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Title

Differences between admitted and discharged cases brought to the emergency department by emergency medical services: a retrospective analysis of linked emergency dispatch and hospital data

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Differences between admitted and discharged cases brought to the emergency department by emergency medical services: a retrospective analysis of linked emergency dispatch and hospital data

Abstract

Objective: Most emergency medical service (EMS) patients are transported to an emergency department (ED) yet not all will need subsequent treatment in a hospital. The aim of this analysis was to compare admitted and discharged cases and to assess whether information accessible to the dispatcher can help identify cases that will not be admitted. A second aim was to examine whether the dispatcher`s assessment matched the hospital diagnosis.

Design: retrospective observational study based on linked secondary data

Setting and participants: Cases brought to one of 14 emergency departments in the city of Munich, Germany by EMS transport between 01.07.2013 – 30.06.2014.

Main outcome measures: Characteristics of admitted and discharged cases were assessed. Logistic regression was used to estimate the association between discharge and age, sex, time of day, ambulance type and dispatch keyword. Keywords were compared to hospital diagnoses.

Results: 39.4% of cases were discharged. Discharged cases were more likely to be young (OR 10.53 (CI 9.31-11.92), comparing <15 year olds to >70 year olds), to call after accidents or trauma (OR 2.87 (CI 2.74-3.01)) or with unspecific complaints (OR 1.23 (CI 1.12-1.34) (compared to cardiovascular problems).The most frequent diagnosis chapter was 'injury and poisoning' (30.1%), yet these diagnoses were more frequent at discharge (42.7 vs. 22.0%) whereas circulatory system disease was less frequent (2.6% vs. 21.8%). Dispatch keywords were distributed across many different ICD 10 diagnosis chapters. Discrepancies between dispatch keyword and later diagnosis were less frequent after dispatch for accidents or trauma and intoxication or poisoning.

Conclusion: Young age and dispatch for accidents or trauma were the strongest predictors of discharge. Rapid transport to the ED might be necessary to exclude life-threatening illness, yet these groups could be suitable for diversion to other hospitals when admission capacities are low or to other settings, provided that the initial urgency is assessed correctly.

Strengths and limitations of this study

- Large sample which includes 78,303 cases brought to the emergency department by emergency medical services after emergency calls
- Linkage of dispatch data with hospital data made it possible to identify which cases were in need of subsequent admission and to study hospital diagnoses of pre -hospital cases
- Main limitations are that 30% of dispatches could not be linked to hospital records, and that diagnosis information was missing for 20% of discharged cases

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Introduction

Pre-hospital emergency medical services (EMS) provide immediate medical care to acutely ill and injured patients. Demand for EMS in Germany is rising, with an increase by 105% since 2001.[1] An increase in EMS activation in both, urban and rural regions of Bavaria was observed over the past 10 years.[2]

Rising demand for EMS and ED services contributes to emergency department crowding and scarcity of hospital admission capacities. The negative consequences of ED crowding on patient outcomes are well established.[3] Yet there is evidence that emergency care and ambulance services are accessed for primary care and low-urgency health problems.[4] [5] Other studies report discharge rates after EMS transport of as high as 70% [6] and classify 16% of EMS patients as potential candidates for primary healthcare.[7] Whereas it is difficult to guide patients that walk into the ED, patients transported by ambulance could be referred to other levels of care if dispatchers were able to clearly identify patients that are safe when diverted to other levels of care.

Triage tools are able to identify patients who do not need pre-hospital interventions,[8] and cases not suitable for an ED presentation can be referred to alternative care pathways after secondary triage.[9] However, a recent review concludes that the overall level of evidence of the accuracy of medical dispatching systems is low.[10] Few studies compare diagnostic discrepancies at different stages of care, but over-triage has been observed when comparing emergency medical dispatch centers and ambulance crews.[11] [12] [13] The addition of demographic information and hospitalization history to the dispatch process has shown the potential to predict adverse outcomes[14]. Conversely, knowing which caller characteristics and initial complaints are associated with discharge from the ED might help dispatchers to pre-select groups that are less likely to need extensive urgent care or acute care beds, in case initial and later assessment is mostly concordant.

The aim of this study was therefore to compare admitted and discharged cases and to assess whether information accessible to the dispatcher can help differentiate between cases who will need subsequent admission to a hospital and those who likely will not. A second aim was to examine whether the dispatcher`s assessment of the emergency situation matched the hospital's diagnosis.

Methods

Design and setting

This is a retrospective observational study using secondary data gathered for an evaluation of the provision of care by emergency departments in the city of Munich.[15]

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The German health care system offers different types of emergency care in different environments. Pre-hospital medical services can be accessed via the national emergency telephone number 112. Calls are managed by regional dispatch centers. Dispatchers use a keyword-based protocol to decide on the type and number of pre-hospital EMS units to be dispatched to the scene of the emergency. Levels of response include ambulances designated to non-emergency transport, paramedic staffed ambulances and rapid response cars staffed with prehospital emergency physicians. A physician will be dispatched according to a pre-specified catalogue when vital signs are suspected to be unstable or when the condition implicates a high probability of need for invasive interventions. Callers that do not need emergency medical transport can be passed on to ambulatory services provided by the Association of Statutory Health Insurance. Patients can also access ambulatory emergency care services on their own initiative, or seek care at a hospital's emergency department.

Data sources and sample

Between 01.07.2013 and 30.06.2014, routinely collected information of all cases presenting to one of 14 emergency departments of 14 major hospitals in Munich was pooled into a study data base. Dispatch information was extracted from a database that holds routinely generated data from the computer-assisted dispatch system of Munich´s central dispatch center and billing information. During the study period, 524.716 cases presented to the 14 EDs and 110.484 emergency dispatches were recorded by the dispatch center, of which 78.307 (71%) could be matched to an ED record. Four emergency dispatches were excluded, as the keyword indicated a non-emergency transport. All data was anonymized and is therefore case-, not patient-based. Repeated presentation by the same patient or EMS activation for the same patient could not be accounted for.

Hospital data included basic case information (age, sex, admission status) and information about diagnoses (ICD-10-GM Codes). Dispatch data includes dispatch keywords, type of ambulance deployed, time stamps and receiving hospital. Billing data includes patient age, an essential identifier for the linkage of hospital and dispatch data. A probabilistic approach was used to link billing and dispatch records, and then dispatch and hospital records. Time stamps of dispatch and billing data were compared and patient age could be assigned to 86% of dispatch records. Second, patient age and admission time of dispatch and hospital records were compared. All records with an exact match of patient age and an arrival time within a 20 minute interval were linked, which was the case for 80% of records. When several records matched, the records with the smallest difference in arrival time were linked. This process was repeated for the remaining records, first through extending the admission time interval to 40 minutes, and then extending the age criterion to a 5 year range.

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Cases were classified as discharged when there was no documentation for admission to the same hospital on the day of ED presentation. Information about admitted cases came from a standardized data set that hospitals are required to collect according to section 21 of the Hospital Remuneration Act (KHEntgG). Participating hospitals provided comparable information about discharged cases from their hospital information system. Records with identical items recorded within the first hour after admission were considered duplicates and removed from the dataset. Recording a primary diagnosis is only mandatory for admitted cases. The amount of missing data is displayed in the results section. More than one diagnosis was recorded for 5.1% of discharged cases. In this case, the diagnosis with the highest estimated resource requirement was chosen as the primary diagnosis. Since dispatch keywords are not standardized, 293 different keywords were condensed and classified into 15 categories (see supplementary material).

Analysis

The sample was characterized by calculating medians with interquartile range (IQR) for continuous variables and frequencies and proportions for categorical variables. Statistical tests ($\chi 2$ test for categorical variables and the Wilcoxon– Mann-Whitney-U-Test for continuous variables) were performed to evaluate differences between admitted and discharged cases. The probability of discharge was calculated for case characteristics. Logistic regression was preformed to estimate the adjusted likelihood of discharge. Covariates were selected based on their availability at dispatch and included age, sex, keywords and day and time of admission at the ED. The 9 most frequent dispatch keywords and ICD-10 diagnosis chapters are displayed, remaining diagnosis chapters and keywords are summarized as "other chapters". Age was categorized into five groups. The final model was selected based on Akaike information criterion (AIC). [16] [17] A subgroup analysis was conducted for age groups and stratified models are provided as supplementary material. The frequencies of hospital diagnoses stratified by dispatch keyword are presented in cross-tabulated tables. Analysis was performed using R statistical software (R Foundation for Statistical Computing, Vienna, AT).

Ethics and patient and public involvement

The study protocol including the description of the dataset and the data protection concept was submitted to the ethics committee of the medical faculty of the University of Munich for review (Project-No 17-530-UE). The committee had no objections and waived obligation to advise according to the law on faculties. Patients or the public were not involved in the design and conduct of this research.

Results

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Characteristics of ED cases transported by EMS

47,430 cases (60.6%) were admitted and 30,873 (39.4%) were discharged. Characteristics of both groups are reported and compared in table 1. The comparison of admitted and discharged cases shows that discharged cases were much younger (median of 40 vs. 70 years, p <0.0001). The share of males in this group was slightly higher (47.7% vs. 44.6%, p <0.0001). Discharged cases were less frequently brought in by an ambulance assisted by emergency physicians (16.0% vs. 34.8%, p <0.0001). The most common keyword was "Accident/Trauma" (44.7%) in case of discharge and "Cardiovascular" (27.8%) in case of admission. The most frequent diagnoses were within the main chapter XIX (Injury, Poisoning), regardless of admission status.

Table 1: Characteristics of ED cases transported by EMS

	Total		Admission status				p-value*
			discharged		admitted		
	N=78,303		n=30,873		n=47,430		
Age median (IQR)	60.0	(45)	40.0	(41)	70.0	(33)	<0.0001
Sex n (%)							<0.0001
Male	35,888	(45.8)	14,735	(47.7)	21,153	(44.6)	
Female	35,646	(45.5)	13,249	(42.9)	22,397	(47.2)	
missing	6,769	(8.6)	2,889	(9.4)	3,880	(8.2)	
Response n (%)							<0.0001
Ambulance without physician	56,856	(72.6)	25,933	(84.0)	30,923	(65.2)	
Ambulance with physician	21,447	(27.4)	4,940	(16.0)	16,507	(34.8)	
Time of admission n (%)							<0.0001
08.00h - 18.00h	33,787	(43.1)	13,897	(45.0)	19,890	(41.9)	
18.00h - 08.00h	44,516	(56.9)	16,976	(55.0)	27,540	(58.1)	
Day of week n (%)							0.25
Monday-Friday	56,019	(71.5)	22,016	(71.3)	34,003	(71.7)	
Saturday-Sunday	22,284	(28.5)	8,857	(28.7)	13,427	(28.3)	
Dispatch keyword n (%)							<0.0001
Accident/Trauma	23,975	(30.6)	13,810	(44.7)	10,165	(21.4)	
Cardiovascular	18,404	(23.5)	5,226	(16.9)	13,178	(27.8)	
Internal disease (unspecified)	7,112	(9.1)	2,018	(6.5)	5,094	(10.7)	

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Neurologic	5,684	(7.3)	1,152	(3.7)	4,532	(9.6)	
Respiratory	5,025	(6.4)	869	(2.8)	4,156	(8.8)	
Pediatric	3,925	(5.0)	2,803	(9.1)	1,122	(2.4)	
Gastrointestinal	3,856	(4.9)	1,178	(3.8)	2,678	(5.6)	
Other emergency (unspecified)	3,449	(4.4)	1,176	(3.8)	2,273	(4.8)	
Intoxication/Poisoning	2,970	(3.8)	1,150	(3.7)	1,820	(3.8)	
Other keywords	3,903	(5.0)	1,491	(4.8)	2,412	(5.1)	
Primary ICD-10 diagnosis n (%)							<0.0001
XIX Injury, poisoning	23,592	(30.1)	13,169	(42.7)	10,423	(22.0)	
IX Circulatory system	11,115	(14.2)	792	(2.6)	10,323	(21.8)	
XVIII not elsewhere classified	8,625	(11.0)	3,695	(12.0)	4,930	(10.4)	
V Mental and behavioural disorders	4,485	(5.7)	1,258	(4.1)	3,227	(6.8)	
XI Digestive system	3,975	(5.1)	597	(1.9)	3,378	(7.1)	
X Respiratory system	3,844	(4.9)	505	(1.6)	3,339	(7.0)	
VI Nervous system	3,620	(4.6)	681	(2.2)	2,939	(6.2)	
I Infectious and parasitic	2,636	(3.4)	459	(1.5)	2,177	(4.6)	
XIII Musculoskeletal system	2,442	(3.1)	1,232	(4.0)	1,210	(2.6)	
Other chapters	7,676	(9.8)	2248	(7.3)	5428	(11.4)	
missing	6,293	(8.0)	6,237	(20.2)	56	(0.1)	

*p-values derived from Chi2 test for distinct variables and from Mann-Whitney-U-Test test for continuous variables

Factors associated with discharge from ED after EMS transport

Figure 1 displays the proportion of cases discharged for different case characteristics. Whereas only 20.8% of cases over the age of 70 were discharged, 72.9% of cases under the age of 15 left the hospital after being seen in the ED. 45.6% of cases arriving in a paramedic-staffed ambulance were discharged, whereas only 23.0% were discharged when the ambulance crew was supported by an emergency physician. The proportion of discharged cases also varied according to dispatch keyword, with highest discharge rates for keywords indicating the involvement of children or accidents/trauma and lowest discharge rates for keywords indicating respiratory of neurologic problems.

Figure 1: Probability of being discharged from ED after EMS transport

Results from logistic regression analysis adjusting for all included variables are displayed in figure 2. After adjustment, the odds of discharge still increased with age: compared to cases over 70 years of age, cases under 15 years of age had 10 times higher odds of being discharged (OR 10.53, CI 9.31-11.92). The adjusted odds of discharge were 6% higher for women compared to men (OR 1.06, CI 1.02-1.10). Arrival between 18:00 and 8:00 (nighttime) decreased the odds of discharge by 26% (OR

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0.74, CI 0.72-0.77). Compared to cases reporting a cardiovascular problem to the dispatcher, dispatch for intoxication or poisoning, respiratory, neurologic or gastrointestinal and unspecified internal disease decreased the odds of being discharged, whereas odds of discharge were higher in case of dispatch for accidents or trauma, when children were involved and when the reported problem was not specified by the dispatcher. When the model was stratified by age group, the strength of the association differed by age category and was reversed for two keywords: Whereas dispatch for respiratory conditions was associated with discharge for cases under the age of 35, cases with respiratory problems aged 35 or older had higher odds of admission. In contrast, intoxication and poisoning led to decreased odds of discharge in younger cases but increased odds of discharge in older cases (see supplementary Table).

Figure 2: Adjusted odds ratios and confidence interval (95%) for discharge

Hospital diagnosis

Most diagnoses were within chapter XIX, which includes injuries, poisoning and certain other consequences of external causes (Table 1). Yet diagnoses from chapter XIX were more common for cases that were discharged (42.7% vs. 22.0 %). In contrast, diagnoses from chapter IX (diseases of the circulatory system) were more common when a case was admitted to the hospital (21.8% vs 2.6 %). Diagnoses from chapters XIX (Injury, poisoning), XVIII (not elsewhere classified) and missing diagnosis information covered 75% of all diagnoses for discharged cases, whereas diagnoses of admitted cases were distributed across different diagnosis chapters.

The most common 3-digit ICD 10 codes in case of admission were F10 (mental and behavioral disorders due to use of alcohol), S06 (intracranial injury), I10 (essential (primary) hypertension), R55 (syncope and collapse), I63 (cerebral infarction). In case of discharge, the most common codes were S01 (open wound of head), S06 (intracranial injury), S00 (superficial injury of head), R55 (syncope and collapse), F10 (mental and behavioral disorders due to use of alcohol). These five most common 3-digit ICD 10 codes accounted for about 20% of diagnosis codes in each group.

Dispatch keywords compared to hospital diagnoses

Tables 2 and 3 show the proportion of diagnoses from each ICD-chapter by dispatch keyword for admitted and discharged cases. Regardless of the initial dispatch keyword, hospital diagnoses fell into many different chapters. Exceptions were dispatch for “accident/trauma” and “intoxication or poisoning”, where the majority of diagnoses (accident/trauma: chapter XIX diagnoses for 65.5% of cases when discharged, 71.6% when admitted; intoxication/poisoning: chapters XIX and V diagnoses for 66.1% of cases when discharged, 85.5% when admitted) came from compatible chapters. Diagnoses for admitted cases did match the initial dispatch keyword more often than diagnoses for

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discharged cases, but still fell into different chapters. With the exception of dispatch for neurological or respiratory problems, the most common hospital diagnosis for discharged cases came from either chapter XIX (injury, poisoning) or XVIII (not elsewhere classified), regardless of dispatch keyword. The most common ICD-codes within chapter XVIII were R55 (syncope and collapse), R07 (pain in throat and chest) R10 (Abdominal and pelvic pain) and R42 (dizziness and giddiness).

