021-9681(87)90171-8

81. Thygesen SK, Christiansen CF, Christensen S, Lash TL, Sørensen HT. The predictive value of ICD-10 diagnostic coding used to assess Charlson comorbidity index conditions in the population-based Danish National Registry of Patients. *BMC Med Res Methodol*. 2011. doi:10.1186/1471-2288-11-83

82. Foundation TDH. Fakta om hjerte-kar-sygdom i Danmark [Facts on cardiovascular disease in Denmark]. https://hjerteforeningen.dk/alt-om-dit-hjerte/noegletal/. Accessed January 19, 2020.

83. Herlitz J, Bång A, Wireklint-Sundström B, et al. Suspicion and treatment of severe sepsis. An overview of the prehospital chain of care. *Scand J Trauma Resusc Emerg Med*. 2012;20:1-8. doi:10.1186/1757-7241-20-42

84. Andersen KK, Olsen TS, Dehlendorff C, Kammersgaard LP. Hemorrhagic and ischemic strokes compared: Stroke severity, mortality, and risk factors. *Stroke*. 2009;40(6):2068-2072. doi:10.1161/STROKEAHA.108.540112

85. Ullits LR, Ejlskov L, Mortensen RN, et al. Socioeconomic inequality and mortality - A regional Danish cohort study. *BMC Public Health*. 2015;15(1):1-9. doi:10.1186/s12889-015-1813-3

86. Møller TP, Ersbøll AK, Tolstrup JS, et al. Why and when citizens call for emergency help: an observational study of 211,193 medical emergency calls. *Scand J Trauma Resusc Emerg Med*. 2015;23(1):88. doi:10.1186/s13049-015-0169-0

87. Christensen EF, Larsen TM, Jensen FB, et al. Diagnosis and mortality in prehospital emergency patients transported to hospital: a population-based and registry-based cohort study. *BMJ Open*. 2016;6(7):e011558. doi:10.1136/bmjopen-2016-011558

88. Moth G, Flarup L, Christensen MB, Olesen F, Vedsted P. *Kontakt- Og Sygdomsmønsteret i Lægevagten LV-KOS 2011 [Contact and Disease Pattern in the GPC LV-KOS 2011]*.; 2011.

89. Flarup L, Moth G, Christensen MB, Vestergaard M, Olesen F, Vedsted P. Chronic-disease patients and their use of out-of-hours primary health care: A cross-sectional study. *BMC Fam Pract*. 2014;15(1). doi:10.1186/1471-2296-15-114

90. Johansen IH, Morken T, Hunskaar S. Contacts related to mental illness and substance abuse in primary health care: A cross-sectional study comparing patient's use of daytime versus out-of-hours primary care in Norway. *Scand*

J Prim Health Care. 2010;28(3):160-165. doi:10.3109/02813432.2010.493310

91. Blinkenberg J, Pahlavanyali S, Hetlevik Ø, Sandvik H, Hunskaar S. General practitioners' and out-of-hours doctors' role as gatekeeper in emergency admissions to somatic hospitals in Norway: registry-based observational study. *BMC Health Serv Res*. 2019;19(1):568. doi:10.1186/s12913-019-4419-0

92. Gradel KO, Nielsen SL, Pedersen C, et al. Low completeness of bacteraemia registration in the Danish National Patient Registry. *PLoS One*. 2015;10(6):1-19. doi:10.1371/journal.pone.0131682

93. Whittaker S-A, Mikkelsen ME, Gaieski DF, Koshy S, Kean C, Fuchs BD. Severe Sepsis Cohorts Derived From Claims-Based Strategies Appear to be Biased Toward a More Severely Ill Patient Population*. *Crit Care Med*. 2013;41(4):945-953. doi:10.1097/CCM.0b013e31827466f1

94. Søvsø MB, Hermansen SB, Færk E, et al. Diagnosis and mortality of emergency department patients in the North Denmark region. *BMC Health Serv Res*. 2018;18(1):548. doi:10.1186/s12913-018-3361-x

95. Singer AJ, Thode HC, Viccellio P, Pines JM. The association between length of emergency department boarding and mortality. *Acad Emerg Med*. 2011;18(12):1324-1329. doi:10.1111/j.1553-2712.2011.01236.x

96. Sun BC, Burstin HR, Brennan TA. Predictors and outcomes of frequent emergency department users. *Acad Emerg Med*. 2003;10(4):320-328.

97. Freitas A, Silva-Costa T, Lopes F, et al. Factors influencing hospital high length of stay outliers. *BMC Health Serv Res*. 2012;12(1). doi:10.1186/1472-6963-12-265

98. Huibers LAMJ, Moth G, Bondevik GT, et al. Diagnostic scope in out-of-hours primary care services in eight European countries: an observational study. *BMC Fam Pract*. 2011;12:30. doi:10.1186/1471-2296-12-30

99. Herlitz J, Wireklintsundström B, Bång A, Berglund A, Svensson L, Blomstrand C. Early identification and delay to treatment in myocardial infarction and stroke: differences and similarities. *Scand J Trauma Resusc Emerg Med*. 2010. doi:10.1186/1757-7241-18-48

100. Seymour CW, Kahn JM, Martin-Gill C, et al. Delays From First Medical Contact to Antibiotic Administration for Sepsis*. *Crit Care Med*. 2017;45(5):759-765.

doi:10.1097/CCM.0000000000002264

101. Morris DL, Rosamond W, Madden K, Schultz C, Hamilton S. Prehospital and emergency department delays after acute stroke: The genentech stroke presentation survey. *Stroke*. 2000. doi:10.1161/01.STR.31.11.2585

102. Johansson I, Strömberg A, Swahn E. Factors related to delay times in patients with suspected acute myocardial infarction. *Hear Lung J Acute Crit Care*. 2004. doi:10.1016/j.hrtlng.2004.04.002

103. Faiz KW, Sundseth A, Thommessen B, Rønning OM. Prehospital delay in acute stroke and TIA. *Emerg Med J*. 2013;30(8):669-674. doi:10.1136/emermed-2012-201543

104. Wester P, Rådberg J, Lundgren B, Peltonen M. Factors associated with delayed admission to hospital and in-hospital delays in acute stroke and TIA: A prospective, multicenter study. *Stroke*. 1999. doi:10.1161/01.STR.30.1.40

105. Ellensen EN, Naess H, Wisborg T, Hunskaar S, Zakariassen E. Stroke identification by criteria based dispatch – a register based study. *Acta Anaesthesiol Scand*. 2018;62(1):105-115. doi:10.1111/aas.13032

106. Loots FJ, Smits M, van Steensel C, Giesen P, Hopstaken R, van Zanten AR. Management of sepsis in out-of-hours primary care: a retrospective study of patients admitted to the intensive care unit. *Br J Gen Pract*. 2018;68(suppl 1):bjgp18X696653. doi:10.3399/bjgp18x696653

107. Devon HA, Rosenfeld A, Steffen AD, Daya M. Sensitivity, specificity, and sex differences in symptoms reported on the 13-item acute coronary syndrome checklist. *J Am Heart Assoc*. 2014;3(2):1-9. doi:10.1161/JAHA.113.000586

108. Goldstein LB. Is This Patient Having a Stroke? *JAMA*. 2005;293(19):2391. doi:10.1001/jama.293.19.2391

109. Vest-Hansen B, Riis AH, Sørensen HT, Christiansen CF. Acute admissions to medical departments in Denmark: Diagnoses and patient characteristics. *Eur J Intern Med*. 2014;25(7):639-645. doi:10.1016/j.ejim.2014.06.017

110. Snooks H, Kearsley N, Dale J, Halter M. New models of care for 999 callers with conditions that are neither life threatening nor serious: results of a national survey. *Pre-hospital Immed Care*. 2000.

