ORIGINAL RESEARCH

Emergency Call versus General Practitioner Requested Ambulances – Patient Mortality, Disease Severity and Pattern

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Introduction: Ambulance requests by general practitioners for primary care patients (GP-requested) are often omitted in studies on increased demand within emergency care but may comprise a substantial patient group. We aimed to assess acute severity, intensive care unit (ICU) admission, and diagnostic pattern, including comorbidity, and mortality among GP-requested ambulance patients, compared to emergency call ambulance patients. Our hypothesis was that emergency call patients had more severe health issues than GP-requested ambulance patients.

Methods: Historic population-based cohort study of ambulance patients in the North Denmark Region, 2016–2020. Hospital contact data including diagnoses, ambulance data, vital signs and vital status was linked using each patient's unique identification number. Primary outcome measure was mortality within 1, 7, and 30 days. Secondary outcomes were disease severity expressed as modified National Early Warning Score (NEWS2), and ICU admission. Admission status and hospital diagnostic pattern, including comorbidity were described and compared.

Results: We included 255,487 patients. GP-requested patients (N = 119,361, 46.7%) were older (median years [IQR] 73 [58–83] versus 61 [37–76]) and more had moderate/severe comorbidity (11.9%, N = 13,806 versus 4.9%, N = 6145) than the emergency call patients. Prehospital mNEWS2 median scores were lower for GP-requested patients. For both groups, mNEWS2 was highest among patients aged 66+. GP-requested patients had higher 30-day mortality (9.0% (95% CI: 8.8–9.2), N = 8996) than emergency call patients (5.2% (95% CI: 5.1–5.4), N = 6727). Circulatory (12.0%, 11,695/97,112) and respiratory diseases (11.6%, 11,219/97,112) were more frequent among GP-requested patients than emergency call patients ((10.7%, 12,640/118,102) and (5.8%, 6858/118,102)). The highest number of deaths was found for health issues 'circulatory diseases' in the emergency call group and 'other factors' followed by "respiratory diseases" in the GP-requested group.

Conclusion: GP-requested patients constituted nearly half of the EMS volume, they were older, with more comorbidity, had serious conditions with substantial acute severity, and a higher 30-day mortality than emergency call patients.

Keywords: emergency medical services, mortality, diagnoses, early warning scores, after-hours care, primary healthcare, general practitioners

Introduction

The entire emergency medical care chain, both the prehospital emergency services (EMS) and the hospitals' emergency departments (ED) face increasing numbers of patients. One of the main reasons are the changes in demography with more elderly and more living with chronic diseases and multimorbidity.[1–4]

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As a result, alternative solutions for optimizing the use of ambulances and reducing the number of hospitalized patients are explored. These include campaigns for when to call for an ambulance, non-conveyance of patients, community paramedics, subacute ambulatory/outpatient care etc.[5–9] The initiatives, often local and concerning a subset of patients, miss the larger picture of the effect on the entire acute EMS population.

In Europe and globally, access to an ED differs from direct access (Sweden), recommended contacting a general practitioner (GP) or out-of-hours GP prior (Netherlands), or requiring referral (Norway). For Denmark, access to hospital care is only possible through referral by either a GP, out-of-hours GP or the national emergency number 112 as triage prior to hospital attendance is mandatory. GPs take care of the less urgent situations during office hours, and out-of-hours GPs are intended for less urgent health problems that cannot wait until the patient's own GP is available in normal office hours. The national emergency number is for potential life or limb threatening and other emergencies where urgent assistance is required.[10] If deemed necessary, ambulances are dispatched following a call to 112, but GPs may also request an ambulance at all hours. When referring to an increasing demand and number of emergency ambulances, ambulances requested by primary care (ie, GPs) are often left out. In countries with established primary care sectors such requests may contribute substantially to the number of ambulances needed.[10] In Denmark, patients do not always contact the emergency number for serious conditions but call the GP and the emergency number is contacted for non-urgent conditions as well.[11]

The demand for and use of ambulances changes over time according to changes in demography and the disease pattern in the patient population. To give a complete picture, we must cover the entire patient population in the ambulances, including ambulances requested both from 112-calls, GPs, and others. The numerous patient registries in Denmark, as well as other Scandinavian countries, enable such studies.[12] To facilitate stable solutions, studies on a population-based level, elucidating the disease pattern of the entire group of ambulance patients, are needed.

We aimed to assess acute severity, ICU admission, and diagnostic pattern, among GP-requested ambulance patients, and mortality compared to emergency call ambulance patients.

Our hypothesis was that the emergency call patients have more severe health issues compared to the GP-requested patients.