Table 2: Distribution of diagnoses within diagnosis chapters by dispatch keyword (%), discharged cases

	Diagnosis chapter											
Dispatch keyword	I	IX	V	VI	X	XI	XIII	XIX	XVIII	Other	missing	total
Accident/Trauma	0.2	0.6	0.7	0.5	0.2	0.5	3.0	**65.5**	2.7	3.4	22.6	100
Cardiovascular	1.7	7.4	6.0	3.1	1.4	2.4	4.3	14.3	**28.3**	9.5	21.6	100
Internal disease (unspecified)	2.0	5.4	6.8	4.3	1.1	3.6	10.3	16.4	**19.5**	13.6	17.1	100
Neurologic	1.1	4.4	6.6	**21.5**	1.0	1.6	3.5	11.5	17.7	12.3	18.7	100
Respiratory	1.6	3.9	6.4	3.0	12.3	1.8	5.6	16.2	19.1	8.6	**21.3**	100
Other emergency (unspecified)	1,6	4,7	3,1	2,6	1,1	2,3	10,7	**29,9**	15	13,2	15,8	100
Pediatric	5.9	0.3	0.2	0.5	7.8	2.4	1.8	**57.4**	4.5	6.8	12.4	100
Gastrointestinal	4.9	1.4	1.0	0.8	0.5	15.1	3.4	8.4	**31.0**	17.9	15.5	100
Intoxication/Poisoning	0.4	0.4	**38.4**	0.3	0.3	0.3	1.8	27.7	5.4	5.7	19.1	100
Other keywords	1.7	2.6	5.7	2.3	1.1	1.6	3.4	**26.2**	23.2	11.5	20.7	100

The most common diagnosis chapter is highlighted in bold.

Table 3: Distribution of diagnoses within diagnosis chapters by dispatch keyword (%), admitted cases

	Diagnosis chapter											
Dispatch keyword	I	IX	V	VI	X	XI	XIII	XIX	XVIII	Other	missing	total
Accident/Trauma	1.4	6.0	3.6	2.0	1.3	1.8	3.2	**71.6**	4.2	4.8	0.2	100
Cardiovascular	5.0	**38.4**	4.5	4.4	4.5	5.4	2.2	6.7	17.6	11.1	0.1	100
Internal disease (unspecified)	9.1	19.3	5.9	5.1	6.0	10.8	5.0	6.2	9.1	**23.2**	0.1	100
Neurologic	3.8	**31.2**	4.9	30.6	3.6	2.0	1.2	3.0	8.7	10.9	0.1	100
Respiratory	5.6	28.2	2.2	2.2	**38.6**	3.6	1.5	3.1	6.0	9.0	0.2	100
Other emergency (unspecified)	5,2	**19,4**	5,2	5,3	5.0	9,2	6,6	17,3	8,2	18,5	0,2	100
Pediatric	6.6	0.5	1.2	3.8	21.4	2.5	1.0	**46.4**	9.1	7.3	0.1	100
Gastrointestinal	7.8	3.7	1.5	0.8	1.8	**50.2**	0.8	1.8	10.5	21.0	0.0	100
Intoxication/Poisoning	0.7	1.7	**69.3**	0.9	0.9	1.5	0.3	16.2	6.2	2.1	0.2	100
Other keywords	4.0	**20.8**	9.2	9.2	4.7	3.4	1.0	17.9	16.4	13.2	0.1	100

The most common diagnosis chapter is highlighted in bold.

I Infectious and parasitic IX Circulatory system V Mental and behavioral VI Nervous system X Respiratory system XI Digestive system XIII Musculoskeletal system XIX Injury, poisoning XVIII not elsewhere classified Other chapters include: VII Eye IV Endocrine, nutritional and metabolic XVII Congenital malformations, Blood and blood-forming organs XII Skin VIII Ear II Neoplasms XVI Originating in perinatal period XV Pregnancy, childbirth XXI Factors influencing health XX External cause

Discussion

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Principal findings

Discharge on the same day was associated with young age, dispatch of an ambulance without additional emergency physician support and arrival during the day. Discharge also depended on the reason for dispatch, with particularly high discharge rates for emergencies related to accidents or trauma. Compared to admitted cases, a larger proportion of discharged cases were diagnosed with injuries or poisoning, whereas the proportion of diseases of the circulatory system was smaller in this group. Some diagnoses (alcohol intoxication, concussion and syncope) were frequently assigned to both admitted and discharged cases. Good agreement between dispatch keyword and hospital diagnosis was observed after dispatch for accident/trauma and intoxication/poisoning, but not for other keywords. Diagnoses of admitted cases matched the initial dispatch keyword more often than diagnoses of discharged cases.

Strengths and weaknesses of the study

Even though a more complete investigation of the rescue chain becomes possible, few studies link dispatch and hospital data. Yet the use of routinely collected data comes along with several potential sources for bias. One of them is that 30% of dispatch records could not be linked to a hospital record because common identifiers (time stamps or patient age) were documented incorrectly or not at all. We believe that missing identifiers is due to input errors which are likely to be completely random, but we cannot rule out that lack of documentation might indicate that these cases were either less or more critically ill. Another major weakness is that diagnosis information was missing for one out of five discharged cases. We therefore report the amount of missing data in all analyses and did not include hospital diagnoses in the regression model. Discharged cases are misclassified when they are admitted on another day, to another hospital or if they die in the ED. Comparison of ICD-10 diagnosis with dispatch keywords implies some degree of imprecision since dispatch keywords often describe emergency situations or medical conditions rather than suspected diagnosis. We could not study patient factors which are likely to be associated with admission, like socioeconomic status or access to care and could not capture comorbid conditions, which are known to increase the risk of short-term adverse outcomes for time-critical 112 callers with the same complaint[14]. The study area is a metropolitan area and results might be different in rural regions or even in metropolitan areas with different pre-hospital treatment or admission practices.

Interpretations and comparison with other studies

40% of cases transported to the emergency department by emergency medical services were not admitted to the hospital. Our results are difficult to compare to results from areas with different

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population composition and healthcare infrastructure. This might explain why even higher discharge rates of 70% were observed in a mixed urban, suburban, and rural area in the United states,[6] where alternatives to hospital emergency care are different. Studies in the pre-hospital setting in Sweden and Australia have assessed more than one third of patients as not being in need of prehospital interventions or ambulance transport, despite of ambulance dispatch.[18] [19] All of these observations correspond with discrepancies between patient perception of urgency and staff assessment.[20] Yet it is hard for dispatchers to identify callers who don't need emergent EMS care or rapid transport to the ED, as they usually have to base response decisions on patients' or bystanders' assessment.

Age was the strongest predictor of discharge even after adjustment for other patient and dispatch characteristics. Particularly young adults and children were most likely to be discharged than older cases. Other studies also have found younger patients to be candidates for primary healthcare [7] and less likely to need paramedic treatment. [19] The decision to access ambulance and urgent care services is influenced by access to primary care, individual circumstances, perceived urgency and beliefs that resources can only be provided by a particular healthcare provider. [4] [5] These reasons were mentioned, along with a need for reassurance, the desire for a second opinion and lack of insurance, by parents who bring their child to the ED for minor illnesses. In these cases a "wait and see" approach seems especially undesirable and the accurate assessment of the child's condition proves difficult to parents.[21] These factors may also be important for EMS missions involving children. Conversely, elderly patients usually bear a higher amount of morbidity and a higher degree of frailty. An increased probability of admission or death after transport to ED was observed for a number of dispatch codes for cases over the age of 65.[6] The lack of safe discharge arrangements for geriatric patients [22] might make hospital admission the best option, even if the acute emergency situation is resolved.

Odds of discharge were lower when emergency physicians were dispatched. We expected the presence of a physician to be a marker of severity and thus decreased likelihood of hospital discharge, as physician dispatch is triggered by a higher probability of critically ill/injured patients and invasive interventions on scene.

Arrival at night also decreased the odds of discharge. Such cases could be of higher acuity. There may also be fewer alternatives to admission available, or decision-making may be postponed due to limited diagnostic availabilities or absence of senior physicians at the ED at night.

We hypothesized that certain dispatch keyword groups would clearly mark situations or health problems that usually don't lead to subsequent hospital admission. Other studies have identified a number of situations that were less likely to lead to hospital admissions or EMS transport or were considered suitable for referral to other levels of care. They include assaults and unconsciousness or fainting in younger patients, [6] pediatric cases, psychiatric conditions, patients with low pain

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scores[19], nausea/vomiting/diarrhoea, seizures/epilepsy, back pain, pain during urination/haematuria, mental illness and unspecified disease.[7] Low-acuity dispatch codes included abdominal pain, assault, back pain, pregnancy and childbirth, injuries and psychiatric conditions [23] and were validated in the same area,[24] but did not turn out to be low-acuity in another community.[25] Non-transport after EMS dispatch was especially more common after assault/sexual assault, unknown problem/man down, traffic/transportation accidents, unconscious/fainting [26] and mental, behavioral and neurodevelopmental disorders [27]. Our analysis shows that, compared to dispatch for cardiovascular problems, odds of discharge were especially high for cases transported after accidents or trauma, emergencies involving children and emergencies where dispatchers did not specify the reason for dispatch. We already discussed reasons why young age might increase the odds of discharge. Higher odds of discharge after accidents and injuries might be because diagnostic resources that are only available in a hospital setting are required for a thorough examination of these cases, after which they can frequently be cleared. This could also apply to emergencies where the problem can't be specified by the dispatcher. Determining the priority level of unclear calls is particularly difficult, and they are therefore often provided with a either lower or higher response than needed.[12][28]

The spectrum of diseases differed between discharged and admitted cases, with a higher proportion of chapter XIX (Injury, poisoning) diagnoses in discharged and more ICD-10 chapter IX (circulatory system) diagnoses in admitted cases. Yet the degree to which dispatch keywords were indicative of the later diagnosis was rather low. Dispatch keywords were usually spread across many different diagnosis chapters for both admitted and discharged cases, even though discrepancies were observed a more frequently in the discharged group. Pre-hospital emergency conditions usually don't present themselves as "textbook examples".[28] Especially nonsurgical emergency patients often lack diagnosis-specific symptoms.[29] This analysis showed that keyword and hospital diagnosis were more similar when a condition seemed easily recognizable, like accidents or trauma and intoxication or poisoning. These situations might be more intuitive for patients and bystanders to describe, and therefore bring about a better diagnostic accuracy at dispatch.

Yet some conditions that are apparently easier to recognize than others and are very common ICD 10 diagnoses are frequently diagnosed in both groups. They include alcohol intoxication, concussion and syncope. Distinguishing between cases with life-threatening illness and other cases comes with assigning some less urgent cases a high priority. Standard operating procedures have been defined to handle these conditions in the ED [30] to identify patients with high risk of adverse outcomes and might be useful for standardized emergency query upon emergency call, too.

Implications for policy and practice and future research

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Diverting eligible patients to other settings could help manage the growing demand for EMS and EDs. This analysis suggests that, at least in part, dispatch information is suitable to assess the likelihood of discharge from the ED after EMS transport. Our findings point to patient groups that are worth a closer look regarding potential diversion away from the ED. These are in particular young and injured patients, who might require hospital-specific resources, but not always urgent EMS transport. Information about predictors of discharge could also be useful to reroute ambulances, especially when admission capacities are low.

Discharge from the ED after EMS transport can't be equated with low potential for critical illness or injury. Rapid transport may be necessary to exclude worrisome differential diagnoses or to treat conditions using resources that are not available outside of a hospital setting. Better pre-hospital triage tools are necessary to accurately identify patients that are not severely ill or injured. This includes the assessment of acuity in addition to symptom keywords at dispatch, to allow for a more differentiated evaluation of patient groups and to allocate adequate resources. More information on discrepancies between diagnoses and acuity levels at dispatch as compared to later assessment is needed, as the pre-selection of patient groups for redirection is only viable when initial assessment and final diagnosis are sufficiently consistent.

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Competing interests

The authors declare that they have no competing interests.

Authors' contributions

KH and SP conceived the study. KH performed the analyses, interpreted the data and drafted the manuscript. HT provided input for interpretation of results and drafting of the manuscript. All authors contributed to the critical revision of the manuscript and approved its final version.

Patient consent form

Not applicable

Availability of data and material

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The data used in this paper was a combination of hospital and dispatch data. Dispatch data are third party data used with permission of the Bavarian State Ministry of the Interior, Sport and Integration and the Bavarian social insurance agencies. Hospital data are third party data analyzed with permission of all participating hospitals. The authors do not have the permission to distribute the data.

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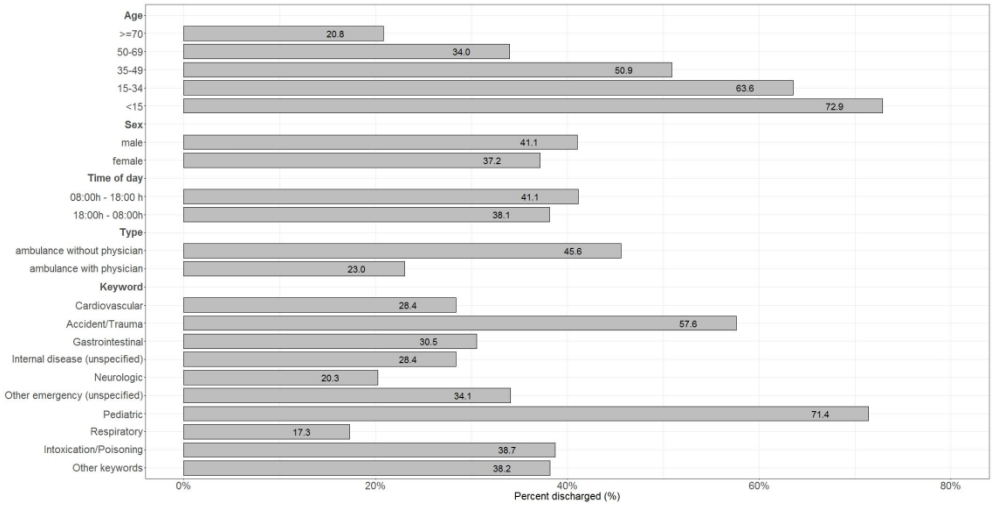

Probability of being discharged from ED after EMS transport

180x90mm (300 x 300 DPI)

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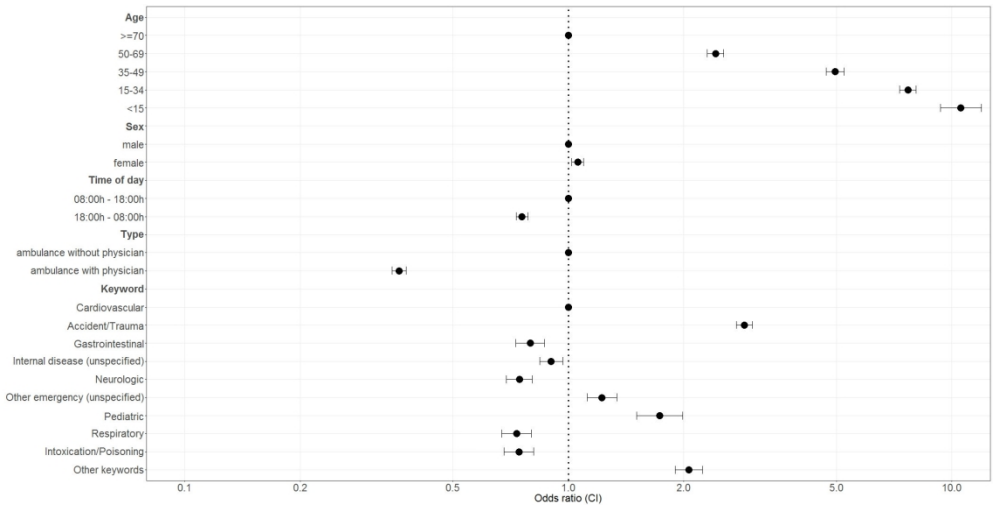

Adjusted odds ratios and confidence interval (95%) for discharge

180x90mm (300 x 300 DPI)

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Supplementary Material

Supplementary Table: Adjusted odds ratios and confidence interval (95%) for discharge, stratified by age category

	<15		15-34		35-49		50-69		>=70	
	OR (CI)	p	OR (CI)	p	OR (CI)	p	OR (CI)		OR (CI)	p
Sex(female)	1,04 (0,91-1,19)	0,91	1,01 (0,94-1,09)	<0.0001	1,31 (1,2-1,42)	<0.0001	1,17 (1,09-1,26)	<0.0001	0,90 (0,85-0,96)	<0.0001
Time (18:00h - 8:00h)	0,64 (0,56- 0,73)	<0.0001	0,72 (0,67- 0,78)	<0.0001	0,74 (0,68- 0,81)	<0.0001	0,77 (0,72- 0,83)	<0.0001	0,77 (0,72- 0,82)	<0.0001
Type (with physician)	0,32 (0,28-0,37)	0,28	0,37 (0,34-0,4)	<0.0001	0,39 (0,35-0,43)	<0.0001	0,38 (0,35-0,41)	<0.0001	0,34 (0,31-0,37)	<0.0001
Dispatch keyword										
Cardiovascular	reference		reference		reference		reference		reference	
Accident/Trauma	1,76 (1,09-2,82)	1,09	2,43 (2,19-2,71)	<0.0001	3,04 (2,72-3,41)	<0.0001	3,36 (3,05-3,7)	<0.0001	2,92 (2,69-3,18)	<0.0001
Other emergency (unspecified)	1,06 (0,56-1,98)	0,56	0,93 (0,77-1,12)	<0.0001	0,99 (0,81-1,21)	0,92	1,31 (1,1-1,56)	<0.0001	1,59 (1,36-1,85)	<0.0001
Gastrointestinal	1,89 (0,84-4,25)	0,84	0,73 (0,63-0,85)	0,42	0,73 (0,61-0,87)	<0.0001	0,76 (0,63-0,92)	<0.0001	0,87 (0,72-1,05)	0,14
Internal disease (unspecified)	1,24 (0,63-2,44)	0,63	0,65 (0,56-0,75)	<0.0001	0,97 (0,84-1,14)	0,74	0,95 (0,83-1,09)	0,46	1,03 (0,91-1,17)	0,65
Neurologic	0,86 (0,37-2,01)	0,37	0,76 (0,64-0,91)	<0.0001	1,03 (0,86-1,24)	0,73	0,75 (0,64-0,88)	<0.0001	0,62 (0,53-0,71)	<0.0001
Respiratory	1,23 (0,59-2,55)	0,59	1,24 (1,01-1,53)	<0.0001	0,95 (0,77-1,19)	0,68	0,54 (0,45-0,64)	<0.0001	0,60 (0,51-0,7)	<0.0001
Intoxication and poisoning	0,86 (0,43-1,73)	0,43	0,5 (0,44-0,57)	0,04	0,88 (0,73-1,05)	0,14	1,46 (1,2-1,77)	<0.0001	1,23 (0,74-2,03)	0,42
Other keywords	1,73 (0,77-3,86)	0,77	1,58 (1,34-1,86)	<0.0001	1,89 (1,55-2,29)	<0.0001	1,83 (1,53-2,19)	<0.0001	2,71 (2,36-3,12)	<0.0001

Dispatch keyword category "pediatric" is omitted

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Keyword categories and examples of assigned keywords

Accident/Trauma	Fall, traffic and other accidents
Cardiovascular	Myocardial infarction, collapse, heart complaints
Internal disease (unspecified)	Undefined problem (internal medicine)
Neurologic	Stroke, Seizure
Respiratory	Respiratory distress, asthma
Pediatric	Child sick or injured
Gastrointestinal	Abdomen, gastro-intestinal bleed
Other emergency (unspecified)	Other emergency (undefined problem)
Intoxication/Poisoning	Alcohol, drugs, medication
Other keywords	Consciousness (unconsciousness, patient without signs of life), Obstetrical/Gynecological (gynecological bleed, parturition), Person in danger (Person in need of assistance, entrapped in residence, stand by in case of fire), Suicide (Suicide and attempted suicide), Bleeding

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The RECORD statement – checklist of items, extended from the STROBE statement, that should be reported in observational studies using routinely collected health data.

