BMC Emergency Medicine

https://doi.org/10.1186/s12873-026-01614-8

Article in Press

Treatment variability among low-acuity EMS patients in a university hospital ED: a retrospective registry study from Southwest Finland

Received: 30 January 2026

Accepted: 7 May 2026

Published online: 30 May 2026

Cite this article as: Kasvi A., Iirola T., Nordquist H. *et al.* Treatment variability among low-acuity EMS patients in a university hospital ED: a retrospective registry study from Southwest Finland. *BMC Emerg Med* (2026). https://doi.org/10.1186/s12873-026-01614-8

Aleksi Kasvi, Timo Iirola, Hilla Nordquist & Mika Kortelainen

Treatment Variability Among Low-Acuity EMS Patients in a University Hospital ED: A Retrospective Registry Study from Southwest Finland

Aleksi Kasvi[1,2*] Timo Iirola[3] Hilla Nordquist[4,5]
Mika Kortelainen[1,6]

Abstract

Background: Emergency medical services (EMS) increasingly convey patients with non-urgent conditions to emergency departments (EDs), contributing to pressure on acute care systems. In many settings, patients classified as low-acuity in the prehospital phase represent a substantial proportion of ED arrivals. This study examined characteristics and ED management patterns among low-acuity EMS conveyances to a university hospital ED in Southwest Finland.

Methods: This retrospective registry-based cohort study used linked EMS and hospital data from 2019 to 2023. Low-acuity patients were defined as missions with a final urgency category D after on-scene EMS reassessment. In total, 34,898 category D conveyances to the university hospital ED were identified. Multivariable logistic regression analyses focused on the four most common conveyance categories—decrease in common general condition, fall, patient transport, and mental disorder—comprising 21,048 complete-case missions. Outcomes included laboratory testing, imaging, medication administration, and inpatient admission. Associations with age (≥70 vs <70 years), sex, night-time (vs daytime), and weekend (vs weekday) were examined.

Results: Older age was associated with higher odds of diagnostic testing in several conveyance categories. The largest age-related odds ratios were observed in mental disorder conveyances, in which age ≥70 years was associated with higher odds of imaging (odds ratio [OR] 5.00, 95% confidence interval [CI] 3.68; 6.79) and laboratory testing (OR 4.62, 95% CI 3.59; 6.00). Night-time conveyance was associated with lower odds of medication administration across all four conveyance categories and with lower odds of imaging in three categories. In the decrease in common general condition subgroup, night-time conveyance was associated with lower odds of laboratory testing (OR 0.41, 95% CI 0.30; 0.56). In the patient transport subgroup, night-time conveyance was associated with higher odds of inpatient admission (OR 1.49, 95% CI 1.27; 1.74). Associations with sex and weekend conveyance varied across categories.

Conclusions: ED management of low-acuity EMS patients varies by age, sex, time of conveyance, and conveyance category. These findings suggest that downstream hospital care for low-acuity EMS patients is shaped not only by patient

*Corresponding author: aleksi.l.kasvi@utu.fi

characteristics but also by temporal and organizational factors. Linked prehospital and hospital registry data can provide system-level evidence to support the development of more appropriate acute care pathways.

Keywords: emergency medical services; emergency department; low-acuity; after-hours care; prehospital care; registry-based study

1 Introduction

Emergency medical services (EMS) play a central role in the organization of acute care systems. In many high-income countries, EMS demand has increased in recent decades, and a substantial proportion of missions involve patients with low-acuity conditions who may not require specialist emergency department (ED) care [1–3]. Registry-based studies from Nordic and other high-income settings have shown that a considerable share of EMS contacts, including both conveyed and non-conveyed patients, involve non-critical or lower-acuity presentations, raising questions about the optimal destination, triage level, and subsequent use of hospital resources for these patients [4–7]. Although the term "low-acuity" is widely used in the international literature, definitions vary between health systems and are typically operationalized using routinely collected clinical or administrative data [8].

At the same time, EDs worldwide face persistent crowding and operational strain, including prolonged boarding, access block, and resource constraints [9, 10]. Boarding of admitted patients in the emergency department has been identified as a major system-level driver of crowding, associated with delays in care, increased lengths of stay, and adverse patient outcomes [10]. System-level factors such as staffing, hospital configuration, and time of arrival have been associated with variation in care processes and outcomes in acute care settings, including trauma populations [11, 12]. These structural features may influence diagnostic testing and treatment patterns independently of patient-level clinical severity.

Low-acuity EMS conveyances are particularly relevant in this context. Previous studies have examined redirection or alternative care pathways for selected low-acuity patients and have highlighted the complexity of prehospital referral decisions and the potential risk of misclassifying time-sensitive conditions [13, 14]. Demographic and temporal factors, including age, sex, and time of arrival, have been associated with differences in ED processes, including the length of stay [15]. Registry-based linkage studies have shown that prehospital dispatch characteristics, age, and the time of arrival are independently associated with hospital admission versus discharge following EMS transport [16]. However, despite growing interest in EMS utilization and ED crowding, studies directly linking prehospital classification to downstream emergency department diagnostic testing and treatment patterns within the same episode of care remain limited. Linking EMS and hospital data at the mission level enables the direct evaluation of how prehospital urgency classification and conveyance decisions are associated with subsequent emergency department management, an interface that remains underexamined in the literature.

This study extends a previously published pilot study from Southwest Finland [4] by analyzing five years of linked registry data from EMS and hospital records. We examine patients classified as low-acuity in the prehospital setting and assess whether demographic

factors and time of conveyance are associated with differences in ED diagnostic testing, medication administration, imaging, and inpatient admission.

The study was conducted in a regional system in which, during the study period, two of three local emergency departments were closed overnight, with out-of-hours emergency care concentrated at the university hospital. This organizational structure provides a natural setting to explore how timing and patient characteristics interact and shape ED management patterns.

By analyzing treatment patterns within defined EMS conveyance categories, this study aims to provide system-level evidence on how low-acuity EMS patients are managed after ED arrival. Rather than assessing the appropriateness of individual visits, the objective is to identify structured patterns of variation in ED management that may inform the development of more suitable and efficient care pathways.

1.1 Overview of the healthcare system of the study region

The study was conducted in an area served by one university hospital (Turku University Hospital, TYKS) and three local hospitals with varying emergency department opening hours. TYKS operates as a 24/7 tertiary emergency care center and receives the most critically ill patients. Core emergency department services, including laboratory testing and imaging, were available at TYKS throughout the day and night during the study period. According to regional EMS protocols, high-acuity patients are conveyed directly to the university hospital, whereas low-acuity patients should be conveyed to the nearest appropriate local hospital when clinically feasible. In the Turku urban area, the university hospital also serves as the local hospital for hospital-level care, and patients are conveyed there when their care needs exceed primary healthcare capacity. EMS units operate across both urban and rural areas. Figure 1 illustrates the study region, including the locations of the university hospital and local hospitals within Southwest Finland. Straight-line distances between local hospitals and Turku University Hospital are shown to provide the geographic context of the EMS conveyance patterns. The inset map indicates the location of the study region within Finland and neighboring countries.

