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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

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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

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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3 74 The German health care system offers different types of emergency care in different
4 75 environments. Pre-hospital medical services can be accessed via the national emergency telephone
5 76 number 112. Calls are managed by regional dispatch centers. Dispatchers use a keyword-based
6 77 protocol to decide on the type and number of pre-hospital EMS units to be dispatched to the scene
7 78 of the emergency. Levels of response include ambulances designated to non-emergency transport,
8 79 paramedic staffed ambulances and rapid response cars staffed with prehospital emergency
9 80 physicians. A physician will be dispatched according to a pre-specified catalogue when vital signs
10 81 are suspected to be unstable or when the condition implicates a high probability of need for
11 82 invasive interventions. Callers that do not need emergency medical transport can be passed on to
12 83 ambulatory services provided by the Association of Statutory Health Insurance. Patients can also
13 84 access ambulatory emergency care services on their own initiative, or seek care at a hospital's
14 85 emergency department.
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23 87 Data sources and sample 24 25

26 89 Between 01.07.2013 and 30.06.2014, routinely collected information of all cases presenting to one of
27 90 14 emergency departments of 14 major hospitals in Munich was pooled into a study data base.
28 91 Dispatch information was extracted from a database that holds routinely generated data from the
29 92 computer-assisted dispatch system of Munich's central dispatch center and billing information.
30 93 During the study period, 524.716 cases presented to the 14 EDs and 110.484 emergency dispatches
31 94 were recorded by the dispatch center, of which 78.307 (71%) could be matched to an ED record.
32 95 Four emergency dispatches were excluded, as the keyword indicated a non-emergency transport. All
33 96 data was anonymized and is therefore case-, not patient-based. Repeated presentation by the same
34 97 patient or EMS activation for the same patient could not be accounted for.
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41 98 Hospital data included basic case information (age, sex, admission status) and information about
42 99 diagnoses (ICD-10-GM Codes). Dispatch data includes dispatch keywords, type of ambulance
43 100 deployed, time stamps and receiving hospital. Billing data includes patient age, an essential
44 101 identifier for the linkage of hospital and dispatch data. A probabilistic approach was used to link
45 102 billing and dispatch records, and then dispatch and hospital records. Time stamps of dispatch and
46 103 billing data were compared and patient age could be assigned to 86% of dispatch records. Second,
47 104 patient age and admission time of dispatch and hospital records were compared. All records with an
48 105 exact match of patient age and an arrival time within a 20 minute interval were linked, which was the
49 106 case for 80% of records. When several records matched, the records with the smallest difference in
50 107 arrival time were linked. This process was repeated for the remaining records, first through
51 108 extending the admission time interval to 40 minutes, and then extending the age criterion to a 5
52 109 year range.
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3 110 Cases were classified as discharged when there was no documentation for admission to the same
4 111 hospital on the day of ED presentation. Information about admitted cases came from a standardized
5 112 data set that hospitals are required to collect according to section 21 of the Hospital Remuneration
6 113 Act (KHEntgG). Participating hospitals provided comparable information about discharged cases
7 114 from their hospital information system. Records with identical items recorded within the first hour
8 115 after admission were considered duplicates and removed from the dataset. Recording a primary
9 116 diagnosis is only mandatory for admitted cases. The amount of missing data is displayed in the
10 117 results section. More than one diagnosis was recorded for 5.1% of discharged cases. In this case, the
11 118 diagnosis with the highest estimated resource requirement was chosen as the primary diagnosis.
12 119 Since dispatch keywords are not standardized, 293 different keywords were condensed and
13 120 classified into 15 categories (see supplementary material).

21 121 22 122 Analysis

23 123
24 124 The sample was characterized by calculating medians with interquartile range (IQR) for continuous
25 125 variables and frequencies and proportions for categorical variables. Statistical tests (χ^2 test for
26 126 categorical variables and the Wilcoxon–Mann-Whitney-U-Test for continuous variables) were
27 127 performed to evaluate differences between admitted and discharged cases. The probability of
28 128 discharge was calculated for case characteristics. Logistic regression was performed to estimate the
29 129 adjusted likelihood of discharge. Covariates were selected based on their availability at dispatch and
30 130 included age, sex, keywords and day and time of admission at the ED. The 9 most frequent dispatch
31 131 keywords and ICD-10 diagnosis chapters are displayed, remaining diagnosis chapters and keywords
32 132 are summarized as "other chapters". Age was categorized into five groups. The final model was
33 133 selected based on Akaike information criterion (AIC). [16] [17] A subgroup analysis was conducted
34 134 for age groups and stratified models are provided as supplementary material. The frequencies of
35 135 hospital diagnoses stratified by dispatch keyword are presented in cross-tabulated tables. Analysis
36 136 was performed using R statistical software (R Foundation for Statistical Computing, Vienna, AT).

37 137 38 138 Ethics and patient and public involvement

39 139
40 140 The study protocol including the description of the dataset and the data protection concept was
41 141 submitted to the ethics committee of the medical faculty of the University of Munich for review
42 142 (Project-No 17-530-UE). The committee had no objections and waived obligation to advise
43 143 according to the law on faculties. Patients or the public were not involved in the design and conduct
44 144 of this research.

45 145 46 146 **Results**

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8 150 47,430 cases (60.6%) were admitted and 30,873 (39.4%) were discharged. Characteristics of both
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10 151 groups are reported and compared in table 1. The comparison of admitted and discharged cases
11 152 shows that discharged cases were much younger (median of 40 vs. 70 years, $p < 0.0001$). The share
12 153 of males in this group was slightly higher (47.7% vs. 44.6%, $p < 0.0001$). Discharged cases were less
13 154 frequently brought in by an ambulance assisted by emergency physicians (16.0% vs. 34.8%, p
14 155 < 0.0001). The most common keyword was "Accident/Trauma" (44.7%) in case of discharge and
15 156 "Cardiovascular" (27.8%) in case of admission. The most frequent diagnoses were within the main
16 157 chapter XIX (Injury, Poisoning), regardless of admission status.
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Table 1: Characteristics of ED cases transported by EMS

	Total		Admission status				p-value*
	N=78,303		discharged n=30,873		admitted 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)	

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)	2,248	(7.3)	5,428	(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 or 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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3 180 0.74, CI 0.72-0.77). Compared to cases reporting a cardiovascular problem to the dispatcher,
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5 181 dispatch for intoxication or poisoning, respiratory, neurologic or gastrointestinal and unspecified
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7 182 internal disease decreased the odds of being discharged, whereas odds of discharge were higher in
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9 183 case of dispatch for accidents or trauma, when children were involved and when the reported
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11 184 problem was not specified by the dispatcher. When the model was stratified by age group, the
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13 185 strength of the association differed by age category and was reversed for two keywords: Whereas
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15 186 dispatch for respiratory conditions was associated with discharge for cases under the age of 35,
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17 187 cases with respiratory problems aged 35 or older had higher odds of admission. In contrast,
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19 188 intoxication and poisoning led to decreased odds of discharge in younger cases but increased odds
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21 189 of discharge in older cases (see supplementary Table).

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23 190
24 191 Figure 2: Adjusted odds ratios and confidence interval (95%) for discharge

25 192 26 193 Hospital diagnosis

27 194 Most diagnoses were within chapter XIX, which includes injuries, poisoning and certain other
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29 195 consequences of external causes (Table 1). Yet diagnoses from chapter XIX were more common for
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31 196 cases that were discharged (42.7% vs. 22.0 %). In contrast, diagnoses from chapter IX (diseases of
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33 197 the circulatory system) were more common when a case was admitted to the hospital (21.8% vs 2.6
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35 198 %). Diagnoses from chapters XIX (Injury, poisoning), XVIII (not elsewhere classified) and missing
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37 199 diagnosis information covered 75% of all diagnoses for discharged cases, whereas diagnoses of
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39 200 admitted cases were distributed across different diagnosis chapters.

40 201 The most common 3-digit ICD 10 codes in case of admission were F10 (mental and behavioral
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42 202 disorders due to use of alcohol), S06 (intracranial injury), I10 (essential (primary) hypertension), R55
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44 203 (syncope and collapse), I63 (cerebral infarction). In case of discharge, the most common codes were
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46 204 S01 (open wound of head), S06 (intracranial injury), S00 (superficial injury of head), R55 (syncope
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48 205 and collapse), F10 (mental and behavioral disorders due to use of alcohol). These five most common
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50 206 3-digit ICD 10 codes accounted for about 20% of diagnosis codes in each group.

51 207 52 208 Dispatch keywords compared to hospital diagnoses

53 209 Tables 2 and 3 show the proportion of diagnoses from each ICD-chapter by dispatch keyword for
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55 210 admitted and discharged cases. Regardless of the initial dispatch keyword, hospital diagnoses fell
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57 211 into many different chapters. Exceptions were dispatch for "accident/trauma" and "intoxication or
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59 212 poisoning", where the majority of diagnoses (accident/trauma: chapter XIX diagnoses for 65.5% of
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213 cases when discharged, 71.6% when admitted; intoxication/poisoning: chapters XIX and V diagnoses
214 for 66.1% of cases when discharged, 85.5% when admitted) came from compatible chapters.
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216 Diagnoses for admitted cases did match the initial dispatch keyword 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. 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

Dispatch keyword	Diagnosis chapter											total
	I	IX	V	VI	X	XI	XIII	XIX	XVIII	Other	missing	
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

Dispatch keyword	Diagnosis chapter											total
	I	IX	V	VI	X	XI	XIII	XIX	XVIII	Other	missing	
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

