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# Trends in diagnostic patterns and mortality in emergency ambulance service patients in 2007–2014: a population-based cohort study from the North Denmark Region

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## ABSTRACT

**Objective** Demand for ambulances is growing. Nevertheless, knowledge is limited regarding diagnoses and outcomes in patients receiving emergency ambulances. This study aims to examine time trends in diagnoses and mortality among patients transported with emergency ambulance to hospital.

**Design** Population-based cohort study with linkage of Danish national registries.

**Setting** The North Denmark Region in 2007–2014.

**Participants** Cohort of 148 757 patients transported to hospital by ambulance after calling emergency services.

**Main outcome measures** The number of emergency ambulance service patients, distribution of their age, sex, hospital diagnoses, comorbidity, and 1-day and 30-day mortality were assessed by calendar year. Poisson regression with robust variance estimation was used to estimate both age-and sex-adjusted relative risk of death and prevalence ratios for Charlson Comorbidity Index (CCI) to allow comparison by year, with 2007 as reference year.

**Results** The annual number of emergency ambulance service patients increased from 24.3 in 2007 to 40.2 in 2014 per 1000 inhabitants. The proportions of women increased from 43.1% to 46.4% and of patients aged 60+ years from 39.9% to 48.6%, respectively. The proportion of injuries gradually declined, non-specific diagnoses increased, especially the last year. Proportion of patients with high comorbidity (CCI≥3) increased from 6.4% in 2007 to 9.4% in 2014, corresponding to an age- and sex-adjusted prevalence ratio of 1.27 (95% CI 1.16 to 1.39). The 1-day and 30 day mortality decreased from 2.40% to 1.21% and from 5.01% to 4.36%, respectively, from 2007 to 2014, corresponding to age-adjusted and sex-adjusted relative risk of 0.43 (95% CI 0.37 to 0.50) and 0.72 (95% CI 0.66 to 0.79), respectively.

**Conclusion** During the 8-year period, the incidence of emergency ambulance service patients, the proportion of women, elderly, and non-specific diagnoses increased. The level of comorbidity increased substantially, whereas the 1-day and 30-day mortality decreased.

## Strengths and limitations of this study

- ► Linkage of ambulance logistic data with patient registries made it possible to investigate the development over time in hospital diagnoses, comorbidity and mortality in a large cohort of emergency ambulance service patients brought to hospital.
- ► The equal access to the prehospital emergency medical services ensured that the socioeconomic status of the patients did not influence inclusion of subjects in the study. This, together with the population-based design and the thorough follow-up, limited the risk for selection bias due to differentiated inclusion or loss of follow-up.
- ► Still, some selection bias cannot entirely be ruled out because of missing civil registration numbers and thereby the lack of follow-up for these patients.
- ► The reported findings regarding changes in the diagnoses relied on diagnostic coding from the hospitals of which most have been shown to be accurate in validation studies, thereby limiting the risk of misclassification and information bias.

## INTRODUCTION

The demand for prehospital emergency care has increased during the last decades throughout the Western world in terms of numbers of emergency calls and dispatched ambulances.[1–3] This development represents a challenge for both the prehospital emergency systems and the emergency departments at the hospitals.[4 5] A few studies have reported an increase in age over time among prehospital patients.[3 4] However, little is known about the possible changes in the demographic and clinical characteristics as well as the outcome in emergency ambulance service patients because most prehospital studies are based only on patient information from ambulance records with no or very limited follow-up. More knowledge in this field is crucial, not only for the prehospital emergency medical services but also for the hospital emergency departments, healthcare planners, decision makers and last but not least for the patients and the population.

Each citizen in Denmark receives a unique civil registration number; this personal identification number allows linkage to patient administrative registries with information about, for example, hospital diagnoses and date of death. This enables a virtually complete follow-up of identified emergency ambulance service patients.[5 6]

The aim of this study was to investigate changes in the number of patients transported to hospital with an emergency ambulance, their sex and age profiles, hospital diagnoses, comorbidity, and 1-day and 30-day mortality during the years 2007–2014 in the North Denmark Region. We hypothesised that the number of emergency ambulance service patients has increased during this period, and that the patient population has changed in terms of age, diagnostic pattern and comorbidity.

## METHOD

### Study design

We conducted a population-based observational cohort study with linkage of routinely collected registry data at the individual level. We followed the REporting of studies Conducted using Observational Routinely collected Data statement, which is an extension of the Strengthening the Reporting of Observational studies in Epidemiology statement.[7 8]

### Setting

The study covers all emergency ambulance service patients in the North Denmark Region from 1 January 2007 to 31 December 2014. The region covers rural and urban areas that are typical for Denmark and has 580 000 inhabitants, corresponding to 10% of the Danish population.[9] The Danish healthcare system is publicly financed and free to all citizens; this also includes prehospital care. The emergency number 112 is used in the entire country. In each of the five Danish regions, a prehospital health organisation is responsible for the entire prehospital patient care pathway; answering emergency calls, dispatching ambulances, laypeople first responders and prehospital doctors. The North Denmark Region was the first Danish region to implement an electronic patient record in the ambulances in 2006.

### Participants

We defined emergency ambulance service patients as patients with hospital contact after a 112 emergency call and dispatch of ambulance, including patients with more than one call and subsequent hospital contact, during the study period. We included all ambulance runs after 112 call, no matter the level of urgency as assessed by the dispatch centre. We excluded patients without known civil registration number. Interhospital transfers, and patients attended by an ambulance and not transported to the hospital, were not included. Follow-up consisted of collection of data on hospital diagnoses and up to 30-day mortality.

