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Research paper

The role of emergency medical services in the management of in-hospital emergencies: Causes and outcomes of emergency calls – A descriptive retrospective register-based study

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A B S T R A C T

Background: Medical emergency teams (METs) are in place in some hospitals in Finland to respond to critical emergency events. However, in hospitals without dedicated METs, staff are instructed to call emergency medical services (EMS) to deal with emergencies. This study examined the reasons for calling EMS to hospitals and the outcomes of these calls.
Methods: Descriptive retrospective register-based study of the response and management of in-hospital emergencies by EMS in the wellbeing services county of Southwest Finland. Patient care reports of the EMS and those of the hospitals were analysed.
Results: In total, 138 medical emergencies managed by EMS were included in this study. 108 of these related to patients, and 25 related to hospital personnel. Cardiac arrest (n = 36) and a reduced level of consciousness (n = 29) were the most common in-hospital emergencies. In 68% of in-hospital emergencies managed by the EMS team, after calling 112, hospital personnel implemented various treatment measures. In 72% of cases, follow-up treatment was required.
Conclusions: Hospital personnel are able to initiate medical measures in emergencies, even when no MET is available. Although EMS are important in responding to in-hospital emergencies, they seem to be performing the same role as METs.
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1. Introduction

Hospitals provide care for patients, some of whom may be seriously ill and experience sudden deterioration in their condition. Hospital staff, as well as patients and visitors, can also suddenly become unwell. Various systems, including the establishment of medical emergency teams (METs), are in place to address in-hospital emergencies. [1–6] The purpose of the MET is to manage abnormal vital signs, begin treatment in the hospital ward, and, if necessary, transfer the patient to the intensive care unit. [7] In Finland, METs or resuscitation teams are not available in every hospital. [1] In such cases, one option is to call an ambulance to take care of the in-hospital emergency. Moreover, as the ability of hospital wards to treat critically ill patients varies, emergency medical service (EMS) can be called for many reasons, even if a physician on duty is present.

No previous research has been conducted on the practice of calling EMS inside a hospital to handle emergencies. Thus, it is not known how common this operational model is. In addition, the EMS systems and the usage possibilities of ambulances vary worldwide. However, the phenomenon is intriguing on a global scale, given the growing constraints on healthcare resources, the shortage of staff competent to manage emergencies, and the emerging opportunities to employ the existing resources in new ways. Therefore, the aim of the current study was to examine 1) the reasons for calling EMS to hospitals with physicians available around the clock, 2) to describe the treatment given prior to the arrival of the EMS, 3) to describe treatment administered by the EMS, and 4) to report the outcomes of these calls.

Abbreviations: BP, blood pressure; CI,, confidence interval; DNR,, do not resuscitate; ECG,, electrocardiogram; EMS,, emergency medical services; ePCR,, electronic patient care report; GCS,, Glasgow coma scale; ICU,, intensive care unit; IV,, intra-venous; IQR,, interquartile range; MET,, medical emergency team; SD,, standard deviation; TUCH,, Turku University Central Hospital; TCH,, Turku City Hospital

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2. Material and methods

This was a descriptive retrospective register-based study of EMS visits to two hospitals in Finland: Turku University Central Hospital (TUCH) main campus and Turku City Hospital (TCH). The study was conducted between January 1, 2017 and December 31, 2021.

2.1. Setting

In the study area, tertiary care was centralized on a campus area of a university hospital (TUCH) with several buildings and 778 beds. MET or an equivalent emergency care team and comprehensive physician services were available around the clock in the two main hospital buildings. Additionally, in one of the campus area main buildings, a physician was available from neighbouring buildings or from home, but hospital personnel were also advised to call the emergency number used in Finland, 112, in case of an emergency.

TCH provided special care services to residents (*n* = 195 137) of the city of Turku. [8] During the study period, the hospital had between 182 and 337 beds available. Similar to TUCH, personnel in TCH had been instructed to call 112 in emergency situations, even when there was a physician available.

In the study area, the ambulances are principally manned by one advanced level paramedic and one basic level paramedic with three-year vocational education or two of the former. Advanced level paramedics are registered nurses with advanced-level out-of-hospital specialization or Emergency Care/Nursing dual Bachelor's degree. [9] The nearest EMS station is located 3 km from the hospitals. During peak congestion periods, EMS may have to be alerted to emergency situations from further away, but an ambulance returning from the hospital may have been alarmed as well.