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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3 274 population composition and healthcare infrastructure. This might explain why even higher discharge
4 rates of 70% were observed in a mixed urban, suburban, and rural area in the United states,[6] where
5 275 alternatives to hospital emergency care are different. Studies in the pre-hospital setting in Sweden
6 276 and Australia have assessed more than one third of patients as not being in need of prehospital
7 interventions or ambulance transport, despite of ambulance dispatch.[18] [19] All of these
8 277 observations correspond with discrepancies between patient perception of urgency and staff
9 278 assessment.[20] Yet it is hard for dispatchers to identify callers who don't need emergent EMS care
10 or rapid transport to the ED, as they usually have to base response decisions on patients' or
11 279 bystanders' assessment.
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19 284 Age was the strongest predictor of discharge even after adjustment for other patient and dispatch
20 285 characteristics. Particularly young adults and children were most likely to be discharged than older
21 cases. Other studies also have found younger patients to be candidates for primary healthcare [7]
22 286 and less likely to need paramedic treatment. [19] The decision to access ambulance and urgent care
23 287 services is influenced by access to primary care, individual circumstances, perceived urgency and
24 beliefs that resources can only be provided by a particular healthcare provider. [4] [5] These reasons
25 288 were mentioned, along with a need for reassurance, the desire for a second opinion and lack of
26 289 insurance, by parents who bring their child to the ED for minor illnesses. In these cases a "wait and
27 see" approach seems especially undesirable and the accurate assessment of the child's condition
28 290 proves difficult to parents.[21] These factors may also be important for EMS missions involving
29 children. Conversely, elderly patients usually bear a higher amount of morbidity and a higher degree
30 291 of frailty. An increased probability of admission or death after transport to ED was observed for a
31 292 number of dispatch codes for cases over the age of 65.[6] The lack of safe discharge arrangements
32 for geriatric patients [22] might make hospital admission the best option, even if the acute
33 293 emergency situation is resolved.
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42 299 Odds of discharge were lower when emergency physicians were dispatched. We expected the
43 presence of a physician to be a marker of severity and thus decreased likelihood of hospital
44 300 discharge, as physician dispatch is triggered by a higher probability of critically ill/injured patients
45 301 and invasive interventions on scene.
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48 303 Arrival at night also decreased the odds of discharge. Such cases could be of higher acuity. There
49 may also be fewer alternatives to admission available, or decision-making may be postponed due to
50 304 limited diagnostic availabilities or absence of senior physicians at the ED at night.
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53 306 We hypothesized that certain dispatch keyword groups would clearly mark situations or health
54 307 problems that usually don't lead to subsequent hospital admission. Other studies have identified a
55 number of situations that were less likely to lead to hospital admissions or EMS transport or were
56 308 considered suitable for referral to other levels of care. They include assaults and unconsciousness or
57 fainting in younger patients, [6] pediatric cases, psychiatric conditions, patients with low pain
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3 311 scores[19], nausea/vomiting/diarrhoea, seizures/epilepsy, back pain, pain during
4 312 urination/haematuria, mental illness and unspecified disease.[7] Low-acuity dispatch codes included
5 313 abdominal pain, assault, back pain, pregnancy and childbirth, injuries and psychiatric conditions [23]
6 314 and were validated in the same area,[24] but did not turn out to be low-acuity in another
7 315 community.[25] Non-transport after EMS dispatch was especially more common after assault/sexual
8 316 assault, unknown problem/man down, traffic/transportation accidents, unconscious/fainting [26]
9 317 and mental, behavioral and neurodevelopmental disorders [27]. Our analysis shows that, compared
10 318 to dispatch for cardiovascular problems, odds of discharge were especially high for cases
11 319 transported after accidents or trauma, emergencies involving children and emergencies where
12 320 dispatchers did not specify the reason for dispatch. We already discussed reasons why young age
13 321 might increase the odds of discharge. Higher odds of discharge after accidents and injuries might be
14 322 because diagnostic resources that are only available in a hospital setting are required for a thorough
15 323 examination of these cases, after which they can frequently be cleared. This could also apply to
16 324 emergencies where the problem can't be specified by the dispatcher. Determining the priority level
17 325 of unclear calls is particularly difficult, and they are therefore often provided with a either lower or
18 326 higher response than needed.[12][28]
19 327

20 328 The spectrum of diseases differed between discharged and admitted cases, with a higher proportion
21 329 of chapter XIX (Injury, poisoning) diagnoses in discharged and more ICD-10 chapter IX (circulatory
22 330 system) diagnoses in admitted cases. Yet the degree to which dispatch keywords were indicative of
23 331 the later diagnosis was rather low. Dispatch keywords were usually spread across many different
24 332 diagnosis chapters for both admitted and discharged cases, even though discrepancies were
25 333 observed a more frequently in the discharged group. Pre-hospital emergency conditions usually
26 334 don't present themselves as "textbook examples".[28] Especially nonsurgical emergency patients
27 335 often lack diagnosis-specific symptoms.[29] This analysis showed that keyword and hospital
28 336 diagnosis were more similar when a condition seemed easily recognizable, like accidents or trauma
29 337 and intoxication or poisoning. These situations might be more intuitive for patients and bystanders
30 338 to describe, and therefore bring about a better diagnostic accuracy at dispatch.

31 339 Yet some conditions that are apparently easier to recognize than others and are very common
32 340 ICD 10 diagnoses are frequently diagnosed in both groups. They include alcohol intoxication,
33 341 concussion and syncope. Distinguishing between cases with life-threatening illness and other cases
34 342 comes with assigning some less urgent cases a high priority. Standard operating procedures have
35 343 been defined to handle these conditions in the ED [30] to identify patients with high risk of adverse
36 344 outcomes and might be useful for standardized emergency query upon emergency call, too.

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38 346 Implications for policy and practice and future research
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3 348 Diverting eligible patients to other settings could help manage the growing demand for EMS and
4 349 EDs. This analysis suggests that, at least in part, dispatch information is suitable to assess the
5 350 likelihood of discharge from the ED after EMS transport. Our findings point to patient groups that
6 351 are worth a closer look regarding potential diversion away from the ED. These are in particular
7 352 young and injured patients, who might require hospital-specific resources, but not always urgent
8 353 EMS transport. Information about predictors of discharge could also be useful to reroute
9 354 ambulances, especially when admission capacities are low.

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15 355 Discharge from the ED after EMS transport can't be equated with low potential for critical illness or
16 356 injury. Rapid transport may be necessary to exclude worrisome differential diagnoses or to treat
17 357 conditions using resources that are not available outside of a hospital setting. Better pre-hospital
18 358 triage tools are necessary to accurately identify patients that are not severely ill or injured. This
19 359 includes the assessment of acuity in addition to symptom keywords at dispatch, to allow for a more
20 360 differentiated evaluation of patient groups and to allocate adequate resources. More information on
21 361 discrepancies between diagnoses and acuity levels at dispatch as compared to later assessment is
22 362 needed, as the pre-selection of patient groups for redirection is only viable when initial assessment
23 363 and final diagnosis are sufficiently consistent.

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35
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37
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39 444 work.

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42 446 Competing interests

43
44 447 The authors declare that they have no competing interests.

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47 449 Authors' contributions

48 450 KH and SP conceived the study. KH performed the analyses, interpreted the data and drafted the
49
50 451 manuscript. HT provided input for interpretation of results and drafting of the manuscript. All
51
52 452 authors contributed to the critical revision of the manuscript and approved its final version.

53 453
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55 454 Patient consent form

56 455 Not applicable

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59 457 Availability of data and material

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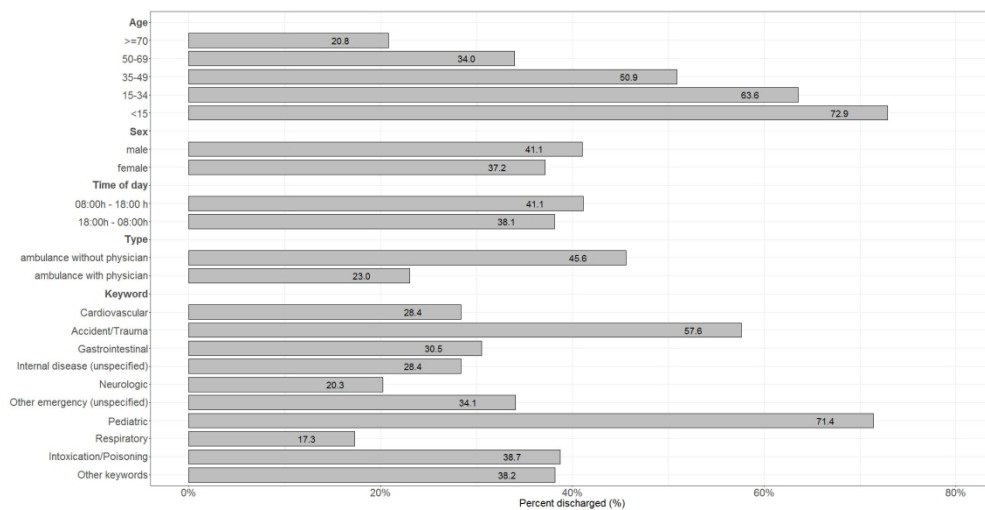
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458 The data used in this paper was a combination of hospital and dispatch data. Dispatch data are third
459 party data used with permission of the Bavarian State Ministry of the Interior, Sport and Integration
460 and the Bavarian social insurance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

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466

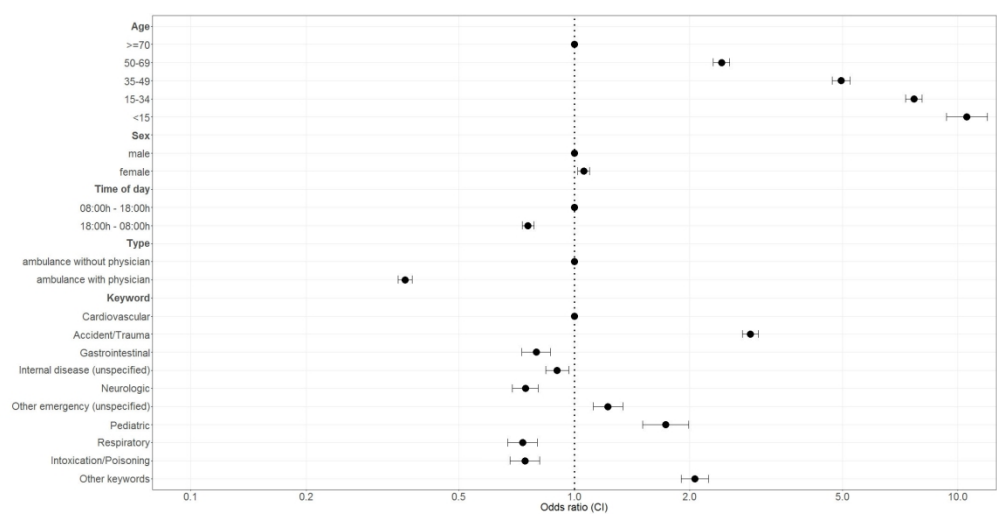
For peer review only



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)

Supplementary Material

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

	<15		15-34		35-49		50-64		≥70	
	OR (CI)	p	OR (CI)	p	OR (CI)	p	OR (CI)	p	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	1,11 (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	0,34 (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	0,77 (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	1,44 (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

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

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) <i>Cohort study</i> - 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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		<p>sources and methods of selection of participants. Describe methods of follow-up</p> <p><i>Case-control study</i> - 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</p> <p><i>Cross-sectional study</i> - Give the eligibility criteria, and the sources and methods of selection of participants</p> <p>(b) <i>Cohort study</i> - For matched studies, give matching criteria and number of exposed and unexposed</p> <p><i>Case-control study</i> - For matched studies, give matching criteria and the number of controls per case</p>		<p>algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided.</p> <p>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.</p> <p>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.</p>	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-

		arrived at			105
1 2 3 4 5 6	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
7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30	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) <i>Cohort study</i> - If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> - If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> - If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses		Page 5, lines 126-127, 134-148,
31 32 33 34 35 36 37 38 39 40 41	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
42 43 44	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 (<i>e.g.</i> , 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>i.e.</i> , 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 (<i>e.g.</i> , 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) <i>Cohort study</i> - summarise follow-up time (<i>e.g.</i> , average and total amount)			Table 1
Outcome data	15	<i>Cohort study</i> - Report numbers of outcome events or summary measures over time <i>Case-control study</i> - Report numbers in each exposure category, or summary measures of exposure <i>Cross-sectional study</i> - Report numbers of outcome events or summary measures			Table 1
Main results	16	(a) Give unadjusted estimates			Figure 1

		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, Guttman A, Harron K, Moher D, Petersen I, Sørensen HT, von Elm E, Langen 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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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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For peer review only

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3 1 **Differences between cases admitted to the hospital and discharged from the emergency**
4 **department after emergency medical services transport: a retrospective analysis**
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9 4 Abstract
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11 5

12 6 Objective: Rising emergency medical services (EMS) utilization increases transport to hospital
13 7 emergency departments (ED). However, some patients receive outpatient treatment (discharged)
14 8 while others are hospitalized (admitted). The aim of this analysis was to better understand EMS
15 9 utilization by comparing admitted and discharged cases, and to assess whether information
16 10 accessible to dispatchers can help identify cases that will be discharged from the ED. A second aim
17 11 was to examine whether dispatch keyword categories match the hospital diagnosis.