### Data sources

We used the following data sources. The ambulance dispatch logistic system provided us with data on dispatched emergency ambulances, patient identity (including age and sex), time of ambulance transports and destination hospital. Statistics Denmark provided data on the background population divided into calendar year, age and sex.[10] The regional patient administrative system gave us information on hospital contacts, including contact to emergency departments, outpatient clinic and hospital admittance, and main diagnoses coded according to the International Classification of Diseases, 10th edition (ICD-10).[11] Danish hospitals routinely collect and report ICD-10 diagnoses to the regional patient administrative registry. The regional registries report data to the Danish National Patient Registry, which has been validated for research as an overall sound data source.[5 12] From the Danish Civil Registration System, we retrieved data on the vital status on patients who were residents in the North Denmark Region during the study period.

### Variables and outcome measurements

The main variables included number of emergency ambulances bringing patients to hospital, sex, age, main hospital diagnosis, comorbidity and vital status (dead or alive) up to 30 days after the emergency call. Demographic and clinical characteristics and mortality among emergency ambulance service patients were compared over time using 2007 as reference year.

Main diagnoses were retrieved for all patients, and we focused on the most frequent main diagnoses, defined as ICD-10 chapters covering at least 5% of the patients' diagnoses in the study. In cases where the main hospital diagnosis was 'factors influencing health status and contact with health services' (ICD-10, chapter 21, abbreviated 'other factors'), which includes tentative 'observation for' diagnoses, we searched for more specific ICD-10 diagnoses during the same hospital stay; this also included individuals transferred to other departments or other hospitals during the stay. If we found an additional and more specific diagnosis, this was used in the analysis instead of ICD-10, chapter 21, 'other factors'.

The level of comorbidity was described according to the Charlson Comorbidity Index (CCI)[13] by searching for CCI comorbidity diagnoses for hospital contacts during the previous five years according to a previously published algorithm.[14] CCI is a scoring system with weighting of 19 defined comorbidities, specific medical chronic diseases, among others specific cardiac, cerebrovascular, liver and renal diseases, diabetes and cancer. CCI of 0 corresponds to no comorbidity and CCI ≥3 to severe morbidity.

We determined all-cause 1-day and 30-day mortality and 1-day and 30-day mortality for the patients with the most frequent diagnoses, covering at least 5% of the patients' diagnoses. Mortality on day 1 was defined as death on the same date *or* the following day after the 112 call because only death by date (not by the hour) is recorded in the registry. Anonymised data for analysis were stored in a separate regional research database. All authors from the North Denmark Region had full access to the research database, and the entire research group had access to the analyses.

### Statistical analysis

As each ambulance takes care of one patient, the fundamental data unit in all analyses was a dispatched ambulance transporting a patient to the hospital after a 112 call (defined as an emergency ambulance service patient), including patients transferred several times to hospital after an emergency call during the 8-year study period. The total study population is the same as the one used in a previous cohort study.[15] Poisson regression was used to model the prevalence of emergency ambulance service patients with year, age and sex as independent variables. The background population divided by age, sex and calendar year served as the offset of the model. This allowed us to estimate the age- and sex-adjusted prevalence ratio (PR) of emergency ambulance service patients for each of the investigated years compared with 2007. The distribution of diagnoses according to the ICD-10 chapters was reported in annual number and frequency. The rate of patients with no comorbidity level (CCI=0) was analysed by dichotomising comorbidity level (0 if CCI=0, and 1 otherwise), and PR between 2007 and 2014 was estimated using Poisson regression with cluster-robust variance estimation.[16] The estimates were adjusted for age (restricted cubic spline) and sex (binary). The development for patients with high-level comorbidity (CCI ≥3) was analysed in a similar manner.

The Kaplan-Meier method was used to estimate mortality rates (1 – Kaplan-Meier estimates) with 95% CIs. In 661 (0.44%) cases, the patients had addresses outside the North Denmark Region, thus rendering updated vital status information unavailable. These cases were censored on the day the patient was discharged from the hospital.

Poisson regression with cluster-robust variance estimation was used to estimate relative risk (RR) to compare mortality rates over the years with 2007 as reference and RR adjusted for age and sex as described above. Using this method, we estimated both 1-day and 30-day RR by dichotomising the outcome variable (0 if alive after 1 and 30 days, respectively; 1 if dead). This method was chosen over Cox proportional hazards regression as the presence of proportional hazards could be questioned, and our choice could be justified because we were able to perform 30-day follow-up on vital status for almost all the included patients (except for 663 corresponding to 0.44%).

We supplemented with an overall mortality analysis including only the first hospital contact during the study period. Furthermore, a second sensitivity analysis was performed for overall mortality. This excluded diagnoses described in chapter 18 of the ICD-10 (symptoms and abnormal findings, not classified elsewhere), referred to as 'other symptoms', because the Danish National Board of Health revised the Danish version of ICD-10 in 2012 and removed the subcategory of unknown dead and found dead (ICD-10, chapter 18, R.96-R99.9).

Statistical analyses were performed with Stata V.13.1. (Stata Corporation, College Station, Texas, USA).

## RESULTS

In the period 2007–2014, a total of 201 996 ambulances were dispatched after a call to emergency number 112 in the North Denmark Region. No identifiable civil registration number was available for the patient in 35 932 (17.8%) cases. The date of death was noted before the 112 call in 31 cases, and the patient was not transported to a hospital in 17 276 cases (8.5%). This study thus included 148 757 emergency ambulance service patients transported to hospital with an ambulance, including patients with several 112 calls during the study period.

The annual number of emergency ambulance service patients increased by 67% from 14 031 to 23 369; this figure corresponds to an annual prevalence of 24.3 emergency ambulance service patients per 1000 inhabitants in 2007 increasing to an annual number of 40.2 in 2014. The estimated age-adjusted and sex-adjusted PR comparing 2007 and 2014 was 1.58 (95% CI 1.55 to 1.62), corresponding to an adjusted increase of 58%. The civil registration number was registered for 76% of the emergency ambulance service patients in 2007 compared with 86% in 2014, corresponding to a relative increase in registered patient identification of 13%.

