Pre-hospital ambulance care of patients following a suspected seizure: a cross sectional study

Running Title: Pre-hospital care after a seizure

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Abstract

Purpose
Patients with suspected seizures generate approximately 3% of all ambulance service emergency incidents in the UK with most of these patients being transported to hospital. We aimed to investigate the characteristics of patients presenting to the ambulance service with suspected seizures, the costs of managing these patients and the factors which predicted transport to hospital.

Methods
We employed a cross-sectional design using routine clinical data from a UK regional ambulance service. Logistic regression was used to identify predictors of transport to hospital from ambulance response times, demographics, clinical (physiological) findings and treatments. Continuous data from physiological variables ('first vital signs') including respiratory rate, oxygen saturation, temperature, systolic blood pressure and heart rate were transformed into categorical variables according to National Early Warning Score (NEWS) categories.

Results
There were 177,715 emergency incidents recorded in 2011/12 of which 2.9% (5,139/177,715) were classified as seizures by ambulance call handlers and 2.7% (4,884/177,715) by paramedics on the scene. Suspected seizures were the seventh most common call type. The annual cost of managing these incidents was £890,148. Clinical and physiological variables were normal for most patients. 59.3% (2,894/4,884) of patients were transported to hospital, the rest were not transported and 1/4,884 (0.02%) patient died. Administration of diazepam, insertion of an airway and pyrexia perfectly predicted transport to hospital, tachycardia had a modest association, but other variables were only weak predictors of transport to hospital.

Conclusions
This study shows that most patients after a suspected seizure are not acutely unwell but nevertheless most patients are transported to hospital. Many more patients after a suspected seizure could potentially be safely managed without transport to hospital. Further research is required to determine which factors are important in decisions to transport to hospital and to create evidence-based tools to help paramedics identify patients who are suitable for non-conveyance.

Introduction

Pre-hospital ambulance care for patients after a suspected seizure is an important step in the emergency care pathway but until recently there has been little research in this area [1]. Suspected seizures are one of the most common causes of emergency calls to ambulance services comprising approximately 3.3% of all emergency incidents [2]. Approximately 75% of suspected seizures are epileptic seizures; the two other most frequent causes are psychogenic non-epileptic seizures (PNES) and cardiogenic syncope (most often vasovagal episodes) [3]. In England (population 53.11 million, 41.77 million adults (≥16 years old) [4]), it is estimated that suspected seizures give rise to approximately 211,000 calls to ambulance services [2], 60,000 seizure-related Emergency Department (ED) attendances (2-3% of all attendances) [5], and 40,000 hospital admissions each year [5 6].

Status epilepticus is a medical emergency requiring rapid treatment with benzodiazepines. Although current national guidelines for paramedics in the United Kingdom (UK) on management of seizures focus on status epilepticus [7], the majority of suspected seizures self-terminate within 90 seconds and are not medical emergencies. Most people after a self-terminating epileptic seizure would fully recover without medical treatment and do not need transport to hospital [2]. However, there are important exceptions [8] and post-ictal patients present multiple challenges for emergency call-handlers and paramedics. One of the main factors which determines transport to hospital is lack of confidence, lack of training, lack of access to medical history and medico-legal concerns amongst ambulance clinicians [9 10 11]. There are currently no criterion-based systems to help paramedics make decisions about leaving these patients safely at home [12,13] and therefore, most patients are transported to hospital generating significant and often avoidable health-care costs [14].

We aimed to investigate the characteristics of patients presenting to a regional ambulance service in the UK with suspected seizures, the costs of managing these patients and the factors which predicted transport to hospital.