	Item No.	STROBE items	Location in manuscript where items are reported	RECORD items	Location in manuscript where items are reported
Title and abstract					
	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found		RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included. RECORD 1.2: If applicable, the geographic region and time frame within which the study took place should be reported in the title or abstract. RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.	1.1: Page 1, Line 14 1.2_ Page 1, lines 16-17 1.3: Page 1, line 2 and 14
Introduction					
Background rationale	2	Explain the scientific background and rationale for the investigation being reported			Page 3, lines 55-72
Objectives	3	State specific objectives, including any prespecified hypotheses			Page 3, lines 73-77
Methods					
Study Design	4	Present key elements of study design early in the paper			Page 4, lines 83/84
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection			Page 4, lines 99-107
Participants	6	*(a) Cohort study* - Give the eligibility criteria, and the		RECORD 6.1: The methods of study population selection (such as codes or	6.1: Page 4/5, lines 99-130

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		sources and methods of selection of participants. Describe methods of follow-up *Case-control study* - Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study* - Give the eligibility criteria, and the sources and methods of selection of participants *(b) Cohort study* - For matched studies, give matching criteria and number of exposed and unexposed *Case-control study* - For matched studies, give matching criteria and the number of controls per case		algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided. RECORD 6.2: Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published elsewhere, detailed methods and results should be provided. RECORD 6.3: If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the number of individuals with linked data at each stage.	6.3: Page 5/5, lines 112-119
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.		RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.	Page 4/5, lines 120-130, 139-142
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group			Page 4, lines 108-111
Bias	9	Describe any efforts to address potential sources of bias			
Study size	10	Explain how the study size was			Page 4, lines 99-

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		arrived at			105
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why			Page 5, lines 129-130, 140-142
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) *Cohort study* - If applicable, explain how loss to follow-up was addressed *Case-control study* - If applicable, explain how matching of cases and controls was addressed *Cross-sectional study* - If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses			Page 5, lines 126-127, 134-148,
Data access and cleaning methods		..		RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population. RECORD 12.2: Authors should provide information on the data cleaning methods used in the study.	12.1: Page 4, lines 99-102 12.2: page 5, lines 124/125
Linkage		..		RECORD 12.3: State whether the study included person-level, institutional-	

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				level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.	
Results					
Participants	13	(a) Report the numbers of individuals at each stage of the study (*e.g.*, numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed) (b) Give reasons for non-participation at each stage. (c) Consider use of a flow diagram		RECORD 13.1: Describe in detail the selection of the persons included in the study (*i.e.,* study population selection) including filtering based on data quality, data availability and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.	Page 4, lines 112-119
Descriptive data	14	(a) Give characteristics of study participants (*e.g.*, demographic, clinical, social) and information on exposures and potential confounders (b) Indicate the number of participants with missing data for each variable of interest (c) *Cohort study* - summarise follow-up time (*e.g.*, average and total amount)			Table 1
Outcome data	15	*Cohort study* - Report numbers of outcome events or summary measures over time *Case-control study* - Report numbers in each exposure category, or summary measures of exposure *Cross-sectional study* - Report numbers of outcome events or summary measures			Table 1
Main results	16	(a) Give unadjusted estimates			Figure 1

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		and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period			Figure 2 Supplementary Table
Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses			
Discussion					
Key results	18	Summarise key results with reference to study objectives			Page 10, lines 241-250
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias		RECORD 19.1: Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported.	Page 10, lines 255-265
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence			Page 11, lines 267-page 12 line 374
Generalisability	21	Discuss the generalisability (external validity) of the study results			Page 11 lines 277-278

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Other Information					
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based			
Accessibility of protocol, raw data, and programming code		..		RECORD 22.1: Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code.	

*Reference: Benchimol EI, Smeeth L, Guttmann A, Harron K, Moher D, Petersen I, Sørensen HT, von Elm E, Langan SM, the RECORD Working Committee. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement. *PLoS Medicine* 2015; in press.

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Differences between cases admitted to hospital and discharged from the emergency department after emergency medical services transport: a retrospective analysis

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Primary Subject Heading:	Emergency medicine
Secondary Subject Heading:	Emergency medicine, Epidemiology, Health services research, Public health
Keywords:	Emergency medical services, Emergency department, pre-hospital, resource allocation, utilisation

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Title

Differences between cases admitted to hospital and discharged from the emergency department after emergency medical services transport: a retrospective analysis

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emergency medical services utilisation, resource allocation, patients, emergency department

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Word count (excluding title page, abstract, references, tables, figures)

4807

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Differences between cases admitted to the hospital and discharged from the emergency department after emergency medical services transport: a retrospective analysis

Abstract

Objective: Rising emergency medical services (EMS) utilization increases transport to hospital emergency departments (ED). However, some patients receive outpatient treatment (discharged) while others are hospitalized (admitted). The aim of this analysis was to better understand EMS utilization by comparing admitted and discharged cases, and to assess whether information accessible to dispatchers can help identify cases that will be discharged from the ED. A second aim was to examine whether dispatch keyword categories match the hospital diagnosis.

Design: retrospective observational study using linked secondary data

Setting and participants: 78,303 cases brought to one of 14 ED in the city of Munich, Germany by EMS between 01.07.2013 – 30.06.2014.

Main outcome measures: Characteristics of admitted and discharged cases were assessed. Logistic regression was used to estimate the association between discharge and age, sex, time of day, ambulance type and dispatch keyword category. Keyword categories were compared to hospital diagnoses.

Results: 39.4% of cases were discharged. They were especially likely to be young (OR 10.53 (CI 9.31-11.92), comparing <15 year olds to >70 year olds) and to fall under the categories 'accidents/trauma' (OR 2.87 (CI 2.74-3.01)) or 'other emergencies (unspecified) '(OR 1.23 (CI 1.12-1.34) (compared to 'cardiovascular'). Most frequent diagnoses came from IDC-10 chapter 'injury and poisoning' (30.1%), yet these diagnoses were more frequent at discharge (42.7 vs. 22.0%) whereas circulatory system disease was less frequent (2.6% vs. 21.8%). Keyword categories were distributed across many different ICD-10 chapters. Discrepancies between them and later diagnosis were less frequent after dispatch for accidents or trauma and intoxication or poisoning.

Conclusion: Young age and dispatch for accidents or trauma were the strongest predictors of discharge. Discharge from the ED does not indicate that urgent evaluation and treatment was not necessary. Yet these cases might be suitable for diversion to hospitals even with high bed occupancy so transport capacities are quickly available again. Further research is needed to better understand the true urgency of these cases to determine if they are suitable for diversion to other settings.

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Strengths and limitations of this study

- Large sample which includes 78,303 cases brought to the emergency department by emergency medical services after emergency calls
- Linkage of dispatch data with hospital data made it possible to identify which cases were in need of subsequent admission and to study hospital diagnoses of pre-hospital cases
- Main limitations are that 30% of dispatches could not be linked to hospital records, and that diagnosis information was missing for 20% of discharged cases

Introduction

Pre-hospital emergency medical services (EMS) provide immediate medical care to acutely ill and injured patients. Demand for EMS in Germany is rising, with an increase by 105% since 2001.[1] An increase in EMS activation in both, urban and rural regions of Bavaria was observed over the past 10 years.[2]

Rising demand for EMS and ED services contributes to emergency department crowding and scarcity of hospital admission capacities. The negative consequences of ED crowding on patient outcomes are well established.[3] There is evidence that emergency care and ambulance services are accessed for primary care and low-urgency health problems.[4] [5] Other studies report discharge rates after EMS transport of as high as 70% [6] and classify 16% of EMS patients as potential candidates for primary healthcare.[7] Whereas it is difficult to guide patients that walk into the ED, dispatchers are involved in the emergency care processes at an early stage. A central task is the allocation of resources to patients and of patients to hospitals. If dispatchers were able to clearly identify patients that are safe when diverted, they could refer callers to other levels of care. Also temporary de-registration from acute care of hospitals with no available inpatient beds and hence longer transport routes could be prevented by a forward-looking distribution of patients who are probably not admitted.

Triage tools are able to identify patients who do not need pre-hospital interventions,[8] and cases not suitable for an ED presentation can be referred to alternative care pathways after secondary triage.[9] However, a recent review concludes that the overall level of evidence of the accuracy of medical dispatching systems is low.[10] Few studies compare diagnostic discrepancies at different stages of care, but overtriage has been observed when comparing emergency medical dispatch centers and ambulance crews.[11] [12] A certain amount of overtriage is accepted and expected to

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prevent overlooking critically ill patients that in consequence suffer from adverse outcomes. Yet over-triage also consumes resources and causes unnecessary crowding of specialized resources. The addition of demographic information and hospitalization history to the dispatch process has shown the potential to predict adverse outcomes [13]. Conversely, knowing which caller characteristics and initial complaints are associated with discharge from the ED might help dispatchers to pre-select groups that are less likely to need acute care beds, and point to groups that might be worth a closer look regarding the suitability for other settings, in case initial and later assessment is mostly concordant.

The aim of this study was therefore to compare admitted and discharged cases and to assess whether information accessible to the dispatcher can help differentiate between cases who will need subsequent admission to a hospital and those who likely will not. A second aim was to examine whether the dispatcher`s assessment of the emergency situation matched the hospital's diagnosis.

Methods

Design and setting

This is a retrospective observational study using secondary data gathered for an evaluation of the provision of care by emergency departments in the city of Munich.[14] In 2014, about 1.5 Million people lived in the city of Munich. The Munich dispatch center covers an area of about 980 sqkm with 1.8 Million inhabitants.

The German health care system offers different types of emergency care in different environments. Pre-hospital medical services can be accessed via the national emergency telephone number 112. Calls are managed by regional dispatch centers that operate full time and coordinate emergency and non-emergency ground and air ambulances and the fire brigade. Call-takers and dispatchers are trained paramedics or firefighters who underwent dispatch training. A local, non-standardized, keyword-based dispatch manual is used to decide on the type and number of pre-hospital EMS units to be dispatched to the scene of the emergency. Levels of EMS response include ambulances designated to non-emergency transport, paramedic staffed ambulances and rapid response cars and helicopters staffed with prehospital emergency physicians. Pre-hospital emergency physicians need a specialty board certification for emergency medicine. A physician will be dispatched according to a pre-specified catalogue when vital signs are suspected to be unstable

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or when the condition implicates a high probability of need for invasive interventions. Physicians can also be activated at the discretion of the dispatcher for tactical reasons or when they are requested by the paramedics on site. According to suitability and intake capacity a dispatchers will suggest a hospital to which an EMS patient should be transported to. This suggestion is usually accepted by ambulance crews, although they can, in consultation with the dispatch center, decide on another destination if special medical considerations prevail. If hospitals temporarily de-register to the dispatch center from acute care, EMS units have to travel to alternative locations, which usually results in longer transport times and deducts units from their home base.

A dispatcher can refer callers that do not need an EMS response to on-call or ambulatory services provided by the Association of Statutory Health Insurance. On-call doctor services can be accessed directly through 116,117 for urgent but non-emergency conditions. Patients can access all ambulatory emergency care services on their own initiative, or seek care at a hospital's emergency department.

Data sources and sample

Between 01.07.2013 and 30.06.2014, routinely collected information of all cases presenting to one of 14 emergency departments of 14 major hospitals in Munich was pooled into a study data base. Dispatch information was extracted from a database that holds routinely generated data from the computer-assisted dispatch systems of Munich´s central dispatch center and surrounding dispatch centers and billing information. During the study period, 524.716 cases presented to the 14 EDs and 110.484 emergency dispatches where a patient was transported to a destination in the city of Munich were recorded by the dispatch centers, of which 78.307 (71%) could be matched to an ED record. Four emergency dispatches were excluded, as the keywords indicated a non-emergency transport. All data was anonymized and is therefore case-, not patient-based. Repeated presentation by the same patient or EMS activation for the same patient could not be accounted for.

Hospital data included basic case information (age, sex, admission status) and information about diagnoses (ICD-10-GM Codes). Dispatch data includes dispatch keywords, type of ambulance deployed, time stamps and receiving hospital. Billing data includes patient age, an essential identifier for the linkage of hospital and dispatch data. A probabilistic approach was used to link billing and dispatch records, and then dispatch and hospital records. Time stamps of dispatch and billing data were compared and patient age could be assigned to 86% of dispatch records. Second,

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patient age and admission time of dispatch and hospital records were compared. All records with an exact match of patient age and an arrival time within a 20 minute interval were linked, which was the case for 80% of records. When several records matched, the records with the smallest difference in arrival time were linked. This process was repeated for the remaining records, first through extending the admission time interval to 40 minutes, and then extending the age criterion to a 5 year range. The study design and case selection are illustrated in figure 1.

Cases were classified as discharged when there was no documentation for admission to the same hospital on the day of ED presentation. Information about admitted cases came from a standardized data set that hospitals are required to collect according to section 21 of the Hospital Remuneration Act (KHEntgG). Participating hospitals provided comparable information about discharged cases from their hospital information system. Records with identical items recorded within the first hour after admission were considered duplicates and removed from the dataset. Recording a primary diagnosis is only mandatory for admitted cases. The amount of missing data is displayed in the results section. More than one diagnosis was recorded for 5.1% of discharged cases. In this case, the diagnosis with the highest estimated resource requirement was chosen as the primary diagnosis. Since dispatch keywords are not standardized, 293 different keywords were condensed and classified into 15 categories (see supplementary material).

Figure 1: study design and case selection

Analysis

The sample was characterized by calculating medians with interquartile range (IQR) for continuous variables and frequencies and proportions for categorical variables. Statistical tests ($\chi 2$ test for categorical variables and the Wilcoxon– Mann-Whitney-U-Test for continuous variables) were performed to evaluate differences between admitted and discharged cases. The probability of discharge was calculated for case characteristics. Logistic regression was preformed to estimate the adjusted likelihood of discharge. Covariates were selected based on their availability at dispatch and included age, sex, dispatch keyword category and day and time of admission at the ED. The nine most frequent dispatch keyword categories and ICD-10 diagnosis chapters are displayed. Remaining diagnosis chapters and keyword categories are summarized as “other chapters” and “other keywords”. Age was categorized into five groups. The final model was selected based on Akaike

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information criterion (AIC). [15] [16] A subgroup analysis was conducted for age groups and results from the stratified models are displayed. The frequencies of hospital diagnoses stratified by dispatch keyword category are presented in cross-tabulated tables. Analysis was performed using R statistical software (R Foundation for Statistical Computing, Vienna, AT).

Ethics and reporting

The study protocol including the description of the dataset and the data protection concept was submitted to the ethics committee of the medical faculty of the University of Munich for review (Project-No 17-530-UE). Analyses are based on retrospective data that is irreversibly anonymized. The ethical review committee therefore waived obligation to advise according to the law on faculties. The reporting of this study is in accordance with STROBE guidelines for the reporting of observational studies in epidemiology.

Patient and public involvement

Patients or the public were not involved in the design and conduct of this research.