2.2. Data collection

Electronic patient care reports (ePCRs) (*n* = 80) and paper patient care reports (*n* = 58) of the EMS and ePCRs (N = 138) of the Hospital District of Southwest Finland were used in this study. In Finland, 112 calls are classified into four urgency categories: A, B, C and D. A and B are urgent (i.e. 'lights and siren' alerts), in which the patient should be reached as quickly as possible. Non-urgent alerts are C and D, in which patients should be reached within 0.5 and 2 h, respectively. [10].

This study focused on EMS alerts classified as A and B from TUCH main campus or TCH during 2017–2021. This study included only EMS alerts in which the alarm had been raised inside the hospital building. We included 112 calls made from the three hospital buildings with a physician available around the clock, and excluded 112 calls made inside the hospitals where the caller had come to the hospital to make the call, and 112 calls relating to paediatric patients.

2.3. Recorded data

Information collected on the EMS alerts included the date, time, dispatch code and type of critical care event. Cancelled EMS alerts were included only if the EMS team had filed an ePCR and the initial reasons for the alerts and the cancellation were available from the report (*n* = 5).

The EMS alerts were divided into two groups, those relating to hospitalized patients or their visitors (later: patients) and those relating to hospital personnel (later: personnel). When referring to these groups together, the term 'victims' is used. Each victim was considered only once in the background characteristics (*n* = 132), even if this victim was the reason for more than one 112 call. The locations of the emergencies were recorded and classified as ward, outpatient clinic or 'other' (e.g. a laboratory or corridor).

The reason for the 112 call, the caller (nurse, physician or unknown), the involvement of a physician on duty and the treatments administered prior to the arrival of the EMS were extracted from the data. Changes in consciousness necessitating a 112 call were classified into those where the patient had regained consciousness prior to the arrival of the EMS and those where the patient had not regained consciousness by the time the EMS arrived. Treatments administered prior to the arrival of the EMS were recorded, and data that remained fewer than five were grouped as "other". The patient's symptoms at the time of EMS arrival and first measured vital signs were also recorded, as well as the patient's condition (vital signs) post-treatment by the EMS. Finally, new diagnoses and treatment limitations post-management by the EMS, patient transfer and destination and 30-day-survival were collected from the ePCRs. A diagnosis was defined as new if not previously reported in the ePCRs.

2.4. Statistical analysis

Statistical analysis was performed separately among patients and personnel. The groups were combined as victims in reporting the location and time of the incident, treatments before and after the arrival of the EMS, vital signs pre-treatment by the EMS and follow-up treatment.

The frequency of 112 calls to the EMS made during office hours (Monday to Friday: 8 a.m. to 4 p.m.) was compared with that during non-office hours using a one-sample binomial test, and differences in the frequency of 112 calls according to the day of the week and month were tested using a one-sample chi-square test. The normality of data was tested using the Kolmogorov–Smirnov test. For normally distributed data, the mean, standard deviation (SD), median, interquartile range (IQR) and minimum-maximum (min-max) are reported. Non-normally distributed data are reported as median, IQR and min-max. The confidence intervals (CIs) for the change between the first vital signs (i.e. those measured at the time of EMS arrival). SPSS version 28 (IBM Corporation, Armonk, NY, USA) was used for all statistical analyses.

2.5. Ethical considerations

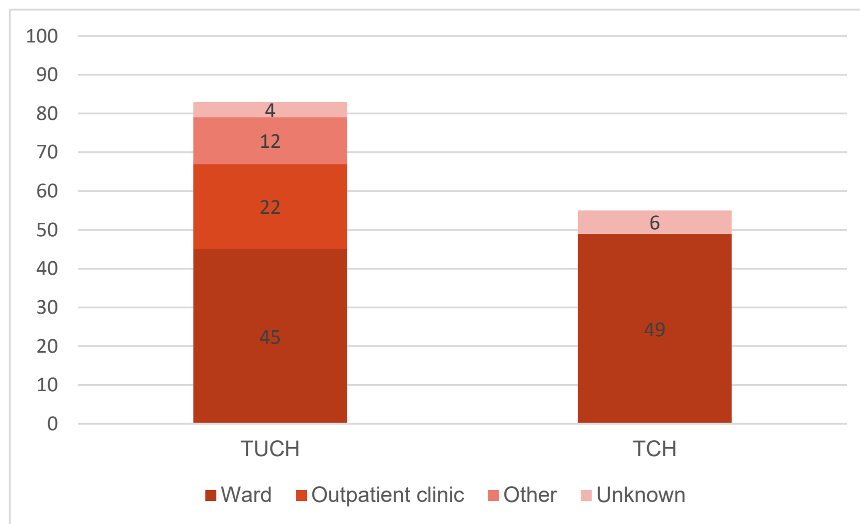
The Hospital District of Southwest Finland granted a permit for the study (T127/2022). As a retrospective registry study, ethics committee review and patient consent were waived by the Finnish National Board on Research Integrity TENK. [11] Personal data (names and personal identification numbers) were removed prior the analysis. In relation to the ages of the personnel in the study, the min-max is not reported.