The proportion of women increased from 43.1% in 2007 to 46.4% in 2014 (p<0.001). The mean age increased from 50.6 years (SD 24.1) to 55.1 years (SD 24.1), corresponding to a mean age difference of 4.5 years (95% CI 4.0 to 5.0).

The proportion of those aged 60+ years increased from 39.9% in 2007 to 48.6% in 2014, corresponding to a rise of 8.7 percentage points (95% CI 7.7 to 9.7). The age distribution of patients in 2007 and 2014, respectively, is illustrated in figure 1.

### Trends in diagnoses and comorbidity

The distribution of the most frequent diagnoses reported as ICD-10 chapters is shown in table 1 in annual numbers, together with the total of the remaining diagnoses chapters, and the index number of each ICD-10 chapters for 2014 compared with 2007. The distribution of all ICD-10 chapters of main diagnoses can be seen in online supplementary appendix 1.

The relative distribution of diagnoses was stable during the study period, with a few exceptions (table 1 and figure 2). We found a gradual decrease in injuries (ICD-10, chapter 19) throughout the period and an increase

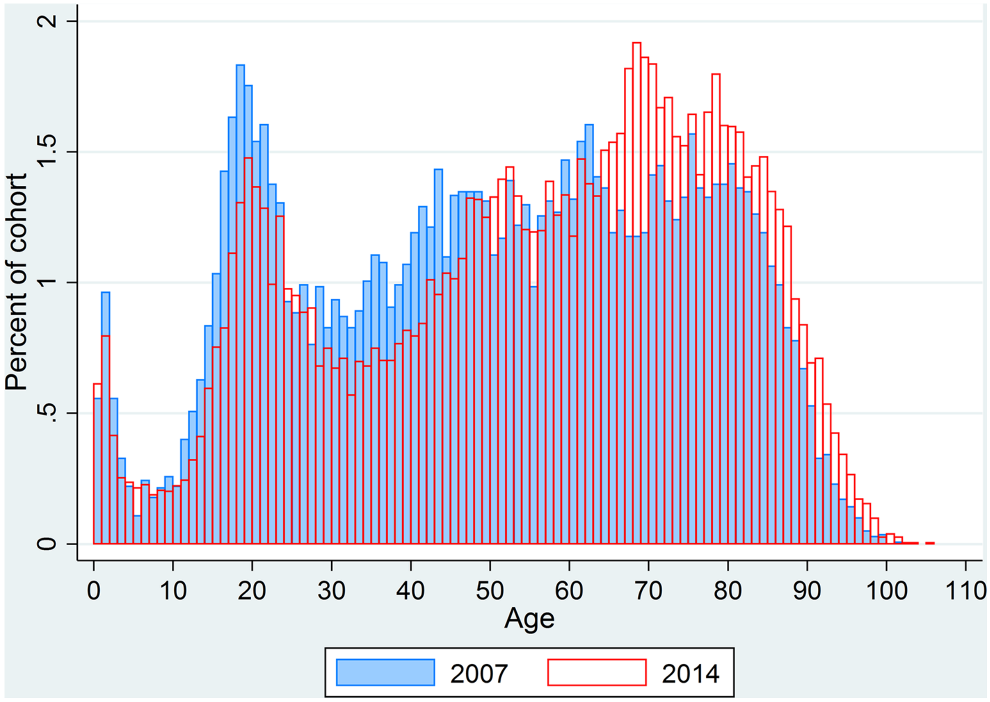


**Figure 1** Age (in years) distribution among emergency ambulance service patients in the North Denmark Region in 2007 and 2014.

in non-specific diagnoses, that is, 'other symptoms' (ICD-10, chapter 18). Together with 'other factors' (ICD-10, chapter 21), the latter two were assigned for a considerable number, corresponding to about two-third of patients throughout the entire study period. We noticed a shift from 2013 towards a sudden large increase in patients with the diagnosis of 'other symptoms' (ICD-10, chapter 18) and at the same time fewer with the diagnosis 'other factors' (ICD-10, chapter 21). Together the proportion of these two non-specific diagnoses increased from 28.8% in 2007 to 37.6% in 2014. The diagnostic pattern varied according to age. We found an increase among all age groups in number of patients diagnosed with 'other symptoms' (ICD-10, chapter 18), but otherwise the relative distribution was similar in 2007 and 2014 (figure 3).

A total of 69.9% of patients had no comorbidity (CCI=0) in 2007 compared with 63.9% in 2014. The estimated age- and sex-adjusted PR was 0.97 (95% CI 0.95 to 0.98), indicating a small but statistically significant decline in patients without comorbidity during the study period. The share of patients with severe comorbidity (CCI ≥3) increased from 6.4% in 2007 to 9.4% in 2014, and the estimated age- and sex-adjusted PR was 1.27 (95% CI 1.16 to 1.39), showing an increase in patients with severe comorbidity from 2007 to 2014.

## Mortality

The overall mortality decreased from 2007 to 2014 among all emergency ambulance service patients (figure 4).The 1-day mortality decreased from 2.40% (95% CI 2.10 to 2.67) in 2007 to 1.21% (95% CI 1.08 to 1.36) in 2014. The 30-day mortality decreased from 5.01% (95% CI 4.66 to 5.39) to 4.36% (95% CI 4.11 to 4.63). Table 2 shows the unadjusted and estimated age- and sex-adjusted RR for 1-day and 30-day mortality by year and the trend during the study period with 2007 as the reference; all showed a decline in mortality from 2007 to 2014.