Results

Characteristics of ED cases transported by EMS

47,430 cases (60.6%) were admitted and 30,873 (39.4%) were discharged. Characteristics of both groups are reported and compared in table 1. The comparison of admitted and discharged cases shows that discharged cases were much younger (median of 40 vs. 70 years, p <0.0001). The share of males in this group was slightly higher (47.7% vs. 44.6%, p <0.0001). Discharged cases were less frequently brought in by an ambulance assisted by emergency physicians (16.0% vs. 34.8%, p <0.0001). The most common keyword category was "Accident/Trauma" (44.7%) in case of discharge and "Cardiovascular" (27.8%) in case of admission. The most frequent diagnoses were within the main chapter XIX (Injury, Poisoning), regardless of admission status.

Table 1: Characteristics of ED cases transported by EMS

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	Total		Admission status				
			discharged		admitted		p-value*
	N=78,303		n=30,873		n=47,430		
Age median (IQR)	60.0	(45)	40.0	(41)	70.0	(33)	<0.0001
Sex n (%)							<0.0001
Male	35,888	(45.8)	14,735	(47.7)	21,153	(44.6)	
Female	35,646	(45.5)	13,249	(42.9)	22,397	(47.2)	
missing	6,769	(8.6)	2,889	(9.4)	3,880	(8.2)	
Response n (%)							<0.0001
Ambulance without physician	56,856	(72.6)	25,933	(84.0)	30,923	(65.2)	
Ambulance with physician	21,447	(27.4)	4,940	(16.0)	16,507	(34.8)	
Time of admission n (%)							<0.0001
08.00h - 18.00h	33,787	(43.1)	13,897	(45.0)	19,890	(41.9)	
18.00h - 08.00h	44,516	(56.9)	16,976	(55.0)	27,540	(58.1)	
Day of week n (%)							0.25
Monday-Friday	56,019	(71.5)	22,016	(71.3)	34,003	(71.7)	
Saturday-Sunday	22,284	(28.5)	8,857	(28.7)	13,427	(28.3)	
Dispatch keyword category n (%)							<0.0001
Accident/Trauma	23,975	(30.6)	13,810	(44.7)	10,165	(21.4)	
Cardiovascular	18,404	(23.5)	5,226	(16.9)	13,178	(27.8)	
Internal disease (unspecified)	7,112	(9.1)	2,018	(6.5)	5,094	(10.7)	
Neurologic	5,684	(7.3)	1,152	(3.7)	4,532	(9.6)	
Respiratory	5,025	(6.4)	869	(2.8)	4,156	(8.8)	
Pediatric	3,925	(5.0)	2,803	(9.1)	1,122	(2.4)	
Gastrointestinal	3,856	(4.9)	1,178	(3.8)	2,678	(5.6)	
Other emergency (unspecified)	3,449	(4.4)	1,176	(3.8)	2,273	(4.8)	
Intoxication/Poisoning	2,970	(3.8)	1,150	(3.7)	1,820	(3.8)	
Other keywords	3,903	(5.0)	1,491	(4.8)	2,412	(5.1)	
Primary ICD-10 diagnosis n (%)							<0.0001

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XIX Injury, poisoning	23,592	(30.1)	13,169	(42.7)	10,423	(22.0)
IX Circulatory system	11,115	(14.2)	792	(2.6)	10,323	(21.8)
XVIII not elsewhere classified	8,625	(11.0)	3,695	(12.0)	4,930	(10.4)
V Mental and behavioural disorders	4,485	(5.7)	1,258	(4.1)	3,227	(6.8)
XI Digestive system	3,975	(5.1)	597	(1.9)	3,378	(7.1)
X Respiratory system	3,844	(4.9)	505	(1.6)	3,339	(7.0)
VI Nervous system	3,620	(4.6)	681	(2.2)	2,939	(6.2)
I Infectious and parasitic	2,636	(3.4)	459	(1.5)	2,177	(4.6)
XIII Musculoskeletal system	2,442	(3.1)	1,232	(4.0)	1,210	(2.6)
Other chapters	7,676	(9.8)	2248	(7.3)	5428	(11.4)
missing	6,293	(8.0)	6,237	(20.2)	56	(0.1)

*p-values derived from Chi2 test for distinct variables and from Mann-Whitney-U-Test test for continuous variables

Factors associated with discharge from ED after EMS transport

Figure 2 displays the proportion of cases discharged for different case characteristics. Whereas only 20.8% of cases over the age of 70 were discharged, 72.9% of cases under the age of 15 left the hospital after being seen in the ED. 45.6% of cases arriving in a paramedic-staffed ambulance were discharged, whereas only 23.0% were discharged when the ambulance crew was supported by an emergency physician. The proportion of discharged cases also varied according to dispatch keyword category, with highest discharge rates for keywords indicating the involvement of children or accidents/trauma and lowest discharge rates for keywords indicating respiratory or neurologic problems.

Figure 2: Probability of being discharged from ED after EMS transport

Figure 3: Adjusted odds ratios and confidence interval (95%) for discharge

Results from logistic regression analysis adjusting for all included variables are displayed in figure 3. After adjustment, the odds of discharge still increased with age: compared to cases over 70 years of age, cases under 15 years of age had 10 times higher odds of being discharged (OR 10.53, CI 9.31-11.92). The adjusted odds of discharge were 6% higher for women compared to men (OR 1.06, CI 1.02-1.10). Arrival between 18:00 and 8:00 (nighttime) decreased the odds of discharge by 26% (OR 0.74, CI 0.72-0.77). Compared to cases reporting a cardiovascular problem to the dispatcher,

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dispatch for intoxication or poisoning, respiratory, neurologic or gastrointestinal and unspecified internal disease decreased the odds of being discharged, whereas odds of discharge were higher in case of dispatch for accidents or trauma, when children were involved and when the reported problem was not specified by the dispatcher. When the model was stratified by age group, the strength of the association differed by age category but was reversed only for two keyword categories: Whereas dispatch for respiratory conditions was associated with discharge for cases under the age of 35, cases with respiratory problems aged 35 or older had higher odds of admission. In contrast, intoxication and poisoning led to decreased odds of discharge in younger cases but increased odds of discharge in older cases (Table 2).

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Table 2: Adjusted odds ratios and confidence interval (95%) for discharge, stratified by age category

	<15 (n= 5,075)		15-34 (n= 15,346)		35-49 (n= 10,859)		50-69 (n= 15,995)		>=70 (n= 31,028)	
	OR (CI)	p	OR (CI)	p	OR (CI)	p	OR (CI)		OR (CI)	p
Sex(female)	1,04 (0,91-1,19)	0,91	1,01 (0,94-1,09)	<0.0001	1,31 (1,2-1,42)	<0.0001	1,17 (1,09-1,26)	<0.0001	0,90 (0,85-0,96)	<0.0001
Time (18:00h - 8:00h)	0,64 (0,56- 0,73)	<0.0001	0,72 (0,67- 0,78)	<0.0001	0,74 (0,68- 0,81)	<0.0001	0,77 (0,72- 0,83)	<0.0001	0,77 (0,72- 0,82)	<0.0001
Response (with physician)	0,32 (0,28-0,37)	0,28	0,37 (0,34-0,4)	<0.0001	0,39 (0,35-0,43)	<0.0001	0,38 (0,35-0,41)	<0.0001	0,34 (0,31-0,37)	<0.0001
Dispatch keyword category										
Cardiovascular	reference		reference		reference		reference		reference	
Accident/Trauma	1,76 (1,09-2,82)	1,09	2,43 (2,19-2,71)	<0.0001	3,04 (2,72-3,41)	<0.0001	3,39 (3,05-3,7)	<0.0001	2,92 (2,69-3,18)	<0.0001
Other emergency (unspecified)	1,06 (0,56-1,98)	0,56	0,93 (0,77-1,12)	<0.0001	0,99 (0,81-1,21)	0,92	1,33 (1,1-1,56)	<0.0001	1,59 (1,36-1,85)	<0.0001
Gastrointestinal	1,89 (0,84-4,25)	0,84	0,73 (0,63-0,85)	0,42	0,73 (0,61-0,87)	<0.0001	0,76 (0,63-0,92)	<0.0001	0,87 (0,72-1,05)	0,14
Internal disease (unspecified)	1,24 (0,63-2,44)	0,63	0,65 (0,56-0,75)	<0.0001	0,97 (0,84-1,14)	0,74	0,91 (0,83-1,09)	0,46	1,03 (0,91-1,17)	0,65
Neurologic	0,86 (0,37-2,01)	0,37	0,76 (0,64-0,91)	<0.0001	1,03 (0,86-1,24)	0,73	0,74 (0,64-0,88)	<0.0001	0,62 (0,53-0,71)	<0.0001
Respiratory	1,23 (0,59-2,55)	0,59	1,24 (1,01-1,53)	<0.0001	0,95 (0,77-1,19)	0,68	0,54 (0,45-0,64)	<0.0001	0,60 (0,51-0,7)	<0.0001
Intoxication and poisoning	0,86 (0,43-1,73)	0,43	0,5 (0,44-0,57)	0,04	0,88 (0,73-1,05)	0,14	1,46 (1,2-1,77)	<0.0001	1,23 (0,74-2,03)	0,42
Other keywords	1,73 (0,77-3,86)	0,77	1,58 (1,34-1,86)	<0.0001	1,89 (1,55-2,29)	<0.0001	1,83 (1,53-2,19)	<0.0001	2,71 (2,36-3,12)	<0.0001

Dispatch keyword category "pediatric" is omitted

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Hospital diagnosis

Most diagnoses were within chapter XIX, which includes injuries, poisoning and certain other consequences of external causes (Table 1). Yet diagnoses from chapter XIX were more common for cases that were discharged (42.7% vs. 22.0 %). In contrast, diagnoses from chapter IX (diseases of the circulatory system) were more common when a case was admitted to the hospital (21.8% vs 2.6 %). Diagnoses from chapters XIX (Injury, poisoning), XVIII (not elsewhere classified) and missing diagnosis information covered 75% of all diagnoses for discharged cases, whereas diagnoses of admitted cases were distributed across different diagnosis chapters.

The most common 3-digit ICD-10 codes in case of admission were F10 (mental and behavioral disorders due to use of alcohol), S06 (intracranial injury), I10 (essential (primary) hypertension), R55 (syncope and collapse), I63 (cerebral infarction). In case of discharge, the most common codes were S01 (open wound of head), S06 (intracranial injury), S00 (superficial injury of head), R55 (syncope and collapse), F10 (mental and behavioral disorders due to use of alcohol). These five most common 3-digit ICD-10 codes accounted for about 20% of diagnosis codes in each group.

Dispatch keyword categories compared to hospital diagnoses

Tables 3 and 4 show the proportion of diagnoses from each ICD-chapter by dispatch keyword category for admitted and discharged cases. Regardless of the initial dispatch keyword, hospital diagnoses fell into many different chapters. Exceptions were dispatch for “accident/trauma” and “intoxication or poisoning”, where the majority of diagnoses (accident/trauma: chapter XIX diagnoses for 65.5% of cases when discharged, 71.6% when admitted; intoxication/poisoning: chapter XIX plus chapter V diagnoses for 66.1% of cases when discharged, 85.5% when admitted) came from compatible chapters. Diagnoses for admitted cases did match the initial dispatch keyword category more often than diagnoses for discharged cases, but still fell into different chapters. With the exception of dispatch for neurological or respiratory problems, the most common hospital diagnosis for discharged cases came from either chapter XIX (injury, poisoning) or XVIII (not elsewhere classified), regardless of dispatch keyword category. The most common ICD-codes within chapter XVIII were R55 (syncope and collapse), R07 (pain in throat and chest) R10 (Abdominal and pelvic pain) and R42 (dizziness and giddiness).

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Table 3: Distribution of diagnoses within diagnosis chapters by dispatch keyword category (%), discharged cases

	Diagnosis chapter											
Dispatch keyword category	I	V	VI	IX	X	XI	XIII	XVIII	XIX	Other	missing	total
Accident/Trauma	0.2	0.7	0.5	0.6	0.2	0.5	3.0	2.7	**65.5**	3.4	22.6	100
Cardiovascular	1.7	6.0	3.1	7.4	1.4	2.4	4.3	**28.3**	14.3	9.5	21.6	100
Internal disease (unspecified)	2.0	6.8	4.3	5.4	1.1	3.6	10.3	**19.5**	16.4	13.6	17.1	100
Neurologic	1.1	6.6	**21.5**	4.4	1.0	1.6	3.5	17.7	11.5	12.3	18.7	100
Respiratory	1.6	6.4	3.0	3.9	12.3	1.8	5.6	19.1	16.2	8.6	**21.3**	100
Other emergency (unspecified)	1,6	3,1	2,6	4,7	1,1	2,3	10,7	15	**29,9**	13,2	15,8	100
Pediatric	5.9	0.2	0.5	0.3	7.8	2.4	1.8	4.5	**57.4**	6.8	12.4	100
Gastrointestinal	4.9	1.0	0.8	1.4	0.5	15.1	3.4	**31.0**	8.4	17.9	15.5	100
Intoxication/Poisoning	0.4	**38.4**	0.3	0.4	0.3	0.3	1.8	5.4	27.7	5.7	19.1	100
Other keywords	1.7	5.7	2.3	2.6	1.1	1.6	3.4	23.2	**26.2**	11.5	20.7	100

The most common diagnosis chapter is highlighted in bold.

Table 4: Distribution of diagnoses within diagnosis chapters by dispatch keyword category (%), admitted cases

	Diagnosis chapter											
Dispatch keyword category	I	V	VI	IX	X	XI	XIII	XVIII	XIX	Other	missing	total
Accident/Trauma	1.4	3.6	2.0	6.0	1.3	1.8	3.2	4.2	**71.6**	4.8	0.2	100
Cardiovascular	5.0	4.5	4.4	**38.4**	4.5	5.4	2.2	17.6	6.7	11.1	0.1	100
Internal disease (unspecified)	9.1	5.9	5.1	19.3	6.0	10.8	5.0	9.1	6.2	**23.2**	0.1	100
Neurologic	3.8	4.9	30.6	**31.2**	3.6	2.0	1.2	8.7	3.0	10.9	0.1	100
Respiratory	5.6	2.2	2.2	28.2	**38.6**	3.6	1.5	6.0	3.1	9.0	0.2	100
Other emergency (unspecified)	5,2	5,2	5,3	**19,4**	5.0	9,2	6,6	8,2	17,3	18,5	0,2	100
Pediatric	6.6	1.2	3.8	0.5	21.4	2.5	1.0	9.1	**46.4**	7.3	0.1	100
Gastrointestinal	7.8	1.5	0.8	3.7	1.8	**50.2**	0.8	10.5	1.8	21.0	0.0	100
Intoxication/Poisoning	0.7	**69.3**	0.9	1.7	0.9	1.5	0.3	6.2	16.2	2.1	0.2	100
Other keywords	4.0	9.2	9.2	**20.8**	4.7	3.4	1.0	16.4	17.9	13.2	0.1	100

The most common diagnosis chapter is highlighted in bold.

I Infectious and parasitic IX Circulatory system V Mental and behavioral VI Nervous system X Respiratory system XI Digestive system XIII Musculoskeletal system XIX Injury, poisoning XVIII not elsewhere classified Other chapters include: VII Eye IV Endocrine, nutritional and

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metabolic XVII Congenital malformations, Blood and blood-forming organs XII Skin VIII Ear II Neoplasms XVI Originating in perinatal period XV Pregnancy, childbirth XXI Factors influencing health XX External cause

Discussion

Principal findings

Discharge on the same day following emergency medical services transport to an emergency department was associated with young age, dispatch of an ambulance without additional emergency physician support and arrival during the day. Discharge also depended on the reason for dispatch, with particularly high discharge rates for emergencies related to accidents or trauma and unspecified emergencies. Compared to admitted cases, a larger proportion of discharged cases were diagnosed with injuries or poisoning, whereas the proportion of circulatory system diseases was smaller in this group. Some diagnoses (alcohol intoxication, concussion and syncope) were frequently assigned to both admitted and discharged cases. Good agreement between dispatch keyword category and hospital diagnosis was observed after dispatch for accident/trauma and intoxication/poisoning, but not for other categories. Diagnoses of admitted cases matched the initial dispatch keyword category more often than diagnoses of discharged cases.

Strengths and weaknesses of the study

Even though a more complete investigation of the rescue chain becomes possible, few studies link dispatch and hospital data. Yet the use of routinely collected data comes along with several potential sources for bias. One of them is that 30% of dispatch records could not be linked to a hospital record because common identifiers (time stamps or patient age) were documented incorrectly or not at all. We believe that missing identifiers is due to input errors which are likely to be completely random, but we cannot rule out that lack of documentation might indicate that these

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cases were either less or more critically ill. We consider an overlap of time stamps together with an overlap of transport destination and patient age as suitable criteria to achieve adequate matches. Yet we can't rule out that false matches introduced some noise to the analyses. Another major weakness is that diagnosis information was missing for one out of five discharged cases. We therefore report the amount of missing data in all analyses and did not include hospital diagnoses in the regression model. Discharged cases are misclassified when they are admitted on another day, to another hospital or if they die in the ED. Comparison of ICD-10 diagnosis with dispatch keyword categories implies some degree of imprecision, since dispatch keywords often describe emergency situations or medical conditions rather than suspected diagnoses. We could not study patient factors which are likely to be associated with the outcome or other variables, like socioeconomic status or access to care and could not capture comorbid conditions, which are known to increase the risk of short-term adverse outcomes for time-critical 112 callers with the same complaint[13]. The study area is a metropolitan area and results might be different in rural regions or even in metropolitan areas with different pre-hospital treatment or admission practices.