Methods

Design and setting

We undertook a cross-sectional study of routine ambulance service clinical data from East Midlands Ambulance Service NHS Trust (EMAS) between 1 August 2011 and 31 July 2012, where the diagnosis of the incident was suspected seizure and to which an ambulance or rapid response vehicle (RRV) was dispatched. EMAS is one of ten National Health Service (NHS) ambulance trusts serving the population of England (one of the devolved nations of the UK) (population 53.11 million, 41.77 million adults (≥16 years old) [4]). Each ambulance trust covers a mean area of 5151 square miles (range 620–7500 m^2) serving a mean population of 5.5 million (range 2.6–7 million). EMAS covers 6425 square miles and has a population of 4.8 million (3.9 million adults). Emergency (999) calls are initially dealt with by trained but non-clinical emergency call handlers who, based on computerised algorithms, make decisions about dispatch of ambulances and their priority. The two systems in the UK are the Advanced Medical Priority Dispatch System (AMPDS) and NHS Pathways. EMAS call handlers use AMPDS. AMPDS is an international system, based on 33 protocols tailored to a range of clinical conditions/presentations. AMPDS code (protocol) 12 is used for suspected seizures in which call-handlers asking predetermined questions assign incidents to specific 'determinant descriptors', which determine the response priority and target response times.

Data extraction

Calls were categorised as suspected seizures using two methods: 1) when AMPDS code 12 was applied to the incident by the ambulance call handler 2) when the primary 'chief complaint' (or other complaint) of 'convulsions/fitting' was selected by the ambulance clinician at the scene (paramedic, emergency medical technician etc.). Or if the chief complaint was a free text entry consistent with this (free text entries were included/excluded after review by one author (JMD)). Case ascertainment using both APMDS and chief complaint were analysed initially to allow comparison but chief complaint alone was used throughout the rest of the paper to define the study cohort. The chief complaint which is determined by a paramedic after a face-to-face clinical assessment is likely to be a more accurate diagnostic indicator than AMPDS codes.

Clinical data were extracted from the clinical record, whether electronic Patient Report Forms (ePRFs) or electronically scanned paper Patient Report Forms (PRFs). Data from all electronically scanned PRFs was subsequently verified by a trained data clerk. The overall use rate of ePRFs in EMAS at the time of the study was 55.7% with the remainder comprising paper PRFs; both were included in the analysis.

Analysis

We used descriptive statistics to summarise available data for ambulance service processes, ambulance response times, demographic data, clinical (physiological) findings and treatments. Continuous data from physiological variables ('first vital signs') including respiratory rate, oxygen saturation, temperature, systolic blood pressure and heart rate were transformed into categorical variables according to National Early Warning Score (NEWS) categories [15]. NEWS is a national UK scoring system, assessing the severity of acute illness using 7 parameters, where scores are allocated according to the extent to which parameters differ from normal values. A normal value is allocated a score of zero and the maximum score for each parameter is 2 or 3. The rate of repeat incidents (the same patient generating more than one incident) was estimated using the patients' date of birth, gender and postcode as identifiers for individual patients.

We used logistic regression to identify predictors of transport to hospital. The dependent variable was transport to hospital (yes/no). Independent variables were selected from the full list of variables where there were clinical or other theoretical reasons to believe that they may predict transport to hospital.

UK ambulance service costs are based on individual agreements between the ambulance services and the contracting CCGs (who negotiate collectively with their local ambulance service). Ambulance services have three tariff bands for managing incidents. Tariffs are applied regardless of the urgency of the ambulance response. Tariffs were obtained from EMAS: calls (C) £5.57, hear and treat/refer (HTR) £32.65 (for managing an incident exclusively with telephone advice), see and treat and convey (STC) £197.99 (for dispatch of an ambulance or RRV plus transport to hospital) and see and treat/refer (STR) £229.00 (for dispatch of an ambulance or RRV without transport to hospital). The total cost of their activity for managing the series of incidents in the study was calculated.

Ethics

This study was a service evaluation and only used anonymised data so NHS Research Ethics Committee permission was not required. We received permission from the Research and Management Governance committee of EMAS and from the ethics committee of the University of Lincoln.

Results

Ambulance calls for seizures or convulsions

Between 1 August 2011 and 31 July 2012 EMAS dealt with 211,317 separate incidents. Of these, 23,305 involved children (<16 years old) or had missing data for age and were excluded from the analysis. Another 10,297 calls were not classed as an emergency incident and were also excluded. After these exclusions, data from 177,715 emergency incidents were analysed. Of these 2.9% (5,139/177,715) were AMPDS code 12 (convulsions/seizures) and 2.7% (4,884/177,715) were recorded as a chief complaint of "convulsions/fitting" or a related free text entry. 1.96% (3,487/177,715) of incidents were coded with both; see Figure 1.

