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ORIGINAL ARTICLE

Burden of suspected epileptic seizures on emergency services: A population-based study

Leena Kämppi[1] | Tuukka Puolakka[2,3] | Jaakko Ritvanen[4] | Kati Tuppurainen[4] | Jari Päkkilä[5] | Markku Kuisma[2] | Jukka Peltola[6]

[1]Epilepsia Helsinki, European Reference Network EpiCARE, Department of Neurology, Helsinki University Hospital and University of Helsinki, Helsinki, Finland

[2]Department of Emergency Medicine and Services, Helsinki University Hospital and University of Helsinki, Helsinki, Finland

[3]Department of Anaesthesiology and Intensive Care Medicine, Helsinki University Hospital and University of Helsinki, Helsinki, Finland

[4]Department of Neurology, Helsinki University Hospital and University of Helsinki, Helsinki, Finland

[5]Department of Mathematical Sciences, University of Oulu, Oulu, Finland

[6]Department of Neurology, Tampere University Hospital and Tampere University, Tampere, Finland

Correspondence
Leena Kämppi, Department of Neurology, Helsinki University Hospital, P.O. Box 340, Helsinki 00029, Finland.
Email: leena.kamppi@hus.fi

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Abstract

Background and purpose: Patients with acute epileptic seizures form a large patient group in emergency neurology. This study aims to determine the burden caused by suspected epileptic seizures at different steps in emergency care.

Methods: A retrospective, cross-sectional, population-based (>1,000,000 inhabitants), 4-year (2015–2018) study was conducted in an urban setting with a single dispatch centre, a university hospital-affiliated emergency medical service (EMS), and five emergency departments (EDs). The study covered all adult (≥16 years old) emergency neurology patients receiving medical attention due to suspected epileptic seizures from the EMS and EDs and during hospital admissions in the Helsinki metropolitan area.

Results: Epileptic seizures were suspected in 14,364 EMS calls, corresponding to 3.3% of all EMS calls during the study period. 9,112 (63.4%) cases were transported to hospital due to suspected epileptic seizures, and 3368 (23.4%) were discharged on the scene. 6969 individual patients had 11,493 seizure-related ED visits, accounting for 3.1% of neurology- and internal medicine-related ED visits and 4607 hospital admissions were needed with 3 days' median length of stay (IQR=4, Range 1-138). Male predominance was noticeable at all stages (EMS 64.7%, EDs 60.1%, hospital admissions 56.2%). The overall incidence was 333/100,000 inhabitants/year for seizure-related EMS calls, 266/100,000 inhabitants/year for ED visits and 107/100,000 inhabitants/year for hospital admissions. Total estimated costs were 6.8 million €/year, corresponding to 0.5% of all specialized healthcare costs in the study area.

Conclusions: Patients with suspected epileptic seizures cause a significant burden on the health care system. Present-day epidemiological data are paramount when planning resource allocation in emergency services.

KEYWORDS
emergency department, emergency medical services, epilepsy, hospital emergency service, incidence, intensive care unit

Leena Kämppi and Tuukka Puolakka contributed equally.

See Editorial by C. D. Cornwall and C. P. Beier on page 2137

INTRODUCTION

Nearly 1 in 10 people have an epileptic seizure during their lifetime, and one third of them are at risk of developing epilepsy [1]. Consequently, epileptic seizures are a common reason for emergency calls and emergency department (ED) visits and form an important patient group within emergency neurology [2, 3]. Although most epileptic seizures are self-limiting and may not require any medical interventions, the timely identification of the condition, rapid medical management, and urgent diagnostic tests are essential in some patient groups. Particularly, patients with epileptic seizures without a preceding diagnosis of epilepsy require comprehensive evaluation to exclude potentially life-threatening aetiologies [4]. Prolonged or repetitive seizures suggestive of status epilepticus (SE) require special attention, as the associated mortality and disability remain high [5, 6]. A recently published audit from several European countries showed that the range of care quality is still wide [7].