111. Christensen EF, Bendtsen MD, Larsen TM, et al. Trends in diagnostic patterns and mortality in emergency ambulance service patients in 2007−2014: a

population-based cohort study from the North Denmark Region. *BMJ Open*. 2017;7(8):e014508. doi:10.1136/bmjopen-2016-014508

112. Kawakami C, Ohshige K, Kubota K, Tochikubo O. Influence of socioeconomic factors on medically unnecessary ambulance calls. *BMC Health Serv Res*. 2007;7(1):120. doi:10.1186/1472-6963-7-120

113. Rucker DW, Edwards RA, Burstin HR, O'Neil AC, Brennan TA. Patient-specific predictors of ambulance use. *Ann Emerg Med*. 1997;29(4):484-491. doi:https://doi.org/10.1016/s0196-0644(97)70221-x

9 APPENDICES

9.1 Paper I

Søvsø, M.B., Christensen, M.B., Bech, B.H., Christensen, H.C., Christensen, E.F., Huibers, L. Contacting out-of-hours primary care or emergency medical services for time-critical conditions - impact on patient outcomes. BMC Health Serv Res 19, 813 (2019) doi:10.1186/s12913-019-4674-0

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BMC Health Services Research

RESEARCH ARTICLE Open Access

Contacting out-of-hours primary care or emergency medical services for time-critical conditions - impact on patient outcomes

Morten Breinholt Søvsø[1,2*], Morten Bondo Christensen[2], Bodil Hammer Bech[3], Helle Collatz Christensen[4], Erika Frischknecht Christensen[1,5] and Linda Huibers[2]

Abstract

Background: Out-of-hours (OOH) healthcare services in Western countries are often differentiated into out-of-hours primary healthcare services (OOH-PC) and emergency medical services (EMS). Call waiting time, triage model and intended aims differ between these services. Consequently, the care pathway and outcome could vary based on the choice of entrance to the healthcare system.
We aimed to investigate patient pathways and 1- and 1–30-day mortality, intensive care unit (ICU) stay and length of hospital stay for patients with acute myocardial infarction (AMI), stroke and sepsis in relation to the OOH service that was contacted prior to the hospital contact.

Methods: Population-based observational cohort study during 2016 including adult patients from two Danish regions with an OOH service contact on the date of hospital contact. Patients <18 years were excluded. Data was retrieved from OOH service databases and national registries, linked by a unique personal identification number. Crude and adjusted logistic regression analyses were performed to assess mortality in relation to contacted OOH service with OOH-PC as the reference and cox regression analysis to assess risk of ICU stay.

Results: We included 6826 patients. AMI and stroke patients more often contacted EMS (52.1 and 54.1%), whereas sepsis patients predominately called OOH-PC (66.9%). Less than 10% (all diagnoses) of patients contacted both OOH-PC & EMS. Stroke patients with EMS or OOH-PC & EMS contacts had higher likelihood of 1- and 1–30-day mortality, in particular 1-day (EMS: OR = 5.33, 95% CI: 2.82–10.08; OOH-PC & EMS: OR = 3.09, 95% CI: 1.06–9.01). Sepsis patients with EMS or OOH-PC & EMS contacts also had higher likelihood of 1-day mortality (EMS: OR = 2.22, 95% CI: 1.40–3.51; OOH-PC & EMS: OR = 2.86, 95% CI: 1.56–5.23) and 1–30-day mortality. Risk of ICU stay was only significantly higher for stroke patients contacting EMS (EMS: HR = 2.38, 95% CI: 1.51–3.75). Stroke and sepsis patients with EMS contact had longer hospital stays.

Conclusions: More patients contacted OOH-PC than EMS. Sepsis and stroke patients contacting EMS solely or OOH-PC & EMS had higher likelihood of 1- and 1–30-day mortality during the subsequent hospital contact. Our results suggest that patients contacting EMS are more severely ill, however OOH-PC is still often used for time-critical conditions.

Keywords: Out-of-hours medical care, Delivery of healthcare, Primary care, Emergency medical services, Denmark, Myocardial infarction, Stroke, Sepsis, Telephone hotlines

* Correspondence: morten.soevsoe@rn.dk
[1]Centre for Prehospital and Emergency Research, Aalborg University, Søndre Skovvej 15, 9000 Aalborg, Denmark
[2]Research Unit for General Practice, Aarhus University, Aarhus, Denmark
Full list of author information is available at the end of the article

Background

In most Western countries, several healthcare services are available for out-of-hours healthcare (OOH), often differentiated into out-of-hours primary healthcare services (OOH-PC) and emergency medical services (EMS). For OOH-PC, various models exist, whereas EMS models are more similar across countries [1]. Different OOH-PC models include GP-cooperatives (GPCs), individual general practitioners (GPs), GP rotation groups and more. Telephone triage is widely used with the aim to ensure the right help to the right patients at the right time, but many services are also freely accessible [2, 3].

In Denmark, all out-of-hours services (i.e. EMS and OOH-PC) use telephone triage [4]. Patients are prompted to contact EMS in life- or limb-threatening situations and OOH-PC in less urgent situations that cannot wait until their own GP is available. Call waiting time and triage model differ between these services (i.e. type of call-handler and triage tools) as well as the intended aims of the services. Consequently, the care pathway and outcome could vary based on the choice of entrance to the healthcare system. If patients with time-critical conditions choose to contact OOH-PC, they may face a treatment delay with potential serious consequences [5, 6].

Time-critical conditions cover a diverse group of conditions, where fast medical intervention is crucial for the best outcome. Some time-critical conditions (e.g. acute myocardial infarction and stroke) often present with characteristic alarm symptoms [7, 8], whereas other conditions (e.g. sepsis) present with a variety of symptoms that may not lead to recognition of the severity or urgency of the situation [9].

Earlier studies have shown that contacting primary care services rather than EMS with symptoms of acute myocardial infarction or stroke increases risk of delayed treatment [5, 6], but only few smaller studies included patient-related clinical outcome measures such as differences in mortality or disease severity [10, 11]. Our objective was to investigate patient pathways and differences in patient-related clinical outcome measures (i.e. 1- and 1–30-day mortality, intensive care unit (ICU) stay and length of hospital stay) in patients with acute myocardial infarction, stroke and sepsis in relation to the OOH service that was contacted prior to hospital contact.