Materials and Methods
Design
Historic population-based cohort study. Reporting was done following STROBE guidelines.[13]

Setting
In Denmark, healthcare is tax-financed and thereby free of charge for all inhabitants. The country is divided into five regions, each responsible for the healthcare services within the region. The North Denmark region is a mixed rural-urban region with a population of 590,000 inhabitants, corresponding to 10% of the Danish population.[14] In the region, GPs (during office hours), out-of-hours GPs, and EMS (around the clock) are available for acute disease or injury. Access to hospital care is only possible through one of the three services as triage prior hospital attendance is mandatory. All patients with a hospital contact receive a diagnosis according to the International Classification of Diseases 10th Edition (ICD-10) and may receive multiple diagnoses during hospitalization.[15]

Participants
Patients transported to a hospital by an ambulance following either a call to the national emergency number 112, *emergency call patients*, or a request from a GP (in and out-of-hours), *GP-requested patients*, during July 1st 2016 to December 31st 2020 in the North Denmark Region, were included.

We excluded patients with no valid Civil Registration Number (number not obtained due to acute situation, unconscious or dead patient, tourist, etc. or invalid format entered), patients with time of death before time of medical record creation or missing vital status, and those who were registered as dead upon hospital arrival: "R092 respiratory arrest", "R96 sudden death", "R98 unattended death", and "R99 certain circumstances regarding death".

Variables and Data Sources

Data concerning sex, age and date of death were retrieved from the Danish Civil Registration System.

Prehospital vital signs were retrieved from the prehospital electronic medical record.[10,16] The patients' first measured vital signs (heart rate, systolic blood pressure, SpO2, Glasgow coma scale and respiratory rate) were used to calculate the modified NEWS2 (mNEWS2) score (temperature excluded as this is rarely measured in the ambulances).[16] mNEWS2 was only calculated for patients older than 16 years.

Logistic data concerning dispatched ambulances were retrieved from the logistic system (LogisCAD).

Administrative information on hospital visits (admission, discharge dates, department and ICU admission) and in-hospital diagnoses according to the ICD-10 were retrieved from the regional patient administrative system.[15] The ICD-10 main chapters comprise cause-specific diagnoses that are organ- or pathology specific (such as Infections, Respiratory diseases, Injuries etc).[15] The patients' initial primary diagnosis was reported. If a patient was registered as having received a non-specific diagnosis (ICD-10 main chapter 18 "symptoms and signs" or chapter 21 "other factors"), we investigated all diagnoses given during hospitalization. If the patient at any point received an organ- or pathology-specific diagnosis during their hospitalization, the later specific diagnosis was used instead of the initial non-specific diagnosis".

Admissions to individual wards were linked into care episodes where there were less than 24 hours since last admission, provided another emergency episode did not take place between admissions.

Hospital contacts were determined to be associated with an emergency episode if the contact time was within six hours of the emergency dispatch.

Comorbidity was evaluated according to the Charlson Comorbidity Index score (CCI) for patients above 16 years and based on the past five years of hospital diagnoses only.[17] Comorbidity is categorized as *none/missing* if no diagnoses were found, *mild* if CCI score was 1–2, and *moderate/severe* if the score was 3 or more. All data sources were linked using the patients' unique civil registration numbers.

Outcomes

Our primary outcome measure was mortality within 1, 7, and 30 days.

Secondary outcomes were disease severity expressed as modified National Early Warning Score (NEWS2), and ICU admission.[18] Furthermore, admission status and diagnoses given, including comorbidity, were described and compared.

Statistical Analysis

Data was pseudonymized prior to analysis.

Outcome rates were stratified by emergency call patients and GP-requested patients and calculated for subgroups.

Mortality within 1-, 7- and 30 days was estimated via Kaplan–Meier survival analysis. To address the possibility of a patient being registered as dead more than once, due to multiple contacts, patients were omitted from the mortality analysis, if they had a subsequent episode within the follow-up period. Mortality estimates are reported with 95% confidence intervals. Differences in survival functions were assessed using a Peto-weighted Log rank test. Differences in point estimates of survival were assessed using log-log transformed survival functions. Adjusted survival was estimated using a Cox Proportional Hazards model with age, sex, mNEWS2, CCI and 112-call status as covariates. Survival analysis was performed using the "lifelines" package.

The mortality analysis was further stratified by initial primary diagnosis and by age groups.