However, not all suspected epileptic seizures are epileptic in origin, but can also be psychogenic seizures, cardiogenic collapses, or syncopes, and not all patients with an epileptic seizure need to see a physician. Emergency medical services (EMS) are frequently called to the scene even in cases of a patient with known epilepsy (PWE), although commonly PWEs are instructed to call EMS only in cases of a clearly unusual or prolonged seizure. Several studies have suggested that some patients with epileptic seizures are referred to an ED unnecessarily [8–11]. At the same time, EDs worldwide are fighting against overcrowding. The challenge is to provide timely emergency care to high-risk patients and avoid unnecessary use of emergency services in others [10, 12]. However, data on the total burden caused by suspected epileptic seizures to EMS and hospitals are limited. The literature mainly focuses only on isolated stages of emergency services [4, 7, 10, 13–16], includes data from brief study periods [10, 13, 16, 17], is single-centred [11, 18, 19], or is outdated [4, 20, 21].

The aim of this study was to investigate comprehensively the burden of suspected epileptic seizures on different stages of emergency services all the way from EMS dispatch to specialized hospital care and to provide up-to-date epidemiological data in a population-based urban setting.

MATERIALS AND METHODS

Study design

This was a retrospective, cross-sectional, population-based study combining electronic prehospital and hospital patient records. Patients ≥16 years of age who received medical attention due to suspected epileptic seizures from the EMS, EDs, hospital wards, or intensive care units (ICUs) in the Helsinki metropolitan area were included.

Standard protocol approvals, registrations, and patient consents

The study plan was approved by Helsinki University Hospital (HUS) and the City of Helsinki. Due to the registry-based nature of the data, no informed consent or ethical review board approval was required according to Finnish research legislation. The data processing practices followed the EU Data Protection Directive rules. This article adheres to the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) statement where applicable.

Study setting

Finland has a population of 5,540,000 (Figure 1a). HUS is the largest tertiary hospital in Finland, providing supportive tertiary care to a population of >2,000,000 (Figure 1b). HUS provides emergency neurological services directly to 1,200,000 people in the Helsinki metropolitan area, including Helsinki and five surrounding cities, which forms the research area in this study (Figure 1c).

EMS system

In Finland, all emergency phone calls are handled by dispatchers working in regional emergency response centres. The EMS operation in the study area is governed by HUS. The EMS consists of basic life support and advanced life support (ALS) units. Additionally, the area has two physician-staffed mobile ICUs (MICUs); one operates by car and one by car or helicopter. The MICUs are dispatched to high-risk calls and provide telephone consultations for ambulance crews. All EMS units follow the HUS emergency care guidelines. For SE treatment, the first-stage medication used by EMS is midazolam. The second-stage antiseizure medication is intravenous levetiracetam, introduced to the EMS system in 2016. The third-stage medication (i.e., general anaesthesia) is induced using propofol or S-ketamine.

The electronic prehospital patient reporting (EPR) system (Merlot Medi, CGI) is used on laptop computers. The EPR provides an interactive template for current neurological symptoms and patient medical history.

Hospital system and EMS transport destination

During the study period, the Helsinki metropolitan area had five hospital EDs (HUS ED and four general EDs) admitting adult patients with acute neurological symptoms (Figure 1c). Private hospitals do not provide emergency medical care.

Neurologists work on a 24/7 basis at the HUS ED. Continuous electroencephalogram (EEG) monitoring, advanced computed tomography (CT), and magnetic resonance imaging are available at all