23 12 Design: retrospective observational study using linked secondary data
24

25 13 Setting and participants: 78,303 cases brought to one of 14 ED in the city of Munich, Germany by
26 14 EMS between 01.07.2013 – 30.06.2014.

29 15 Main outcome measures: Characteristics of admitted and discharged cases were assessed. Logistic
30 16 regression was used to estimate the association between discharge and age, sex, time of day,
31 17 ambulance type and dispatch keyword category. Keyword categories were compared to hospital
32 18 diagnoses.

36 19 Results: 39.4% of cases were discharged. They were especially likely to be young (OR 10.53 (CI 9.31-
37 20 11.92), comparing <15 year olds to >70 year olds) and to fall under the categories
38 21 'accidents/trauma' (OR 2.87 (CI 2.74-3.01)) or 'other emergencies (unspecified)' (OR 1.23 (CI 1.12-
39 22 1.34) (compared to 'cardiovascular'). Most frequent diagnoses came from ICD-10 chapter 'injury
40 23 and poisoning' (30.1%), yet these diagnoses were more frequent at discharge (42.7 vs. 22.0%)
41 24 whereas circulatory system disease was less frequent (2.6% vs. 21.8%). Keyword categories were
42 25 distributed across many different ICD-10 chapters. Discrepancies between them and later diagnosis
43 26 were less frequent after dispatch for accidents or trauma and intoxication or poisoning.

51 27 Conclusion: Young age and dispatch for accidents or trauma were the strongest predictors of
52 28 discharge. Discharge from the ED does not indicate that urgent evaluation and treatment was not
53 29 necessary. Yet these cases might be suitable for diversion to hospitals even with high bed occupancy
54 30 so transport capacities are quickly available again. Further research is needed to better understand
55 31 the true urgency of these cases to determine if they are suitable for diversion to other settings.
56 32

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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3 65 prevent overlooking critically ill patients that in consequence suffer from adverse outcomes. Yet
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5 66 over-triage also consumes resources and causes unnecessary crowding of specialized resources. The
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7 67 addition of demographic information and hospitalization history to the dispatch process has shown
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9 68 the potential to predict adverse outcomes [13]. Conversely, knowing which caller characteristics and
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11 69 initial complaints are associated with discharge from the ED might help dispatchers to pre-select
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13 70 groups that are less likely to need acute care beds, and point to groups that might be worth a closer
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15 71 look regarding the suitability for other settings, in case initial and later assessment is mostly
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17 72 concordant.

18 73 The aim of this study was therefore to compare admitted and discharged cases and to assess
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20 74 whether information accessible to the dispatcher can help differentiate between cases who will need
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22 75 subsequent admission to a hospital and those who likely will not. A second aim was to examine
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24 76 whether the dispatcher's assessment of the emergency situation matched the hospital's diagnosis.
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27 78 **Methods**

29 79 30 80 Design and setting

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33 82 This is a retrospective observational study using secondary data gathered for an evaluation of the
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35 83 provision of care by emergency departments in the city of Munich.[14] In 2014, about 1.5 Million
36
37 84 people lived in the city of Munich. The Munich dispatch center covers an area of about 980 sqkm
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39 85 with 1.8 Million inhabitants.

40 86 The German health care system offers different types of emergency care in different
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42 87 environments. Pre-hospital medical services can be accessed via the national emergency telephone
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44 88 number 112. Calls are managed by regional dispatch centers that operate full time and coordinate
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46 89 emergency and non-emergency ground and air ambulances and the fire brigade. Call-takers and
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48 90 dispatchers are trained paramedics or firefighters who underwent dispatch training. A local, non-
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50 91 standardized, keyword-based dispatch manual is used to decide on the type and number of pre-
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52 92 hospital EMS units to be dispatched to the scene of the emergency. Levels of EMS response include
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54 93 ambulances designated to non-emergency transport, paramedic staffed ambulances and rapid
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56 94 response cars and helicopters staffed with prehospital emergency physicians. Pre-hospital
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58 95 emergency physicians need a specialty board certification for emergency medicine. A physician will
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60 96 be dispatched according to a pre-specified catalogue when vital signs are suspected to be unstable

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3 97 or when the condition implicates a high probability of need for invasive interventions. Physicians can
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5 98 also be activated at the discretion of the dispatcher for tactical reasons or when they are requested
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7 99 by the paramedics on site. According to suitability and intake capacity a dispatchers will suggest a
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9 100 hospital to which an EMS patient should be transported to. This suggestion is usually accepted by
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11 101 ambulance crews, although they can, in consultation with the dispatch center, decide on another
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13 102 destination if special medical considerations prevail. If hospitals temporarily de-register to the
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15 103 dispatch center from acute care, EMS units have to travel to alternative locations, which usually
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17 104 results in longer transport times and deducts units from their home base.

18 105 A dispatcher can refer callers that do not need an EMS response to on-call or ambulatory services
19
20 106 provided by the Association of Statutory Health Insurance. On-call doctor services can be accessed
21
22 107 directly through 116,117 for urgent but non-emergency conditions. Patients can access all
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24 108 ambulatory emergency care services on their own initiative, or seek care at a hospital's emergency
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26 109 department.

27 110 28 29 111 Data sources and sample

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33 113 Between 01.07.2013 and 30.06.2014, routinely collected information of all cases presenting to one of
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35 114 14 emergency departments of 14 major hospitals in Munich was pooled into a study data base.
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37 115 Dispatch information was extracted from a database that holds routinely generated data from the
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39 116 computer-assisted dispatch systems of Munich's central dispatch center and surrounding dispatch
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41 117 centers and billing information. During the study period, 524.716 cases presented to the 14 EDs and
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43 118 110.484 emergency dispatches where a patient was transported to a destination in the city of
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45 119 Munich were recorded by the dispatch centers, of which 78.307 (71%) could be matched to an ED
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47 120 record. Four emergency dispatches were excluded, as the keywords indicated a non-emergency
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49 121 transport. All data was anonymized and is therefore case-, not patient-based. Repeated presentation
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51 122 by the same patient or EMS activation for the same patient could not be accounted for.

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53 123 Hospital data included basic case information (age, sex, admission status) and information about
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55 124 diagnoses (ICD-10-GM Codes). Dispatch data includes dispatch keywords, type of ambulance
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57 125 deployed, time stamps and receiving hospital. Billing data includes patient age, an essential
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59 126 identifier for the linkage of hospital and dispatch data. A probabilistic approach was used to link
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127 billing and dispatch records, and then dispatch and hospital records. Time stamps of dispatch and
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129 billing data were compared and patient age could be assigned to 86% of dispatch records. Second,

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3 129 patient age and admission time of dispatch and hospital records were compared. All records with an
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5 130 exact match of patient age and an arrival time within a 20 minute interval were linked, which was the
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7 131 case for 80% of records. When several records matched, the records with the smallest difference in
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9 132 arrival time were linked. This process was repeated for the remaining records, first through
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11 133 extending the admission time interval to 40 minutes, and then extending the age criterion to a 5
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13 134 year range. The study design and case selection are illustrated in figure 1.

14 135 Cases were classified as discharged when there was no documentation for admission to the same
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16 136 hospital on the day of ED presentation. Information about admitted cases came from a standardized
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18 137 data set that hospitals are required to collect according to section 21 of the Hospital Remuneration
19
20 138 Act (KHEntgG). Participating hospitals provided comparable information about discharged cases
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22 139 from their hospital information system. Records with identical items recorded within the first hour
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24 140 after admission were considered duplicates and removed from the dataset. Recording a primary
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26 141 diagnosis is only mandatory for admitted cases. The amount of missing data is displayed in the
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28 142 results section. More than one diagnosis was recorded for 5.1% of discharged cases. In this case, the
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30 143 diagnosis with the highest estimated resource requirement was chosen as the primary diagnosis.
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32 144 Since dispatch keywords are not standardized, 293 different keywords were condensed and
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34 145 classified into 15 categories (see supplementary material).
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36 147 **Figure 1: study design and case selection**

39 149 Analysis

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42 150
43 151 The sample was characterized by calculating medians with interquartile range (IQR) for continuous
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45 152 variables and frequencies and proportions for categorical variables. Statistical tests (χ^2 test for
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47 153 categorical variables and the Wilcoxon–Mann-Whitney-U-Test for continuous variables) were
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49 154 performed to evaluate differences between admitted and discharged cases. The probability of
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51 155 discharge was calculated for case characteristics. Logistic regression was performed to estimate the
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53 156 adjusted likelihood of discharge. Covariates were selected based on their availability at dispatch and
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55 157 included age, sex, dispatch keyword category and day and time of admission at the ED. The nine
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57 158 most frequent dispatch keyword categories and ICD-10 diagnosis chapters are displayed. Remaining
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59 159 diagnosis chapters and keyword categories are summarized as “other chapters” and “other
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60 160 keywords”. Age was categorized into five groups. The final model was selected based on Akaike

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3 161 information criterion (AIC). [15] [16] A subgroup analysis was conducted for age groups and results
4 162 from the stratified models are displayed. The frequencies of hospital diagnoses stratified by dispatch
5 163 keyword category are presented in cross-tabulated tables. Analysis was performed using R statistical
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7 164 software (R Foundation for Statistical Computing, Vienna, AT).
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12 166 Ethics and reporting

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15
16 168 The study protocol including the description of the dataset and the data protection concept was
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18 169 submitted to the ethics committee of the medical faculty of the University of Munich for review
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20 170 (Project-No 17-530-UE). Analyses are based on retrospective data that is irreversibly anonymized.
21
22 171 The ethical review committee therefore waived obligation to advise according to the law on
23
24 172 faculties. The reporting of this study is in accordance with STROBE guidelines for the reporting of
25
26 173 observational studies in epidemiology.
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29 175 Patient and public involvement

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33 177 Patients or the public were not involved in the design and conduct of this research.
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36 179 Results

38 180 Characteristics of ED cases transported by EMS

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42 182 47,430 cases (60.6%) were admitted and 30,873 (39.4%) were discharged. Characteristics of both
43
44 183 groups are reported and compared in table 1. The comparison of admitted and discharged cases
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46 184 shows that discharged cases were much younger (median of 40 vs. 70 years, $p < 0.0001$). The share
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48 185 of males in this group was slightly higher (47.7% vs. 44.6%, $p < 0.0001$). Discharged cases were less
49
50 186 frequently brought in by an ambulance assisted by emergency physicians (16.0% vs. 34.8%, p
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52 187 < 0.0001). The most common keyword category was "Accident/Trauma" (44.7%) in case of discharge
53
54 188 and "Cardiovascular" (27.8%) in case of admission. The most frequent diagnoses were within the
55
56 189 main chapter XIX (Injury, Poisoning), regardless of admission status.
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58 190

58 191 **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 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)
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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214 dispatch for intoxication or poisoning, respiratory, neurologic or gastrointestinal and unspecified
215 internal disease decreased the odds of being discharged, whereas odds of discharge were higher in
216 case of dispatch for accidents or trauma, when children were involved and when the reported
217 problem was not specified by the dispatcher. When the model was stratified by age group, the
218 strength of the association differed by age category but was reversed only for two keyword
219 categories: Whereas dispatch for respiratory conditions was associated with discharge for cases
220 under the age of 35, cases with respiratory problems aged 35 or older had higher odds of
221 admission. In contrast, intoxication and poisoning led to decreased odds of discharge in younger
222 cases but increased odds of discharge in older cases (Table 2).