3. Results

Of 138 emergency calls, 25 calls related to hospital personnel, and 108 calls related to patients (Appendix 1). The mean age of the victims (*n* = 127) was 68.4 years, and 53% of them were women. Among the patients, the most common reasons for initial hospitalization were infection 22% and other internal diseases 20% (e.g reduced general condition or pulmonary disease). In the patient group, 16% had treatment limitations, of which 77% were Do Not Resuscitate (DNR) orders.

3.1. Reasons for calling the EMS to hospitals

There were 138 emergency calls to EMS relating to 132 victims, with TUCH making 83 (60%) calls and TCH making 55 (40%) calls. The number of EMS alerts to wards in TUCH and TCH was the same, but the total number of alerts to TUCH was higher due to the presence of outpatient clinics and other hospital facilities (Fig. 1). Cardiac arrest was the reason for 42% of emergency calls by TUCH and 20% of



TUCH: Turku University Central Hospital main campus; TCH: Turku City Hospital.

Fig. 1. Frequency distribution of EMS alerts ($N = 138$) by ward, outpatient clinic and other location.

Table 1
Reasons for emergency calls ($N = 138$).

	Patients % (n)	Personnel % (n)
Cardiac arrest	26 (36)	0 (0)
Altered state of consciousness	19 (26)	2 (3)
Fainting/syncope	6 (8)	1 (2)
Deterioration of general condition	8 (11)	2 (3)
Pain	4 (5)	4 (5)
Stroke	5 (7)	1 (2)
Respiratory failure	6 (8)	0 (0)
Seizure	4 (5)	1 (2)
Trauma	3 (4)	1 (2)
Other	2 (3)	4 (6)

emergency calls by TCH. The most common final reason for calling 112 was cardiac arrest ($n = 36$). The reasons for calling EMS are shown in Table 1.

In 78% of cases, the 112 caller was a nurse. The 112 call was ordered by a physician in 4% of cases. In 96% of cases, the proposer of the call was not clearly documented. There was a physician present at the time of 33% of 112 calls. In 49% of the 112 calls, it was not recorded, whether a physician was involved.

In terms of the EMS alerts and type of speciality, the highest number of alerts were to internal medicine wards (12%), followed by ophthalmology outpatient clinics (10%). In relation to the times of the 112 emergency calls, 45% of calls were made during office hours (Monday to Friday: 8 a.m. to 4 p.m.). In terms of the distribution of these calls according to day (weekday) or month, there was no statistically significant difference ($p = 0.191$ and $p = 0.383$, respectively, Fig. 2). Fig. 3 shows the distribution of EMS alerts by weekday and weekend.

3.2. Treatment prior to the arrival of the EMS

In relation to the 46 calls due to cardiac arrest, 31 patients were in cardiac arrest when the EMS arrived on scene. Another two patients suffered cardiac arrests, although the EMS had been called for other reasons.

Most (91%) of the cardiac arrests occurred in hospital wards. Cardiopulmonary resuscitation had been initiated for every cardiac arrest patient ($n = 33$) before the EMS arrived. None of these patients had DNR orders. The mean age of the resuscitated patients was 76.3 years. In the resuscitation cases, a defibrillator had been attached in 16 cases, and in 7 cases the patient had been defibrillated. The initial rhythm had been documented in only three of the 33 cardiac arrest patients.

Table 2 shows the treatment procedures before the arrival of the EMS.

3.3. Treatment administered by the EMS

At the time of the EMS arrival, the most common symptoms of the victims were dyspnoea (21%), pain (15%) or an altered level of consciousness (14%). Table 3 shows the victims' vital signs measured by the EMS upon arrival at the hospital.