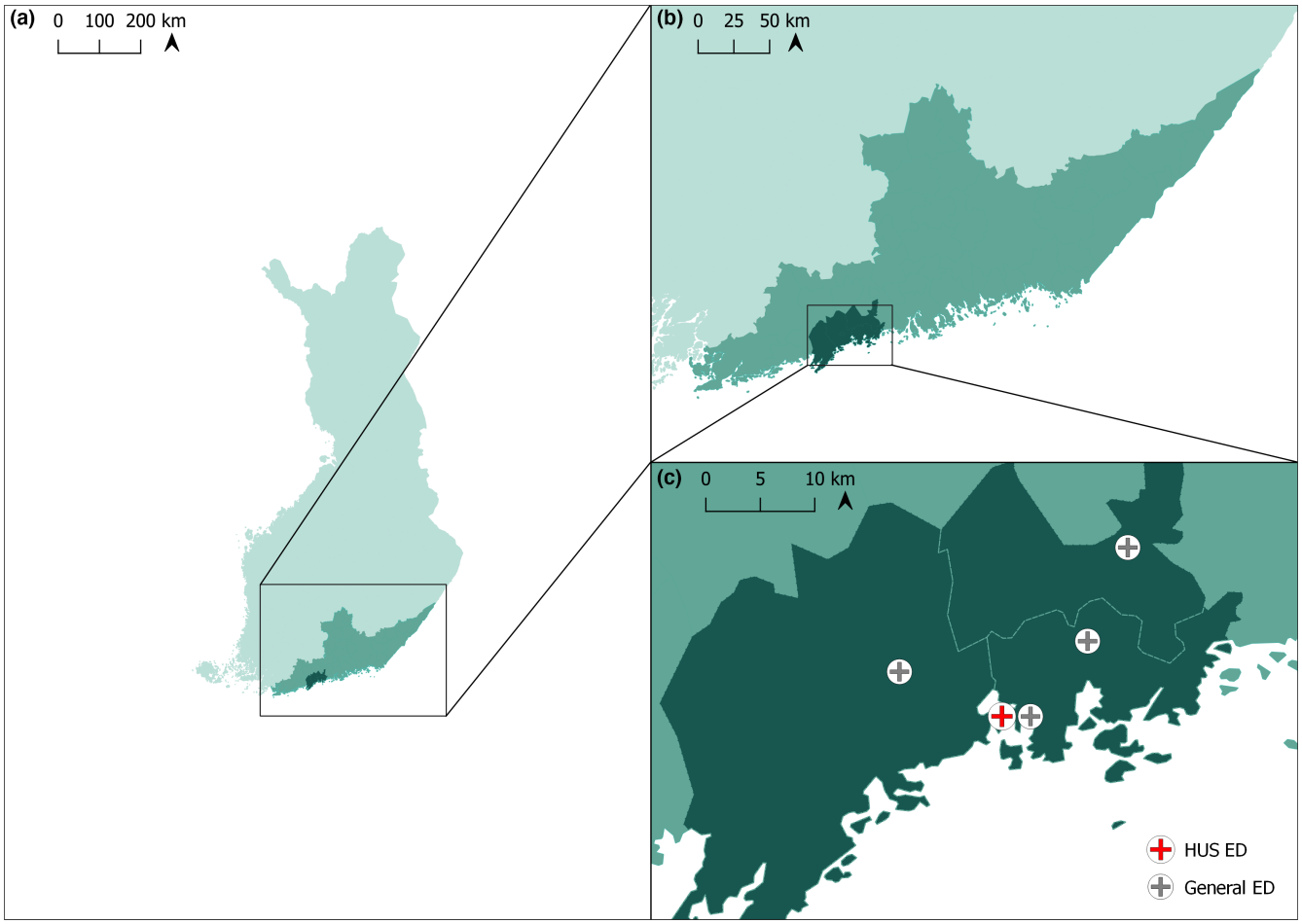

FIGURE 1 Study area. The Helsinki University Hospital (HUS) area and hospital emergency departments (EDs) that admit neurological patients are shown. [Colour figure can be viewed at wileyonlinelibrary.com]

times. Patients with epileptic seizures are treated in the neurological wards, ICUs, and high-dependency stroke unit.

The four general EDs in the area are staffed by internists and emergency physicians, and their on-call imaging capability is limited to CT. EEG recording is available during office hours. A consulting neurologist is available during office hours, and an HUS ED neurologist can be consulted otherwise. Neurological patients are treated in the neurological or general wards and high-dependency units. High-dependency units are intended for patients who require close observation but do not require invasive ventilation or organ support such as dialysis.

The ambulance crews select the receiving hospital based on the HUS prehospital referral guidelines. Patients with first-time epileptic seizures from Helsinki and those with repetitive, prolonged, or ongoing epileptic seizures from the whole study area are transported directly to the HUS ED. Patients who are not independent in the activities of daily living or do not meet the abovementioned criteria for seizures are transported to the four other hospital EDs. Ambulance crews can also leave a well-recovering patient on the scene according to the nonconveyance protocol [22].

Data collection and patient selection

The study period was 1 January 2015 to 31 December 2018. All prehospital patient reports were retrieved from the Merlot Medi EPR system, and the hospital data from the electronic patient database systems of HUS and the City of Helsinki. Population information was retrieved from an official open database maintained by Statistics of Finland [23].

The selection of patients with suspected epileptic seizures was based on a prespecified identification algorithm covering the different stages of the patient care pathway in which the patients received acute medical care (Figure 2). One patient may have multiple events during the study period. In this study, "patient" refers to one unique patient in the material and "cases," "EMS calls," "ED visits," "ward periods," and "admissions" to individual events of the patients.