The mortality for the most frequent diagnoses (defined as constituting at least 5% of the diagnoses) is shown in figure 5. Both 1-day and 30-day mortality decreased among patients with cardiovascular diseases; the 1-day mortality decreased from 12.3% (95% CI 10.7 to 14.2) in 2007 to 5.8% (95% CI 5.0 to 6.9) in 2014, and the 30-day mortality decreased from 20.1% (95% CI 18.1 to 22.3) to 12.2% (95% CI 11.0 to 13.6). The mortality also decreased for 'other symptoms' (ICD-10, chapter 18); the 1-day mortality decreased from 4.6% (95% CI 3.7 to 5.5) to 0.7% (95% CI 0.5 to 0.9), and the 30-day mortality decreased from 6.2% (95% CI 5.3 to 7.3) to 3.5% (95% CI 3.1 to 4.0). No mortality differences were found in patients with psychiatric disease, respiratory disease, injury and 'other factors'.

The sensitivity analysis of mortality, which included only the first hospital contact for each patient, showed similar trends of decline in the overall mortality. The 1-day mortality decreased from 2.56% (95% CI 2.30 to 2.86) in 2007 to 1.15% (95% CI 0.98 to 1.35) in 2014. The 30-day mortality decreased from 4.99% (95% CI 4.62 to 5.39) in 2007 to 3.90% (95% CI 3.58 to 4.25) in 2014. This trend was seen in both unadjusted and adjusted RR during the study period (online supplementary appendix 2).

The second sensitivity analysis of mortality, which excluded the diagnoses of chapter 18 in the ICD-10, showed no decrease in the unadjusted RR of the 30-day mortality, whereas the age-adjusted and sex-adjusted RR

**Table 1** The most frequent diagnoses according to International Classification of Diseases, 10th edition (ICD-10) chapters among 148 757 emergency ambulance service patients in the North Denmark Region in 2007–2014

| | ICD-10 chapters according to year | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | N (%) | N (%) | N (%) | N (%) | N (%) | N (%) | N (%) | N (%) | Index |
| V. | Mental and behavioural disorders | 915 (6.5) | 856 (5.6) | 915 (5.7) | 955 (5.3) | 984 (5.0) | 1 109 (5.4) | 1 181 (5.5) | 1 144 (4.9) | 126 |
| IX. | Diseases of the circulatory system | 1 377 (9.8) | 1 534 (10.1) | 1 531 (9.5) | 2 051 (11.3) | 2 267 (11.5) | 2 320 (11.2) | 2 333 (10.8) | 2 349 (10.1) | 170 |
| X. | Diseases of the respiratory system | 842 (6.0) | 886 (5.8) | 988 (6.1) | 1 272 (7.0) | 1 397 (7.1) | 1 507 (7.3) | 1 631 (7.6) | 1 422 (6.1) | 168 |
| XVIII. | Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified | 2 113 (15.1) | 2 412 (15.9) | 2 503 (15.6) | 2 809 (15.5) | 2 965 (15.0) | 3 042 (14.7) | 3 583 (16.6) | 6 550 (28.0) | 310 |
| XIX. | Injury, poisoning and certain other consequences of external causes | 4 777 (34.0) | 5 089 (33.5) | 5 291 (32.9) | 5 554 (30.6) | 5 967 (30.3) | 5 909 (28.6) | 5 954 (27.6) | 6 137 (26.3) | 128 |
| XXI. | Factors influencing health status and contact with health services | 1 916 (13.7) | 2 171 (14.3) | 2 267 (14.1) | 2 700 (14.9) | 3 082 (15.6) | 3 408 (16.5) | 3 167 (14.7) | 2 235 (9.6) | 116 |
| | Remaining chapters and codes for special purposes | 2 091 (14.89) | 2 241 (14.8) | 2 577 (15.9) | 2 821 (15.6) | 3 048 (15.5) | 3 363 (16.2) | 3 717 (17.0) | 3 532 (15.0) | 169 |
| | Total | 14 031 (100.0) | 15 189 (100.0) | 16 072 (100.0) | 18 162 (100.0) | 19 710 (100.0) | 20 658 (100.0) | 21 566 (100.0) | 23 369 (100.0) | 167 |

Numbers (N) and percentages (%), index=100 in 2007.

showed a decrease in both the 1-day and 30-day mortality; the latter is in line with the primary analyses including all ICD-10 diagnoses.

## DISCUSSION

### Principal findings

The number and prevalence of patients calling the 112 emergency number who were subsequently transported to hospital by ambulance increased during the years 2007–2014. The mean age of the patients increased, the age and sex distribution changed towards more elderly and more women. The non-specific diagnoses constituted approximately one-third and increased especially the last year, whereas the proportion of injuries decreased during the study period. The comorbidity increased, whereas both the 1-day and 30-day mortality decreased. The age-related and comorbidity-related patterns in these patients correspond to the recent demographic changes in most Western populations, in Japan and in China, where more elderly are seen with more chronic diseases and higher occurrence of multimorbidity.[17 18]

### Strengths and weaknesses of the study

The population-based design and the thorough follow-up, which were made possible by the nationwide Danish registries, offered reduced risk of bias due to loss of follow-up. The free access to the prehospital emergency medical services ensured that the economic capacity of the patients did not limit the access to medical care and thus did not influence inclusion of subjects in the study. Generalisation must be cautious, but the results might be applicable to other settings with similar prehospital emergency systems and population demographics as the study covers a mixed rural–urban region. It is important to note that the findings do not apply to prehospital patients who have not been transported to hospital by ambulance as these were not included in our study. The Danish Civil Registration System provides a unique possibility for collecting valid information on the date of death for Danish citizens.[6] We used the regional patient administrative system; this system is based on the same ICD-10 diagnostic coding system as the Danish National Patient Registry, which is regarded as a valuable tool and has been validated for clinical epidemiological research.[5 12] The reported findings regarding changes in the diagnoses rely on stable and valid diagnostic coding from the hospital, and we have no reason to believe that the practicalities of assigning diagnoses should have changed considerably during the study period. However, a regional administrative recommendation for the new emergency departments of applying specific ICD-10 diagnostic codes instead of 'other factors' (ICD-10, chapter 21) directed to the hospitals in 2013 could possibly explain the sudden shift seen for the two non-specific diagnoses 'other symptoms' (ICD-10, chapter 18) and 'other factors' (ICD-10, chapter 21).