Interpretations and comparison with other studies

40% of cases transported to the emergency department by emergency medical services were not admitted to the hospital. Our results are difficult to compare to results from areas with different population composition and healthcare infrastructure. This might explain why even higher discharge rates of 70% were observed in a mixed urban, suburban, and rural area in the United States,[6] where alternatives to hospital emergency care are different. Another study from the United States reports a 50% discharge rate of ambulance patients in an urban area. [17] Studies in the pre-hospital setting in Sweden and Australia have assessed more than one third of patients as not being in need of prehospital interventions or ambulance transport, despite of ambulance dispatch.[18] [19]

All of these observations correspond with discrepancies between patient perception of urgency and staff assessment.[20] Yet it is hard for dispatchers to identify callers who don't need emergent EMS care or rapid transport to the ED. The dispatch center is the earliest point of time within the rescue chain at which triage might occur, but due to limited information it is also one of the most difficult ones. [21] Yet the dispatcher plays a key role in identifying the best resources for the caller or patient, [10] and has the possibility to identify patients that might benefit from other paths of care and guide them to – eventually more appropriate - settings or hospitals at an early stage. In

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addition, a dispatcher gives medical advice and allocates ambulances and specialized prehospital units. [22] Over-triage costly can result in resources not being available to someone who needs them. On the other hand there is a high risk of adverse outcomes due to under-triage i.e. when patients are denied access to adequate treatment even though that was medically justified. Therefore most emergency response systems accept a certain level of over-triage as a safety margin. [10] [18] Appraising the need for an EMS response in retrospect is easy, but the dispatch process has to discriminate between required EMS resources and the priority of these at an very early stage [10] and still be safe. This mostly depends on the accurate assessment of the urgency of chief complaints and acute symptoms, and not on the overlap with later confirmed diagnosis or discharge from the ED. Information about hospital diagnoses and the probability of subsequent discharge is not a suitable criterion to support responses decisions in the dispatch center, as a patient may still have needed quick transport and assessment in an ED. This study was therefore not intended to investigate into the quality of EMS dispatch. Nevertheless, patient groups that are frequently discharged might be particularly interesting for further research regarding the urgency of their condition. Information about the probability of discharge may furthermore also be helpful for deciding on transport destinations and allocation of patients to hospitals when hospital beds are congested.

Age was the strongest predictor of discharge even after adjustment for other patient and dispatch characteristics. Particularly young adults and children were most likely to be discharged than older cases. Other studies also have found younger patients to be candidates for primary healthcare [7] and less likely to need paramedic treatment. [19] The decision to access ambulance and urgent care services is influenced by access to primary care, individual circumstances, perceived urgency and beliefs that resources can only be provided by a particular healthcare provider. [4] [5] These reasons were mentioned, along with a need for reassurance, the desire for a second opinion and lack of insurance, by parents who bring their child to the ED for minor illnesses. In these cases a “wait and see” approach seems especially undesirable and the accurate assessment of the child’s condition proves difficult to parents.[23] These factors may also be important for EMS missions involving children. Conversely, elderly patients usually bear a higher amount of morbidity and a higher degree of frailty. An increased probability of admission or death after transport to ED was observed for a number of dispatch codes for cases over the age of 65.[6] The lack of safe discharge arrangements for geriatric patients [24] might make hospital admission the best option, even if the acute emergency situation is resolved. Age did modify the estimates, but rather impacted on the strength

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than the direction of the association, especially when looking at dispatch keyword categories. This might be because the spectrum of disease behind the same category is probably broad. If diseases behind the same keyword category vary by age group odds ratios of discharge between keywords categories subsequently shift.

Odds of discharge were lower when emergency physicians were dispatched. We expected the presence of a physician to be a marker of severity and thus decreased likelihood of hospital discharge, as physician dispatch is triggered by a higher probability of critically ill/injured patients and invasive interventions on scene.

Arrival at night also decreased the odds of discharge. Such cases could be of higher acuity. There may also be fewer alternatives to admission available, or decision-making may be postponed due to limited diagnostic availabilities or absence of senior physicians at the ED at night.

We hypothesized that certain dispatch keyword groups would clearly mark situations or health problems that usually don't lead to subsequent hospital admission. Other studies have identified a number of situations that were less likely to lead to hospital admissions or EMS transport or were considered suitable for referral to other levels of care. They include assaults and unconsciousness or fainting in younger patients, [6] pediatric cases, psychiatric conditions, patients with low pain scores[19], nausea/vomiting/diarrhoea, seizures/epilepsy, back pain, pain during urination/haematuria, mental illness and unspecified disease.[7] Low-acuity dispatch codes included abdominal pain, assault, back pain, pregnancy and childbirth, injuries and psychiatric conditions [25] and were validated in the same area,[26] but did not turn out to be low-acuity in another community.[27] Non-transport after EMS dispatch was especially more common after assault/sexual assault, unknown problem/man down, traffic/transportation accidents, unconscious/fainting [28] and mental, behavioral and neurodevelopmental disorders [29]. Our analysis shows that, compared to dispatch for cardiovascular problems, odds of discharge were especially high for cases transported after accidents or trauma, emergencies involving children and emergencies where dispatchers did not specify the reason for dispatch. We already discussed reasons why young age might increase the odds of discharge. Higher odds of discharge after accidents and injuries might be because diagnostic resources that are only available in a hospital setting are required for a thorough examination of these cases, after which they can frequently be cleared. Injury severity and whether these patients were readmitted for elective surgery remains unknown. However, that they could initially be discharged suggests that, overall, injury severity was presumably low. A need of hospital-specific resources could also apply to emergencies where the problem can't be specified by the

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dispatcher. Determining the priority level of unclear calls is particularly difficult, and they are therefore often provided with a either lower or higher response than needed.[12][30]

There are other variables that are probably impact on discharge or distort the relationship between included variables and discharge, and not considering them has consequences for the interpretation of estimates. They were not included in the analysis as they are not available at dispatch and not part of the routine data collection, and they are usually not available at the point where prediction is needed. Two important factors are morbidity and socioeconomic status. Socioeconomic status is brings a higher burden of disease, and patients with low socioeconomic status are more likely to use acute and hospital care. [31] Socioeconomic differences between chronic diseases seem to vary, with larger disparities for stroke, diseases of the nervous system, diabetes mellitus, and arthritis.[32] Socioeconomic status is therefore likely linked with certain dispatch keyword categories and for instance low odds of discharge for neurologic keywords might partially be masked by socioeconomic status. Regardless of the initial complaint, previous illness and comorbid conditions might always complicate treatment and therefore also decrease the odds of discharge. As morbidity increases with age, a part of the effect of age might actually be traced back to comorbid conditions.

The spectrum of diseases differed between discharged and admitted cases, with a higher proportion of chapter XIX (Injury, poisoning) diagnoses in discharged and more ICD-10 chapter IX (circulatory system) diagnoses in admitted cases. Yet the degree to which dispatch keyword categories were indicative of the later diagnosis was rather low. Dispatch keywords were usually spread across many different diagnosis chapters for both admitted and discharged cases, even though discrepancies were observed a more frequently in the discharged group. Pre-hospital emergency conditions usually don't present themselves as "textbook examples".[30] Especially nonsurgical emergency patients often lack diagnosis-specific symptoms.[33] This analysis showed that keyword category and hospital diagnosis were more similar when a condition seemed easily recognizable, like accidents or trauma and intoxication or poisoning. These situations might be more intuitive for patients and bystanders to describe, and therefore bring about a better diagnostic accuracy at dispatch. However a correct assessment of urgency with limited information available at dispatch is more important than diagnostic accuracy. Some conditions are apparently easier to recognize than others and very common in both groups. They included alcohol intoxication, concussion and syncope. Distinguishing between cases with life-threatening illness and other cases, whilst putting as

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few critically ill patients as possible at risk, comes with assigning some less urgent cases a high priority. Standard operating procedures have been defined to handle these conditions in the ED [34] to safely identify patients with high risk of adverse outcomes and might be useful for standardized emergency query upon emergency call, too.

Implications for policy and practice and future research

Diverting eligible patients to other settings or hospitals could help manage the growing demand for emergency medical resources. This analysis suggests that, at least in part, dispatch information is suitable to assess the likelihood of discharge from the ED after EMS transport. However, discharge from the ED after EMS transport can't be equated with low potential for critical illness or injury or no need for pre-hospital resources. Rapid transport may be necessary to exclude worrisome differential diagnoses or to treat conditions using resources that are not available outside of a hospital setting. This analysis was not able to consider initial urgency, because a standardized assessment of different levels of urgency is not part of the dispatch process. However our findings may be useful to guide transport disposition with regard to hospital intake capacity. Young and injured patients have a high probability of discharge, and thus might be suitable for allocation to hospitals even with high bed occupancy, so that transport capacities are quickly available again. These groups might also be worth a closer look regarding the urgency of their condition. For a better evaluation of resource allocation better pre-hospital triage tools are necessary. This especially includes the assessment of acuity in addition to symptom keywords at dispatch to accurately identify patients that are not severely ill or injured. More information on discrepancies between diagnoses and acuity levels at dispatch as compared to later assessment is needed, as the pre-selection of patient groups for redirection is only viable when initial assessment and final diagnosis are sufficiently consistent.

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Competing interests

The authors declare that they have no competing interests.

Authors' contributions

KH and SP conceived the study. KH performed the analyses, interpreted the data and drafted the manuscript. HT provided input for interpretation of results and drafting of the manuscript. All authors contributed to the critical revision of the manuscript and approved its final version.

Patient consent form

Not applicable

Availability of data and material

The data used in this paper was a combination of hospital and dispatch data. Dispatch data are third party data used with permission of the Bavarian State Ministry of the Interior, Sport and Integration

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and the Bavarian social insurance agencies. Hospital data are third party data analyzed with permission of all participating hospitals. The authors do not have the permission to distribute the data.

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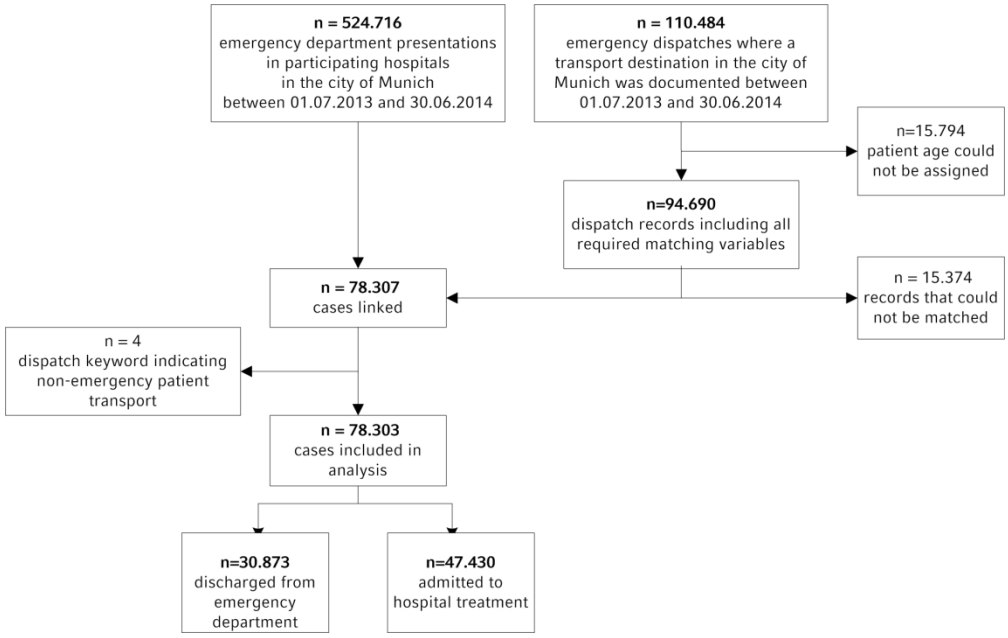

Figure 1: Study desing and case selection

170x107mm (300 x 300 DPI)

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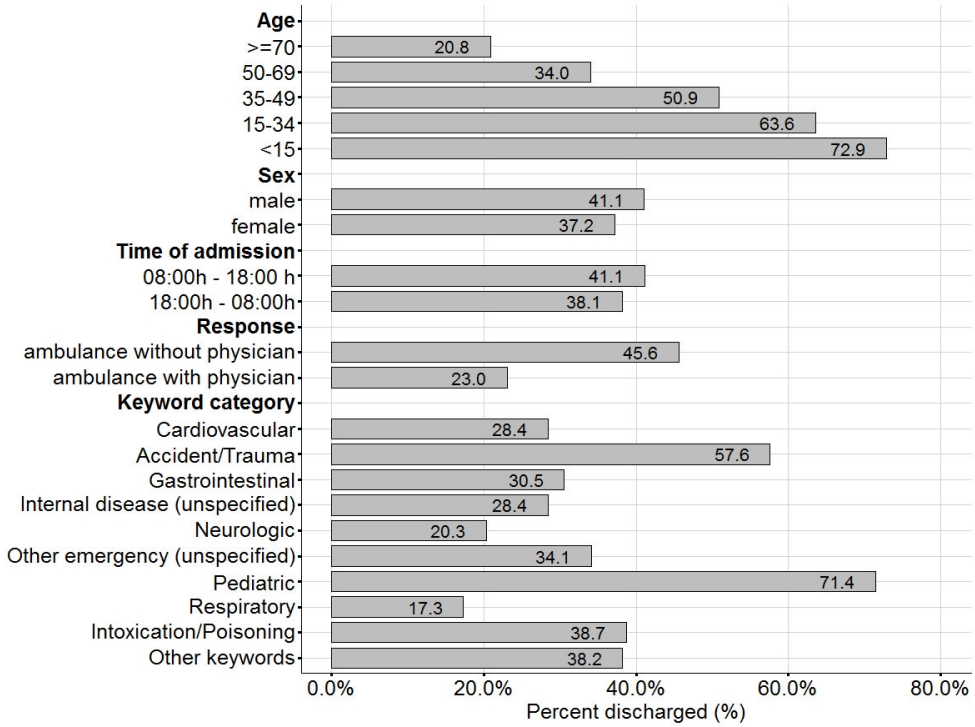

Figure 2: Probability of being discharged from ED after EMS transport

101x73mm (300 x 300 DPI)

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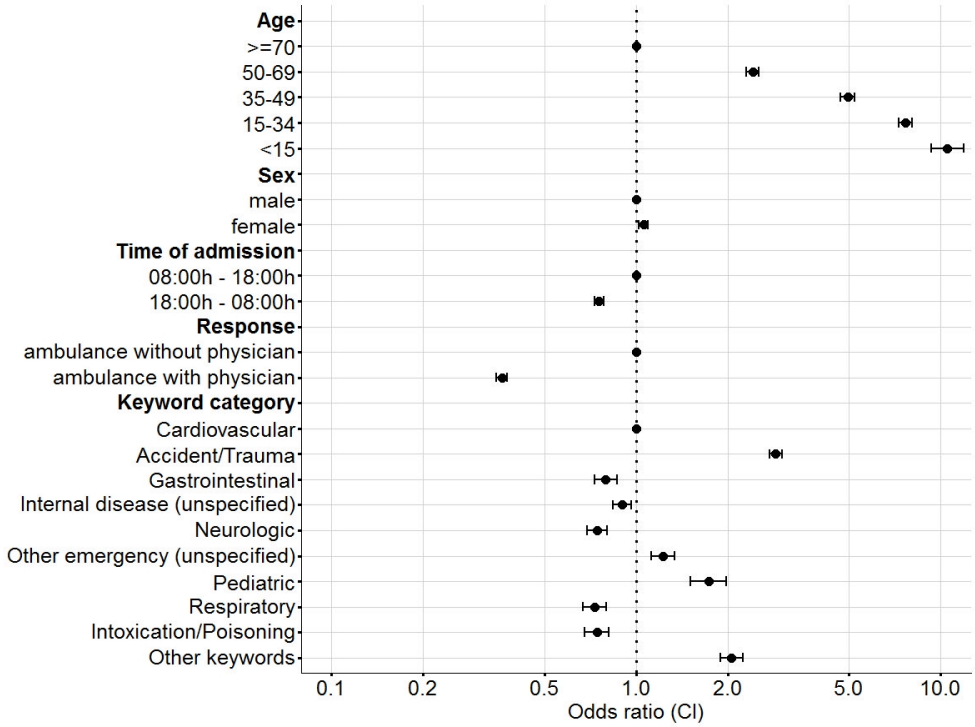

Figure 3: Adjusted odds ratios and confidence interval (95%) for discharge

101x73mm (300 x 300 DPI)

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Keyword categories and examples of assigned keywords

Accident/Trauma	Fall, traffic and other accidents
Cardiovascular	Myocardial infarction, collapse, heart complaints
Internal disease (unspecified)	Undefined problem (internal medicine)
Neurologic	Stroke, Seizure
Respiratory	Respiratory distress, asthma
Pediatric	Child sick or injured
Gastrointestinal	Abdomen, gastro-intestinal bleed
Other emergency (unspecified)	Other emergency (undefined problem)
Intoxication/Poisoning	Alcohol, drugs, medication
Other keywords	Consciousness (unconsciousness, patient without signs of life), Obstetrical/Gynecological (gynecological bleed, parturition), Person in danger (Person in need of assistance, entrapped in residence, stand by in case of fire), Suicide (Suicide and attempted suicide), Bleeding