At the prehospital level, the cases with suspected epileptic seizures (i.e., EMS calls) were identified by the dispatch and transport codes for seizure used in the EMS patient reports. At the hospital level, the cases (i.e., ED visits and ward periods) were

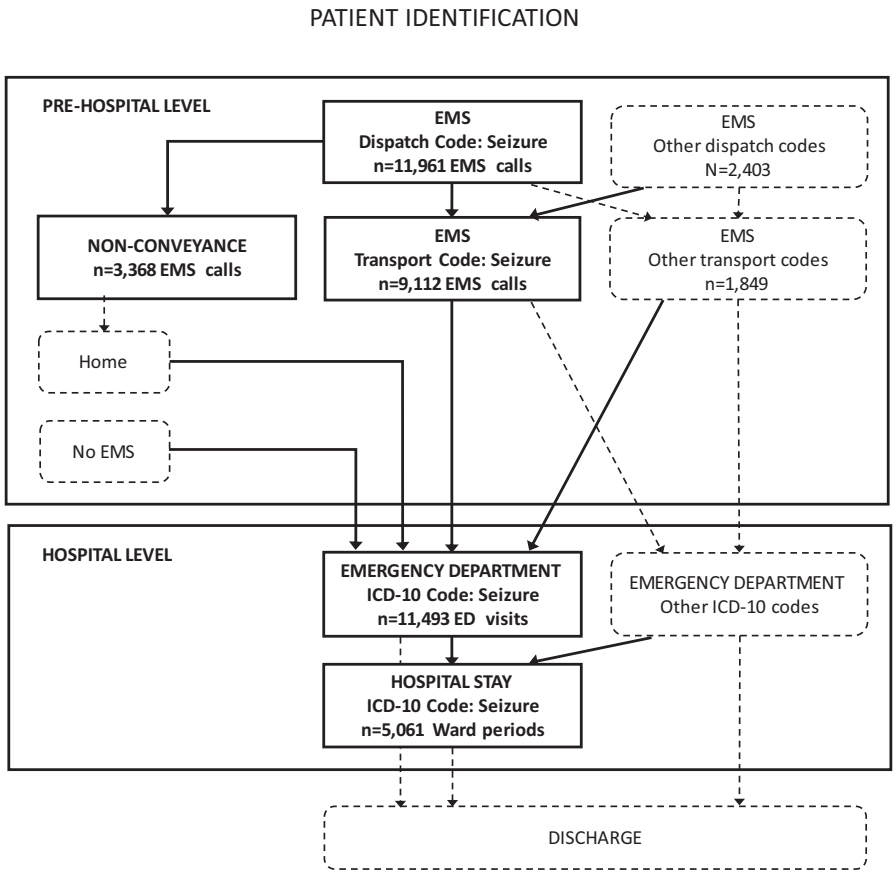

FIGURE 2 Patient identification algorithm. Description of the process during data collection and numbers of emergency medical service (EMS) calls, emergency department (ED) visits, and hospital ward periods due to acute suspected epileptic seizures identified at each link of the chain of care are shown. Squares with continuous lines indicate the stages in the emergency care pathway from which the patients were identified for the study material. Continuous arrows demonstrate patient flow to the identification stages and into the study material. Dashed boxes and lines demonstrate potential sources and routes of the patients into the study material. The dispatch code was given by the dispatcher, and the transport code was given by the ambulance crew. ICD-10, International Classification of Diseases, 10th Revision.

identified based on the International Classification of Diseases, 10th Revision (ICD-10) codes for epileptic seizure: epilepsy (diagnosed; G40.0–G40.9), SE (G41.0–G41.9), other of unspecified convulsion (i.e., seizure without diagnosed epilepsy; R56.8), or alcohol-related seizure (F10.06, F10.31, F10.41). Only the discharge codes were used. Some identified cases had several ICD-10 codes, and they were recoded (one code/case) by the investigators according to the order of importance: (i) SE, (ii) epilepsy, (iii) alcohol-related seizure, and (iv) other or unspecified convulsion. ED visits and ward periods in different units (hospital ward, high-dependency unit, ICU) treating neurological patients in all five hospitals were included in the data collection. The hospital admission includes all ward periods needed to treat the patient during one hospital stay. Twenty-nine cases identified with diagnosis code F10.41 in the general hospital were missing other information and were excluded from further analyses. Otherwise, there were no missing data.