The mNEWS2 was calculated using the first measured vital signs in each patient's prehospital medical record. If one or more vital signs were missing, mNEWS2 was calculated based on the vital signs available with the assumption that the missing data were normal, ie, not adding further to the calculated mNEWS2 score. eFigure 1 shows the proportion of missing values in relation to the mNEWS2 scores. This approach to missing values was used in previously published work.[19]

Categorical data were described as n (%), and continuous data described as median [IQR]. Differences between categorical data were assessed using the chi-squared test. Differences between continuous data were assessed using the non-parametric Mann–Whitney *U*-test.

All analysis was done in Python version 3.10. Survival analysis used the lifelines package (version 0.27.8). Hypothesis tests used the implementations in the SciPy package (version 1.11.3).[20]

Results

A total of 274,042 patients requested an ambulance in the study period. The exclusion criteria resulted in 255,487 included patients, consisting of 113,587 unique patients (Figure 1). Of the 255,487 included patients, 136,126 (53.3%) were emergency call patients, and 119,361 (46.7%) were GP-requested patients. The total number of prehospital medical records created for each unique patient over the study period can be seen in eTable 1. Most patients received an ambulance after either calling 112 or the GP, and 24.9% of the population (33,237/133,587) received an ambulance calling both 112 and the GP (eTable 1). Most of the ambulance patients were brought to the hospital (84.2%, (215,214/ 255,487)) and thus had a diagnosis assigned.
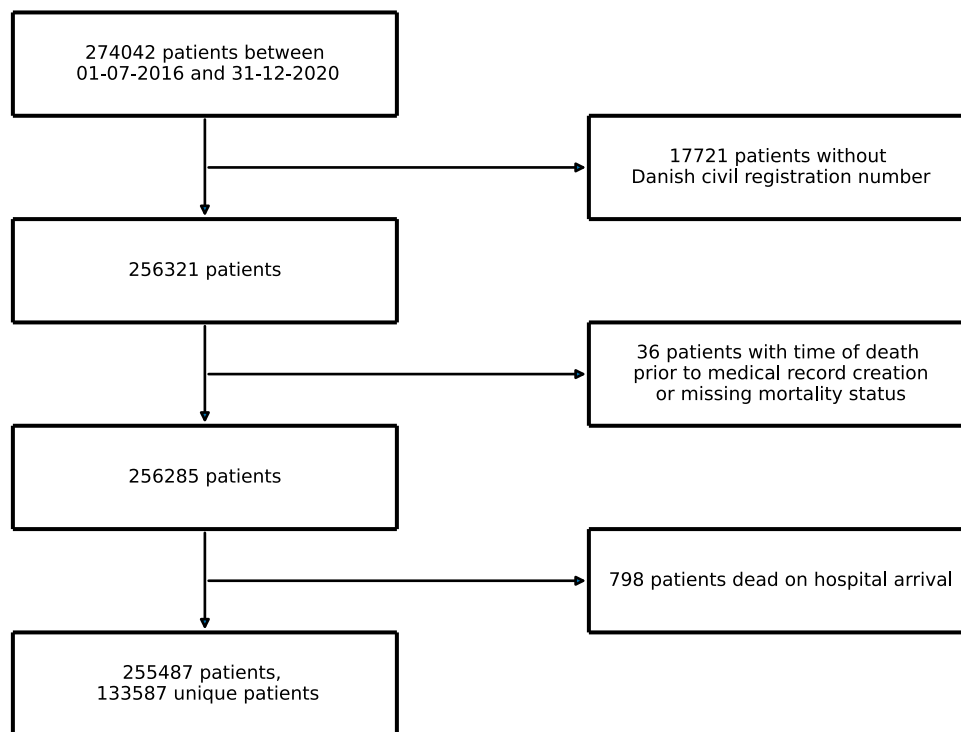
There were three age peaks at infant age, early twenties, and older age (Figure 2). The GP-requested patients were older (median 73 years IQR [58–83]) than the emergency call patients (median 61 years IQR [37–76]) (Table 1).

Overall, comorbidity was more prevalent among GP-requested patients compared to emergency call patients, as was moderate/severe comorbidity (Table 1).

Most patients 82.4% (N = 215,214/255,487) were brought to the emergency department as the first department, but less frequent for the GP-requested patients (72.4% (70,296/97,112) than for the emergency call patients (90.7% (107,118/118,102).

Disease severity based on the mNEWS2 score differed across age groups and by emergency call status. GP-requested patients had lower median mNEWS2 scores in all age groups compared to emergency call patients, with low scores most frequent among the younger patients. However, in patients aged 66 years and above, score distribution was more similar, the median score was higher and acute disease severity increased with age for both GP-requested and emergency call patients (eTable 2 and Figure 3). In less than 10% of the population, no vital signs were measured and a mNEWS2 score could not be calculated. Most patients had three or more vital signs measured (eFigure 1).