Methods

Study design and participants

We conducted a population-based observational cohort study from January 1st 2016 to December 31st 2016 including patients from two Danish regions with a contact to an OOH service on the date of hospital contact for acute myocardial infarction, stroke or sepsis. Diagnoses were identified according to the International Statistical Classification of Diseases and Health related Problems 10th Revision (ICD-10) [12]. See Additional file 1 for details and ICD-10 codes. Our sepsis definition was based on a previously published definition containing a number of selected ICD-10 codes [13] and our stroke definition included both hemorrhagic and ischemic stroke. Patients were only included with their first contact if they had more than one hospital contact during the study period. Other inclusion criteria were: minimum 18 years old, residing in one of the two regions, having a valid personal identification number (PIN), and having a contact outside office hours (as the OOH services had different opening hours). This study used the unique 10-digit PIN [14] for linkage to national registries (i.e. identifying hospital contacts with the diagnoses of interest [15]) and the OOH service databases (i.e. identifying whether the patient called OOH-PC and/or EMS [16]). Results are reported according to STROBE guidelines [17, 18].

Setting

Two regions were selected to include patients from three types of OOH services. The North Denmark Region is a mixed rural and urban region with a population of 587,000 inhabitants [19] and the OOH services available are EMS and GPC. In the urban Capital Region of Copenhagen with 1.8 million inhabitants [19], the OOH services available are EMS and the Medical Helpline 1813. GPC and MH-1813 are both considered as OOH primary care.

Medical emergency calls to the national emergency number 1-1-2 are forwarded to the regional EMS, when health-related. Primarily nurses answer the calls, using a criteria-based dispatch protocol to assess the urgency and severity of the situation and the appropriate response (e.g. telephone advice, ambulance, paramedics, doctors) [20, 21]. EMS operate in a similar fashion in all five Danish regions. At the GPC, GPs answer all calls, performing triage and assessing the appropriate response (i.e. telephone advice, consultation, home visit or direct referral to hospital) [22]. Nurses (for the most part) and physicians answer the telephone at the Medical Helpline 1813 to decide whether the patient is in need of a telephone advice, consultation, a home visit, or a direct referral to the hospital [23]. The nurses use a decision support tool. Danish healthcare is tax-financed and free of charge, including the OOH services.

Exposure, outcome measures and potential confounders

We defined the patients' choice to contact a specific OOH service (i.e. OOH-PC, EMS or both EMS & OOH-PC) as the exposure in the present study. For each hospital contact considering the three time-critical conditions, we examined if an OOH service had been contacted on the same date and which service(s). This data was retrieved from the National Health Service Registry [16] and the OOH service databases.

Our primary outcome was defined as mortality 1 and 1–30 days after the hospital contact. Vital status was retrieved from the Civil Registration System [14].

Secondary outcomes were defined as probability of ICU stay during hospital stay and length of hospital stay associated with the contacted OOH service. This information was retrieved from the Danish National Patient Registry [15].

The association between exposure and outcome measures in this study could be confounded by patient characteristics (i.e. age, gender, ethnicity, employment status, income, education length and comorbidity). These factors have been found to relate to patient's help-seeking behaviour and choice of entrance [24] as well as to mortality [25, 26]. Information on potential confounders was retrieved from Statistics Denmark [27] and the Danish National Patient Registry (i.e. diagnoses from past 5 years to determine comorbidity according to the Charlson Comorbidity Index [26, 28]).

Statistical analysis

Data were anonymized for statistical analysis. Descriptive statistics were used for reporting population baseline characteristics, distribution of contacts to OOH services as well as length of stay.

Odds ratios (ORs) for 1- and 1–30-day mortality were calculated using logistic regression analyses. OOH service contact was the independent variable of primary interest. Income level was divided into quantiles based on the income level range in our population. Cox regression analysis was used to determine likelihood of ICU stay during hospital stay (hazard ratio (HR)) between OOH services for each of the time-critical conditions. Both crude and adjusted (for age, gender, ethnicity, income level, employment status, education length and comorbidity) analyses were performed for all analyses. The adjustment did not substantially change the results, therefore crude results are presented in the main text. However, results of the adjusted analyses can be seen in the appendix (Additional file 2).

We performed additional sensitivity analysis using the patient's last contact (rather than the first contact) during the study period. This did not lead to any noteworthy changes as shown in Additional file 3. Kaplan-Meier survival curves were also computed to visualize differences in mortality in relation to OOH service. Results presented with 95% confidence intervals (CI), when relevant. Statistical analyses were performed with Stata V.15.0/MP (Stata Corporation, College Station, Texas, USA).

Results

Population

In the North Denmark Region and the Capital Region of Copenhagen, 7114 admissions comprised the diagnoses of interest and had a registered contact to OOH services on the date of hospital contact during 2016. Only first hospital contacts were included in the study resulting in 6826 patients (Fig. 1).

Patients contacting OOH-PC or EMS had similar mean age (70.2 years (95% CI: 69.7–70.8) vs. 70.8 years (95% CI: 70.3–71.3)). OOH-PC contacts concerned women in 43.1% of the cases vs. 42.0% for EMS (Table 1). Additional population characteristics can be seen in Table 1 stratified by the OOH service contacted.

OOH-PC handled 49.8% of all included patients and EMS 42.5%, whereas 7.6% had contacts to both OOH-PC & EMS. EMS handled the majority of AMI patients (52.1%) (Fig. 2), while 39.2% had a contact with OOH-PC. Two-thirds of all sepsis patients (66.9%) solely had contact with OOH-PC on the date of hospital contact. Stroke patients were predominately handled by EMS (54.1%) followed by OOH-PC (39.9%). Patients with stroke included both hemorrhagic (21.3%) and ischemic stroke (78.7%). Their pathway differed as 65.3% of patients with hemorrhagic stroke contacted EMS compared to 51.1% of patients with ischemic stroke (Additional file 4).