Direct medical costs

Expenditures for the acute care of suspected epileptic seizures were calculated by multiplying the total number of cases at each level with the provider-specific charges. EMS calls are charged capitation-based and ED visits and hospital admissions diagnosis-related group-based. For the calculations, average charges from the study period (2015–2018) were used; for two EDs and hospitals, the charges from the year 2019 were used.

Statistical analysis

The results are mainly descriptive. For the categorical variables, the distributions are presented as frequencies and percentages. The median and interquartile range (IQR) were calculated for the quantitative variables. The chi-squared test of independence was used to compare groups where applicable. Fisher exact tests with adjusted *p*-values based on Holm's method were used as post hoc tests for the test of independence. *p*-Values <0.05 were considered significant. The data were analysed using Excel (Microsoft) and the SPSS statistical package (v26.0, IBM).

RESULTS

Use of EMS

The EMS received a total of 431,619 (10,687/100,000 inhabitants/year) calls during the study period. In 14,364 (356/100,000 inhabitants/year) calls (3.3%), either the dispatch code, transport code, or both was seizure. Seizure was the 11th most common reason for EMS calls, almost equal in number with stroke in 10th place. The

majority of the suspected epileptic seizure cases (9281, 64.7%) were male, and the median age was 46.5 (IQR = 28.9) years. These seizure calls concerned 7961 individual patients. Altogether, 5818 (73.1%) of the patients needed EMS once and the rest (2143 patients, 26.9%) more than once.

A total of 9112 (226/100,000 inhabitants/year) cases were transported to hospital due to suspected epileptic seizures (Figure 2). This included 2403 (26.4%) cases whose condition was initially missed during the emergency phone call and whose ambulance was dispatched using other dispatch codes. Of all the cases who were transported to hospital, both the dispatchers and ambulance crews identified the condition in 6709 (73.6%) cases. A total of 3368 (23.4%) cases were discharged on the scene. Of these nonconveyance cases, 2530 (75.1%) did not require ambulance transport, and 838 (24.9%) declined it. Sixty-three (0.4%) of the encountered cases were in cardiac arrest and received cardiopulmonary resuscitation. Twenty-eight (44.4%) of those cases survived to hospital, whereas 35 (55.6%, representing 0.2% of all cases) were pronounced dead on the scene. Additional information on the cases is presented in Table 1.

TABLE 1 Information on the cases using EMS.

Variables	*n*	%
All cases	14,364	100
Abnormal vital life functions		
SpO_2 < 85%	374	2.6
Systolic BP < 90 mmHg	250	1.7
Pulse < 40/min	44	0.3
Pulse > 160/min	113	0.8
GCS < 9	917	6.4
Hypoglycaemia: blood glucose < 4.0 mmol/L	338	0.8
Tympanic temperature ≥ 38.5°C	250	1.7
Use of ASM		
First stage	2265	15.8
Second stage	69	0.05
Third stage	139	1.0
Demanding treatment		
EMS calls using high priority		
Dispatch	10,042	69.9
Transport	1201	13.1
Physician consultation per phone	3193	22.2
MICU physician needed on the scene	406	2.8
Endotracheal intubation	155	1.1

Note: Information on the abnormal initial vital life functions, use of ASMs, and need for demanding treatment in EMS.

Abbreviations: ASM, antiseizure medication; BP, blood pressure; EMS, emergency medical services; GCS, Glasgow Coma Scale; MICU, mobile intensive care unit; SpO_2, saturation of peripheral oxygen.

Emergency department

The HUS and general hospital EDs received 375,718 (9304/100,000 inhabitants/year) visits related to acute neurological and internal medicine causes during the study period. A total of 11,493 (276/100,000 inhabitants/year; 3.1%) visits were made due to suspected epileptic seizures. The majority of cases (6905, 60.1%) were male, and the median age was 51.5 (IQR = 30.8) years. The seizure visits concerned 6969 individual patients. Altogether, 5049 (72.4%) patients visited an ED once and the rest (1920 patients, 27.6%) more than once. Of the 29,735 acute neurological visits at the HUS ED, 3092 (10.4%) were due to suspected epileptic seizures.