Throughout the study period, EMS was provided by advanced-level units staffed by either two advanced-level paramedics or one advanced-level paramedic and one basic-level paramedic. The EMS system also included a physician-staffed helicopter EMS (HEMS) unit and a Finnish Border Guard helicopter. The region had a population of 490,494 (November 2023) and approximately 60,000 EMS missions annually.

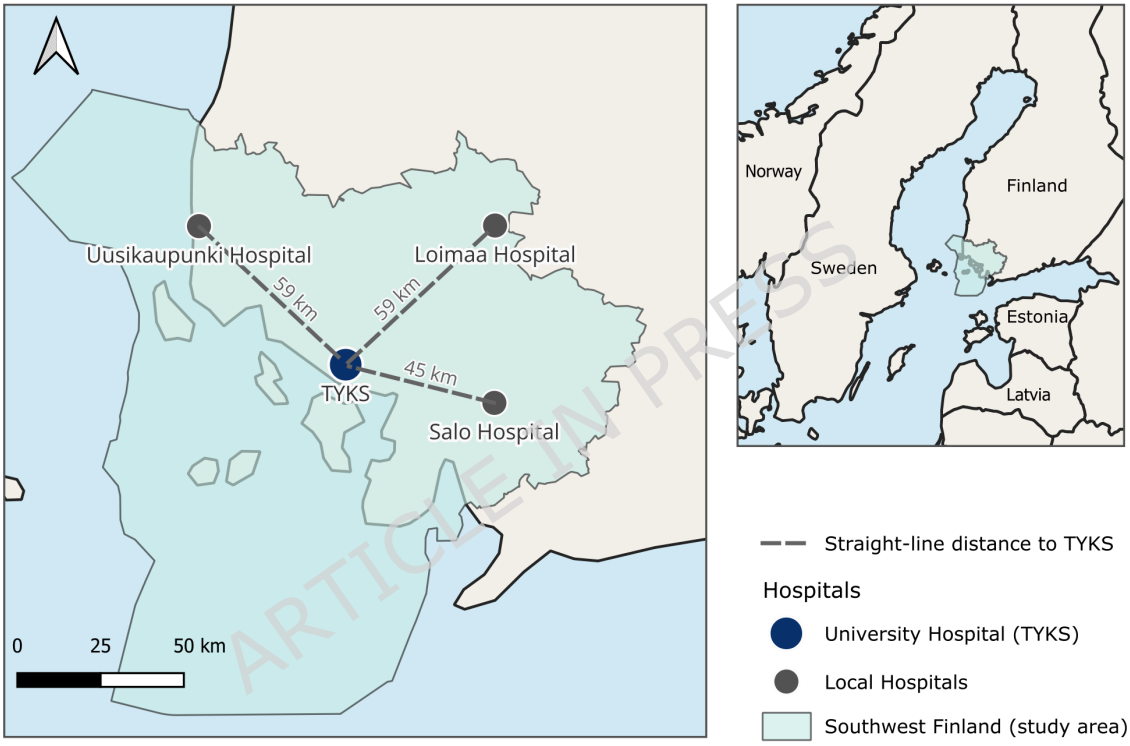


Figure 1: The map illustrates Southwest Finland, highlighting the locations of the university hospital (TYKS) and three local hospitals, with straight-line distances between the local hospitals and TYKS. An inset map shows the position of the study region within Finland and neighboring countries.

1.2 Description of the data

This study was a retrospective registry-based cohort study conducted in the Wellbeing Services County of Southwest Finland, following principles consistent with the RECORD (The REporting of studies Conducted using Observational Routinely Collected health data) guidelines [17]. The methodological approach builds on a previously conducted pilot study [4] of low-acuity EMS conveyances in the same region, with modifications and an expanded dataset covering the years 2019–2023.

EMS mission data were extracted from the EMS electronic patient information system by the Information Services of the Wellbeing Services County of Southwest Finland. Linked hospital emergency department records, including diagnostics, treatments, and disposition, were retrieved from the hospital electronic health record system using deterministic linkage based on personal identifiers. After linkage, the dataset was pseudonymized and transferred to a secure research environment for analysis.

During the study period, 68,035 EMS missions were included in the extracted dataset provided for this study. The dataset was assembled to capture missions relevant to category D conveyances and included missions with different initial dispatch priorities. Of these, 61,572 missions had a final urgency category D after on-scene paramedic reassessment. Among the final category D missions, 58,316 had a recorded transport destination and were classified as conveyed missions. Of these conveyed final category D missions, 34,898 were conveyed to the university hospital emergency department and formed the descriptive study cohort, while 23,418 were conveyed to other destinations. For analyses of hospital diagnostics and treatments, EMS missions in the descriptive cohort were deterministically linked to hospital emergency department records. In total, 27,315 missions were successfully linked to hospital data, whereas 7,583 could not be linked. For the primary multivariable regression analyses, missions with missing age, sex, or handover time were excluded, yielding a complete-case cohort of 26,515 missions. Of these, 21,048 belonged to the four most common conveyance categories and were included in the primary regression analyses. The full inclusion and exclusion process is presented in Figure 2.