Primary outcome - mortality

As illustrated by the Kaplan-Meier survival curves (Fig. 3), mortality was high in the first 24 h after hospital

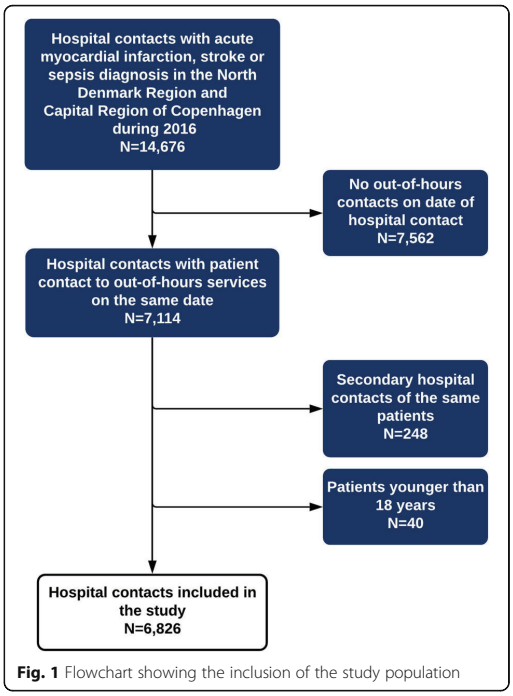

Fig. 1 Flowchart showing the inclusion of the study population

Table 1 Population baseline characteristics stratified by OOH service (N = 6826) (n, (%))

	OOH-PC	EMS	OOH-PC & EMS
Number	3401	2903	522
Age, mean, (95% CI)	70.2 (69.7–70.8)	70.8.1 (70.3–71.3)	71.6 (70.3–72.8)
Female gender	1464 (43.1)	1220 (42.0)	210 (40.2)
Employment status			
Employed	743 (21.9)	579 (19.9)	91 (17.4)
Unemployed (retired, on benefits, under education etc.)	2658 (78.2)	2324 (80.1)	431 (82.6)
Ethnicity			
Danish	3110 (91.4)	2642 (91.0)	488 (93.5)
Western countries	101 (3.0)	91 (3.1)	14 (2.7)
Non-western countries	190 (5.6)	170 (5.9)	20 (3.8)
Education length[a]			
<=10 years	1404 (41.3)	1180 (40.6)	237 (45.4)
>10- ≤ 15 years	1380 (40.6)	1250 (43.1)	214 (41.0)
>15 years	617 (18.1)	473 (16.3)	71 (13.6)
Income level (quantiles)			
1 (low)	727 (21.4)	739 (25.5)	127 (24.3)
2	922 (27.1)	815 (28.1)	156 (29.9)
3	849 (25.0)	693 (23.9)	148 (28.4)
4 (high)	903 (26.6)	656 (22.6)	91 (17.4)
Charlson Comorbidity Index (CCI)			
CCI 0	1824 (53.6)	1624 (55.9)	282 (54.0)
CCI 1–2	1121 (33.0)	916 (31.6)	178 (34.1)
CCI > =3	456 (13.4)	363 (12.5)	62 (11.9)

[a] < =10 years (primary school), > 10–15 years (vocational educations, gymnasium, short-cycle higher education), > 15 years (medium-cycle higher education, long-cycle higher education, university)

contact for patients with AMI, stroke and sepsis. Patients with AMI displayed no evident differences in mortality on the basis of the OOH service, whereas both stroke and sepsis patients displayed higher mortality after EMS contact or OOH-PC & EMS contact throughout the 30 days studied compared to OOH-PC contact alone. Mortality in percent for the included conditions can be seen in Table 2.

No significant differences in odds for 1- nor 1–30-day mortality for AMI patients in relation to OOH service were found (Table 2). On the contrary, stroke patients had a higher likelihood of 1- and 1–30-day mortality, when contacting EMS alone or OOH-PC & EMS compared to OOH-PC, in particular 1-day mortality (EMS: OR = 5.33, 95%CI: 2.82–10.08; OOH-PC & EMS: OR = 3.09, 95%CI: 1.06–9.01). Within the stroke group, patients with hemorrhagic stroke had substantially higher mortality than patients with ischemic stroke, especially around day 1 (Additional file 5). Patients who contacted EMS alone or OOH-PC & EMS prior to a hospital contact for sepsis also had a higher likelihood of 1-day mortality (EMS: OR = 2.22. 95%CI: 1.40–3.51; OOH-PC & EMS: OR = 2.86. 95%CI: 1.56–5.23) and 1–30-day mortality as well (EMS: OR = 1.26 95%CI: 1.00–1.58; OOH-PC & EMS: OR = 1.49 95%CI: 1.07–2.08).

Secondary outcomes – ICU stay and length of stay

Regardless of the diagnosis, patients contacting EMS showed a tendency towards increased risk of ICU stay compared to patients contacting OOH-PC (Table 2). However, this association was only statistically significant for stroke patients. Patients with AMI and OOH-PC contacts had more one-day hospital stays, whereas more stroke and sepsis patients with EMS contacts had longer hospital stays (Fig. 4).

Discussion

Key results

In almost half of OOH hospital contacts with the three included time-critical conditions, patients contacted OOH-PC. In addition, more than two-thirds of patients with sepsis solely contacted OOH-PC prior to hospital contact.

Contacting the EMS or OOH-PC & EMS prior to admission for stroke or sepsis showed higher likelihood of

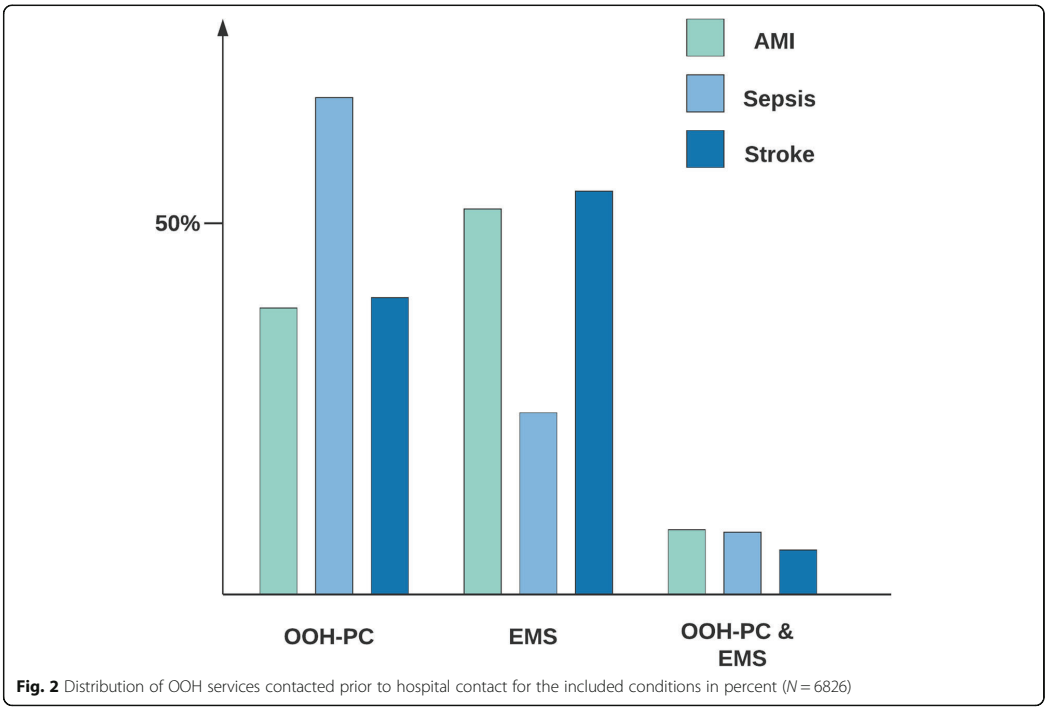

Fig. 2 Distribution of OOH services contacted prior to hospital contact for the included conditions in percent ($N = 6826$)

1- and 1–30-day mortality compared to contacting OOH-PC – in particular 1-day mortality. As expected, EMS contacts prior to hospital contact displayed a tendency towards higher risk of ICU stays. Hospital contacts with stroke or sepsis following EMS contacts more often resulted in longer hospital stays compared to OOH-PC contacts.