For GP-requested patients, hospital length of stay was longer, with a median 2.2 days compared to 0.5 days for emergency call patients, whereas ICU admissions were more frequent among emergency call patients (Table 1). The distribution of first primary diagnoses at ICD-10-chapter level stratified by age and call-status is illustrated in eFigure 2 and eTable 3. The most frequent diagnoses assigned were within the two non-specific diagnostic chapters, "symptoms and signs", "other factors", and the chapter "injuries and poisoning". Injuries were more frequent among the younger part

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│   274042 patients between    │
│   01-07-2016 and 31-12-2020  │
└─────────────────────────────┘
              │      ┌──────────────────────────────────┐
              ├─────▶│ 17721 patients without           │
              │      │ Danish civil registration number │
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│      256321 patients         │
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              ├─────▶│ 36 patients with time of death   │
              │      │ prior to medical record creation │
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│      256285 patients         │
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              ├─────▶│ 798 patients dead on hospital    │
              │      │ arrival                           │
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│      255487 patients,        │
│     133587 unique patients   │
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Figure 1 Study inclusion flowchart of all ambulance patients between July 1st 2016 to December 31st 2020 in the North Denmark Region (N = 255487).
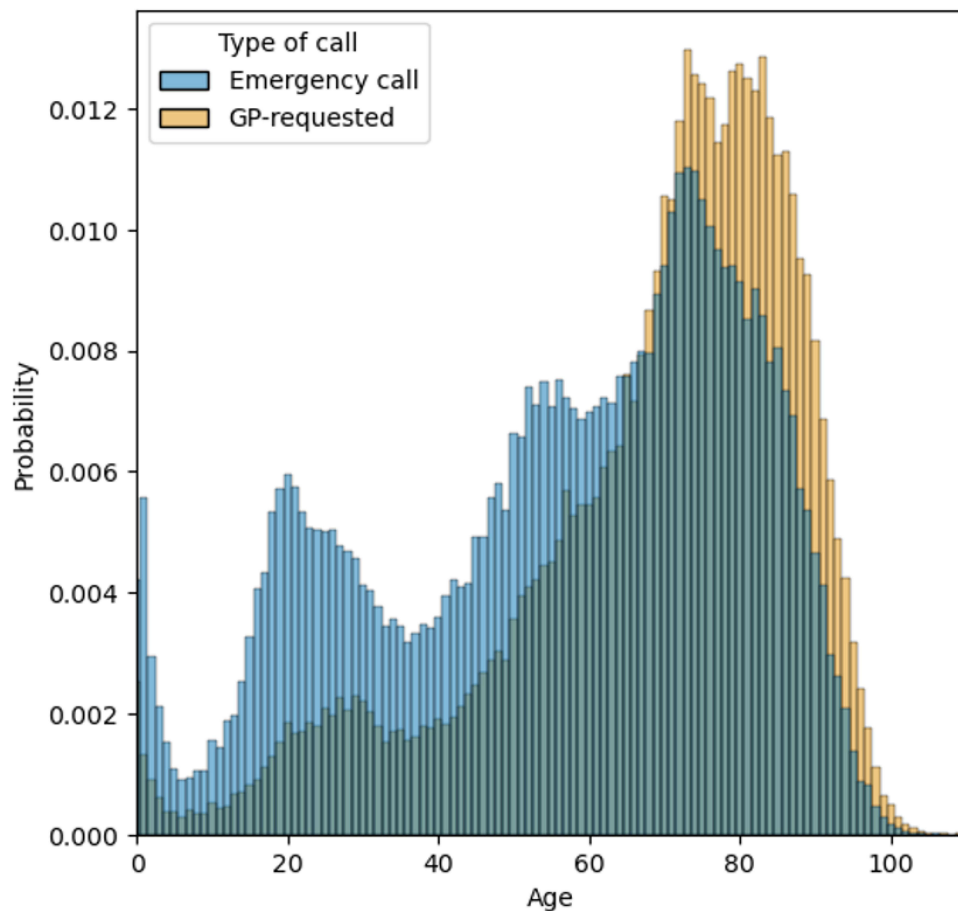
Figure 2 Age distribution of all ambulance patients stratified by emergency call status (N = 255,487).

of the population, and especially for the emergency call patients. The proportion of patients diagnosed within the ICD-10 main chapter "circulatory diseases", generally increased with age in both groups. Patients diagnosed within chapter 10 "respiratory diseases", were most prominent among the youngest and oldest, for both the GP-requested and emergency call patients. Overall, the proportions of non-causal diagnoses were higher among the emergency call patients, 44.8% (52,941/118,102), versus 35.8% (34,805/97,112) among GP-requested patients (eTable 3).