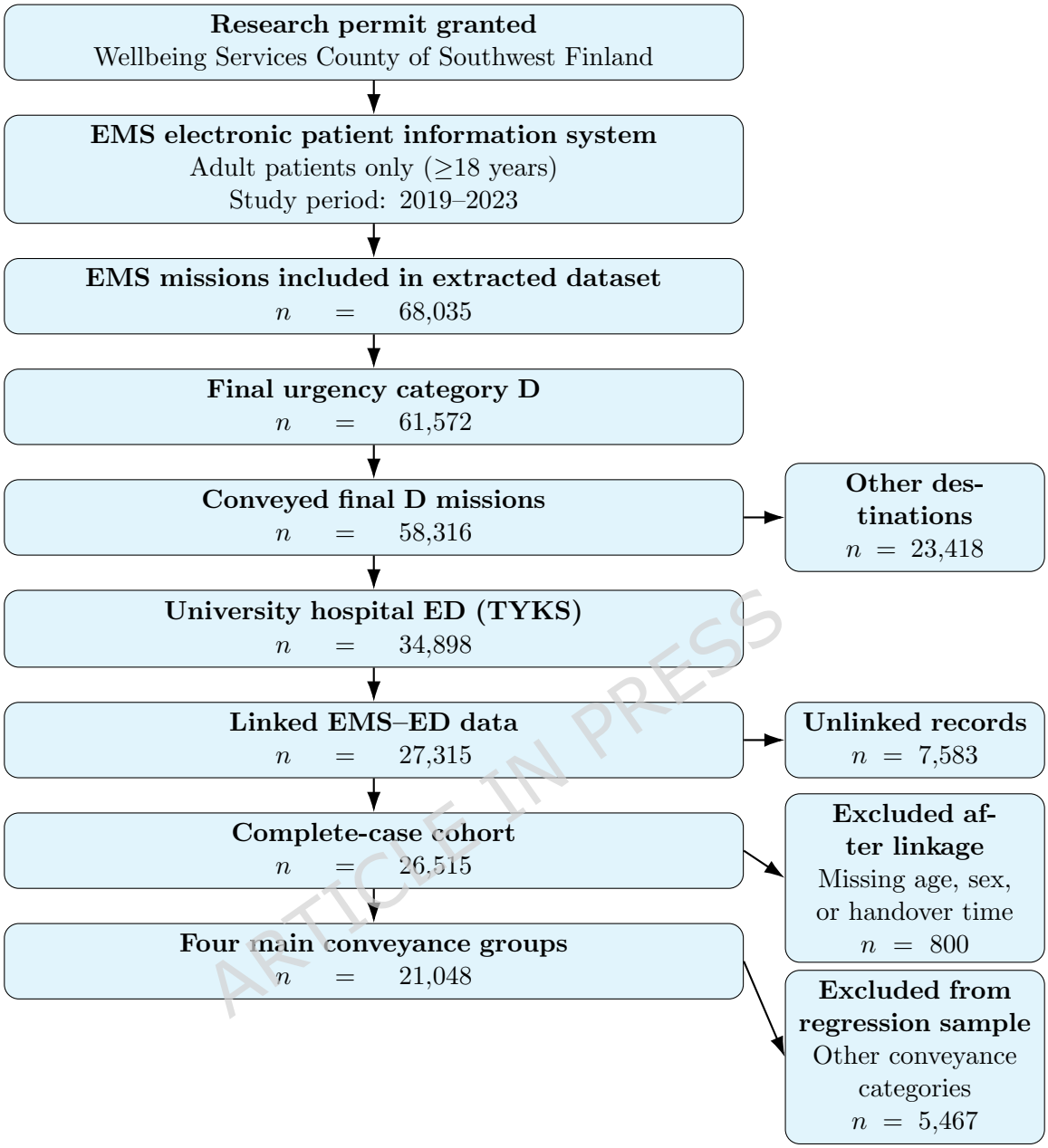
The unit of analysis was an EMS mission. Because individual patients could contribute multiple missions during the study period, the number of unique patients and the number of repeated missions were quantified. Sensitivity analyses were performed by restricting the dataset to one mission per patient to evaluate potential clustering effects.

The dataset included routinely collected structured variables recorded at the point of care, including patient demographics, EMS conveyance codes, ICPC-2 (International Classification of Primary Care, Second Edition) diagnostic codes assigned in the prehospital setting, and hospital outcomes, including laboratory testing, diagnostic imaging, medication administration, and inpatient admission. Implausible or missing values were addressed during systematic data cleaning.

Within the Finnish EMS system, missions are initially assigned an urgency category by the emergency dispatch center using a standardized national four-level classification ranging from A (highest urgency) to D (lowest urgency), as defined in the Finnish Ministry of Social Affairs and Health Decree on Emergency Medical Services (585/2017, §6). The urgency category reflects the estimated risk to the patient's vital functions at the time of dispatch. Category D missions are defined as cases in which the patient's condition is

considered stable, without disturbances in vital functions, and requiring assessment but not immediate emergency intervention. These missions are typically conducted without lights and sirens when clinically appropriate. The urgency category is reassessed on scene by EMS personnel and may be modified based on clinical evaluation. Previous Finnish registry-based research has evaluated the accuracy and triage performance of dispatch priority classifications within this system [18]. In the present study, low-acuity EMS patients were defined as missions that retained urgency category D after on-scene paramedic reassessment and were conveyed to the university hospital emergency department.

EMS conveyance codes and ICPC-2 classifications describe different aspects of the same encounter. Conveyance codes are operational classifications used to document the primary reason for conveyance and reflect the prehospital categorization at the time of decision-making. The conveyance code "patient transport" refers to an interfacility transfer initiated by a physician, typically requested via the emergency dispatch center (112), in which the primary purpose of the mission is patient transfer rather than a response to a new emergency event. When assigned urgency category D, such missions are considered non-urgent and are operationally targeted so that the patient is reached by EMS within approximately two hours of the request, consistent with other category D missions in the Finnish EMS system. ICPC-2 codes describe the main underlying health problem identified during the encounter. Because these systems serve different purposes, they do not correspond one-to-one. Primary analyses were based on EMS conveyance codes, while sensitivity analyses incorporated ICPC-2 diagnostic categories.



Adult EMS missions (≥18 years) during 2019–2023 were included in the extracted EMS dataset provided for this study. Of the 68,035 extracted missions, 61,572 had final urgency category D after on-scene reassessment by EMS personnel. Among these, 58,316 had a recorded transport destination and were classified as conveyed missions. Of the conveyed final category D missions, 34,898 were conveyed to the university hospital emergency department and formed the descriptive cohort, while 23,418 were conveyed to other destinations. After deterministic EMS–ED linkage, 27,315 missions had hospital data available, whereas 7,583 could not be linked. An additional 800 linked missions were excluded because of missing age, sex, or handover time, yielding a complete-case cohort of 26,515 missions. Of these, 21,048 belonged to the four most common conveyance categories and were included in the primary regression analyses, while 5,467 were excluded as they belonged to other conveyance categories.

Figure 2: Flowchart of data sources, linkage, and cohort selection.

1.3 Statistical methods

Descriptive statistics were used to summarize patient characteristics across EMS conveyance categories. Frequencies and percentages were calculated for conveyance code groups and sex distribution. Continuous variables, including age, were summarized using means and standard deviations. Percentages by sex were calculated using only cases with known binary sex coding, whereas the total mission counts included all cases.

Multivariable logistic regression models were constructed to examine associations between demographic and temporal variables and the likelihood of receiving laboratory testing, medication administration, diagnostic imaging, or inpatient admission. The independent variables included age group (70 years and older versus younger than 70 years), sex, time of day (night versus day), day type (weekend versus weekday), and the EMS conveyance group, with a decrease in common general condition serving as the reference category. Primary regression analyses were restricted to the four most common conveyance categories: decrease in common general condition, fall, patient transport, and mental disorder.