The EMS teams initiated fluid therapy in 26% of cases, and 33% of victims were given medications of which the most common were vasopressors (35%), analgesics (25%) and sedatives (8%). The treatments administered by the EMS teams are shown in Table 4. In 33% of EMS visits, a physician guided the treatment at the patient's bedside. The EMS teams consulted a physician by phone in 17% of patient cases. In addition, in 2% of cases, the EMS team tried to contact a physician, but a physician could not be reached (listed in the patient's records). An emergency medicine physician ($n = 7$) and a neurologist ($n = 6$) were most often consulted.

There was large variation in the level of registering of patient data. For example, vital signs were not systematically measured in all cases at the time of arrival of the EMS on scene. The reporting of the first vital values was variably missing between 5% and 58% of cases (Table 3). In addition, the EMS team measured vital signs post-treatment in fewer than 20% of cases.

3.4. Outcomes of the calls

In total, 72% ($n = 100$) of the victims were transferred. The most common transfer destination was TUCH emergency department (95%). The outcomes of the EMS missions are shown in Table 5.

All the 112 calls that culminated in victims' deaths had been cardiac arrest cases ($n = 18$). In total, 24% of resuscitated patients ($n = 33$) were alive 30 days after the incident necessitating the 112 call.

Forty-eight victims received a new diagnosis after the EMS visit, which was different from the original diagnosis at the time of

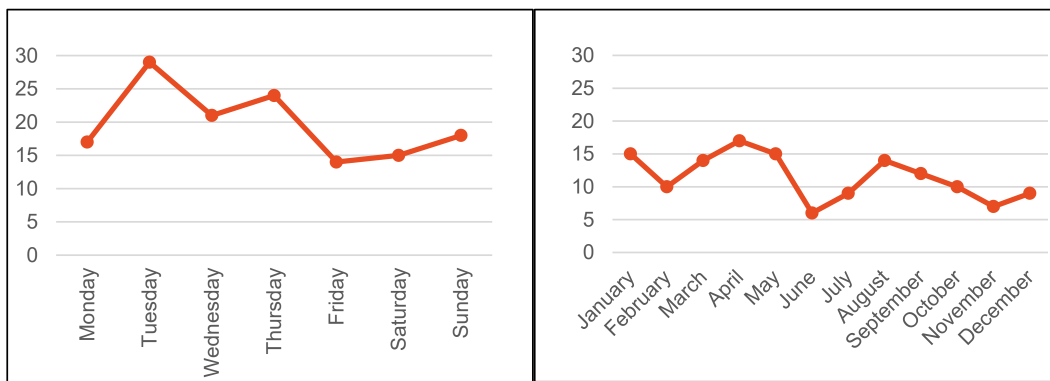


Fig. 2. Frequency distribution of EMS alerts ($N = 138$) by day of the week ($p = 0.191$) and month ($p = 0.383$).

hospitalization. Cardiovascular diseases ($n = 13$) and neurological diseases ($n = 13$) were the most common new diagnoses. Other diagnoses included internal diseases ($n = 9$), infectious diseases ($n = 7$), pulmonary diseases ($n = 5$) and diseases requiring surgery ($n = 1$). After the care in emergency department, 41% of victims were transferred for follow-up treatment to other specialised medical care wards. A flow chart of the victims who were transferred by EMS to the emergency department ($n = 95$) is shown in Fig. 4. In total, 67% of victims ($n = 133$) were alive 30 days after the EMS visit.

4. Discussion

In this study, cardiac arrest and a reduced level of consciousness were the most common reasons to call EMS to the hospital. One-third of the victims attended by EMS teams received medication. In most cases, EMS transferred the victim to the emergency department, which is the transport destination according to the area guidelines. Of the victims transferred, the majority of cases were for follow-up treatment in monitoring wards, intensive care units or other specialised medical care wards.

The most common emergency was cardiac arrest. This finding differs from that of previous studies, where the proportion of cardiac arrests among MET or rapid response team alerts was significantly lower. [3–7,12–16] One possible explanation for this might be that in the hospitals in the present study, the personnel has been instructed to call an ambulance in cardiac arrest and other emergency cases but treat less severe cases themselves.