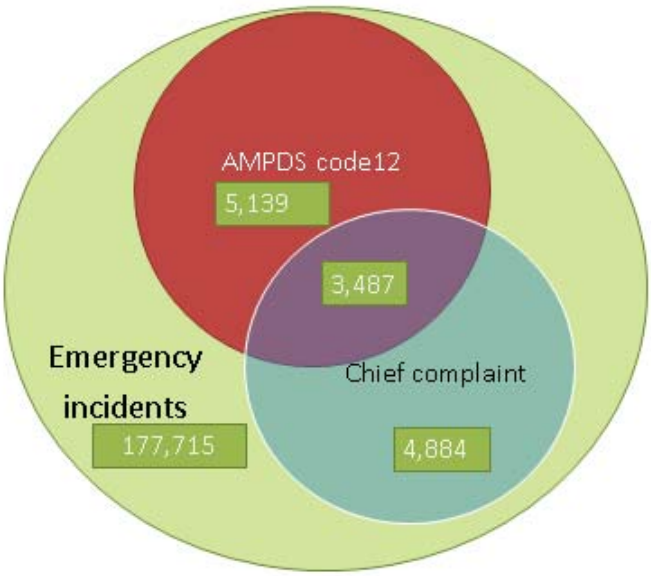

Figure 1 A Venn diagram to show the interaction of the total number of emergency incidents, the number of incidents assigned AMPDS code 12 by the ambulance call handler and the chief complaint recorded by the paramedic on arrival at the scene.

Dispatch to patients with seizures or convulsions

AMPDS Code 12 (convulsions/seizures) was the seventh most common call type (see Table 1). The diurnal pattern in call frequency matched that of all other calls with a peak late morning, a plateau throughout the day and a relatively rapid drop from midnight to the nadir at 5am, from which it rose to its late morning peak. An emergency vehicle was dispatched by the call handlers with an 8-minute response (the highest priority) in 58.9% (3,026/5,139), 20-minute response in 9.1% (469/5,139), 30-minute response in 30.9% (1,587/5,139) and telephone advice alone in 1.1% (57/5,139). Four determinant descriptors encompassed 93.2% (4,789/5,139) of the incidents (see Table 2): continuous or multiple fitting (12-D-02) 44.2% (2,273/5,139), effective breathing not verified ≥35 (12-D-04) 12.6% (647/5,139), effective breathing not verified <35 (12-B-01) 5.5% (282/5,139) and not fitting now and breathing effectively (verified) (12-A-01) 30.9% (1,587/5,139).

Chief complaint and Demographics

There were 4,884 incidents where the primary chief complaint was "convulsions/fitting" or a related free text entry. Most incidents were from individual patients but a significant minority were due to repeat calls from the same patient. There were more men (52.6%) than women, more calls from younger people than older people, more calls from people with high deprivation (see Table 3). The median age of the study cohort was 66 with IQR [82-42].

Clinical assessment, clinical status and treatments

Most patients had normal physiological parameters and a normal NEWS score. 2.8% (135/4884) of patients had an ECG. Diazepam was administered in 1.5% (74/4,884) of incidents (see Table 4).

Outcomes and costs

59.3% (2,894/4,884) of the patients were transported to hospital and 40.7% (1,990/4,884) were not. Of those that were not transported to hospital, 11.4% (559/4,884) refused transport, treatment was not required in 3.9% (192/4,884) and 1 patient (1/4,884) was deceased (see Table 5). The total cost of managing the entire cohort of incidents was £890,148. The most expensive single category of patients was those that were transported to hospital £572,983 (64.4% of the total costs). If this figure is extrapolated to the whole of England the cost of managing suspected seizures is £9.8 million per year (this is likely to be an underestimate because of the missing outcomes/costs data).