The time of day was defined according to the patient handover time from EMS to hospital, with daytime defined as 06:00–17:59 and night-time defined as 18:00–05:59. The day type was classified as weekday (Monday through Friday) or weekend, with Saturdays, Sundays, and national public holidays treated as weekends. Results are presented as odds ratios with 95% confidence intervals.

Because multiple regression models were estimated across outcomes and conveyance groups, p-values were adjusted using the Benjamini–Hochberg procedure to control the false discovery rate at 5% [19]. The correction was applied across the full set of regression coefficient tests reported from all multivariable models combined. As a sensitivity analysis, a Bonferroni correction [20] was applied across the same family of tests to evaluate the robustness of statistically significant findings under a more conservative multiplicity adjustment. As expected, the Bonferroni correction resulted in fewer statistically significant coefficients than the Benjamini–Hochberg procedure; however, the overall pattern and direction of the associations remained consistent.

Several additional sensitivity analyses were conducted to assess robustness. Age was evaluated both as a dichotomous variable ($\geq$ 70 vs $<$ 70 years) and as a continuous predictor to examine the impact of categorization. Model fit was compared using the Akaike Information Criterion (AIC), defined as $-2 \log L + 2k$, where L is the maximized likelihood and k the number of estimated parameters [21]; lower values indicate improved relative model fit. Analyses were repeated using a single mission per patient to assess the potential influence of repeated observations from the same individual. In addition, subgroup models were re-estimated with additional adjustment for the ICPC-2 diagnostic category to evaluate potential residual confounding by presenting complaint. Differences in model fit between the base and ICPC-adjusted models were assessed using AIC and interpreted as relative measures of fit rather than formal hypothesis tests.

All analyses were performed using R (version 4.3.3; R Foundation for Statistical Computing, Vienna, Austria).

2 Results

2.1 Characteristics of patients conveyed to the ED

2.1.1 Reasons for EMS conveyance to the university hospital ED

In total, 34,898 urgency category D EMS conveyances to the university hospital ED were identified (Table 1). The mean age of the conveyed patients was 67.1 years (SD 21.7), and 52.7% were female.

The most common reasons for EMS conveyance were decrease in common general condition (30.0%, n = 10,455), patient transport (17.0%, n = 5,950), fall (17.0%, n = 5,934), and mental disorder (13.3%, n = 4,644). Other category D reasons accounted for 22.7% (n = 7,915) of conveyances.

Patients conveyed for decrease in common general condition and falls were older than those in the other conveyance categories, whereas mental disorder conveyances involved younger patients. Patient transport conveyances showed an intermediate age distribution.

The sex distribution was broadly similar across conveyance categories, with only modest variation between groups.

Table 1: Urgency category D EMS conveyances to the university hospital ED by conveyance reason (N = 34,898).

Conveyance reason	*n*	%	Mean age	SD	Female *n*	Male *n*	Missing sex	Female %
Total	34,898	100.0	67.1	21.7	18,200	16,319	379	52.7
Decrease in common general condition	10,455	30.0	75.6	15.8	5,502	4,902	51	52.9
Fall	5,934	17.0	74.2	18.1	3,279	2,619	36	55.6
Mental disorder	4,644	13.3	42.8	19.4	2,401	2,232	11	51.8
Patient transport	5,950	17.0	68.9	19.2	2,892	2,849	209	50.4
Other category D reasons	7,915	22.7	63.5	22.7	4,126	3,717	72	52.6

Note: Percentages are calculated using the full cohort (N = 34,898). Female percentages were calculated among cases coded as female or male in the original registry. Missing sex includes cases where sex was not recorded in the registry.

2.1.2 ICPC-2 presentations

ICPC-2 codes assigned during EMS care showed a broad range of clinical presentations (Table 2). The most common code was A04 (weakness/tiredness, general), accounting for 13.3% (n = 4,657) of conveyances. Other frequent codes included P76 (depressive disorder, 6.8%, n = 2,366), A29 (general symptom/complaint, other, 6.6%, n = 2,319), and A03 (fever, 5.7%, n = 1,990).

Several high-frequency codes reflected nonspecific medical symptoms commonly observed in older adults, including A04, A29, A03, R83, and L13. In contrast, psychological presentations such as P76 and P98 were more common among younger patients.

The sex distribution also varied across ICPC-2 categories. For example, L13 (hip symptom/complaint) had a relatively high proportion of female patients (65.6%), whereas A03 (fever) had a lower female proportion (42.9%).

Table 2: Most common ICPC-2 codes among urgency category D EMS conveyances to the university hospital ED (N = 34,898).

Code	Definition	n	%	Mean age	SD	Female n	Male n	Female %
A04	Weakness/tiredness, general	4,657	13.3	77.9	13.8	2,514	2,116	54.3
P76	Depressive disorder	2,366	6.8	40.6	18.9	1,253	1,104	53.2
A29	General symptom/complaint, other	2,319	6.6	76.4	15.7	1,241	1,060	53.9
A03	Fever	1,990	5.7	76.1	14.8	849	1,129	42.9
S18	Laceration/cut	1,540	4.4	63.4	24.5	758	773	49.5
P98	Psychological symptom/complaint, other	1,324	3.8	46.7	18.8	614	706	46.5
R83	Respiratory infection, other	1,137	3.3	72.7	17.5	560	571	49.5
D01	Abdominal pain/cramps, general	1,130	3.2	65.2	20.8	640	479	57.2
L13	Hip symptom/complaint	974	2.8	81.1	11.1	630	330	65.6
N80	Head injury, other	974	2.8	70.7	19.9	470	500	48.5

Note: Percentages were calculated using the full cohort (N = 34,898). Female percentages were calculated among cases coded as female or male in the original registry.

2.2 Emergency department diagnostics and treatments

Table 3 presents the multivariable associations between patient characteristics, conveyance timing, EMS conveyance group, and emergency department diagnostics and treatments. Descriptive analyses were based on the full university hospital emergency department cohort (n = 34,898), whereas multivariable regression analyses were based on the linked complete-case cohort (n = 26,515) and restricted to the four most common conveyance categories (n = 21,048).

Age ≥70 years was associated with higher odds of laboratory testing, medication administration, and imaging. In contrast, age ≥70 years was associated with lower odds of inpatient admission.

Night-time conveyance was associated with lower odds of laboratory testing, medication administration, and imaging. For inpatient admission, the association was in the opposite direction, with higher odds observed at night.

Weekend conveyance was associated with higher odds of imaging, whereas associations with laboratory testing, medication administration, and inpatient admission were not statistically significant after adjustment.

Compared with conveyances due to decrease in common general condition (reference category), fall and mental disorder conveyances were associated with lower odds of laboratory testing. Fall conveyances were associated with higher odds of imaging, whereas mental disorder and patient transport conveyances were associated with higher odds of medication administration and inpatient admission.