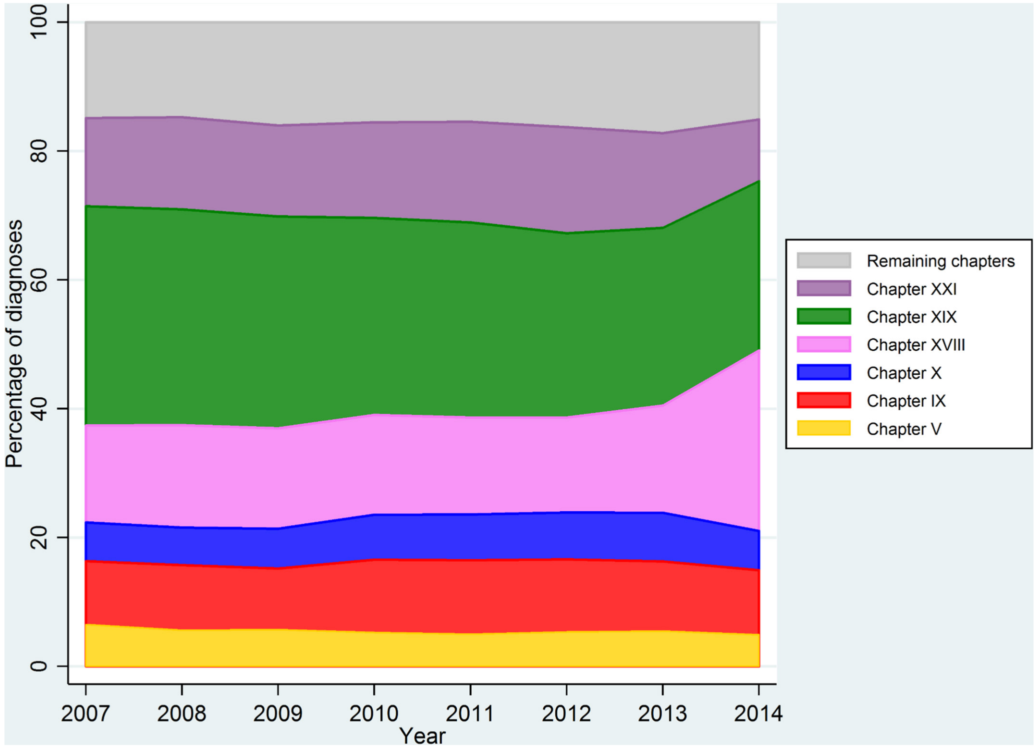


**Figure 2** Diagnoses according to International Classification of Diseases, 10th edition, chapters among 148 757 emergency ambulance service patients in the North Denmark Region in 2007–2014.

The major weakness of the study was the missing civil registration number for some patients and the lack of follow-up for these. However, this weakness is generally seen in studies of the prehospital emergency service as information on patient identity is not always available in this setting. Patients with missing civil registration number may be more or less severely ill or injured, and may introduce bias in either direction. The civil registration number is the only link to both the registry of hospital diagnoses and the Danish Civil Registry (vital status, date of death), and it is not possible to retrieve valid information on death from the Prehospital Patient Record as only the doctors, not the paramedics, legally can pronounce a patient's death. Yet, both comorbidity and age were found to increase among the included patients during the years among the study population. Patients with multiple 112 calls and transported to hospital by ambulance several times were included because our main purpose of the study was to describe the increasing number of emergency ambulances and the disease and comorbidity pattern seen from the emergency medical service point of view. The paramedics meet each patient as a new patient, and only in a very few cases the same ambulance crew will attend the same patient several times. We used cluster-robust variance estimation to address the problem of non-independency. Moreover, the sensitivity analyses performed on patients only with the first contact showed similar trends of decline in mortality. The explorative study design provides no explanation for the decrease in mortality. The increase in the number of emergency ambulance service patients and the gradual improvement of the registration of patient identity may explain part of our findings; yet, both age and comorbidity among the included patients increased during the same period. There were several improvements in emergency medical services during the study period: more supplemental prehospital care units were established (some with paramedics and others with doctors), Healthcare professionals (instead of police only) started to serve as call-takers for medical emergencies. Whereas the response times for ambulances did not improve. The ambulance response time actually increased from mean 9.60 min (95% CI 9.50 to 9.71) in 2007 to 10.60 min (95% CI 10.49 to 10.71) in 2014. The main change in hospital emergency care was new emergency departments were set up during the period. The decline in the mortality among patients with 'other symptoms' (ICD-10, chapter 18) was mainly explained by the nationwide revision of the Danish ICD-10 with removal of the subcategories of 'dead of unknown cause' and 'found dead' in chapter 18. However, this was not the explanation of the overall decrease in mortality as the sensitivity analysis excluding ICD-10, chapter 18, confirmed the findings of decline in the RR of mortality, when adjusted for age and sex. Apart from chapter 18, the largest decrease in mortality was found among patients with cardiovascular disease. This ICD-10 chapter covers both cardiac and cerebrovascular diseases. The improvements in early prehospital diagnosis that we have seen in recent years, including direct transfer to specialised medical centres and with new treatment strategies in hospital (such as endovascular procedures, stroke units), may contribute to the decrease in mortality.[19 20]