223 **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)	p	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	1,19 (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	0,79 (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	0,39 (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	3,36 (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	1,19 (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	0,79 (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	0,99 (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	0,79 (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	0,59 (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	1,49 (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	1,89 (1,53-2,19)	<0.0001	2,71 (2,36-3,12)	<0.0001

224 Dispatch keyword category "pediatric" is omitted

1
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3 225 Hospital diagnosis

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6 226 Most diagnoses were within chapter XIX, which includes injuries, poisoning and certain other
7
8 227 consequences of external causes (Table 1). Yet diagnoses from chapter XIX were more common for
9
10 228 cases that were discharged (42.7% vs. 22.0 %). In contrast, diagnoses from chapter IX (diseases of
11
12 229 the circulatory system) were more common when a case was admitted to the hospital (21.8% vs 2.6
13
14 230 %). Diagnoses from chapters XIX (Injury, poisoning), XVIII (not elsewhere classified) and missing
15
16 231 diagnosis information covered 75% of all diagnoses for discharged cases, whereas diagnoses of
17
18 232 admitted cases were distributed across different diagnosis chapters.

19 233 The most common 3-digit ICD-10 codes in case of admission were F10 (mental and behavioral
20
21 234 disorders due to use of alcohol), S06 (intracranial injury), I10 (essential (primary) hypertension), R55
22
23 235 (syncope and collapse), I63 (cerebral infarction). In case of discharge, the most common codes were
24
25 236 S01 (open wound of head), S06 (intracranial injury), S00 (superficial injury of head), R55 (syncope
26
27 237 and collapse), F10 (mental and behavioral disorders due to use of alcohol). These five most common
28
29 238 3-digit ICD-10 codes accounted for about 20% of diagnosis codes in each group.

30 239
31 240 Dispatch keyword categories compared to hospital diagnoses

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33 241
34
35 242 Tables 3 and 4 show the proportion of diagnoses from each ICD-chapter by dispatch keyword
36
37 243 category for admitted and discharged cases. Regardless of the initial dispatch keyword, hospital
38
39 244 diagnoses fell into many different chapters. Exceptions were dispatch for "accident/trauma" and
40
41 245 "intoxication or poisoning", where the majority of diagnoses (accident/trauma: chapter XIX
42
43 246 diagnoses for 65.5% of cases when discharged, 71.6% when admitted; intoxication/poisoning:
44
45 247 chapter XIX plus chapter V diagnoses for 66.1% of cases when discharged, 85.5% when admitted)
46
47 248 came from compatible chapters. Diagnoses for admitted cases did match the initial dispatch
48
49 249 keyword category more often than diagnoses for discharged cases, but still fell into different
50
51 250 chapters. With the exception of dispatch for neurological or respiratory problems, the most common
52
53 251 hospital diagnosis for discharged cases came from either chapter XIX (injury, poisoning) or XVIII (not
54
55 252 elsewhere classified), regardless of dispatch keyword category. The most common ICD-codes within
56
57 253 chapter XVIII were R55 (syncope and collapse), R07 (pain in throat and chest) R10 (Abdominal and
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59 254 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

Dispatch keyword category	Diagnosis chapter											total
	I	V	VI	IX	X	XI	XIII	XVIII	XIX	Other	missing	
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

Dispatch keyword category	Diagnosis chapter											total
	I	V	VI	IX	X	XI	XIII	XVIII	XIX	Other	missing	
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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3 270 metabolic XVII Congenital malformations, Blood and blood-forming organs XII Skin VIII Ear II Neoplasms XVI Originating in perinatal
4 271 period XV Pregnancy, childbirth XXI Factors influencing health XX External cause
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17 278 **Discussion**

20 280 Principal findings

24 282 Discharge on the same day following emergency medical services transport to an emergency
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26 283 department was associated with young age, dispatch of an ambulance without additional
27
28 284 emergency physician support and arrival during the day. Discharge also depended on the reason for
29
30 285 dispatch, with particularly high discharge rates for emergencies related to accidents or trauma and
31
32 286 unspecified emergencies. Compared to admitted cases, a larger proportion of discharged cases were
33
34 287 diagnosed with injuries or poisoning, whereas the proportion of circulatory system diseases was
35
36 288 smaller in this group. Some diagnoses (alcohol intoxication, concussion and syncope) were
37
38 289 frequently assigned to both admitted and discharged cases. Good agreement between dispatch
39
40 290 keyword category and hospital diagnosis was observed after dispatch for accident/trauma and
41
42 291 intoxication/poisoning, but not for other categories. Diagnoses of admitted cases matched the initial
43
44 292 dispatch keyword category more often than diagnoses of discharged cases.
45

46 294 Strengths and weaknesses of the study

50 296 Even though a more complete investigation of the rescue chain becomes possible, few studies link
51
52 297 dispatch and hospital data. Yet the use of routinely collected data comes along with several
53
54 298 potential sources for bias. One of them is that 30% of dispatch records could not be linked to a
55
56 299 hospital record because common identifiers (time stamps or patient age) were documented
57
58 300 incorrectly or not at all. We believe that missing identifiers is due to input errors which are likely to
59
60 301 be completely random, but we cannot rule out that lack of documentation might indicate that these

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2
3 302 cases were either less or more critically ill. We consider an overlap of time stamps together with an
4
5 303 overlap of transport destination and patient age as suitable criteria to achieve adequate matches.
6
7 304 Yet we can't rule out that false matches introduced some noise to the analyses. Another major
8
9 305 weakness is that diagnosis information was missing for one out of five discharged cases. We
10
11 306 therefore report the amount of missing data in all analyses and did not include hospital diagnoses in
12
13 307 the regression model. Discharged cases are misclassified when they are admitted on another day, to
14
15 308 another hospital or if they die in the ED. Comparison of ICD-10 diagnosis with dispatch keyword
16
17 309 categories implies some degree of imprecision, since dispatch keywords often describe emergency
18
19 310 situations or medical conditions rather than suspected diagnoses. We could not study patient
20
21 311 factors which are likely to be associated with the outcome or other variables, like socioeconomic
22
23 312 status or access to care and could not capture comorbid conditions, which are known to increase
24
25 313 the risk of short-term adverse outcomes for time-critical 112 callers with the same complaint[13].
26
27 314 The study area is a metropolitan area and results might be different in rural regions or even in
28
29 315 metropolitan areas with different pre-hospital treatment or admission practices.

30 31 317 Interpretations and comparison with other studies

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33 318
34 319 40% of cases transported to the emergency department by emergency medical services were not
35
36 320 admitted to the hospital. Our results are difficult to compare to results from areas with different
37
38 321 population composition and healthcare infrastructure. This might explain why even higher discharge
39
40 322 rates of 70% were observed in a mixed urban, suburban, and rural area in the United States,[6]
41
42 323 where alternatives to hospital emergency care are different. Another study from the United States
43
44 324 reports a 50% discharge rate of ambulance patients in an urban area. [17] Studies in the pre-hospital
45
46 325 setting in Sweden and Australia have assessed more than one third of patients as not being in need
47
48 326 of prehospital interventions or ambulance transport, despite of ambulance dispatch.[18] [19]

49 327 All of these observations correspond with discrepancies between patient perception of urgency
50
51 328 and staff assessment.[20] Yet it is hard for dispatchers to identify callers who don't need emergent
52
53 329 EMS care or rapid transport to the ED. The dispatch center is the earliest point of time within the
54
55 330 rescue chain at which triage might occur, but due to limited information it is also one of the most
56
57 331 difficult ones. [21] Yet the dispatcher plays a key role in identifying the best resources for the caller
58
59 332 or patient, [10] and has the possibility to identify patients that might benefit from other paths of
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333 care and guide them to – eventually more appropriate - settings or hospitals at an early stage. In

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3 334 addition, a dispatcher gives medical advice and allocates ambulances and specialized prehospital
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5 335 units. [22] Over-triage costly can result in resources not being available to someone who needs
6
7 336 them. On the other hand there is a high risk of adverse outcomes due to under-triage i.e. when
8
9 337 patients are denied access to adequate treatment even though that was medically justified.
10
11 338 Therefore most emergency response systems accept a certain level of over-triage as a safety margin.
12
13 339 [10] [18] Appraising the need for an EMS response in retrospect is easy, but the dispatch process has
14
15 340 to discriminate between required EMS resources and the priority of these at an very early stage [10]
16
17 341 and still be safe. This mostly depends on the accurate assessment of the urgency of chief complaints
18
19 342 and acute symptoms, and not on the overlap with later confirmed diagnosis or discharge from the
20
21 343 ED. Information about hospital diagnoses and the probability of subsequent discharge is not a
22
23 344 suitable criterion to support responses decisions in the dispatch center, as a patient may still have
24
25 345 needed quick transport and assessment in an ED. This study was therefore not intended to
26
27 346 investigate into the quality of EMS dispatch. Nevertheless, patient groups that are frequently
28
29 347 discharged might be particularly interesting for further research regarding the urgency of their
30
31 348 condition. Information about the probability of discharge may furthermore also be helpful for
32
33 349 deciding on transport destinations and allocation of patients to hospitals when hospital beds are
34
35 350 congested.

34
35 351 Age was the strongest predictor of discharge even after adjustment for other patient and dispatch
36
37 352 characteristics. Particularly young adults and children were most likely to be discharged than older
38
39 353 cases. Other studies also have found younger patients to be candidates for primary healthcare [7]
40
41 354 and less likely to need paramedic treatment. [19] The decision to access ambulance and urgent care
42
43 355 services is influenced by access to primary care, individual circumstances, perceived urgency and
44
45 356 beliefs that resources can only be provided by a particular healthcare provider. [4] [5] These reasons
46
47 357 were mentioned, along with a need for reassurance, the desire for a second opinion and lack of
48
49 358 insurance, by parents who bring their child to the ED for minor illnesses. In these cases a "wait and
50
51 359 see" approach seems especially undesirable and the accurate assessment of the child's condition
52
53 360 proves difficult to parents.[23] These factors may also be important for EMS missions involving
54
55 361 children. Conversely, elderly patients usually bear a higher amount of morbidity and a higher degree
56
57 362 of frailty. An increased probability of admission or death after transport to ED was observed for a
58
59 363 number of dispatch codes for cases over the age of 65.[6] The lack of safe discharge arrangements
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364 for geriatric patients [24] might make hospital admission the best option, even if the acute
365 emergency situation is resolved. Age did modify the estimates, but rather impacted on the strength

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3 366 than the direction of the association, especially when looking at dispatch keyword categories. This
4
5 367 might be because the spectrum of disease behind the same category is probably broad. If diseases
6
7 368 behind the same keyword category vary by age group odds ratios of discharge between keywords
8
9 369 categories subsequently shift.