Subgroup-specific regression models are presented in Additional File 1, Tables 1–4. Base and ICPC-adjusted subgroup models are shown in Additional File 1, Tables 5–8, and model fit comparisons using AIC are provided in Additional File 1, Table 9.

2.2.1 Decrease in common general condition ($n = 9{,}480$)

Among conveyances due to a decrease in common general condition, age ≥ 70 years was associated with higher odds of laboratory testing (OR 1.49 (1.06; 2.06)), medication administration (OR 1.61 (1.46; 1.78)), and imaging (OR 1.72 (1.56; 1.90)), but lower odds of inpatient admission (OR 0.84 (0.73; 0.96)). Female sex was associated with lower odds

Table 3: Multivariable associations with emergency department treatments in low-acuity EMS conveyances (N = 21,048)

Outcome	Predictor	OR (95% CI)	Adj. p (BH)
Laboratory Testing	Age ≥70 years	2.93 (2.66; 3.22)	< 0.001
	Female	0.94 (0.86; 1.03)	0.187
	Night	0.71 (0.65; 0.78)	< 0.001
	Weekend	1.04 (0.94; 1.15)	0.430
	Fall	0.04 (0.04; 0.05)	< 0.001
	Mental disorder	0.03 (0.02; 0.04)	< 0.001
	Patient transport	0.11 (0.10; 0.14)	< 0.001
Medication Administration	Age ≥70 years	1.32 (1.23; 1.41)	< 0.001
	Female	1.04 (0.99; 1.10)	0.142
	Night	0.44 (0.41; 0.47)	< 0.001
	Weekend	0.98 (0.92; 1.04)	0.496
	Fall	0.66 (0.61; 0.71)	< 0.001
	Mental disorder	2.51 (2.25; 2.80)	< 0.001
	Patient transport	1.73 (1.61; 1.87)	< 0.001
Imaging	Age ≥70 years	1.89 (1.76; 2.02)	< 0.001
	Female	0.89 (0.84; 0.95)	< 0.001
	Night	0.51 (0.47; 0.54)	< 0.001
	Weekend	1.11 (1.04; 1.19)	< 0.001
	Fall	5.28 (4.79; 5.83)	< 0.001
	Mental disorder	0.10 (0.09; 0.12)	< 0.001
	Patient transport	1.13 (1.05; 1.22)	< 0.001
Inpatient Admission	Age ≥70 years	0.87 (0.80; 0.95)	0.002
	Female	0.93 (0.86; 1.00)	0.069
	Night	1.15 (1.06; 1.25)	< 0.001
	Weekend	0.99 (0.91; 1.08)	0.885
	Fall	0.67 (0.60; 0.76)	< 0.001
	Mental disorder	2.02 (1.77; 2.29)	< 0.001
	Patient transport	1.80 (1.64; 1.98)	< 0.001

Models were adjusted for age group (≥ 70 years vs < 70 years), sex, night-time (vs day), weekend (vs weekday), and EMS conveyance group. The reference category for the conveyance group was decrease in common general condition. Adjusted p-values were calculated using the Benjamini–Hochberg false discovery rate procedure.

of laboratory testing (OR 0.69 (0.50; 0.94)), imaging (OR 0.80 (0.73; 0.87)), and inpatient admission (OR 0.74 (0.65; 0.84)). Night-time conveyance was associated with lower odds of laboratory testing (OR 0.41 (0.30; 0.56)), medication administration (OR 0.36 (0.33; 0.39)), and imaging (OR 0.43 (0.39; 0.46)). Weekend conveyance was associated with higher odds of laboratory testing (OR 1.61 (1.13; 2.34)), whereas no statistically significant weekend associations were observed for the other outcomes. Detailed subgroup regression estimates are presented in Additional File 1, Table 1.

2.2.2 Falls ($n = 4{,}652$)

Among fall-related conveyances, age ≥ 70 years was associated with higher odds of laboratory testing (OR 3.03 (2.61; 3.51)) and medication administration (OR 1.88 (1.61; 2.20)), but not with imaging or inpatient admission after adjustment. Female sex was associated with higher odds of medication administration (OR 1.24 (1.09; 1.41)) and imaging (OR 1.34 (1.12; 1.61)). Night-time conveyance was associated with lower odds of laboratory testing (OR 0.63 (0.55; 0.72)), medication administration (OR 0.43 (0.38; 0.49)), and imaging (OR 0.47 (0.39; 0.56)). No statistically significant weekend associations were observed after adjustment. Complete regression estimates for fall-related conveyances are shown in Additional File 1, Table 2.

2.2.3 Patient transport ($n = 4{,}885$)

Among patient transport conveyances, age ≥ 70 years was associated with higher odds of laboratory testing (OR 2.59 (2.20; 3.05)) and imaging (OR 2.44 (2.16; 2.75)), but not with medication administration or inpatient admission. Night-time conveyance was associated with lower odds of medication administration (OR 0.76 (0.66; 0.87)) and imaging (OR 0.72 (0.63; 0.83)), while higher odds were observed for inpatient admission (OR 1.49 (1.27; 1.74)). Weekend conveyance was associated with higher odds of laboratory testing (OR 1.35 (1.05; 1.75)) and imaging (OR 1.24 (1.04; 1.48)), whereas no statistically significant weekend associations were observed for medication administration or inpatient admission. Full subgroup regression results are provided in Additional File 1, Table 3.

2.2.4 Mental disorders ($n = 2{,}031$)

Among conveyances for mental disorder, age ≥ 70 years was associated with higher odds of laboratory testing (OR 4.62 (3.59; 6.00)) and imaging (OR 5.00 (3.68; 6.79)), but lower odds of medication administration (OR 0.54 (0.43; 0.68)) and inpatient admission (OR 0.66 (0.50; 0.87)). Female sex was associated with lower odds of laboratory testing (OR 0.75 (0.62; 0.90)) and higher odds of medication administration (OR 1.25 (1.03; 1.51)). Night-time conveyance was associated with lower odds of medication administration (OR 0.43 (0.36; 0.53)), whereas no statistically significant associations were observed for laboratory testing, imaging, or inpatient admission. Weekend conveyance was associated with higher odds of imaging (OR 1.49 (1.08; 2.03)), while no statistically significant weekend associations were observed for the other outcomes. Detailed subgroup results for mental disorder conveyances are presented in Additional File 1, Table 4.

2.3 Summary of treatment patterns

Across the four most common conveyance categories, age ≥ 70 years was associated with higher odds of laboratory testing in three categories and with higher odds of imaging in decrease in common general condition, patient transport, and mental disorder conveyances. The largest age-related associations were observed in mental disorder conveyances for laboratory testing and imaging. In contrast, age ≥ 70 years was associated with lower odds of medication administration and inpatient admission in mental disorder conveyances and with lower odds of inpatient admission in the decrease in common general condition subgroup.