One unanticipated finding was that one-fifth of the EMS alerts concerned hospital workers or visitors. Other studies have reported a similar phenomenon in which the proportion of outpatients was 13% in one study [17] and 24% in another. [7] However, it should be noted that the outpatient group in the aforementioned studies included polyclinic patients. In the present study, for most of the 112 calls made in relation to employees, the cases were not serious, and only a small number of employees were transferred urgently to the emergency department and required follow-up treatment. Some

Table 2
Treatment after the 112 call, prior to the arrival of the EMS ($N = 133$).

Cardiopulmonary resuscitation	25%
Airway management*	19%
Any supplementary oxygen	16%
Defibrillator attached	14%
IV access/fluid therapy	13%
IV medication	23%
Oral, inhaled or rectal medication	8%
Vital signs measurement	8%
Patient positioning	8%
Not done or not recorded	32%

* Supraglottic airway device or intubation. IV: intra-venous.

Table 3
First vital signs of the living victims ($N = 112$) measured by the EMS teams.

	Mean (SD)*	Median (IQR)	Min-Max	*Missing*
Systolic BP mmHg	135.7 (31.7)	135.5 (44)	58–247	*5%*
Diastolic BP mmHg	78.4 (18.5)	77.0 (27)	28–120	*5%*
Heart rate / min		85.5 (33)	30–210	*5%*
Oxygen saturation %		97 (6)	50–100	*7%*
Respiratory rate / min		16 (8)	10–50	*58%*
GCS		15 (4)	3–15	*34%*
Temperature	36.9 (0.8)	36.8 (0–7)	35.2–39.6	*46%*
Blood sugar	7.8 (2.6)	7.2 (3.3)	2.4–15.6	*52%*

* Only normally distributed data are presented in mean and SD. BP: blood pressure; GCS: Glasgow coma scale; IQR: inter-quartile range; SD: standard deviation.

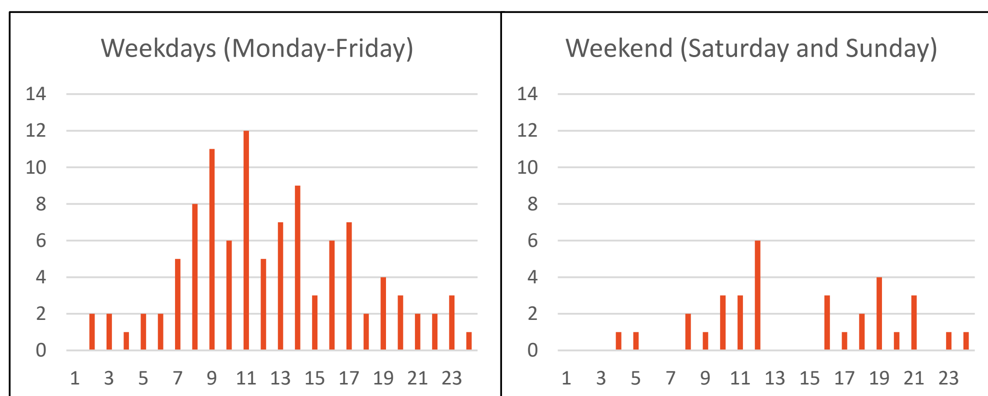


Fig. 3. Frequency distribution of EMS alerts ($N = 138$) by weekday and weekend.

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Table 4
Treatments administered to the victims ($N = 133$) by the EMS teams.

Airway management*	19%
Non-invasive ventilation	6%
Supplementary oxygen	11%
Cardiopulmonary resuscitation	14%
IV, oral or inhaled medication	33%
Fluid therapy	26%
Other	8%
Unclear	2%
ECG recording or monitoring	26%

* Supraglottic airway device or intubation. ECG: electrocardiogram; IV: intra-venous.

Table 5
Victims transfer ($N = 133$) post-EMS management.

	Patients ($n = 108$)	Personnel ($n = 25$)
Transferred		
Urgent	50%	16%
Non-urgent	24%	64%
Not transferred		
Remained in the same ward	9%	
No further treatment needed		20%
Deceased	17%	0%

evidence exists among EMS that treating a colleague can be a stressful experience. [18–20] This may partly explain why hospital personnel called 112 for colleagues with non-serious illness.

In the current study, most of the incidents occurred in the ophthalmology out-patient clinic and internal medicine ward. A possible explanation for this might be that the ophthalmology clinic has no special expertise in treating emergencies and that the internal medicine ward deals with a large proportion of elderly patients with multimorbidity. [21,22].