10
11 370 Odds of discharge were lower when emergency physicians were dispatched. We expected the
12
13 371 presence of a physician to be a marker of severity and thus decreased likelihood of hospital
14
15 372 discharge, as physician dispatch is triggered by a higher probability of critically ill/injured patients
16
17 373 and invasive interventions on scene.

18 374 Arrival at night also decreased the odds of discharge. Such cases could be of higher acuity. There
19
20 375 may also be fewer alternatives to admission available, or decision-making may be postponed due to
21
22 376 limited diagnostic availabilities or absence of senior physicians at the ED at night.

23 377 We hypothesized that certain dispatch keyword groups would clearly mark situations or health
24
25 378 problems that usually don't lead to subsequent hospital admission. Other studies have identified a
26
27 379 number of situations that were less likely to lead to hospital admissions or EMS transport or were
28
29 380 considered suitable for referral to other levels of care. They include assaults and unconsciousness or
30
31 381 fainting in younger patients, [6] pediatric cases, psychiatric conditions, patients with low pain
32
33 382 scores[19], nausea/vomiting/diarrhoea, seizures/epilepsy, back pain, pain during
34
35 383 urination/haematuria, mental illness and unspecified disease.[7] Low-acuity dispatch codes included
36
37 384 abdominal pain, assault, back pain, pregnancy and childbirth, injuries and psychiatric conditions [25]
38
39 385 and were validated in the same area,[26] but did not turn out to be low-acuity in another
40
41 386 community.[27] Non-transport after EMS dispatch was especially more common after assault/sexual
42
43 387 assault, unknown problem/man down, traffic/transportation accidents, unconscious/fainting [28]
44
45 388 and mental, behavioral and neurodevelopmental disorders [29]. Our analysis shows that, compared
46
47 389 to dispatch for cardiovascular problems, odds of discharge were especially high for cases
48
49 391 transported after accidents or trauma, emergencies involving children and emergencies where
50
51 392 dispatchers did not specify the reason for dispatch. We already discussed reasons why young age
52
53 393 might increase the odds of discharge. Higher odds of discharge after accidents and injuries might be
54
55 394 because diagnostic resources that are only available in a hospital setting are required for a thorough
56
57 395 examination of these cases, after which they can frequently be cleared. Injury severity and whether
58
59 396 these patients were readmitted for elective surgery remains unknown. However, that they could
60
397 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

1
2
3 398 dispatcher. Determining the priority level of unclear calls is particularly difficult, and they are
4
5 399 therefore often provided with a either lower or higher response than needed.[12][30]
6

7 400 There are other variables that are probably impact on discharge or distort the relationship
8
9 401 between included variables and discharge, and not considering them has consequences for the
10
11 402 interpretation of estimates. They were not included in the analysis as they are not available at
12
13 403 dispatch and not part of the routine data collection, and they are usually not available at the point
14
15 404 where prediction is needed. Two important factors are morbidity and socioeconomic status.
16
17 405 Socioeconomic status is brings a higher burden of disease, and patients with low socioeconomic
18
19 406 status are more likely to use acute and hospital care. [31] Socioeconomic differences between
20
21 407 chronic diseases seem to vary, with larger disparities for stroke, diseases of the nervous system,
22
23 408 diabetes mellitus, and arthritis.[32] Socioeconomic status is therefore likely linked with certain
24
25 409 dispatch keyword categories and for instance low odds of discharge for neurologic keywords might
26
27 410 partially be masked by socioeconomic status. Regardless of the initial complaint, previous illness and
28
29 411 comorbid conditions might always complicate treatment and therefore also decrease the odds of
30
31 412 discharge. As morbidity increases with age, a part of the effect of age might actually be traced back
32
33 413 to comorbid conditions.
34

35 414
36 415 The spectrum of diseases differed between discharged and admitted cases, with a higher proportion
37
38 416 of chapter XIX (Injury, poisoning) diagnoses in discharged and more ICD-10 chapter IX (circulatory
39
40 417 system) diagnoses in admitted cases. Yet the degree to which dispatch keyword categories were
41
42 418 indicative of the later diagnosis was rather low. Dispatch keywords were usually spread across many
43
44 419 different diagnosis chapters for both admitted and discharged cases, even though discrepancies
45
46 420 were observed a more frequently in the discharged group. Pre-hospital emergency conditions
47
48 421 usually don't present themselves as "textbook examples".[30] Especially nonsurgical emergency
49
50 422 patients often lack diagnosis-specific symptoms.[33] This analysis showed that keyword category
51
52 423 and hospital diagnosis were more similar when a condition seemed easily recognizable, like
53
54 424 accidents or trauma and intoxication or poisoning. These situations might be more intuitive for
55
56 425 patients and bystanders to describe, and therefore bring about a better diagnostic accuracy at
57
58 426 dispatch. However a correct assessment of urgency with limited information available at dispatch is
59
60 427 more important than diagnostic accuracy. Some conditions are apparently easier to recognize than
61
62 428 others and very common in both groups. They included alcohol intoxication, concussion and
63
64 429 syncope. Distinguishing between cases with life-threatening illness and other cases, whilst putting as

1
2
3 430 few critically ill patients as possible at risk, comes with assigning some less urgent cases a high
4
5 431 priority. Standard operating procedures have been defined to handle these conditions in the ED [34]
6
7 432 to safely identify patients with high risk of adverse outcomes and might be useful for standardized
8
9 433 emergency query upon emergency call, too.

10
11 434
12 435 Implications for policy and practice and future research

13
14 436
15
16 437 Diverting eligible patients to other settings or hospitals could help manage the growing demand for
17
18 438 emergency medical resources. This analysis suggests that, at least in part, dispatch information is
19
20 439 suitable to assess the likelihood of discharge from the ED after EMS transport. However, discharge
21
22 440 from the ED after EMS transport can't be equated with low potential for critical illness or injury or no
23
24 441 need for pre-hospital resources. Rapid transport may be necessary to exclude worrisome differential
25
26 442 diagnoses or to treat conditions using resources that are not available outside of a hospital setting.
27
28 443 This analysis was not able to consider initial urgency, because a standardized assessment of different
29
30 444 levels of urgency is not part of the dispatch process. However our findings may be useful to guide
31
32 445 transport disposition with regard to hospital intake capacity. Young and injured patients have a high
33
34 446 probability of discharge, and thus might be suitable for allocation to hospitals even with high bed
35
36 447 occupancy, so that transport capacities are quickly available again. These groups might also be
37
38 448 worth a closer look regarding the urgency of their condition. For a better evaluation of resource
39
40 450 allocation better pre-hospital triage tools are necessary. This especially includes the assessment of
41
42 451 acuity in addition to symptom keywords at dispatch to accurately identify patients that are not
43
44 452 severely ill or injured. More information on discrepancies between diagnoses and acuity levels at
45
46 453 dispatch as compared to later assessment is needed, as the pre-selection of patient groups for
47
48 454 redirection is only viable when initial assessment and final diagnosis are sufficiently consistent.
49
50 455

51
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20 535
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31 540
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36 543 Competing interests

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38 544 The authors declare that they have no competing interests.
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40 545

41 546 Authors' contributions

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43 547 KH and SP conceived the study. KH performed the analyses, interpreted the data and drafted the
44 manuscript. HT provided input for interpretation of results and drafting of the manuscript. All
45 548 authors contributed to the critical revision of the manuscript and approved its final version.
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47 549
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51 551 Patient consent form

52
53 552 Not applicable
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55 553

56 554 Availability of data and material

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58 555 The data used in this paper was a combination of hospital and dispatch data. Dispatch data are third
59 party data used with permission of the Bavarian State Ministry of the Interior, Sport and Integration
60 556

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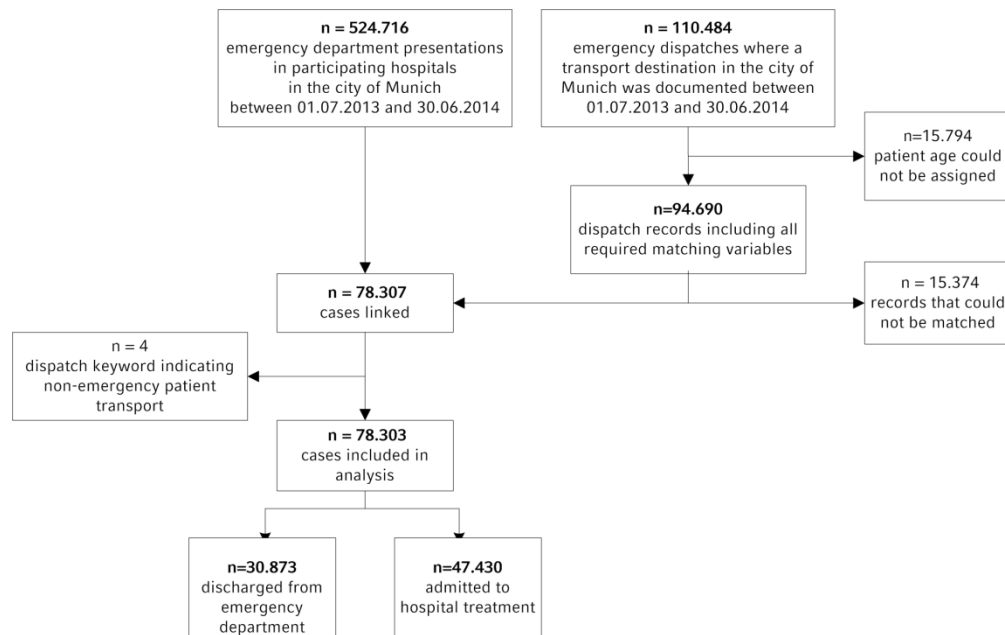


Figure 1: Study desing and case selection

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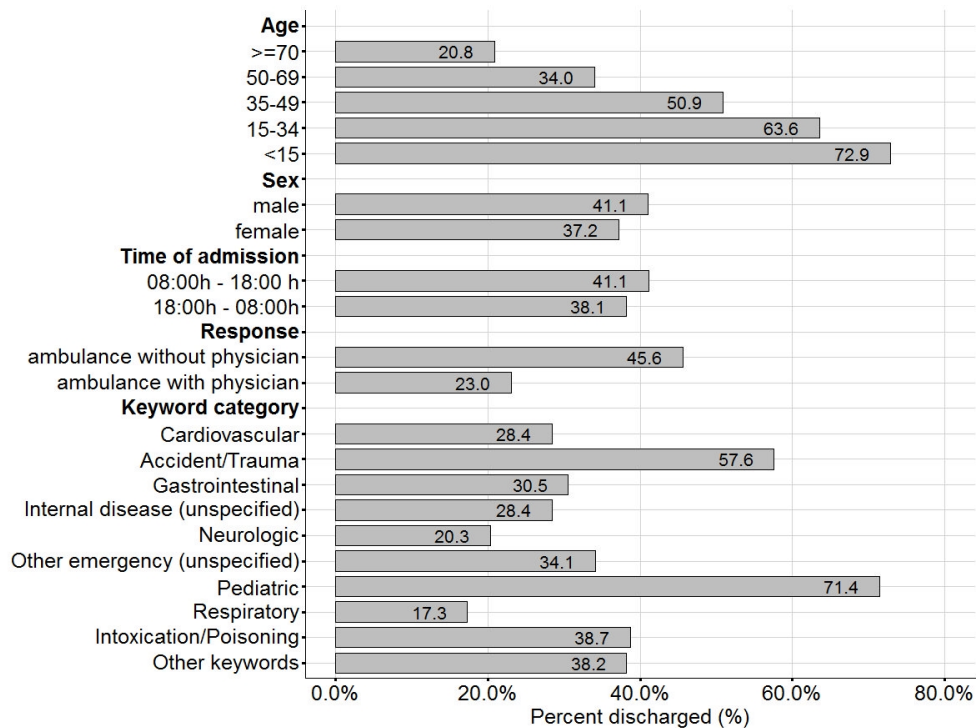