Night-time conveyance was associated with lower odds of medication administration across all four conveyance categories. It was also associated with lower odds of laboratory testing and imaging in most subgroups. For inpatient admission, associations varied by conveyance category, with higher odds observed at night among patient transport conveyances and no statistically significant associations in the other subgroups.

Weekend conveyance was associated with different patterns across subgroups. Higher odds of laboratory testing were observed in decrease in common general condition and patient transport conveyances, whereas higher odds of imaging were observed in patient transport and mental disorder conveyances. No statistically significant weekend associations were observed for inpatient admission.

The overall direction and consistency of these associations across subgroups are summarized in Table 4.

Table 4: Direction of statistically significant associations in subgroup analyses

Factor	Outcome	Decrease	Fall	Patient transport	Mental disorder
Age ≥ 70 years					
	Laboratory testing	+	+	+	++
	Medication administration	+	+	0	−
	Imaging	+	0	+	++
	Inpatient admission	−	0	0	−
Night-time conveyance					
	Laboratory testing	−	−	0	0
	Medication administration	−	−	−	−
	Imaging	−	−	−	0
	Inpatient admission	0	0	+	0
Weekend conveyance					
	Laboratory testing	+	0	+	0
	Medication administration	0	0	0	0
	Imaging	0	0	+	+
	Inpatient admission	0	0	0	0

Symbols indicate the direction of statistically significant associations in multivariable subgroup models. + = higher odds (adjusted OR > 1.0 and < 4.0); ++ = substantially higher odds (adjusted OR ≥ 4.0); − = lower odds (adjusted OR < 1.0 and > 0.25); −− = substantially lower odds (adjusted OR ≤ 0.25); 0 = no statistically significant association.
Decrease = decrease in common general condition.
Models adjusted for age group (≥ 70 vs < 70 years), sex, night-time (vs day), and weekend (vs weekday).

3 Discussion

This study examined urgency category D EMS conveyances to a university hospital emergency department in Southwest Finland, focusing on the four most common conveyance categories: a decrease in common general condition, falls, patient transport, and mental disorders. Together, these categories accounted for a substantial proportion of low-acuity EMS conveyances. Patients conveyed for a decrease in common general condition and falls were generally older, whereas mental disorder–related conveyances involved younger patients. These patterns are consistent with international literature describing a substantial proportion of EMS activity involving non-critical conditions, as well as evidence of increasing ambulance demand in several high-income settings [1–3].

Differences in emergency department diagnostic and treatment practices were observed across demographic groups, time of conveyance, and conveyance categories. Older age was associated with higher odds of laboratory testing and imaging in several conveyance categories, with the largest odds ratios observed in mental disorder–related conveyances. However, older age was not uniformly associated with a greater likelihood of recorded hospital interventions across all outcomes. In some subgroups, including mental disorder conveyances, older age was associated with lower odds of medication administration and inpatient admission. This pattern suggests that the relationship between age and ED management among low-acuity EMS patients varies across outcomes and may reflect differences in case mix, clinical uncertainty, and thresholds for hospital-based intervention. Previous research has highlighted the vulnerability of older adults discharged from emergency departments, particularly during out-of-hours periods, emphasizing the importance of careful assessment and discharge planning for this population [22].

Night-time conveyance was consistently associated with lower odds of medication administration across all four conveyance categories and with lower odds of laboratory testing and imaging in most subgroup analyses. Prior research has documented differences in emergency care processes and outcomes by time of arrival, which have been attributed to variations in staffing, service availability, and workflow during non-working hours [11, 12]. Although our study was not designed to directly examine these mechanisms, the observed patterns are consistent with the possibility that structural and organizational factors may contribute to temporal variation in ED management. These findings should also be interpreted in the context of broader structural pressures affecting emergency departments, including boarding and access blockage, which may influence patient flows and diagnostic processes during periods of constrained capacity [10].

In the present setting, regional organizational factors are also likely to have contributed to the observed patterns. During the study period, two of the three local hospitals in the region were closed overnight, resulting in the concentration of out-of-hours EMS conveyances at the university hospital. Consequently, some patients conveyed at night may have been redirected from local facilities rather than representing inherently higher-acuity cases. The lower frequency of diagnostic testing and medication administration observed during night-time hours may therefore reflect differences in case mix and referral pathways related to regional service configuration. At the same time, the association between night-time conveyance and inpatient admission was not uniform across subgroups and was higher among patient transport conveyances. This interpretation is consistent with recent Finnish registry-based research demonstrating that measures such as non-conveyance rates are closely associated with dispatch over-triage at the system level, underscoring

how the prehospital urgency classification and organizational structures can shape downstream care pathways [23]. Together, these findings suggest that observed variations in emergency department management may partly reflect upstream triage processes and regional system organization rather than solely patient-level clinical differences.

Weekend conveyances showed different patterns across subgroups. Higher odds of laboratory testing were observed in some subgroups, including decrease in common general condition and patient transport conveyances, whereas higher odds of imaging were observed in patient transport and mental disorder conveyances. In contrast, no statistically significant weekend associations were observed for inpatient admission. These findings underscore that temporal effects on emergency department processes are not uniform and are consistent with prior literature describing mixed and context-dependent weekend effects in acute care systems [11].

Subgroup analyses showed similar overall patterns across conveyance categories in that the directions of the main associations remained interpretable, although the magnitude and significance of individual coefficients varied between groups. Including ICPC-2 diagnostic categories in the adjusted models attenuated several associations, in some cases substantially, particularly in the medication administration model for the decrease in common general condition subgroup, although the overall interpretation remained similar. Comparisons of model fit showed lower AIC values for most ICPC-adjusted models, indicating improved relative model fit. These findings suggest that the primary associations were not solely driven by differences in the presenting complaint and were broadly stable across model specifications.

The relatively low frequency of diagnostic testing and treatment observed in certain conveyance categories, particularly among younger patients and selected mental health presentations, highlights the heterogeneity within low-acuity EMS populations and raises questions regarding optimal care pathways. Previous studies have demonstrated that structured pre-dispatch triage and telephone-based assessment models can reduce non-urgent EMS missions without compromising short-term patient safety, suggesting potential opportunities for system-level demand management strategies [24]. While some low-acuity EMS patients may benefit from emergency department evaluation, others may be more appropriately managed through alternative assessment or redirection pathways designed to reduce reliance on tertiary emergency departments. Observational studies have shown that alternative care pathways for selected low-acuity patients are feasible and safe when supported by structured triage and risk-stratification processes [13]. From a patient safety perspective, prior reviews and registry-based studies of EMS non-conveyance emphasize the importance of structured decision-making frameworks and careful risk assessment to minimize adverse events [7, 14, 25]. However, the variation observed within and between the conveyance categories in the present study underscores the need for careful patient selection before implementing structural changes to care pathways.