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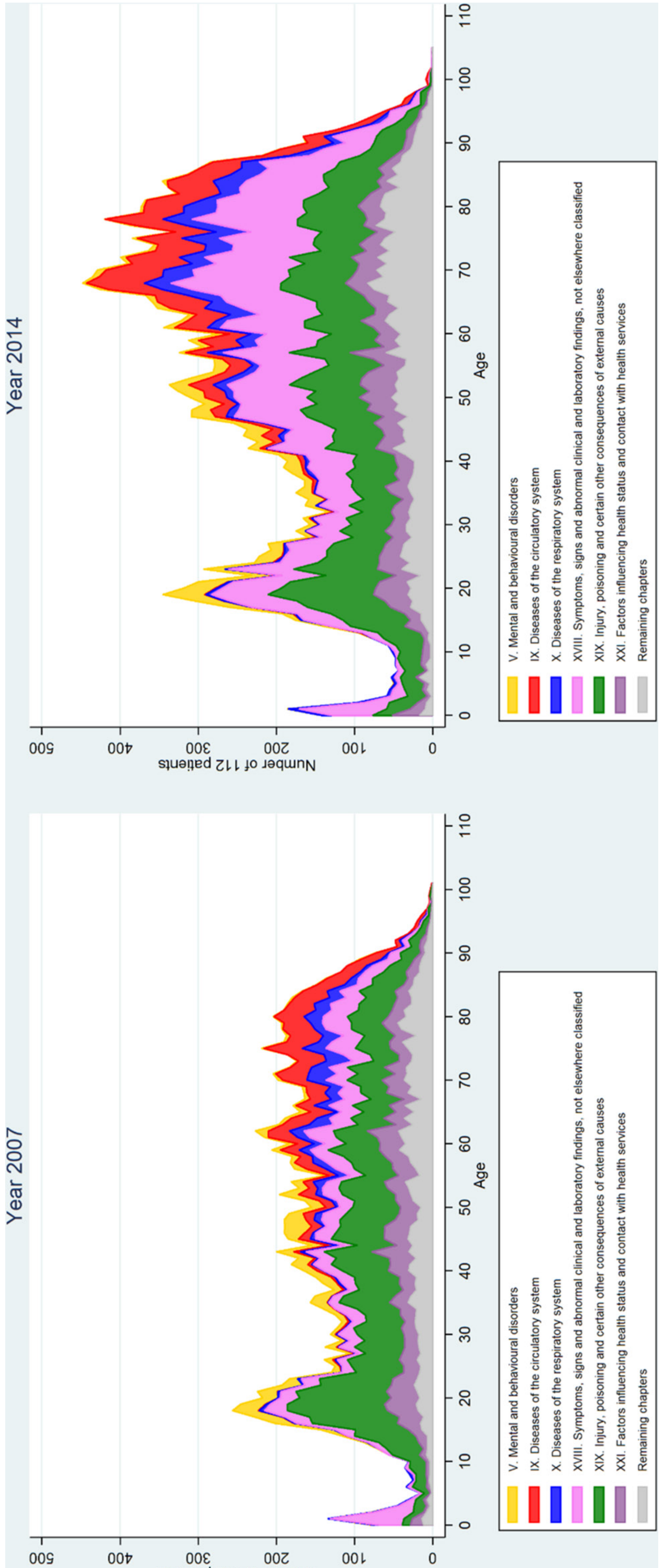


**Figure 3** Distribution of diagnoses according to International Classification of Diseases, 10th edition, chapters distributed by age among 148 757 emergency ambulance service patients in the North Denmark Region in 2007–2014.

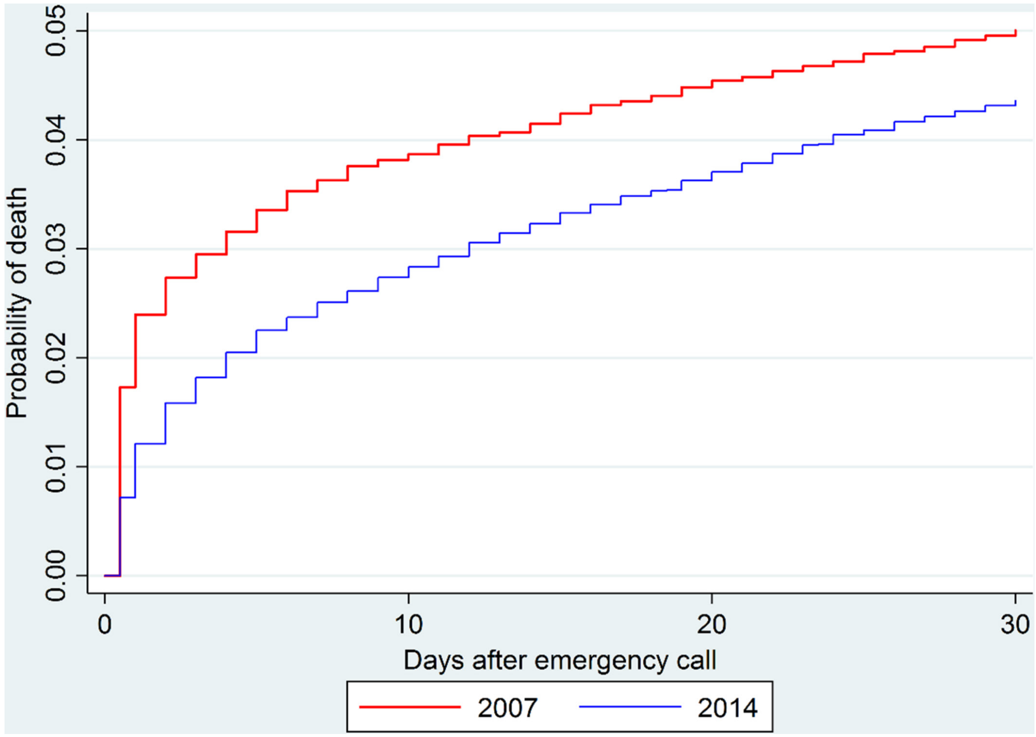


**Figure 4** Mortality up to 30 days after calling for an emergency ambulance in the North Denmark Region in 2007 and 2014.