Figure 2: Probability of being discharged from ED after EMS transport

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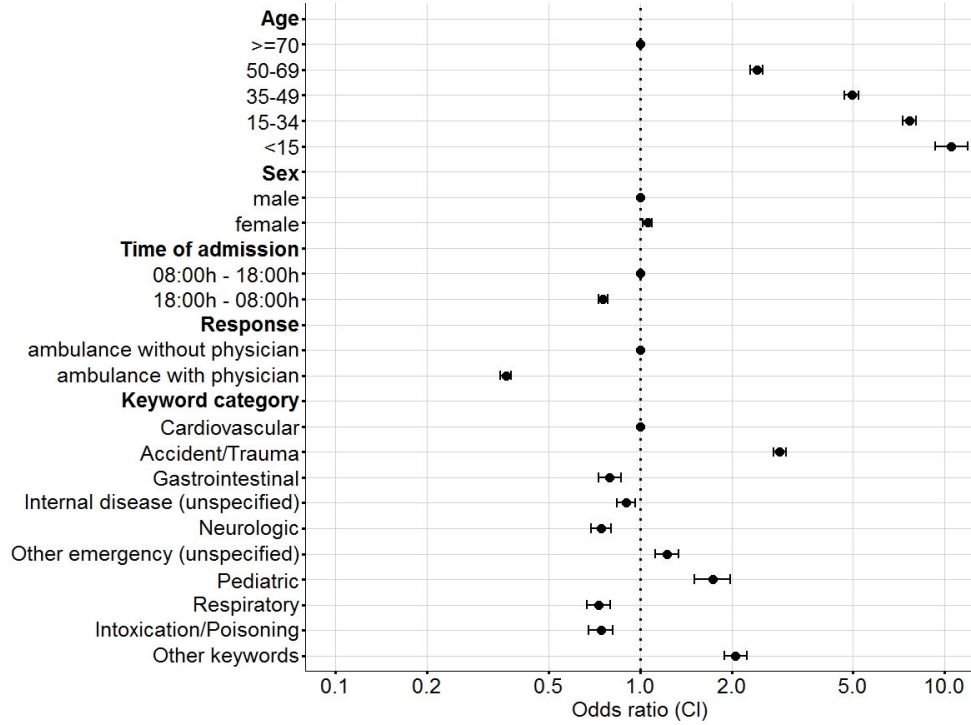


Figure 3: Adjusted odds ratios and confidence interval (95%) for discharge

101x73mm (300 x 300 DPI)

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

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) <i>Cohort study</i> - Give the		RECORD 6.1: The methods of study	6.1: Page 4/5,

		<p>eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up</p> <p><i>Case-control study</i> - 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</p> <p><i>Cross-sectional study</i> - Give the eligibility criteria, and the sources and methods of selection of participants</p> <p>(b) <i>Cohort study</i> - For matched studies, give matching criteria and number of exposed and unexposed</p> <p><i>Case-control study</i> - For matched studies, give matching criteria and the number of controls per case</p>		<p>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.</p> <p>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.</p> <p>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.</p>	<p>lines 116-138 figure 1 6.3: Page 4, lines 130-138, figure 1</p>
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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1	Study size	10	Explain how the study size was arrived at			Page 4, lines 116-123
2	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
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4	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) <i>Cohort study</i> - If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> - If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> - If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses			Page 5, lines 155-169, 307-315
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16	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
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18	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 (<i>e.g.</i> , 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>i.e.</i> , 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 (<i>e.g.</i> , 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) <i>Cohort study</i> - summarise follow-up time (<i>e.g.</i> , average and total amount)			Table 1
Outcome data	15	<i>Cohort study</i> - Report numbers of outcome events or summary measures over time <i>Case-control study</i> - Report numbers in each exposure category, or summary measures of exposure <i>Cross-sectional study</i> - Report numbers of outcome events or summary measures			Table 1

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	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
16 17 18 19 20	Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses			Table 2
21	Discussion					
22 23	Key results	18	Summarise key results with reference to study objectives			Page 12, lines 288-299
24 25 26 27 28 29 30 31 32 33	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
34 35 36 37 38 39 40 41	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
42 43 44	Generalisability	21	Discuss the generalisability (external validity) of the study			Page 13 lines 321-322

		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, Guttman A, Harron K, Moher D, Petersen I, Sørensen HT, von Elm E, Langen 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

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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

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1 Abstract

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

7 Design: retrospective observational study using linked secondary data

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

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

14 Results: 39.4% of cases were discharged. They were especially likely to be young (OR 10.53 (CI 9.31-
15 11.92), comparing <15 year olds to >70 year olds) and to fall under the categories
16 'accidents/trauma' (OR 2.87 (CI 2.74-3.01)) or 'other emergencies (unspecified)' (OR 1.23 (CI 1.12-
17 1.34) (compared to 'cardiovascular'). Most frequent diagnoses came from IDC-10 chapter 'injury and
18 poisoning' (30.1%), yet these diagnoses were more frequent at discharge (42.7 vs. 22.0%) whereas
19 circulatory system disease was less frequent (2.6% vs. 21.8%). Except for accidents/trauma and
20 intoxication/poisoning many underlying diagnoses were observed for the same dispatch keyword
21 Conclusion: Young age and dispatch for accidents or trauma were the strongest predictors of
22 discharge. Even within the same dispatch keyword category the distribution of diagnoses differed
23 between admitted and discharged cases. Discharge from the ED does not indicate that urgent
24 response was unnecessary. However, these cases could be suitable for allocation to hospitals with
25 low inpatient bed capacities and are of particular interest for future studies regarding the urgency of
26 their condition.

27 Strengths and limitations of this study

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

34 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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2
3 75 number 112. Calls are managed by regional dispatch centers that operate full time and coordinate
4 emergency and non-emergency ground and air ambulances and the fire brigade. Call-takers and
5 76 dispatchers are trained paramedics or firefighters who underwent dispatch training. A local, non-
6 77 standardized, keyword-based dispatch manual which is mainly based on chief complaints and
7 78 reported events is used to decide on the type and number of pre-hospital EMS units to be
8 79 dispatched to the scene of the emergency. Levels of EMS response include ambulances designated
9 80 to non-emergency transport, paramedic staffed ambulances and rapid response cars and helicopters
10 81 staffed with prehospital emergency physicians. Pre-hospital emergency physicians need a specialty
11 82 board certification for emergency medicine. A physician will be dispatched according to a pre-
12 83 specified catalogue when vital signs are suspected to be unstable or when the condition implicates a
13 84 high probability of need for invasive interventions. Physicians can also be activated at the discretion
14 85 of the dispatcher for tactical reasons or when they are requested by the paramedics on site.
15 86 According to suitability and intake capacity a dispatchers will suggest a hospital to which an EMS
16 87 patient should be transported to. This suggestion is usually accepted by ambulance crews, although
17 88 they can, in consultation with the dispatch center, decide on another destination if special medical
18 89 considerations prevail. Only a physician can decide whether a patient is left on scene. If hospitals
19 90 temporarily de-register to the dispatch center from acute care, EMS units have to travel to
20 91 alternative locations, which usually results in longer transport times and deducts units from their
21 92 home base.

22 93
23 94 A dispatcher can refer callers that do not need an EMS response to on-call or ambulatory services
24 95 provided by the Association of Statutory Health Insurance. On-call doctor services can be accessed
25 96 directly through 116,117 for urgent but non-emergency conditions. Patients can access all
26 97 ambulatory emergency care services on their own initiative, or seek care at a hospital's emergency
27 98 department.

28 99 29 100 Data sources and sample

30 101
31 102 Between 01.07.2013 and 30.06.2014, routinely collected information of all cases presenting to one of
32 103 14 emergency departments of 14 major hospitals in Munich was pooled into a study data base.
33 104 Dispatch information was extracted from a database that holds routinely generated data from the
34 105 computer-assisted dispatch systems of Munich's central dispatch center and surrounding dispatch
35 106 centers and billing information. During the study period, 524.716 cases presented to the 14 EDs and
36 107 110.484 emergency dispatches where a patient was transported to a destination in the city of
37 108 Munich were recorded by the dispatch centers, of which 78.307 (71%) could be matched to an ED
38 109 record. Four emergency dispatches were excluded, as the keywords indicated a non-emergency
39 110 transport. All data was anonymized and is therefore case-, not patient-based. Repeated presentation
40 111 by the same patient or EMS activation for the same patient could not be accounted for.
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3 112 Hospital data included basic case information (age, sex, admission status) and information about
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5 113 diagnoses (ICD-10-GM Codes). Dispatch data includes dispatch keywords, type of ambulance
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7 114 deployed, time stamps and receiving hospital. Billing data includes patient age, an essential
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9 115 identifier for the linkage of hospital and dispatch data. A probabilistic approach was used to link
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11 116 billing and dispatch records, and then dispatch and hospital records. Time stamps of dispatch and
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13 117 billing data were compared and patient age could be assigned to 86% of dispatch records. Second,
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15 118 patient age and admission time of dispatch and hospital records were compared. All records with an
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17 119 exact match of patient age and an arrival time within a 20 minute interval were linked, which was the
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19 120 case for 80% of records. When several records matched, the records with the smallest difference in
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21 121 arrival time were linked. This process was repeated for the remaining records, first through
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23 122 extending the admission time interval to 40 minutes, and then extending the age criterion to a 5
24
25 123 year range. The study design and case selection are illustrated in figure 1.

26
27 124 Cases were classified as discharged when there was no documentation for admission to the same
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29 125 hospital on the day of ED presentation. Information about admitted cases came from a standardized
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31 126 data set that hospitals are required to collect according to section 21 of the Hospital Remuneration
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33 127 Act (KHEntgG). Participating hospitals provided comparable information about discharged cases
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35 128 from their hospital information system. Records with identical items recorded within the first hour
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37 129 after admission were considered duplicates and removed from the dataset. Recording a primary
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39 130 diagnosis is only mandatory for admitted cases. The amount of missing data is displayed in the
40
41 131 results section. More than one diagnosis was recorded for 5.1% of discharged cases. In this case, the
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43 132 diagnosis with the highest estimated resource requirement was chosen as the primary diagnosis.
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45 133 Since dispatch keywords are not standardized, 293 different keywords were condensed and
46
47 134 classified into 15 categories (see supplementary material).