To assess potential selection bias related to the analytic sample, we compared the characteristics of missions included in the multivariable analyses with those excluded (Additional File 1, Tables 10 and 11). The included cohort was older on average and consisted exclusively of the four most common conveyance categories, whereas the excluded cohort contained a higher proportion of other category D conveyance reasons and missions with incomplete linkage or missing covariate data. Differences were also observed in the distribution of selected ICPC-2 codes. These findings indicate that the analytic sam-

ple represents a more selected subset of low-acuity EMS conveyances, which should be considered when interpreting the generalizability of the regression results.

A key strength of this study is the linkage of EMS and emergency department registry data at the mission level. While prior studies have examined EMS utilization, conveyance, and non-conveyance outcomes, fewer have used linked mission-level EMS and hospital data to examine how prehospital classification relates to downstream ED diagnostic testing and treatment. By linking these data sources, the present study provides an integrated view of the EMS–ED interface.

4 Limitations of the study

This study has several limitations. The retrospective design relies on routinely collected EMS and hospital registry data, which limits control over data completeness and accuracy. Missing or mis-coded variables, particularly timestamps and diagnostic fields, may introduce information biases that affect subgroup classification and the measurement of treatment outcomes. Because the treatment variables were derived from structured registry fields, potential misclassifications were more likely to result in underestimation than overestimation of treatment rates.

Using EMS conveyance codes as the primary grouping variable also introduces conceptual limitations. Conveyance codes are operational classifications that reflect the reason for the conveyance or the conveyance decision itself, whereas ICPC-2 classifications aim to describe the underlying health problem identified during the encounter. These coding systems do not correspond one-to-one. For example, falls may reflect trauma, acute medical deterioration, or functional decline, and the "patient transport" category includes interfacility transfers with heterogeneous clinical indications. Although this heterogeneity may attenuate within-group associations, it reflects real-world prehospital documentation and operational decision-making. Importantly, emergency department diagnostics and treatment decisions were based on hospital clinical assessment rather than EMS conveyance codes, reducing the likelihood that prehospital categorization directly influenced in-hospital management.

Hospital interventions were recorded only as binary indicators without detailed information on clinical findings, diagnostic results, the content or complexity of treatment, or appropriateness. The analysis therefore captures whether an intervention occurred but cannot assess its clinical justification, quality of care, or longer-term patient outcomes beyond admission status.

A deterministic linkage between EMS and hospital datasets may have failed in cases of incomplete identifiers or repeated visits, leading to the exclusion of some missions from hospital-based analyses. Residual selection bias cannot therefore be excluded. In addition, comparisons between missions included in the multivariable analyses and those excluded (Additional File 1, Tables 10 and 11) showed systematic differences in age and conveyance category distribution. The included cohort was older on average and comprised only the four most common conveyance categories, whereas the excluded cohort contained a higher proportion of other category D conveyance reasons. These findings indicate that the regression sample represents a selected subset of the overall cohort and should be considered when interpreting the generalizability of the results.

The findings reflect one regional EMS system and its associated hospital network. EMS dispatch protocols, staffing models, hospital capacity, and availability of alternative care pathways vary between regions and countries, and generalizability to other healthcare systems should therefore be interpreted with caution.

Although multivariable logistic regression models were adjusted for age, sex, time of day, and day type (weekday versus weekend), important confounders, including clinical severity beyond urgency category, comorbidity burden, prior healthcare utilization, and social determinants of health, were not available in the registry data. Residual confounding may therefore influence the observed associations. In addition, some subgroup and sensitivity models, particularly those adjusted for ICPC-2 category, may have been affected by sparse cells in specific outcome strata, which may have reduced the precision of some estimates.

5 Conclusions

This registry-based cohort study demonstrates that patient characteristics, time of conveyance, and conveyance category are associated with variation in emergency department diagnostic testing and treatment among low-acuity EMS conveyances. In particular, age-related differences were not uniform across outcomes, and night-time conveyance was associated with lower odds of several diagnostic and treatment measures in most subgroups. These findings indicate that management patterns for low-acuity patients are shaped not only by clinical factors but also by structural and temporal features of the emergency care system.

By linking EMS and hospital registry data over a five-year period, this study provides an overview of how low-acuity patients are managed after ED arrival. The results suggest that a subset of conveyed patients receive limited diagnostic or therapeutic interventions, underscoring the importance of evaluating whether current conveyance pathways align optimally with patient needs, particularly in regions with centralized emergency care models. Further research examining patient outcomes after ED visits, including repeat EMS contacts and subsequent healthcare utilization, is needed to support the safe and evidence-based development of alternative care pathways.

Abbreviations

AIC Akaike Information Criterion

CI Confidence interval

ED Emergency department

EMS Emergency Medical Services

HEMS Helicopter Emergency Medical Services

ICPC-2 International Classification of Primary Care, Second Edition

OR Odds ratio

SD Standard deviation

TYKS Turku University Hospital

Declarations

Ethics approval and consent to participate

This study followed good scientific practices as defined by the Finnish National Board on Research Integrity (TENK) and was conducted in accordance with the principles of the Declaration of Helsinki and applicable national guidelines. The study used pseudonymized registry data from the Emergency Medical Services and the Emergency Department of Turku University Hospital. According to Finnish legislation governing the secondary use of health data, informed consent from individual patients is not required for retrospective register-based studies in which no identifiable personal information is accessible to the researchers. The study protocol and data processing procedures were approved by the Wellbeing Services County of Southwest Finland (research permit: T1979/2023). All data handling followed national data protection regulations and institutional requirements, and no personal identifiers were handled outside secure hospital research environments.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and analysed during the current study contain sensitive patient information and cannot be made publicly available. The data are stored within a secure research environment, and access requires the requesting individual to be added to the approved research permit. Data may be made available by the corresponding author upon reasonable request, subject to any necessary permit amendments.

Competing interests

The authors declare that they have no competing interests.

Funding

This work was supported by Yrjö Jahnsson's Foundation (grant number 20227537) and State Research Funding (grant number 30134). The funding bodies had no role in the study design, data collection, analysis, interpretation, or manuscript preparation.

Authors' contributions

A.K.: Conceptualization, Methodology, Formal analysis, Investigation, Writing – Original Draft, Writing – Review and Editing. T.I.: Conceptualization, Methodology, Writing – Review and Editing, Supervision. H.N.: Conceptualization, Methodology, Writing – Review and Editing, Supervision. M.K.: Conceptualization, Methodology, Writing – Review and Editing, Supervision, Project administration. All authors read and approved the final manuscript.