The majority (8401, 73.1%) of all suspected epileptic seizure cases were treated in general hospital EDs. The ED visits included 4821 (41.9%) PWEs and 1519 (13.2%) cases with alcohol-related seizures. The distribution of diagnoses differed significantly between the HUS ED and general EDs ($p < 0.001$). Post hoc analysis of the diagnoses showed that seizures of PWEs and alcohol-related seizures were significantly more often treated in general hospital EDs (both $p < 0.001$), whereas SE and seizures without previously diagnosed epilepsy were more often treated in the tertiary hospital (HUS) ED (both $p < 0.001$; Table 2).

Hospital stay

A total of 5061 (125/100,000 inhabitants/year) ward periods in different hospital departments were needed due to suspected epileptic seizures. Altogether, 3283 patients had 4607 (114/100,000 inhabitants/year) hospital admissions. Of all ward periods, 1686 (33.3%) were in the tertiary hospital, 364 (7.2%) in ICUs, and 1777 (35.1%) in ICUs or high-dependency units. Detailed information on the hospital periods is presented in Table 3.

The patients spent a total of 23,091 (571/100,000 inhabitants/year) days in hospital during the study period, with a median length of hospital stay (LOS) of 3 days (IQR = 4, range = 1–138). The median LOS was 4 days (IQR = 4, range = 1–138) in the tertiary hospital and 2 days (IQR = 1.8, range = 1–138) in ICUs or high-dependency units.

The median age of the cases was 60.2 years (IQR = 25.6). Although the male predominance still existed among all ward periods (56.2%), the distribution of gender nearly evened out in tertiary hospital admissions (50.8%), and the proportion of males was highest in high-dependency units (65%).

The distribution of diagnoses differed significantly between the tertiary hospital and general hospitals ($p < 0.001$) and among different departments ($p < 0.001$). According to post hoc analyses, SE cases were more likely to be treated in the tertiary hospital ($p < 0.001$) and in ICUs ($p < 0.001$), whereas PWEs were more likely to be treated in normal wards ($p < 0.001$) and alcohol-related cases in general hospitals ($p < 0.001$) and high-dependency units ($p < 0.001$). A significant male predominance was seen in alcohol-related seizures ($p < 0.001$) and seizures without previously diagnosed epilepsy ($p < 0.001$).

Population-based incidence of key events

During the study period, the average number of inhabitants (≥16 years) in the area was 1,009,600 [23]. On average, 93.5% of the patients using emergency services lived permanently in the area. The overall incidence was 333/100,000 inhabitants/year for suspected epileptic seizure-related EMS calls, 266/100,000 inhabitants/year for ED visits, and 107/100,000 inhabitants/year for hospital admissions.

TABLE 2 ED visits.

	ED visits		
Seizure-related diagnosis	**HUS ED, *n* (%)**	**General ED, *n* (%)**	**Total, *n* (%)**
Epilepsy	1022 (33.1)	3799 (45.2)	4821 (41.9)
Status epilepticus	153 (4.9)	109 (1.3)	262 (2.3)
Seizure	1835 (59.3)	3056 (36.4)	4891 (42.6)
Alcohol-related seizure	82 (2.7)	1437 (17.1)	1519 (13.2)
Total	3092 (100.0)	8401 (100.0)	11,493 (100.0)
p		<0.001	

Note: The number of ED visits and the distribution of seizure-related diagnoses among EDs.

Abbreviations: ED, Emergency department; HUS, Helsinki University Hospital.

Economic burden

During the study period, the mean gross domestic product (GDP)/year was €222.2 billion and mean GDP/inhabitant €40,000 in Finland. Health care costs corresponded to 9% of GDP (average = €20.7 billion) and specialized health care to 35.1% (average = €7.3 billion) of total health care expenditure [24]. The average expenditure for specialized health care in the study area was €1.3 billion between 2015 and 2018 [25].

Total estimated costs for EMS calls in this study were €5.5 million (€1.4 million/year, €385/call), for ED visits €8.2 million (€2.0 million/year, €713/visit), and for hospital admissions €13.5 million (€3.4 million/year, €2930/admission). Total annual estimated costs were €6.8 million, which corresponded to 0.5% of all specialized health care costs in the study area.

DISCUSSION

This study provides present-day population-based high-quality epidemiological data on suspected epileptic seizures in emergency services. The novelty and strength of this study are the meticulous and unique data collection process involving all suspected epileptic seizure-related EMS calls, ED visits, and hospital admissions over a 4-year study period. This study provides contemporaneous information on the burden caused by suspected epileptic seizures at all three levels of the emergency system, including economic aspects, for the first time. Considering the previously available limited literature handling emergency services in a fragmentary manner, accurate,

TABLE 3 Hospital ward periods.