40 136 **Figure 1: study design and case selection**

43 138 Analysis

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47 140 The sample was characterized by calculating medians with interquartile range (IQR) for continuous
48
49 141 variables and frequencies and proportions for categorical variables. Statistical tests (χ^2 test for
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51 142 categorical variables and the Wilcoxon–Mann-Whitney-U-Test for continuous variables) were
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53 143 performed to evaluate differences between admitted and discharged cases. The probability of
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55 144 discharge was calculated for case characteristics. Logistic regression was performed to estimate the
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57 145 adjusted likelihood of discharge. Covariates were selected based on their availability at dispatch and
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59 146 included age, sex, dispatch keyword category and day and time of admission at the ED. The nine
60
61 147 most frequent dispatch keyword categories and ICD-10 diagnosis chapters are displayed. Remaining
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63 148 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			p-value*	
	N=78,303		discharged n=30,873	admitted n=47,430			
Age median (IQR)	60.0	(45)	40.0	(41)	70.0	(33)	<0.0001

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5	Sex n (%)						<0.0001
6	Male	35,888	(45.8)	14,735	(47.7)	21,153	(44.6)
7	Female	35,646	(45.5)	13,249	(42.9)	22,397	(47.2)
8	missing	6,769	(8.6)	2,889	(9.4)	3,880	(8.2)
9							
10							
11	Response n (%)						<0.0001
12	Ambulance without physician	56,856	(72.6)	25,933	(84.0)	30,923	(65.2)
13	Ambulance with physician	21,447	(27.4)	4,940	(16.0)	16,507	(34.8)
14							
15							
16							
17	Time of admission n (%)						<0.0001
18	08.00h - 18.00h	33,787	(43.1)	13,897	(45.0)	19,890	(41.9)
19	18.00h - 08.00h	44,516	(56.9)	16,976	(55.0)	27,540	(58.1)
20							
21							
22							
23	Day of week n (%)						0.25
24	Monday-Friday	56,019	(71.5)	22,016	(71.3)	34,003	(71.7)
25	Saturday-Sunday	22,284	(28.5)	8,857	(28.7)	13,427	(28.3)
26							
27							
28	Dispatch keyword category n (%)						<0.0001
29	Accident/Trauma	23,975	(30.6)	13,810	(44.7)	10,165	(21.4)
30	Cardiovascular	18,404	(23.5)	5,226	(16.9)	13,178	(27.8)
31	Internal disease (unspecified)	7,112	(9.1)	2,018	(6.5)	5,094	(10.7)
32	Neurologic	5,684	(7.3)	1,152	(3.7)	4,532	(9.6)
33	Respiratory	5,025	(6.4)	869	(2.8)	4,156	(8.8)
34	Pediatric	3,925	(5.0)	2,803	(9.1)	1,122	(2.4)
35	Gastrointestinal	3,856	(4.9)	1,178	(3.8)	2,678	(5.6)
36	Other emergency (unspecified)	3,449	(4.4)	1,176	(3.8)	2,273	(4.8)
37	Intoxication/Poisoning	2,970	(3.8)	1,150	(3.7)	1,820	(3.8)
38	Other keywords	3,903	(5.0)	1,491	(4.8)	2,412	(5.1)
39							
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44							
45	Primary ICD-10 diagnosis n (%)						<0.0001
46	XIX Injury, poisoning	23,592	(30.1)	13,169	(42.7)	10,423	(22.0)
47	IX Circulatory system	11,115	(14.2)	792	(2.6)	10,323	(21.8)
48	XVIII not elsewhere classified	8,625	(11.0)	3,695	(12.0)	4,930	(10.4)
49	V Mental and behavioural disorders	4,485	(5.7)	1,258	(4.1)	3,227	(6.8)
50	XI Digestive system	3,975	(5.1)	597	(1.9)	3,378	(7.1)
51	X Respiratory system	3,844	(4.9)	505	(1.6)	3,339	(7.0)
52	VI Nervous system	3,620	(4.6)	681	(2.2)	2,939	(6.2)
53	I Infectious and parasitic	2,636	(3.4)	459	(1.5)	2,177	(4.6)
54	XIII Musculoskeletal system	2,442	(3.1)	1,232	(4.0)	1,210	(2.6)
55	Other chapters	7,676	(9.8)	2,248	(7.3)	5,428	(11.4)
56							
57							
58							
59							
60							

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).

213 **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)	p	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	1,11 (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	0,71 (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	0,31 (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	3,31 (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	1,11 (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	0,71 (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	0,71 (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	0,51 (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	1,41 (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	1,81 (1,53-2,19)	<0.0001	2,71 (2,36-3,12)	<0.0001

214 Dispatch keyword category "pediatric" is omitted

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).

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

Dispatch keyword category	Diagnosis chapter											total
	I	V	VI	IX	X	XI	XIII	XVIII	XIX	Other	missing	
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

Dispatch keyword category	Diagnosis chapter											total
	I	V	VI	IX	X	XI	XIII	XVIII	XIX	Other	missing	
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

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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3 299 could not capture comorbid conditions, which are known to increase the risk of short-term adverse
4 300 outcomes for time-critical 112 callers with the same complaint[14]. The study area is a metropolitan
5 301 area and results might be different in rural regions or even in metropolitan areas with different pre-
6 302 hospital treatment or admission practices.

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11 304 Interpretations and comparison with other studies

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14 306 40% of cases transported to the emergency department by emergency medical services were not
15 307 admitted to the hospital. Our results can't be transferred to areas with different population
16 308 composition and healthcare infrastructure. This might explain why even higher discharge rates of
17 309 70% were observed in a mixed urban, suburban, and rural area in the United States,[7] where
18 310 alternatives to hospital emergency care are different. Another study from the United States reports a
19 311 50% discharge rate of ambulance patients in an urban area. [15] Studies in the pre-hospital setting
20 312 in Sweden and Australia have assessed more than one third of patients as not being in need of
21 313 prehospital interventions or ambulance transport, despite of ambulance dispatch.[16] [17]

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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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3 335 discharge, as physician dispatch is triggered by a higher probability of critically ill/injured patients
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5 336 and invasive interventions on scene.

6 337 Arrival at night also decreased the odds of discharge. Such cases could be of higher acuity. There
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8 338 may also be fewer alternatives to admission available, or decision-making may be postponed due to
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10 339 limited diagnostic availabilities or absence of senior physicians at the ED at night.

11 340 We hypothesized that certain dispatch keyword groups would clearly mark situations or health
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13 341 problems that usually don't lead to subsequent hospital admission. Other studies have identified a
14 342 number of situations that were less likely to lead to hospital admissions or EMS transport or were
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16 343 considered suitable for referral to other levels of care. They include assaults and unconsciousness or
17 344 fainting in younger patients, [7] pediatric cases, psychiatric conditions, patients with low pain
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19 345 scores[17], nausea/vomiting/diarrhoea, seizures/epilepsy, back pain, pain during
20 346 urination/haematuria, mental illness and unspecified disease.[8] Low-acuity dispatch codes included
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22 347 abdominal pain, assault, back pain, pregnancy and childbirth, injuries and psychiatric conditions [20]
23 348 and were validated in the same area,[21] but did not turn out to be low-acuity in another
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25 349 community.[22] Non-transport after EMS dispatch was especially more common after assault/sexual
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27 350 assault, unknown problem/man down, traffic/transportation accidents, unconscious/fainting [23]
28 351 and mental, behavioral and neurodevelopmental disorders [24]. Our analysis shows that, compared
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30 352 to dispatch for cardiovascular problems, odds of discharge were especially high for cases
31 353 transported after accidents or trauma, emergencies involving children and emergencies where
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33 354 dispatchers did not specify the reason for dispatch. We already discussed reasons why young age
34 355 might increase the odds of discharge. Higher odds of discharge after accidents and injuries might be
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36 356 because diagnostic resources that are only available in a hospital setting are required for a thorough
37 357 examination of these cases, after which they can frequently be cleared. Injury severity and whether
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39 358 these patients were readmitted for elective surgery remains unknown. However, that they could
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41 359 initially be discharged suggests that, overall, injury severity was presumably low. A need of hospital-
42 360 specific resources could also apply to emergencies where the problem can't be specified by the
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44 361 dispatcher. Determining the priority level of unclear calls is particularly difficult, and they are
45 362 therefore often provided with a either lower or higher response than needed.[25][26]
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48 364 The spectrum of disease differed between discharged and admitted cases, with a higher proportion
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50 365 of chapter XIX (Injury, poisoning) diagnoses in discharged and more ICD-10 chapter IX (circulatory
51 366 system) diagnoses in admitted cases. Except for two keyword categories (accident/trauma and
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53 367 intoxication/poisoning), a broad range of underlying diagnoses was reflected by the same initial
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55 368 complaint for both admitted and discharged patients. Keyword category and hospital diagnosis
56 369 were more similar when a condition seemed easily recognizable, like accidents or trauma and
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58 370 intoxication or poisoning. These situations might be more intuitive for patients and bystanders to
59 371 describe. Discrepancies between keyword and diagnosis might point to patient groups that are
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3 372 probably more difficult to manage and were observed slightly more frequently for discharged cases.

4 373 The distribution of cases across diagnosis chapters differed between admitted and discharged cases,

6 374 even within the same keyword category. This suggests that the disease spectrum of both groups

7 375 differs, even if similar complaints are initially expressed.

9 376 At dispatch, the correct assessment of urgency is more important than diagnostic accuracy. Still,

10 377 complaints influence patient management. Pre-hospital emergency conditions usually don't present

12 378 themselves as "textbook examples". [26] Especially nonsurgical emergency patients often lack

14 379 diagnosis-specific symptoms. [27] The analyses show that some conditions are very common in both

15 380 groups. They included alcohol intoxication, concussion and syncope. Standard operating procedures

17 381 have been defined to handle these conditions in the ED [28] to safely identify patients with high risk

18 382 of adverse outcomes and might be useful for a standardized assessment of emergency calls as well.

20 383

21 384 The dispatch center is the earliest point of time in the rescue chain at which triage might occur, but

23 385 due to limited information it is also one of the most difficult ones. [29] Most emergency response

24 386 systems accept a certain level of over-triage as a safety margin. [30] [16] but over-triage is also

26 387 costly can result in resources not being available to someone who needs them. The dispatcher

27 388 allocates ambulances and specialized prehospital units [31] and plays a key role in identifying the

29 389 best resources for the caller or patient. [30] mostly depends on an accurate assessment of the

31 390 urgency and acute symptoms, and not on the overlap of dispatch data with later confirmed

32 391 diagnosis or discharge from the ED. Odds of discharge and overlap with diagnosis are therefore not

34 392 suitable to assess the quality of response decisions and not good criteria to base response decisions

35 393 on. Yet patient groups that are frequently discharged could be of particular interest or further more

37 394 detailed analyses with regard to the urgency of their conditions. Information about the probability

38 395 of discharge may furthermore be helpful to allocate of patients to hospitals when hospital beds are

40 396 congested.