Strengths and weaknesses of the study

The present study investigated the impact of the choice of contacting an OOH service in case of a time-critical condition on patient outcomes, including all available OOH services and a large cohort. Furthermore, the study has a population-based design, which minimized selection bias, as every hospital contact of patients within two regions with the diagnoses of interest were included. This was made possible through the unique PIN, which also allowed for extensive registry linkage (including sociodemographic data), linkage to OOH services and complete follow-up.

The disease groups in the present study were compiled by relevant ICD-10 diagnoses, which entailed two limitations: diagnoses included may vary when comparing to other studies and no other clinical data was obtained to verify the diagnoses. However, the validity of the Danish National Patient Registry is relatively high (positive predictive values range for AMI: 81.9–100 (I24 not included), stroke: 71.8–97.0 (similar definition), sepsis: 21.7–85.7 (definition varies)) [29]. We based the inclusion of relevant ICD-10 codes for sepsis on an earlier study to include as many relevant diagnoses as possible, but this study also found that sepsis is underreported in Danish registries [13]. Consequently, we have most likely missed some patients with sepsis in hospital. In addition, an earlier study found increasing completeness of sepsis registration with increasing severity of the patient's condition [30]. If this is the case in our cohort, we will have missed patients with less severe conditions. The majority of sepsis patients contacted OOH-PC in our study and we would also expect patients with less severe conditions to do so. If these missing patients were included, this would not change our message of patients with contacts to EMS being more severely ill compared to OOH-PC contacts prior to hospital contact. Our stroke group included both hemorrhagic and ischemic stroke. Although other studies have done the same [11, 31], combining the two may level out associations between stroke subtype and outcome measures. Furthermore, a number of contacts to the OOH services did not have a registered PIN, primarily at the EMS. Consequently, we may have missed some patient contacts with the EMS prior

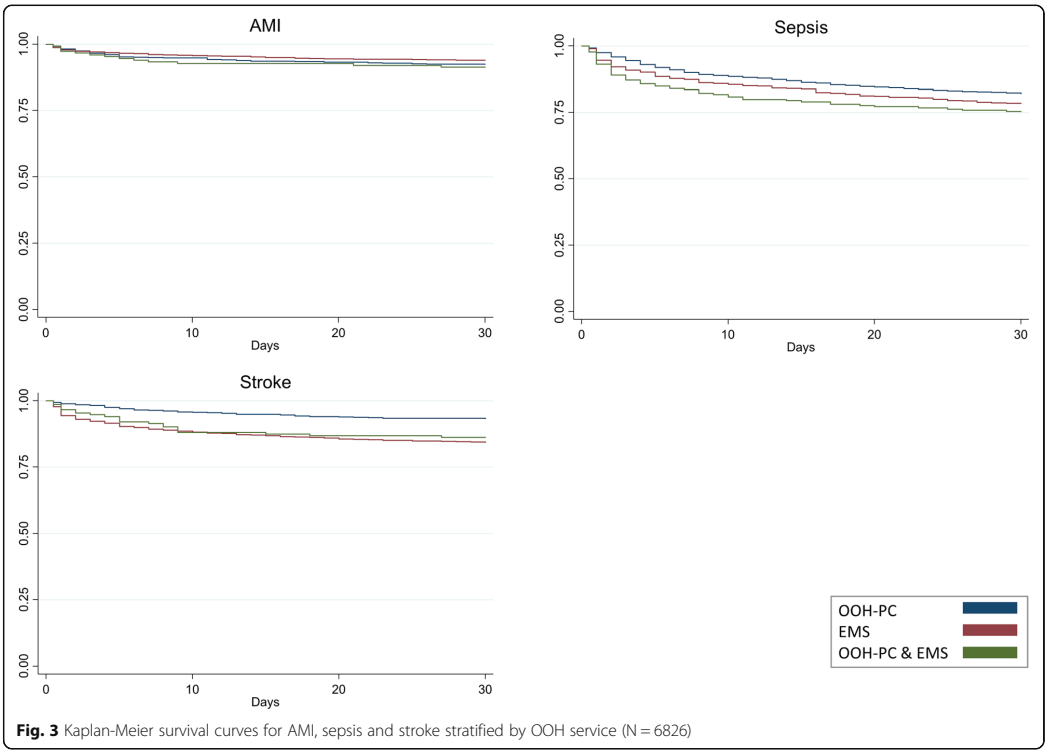

Fig. 3 Kaplan-Meier survival curves for AMI, sepsis and stroke stratified by OOH service (N = 6826)

to hospital contact, which implies a risk of selection bias. Missing PIN have been shown to be an issue in the least urgent EMS contacts [32] and is known to occur in contacts with very high urgency. This may have affected our cohort size, but not likely our results as the high and low urgency would level out each other in the association with outcome. However, our study might have been limited by possible data loss regarding hospital contacts due to implementation of new electronic medical records in the hospitals in the Capital Region of Copenhagen. Thus, the number of patients with the conditions of interests might be underestimated. However, the data loss was a general problem not related to which OOH service was used, thus we have no reason to believe it influences our outcome measures. We may have underestimated the group of patients that have contacts to OOH-PC & EMS as well as patients calling just before midnight with a subsequent hospital contact the following date, since we based our method on dates and not on time-intervals measured as hours. Most likely this would only affect cohort size and not the results. Lastly, the association between exposure and outcome measures in this study could be confounded by other key variables than patient characteristics (e.g. emergency department crowding, hospital characteristics [33–35]), which we did not have access to. Lack of this information may have led to an overestimation of the association between choice of OOH service and our outcome measures.

Comparison with literature

Studies from Western countries on time-critical conditions in OOH services are dominated by time-to-treatment and components-of-delay studies – especially regarding AMI, closely followed by sepsis and stroke [5, 6, 11, 31, 36, 37]. However, some of these earlier studies have also investigated the patient pathway for certain time-critical conditions. Studies investigating acute coronary syndrome/STEMI found that the proportion of contacts to primary care (not specifically OOH-PC) as the first medical contact ranged from 14 to 47.5% of included cases. In similar studies investigating stroke patients, the number ranged from 36.1 to 49.4%. The majority of these studies found that contacting primary care increased prehospital delay, which was most often defined as the time from symptom onset to arrival at hospital. Nevertheless, patient delay (from symptom onset to healthcare contact) was often quite substantial for patients who chose to contact primary care when compared to EMS. Among the studies of stroke patients, only one reported patient outcome. This study by Faiz et al.