	Hospital		Department			
	Tertiary, *n* (%)	**General, *n* (%)**	**ICU, *n* (%)**	**High-dependency unit, *n* (%)**	**Ward, *n* (%)**	**Total, *n* (%)**
Gender						
Female	829 (49.2)	1373 (41.0)	172 (47.3)	494 (35.0)	1536 (47.2)	2202 (43.8)
Male	857 (50.8)	1973 (59.0)	192 (52.7)	919 (65.0)	1719 (52.8)	2830 (56.2)
Total	1686 (100.0)	3346 (100.0)				
p		<0.001			<0.001	
Seizure-related diagnosis						
Epilepsy	928 (55.0)	1833 (54.8)	100 (27.5)	485 (34.3)	2176 (66.9)	2761 (54.9)
Status epilepticus	233 (13.8)	135 (4.0)	126 (34.6)	55 (3.9)	187 (5.7)	368 (7.3)
Seizure	475 (28.2)	733 (21.9)	111 (30.5)	464 (32.8)	633 (19.4)	1208 (24.0)
Alcohol-related seizure	50 (3.0)	645 (19.3)	27 (7.4)	409 (28.9)	259 (8.0)	695 (13.8)
Total	1686 (100.0)	3346 (100.0)	364 (100.0)	1413 (100.0)	3255 (100.0)	5032 (100.0)
p		<0.001			<0.001	

Note: The numbers of ward periods during hospital stays and distribution of gender and seizure-related diagnoses among hospitals and departments. Twenty-nine cases identified with F10.41 in a general hospital but missing other information were not included.

Abbreviation: ICU, intensive care unit.

comprehensive, and updated epidemiological data are needed when planning resource allocation in emergency services for the future.

When addressing the burden of suspected epileptic seizures among all events regarding different stages of emergency services, several findings emerged.

First, the large number of patients causes a considerable burden to the system. The identified annual incidence of 333/100,000 inhabitants/year for EMS seizure calls was lower than the previously reported incidence of 520/100,000 in England [13], and the ED visit incidence of 266/100,000 fell in the middle of previously reported incidences of 113–400/100,000 [4, 16, 26, 27]. However, the present study confirms the previous finding that suspected epileptic seizures comprise up to 3.3% of all EMS calls [2, 10, 13], which somewhat surprisingly was nearly equal to stroke calls. Furthermore, the proportion (3.1%) of ED seizure visits in our study was higher than the 0.2%–1.6% reported previously [4, 11, 17, 19, 26–29]. This difference might be explained by variable study designs and the organization of emergency services, but still reflects a substantial burden. Approximately one fourth of the patients used EMS and ED services at least twice during the study period. Repeated use, 12.8%–60% in earlier studies [26, 27, 30, 31], has been linked to poor insurance status, problems in further treatment [32], male gender, and alcohol abuse [30]. Further studies are needed to properly identify and characterize repeated users to provide adequate support for this patient group and thus reduce the burden on the system.

Second, the economic burden of suspected epileptic seizures accounted for 0.5% of all costs of specialized health care in the study area, €6.8 million/year. Previous literature provided no real equivalent for the comparison; however, the reported median cost of €4063/admission among nonrefractory SE patients [33] seems to be in line with our €2930/admission for all seizure patients. The suggested creation of and agreement on guidelines of management and use for investigations on those presenting with acute seizures would benefit the system by optimizing expenditure [7].

Third, a remarkably small proportion of suspected epileptic seizure patients had clearly abnormal vital functions in this study population, which included patients who were actually in cardiac arrest. It has been noted that for the most part, the condition of patients with suspected epileptic seizures is good [14], and ALS interventions are rarely necessary [34]. The change in priority rating between dispatchers and EMS personnel in this study, also reported previously (80%–>15%) [15], reflects the same issue and correlates well with most epileptic seizures being short in duration and spontaneous recovery being likely. Nevertheless, the importance of early identification of serious cases cannot be ignored due to the evidence of delays affecting the outcome of SE patients [35]. It has been previously reported that similarly to the prehospital setting, a minority of patients require complex treatment in a hospital [34] and <10% in an ICU [10], which is concordant with the present study regarding ICU treatment.