Mortality

The 30-day mortality among GP-requested patients was higher, when compared to emergency call patients, with 8996 (9.0%) and 6727 (5.2%) deaths, respectively (Table 1). Probability of survival was lower for GP-requested patients especially in the interval 7–30 days following the ambulance run. Mortality closer to the ambulance run (days 1–6) was higher for emergency call patients, especially 1-day mortality.

In the Cox proportional hazards model, the hazard ratios for age were 1.58 (1.55–1.61) for GP-requested and 1.53 (1.50–1.56) for emergency call patients. For comorbidity, it was 1.21 (1.18–1.23) and 1.26 (1.25–1.28), respectively, mNEWS2 score 1.25 (1.24–1.27) and 1.22 (1.21–1.23), and for male sex 1.16 (1.10–1.23) and 1.12 (1.07–1.18) (Figure 4).

For GP-requested patients, the two non-specific diagnosis chapters, "symptoms and signs" and "other factors", as well as "diseases of the respiratory system" were associated with the highest number of deaths. Compared to emergency call patients, the number of deaths within these main diagnostic chapters was twice as high (Figure 5).

Deaths among patients diagnosed with "diseases of the circulatory system" were the most frequent group among the emergency call patients and more frequent than among GP-requested patients (Figure 5).

Table 1 Demographics, Characteristics, and Outcome Rates for All Ambulance Patients (N = 255487)

|	All	GP-Requested Patients	Emergency Call Patients	p-value
Missing Civil Registration Number, N (%)	17,721	4421 (24.9)	13,300 (75.1)	
N (%)	255,487 (100.0)	119,361 (46.7)	136,126 (53.3)	
N unique	133,587	88,242	78,582	
Age, median [IQR]	68 [48–80]	73 [58–83]	61 [37–76]	<0.0001
Sex=Female, n (%)	122,192 (47.8)	59,396 (49.8)	62,796 (46.1)	<0.0001
Charlson Comorbidity Index*				<0.0001
None/missing (0)	160,522 (62.8)	65,143 (56.0)	95,379 (75.5)	
Mild (1–2)	62,222 (24.4)	37,350 (32.1)	24,872 (19.7)	
Moderate/severe (≥3)	19,951 (7.8)	13,806 (11.9)	6145 (4.9)	
1-day mortality, n, %, (95% CI)	5550, 2.2 (2.2–2.3)	1425, 1.2 (1.2–1.3)	4125, 3.1 (3.0–3.2)	<0.0001
7-day mortality, n, %, (95% CI)	10,379, 4.3 (4.3–4.4)	4833, 4.5 (4.4–4.6)	5546, 4.2 (4.1–4.3)	0.0006
30-day mortality, n, %, (95% CI)	15,723, 6.9 (6.8–7.0)	8996, 9.0 (8.8–9.2)	6727, 5.2 (5.1–5.4)	<0.0001
No hospital contact, n, %	40,273 (15.8)	22,249 (18.6)	18,024 (13.2)	<0.0001
Hospital contact, n, %**	215,214 (84.2)	97,112 (81.4)	118,102 (86.8)	<0.0001
First department: Emergency department, n, %***	177,414 (82.4)	70,296 (72.4)	107,118 (90.7)	<0.0001
ICU Admission, n, %	5427 (2.5)	2076 (2.1)	3351 (2.8)	<0.0001
Hospital length of stay, days, median, [IQR]	1.0 [0.2–4.0]	2.2 [0.6–5.8]	0.5 [0.1–2.1]	<0.0001

Notes: *Patients aged 16 or younger not included when reporting CCI (12792 patients excluded). **Details regarding departments, ICU admission and length of stay concerns patients brought to hospital only (N = 215214). ***Patients brought to the emergency department as the first department.