Predictors of transportation to hospital

The multivariable logistic regression model showing factors which predicted transport to hospital is shown in Table 6. The following clinical variables perfectly predicted transport to hospital (i.e. patients were always transported to hospital if they had this feature) and were therefore excluded from the regression model: diazepam administered, airway inserted, or temperature ≥39.1. AMPDS determinant descriptor codes: 12-A-02, 12-A-03, 12-C-01, 12-C-02, 12-D-03 (see Table 2 for the full name of each determinant descriptor code) were also perfect predictors of transport, and so were excluded in the model outputs during the analysis,even though the model of predictors included all of the descriptors detailed in table 2. Two additional determinant descriptors were excluded from the model because they occurred very infrequently in the data: AMPDS 12-D-00 and AMPDS 12-D-01. The following variables had an odds ratio higher that 1 ($p<0.05$) and were associated with conveyance to hospital: male gender, age 40-49, abnormal heart rate, reduced consciousness, low oxygen saturation, abnormal blood glucose, time on the scene, pregnancy. The statistical model had an R^2 of 18% showing that most of the explanation of the variance lay elsewhere.

Discussion

Clinical Acuity and Transport to hospital

Clinical and physiological variables, such as respiratory rate and consciousness, were normal in the majority of incidents. Nevertheless, the majority of patients were transported to hospital (59.3%). Some variables perfectly predicted transport to hospital (i.e. patients were always transported to hospital if they had this feature) and were therefore excluded from the regression model and some variables were weak predictors of transport (see *Predictors of transportation to hospital above).* The statistical model had an R^2 of 18% showing that most of the explanation of the variance lay elsewhere. There are many clinical factors (especially features in the history) which are likely to be important and which were not recorded in our data such as a change in seizure pattern, additional clinical features e.g. associated headache or injury and type of seizure (first seizure versus usual seizure in patient with established epilepsy). Qualitative research amongst paramedics shows that they think that transport to hospital is both clinically safer and a lower risk medico-legally [9,16]. Important factors identified in the published qualitative studies include lack of experience/training, patient views, anxiety over litigation, lack of access to the patients' medical records and bystander expectation. Further research is required to determine which factors are important in decisions to transport to hospital and to create evidence-based tools to help paramedics identify patients who are suitable for non-conveyance.

Call volumes, Diagoses and Dispatch (AMPDS) Codes

The methods of case ascertainment in this study were AMPDS code 12 recorded by ambulance call handlers and 'chief complaint' recorded by ambulance clinicians. The proportion of patients allocated to specific AMPDS code 12 determinant descriptors was very similar to previous studies involving other ambulance services [2 3] suggesting that its performance is robust between ambulance services. We found a high concordance between the call-handlers allocating AMPDS 12 to an incident and the paramedics chief complaint. Only 4.4% (225/5,139) of those categorised as AMPDS code 12 were not assigned a chief complaint of convulsions/fitting by the ambulance clinician. This suggests that the AMPDS algorithm is sensitive for identify patients with convulsions/fitting, however it is not specific because 28.7% (1,397/4,884) of patients diagnosed with convulsions/fitting by an ambulance clinician were given an alternative AMPDS code (ie not code 12); see Figure 1.

There are a small number of previously published studies looking at the sensitivity and specificity of questions in the AMPDS algorithm for suspected seizures but most of these are focussed on cardiac arrests (which may be manifest as brief convulsions) [17,18 19 20]. 58.9% (3,026/5,139) of our incidents were dispatched with an 8-minute response time (the highest priority response time) but only 1 of 4884 of our patients died. We do not have specific data on the diagnosis of cardiac arrest amongst our cohort but our results suggest that more research may be required to optimise the performance of AMPDS for diagnosis of seizures and to consider the possibility of dispatching lower priority ambulances for most AMPDS code 12s. Linkage between pre-hospital and hospital data-sets is potentially a powerful way of studying this. It would allow collection of more definitive diagnostic and outcome data at the level of individual patients than was possible in this study.

Demographic characteristics

Our data show the previously reported slight excess of male patients (52.6%). The age profile of patients in this study shows an excess of middle-aged patients which does not reflect the prevalence of epilepsy in the general

population where there is a peak in old age. The relatively low number of incidents involving elderly patients was therefore unexpected. The apparent excess of middle-aged patients may represent discretionary use of health services in middle age, it may reflect a population bulge in these age categories, or it may reflect misdiagnosed psychogenic seizures (which are more common in middle-age) and further research is required to explore this phenomenon. It is not possible to comment on ethnicity of our cohort because of the large proportion of missing data. Non-recording of ethnicity has been previously reported [21]. There was a very close correlation between deprivation and number of incidents with higher numbers of calls from higher deprivation groups.