Acknowledgments

We thank the Information Services of the Wellbeing Services County of Southwest Finland for their assistance with the data extraction and secure data access arrangements. We also acknowledge the EMS and emergency department personnel whose documentation made this research possible.

Use of Artificial Intelligence Tools

In accordance with COPE and BMC guidelines on the responsible use of artificial intelligence in scholarly writing, the authors disclose that ChatGPT (OpenAI) was used to support language editing and to generate preliminary drafts of selected R code segments for data handling and figure preparation. The model did not have access to the study data, did not perform any statistical analyses, and did not contribute to the interpretation of findings. All AI-assisted outputs were manually reviewed, tested, and validated by the authors. All decisions regarding the study design, analysis, and reporting were made solely by the authors, who assume full responsibility for the accuracy and integrity of the work.

References

[1] Andrew E, Nehme Z, Cameron P, Smith K. Drivers of Increasing Emergency Ambulance Demand. Prehospital Emergency Care. 2020;24(3):385–392.

[2] Eastwood K, Morgans A, Stoelwinder J, Smith K. The appropriateness of low-acuity cases referred for emergency ambulance dispatch following ambulance service secondary telephone triage: A retrospective cohort study. PLOS ONE. 2019;14(8):e0221158.

[3] Todd VF, Swain A, Howie G, Tunnage B, Smith T, Dicker B. Factors Associated with Emergency Medical Service Reattendance in Low Acuity Patients Not Transported by Ambulance. Prehospital Emergency Care. 2022;26(1):66–77.

[4] Kasvi A, et al. Rethinking non-urgent EMS conveyances: A registry-based pilot study from Southwest Finland. BMC Emergency Medicine. 2023;23:112.

[5] Schehadat MS, Scherer G, Groneberg DA, Manfred K, Bendels MHK. Outpatient care in acute and prehospital emergency medicine by emergency medical and patient

transport service over a 10-year period: a retrospective study based on dispatch data from a German emergency medical dispatch centre (OFF-RESCUE). BMC Emergency Medicine. 2021;21:29.

[6] Hoikka M, Silfvast T, Ala-Kokko TI. A high proportion of prehospital emergency patients are not transported by ambulance: a retrospective cohort study in Northern Finland. Acta Anaesthesiologica Scandinavica. 2017;61(5):549–556.

[7] Paulin J, Kurola J, Koivisto M, Iirola T. EMS non-conveyance: A safe practice to decrease ED crowding or a threat to patient safety? BMC Emergency Medicine. 2021;21:115.

[8] Slagman A, Fischer-Rosinský A, Legg D, Schmieder K, Möckel M. Identification of low-acuity attendances in routine clinical information documented in German Emergency Departments. BMC Emergency Medicine. 2023;23:64.

[9] McKenna P, Heslin SM, Viccellio P, Mallon WK, Hernandez C, Morley EJ. Emergency department and hospital crowding: causes, consequences, and cures. Clinical and Experimental Emergency Medicine. 2019;6(3):189–195.

[10] da Silva Ramos FJ, Freitas FGR, Machado FR. Boarding in the emergency department: challenges and mitigation strategies. Current Opinion in Critical Care. 2024 Jun;30(3):239–245.

[11] Abdelrahman H, Al-Thani H, Naushad AK, Mollazehi M, Asim M, El-Menyar A. The patterns and impact of off-working hours, weekends and seasonal admissions of patients with major trauma in a level 1 trauma center. International Journal of Environmental Research and Public Health. 2021;18(16):8542.

[12] LaRosa SK, Stone XA, Fenninger AA, Harshaw NS, Hoffman KM, Moore KG, et al. Effects of Time of Arrival on Trauma Patient Outcomes. The American Surgeon. 2024;90(9):2188–2193.

[13] Feral-Pierssens AL, Morris J, Marquis M, Daoust R, Cournoyer A, Lessard J, et al. Safety assessment of a redirection program using an electronic application for low-acuity patients visiting an emergency department. BMC Emergency Medicine. 2022;22(1):71.

[14] Magnusson C, Hagiwara MA, Norberg-Boysen G, Kauppi W, Herlitz J, Axelsson C, et al. Suboptimal prehospital decision-making for referral to alternative levels of care – frequency, measurement, acceptance rate and room for improvement. BMC Emergency Medicine. 2022;22:89.

[15] Alnahari A, A'aqoulah A. Influence of demographic factors on prolonged length of stay in an emergency department. PLOS ONE. 2024;19(3):e0298598.

[16] Hegenberg K, Trentzsch H, Prückner S. Differences between cases admitted to hospital and discharged from the emergency department after emergency medical services transport. BMJ Open. 2019;9(9):e030636.

[17] Benchimol EI, Smeeth L, Guttmann A, Harron K, Moher F, Petersen I, et al. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) statement. PLoS Medicine. 2015;12(10):e1001885.

[18] Salminen T, Kaartinen K, Roos M, Vaajanen V, Ekstrand A, Setälä P, et al. Differences between the dispatch priority assessments of emergency medical dispatchers and emergency medical services: a prospective register-based study in Finland. Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine. 2023 Feb;31(1):8.

[19] Benjamini Y, Hochberg Y. Controlling the false discovery rate: a practical and powerful approach to multiple testing. Journal of the Royal Statistical Society: Series B (Methodological). 1995;57(1):289–300.

[20] Dunn OJ. Multiple comparisons among means. Journal of the American Statistical Association. 1961;56(293):52–64.

[21] Akaike H. A new look at the statistical model identification. IEEE Transactions on Automatic Control. 1974;19(6):716–723.

[22] Dunnion M, Ryan A, Goode D, McIlfatrick S. Supporting older people following out of hours discharge from the Emergency Department: An integrative review of the literature. International Journal of Older People Nursing. 2023;18:e12529.

[23] Salminen T, Kaartinen K, Palonen M, Setälä P, Paavilainen E, Hoppu S. Correlation between the accuracy of the emergency response centre's urgency assessment and emergency medical services non-conveyance: a retrospective register-based study in Finland. BMC Emergency Medicine. 2024;24:193.

[24] Roivainen P, Hoikka MJ, Raatiniemi L, Silfvast T, Ala-Kokko T, Kääriäinen M. Telephone triage performed by nurses reduces non-urgent ambulance missions: A prospective observational pilot study in Finland. Acta Anaesthesiologica Scandinavica. 2020;64(4):556–563.

[25] Ebben RHA, Vloet LCM, Speijers RFH, Tonjes NW, Loef J, Pelgrim T, et al. A patient-safety and professional perspective on non-conveyance in emergency medical services: a systematic review. Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine. 2017;25(1):71.