# Discussion
Key Results
Mortality was significantly higher for GP-requested patients by 7 to 30 days following the ambulance run, yet mortality closer to the ambulance run (days 1–6) was higher for emergency call patients. GP-requested patients had significantly lower mNEWS2 scores in all age groups. In patients aged 66 years and above, median scores for both GP-requested and emergency call patients were similar and higher. GP-requested patients were older, with a higher degree of comorbidity
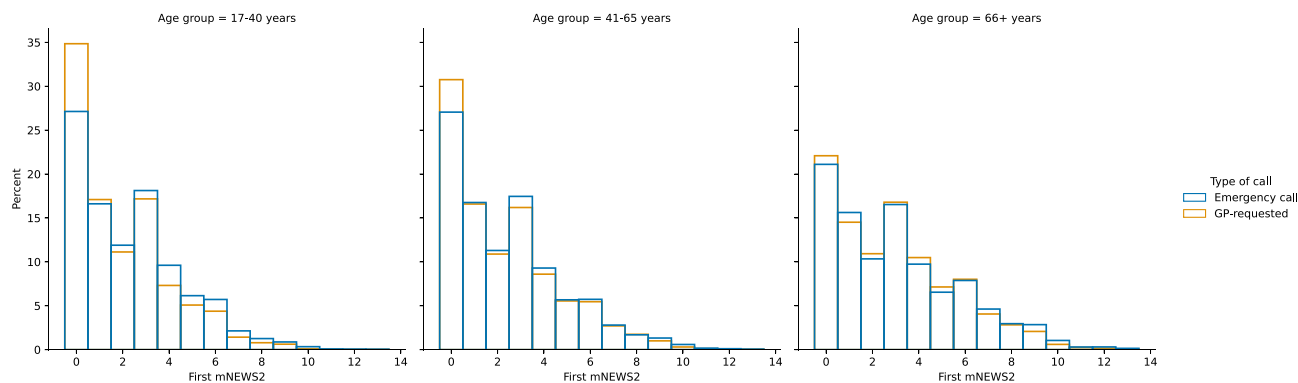
Figure 3 Distribution of mNEWS2 scores for all ambulance patients aged >16 years stratified by emergency call status (N = 220344).
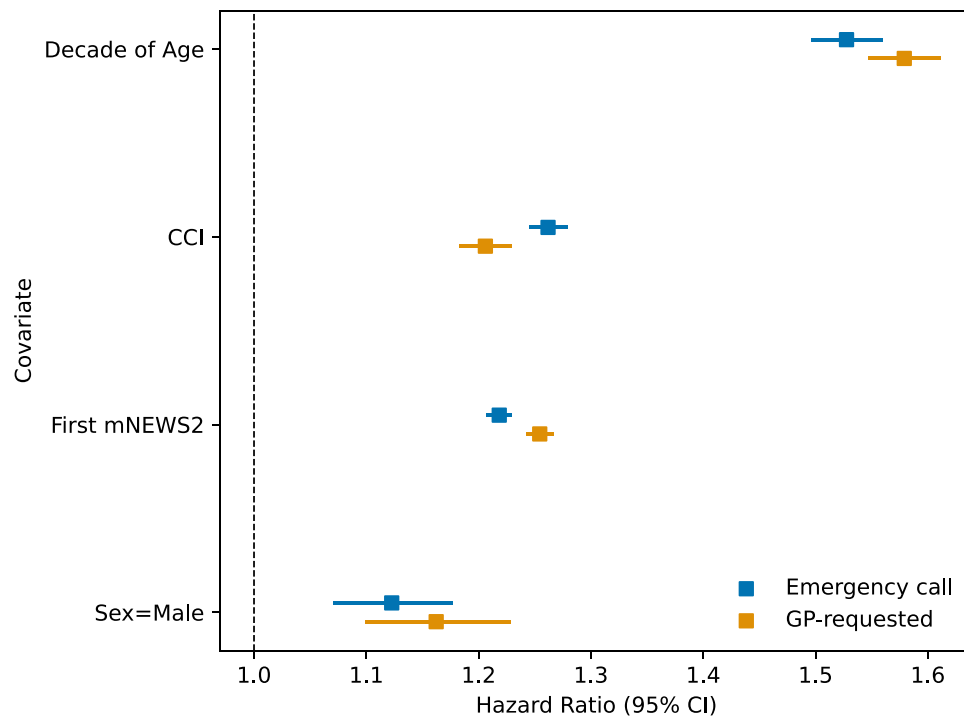
Figure 4 Plot of co-variate hazard ratios for the Cox Proportional Hazard model of mortality (N = 220,344).
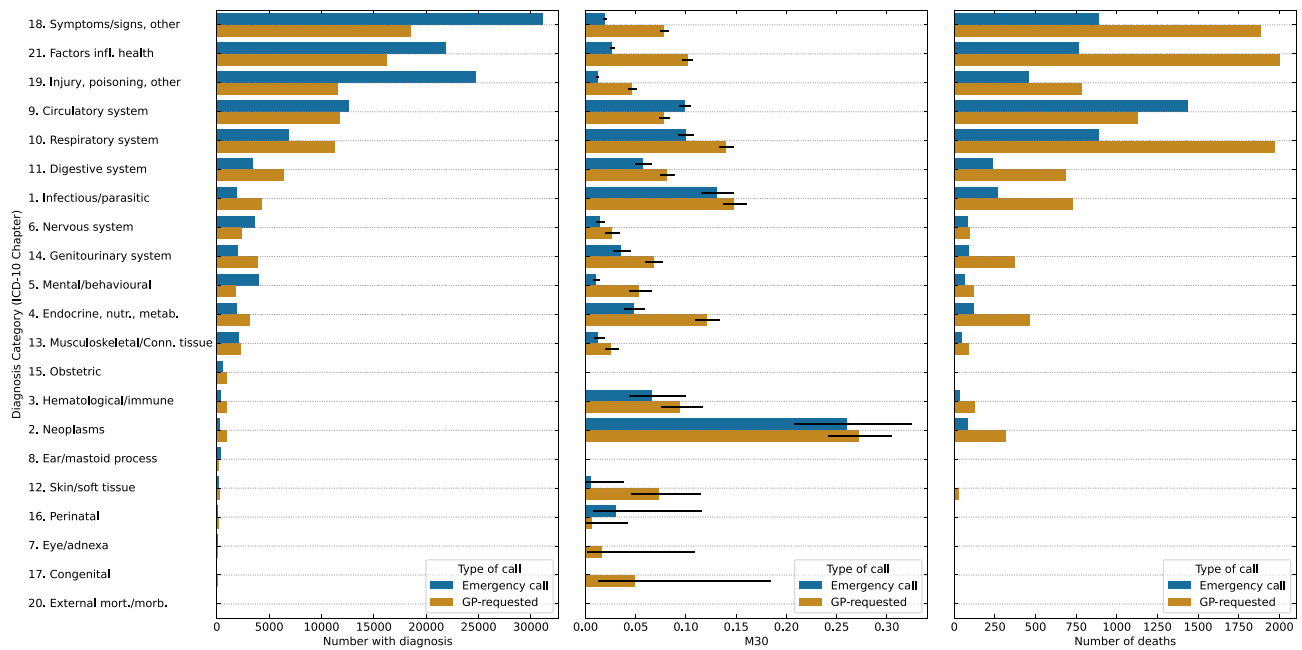
Figure 5 Number of diagnoses, mortality and number of deaths stratified by emergency call status and first primary diagnosis, according to the International Classification of Diseases 10th Edition (ICD-10) for ambulance patients brought to hospital (N = 215214).
Abbreviation: M30: 30-day mortality.