Table 2 Crude analysis of the association between OOH service prior to contact, 1- and 1–30-day mortality and ICU stay (*N* = 6826)

Diagnosis	Service	1-day mortality		1–30-day mortality		Intensive care unit stay	
	N	N (%)	OR (95% CI)	N (%)	OR (95% CI)	N (%)	HR (95% CI)
AMI (*N* = 1734)	OOH-PC (679)	12 (1.77)	ref	51 (7.51)	ref	12 (1.77)	ref
	EMS (904)	19 (2.10)	1.29 (0.58–2.48)	54 (5.97)	0.78 (0.53–1.16)	29 (3.21)	1.66 (0.85–3.27)
	OOH-PC & EMS (151)	<5 (NR[a])	1.51 (0.48–4.76)	13 (8.61)	1.16 (0.61–2.19)	<5 (NR[a])	1.44 (0.46–4.49)
Sepsis (*N* = 2561)	OOH-PC (1713)	43 (2.51)	ref	308 (17.98)	ref	42 (2.45)	ref
	EMS (629)	34 (5.41)	2.22 (1.40–3.51)	136 (21.62)	1.26 (1.00–1.58)	39 (6.20)	1.56 (0.99–2.46)
	OOH-PC & EMS (219)	15 (6.85)	2.86 (1.56–5.23)	54 (24.66)	1.49 (1.07–2.08)	8 (3.65)	1.14 (0.53–2.43)
Stroke (*N* = 2531)	OOH-PC (1009)	11 (1.09)	ref	68 (6.74)	ref	23 (2.28)	ref
	EMS (1370)	76 (5.55)	5.33 (2.82–10.08)	214 (15.62)	2.56 (1.92–3.41)	110 (8.03)	2.38 (1.51–3.75)
	OOH-PC & EMS (152)	5 (3.29)	3.09 (1.06–9.01)	21 (13.82)	2.22 (1.32–3.74)	7 (4.61)	1.94 (0.83–4.53)

[a]*NR* not reported due to too few observations

found milder neurologic deficits in patients calling primary care compared to patients calling EMS [11], still mortality was not reported.

Loots et al. [38] investigated 263 sepsis patients admitted to the ICU with (48.3%) and without GP contact, whereas Latten et al. [10] investigated 440 adult emergency department patients with infections or suspected infections comparing GP referred patients (83%) with EMS patients. No significant differences in mortality was found among patients with or without a GP contact, not unlikely due to study sizes. Nevertheless, Latten et al. did find that GP-referred patients were less often triaged with high urgency and admitted to the ICU.

Our results indicate that patients with more severe disease contacted EMS to a greater extent, possibly due to self-triage, suggesting that patients may be able to choose the best fit OOH service. On the other hand a large proportion of patients with AMI and stroke – conditions that often present with alarming symptoms – contacted OOH-PC. Two studies of patients with suspected AMI not calling an ambulance reported that non-callers were less likely to have an AMI and fewer had a history of ischemic

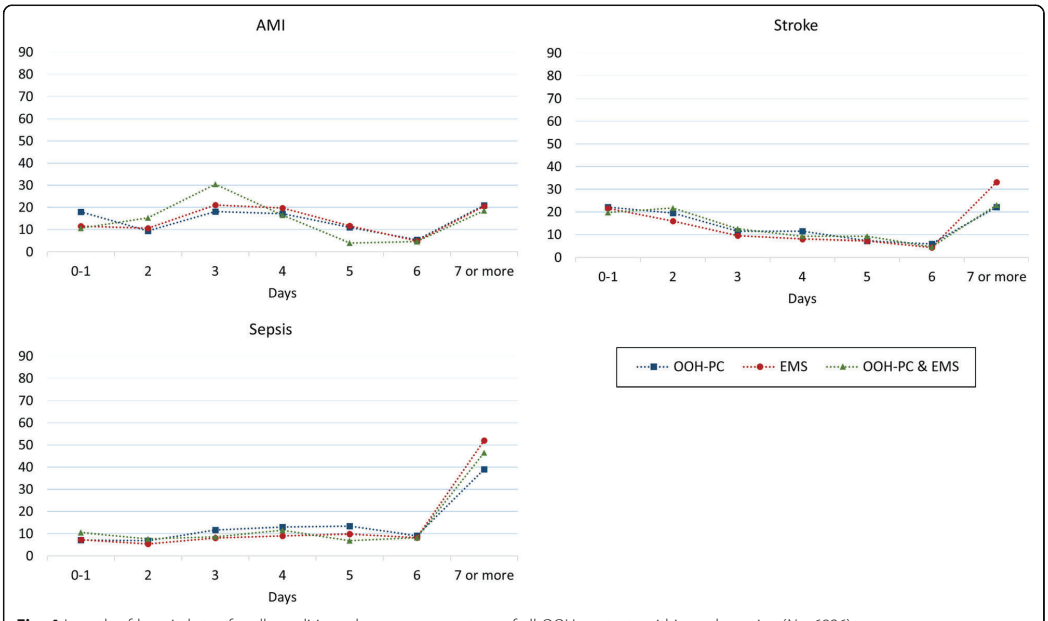

Fig. 4 Length of hospital stay for all conditions shown as percentage of all OOH contacts within each service (*N* = 6826)

heart disease [39, 40]. Not feeling critically ill was the main reason reported for not calling an ambulance, nevertheless 46 and 10% of non-callers had a confirmed AMI in the two studies, perhaps due to poor understanding of symptoms and/or severity of the condition. Patients' evaluation of their own health is only one part of help-seeking behavior - a complex concept comprised of cultural, social, economic, geographical and organizational determinants [41, 42]. Some of these determinants have been investigated in relation to seeking OOH healthcare. Age, ethnicity, low education, unemployment and history of frequent healthcare contacts were associated with higher likelihood of contacting OOH service, whereas no or little social support and/or a high health literacy level was associated with less likelihood of using OOH [24].

Implications for practice and future research

Although the conditions AMI and stroke often present with alarming symptoms, 40% of these patients contacted OOH-PC and not EMS. Furthermore, patients contacting OOH-PC & EMS were at risk of poor outcome, thus additional public information on when a situation is urgent and how to utilize the OOH system is necessary. In addition, organization of the OOH services could be adjusted to match patient behavior and need, when calling either the acute or non-acute number. Improving the collaboration of the OOH services or creating a more seamless transition between OOH-PC and EMS may aid the patient when contacting healthcare, as the possibility of redirecting the patient to the best fit OOH service would be improved for the healthcare personnel. This could be through compatible telephone systems and medical record systems accessible to both OOH-PC and EMS and perhaps co-location of call centers. Furthermore, hospital healthcare personnel should be aware that patients referred directly from OOH-PC may still be severely ill and that double contact patients seem to be a risk group in need of special attention. Future research should focus on patients with double contacts, to get more insight in their care pathway and symptom presentation. Also, the possibility of establishing more collaboration between OOH services should be studied.