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The RECORD statement – checklist of items, extended from the STROBE statement, that should be reported in observational studies using routinely collected health data.
Resubmission

	Item No.	STROBE items	Location in manuscript where items are reported	RECORD items	Location in manuscript where items are reported
Title and abstract					
	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found		RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included. RECORD 1.2: If applicable, the geographic region and time frame within which the study took place should be reported in the title or abstract. RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.	1.1: Page 1, line 12 1.2_ Page 1, lines 13-14 1.3: Page 1, line 12
Introduction					
Background rationale	2	Explain the scientific background and rationale for the investigation being reported			Page 3, lines 44-73
Objectives	3	State specific objectives, including any prespecified hypotheses			Page 3, lines 74-78
Methods					
Study Design	4	Present key elements of study design early in the paper			Page 4, lines 84/85
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection			Page 4, lines 84-112
Participants	6	*(a) Cohort study* - Give the		RECORD 6.1: The methods of study	6.1: Page 4/5,

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		eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study* - Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study* - Give the eligibility criteria, and the sources and methods of selection of participants *(b) Cohort study* - For matched studies, give matching criteria and number of exposed and unexposed *Case-control study* - For matched studies, give matching criteria and the number of controls per case		population selection (such as codes or algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided. RECORD 6.2: Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published elsewhere, detailed methods and results should be provided. RECORD 6.3: If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the number of individuals with linked data at each stage.	lines 116-138 figure 1 6.3: Page 4, lines 130-138, figure 1
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.		RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.	Page 5, lines 158-162
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group			Page 4/5, lines 127-130, lines 139-149
Bias	9	Describe any efforts to address potential sources of bias			

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Study size	10	Explain how the study size was arrived at			Page 4, lines 116-123
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why			Page 5, lines 129-130, 140-142
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) *Cohort study* - If applicable, explain how loss to follow-up was addressed *Case-control study* - If applicable, explain how matching of cases and controls was addressed *Cross-sectional study* - If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses			Page 5, lines 155-169, 307-315
Data access and cleaning methods		..		RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population. RECORD 12.2: Authors should provide information on the data cleaning methods used in the study.	12.1: Page 4, lines 116-120 12.2: page 4/5, lines 143-149
Linkage		..		RECORD 12.3: State whether the study	12.3: Page 4 lines

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				included person-level, institutional-level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.	130-138
Results					
Participants	13	(a) Report the numbers of individuals at each stage of the study (*e.g.*, numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed) (b) Give reasons for non-participation at each stage. (c) Consider use of a flow diagram		RECORD 13.1: Describe in detail the selection of the persons included in the study (*i.e.,* study population selection) including filtering based on data quality, data availability and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.	Page 4, lines 112-119
Descriptive data	14	(a) Give characteristics of study participants (*e.g.*, demographic, clinical, social) and information on exposures and potential confounders (b) Indicate the number of participants with missing data for each variable of interest (c) *Cohort study* - summarise follow-up time (*e.g.*, average and total amount)			Table 1
Outcome data	15	*Cohort study* - Report numbers of outcome events or summary measures over time *Case-control study* - Report numbers in each exposure category, or summary measures of exposure *Cross-sectional study* - Report numbers of outcome events or summary measures			Table 1

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Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period			Figure 2 Figure 3
Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses			Table 2
Discussion					
Key results	18	Summarise key results with reference to study objectives			Page 12, lines 288-299
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias		RECORD 19.1: Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported.	Page 12, lines 303-322
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence			Page 13, line 326 –page 16 line 443
Generalisability	21	Discuss the generalisability (external validity) of the study			Page 13 lines 321-322

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		results			
Other Information					
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based			
Accessibility of protocol, raw data, and programming code		..		RECORD 22.1: Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code.	

*Reference: Benchimol EI, Smeeth L, Guttmann A, Harron K, Moher D, Petersen I, Sørensen HT, von Elm E, Langan SM, the RECORD Working Committee. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement. *PLoS Medicine* 2015; in press.

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Title

Differences between cases admitted to hospital and discharged from the emergency department after emergency medical services transport

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Abstract

Objective: Rising emergency medical services (EMS) utilization increases transport to hospital emergency departments (ED). However, some patients receive outpatient treatment (discharged) while others are hospitalized (admitted). The aims of this analysis were to compare admitted and discharged cases, to assess whether cases that will be discharged from the ED can be identified using dispatch data and to compare dispatch keyword categories and hospital diagnoses.

Design: retrospective observational study using linked secondary data

Setting and participants: 78,303 cases brought to one of 14 ED in the city of Munich, Germany by EMS between 01.07.2013 – 30.06.2014.

Main outcome measures: Characteristics of admitted and discharged cases were assessed. Logistic regression was used to estimate the association between discharge and age, sex, time of day, ambulance type and dispatch keyword category. Keyword categories were compared to hospital diagnoses.

Results: 39.4% of cases were discharged. They were especially likely to be young (OR 10.53 (CI 9.31-11.92), comparing <15 year olds to >70 year olds) and to fall under the categories 'accidents/trauma' (OR 2.87 (CI 2.74-3.01)) or 'other emergencies (unspecified) '(OR 1.23 (CI 1.12-1.34) (compared to 'cardiovascular'). Most frequent diagnoses came from IDC-10 chapter 'injury and poisoning' (30.1%), yet these diagnoses were more frequent at discharge (42.7 vs. 22.0%) whereas circulatory system disease was less frequent (2.6% vs. 21.8%). Except for accidents/trauma and intoxication/poisoning many underlying diagnoses were observed for the same dispatch keyword

Conclusion: Young age and dispatch for accidents or trauma were the strongest predictors of discharge. Even within the same dispatch keyword category the distribution of diagnoses differed between admitted and discharged cases. Discharge from the ED does not indicate that urgent response was unnecessary. However, these cases could be suitable for allocation to hospitals with low inpatient bed capacities and are of particular interest for future studies regarding the urgency of their condition.

Strengths and limitations of this study

- Large sample which includes 78,303 cases brought to the emergency department by emergency medical services after emergency calls in an urban region
- Linkage of dispatch data with hospital data made it possible to identify which cases were in need of subsequent admission and to study hospital diagnoses of pre-hospital cases
- Main limitations are that 30% of dispatches could not be linked to hospital records, and that diagnosis information was missing for 20% of discharged cases

Introduction

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Pre-hospital emergency medical services (EMS) provide immediate medical care to acutely ill and injured patients. Demand for EMS in Germany is rising, with an increase of 105% since 2001.[1] An increase in EMS activation in both, urban and rural regions of Bavaria was observed over the past 10 years.[2] Rising use of EMS and emergency departments (ED) contributes to ED crowding and scarcity of hospital admission capacities. The negative consequences of ED crowding on patient outcomes are well established.[3] A growing proportion of ED outpatient treatments has been observed in Germany.[4] There is also evidence that emergency care and ambulance services are accessed for primary care and low-urgency health problems.[5] [6] Other studies report discharge rates after EMS transport of as high as 70% [7] and classify 16% of EMS patients as potential candidates for primary healthcare.[8] A certain amount of over-triage is accepted and expected to prevent overlooking critically ill patients that in consequence suffer from adverse outcomes, but it also consumes resources and causes unnecessary crowding of specialized resources. Reasons of and therefore solutions for ED crowding lie largely outside of the ED. [3] Whereas it is difficult to guide patients that walk into the ED, dispatchers and EMS crews are involved in the emergency care processes at an early stage and play a central role for the allocation of resources to patients and of patients to hospitals. Grusd et al. found that patients who do not need pre-hospital interventions can be identified at dispatch [9] and Eastwood et al. suggest that cases not suitable for an ED presentation can be referred to alternative care pathways after secondary telephone triage.[10]

Knowing which caller characteristics are associated with discharge from the ED and whether the dispatchers assessment of the complaints reflect later diagnoses of admitted and discharged cases might help contribute to dispatch and patient allocation decisions in patients that are less likely to need acute care beds, and point to groups that are worth a closer look regarding the suitability for other settings. The aims of this study were therefore to compare admitted and discharged cases, to assess whether information accessible at dispatch can help differentiate between cases who will need subsequent admission to a hospital and those who likely will not and to investigate differences between dispatch keywords and hospitals diagnoses of admitted and discharged cases.

Methods

Design and setting

This is a retrospective observational study using secondary data gathered for an evaluation of the provision of care by emergency departments in the city of Munich.[11] In 2014, about 1.5 Million people lived in the city of Munich. The Munich dispatch center covers an area of about 980 sqkm with 1.8 Million inhabitants.

The German health care system offers different types of emergency care in different environments. Pre-hospital medical services can be accessed via the national emergency telephone

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number 112. Calls are managed by regional dispatch centers that operate full time and coordinate emergency and non-emergency ground and air ambulances and the fire brigade. Call-takers and dispatchers are trained paramedics or firefighters who underwent dispatch training. A local, non-standardized, keyword-based dispatch manual which is mainly based on chief complaints and reported events is used to decide on the type and number of pre-hospital EMS units to be dispatched to the scene of the emergency. Levels of EMS response include ambulances designated to non-emergency transport, paramedic staffed ambulances and rapid response cars and helicopters staffed with prehospital emergency physicians. Pre-hospital emergency physicians need a specialty board certification for emergency medicine. A physician will be dispatched according to a pre-specified catalogue when vital signs are suspected to be unstable or when the condition implicates a high probability of need for invasive interventions. Physicians can also be activated at the discretion of the dispatcher for tactical reasons or when they are requested by the paramedics on site. According to suitability and intake capacity a dispatchers will suggest a hospital to which an EMS patient should be transported to. This suggestion is usually accepted by ambulance crews, although they can, in consultation with the dispatch center, decide on another destination if special medical considerations prevail. Only a physician can decide whether a patient is left on scene. If hospitals temporarily de-register to the dispatch center from acute care, EMS units have to travel to alternative locations, which usually results in longer transport times and deducts units from their home base.

A dispatcher can refer callers that do not need an EMS response to on-call or ambulatory services provided by the Association of Statutory Health Insurance. On-call doctor services can be accessed directly through 116,117 for urgent but non-emergency conditions. Patients can access all ambulatory emergency care services on their own initiative, or seek care at a hospital's emergency department.

Data sources and sample

Between 01.07.2013 and 30.06.2014, routinely collected information of all cases presenting to one of 14 emergency departments of 14 major hospitals in Munich was pooled into a study data base. Dispatch information was extracted from a database that holds routinely generated data from the computer-assisted dispatch systems of Munich´s central dispatch center and surrounding dispatch centers and billing information. During the study period, 524.716 cases presented to the 14 EDs and 110.484 emergency dispatches where a patient was transported to a destination in the city of Munich were recorded by the dispatch centers, of which 78.307 (71%) could be matched to an ED record. Four emergency dispatches were excluded, as the keywords indicated a non-emergency transport. All data was anonymized and is therefore case-, not patient-based. Repeated presentation by the same patient or EMS activation for the same patient could not be accounted for.

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Hospital data included basic case information (age, sex, admission status) and information about diagnoses (ICD-10-GM Codes). Dispatch data includes dispatch keywords, type of ambulance deployed, time stamps and receiving hospital. Billing data includes patient age, an essential identifier for the linkage of hospital and dispatch data. A probabilistic approach was used to link billing and dispatch records, and then dispatch and hospital records. Time stamps of dispatch and billing data were compared and patient age could be assigned to 86% of dispatch records. Second, patient age and admission time of dispatch and hospital records were compared. All records with an exact match of patient age and an arrival time within a 20 minute interval were linked, which was the case for 80% of records. When several records matched, the records with the smallest difference in arrival time were linked. This process was repeated for the remaining records, first through extending the admission time interval to 40 minutes, and then extending the age criterion to a 5 year range. The study design and case selection are illustrated in figure 1.

Cases were classified as discharged when there was no documentation for admission to the same hospital on the day of ED presentation. Information about admitted cases came from a standardized data set that hospitals are required to collect according to section 21 of the Hospital Remuneration Act (KHEntgG). Participating hospitals provided comparable information about discharged cases from their hospital information system. Records with identical items recorded within the first hour after admission were considered duplicates and removed from the dataset. Recording a primary diagnosis is only mandatory for admitted cases. The amount of missing data is displayed in the results section. More than one diagnosis was recorded for 5.1% of discharged cases. In this case, the diagnosis with the highest estimated resource requirement was chosen as the primary diagnosis. Since dispatch keywords are not standardized, 293 different keywords were condensed and classified into 15 categories (see supplementary material).

Figure 1: study design and case selection

Analysis

The sample was characterized by calculating medians with interquartile range (IQR) for continuous variables and frequencies and proportions for categorical variables. Statistical tests ($\chi 2$ test for categorical variables and the Wilcoxon– Mann-Whitney-U-Test for continuous variables) were performed to evaluate differences between admitted and discharged cases. The probability of discharge was calculated for case characteristics. Logistic regression was preformed to estimate the adjusted likelihood of discharge. Covariates were selected based on their availability at dispatch and included age, sex, dispatch keyword category and day and time of admission at the ED. The nine most frequent dispatch keyword categories and ICD-10 diagnosis chapters are displayed. Remaining diagnosis chapters and keyword categories are summarized as “other chapters” and “other

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keywords". Age was categorized into five groups. The final model was selected based on Akaike information criterion (AIC). [12] [13] A subgroup analysis was conducted for age groups and results from the stratified models are displayed. The frequencies of hospital diagnoses stratified by dispatch keyword category are presented in cross-tabulated tables. Analysis was performed using R statistical software (R Foundation for Statistical Computing, Vienna, AT).

Ethics and reporting

The study protocol including the description of the dataset and the data protection concept was submitted to the ethics committee of the medical faculty of the University of Munich for review (Project-No 17-530-UE). Analyses are based on retrospective data that is irreversibly anonymized. The ethical review committee therefore waived obligation to advise according to the law on faculties. The reporting of this study is in accordance with STROBE guidelines for the reporting of observational studies in epidemiology.

Patient and public involvement

Patients or the public were not involved in the design and conduct of this research.

Results

Characteristics of ED cases transported by EMS

47,430 cases (60.6%) were admitted and 30,873 (39.4%) were discharged. Characteristics of both groups are reported and compared in table 1. The comparison of admitted and discharged cases shows that discharged cases were much younger (median of 40 vs. 70 years, p <0.0001). The share of males in this group was slightly higher (47.7% vs. 44.6%, p <0.0001). Discharged cases were less frequently brought in by an ambulance assisted by emergency physicians (16.0% vs. 34.8%, p <0.0001). The most common keyword category was "Accident/Trauma" (44.7%) in case of discharge and "Cardiovascular" (27.8%) in case of admission. The most frequent diagnoses were within the main chapter XIX (Injury, Poisoning), regardless of admission status.

Table 1: Characteristics of ED cases transported by EMS

	Total		Admission status				
			discharged		admitted		p-value*
	N=78,303		n=30,873		n=47,430		
Age median (IQR)	60.0	(45)	40.0	(41)	70.0	(33)	<0.0001

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Sex n (%)							<0.0001
Male	35,888	(45.8)	14,735	(47.7)	21,153	(44.6)	
Female	35,646	(45.5)	13,249	(42.9)	22,397	(47.2)	
missing	6,769	(8.6)	2,889	(9.4)	3,880	(8.2)	
Response n (%)							<0.0001
Ambulance without physician	56,856	(72.6)	25,933	(84.0)	30,923	(65.2)	
Ambulance with physician	21,447	(27.4)	4,940	(16.0)	16,507	(34.8)	
Time of admission n (%)							<0.0001
08.00h - 18.00h	33,787	(43.1)	13,897	(45.0)	19,890	(41.9)	
18.00h - 08.00h	44,516	(56.9)	16,976	(55.0)	27,540	(58.1)	
Day of week n (%)							0.25
Monday-Friday	56,019	(71.5)	22,016	(71.3)	34,003	(71.7)	
Saturday-Sunday	22,284	(28.5)	8,857	(28.7)	13,427	(28.3)	
Dispatch keyword category n (%)							<0.0001
Accident/Trauma	23,975	(30.6)	13,810	(44.7)	10,165	(21.4)	
Cardiovascular	18,404	(23.5)	5,226	(16.9)	13,178	(27.8)	
Internal disease (unspecified)	7,112	(9.1)	2,018	(6.5)	5,094	(10.7)	
Neurologic	5,684	(7.3)	1,152	(3.7)	4,532	(9.6)	
Respiratory	5,025	(6.4)	869	(2.8)	4,156	(8.8)	
Pediatric	3,925	(5.0)	2,803	(9.1)	1,122	(2.4)	
Gastrointestinal	3,856	(4.9)	1,178	(3.8)	2,678	(5.6)	
Other emergency (unspecified)	3,449	(4.4)	1,176	(3.8)	2,273	(4.8)	
Intoxication/Poisoning	2,970	(3.8)	1,150	(3.7)	1,820	(3.8)	
Other keywords	3,903	(5.0)	1,491	(4.8)	2,412	(5.1)	
Primary ICD-10 diagnosis n (%)							<0.0001
XIX Injury, poisoning	23,592	(30.1)	13,169	(42.7)	10,423	(22.0)	
IX Circulatory system	11,115	(14.2)	792	(2.6)	10,323	(21.8)	
XVIII not elsewhere classified	8,625	(11.0)	3,695	(12.0)	4,930	(10.4)	
V Mental and behavioural disorders	4,485	(5.7)	1,258	(4.1)	3,227	(6.8)	
XI Digestive system	3,975	(5.1)	597	(1.9)	3,378	(7.1)	
X Respiratory system	3,844	(4.9)	505	(1.6)	3,339	(7.0)	
VI Nervous system	3,620	(4.6)	681	(2.2)	2,939	(6.2)	
I Infectious and parasitic	2,636	(3.4)	459	(1.5)	2,177	(4.6)	
XIII Musculoskeletal system	2,442	(3.1)	1,232	(4.0)	1,210	(2.6)	
Other chapters	7,676	(9.8)	2248	(7.3)	5428	(11.4)	

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missing	6,293	(8.0)	6,237	(20.2)	56	(0.1)

*p-values derived from Chi2 test for distinct variables and from Mann-Whitney-U-Test test for continuous variables

Factors associated with discharge from ED after EMS transport

Figure 2 displays the proportion of cases discharged for different case characteristics. Whereas only 20.8% of cases over the age of 70 were discharged, 72.9% of cases under the age of 15 left the hospital after being seen in the ED. 45.6% of cases arriving in a paramedic-staffed ambulance were discharged, whereas only 23.0% were discharged when the ambulance crew was supported by an emergency physician. The proportion of discharged cases also varied according to dispatch keyword category, with highest discharge rates for keywords indicating the involvement of children or accidents/trauma and lowest discharge rates for keywords indicating respiratory or neurologic problems.