Of note, in the present study, hospital personnel tried to implement various treatment measures after calling 112. Cardiopulmonary resuscitation had been started for all cardiac arrest patients before the EMS arrived at the hospital. In three-fifths of the EMS visits to deal with cardiac arrests, the emergency was in an internal medicine ward. It is possible that some of these cardiac arrests could have been prevented if a MET had been present in the hospital and the patient's condition had been assessed. [3,23–27] In addition, it is possible that by increasing competence in handling emergencies by additional training, wards could be able to treat less severe situations independently.

The most common treatments administered by the EMS team was medication (33.1%) fluid therapy (26.3%), airway management (18.8%) and supplementary oxygen (10.5%). Similar results were observed in studies by Jung et al. [3] and Silva et al. [7] In our study, one-seventh of the victims died after the arrival of the EMS at the scene, 40.6% of victims required urgent transfer to other departments, and 31.5% of victims required non-urgent transfer to other departments. Thus, it can be concluded that alerting EMS was necessary.

This study revealed incomplete records in EMS team's patient information systems. Other studies have reported similar findings for records of vital signs by EMS. [28–30] A potential explanation is that EMS teams focus on victim care rather than registering victims' vital signs and treatments in ePCRs. In addition, as the transport time in the current setting to the emergency department is less than 10 min, it is possible that the EMS team did not have time to record all the victims' details. In about 20% of the alerts, vital signs were recorded a second time. In the cases where all relevant patient details were not recorded in ePCRs, the victims may have been monitored more frequently and received more treatments.

During the study period, there were approximately 65,000 EMS alerts per year in the Hospital District of Southwest Finland. (T. Iirola, personal communication 29.1.2023). Thus, 112 calls from hospitals are not a burden on EMS. Previous research reported that METs could prevent in-hospital emergencies and improve patient survival. [24] Although EMS is able to handle in-hospital emergencies, it is important to consider, however, that an emergency situation can be resolved much more quickly by METs than EMS, which may have to travel some distance to the hospital. Ultimately, METs could also be important in less-severe situations where EMS in the current setting had not been called [3,5,13] and the MET can also be alerted only due to the clinical concern. [4,5] Further research should be undertaken to investigate the effectiveness of EMS in hospital emergency situations in situations where the MET is not available.

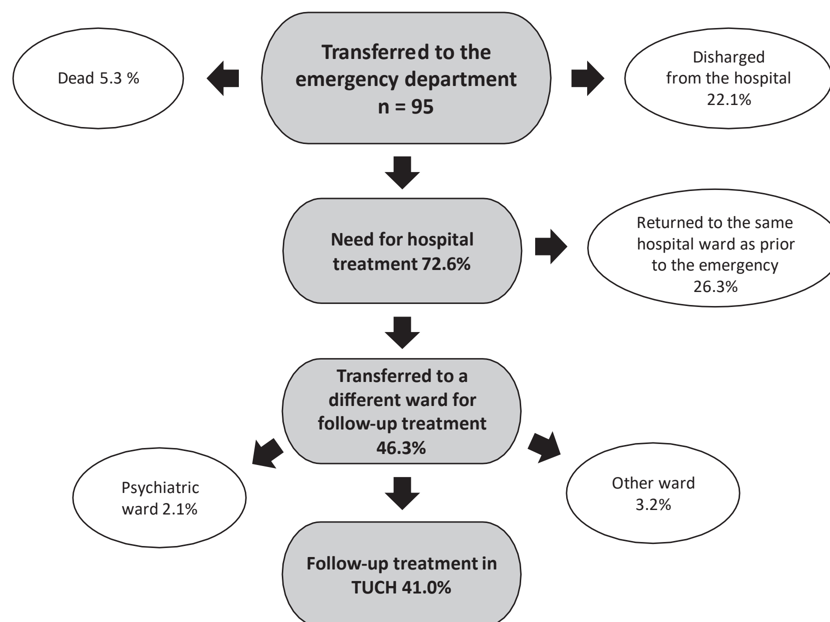

Fig. 4. Flow chart of the victims who were transferred to the emergency department ($n = 95$).

4.1. Strengths and limitations

A major strength of the current study is that all EMS alerts with timestamps and location information were automatically recorded in the electronic database of the Hospital District, which makes the data comprehensive. Therefore, it was possible to match all 112 calls with the relevant hospital emergency from the ePCRs. In addition, the data recorded in the ePCRs were clear and unambiguous.