Conclusion

With this study, we aimed to investigate whether patients choose the OOH service best fit to handle their condition. We expected EMS patients to be more severely ill than OOH-PC patients, since the aim of EMS is to provide care to patients with life-threatening conditions. Compared to patients contacting OOH-PC prior to hospital contacts, stroke and sepsis patients contacting EMS only or OOH-PC & EMS had higher likelihood of 1- and 1–30-day mortality, a tendency towards higher likelihood of ICU stay and more often longer hospital stays. Nevertheless, we found that the nearly half of patients with the included time-critical conditions contacted OOH-PC.

Supplementary information

Supplementary information accompanies this paper at https://doi.org/10.1186/s12913-019-4674-0.

Additional file 1. ICD-10 codes included in study population. List of all included ICD-10 codes in the study.

Additional file 2. Adjusted analysis of the association between OOH service, ICU stay and mortality ($N = 6826$). Analysis of the association between OOH service, 1- and 1–30-day mortality and ICU stay. Adjusted for age, gender, ethnicity, employment status, education level, income level & comorbidity. * NR = not reported due to too few observations.

Additional file 3. Sensitivity analysis for the association between OOH service, ICU stay and mortality ($N = 6826$). Crude analysis of the association between OOH service, 1- and 1–30 day mortality and ICU stay using the patients' last hospital contact during the study period.

Additional file 4. OOH services contacted prior to hospital contact within the stroke subgroups. Stroke subtypes (brain hemorrhage ($N = 539$) and stroke ($N = 1996$) and choice of OOH service prior to hospital contact.

Additional file 5. Differences in mortality for brain hemorrhage & ischemic stroke. Kaplan-Meier survival curve showing differences in mortality for stroke subtypes (brain hemorrhage ($N = 539$) and stroke ($N = 1996$).

Abbreviations

AMI: acute myocardial infarction; CI: confidence intervals; EMS: Emergency Medical Services; GP: general practitioner; GPC: general practitioner cooperative; HR: hazard ratio; ICD-10: International Statistical Classification of Diseases, 10th Edition; ICU: intensive care unit; OOH: out-of-hours; OOH-PC: out-of-hours primary care; OR: odds ratio; PIN: personal identification number; STEMI: ST-elevation myocardial infarction; STROBE: STrengthening the Reporting of Observational Studies in Epidemiology

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Authors' contributions

MBS, EFC, MBC, LH and BHB co-conceived the research. MBS performed the analysis. MBS wrote the first draft. MBS, EFC, MBC, LH, BHB and HCC all contributed to the drafting of the final manuscript as well as the interpretation of the results. All authors approve of the publication of this paper and agree to be held accountable for all aspects of the work.

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Availability of data and materials

The data that support the findings of this study are available from the North Denmark Region and the Capital Region of Copenhagen, but restrictions apply to the availability of these data, which were used under license from the Danish Patient Safety Authority for the current study, and so are not publicly available.

Ethics approval and consent to participate
The study was approved by the Danish Data Protection Agency (North Denmark Region record number 2008-58-0028 and project identification number 2017–171) and by the Danish Patient Safety Authority (record number 3–3013-2315/1).

Consent for publication
Not applicable.

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

Author details
[1]Centre for Prehospital and Emergency Research, Aalborg University, Søndre Skovvej 15, 9000 Aalborg, Denmark. [2]Research Unit for General Practice, Aarhus University, Aarhus, Denmark. [3]Department of Public Health, Research Unit of Epidemiology, Aarhus University, Aarhus, Denmark. [4]Emergency Medical Services, Copenhagen, University of Copenhagen, Copenhagen, Denmark. [5]Emergency Medical Services, North Denmark Region, Aalborg, Denmark.