### Comparison with other studies

The ageing population and the growing demand for emergency ambulances was retrospectively studied in 1995–2015 in the metropolitan area of Melbourne[4] and in urban and rural areas of Bavaria in connection with long-term planning of the emergency medical services for 2012–2032.[3] Still, it has not been investigated whether emergency ambulance patients exhibit similar trends for disease pattern as the general population in which an increasing number of patients are diagnosed with one or more chronic diseases, that is, multimorbidity.[17 18] Despite the lack of knowledge on hospital diagnoses of the patients, several studies question the medical necessity of the number of emergency ambulances to patients with all kinds of illnesses and injuries, especially the magnitude of increase in emergency ambulances that we have witnessed the last decades.[21–24] A cluster-randomised trial of specially trained paramedics attending emergency calls from elderly people showed fewer emergency department visits and more satisfied patients.[25] However, the patients in the intervention group were more likely to have subsequent secondary contact with healthcare system. The paper reported that within 28 days >40% had required hospital admission and 5.0% had died. In this study, the patients were characterised only by the presenting complaint (fall, haemorrhage or acute medical condition), not by any

**Table 2** Unadjusted (crude) and age- and sex-adjusted (adjusted) relative risk (RR) reported with 95% CIs for 1-day mortality and 30-day mortality by year and trend among 148 757 emergency ambulance service patients in the North Denmark Region in 2007–2014, with the year 2007 as reference

| | 1-Day mortality | | 30-Day mortality | |
|---|---|---|---|---|
| | Crude | Adjusted | Crude | Adjusted |
| Year | RR (95% CI) | RR (95% CI) | RR (95% CI) | RR (95% CI) |
| 2007 | 1 (ref) | 1 (ref) | 1 (ref) | 1 (ref) |
| 2008 | 0.91 (0.79 to 1.06) | 0.89 (0.77 to 1.03) | 0.94 (0.84 to 1.04) | 0.91 (0.82 to 1.00) |
| 2009 | 0.82 (0.70 to 0.95) | 0.79 (0.68 to 0.92) | 0.94 (0.85 to 1.05) | 0.91 (0.82 to 1.00) |
| 2010 | 0.90 (0.78 to 1.04) | 0.83 (0.72 to 0.95) | 1.03 (0.93 to 1.14) | 0.93 (0.85 to 1.03) |
| 2011 | 0.70 (0.61 to 0.82) | 0.65 (0.56 to 0.76) | 0.91 (0.82 to 1.00) | 0.83 (0.75 to 0.92) |
| 2012 | 0.67 (0.57 to 0.78) | 0.60 (0.52 to 0.70) | 0.93 (0.84 to 1.03) | 0.83 (0.75 to 0.92) |
| 2013 | 0.59 (0.50 to 0.68) | 0.51 (0.44 to 0.60) | 0.86 (0.77 to 0.95) | 0.73 (0.66 to 0.81) |
| 2014 | 0.50 (0.43 to 0.59) | 0.43 (0.37 to 0.50) | 0.87 (0.79 to 0.96) | 0.72 (0.66 to 0.79) |
| Trend | 0.91 (0.90 to 0.93) | 0.89 (0.88 to 0.91) | 0.98 (0.97 to 0.99) | 0.96 (0.95 to 0.97) |