Figure 2: Probability of being discharged from ED after EMS transport

Figure 3: Adjusted odds ratios and confidence interval (95%) for discharge

Results from logistic regression analysis adjusting for all included variables are displayed in figure 3. After adjustment, the odds of discharge still increased with age: compared to cases over 70 years of age, cases under 15 years of age had 10 times higher odds of being discharged (OR 10.53, CI 9.31-11.92). The adjusted odds of discharge were 6% higher for women compared to men (OR 1.06, CI 1.02-1.10). Arrival between 18:00 and 8:00 (nighttime) decreased the odds of discharge by 26% (OR 0.74, CI 0.72-0.77). Compared to cases reporting a cardiovascular problem to the dispatcher, dispatch for intoxication or poisoning, respiratory, neurologic or gastrointestinal and unspecified internal disease decreased the odds of being discharged, whereas odds of discharge were higher in case of dispatch for accidents or trauma, when children were involved and when the reported problem was not specified by the dispatcher. When the model was stratified by age group, the strength of the association differed by age category but was reversed only for two keyword categories: Whereas dispatch for respiratory conditions was associated with discharge for cases under the age of 35, cases with respiratory problems aged 35 or older had higher odds of admission. In contrast, intoxication and poisoning led to decreased odds of discharge in younger cases but increased odds of discharge in older cases (Table 2).

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Table 2: Adjusted odds ratios and confidence interval (95%) for discharge, stratified by age category

	<15 (n= 5,075)		15-34 (n= 15,346)		35-49 (n= 10,859)		50-69 (n= 15,995)		>=70 (n= 31,028)	
	OR (CI)	p	OR (CI)	p	OR (CI)	p	OR (CI)		OR (CI)	p
Sex(female)	1,04 (0,91-1,19)	0,91	1,01 (0,94-1,09)	<0.0001	1,31 (1,2-1,42)	<0.0001	1,18 (1,09-1,26)	<0.0001	0,90 (0,85-0,96)	<0.0001
Time (18:00h - 8:00h)	0,64 (0,56- 0,73)	<0.0001	0,72 (0,67- 0,78)	<0.0001	0,74 (0,68- 0,81)	<0.0001	0,77 (0,72- 0,83)	<0.0001	0,77 (0,72- 0,82)	<0.0001
Response (with physician)	0,32 (0,28-0,37)	0,28	0,37 (0,34-0,4)	<0.0001	0,39 (0,35-0,43)	<0.0001	0,38 (0,35-0,41)	<0.0001	0,34 (0,31-0,37)	<0.0001
Dispatch keyword category										
Cardiovascular	reference		reference		reference		reference		reference	
Accident/Trauma	1,76 (1,09-2,82)	1,09	2,43 (2,19-2,71)	<0.0001	3,04 (2,72-3,41)	<0.0001	3,4 (3,05-3,7)	<0.0001	2,92 (2,69-3,18)	<0.0001
Other emergency (unspecified)	1,06 (0,56-1,98)	0,56	0,93 (0,77-1,12)	<0.0001	0,99 (0,81-1,21)	0,92	1,3 (1,1-1,56)	<0.0001	1,59 (1,36-1,85)	<0.0001
Gastrointestinal	1,89 (0,84-4,25)	0,84	0,73 (0,63-0,85)	0,42	0,73 (0,61-0,87)	<0.0001	0,76 (0,63-0,92)	<0.0001	0,87 (0,72-1,05)	0,14
Internal disease (unspecified)	1,24 (0,63-2,44)	0,63	0,65 (0,56-0,75)	<0.0001	0,97 (0,84-1,14)	0,74	0,95 (0,83-1,09)	0,46	1,03 (0,91-1,17)	0,65
Neurologic	0,86 (0,37-2,01)	0,37	0,76 (0,64-0,91)	<0.0001	1,03 (0,86-1,24)	0,73	0,75 (0,64-0,88)	<0.0001	0,62 (0,53-0,71)	<0.0001
Respiratory	1,23 (0,59-2,55)	0,59	1,24 (1,01-1,53)	<0.0001	0,95 (0,77-1,19)	0,68	0,54 (0,45-0,64)	<0.0001	0,60 (0,51-0,7)	<0.0001
Intoxication and poisoning	0,86 (0,43-1,73)	0,43	0,5 (0,44-0,57)	0,04	0,88 (0,73-1,05)	0,14	1,4 (1,2-1,77)	<0.0001	1,23 (0,74-2,03)	0,42
Other keywords	1,73 (0,77-3,86)	0,77	1,58 (1,34-1,86)	<0.0001	1,89 (1,55-2,29)	<0.0001	1,8 (1,53-2,19)	<0.0001	2,71 (2,36-3,12)	<0.0001

Dispatch keyword category "pediatric" is omitted

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Hospital diagnoses

Most diagnoses were within chapter XIX, which includes injuries, poisoning and certain other consequences of external causes (Table 1). Yet diagnoses from chapter XIX were more common for cases that were discharged (42.7% vs. 22.0 %). In contrast, diagnoses from chapter IX (diseases of the circulatory system) were more common when a case was admitted to the hospital (21.8% vs 2.6 %). Diagnoses from chapters XIX (Injury, poisoning), XVIII (not elsewhere classified) and missing diagnosis information covered 75% of all diagnoses for discharged cases, whereas diagnoses of admitted cases were distributed across different diagnosis chapters.

The most five common 3-digit ICD-10 codes in case of admission were F10 (mental and behavioral disorders due to use of alcohol), S06 (intracranial injury), I10 (essential (primary) hypertension), R55 (syncope and collapse), I63 (cerebral infarction). In case of discharge, the most common codes were S01 (open wound of head), S06 (intracranial injury), S00 (superficial injury of head), R55 (syncope and collapse), F10 (mental and behavioral disorders due to use of alcohol). These five most common 3-digit ICD-10 codes accounted for about 20% of diagnosis codes in each group.

Dispatch keyword categories compared to hospital diagnoses

Tables 3 and 4 show the proportion of diagnoses from each ICD-chapter by dispatch keyword category for admitted and discharged cases. Regardless of the initial dispatch keyword, hospital diagnoses fell into many different chapters. Exceptions were dispatch for “accident/trauma” and “intoxication or poisoning”, where the majority of diagnoses (accident/trauma: chapter XIX diagnoses for 65.5% of cases when discharged, 71.6% when admitted; intoxication/poisoning: chapter XIX plus chapter V diagnoses for 66.1% of cases when discharged, 85.5% when admitted) came from compatible chapters. Diagnoses for admitted cases did match the initial dispatch keyword category more often than diagnoses for discharged cases, but still fell into different chapters. The distribution of diagnosis chapters differs between admitted and discharged cases, even within the same keyword category. With the exception of dispatch for neurological or respiratory problems, the most common hospital diagnosis for discharged cases came from either chapter XIX (injury, poisoning) or XVIII (not elsewhere classified), regardless of dispatch keyword category. The most common ICD-codes within chapter XVIII were R55 (syncope and collapse), R07 (pain in throat and chest) R10 (Abdominal and pelvic pain) and R42 (dizziness and giddiness).

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Table 3: Distribution of diagnoses within diagnosis chapters by dispatch keyword category (%), discharged cases

	Diagnosis chapter											
Dispatch keyword category	I	V	VI	IX	X	XI	XIII	XVIII	XIX	Other	missing	total
Accident/Trauma	0.2	0.7	0.5	0.6	0.2	0.5	3.0	2.7	**65.5**	3.4	22.6	100
Cardiovascular	1.7	6.0	3.1	7.4	1.4	2.4	4.3	**28.3**	14.3	9.5	21.6	100
Internal disease (unspecified)	2.0	6.8	4.3	5.4	1.1	3.6	10.3	**19.5**	16.4	13.6	17.1	100
Neurologic	1.1	6.6	**21.5**	4.4	1.0	1.6	3.5	17.7	11.5	12.3	18.7	100
Respiratory	1.6	6.4	3.0	3.9	12.3	1.8	5.6	19.1	16.2	8.6	**21.3**	100
Other emergency (unspecified)	1,6	3,1	2,6	4,7	1,1	2,3	10,7	15	**29,9**	13,2	15,8	100
Pediatric	5.9	0.2	0.5	0.3	7.8	2.4	1.8	4.5	**57.4**	6.8	12.4	100
Gastrointestinal	4.9	1.0	0.8	1.4	0.5	15.1	3.4	**31.0**	8.4	17.9	15.5	100
Intoxication/Poisoning	0.4	**38.4**	0.3	0.4	0.3	0.3	1.8	5.4	27.7	5.7	19.1	100
Other keywords	1.7	5.7	2.3	2.6	1.1	1.6	3.4	23.2	**26.2**	11.5	20.7	100

The most common diagnosis chapter is highlighted in bold.

Table 4: Distribution of diagnoses within diagnosis chapters by dispatch keyword category (%), admitted cases

	Diagnosis chapter											
Dispatch keyword category	I	V	VI	IX	X	XI	XIII	XVIII	XIX	Other	missing	total
Accident/Trauma	1.4	3.6	2.0	6.0	1.3	1.8	3.2	4.2	**71.6**	4.8	0.2	100
Cardiovascular	5.0	4.5	4.4	**38.4**	4.5	5.4	2.2	17.6	6.7	11.1	0.1	100
Internal disease (unspecified)	9.1	5.9	5.1	19.3	6.0	10.8	5.0	9.1	6.2	**23.2**	0.1	100
Neurologic	3.8	4.9	30.6	**31.2**	3.6	2.0	1.2	8.7	3.0	10.9	0.1	100
Respiratory	5.6	2.2	2.2	28.2	**38.6**	3.6	1.5	6.0	3.1	9.0	0.2	100
Other emergency (unspecified)	5,2	5,2	5,3	**19,4**	5.0	9,2	6,6	8,2	17,3	18,5	0,2	100
Pediatric	6.6	1.2	3.8	0.5	21.4	2.5	1.0	9.1	**46.4**	7.3	0.1	100
Gastrointestinal	7.8	1.5	0.8	3.7	1.8	**50.2**	0.8	10.5	1.8	21.0	0.0	100
Intoxication/Poisoning	0.7	**69.3**	0.9	1.7	0.9	1.5	0.3	6.2	16.2	2.1	0.2	100
Other keywords	4.0	9.2	9.2	**20.8**	4.7	3.4	1.0	16.4	17.9	13.2	0.1	100

The most common diagnosis chapter is highlighted in bold.

I Infectious and parasitic IX Circulatory system V Mental and behavioral VI Nervous system X Respiratory system XI Digestive system XIII Musculoskeletal system XIX Injury, poisoning XVIII not elsewhere classified Other chapters include: VII Eye IV Endocrine, nutritional and metabolic XVII Congenital malformations, Blood and blood-forming organs XII Skin VIII Ear II Neoplasms XVI Originating in perinatal period XV Pregnancy, childbirth XXI Factors influencing health XX External cause

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Discussion

Principal findings

Discharge on the same day following emergency medical services transport to an emergency department was associated with young age, dispatch of an ambulance without additional emergency physician support and arrival during the day. Discharge also was dependent on the dispatch keyword, with particularly high discharge rates for emergencies related to accidents or trauma and unspecified emergencies. A broad range of underlying diagnoses was observed for almost all dispatch keyword categories. Keywords and diagnoses were more similar when a condition seemed easily recognizable, like accidents or trauma and intoxication or poisoning. The distribution of diagnosis chapters differed between admitted and discharged cases, usually even within the same keyword category. Compared to admitted cases, a larger proportion of discharged cases were diagnosed with injuries or poisoning, whereas the proportion of circulatory system diseases was smaller in this group. Some diagnoses (alcohol intoxication, concussion and syncope) were frequently assigned to both, admitted and discharged cases

Strengths and weaknesses of the study

Even though it allows a more complete investigation of the rescue chain, few studies link dispatch and hospital data. The use of routinely collected data comes along with several potential sources for bias. One of them is that 30% of dispatch records could not be linked to a hospital record because common identifiers (time stamps or patient age) were documented incorrectly or not at all. We believe that missing identifiers is due to input errors which are likely to be completely random, but we cannot rule out that lack of documentation might indicate that these cases were either less or more critically ill. We consider an overlap of time stamps together with an overlap of transport destination and patient age as suitable criteria to achieve adequate matches. Yet we can't rule out that false matches introduced some noise to the analyses. Another major weakness is that diagnosis information was missing for one out of five discharged cases because it is not relevant for reimbursement of these cases and not all hospitals ensure that diagnosis information of patients discharged from the ED is routinely documented. We therefore report the amount of missing data in all analyses and did not include hospital diagnoses in the regression model. Discharged cases are misclassified when they are admitted on another day, to another hospital or if they die in the ED. Comparison of ICD-10 diagnosis with dispatch keyword categories implies some degree of imprecision, since dispatch keywords often describe emergency situations or medical conditions rather than suspected diagnoses. We could not study patient factors which are likely to be associated with the outcome or other variables, like socioeconomic status or access to care and

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could not capture comorbid conditions, which are known to increase the risk of short-term adverse outcomes for time-critical 112 callers with the same complaint[14]. The study area is a metropolitan area and results might be different in rural regions or even in metropolitan areas with different pre-hospital treatment or admission practices.

Interpretations and comparison with other studies

40% of cases transported to the emergency department by emergency medical services were not admitted to the hospital. Our results can't be transferred to areas with different population composition and healthcare infrastructure. This might explain why even higher discharge rates of 70% were observed in a mixed urban, suburban, and rural area in the United States,[7] where alternatives to hospital emergency care are different. Another study from the United States reports a 50% discharge rate of ambulance patients in an urban area. [15] Studies in the pre-hospital setting in Sweden and Australia have assessed more than one third of patients as not being in need of prehospital interventions or ambulance transport, despite of ambulance dispatch.[16] [17]

Age was the strongest predictor of discharge even after adjustment for other patient and dispatch characteristics. Particularly young adults and children were most likely to be discharged than older cases. Other studies have found younger patients to be candidates for primary healthcare [8] and less likely to need paramedic treatment. [17] The decision to access ambulance and urgent care services is influenced by access to primary care, individual circumstances, perceived urgency and beliefs that resources can only be provided by a particular healthcare provider. [5] [6] These reasons were mentioned, along with a need for reassurance, the desire for a second opinion and lack of insurance, by parents who bring their child to the ED for minor illnesses. In these cases a "wait and see" approach seems especially undesirable and the accurate assessment of the child's condition proves difficult to parents.[18] These factors may also be important for EMS missions involving children. Conversely, elderly patients usually bear a higher amount of morbidity and a higher degree of frailty. An increased probability of admission or death after transport to ED was observed for a number of dispatch codes for cases over the age of 65.[7] The lack of safe discharge arrangements for geriatric patients [19] might make hospital admission the best option, even if the acute emergency situation is resolved. Age did modify the estimates, but rather impacted on the strength than the direction of the association, especially when looking at dispatch keyword categories. This might be because the spectrum of disease behind the same category is probably broad. If diseases behind the same keyword category vary by age group odds ratios of discharge between keywords categories subsequently shift.

Odds of discharge were lower when emergency physicians were dispatched. We expected the presence of a physician to be a marker of severity and thus decreased likelihood of hospital

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discharge, as physician dispatch is triggered by a higher probability of critically ill/injured patients and invasive interventions on scene.

Arrival at night also decreased the odds of discharge. Such cases could be of higher acuity. There may also be fewer alternatives to admission available, or decision-making may be postponed due to limited diagnostic availabilities or absence of senior physicians at the ED at night.