Finally, it is important to acknowledge that not all patients treated for suspected epileptic seizures have an epileptic seizure or need hospital evaluation. Dickson et al. [10] demonstrated that 12.3% of the suspected epileptic seizures encountered by paramedics were not epileptic. Emergency medical dispatchers and paramedics are key professionals in seizure recognition and triage. Unfortunately, the literature is scarce regarding the diagnostic accuracy of emergency services. The present study showed that >70% of suspected epileptic seizure patients requiring transportation to a hospital were similarly identified by dispatchers and paramedics, a finding that is comparable to or even better than identifying acute stroke [36]. On the other hand, in this study, the nonconveyance rate of 25% was in the lower half of the previously reported 16.3%–45% [10, 13–15] and was significantly lower than that of the general EMS population [22]. It has been speculated that a higher proportion would be suitable for home management if paramedics felt appropriately supported [13, 37]. However, the use of benzodiazepines, decreased level of consciousness, and risk of recurrent seizures favour ambulance transport [38], and data on selecting candidates for safe nonconveyance are nearly nonexistent.

In this study, the demographic data corresponded to previous literature. The median age was 47 years in the prehospital setting, increasing to 60 in hospital admissions. The peak occurrence of middle-aged patients has been recognized in adult studies from the UK [10, 13, 14, 16] and has been explained by multifactorial reasons, partly by alcohol [4]. Male predominance was relatively clear at all levels of acute emergency services, similar to previous reports [13, 15, 16, 19, 26, 31]. Although males with epileptic seizures visit EDs 1.4 times more often than females [4], it is still unknown why seizures are more common in males. The present study showed a male predominance, especially in alcohol-related seizures, although alcohol or traumas have not been linked to male predominance previously [20]. The distribution of seizure types in EDs differed slightly from the previous reports. Seizures without previously diagnosed epilepsy were encountered more often in this study than reported (42.6% vs. 20%–43% [16–19, 29]), and conversely, SE cases (2.3%), PWEs (41.9%), and alcohol-related seizures were fewer than described in earlier studies (3.5%–7.9% [11,17–20,26,39], 44%–72.6% [11, 16, 19, 29, 39, 40], and 15.5%–19% [19, 28], respectively).

The study is limited by its observational and retrospective design and entails a risk of reporting bias due to misdiagnosis or incorrect coding during the treatment period. These issues are present in all big data-type studies and cannot be ruled out without further examination of patient records. However, epilepsy-related coding has been reported with high validity [41], and using administrative data has been considered reasonable in epidemiological research [42]. Recording at least one diagnostic code (ICD-10) at hospital discharge is mandatory in Finland, which enables reliable diagnosis-based collection of study material and extensive recognition of potential cases at different levels of the system. A notable feature of the Finnish health care system is that public health care organizes and manages acute medical care at all levels, whereas private health care is not involved. Furthermore, all patients, regardless of their insurance status, receive the same public service. After balancing the strengths and limitations, this work can be considered a representative population-based study. However, taking into account the

differences in health care systems in different countries, some caution should be considered before generalizing these results.

CONCLUSIONS

Acute suspected epileptic seizures cause a considerable burden on emergency services and health care as a whole, although only a minority of cases require the most demanding medical treatment. The novel epidemiological framework provided by this study is paramount when planning resource allocation in emergency services. To be able to influence this burden by medical protocols, further studies are needed to clarify the diagnostic accuracy of emergency services and reasons for ED visits and hospital admissions, to identify patients suitable for safe nonconveyance, to characterize the most frequent consumers of the system, and to explain the overrepresentation of men.

AUTHOR CONTRIBUTIONS

Leena Kämppi, Tuukka Puolakka, and Jukka Peltola planned the study. Tuukka Puolakka and Markku Kuisma were responsible for the prehospital data collection, and Jaakko Ritvanen, Kati Tuppurainen, and Leena Kämppi collected the hospital data. The data were analysed by Leena Kämppi and Jari Päkkilä, and Leena Kämppi and Tuukka Puolakka drafted the manuscript. All authors reviewed and edited the draft and approved the final version of the manuscript.

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CONFLICT OF INTEREST STATEMENT

None of the authors has any conflict of interest to disclose. We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

ORCID

Leena Kämppi https://orcid.org/0000-0001-5084-2159
Tuukka Puolakka https://orcid.org/0000-0002-3748-1202
Jukka Peltola https://orcid.org/0000-0002-4119-8063

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