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43 398 There are other variables that probably impact on discharge or distort the relationship between

44 399 included variables and discharge, and not considering them has consequences for the interpretation

46 400 of estimates. They were not included in the analysis as they are not available at dispatch and not

48 401 part of the routine data collection, and they are usually not available at the point where a response

49 402 decision is made. Two important factors are morbidity and socioeconomic status. Socioeconomic

51 403 status is brings a higher burden of disease, and patients with low socioeconomic status are more

52 404 likely to use acute and hospital care. [32] Socioeconomic differences between chronic diseases seem

54 405 to vary, with larger disparities for stroke, diseases of the nervous system, diabetes mellitus, and

55 406 arthritis.[33] Socioeconomic status is therefore likely linked with certain dispatch keyword categories

57 407 and for instance low odds of discharge for neurologic keywords might partially be masked by

58 408 socioeconomic status. Regardless of the initial complaint, previous illness and comorbid conditions

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3 409 might always complicate treatment and therefore also decrease the odds of discharge. As morbidity
4 410 increases with age, a part of the effect of age might actually be traced back to comorbid conditions.

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8 412 **Conclusion**

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11 414 Discharge was especially likely when patients were young or after dispatch for accidents/trauma.
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13 415 Except for accidents/trauma and intoxication/poisoning many underlying diagnoses were observed
14 416 within dispatch categories. Even within the same dispatch keyword category, the distribution of
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16 417 hospital diagnoses differed between admitted and discharged cases, indicating a differing spectrum
17 418 of disease. Discharge from the emergency department after emergency medical services transport
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19 419 can't be equated with low potential for critical illness or injury or no need for pre-hospital resources.
20 420 Rapid transport may be necessary to exclude worrisome differential diagnoses or to treat conditions
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22 421 using resources that are not available outside of a hospital setting. Yet the findings could guide
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24 422 allocation of ambulances to hospitals when hospital bed capacities are low, so that transport
25 423 capacities are quickly available again. Frequently discharged patients are also worth a closer look
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27 424 regarding the urgency of their condition to manage the growing demand for emergency medical
28 425 resources. To accurately identify patients that are not severely ill or injured and for a better
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30 426 evaluation of resource allocation, acuity should be assessed in addition to symptom keywords at
31 427 dispatch.
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33 428
34 429 **References**

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47 513

48 514 Competing interests

49 515 The authors declare that they have no competing interests.
50 516

51 517 Authors' contributions

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

Patient consent form

Not applicable

Availability of data and material

526 The data used in this paper was a combination of hospital and dispatch data. Dispatch data are third
527 party data used with permission of the Bavarian State Ministry of the Interior, Sport and Integration
528 and the Bavarian social insurance agencies. Hospital data are third party data analyzed with
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530 data.

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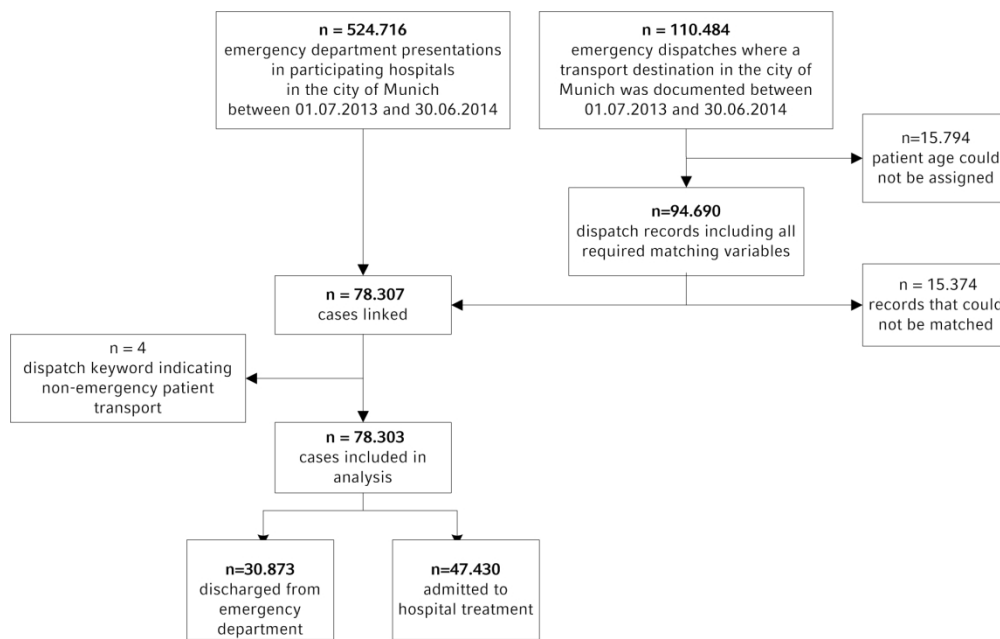


Figure 1: Study desing and case selection

170x107mm (300 x 300 DPI)

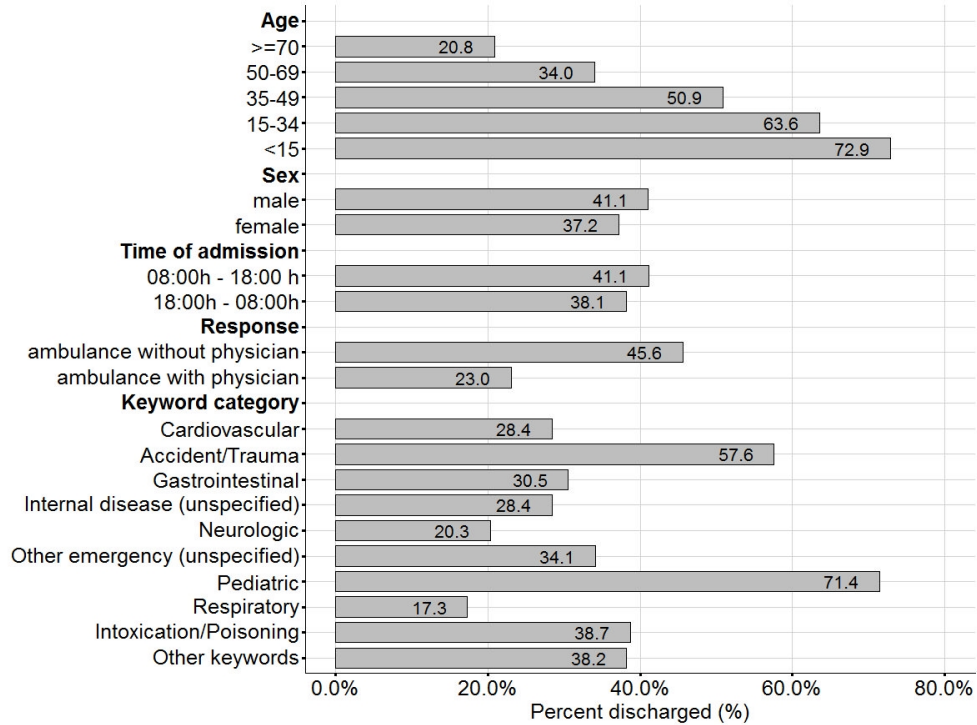


Figure 2: Probability of being discharged from ED after EMS transport

101x73mm (300 x 300 DPI)

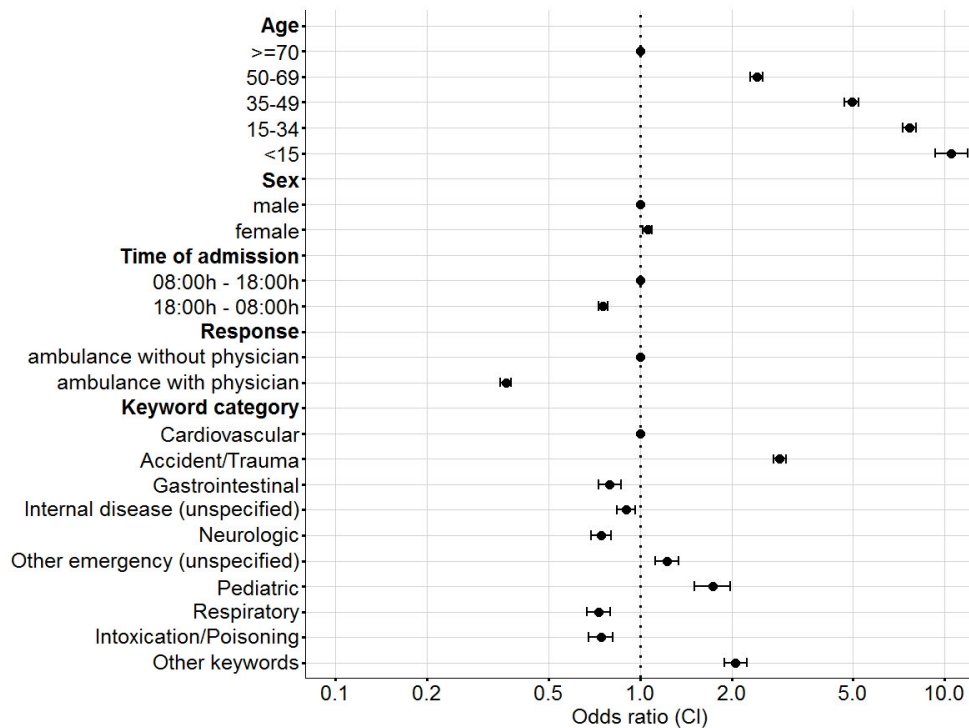


Figure 3: Adjusted odds ratios and confidence interval (95%) for discharge

101x73mm (300 x 300 DPI)

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

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) <i>Cohort study</i> - Give the		RECORD 6.1: The methods of study	6.1: Page 3/4,

		<p>eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up</p> <p><i>Case-control study</i> - 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</p> <p><i>Cross-sectional study</i> - Give the eligibility criteria, and the sources and methods of selection of participants</p> <p>(b) <i>Cohort study</i> - For matched studies, give matching criteria and number of exposed and unexposed</p> <p><i>Case-control study</i> - For matched studies, give matching criteria and the number of controls per case</p>		<p>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.</p> <p>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.</p> <p>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.</p>	<p>lines 104-114 figure 1 6.3: Page 4, lines 118-126 , figure 1</p>
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	<p>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</p>			Page 4, lines 115-118, lines 104-208
Bias	9	Describe any efforts to address potential sources of bias			

1 2 3 4 5 6 7	Study size	10	Explain how the study size was arrived at			Page 4, lines 116-123
8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32	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
33 34 35 36 37 38 39 40 41 42	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) <i>Cohort study</i> - If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> - If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> - If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses			Page 4/5, lines 143-157
43 44 45 46 47	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 (<i>e.g.</i> , 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>i.e.</i> , 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 (<i>e.g.</i> , 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) <i>Cohort study</i> - summarise follow-up time (<i>e.g.</i> , average and total amount)			Table 1
Outcome data	15	<i>Cohort study</i> - Report numbers of outcome events or summary measures over time <i>Case-control study</i> - Report numbers in each exposure category, or summary measures of exposure <i>Cross-sectional study</i> - Report numbers of outcome events or summary measures			Table 1

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1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	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
16 17 18 19 20	Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses			Table 2
21	Discussion					
22 23 24	Key results	18	Summarise key results with reference to study objectives			Page 12, lines 271-282
25 26 27 28 29 30 31 32 33	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
34 35 36 37 38 39 40 41	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
42 43 44	Generalisability	21	Discuss the generalisability (external validity) of the study			Page 13 lines 305-307

		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, Guttman A, Harron K, Moher D, Petersen I, Sørensen HT, von Elm E, Langen 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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