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References
1. Langhelle A, Lossius HM, Silfvast T, Björnsson HM, Lippert FK, Ersson A, et al. International EMS systems: the Nordic countries. Resuscitation. 2004;61(1):9–21.
2. Huibers L, Giesen P, Wensing M, Grol R. Out-of-hours care in western countries: assessment of different organizational models. BMC Health Serv Res. 2009;9:1–8.
3. Munro J, Nicholl J, O'Cathain A. Impact of NHS Direct on demand for immediate care: Observational study [Internet]. Vol. 321, British Medical Journal. J. Munro, Medical Care Research Unit, University of Sheffield, Regent Court, Sheffield S1 4DA, United Kingdom. E-mail: j.f.munro@sheffield.ac.uk: BMJ Publishing Group (Tavistock Square, London WC1H 9JR, United Kingdom); 2000. p. 150–3. Available from: http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=emed8&NEWS=N&AN=30447009.
4. Søvsø MB, Hermansen SB, Færk E, Lindskou TA, Ludwig M, Møller JM, et al. Diagnosis and mortality of emergency department patients in the North Denmark region. BMC Health Serv Res [Internet]. 2018 Jul;18(1):548. Available from: https://doi.org/10.1186/s12913-018-3361-x.
5. Doggen CJM, Zwerink M, Droste HM, Brouwers PJAM, van Houwelingen GK, van Eenennaam FL, et al. Prehospital paths and hospital arrival time of patients with acute coronary syndrome or stroke, a prospective observational study. BMC Emerg Med [Internet]. 2016;16:3. Available from: http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=emex&NEWS=N&AN=616003708.
6. Thylén I, Ericsson M, Hellström Ängerud K, Isaksson RM, Sederholm LS. First medical contact in patients with STEMI and its impact on time to diagnosis; an explorative cross-sectional study. BMJ Open. 2015;5(4):1–7.
7. Devon HA, Rosenfeld A, Steffen AD, Daya M. Sensitivity, specificity, and sex differences in symptoms reported on the 13-item acute coronary syndrome checklist. J Am Heart Assoc. 2014;3(2):1–9.
8. Goldstein LB, Simel DL. CLINICIAN ' S CORNER is this patient having a stroke ? EXAMINATION OF PATIENTS WITH SUSPECTED STROKE. Jama. 2008;293(19):2391–402.
9. Van Der Wekken LCW, Alam N, Holleman F, Van Exter P, Kramer MHH, Nanayakkara PWB. Epidemiology of sepsis and its recognition by emergency medical services personnel in the Netherlands. Prehospital Emerg Care. 2016;20(1):90–6.
10. Latten GHP, Claassen L, Jonk M, Cals JWL, Muris JWM, Stassen PM. Characteristics of the prehospital phase of adult emergency department patients with an infection: a prospective pilot study. PLoS One. 2019;14(2):1–10.
11. Faiz KW, Sundseth A, Thommessen B, Rønning OM. Prehospital path in acute stroke. Tidsskr Den Nor Laegeforening Tidsskr Prakt Med Ny Raekke [Internet] 2017;137(11):798–802. Available from: http://ezproxy.lib.umb.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=cmedm&AN=28597634&site=ehost-live
12. World Health Organization. International Statistical Classification of Diseases and Related Health Problems 10th Revision [Internet]. 2016 [cited 2016 Feb 5]. Available from: http://apps.who.int/classifications/icd10/browse/2016/en
13. Gradel KO, Nielsen SL, Pedersen C, Knudsen JD, Østergaard C, Arpi M, et al. Low completeness of bacteraemia registration in the Danish National Patient Registry. PLoS One. 2015;10(6):1–19.
14. Schmidt M, Pedersen L, Sørensen HT. The Danish civil registration system as a tool in epidemiology. Eur J Epidemiol. 2014;29(8):541–9.
15. Schmidt M, Schmidt SAJ, Sandegaard JL, Ehrenstein V, Pedersen L, Sorensen HT, et al. The Danish National Patient Registry: a review of content, data quality, and research potential. Clin Epidemiol [Internet] 2015;7:449–90. Available from: https://www.dovepress.com/getfile.php?fileID=28043
16. Andersen JS, Olivarius NDF, Krasnik A. The Danish National Health Service Register. Scand J Public Health 2011;39(7 Suppl):34–7.
17. STROBE group. index @ strobe-statement.org [Internet]. [cited 2016 Nov 30]. Available from: http://strobe-statement.org/index.php?id=strobe-home
18. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: Guidelines for reporting observational studies. Int J Surg [Internet]. 2014 Dec 1 [cited 2019 Jun 13];12(12):1495–9. Available from: https://www.sciencedirect.com/science/article/pii/S1743911400212X?via%3Dihub
19. Statistics Denmark. Danmarks Statistik [Internet]. [cited 2016 Aug 29]. Available from: http://www.statistikbanken.dk/statbank5a/default.asp?w=1440
20. Regioner D. Dansk Indeks for Akuthjælp; 2014.
21. Andersen MS, Johnsen SP, Sørensen JN, Jepsen SB, Hansen JB, Christensen EF. Implementing a nationwide criteria-based emergency medical dispatch system: A register-based follow-up study. Scand J Trauma Resusc Emerg Med [Internet]. 2013;21(1):53. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3708811&tool=pmcentrez&rendertype=abstract
22. Olesen F, Jolleys J V. Out of hours service: the Danish solution examined. BMJ [Internet]. 1994;309(6969):1624–6. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2542018&tool=pmcentrez&rendertype=abstract
23. Region Hovedstaden. Afrapportering af akut og præhospital indsats i Region Hovedstaden [Internet]. 2013. Available from: https://www.regionh.dk/om-region-hovedstaden/Den-Praehospitale-Virksomhed/om-akutberedskabet/publikationer/Documents/Aarsrapport 2013_April 2014_Endelig.pdf.
24. Keizer E, Christensen MB, Carlsen AH, Smits M, Wensing M, Senn O, et al. Factors related to out-of-hours help-seeking for acute health problems: a survey study using case scenarios 11 medical and health sciences 1117 public health and health services. BMC Public Health. 2019;19(1):1–12.
25. Franks P, Gold MR, Fiscella K. Sociodemographics, self-rated health, and mortality in the US. Soc Sci Med. 2003;56(12):2505–14.
26. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J chronic dis [internet]. 1987;40(5):373–83. Available from: http://www.ncbi.nlm.nih.gov/pubmed/3558716.
27. Statistics Denmark. About Us - Statistics Denmark [Internet]. [cited 2016 Aug 29]. Available from: http://www.dst.dk/en/OmDS#.
28. Thygesen SK, Christiansen CF, Christensen S, Lash TL, Sørensen HT. The predictive value of ICD-10 diagnostic coding used to assess Charlson comorbidity index conditions in the population-based Danish National Registry of Patients. BMC Med Res Methodol [Internet]. 2011;11(1):83. Available from: http://www.biomedcentral.com/1471-2288/11/83
29. Schmidt M, Schmidt SAJ, Sandegaard JL, Ehrenstein V, Pedersen L, Sørensen HT. The Danish National Patient Registry: a review of content, data quality, and research potential. Clin Epidemiol [Internet]. 2015 Nov;7:449. Available from: https://www.dovepress.com/the-danish-national-patient-registry-a-review-of-content-data-quality%2D%2Dpeer-reviewed-article-CLEP
30. Koshy S, Kean C, Fuchs BD. Severe sepsis cohorts derived from claims-based strategies appear to be biased towards a more severely ill patient population. Crit Care Med [Internet] 2014;41(4):1–15. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3810475/
31. Faiz KW, Sundseth A, Thommessen B, Rønning OM. Prehospital delay in acute stroke and TIA. Emerg Med J. 2013;30(8):669–74.
32. Lehm KK, Andersen MS, Riddervold IS. Non-urgent emergency callers: characteristics and prognosis. Prehospital Emerg Care [Internet] 2017 Mar 4;21(2):166–73. Available from: https://www.tandfonline.com/doi/full/10.1080/10903127.2016.1218981.

33. Sun BC, Hsia RY, Weiss RE, Zingmond D, Liang L-J, Han W, et al. Effect of emergency department crowding on outcomes of admitted patients NIH public access author manuscript. Ann Emerg Med [Internet] 2011;61(6):605–11. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3690784/pdf/nihms-445308.pdf.
34. Singer AJ, Thode HC, Viccellio P, Pines JM. The association between length of emergency department boarding and mortality. Acad Emerg Med. 2011; 18(12):1324–9.
35. Freitas A, Silva-Costa T, Lopes F, Garcia-Lema I, Teixeira-Pinto A, Brazdil P, et al. Factors influencing hospital high length of stay outliers. BMC Health Serv Res. 2012;12(1).
36. Hamilton BH, Sheth A, McCormack RT, McCormack RP. Imaging of frequent emergency department users with alcohol use disorders. J Emerg Med. 2014;46(4):582–7.
37. Seymour CW, Kahn JM, Martin-Gill C, Callaway CW, Yealy DM, Scales D, et al. Delays from first medical contact to antibiotic administration for sepsis. Crit Care Med. 2017;45(5):759–65.
38. Loots FJ, Smits M, van Steensel C, Giesen P, Hopstaken R, van Zanten AR. Management of sepsis in out-of-hours primary care: a retrospective study of patients admitted to the intensive care unit. Br J Gen Pract. 2018;68(suppl 1):e022832. bjgp18X696653.
39. Meischke H, Ho MT, Eisenberg MS, Schaeffer SM, Larsen MP. Reasons patients with chest pain delay or do not call 911. Ann Emerg Med. 1995.
40. Lozzi L, Carstensen S, Rasmussen H, Nelson G. Why do acute myocardial infarction patients not call an ambulance? An interview with patients presenting to hospital with acute myocardial infarction symptoms. Intern Med J. 2005;35(11):668–71.
41. Mackian S, Bedri N, Lovel H. Up the garden path and over the edge: where might health-seeking behaviour take us? Health Policy Plan. 2004;19(3):137–46.
42. Andersen R, Newman JF. Societal and individual determinants of medical care utilization in the United States. Milbank Mem fund Q health Soc [internet]. 1973;51(1):95–124. Available from: http://www.ncbi.nlm.nih.gov/pubmed/4198894.

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