and significantly longer hospital stays, whereas emergency call patients were more often admitted to the ICU. Age, comorbidity, mNEWS2 score and male sex were associated with increased risk of mortality for both groups. Non-specific diagnoses were frequently assigned in both groups, though most prevalent for emergency call patients. For GP-requested patients, the highest number of deaths were among the non-specific diagnoses and respiratory diseases, whereas most deaths were found among patients with circulatory diseases in the emergency call group.

In a Danish population of adult emergency department patients, Bech et al found that abnormal vital sign values and urgency level were associated with immediate mortality (within 4 hours of ED arrival), whereas age, male sex, and comorbidity were all increasingly associated with 30-day mortality.[21] Immediate mortality was also associated with circulatory diseases. In the present study, abnormal vital signs (high mNEWS2 score) and ICU admission were more frequent among emergency call patients, as were deaths among patients with circulatory diseases, partially explaining the higher immediate mortality in this group. At 7 days, the difference in mortality between the two groups diminished and beyond one week mortality was more frequent in the group of GP-requested patients, who were older and with more comorbidity. During our study period, 25% of the patients had runs with both emergency calls and GP-requested ambulances, which could suggest overlap in patient groups or independent disease episodes of different character. Patients often experience difficulty in navigating acute healthcare services, which may result in both more calls to primary care rather than 112, even for time-critical diseases, and more calls to 112 among patients not in need of urgent healthcare.[22,23]

In the UK, a new medical hotline number for non-emergency health problems was introduced in 2013. The expectation was that this would reduce calls to emergency medical services, yet following the introduction there was an increase in ambulance dispatches.[24,25] Similarly, in 2014 a medical hotline number staffed primarily by nurses was introduced in the Capital Region of Denmark, replacing the out-of-hours GP service. The number was for non-life- or limb-threatening acute disease or injury that could not wait until GP office hours. After implementation, an increase in acute hospital contacts was reported.[25]

Patient diagnoses were dominated by injuries, non-specific diagnoses, circulatory- and respiratory diseases in the present study. This is in accordance with earlier findings in other Danish regions and other countries.[26–30] The proportion of non-specific diagnoses was lower among the GP-requested patients. In Denmark, patients are often seen and examined physically by a GP before ambulance request and conveyance to hospital, improving triage ability. As opposed to a physical examination, telephone triage is limited by lack of visual clues and vital signs.[31]

Non-specific diagnoses comprised the largest groups of assigned diagnoses in both groups, and especially in the GP-requested patients, there were many deaths within these diagnoses. The oldest ambulance patients in the current study exhibited a high degree of acute disease severity, putting them at a higher risk of dying within a short-time frame.