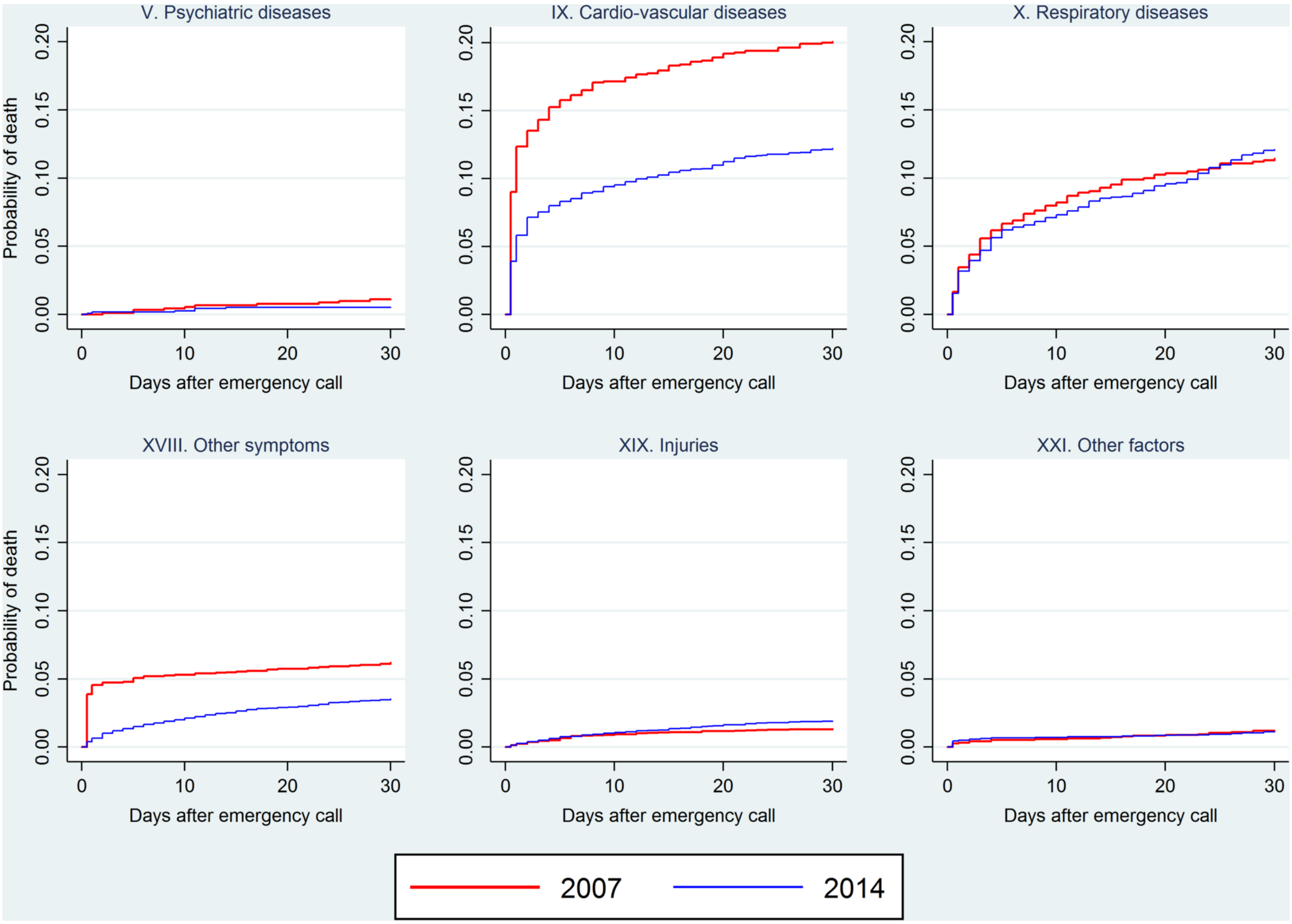


**Figure 5** Mortality up to 30 days after calling for an emergency ambulance among emergency ambulance service patients with the most frequent hospital diagnoses according to International Classification of Diseases, 10th edition, chapters in the North Denmark Region in 2007 and 2014.

diagnoses.[25] Other prehospital studies have focused on describing either the main symptoms when calling for an emergency ambulance or the tentative diagnoses made by the prehospital professionals,[1 21–24] whereas the hospital diagnoses which served as the basis in the present study were not included as the studies did not have access to hospital data. To overcome this, a large Australian study examined whether an adaptation ICD coding system could be applied retrospectively to the paramedic assessment to develop more clinically relevant case definitions. They converted data for the assessment made by the ambulance staff against the Australian modification of ICD-10.[26] This is an interesting method for ambulance services without access to hospital diagnoses, though it seems as a huge work. The lack of studies on hospital diagnoses in emergency ambulance service patients makes comparisons difficult; however, a few studies find similar trends in emergency patients in hospital.[27 28] One of these, a recent study from the USA, showed that chronic diseases cause more visits to emergency departments than injuries, which are on the decline[27]; this trend is similar to our findings based on Danish prehospital data in this study. In line with this, studies of emergency patients in hospitals in Denmark and California showed that non-specific diagnoses, such as 'other symptoms' and 'other factors', constituted major groups in the patient population.[27 28] It may be tempting to believe that most of these non-specific diagnoses represent unnecessary ambulances and/or hospital contacts. However, this cannot be concluded based on the results from our study as the mortality in patients with non-specific diagnoses was not negligible, which indicates that they are not all low-risk patients. We lack information for the patients who were not transported to hospital because they have no hospital diagnoses and hence are not included in our study. One of the ways to minimise non-essential transportation to hospital is to have a prehospital doctor assess and treat the patient directly at the scene. A recent study, which was conducted in another Danish region in 2008–2010, included 1609 prehospital patients seen by a prehospital doctor and subsequently not transported to hospital but released on site.[29] The on-site doctor entered ICD-10 codes for the diagnoses, and more than half of the patients were given one of the two non-specific diagnoses, that is, 'other symptoms' and 'other factors', which is similar to the findings in our study. The follow-up showed that 93% of all contacts did not have secondary contact with the hospital, and only four patients (0.2%) died within the next 24 hours.

## Clinical implications and future perspectives

This observational study showed an increase in the number of emergency ambulance service patients during an 8-year period, and it also showed a rise in age and comorbidity. These patients thus exhibit a disease pattern that corresponds well with the trends seen in the general population. The increase in average life expectancy and the high prevalence of multiple disease have considerable implications for diagnostics, treatment capacity, staffing, education and training in healthcare, also in the emergency medical services. A change in the pattern of diseases means a change in exposure to the types of cases seen by emergency medical service, which can have implications for their routine in handling less frequent, critical emergencies. This may influence outcome, as shown in the study of Dyson *et al* of the association of exposure and survival after cardiac arrest.[30]

Additionally, the logistics in the prehospital emergency medical services, the primary care sector and the hospitals are under pressure. Knowledge about patient diagnoses and prognosis is necessary not only for the healthcare personnel, the healthcare planners and decision makers, but also to the public and the patients to establish solutions to this growing problem.

The study leaves several questions unanswered. The large and growing number of non-specific diagnoses may be a concern. It would be especially interesting to investigate whether they represent appropriate use of the emergency medical services or if other health and/or social care would be more adequate. The prognosis for the patients who are not transported to hospital is another concern and remains an issue for future research.

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# Trends in diagnostic patterns and mortality in emergency ambulance service patients in 2 007–2014: a population-based cohort study from the North Denmark Region

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