However, the current study is also subject to several limitations. First, some data had to be collected from paper reports, as ePCRs were introduced during the research period. Although timestamps and location information were available for all EMS alerts, the EMS team had to record alert- and patient-related information on paper when technical problems occurred. However, in the case of unclear paper reports, the hospitals' medical records information could be used to verify the data. Second, data for six alerts, were not available, although the amount of missing information was not significant. Third, we found large differences in the way EMS teams input data into ePCRs. Due to these differences, the effectiveness of the treatment administered by the EMS team could not be comprehensively assessed. It is possible that the EMS teams completed ePCRs after the patient had been transferred to the emergency department. However, we could not take entries made at this stage into account in the current study, as the database shows such entries as part of the emergency department's records. In addition, treatment recorded by EMS team was reported as treatment administered by EMS, although it is possible that some of the treatments have been initiated by hospital staff. Moreover, not taking into account the information on potential early warning signs of the emergency is a limitation of the current study, and it is important to include this aspect in future studies. Finally, hospital practices and abilities to handle emergencies vary greatly, depending on variables, such as the location of hospital and the competence and specialization of personnel. Therefore, the results of this study cannot be generalized to other hospitals. Further studies with more hospitals dispersed throughout the country are warranted.

5. Conclusions

During the study, the two hospitals made 138 emergency calls to the EMS, of which one-third were calls relating to cardiac arrests. Just over half of these cases culminated in urgent transfer or death. As shown by the results of this study, hospital personnel are able to implement necessary medical measures in emergencies, even if there is no emergency team available. Despite this, more training in handling emergencies is needed to deal with less severe situations within the ward. EMS have an important role to play in responding to in-hospital emergencies. However, EMS seem to be doing the same measures as METs. Thus, EMS may be an appropriate substitute for METs in some hospitals.

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CRediT authorship contribution statement

H.M.: Conceptualization, Methodology, Formal analysis, Investigation, Writing – original draft, Writing – review & editing. **T.I.:** Conceptualization, Methodology, Writing – review & editing, Supervision. **H.N.:** Conceptualization, Methodology, Writing – review & editing, Supervision. All authors read and approved the final manuscript.

Declaration of Competing Interest

The authors declare that they have no competing interests.

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Ethical considerations

The study followed the good scientific practice defined by the Finnish National Board on Research Integrity TENK. [11] The study was conducted in accordance with the Helsinki Declaration and all the appropriate national guidelines and regulations. Conventions of data protection and information security were applied. The Hospital District of Southwest Finland granted a permit for the study (T127/2022). As a retrospective registry study, ethics committee review and patient consent were waived by the Finnish National Board on Research Integrity TENK. [11].

Appendix 1. Characteristics of the patient and personnel groups (*N* = 133)

	Patients *n* = 108	Personnel *n* = 25
Woman	51%	72%
Man	49%	28%
Age, mean (SD)	73.2 (14.9)	41.0 (14.0)
Treatment measures before EMS arrival		
IV access	33%	16%
IV medication	26%	8%
Measurement of vital signs	6%	8%
No treatment measures	22%	64%
On duty physician present	40%	8%
Symptoms		
Altered state of consciousness	14%	8%
Pain	12%	32%
No symptoms	30%	20%
First vital signs measurement by EMS team, median (IQR)		
Systolic BP mmHg	138.5 (49)	131.0 (23)
Diastolic BP mmHg	75.0 (25)	85.0 (25)
Heart rate / min	80.0 (33)	90.0 (27)
Oxygen saturation %	95.5 (7)	99.0 (2)
Temperature	36.8 (0.8)	36.9 (0.9)
Blood sugar	7.7 (3.8)	6.6 (3)

Respiratory rate / min	17.0 (10)	15.0 (6)
GCS	15 (4)	15 (0)
Treatment measures by EMS		
Airway management*	23%	0%
Non-invasive ventilation	7%	0%
Supplementary oxygen	13%	0%
Cardiopulmonary resuscitation with ALS techniques	17%	0%
IV, oral or inhaled medication	35%	24%
Fluid therapy	16%	28%
ECG recording	28%	12%
Other	7%	12%
Nothing or not recorded	2%	48%
Primary survival	83%	100%
30-day survival	59%	100%

*Supraglottic airway device or intubation. ALS: advanced life support; BP: blood pressure; ECG: electrocardiogram; EMS: emergency medical services; GCS: Glasgow coma scale; IQR: inter-quartile range; IV: intra-venous.

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