Study Limitations

Medical records without a registered Danish civil registration number were excluded from the study (N = 17,721), corresponding to 6.5% of the initial data set. This could introduce a possibility of bias as these patients may have unknown common characteristics that would be missing from the included data set. Since GPs know the identity of the majority of their patients, most patients with missing registration number are found in the emergency call group. Here, more than twice as many registration numbers are missing, which is a limitation in the comparison of the two groups as missingness could be associated with both high or low disease severity.

Danish registries are among the best in the world, strengthening the follow-up and information on preexisting conditions.[12,32] In the present study, comorbidity was based on patients with hospital contacts within the last five years only, while comorbidities managed by their GP only were not included. This will most likely mean that patients with the most serious comorbidities are included (since they will more often require hospital contacts in outpatient clinics and similar setups).

The exclusion of patients with certain diagnoses who died upon hospital arrival is a limitation as they represent seriously ill patients. However, since the use of these diagnoses is inconsistent, this presents a poor basis for comparison, which was the reason for exclusion.

Another limitation is the possible overlap between the GP-requested and emergency call groups. One fourth of the patients had ambulance runs both after emergency calls and requested by a GP during the entire study period. Since patients could potentially be part of both groups, this might lead to an underestimating of the differences between the two groups, especially regarding inherent patient characteristics such as age, sex, and comorbidity, less so disease severity in each independent disease episode.

The missing measurements of vital signs is a limitation. In our calculation of the mNEWS2 score, we chose to consider missing vital signs as normal – ie, not changing the score calculation based on the vital signs available. Missing vital signs may be associated with both severe and mild disease. In a previous study by our group using the same method and a similar cohort, high degree of missing vital signs was associated with higher mortality.[19] In our study, less than 10% had no vital signs measured and a mNEWS2 score could therefore not be calculated. However, most patients had more than three vital signs measured and especially for high mNEWS2 scores there were only few missing values (eFigure 1). Despite this, in the comparison of disease severity, our approach may have led to an underestimation – both in the GP-requested and emergency call group.

The study period included the covid-19 pandemic period, although this only accounts for a minor portion of the study period. A previous Danish study found a marked reduction in unplanned hospital attendances during the pandemic, which should be taken into consideration when interpreting the results of the current study.

Conclusion

GP-requested ambulance patients constituted close to half of all emergency ambulance runs and mortality surpassed that of the emergency call ambulance patients a week after the ambulance run. GP-requested patients were older and with more comorbidity, but also with substantial acute disease severity, longer hospital stays and serious conditions, especially among the oldest patients.

As the proportion of older people increases in most western countries, it is expected that ambulance requests will also increase. This study showed that especially older patients were conveyed by ambulance after primary care contacts. Thus, it is not unlikely that primary care ambulance requests may rise substantially in the coming years in countries with similar healthcare setups (eg, Norway, the Netherlands, UK). Alongside the increasing focus by ambulance services on non-conveyance of emergency call patients, perhaps it is time to revisit collaboration between primary care and ambulance services to ensure the best possible planning of patient courses and resource utilization. Especially, as reducing or altering access to one type of emergency care, will most likely lead to increased flow to another access point. This has been seen in both the UK and Denmark. It is important to investigate how these reductions or alterations may affect the entire acute patient population and the entire healthcare system and which solutions are possible going forward.

Data Sharing Statement

Data cannot be shared publicly as it contains sensitive patient information and restrictions apply. However, for researchers who have obtained approval for the handover of medical records (https://rn.dk/da/Til-fagfolk/Sundhed/Forskning/Videregivelse-af-patientjournaloplysninger), the dataset can be constructed by requesting data from the North Denmark EMS, and the Danish health data Authority at https://sundhedsdatastyrelsen.dk/da/english/health_data_and_registers/research_services/before_applying.

Ethics

As per Danish legislation, registry-based studies do not need approval by an Ethical Committee. Handover of medical records without informed patient consent was approved by the Danish Patient Safety Authority (2021-012621).

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; or decision to submit the manuscript for publication.

Disclosure

LMW and MLM are minor shareholders in Treat Systems ApS. The authors report no other conflicts of interest in this work.

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