We hypothesized that certain dispatch keyword groups would clearly mark situations or health problems that usually don't lead to subsequent hospital admission. Other studies have identified a number of situations that were less likely to lead to hospital admissions or EMS transport or were considered suitable for referral to other levels of care. They include assaults and unconsciousness or fainting in younger patients, [7] pediatric cases, psychiatric conditions, patients with low pain scores[17], nausea/vomiting/diarrhoea, seizures/epilepsy, back pain, pain during urination/haematuria, mental illness and unspecified disease.[8] Low-acuity dispatch codes included abdominal pain, assault, back pain, pregnancy and childbirth, injuries and psychiatric conditions [20] and were validated in the same area,[21] but did not turn out to be low-acuity in another community.[22] Non-transport after EMS dispatch was especially more common after assault/sexual assault, unknown problem/man down, traffic/transportation accidents, unconscious/fainting [23] and mental, behavioral and neurodevelopmental disorders [24]. Our analysis shows that, compared to dispatch for cardiovascular problems, odds of discharge were especially high for cases transported after accidents or trauma, emergencies involving children and emergencies where dispatchers did not specify the reason for dispatch. We already discussed reasons why young age might increase the odds of discharge. Higher odds of discharge after accidents and injuries might be because diagnostic resources that are only available in a hospital setting are required for a thorough examination of these cases, after which they can frequently be cleared. Injury severity and whether these patients were readmitted for elective surgery remains unknown. However, that they could initially be discharged suggests that, overall, injury severity was presumably low. A need of hospital-specific resources could also apply to emergencies where the problem can't be specified by the dispatcher. Determining the priority level of unclear calls is particularly difficult, and they are therefore often provided with a either lower or higher response than needed.[25][26]

The spectrum of disease differed between discharged and admitted cases, with a higher proportion of chapter XIX (Injury, poisoning) diagnoses in discharged and more ICD-10 chapter IX (circulatory system) diagnoses in admitted cases. Except for two keyword categories (accident/trauma and intoxication/poisoning), a broad range of underlying diagnoses was reflected by the same initial complaint for both admitted and discharged patients. Keyword category and hospital diagnosis were more similar when a condition seemed easily recognizable, like accidents or trauma and intoxication or poisoning. These situations might be more intuitive for patients and bystanders to describe. Discrepancies between keyword and diagnosis might point to patient groups that are

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probably more difficult to manage and were observed slightly more frequently for discharged cases. The distribution of cases across diagnosis chapters differed between admitted and discharged cases, even within the same keyword category. This suggests that the disease spectrum of both groups differs, even if similar complaints are initially expressed.

At dispatch, the correct assessment of urgency is more important than diagnostic accuracy. Still, complaints influence patient management. Pre-hospital emergency conditions usually don't present themselves as "textbook examples". [26] Especially nonsurgical emergency patients often lack diagnosis-specific symptoms. [27] The analyses show that some conditions are very common in both groups. They included alcohol intoxication, concussion and syncope. Standard operating procedures have been defined to handle these conditions in the ED [28] to safely identify patients with high risk of adverse outcomes and might be useful for a standardized assessment of emergency calls as well.

The dispatch center is the earliest point of time in the rescue chain at which triage might occur, but due to limited information it is also one of the most difficult ones. [29] Most emergency response systems accept a certain level of over-triage as a safety margin. [30] [16] but over-triage is also costly can result in resources not being available to someone who needs them. The dispatcher allocates ambulances and specialized prehospital units [31] and plays a key role in identifying the best resources for the caller or patient. [30] mostly depends on an accurate assessment of the urgency and acute symptoms, and not on the overlap of dispatch data with later confirmed diagnosis or discharge from the ED. Odds of discharge and overlap with diagnosis are therefore not suitable to assess the quality of response decisions and not good criteria to base response decisions on. Yet patient groups that are frequently discharged could be of particular interest or further more detailed analyses with regard to the urgency of their conditions. Information about the probability of discharge may furthermore be helpful to allocate of patients to hospitals when hospital beds are congested.

There are other variables that probably impact on discharge or distort the relationship between included variables and discharge, and not considering them has consequences for the interpretation of estimates. They were not included in the analysis as they are not available at dispatch and not part of the routine data collection, and they are usually not available at the point where a response decision is made. Two important factors are morbidity and socioeconomic status. Socioeconomic status is brings a higher burden of disease, and patients with low socioeconomic status are more likely to use acute and hospital care. [32] Socioeconomic differences between chronic diseases seem to vary, with larger disparities for stroke, diseases of the nervous system, diabetes mellitus, and arthritis.[33] Socioeconomic status is therefore likely linked with certain dispatch keyword categories and for instance low odds of discharge for neurologic keywords might partially be masked by socioeconomic status. Regardless of the initial complaint, previous illness and comorbid conditions

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might always complicate treatment and therefore also decrease the odds of discharge. As morbidity increases with age, a part of the effect of age might actually be traced back to comorbid conditions.

Conclusion

Discharge was especially likely when patients were young or after dispatch for accidents/trauma. Except for accidents/trauma and intoxication/poisoning many underlying diagnoses were observed within dispatch categories. Even within the same dispatch keyword category, the distribution of hospital diagnoses differed between admitted and discharged cases, indicating a differing spectrum of disease. Discharge from the emergency department after emergency medical services transport can't be equated with low potential for critical illness or injury or no need for pre-hospital resources. Rapid transport may be necessary to exclude worrisome differential diagnoses or to treat conditions using resources that are not available outside of a hospital setting. Yet the findings could guide allocation of ambulances to hospitals when hospital bed capacities are low, so that transport capacities are quickly available again. Frequently discharged patients are also worth a closer look regarding the urgency of their condition to manage the growing demand for emergency medical resources. To accurately identify patients that are not severely ill or injured and for a better evaluation of resource allocation, acuity should be assessed in addition to symptom keywords at dispatch.

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Competing interests

The authors declare that they have no competing interests.

Authors' contributions

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KH and SP conceived the study. KH performed the analyses, interpreted the data and drafted the manuscript. HT provided input for interpretation of results and drafting of the manuscript. All authors contributed to the critical revision of the manuscript and approved its final version.

Patient consent form

Not applicable

Availability of data and material

The data used in this paper was a combination of hospital and dispatch data. Dispatch data are third party data used with permission of the Bavarian State Ministry of the Interior, Sport and Integration and the Bavarian social insurance agencies. Hospital data are third party data analyzed with permission of all participating hospitals. The authors do not have the permission to distribute the data.

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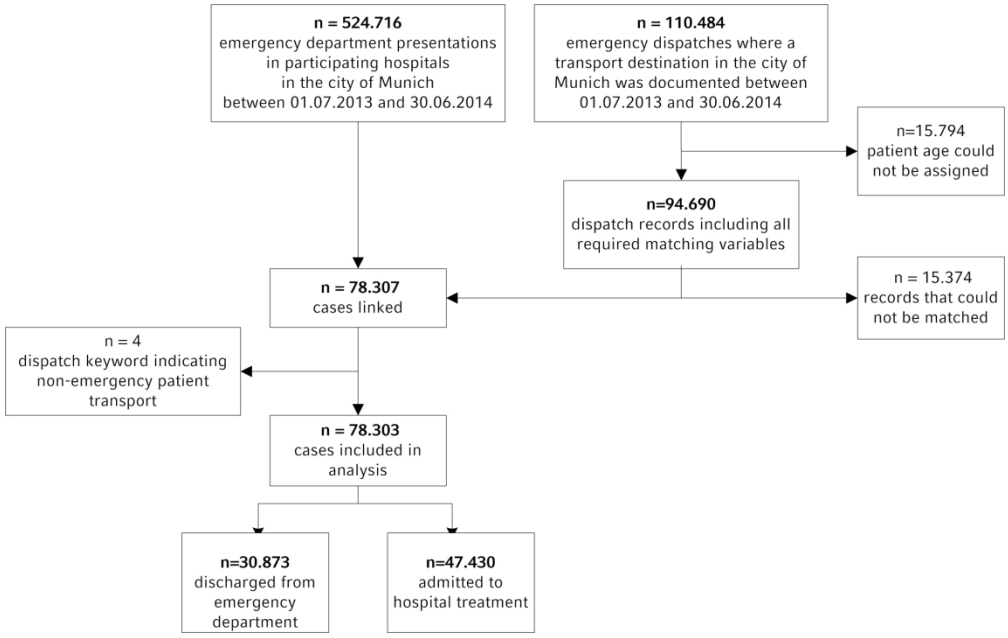

Figure 1: Study desing and case selection

170x107mm (300 x 300 DPI)

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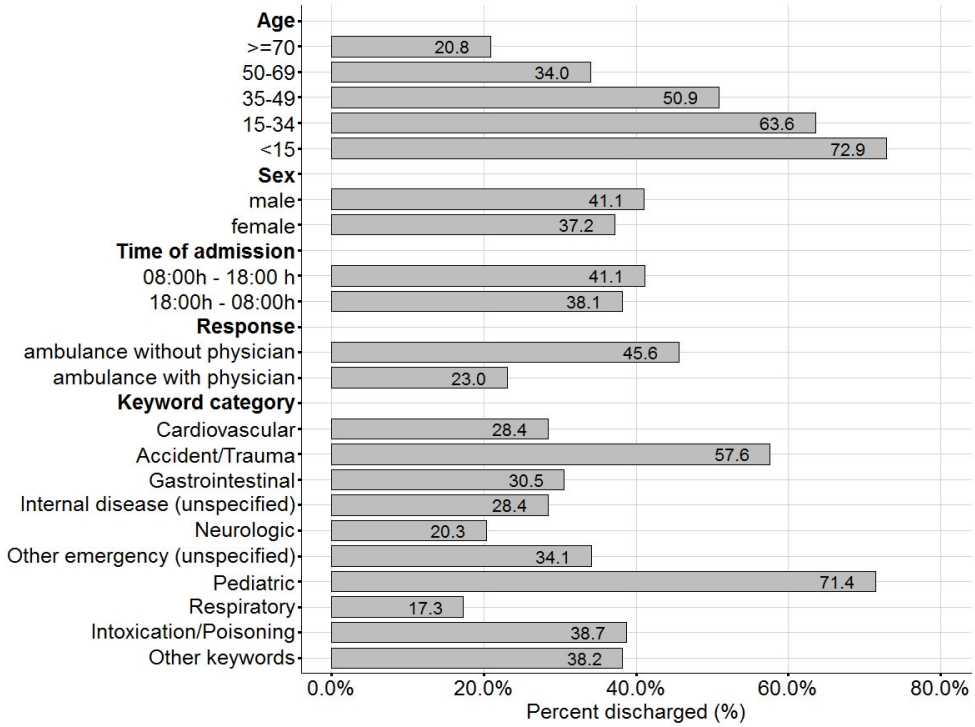

Figure 2: Probability of being discharged from ED after EMS transport

101x73mm (300 x 300 DPI)

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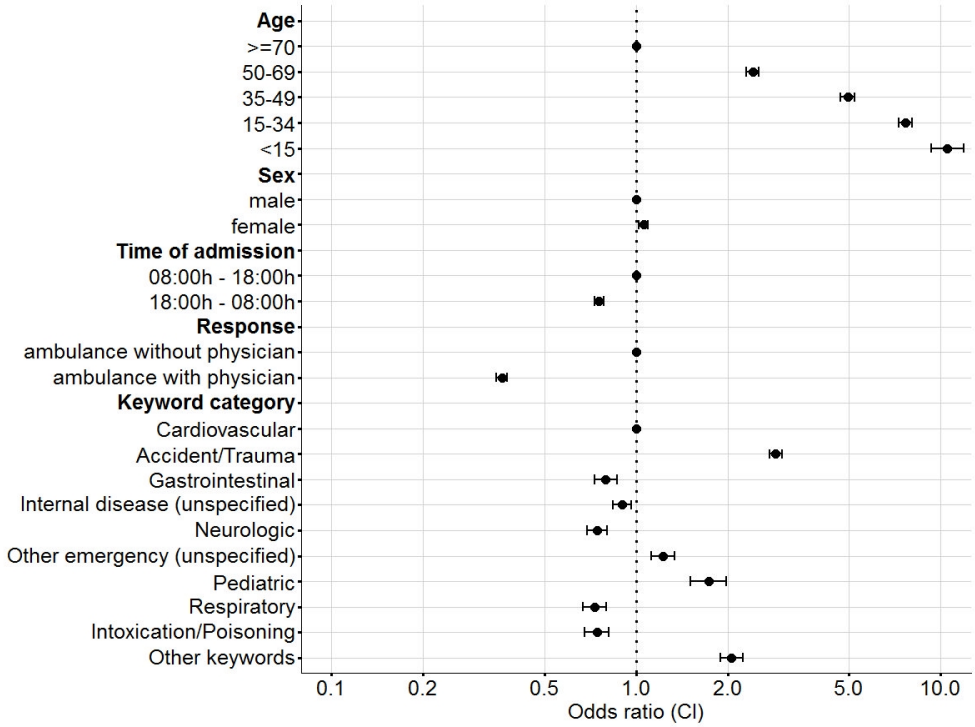

Figure 3: Adjusted odds ratios and confidence interval (95%) for discharge

101x73mm (300 x 300 DPI)

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Keyword categories and examples of assigned keywords

Accident/Trauma	Fall, traffic and other accidents
Cardiovascular	Myocardial infarction, collapse, heart complaints
Internal disease (unspecified)	Undefined problem (internal medicine)
Neurologic	Stroke, Seizure
Respiratory	Respiratory distress, asthma
Pediatric	Child sick or injured
Gastrointestinal	Abdomen, gastro-intestinal bleed
Other emergency (unspecified)	Other emergency (undefined problem)
Intoxication/Poisoning	Alcohol, drugs, medication
Other keywords	Consciousness (unconsciousness, patient without signs of life), Obstetrical/Gynecological (gynecological bleed, parturition), Person in danger (Person in need of assistance, entrapped in residence, stand by in case of fire), Suicide (Suicide and attempted suicide), Bleeding

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The RECORD statement – checklist of items, extended from the STROBE statement, that should be reported in observational studies using routinely collected health data.
Resubmission

	Item No.	STROBE items	Location in manuscript where items are reported	RECORD items	Location in manuscript where items are reported
Title and abstract					
	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found		RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included. RECORD 1.2: If applicable, the geographic region and time frame within which the study took place should be reported in the title or abstract. RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.	1.1: Page 1, line 7 1.2_ Page 1, lines 8-9 1.3: Page 1, line 7
Introduction					
Background rationale	2	Explain the scientific background and rationale for the investigation being reported			Page 2, lines 40-58
Objectives	3	State specific objectives, including any prespecified hypotheses			Page 2, lines 59-66
Methods					
Study Design	4	Present key elements of study design early in the paper			Page 2, lines 871/72
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection			Page 3/4, lines 104-137
Participants	6	*(a) Cohort study* - Give the		RECORD 6.1: The methods of study	6.1: Page 3/4,

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		eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study* - Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study* - Give the eligibility criteria, and the sources and methods of selection of participants *(b) Cohort study* - For matched studies, give matching criteria and number of exposed and unexposed *Case-control study* - For matched studies, give matching criteria and the number of controls per case		population selection (such as codes or algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided. RECORD 6.2: Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published elsewhere, detailed methods and results should be provided. RECORD 6.3: If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the number of individuals with linked data at each stage.	lines 104-114 figure 1 6.3: Page 4, lines 118-126 , figure 1
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.		RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.	Page 5, lines 149-152
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group			Page 4, lines 115-118, lines 104-208
Bias	9	Describe any efforts to address potential sources of bias			

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Study size	10	Explain how the study size was arrived at			Page 4, lines 116-123
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why			Page 4/5, lines 108-111
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) *Cohort study* - If applicable, explain how loss to follow-up was addressed *Case-control study* - If applicable, explain how matching of cases and controls was addressed *Cross-sectional study* - If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses			Page 4/5, lines 143-157
Data access and cleaning methods		..		RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population. RECORD 12.2: Authors should provide information on the data cleaning methods used in the study.	12.1: Page 3, lines 104-108 12.2: page 4, lines 127-137
Linkage		..		RECORD 12.3: State whether the study	12.3: Page 4 lines

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				included person-level, institutional-level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.	118
Results					
Participants	13	(a) Report the numbers of individuals at each stage of the study (*e.g.*, numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed) (b) Give reasons for non-participation at each stage. (c) Consider use of a flow diagram		RECORD 13.1: Describe in detail the selection of the persons included in the study (*i.e.,* study population selection) including filtering based on data quality, data availability and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.	Page 3/4, lines 104-111
Descriptive data	14	(a) Give characteristics of study participants (*e.g.*, demographic, clinical, social) and information on exposures and potential confounders (b) Indicate the number of participants with missing data for each variable of interest (c) *Cohort study* - summarise follow-up time (*e.g.*, average and total amount)			Table 1
Outcome data	15	*Cohort study* - Report numbers of outcome events or summary measures over time *Case-control study* - Report numbers in each exposure category, or summary measures of exposure *Cross-sectional study* - Report numbers of outcome events or summary measures			Table 1

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Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period			Figure 2 Figure 3
Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses			Table 2
Discussion					
Key results	18	Summarise key results with reference to study objectives			Page 12, lines 271-282
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias		RECORD 19.1: Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported.	Page 12/13, lines 286-307
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence			Page 13, line 311 –page 16 line 418
Generalisability	21	Discuss the generalisability (external validity) of the study			Page 13 lines 305-307

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		results			
Other Information					
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based			Page 18/19 lines 522-525
Accessibility of protocol, raw data, and programming code		..		RECORD 22.1: Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code.	

*Reference: Benchimol EI, Smeeth L, Guttmann A, Harron K, Moher D, Petersen I, Sørensen HT, von Elm E, Langan SM, the RECORD Working Committee. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement. *PLoS Medicine* 2015; in press.

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