Investigations and quality standards

Most patients in our cohort did not have an ECG performed (97.2%). Undertaking an ECG is not mentioned in the UK national ambulance guidance for seizures [22] but NICE states that all patients with transient loss of consciousness should have an ECG to exclude serious cardiac causes which can manifest as convulsions [23]. ECG is a relatively simple investigation which paramedics are trained to undertake and this may be the ideal opportunity to ensure this investigation is undertaken. Although this may not be necessary in patients with an established diagnosis of epilepsy after a typical seizure many patients in this cohort have experienced a first seizure or syncope in which case an ECG would be appropriate investigation.

Time on scene and outcomes

This is the first study to document the amount of time spent at the scene of seizure incident and it shows that these are protracted incidents with the majority taking more than one hour and 38.7% taking over 1.5 hours. We did not have data for comparator conditions, and are not aware of any published data looking at on-scene times and making condition-by-condition comparisons but this data would be of interest. 59.3% of patients were transported to hospital, 9.8% were treated at the scene and not transported, and 11.4% refused transport. Refusal to be transported implies that patients did not agree with the ambulance clinician's assessment that transport was required. Many patients do not feel transport to ED is necessary, helpful or desirable but qualitative research shows that paramedics feel do not feel confident assessing patients after a seizure and they feel that transport to hospital is both clinically safer and a lower risk medico-legally [9]. Alternative care pathways (ACPs) may allow patients after a seizure to be referred to specialist services and avoid unnecessary transport to hospital [24] but there is no specific ACP in EMAS for seizures and very few patients in our study were referred to other care providers, such as their GP, as an alternative to transport to hospital. Based on the clinical parameters our data suggest that a large proportion of our cohort may be suitable but a prospective criterion-based approach would be required to determine the actual number of suitable patients. The physiological variables reported in this study are 'first vitals' i.e. the assessment performed on arrival. It is likely that by the end of the assessment many abnormal results would have returned to normal allowing conformation that the patient was not acutely unwell and therefore potentially suitable for non-conveyance.

Repeat incidents

Our data shows that repeat incidents were common (10.1%) i.e. the same patient generating more than one incident in the study period. This is well documented but exact rates vary on the methodology used [25]. In many cases repeat incidents are a marker of failed ambulatory care. Ongoing seizures in epilepsy should trigger expert review to review the diagnosis, optimise treatment and in patients with refractory epilepsy develop an emergency care plan. Some patients with severe and refractory epilepsy will require frequent emergency treatment but this scenario is rare.

Strengths and limitations

The main strength of this study is the relatively large size of the cohort. Previous studies have been much smaller and relied on manual extraction of the data from clinical records. Clinical and process data is routinely and automatically collected in EMAS which means that a large data-set was available for this research. Our study allowed us to show that the majority of clinical/physiological variables were normal on arrival but we were not able to include other important factors which were not included in our data such as a change in seizure pattern, additional clinical features e.g. associated headache, injury or type of seizure (first seizure versus usual seizure in patient with established epilepsy). Further research is required to determine which factors are important in decisions to transport to hospital and to create evidence-based tools to help paramedics identify patients who are suitable for non-conveyance. Our data is 5 years old which is a limitation. Patterns of ambulance service use change every year with a general trend towards increased demand and a new set of national ambulance service standards were introduced in 2017. Individual ambulance services are under constant pressure to review

their processes as a result of increasing demands and some EMAS processes may been updated since the study was conducted. However, there is no reason to believe that the fundamentals of this study, such as the clinical characteristics of the patients and the aetiology of the events, have changed in the intervening five years. Suspected seizures continue to generate a large number of emergency incidents and present a major challenge in delivering clinically effective and cost effective care. As such this paper is an important addition to what is already known in this area.

Competing Interests

ANS is an Associate Clinical Director of East Midlands Ambulance Service NHS Trust. JMD received a grant of £3,500 in 2014 from UCB Pharma Limited (paid to The University of Sheffield) to study unscheduled admissions for seizures using Hospital Episode Statistics (outside the submitted work). ZA has no competing interests.

Funding

This study was not funded.

Table 1 Ten commonest AMPDS codes assigned to incidents between 1/8/2011 and 31/7/2012

Rank	AMPDS Protocol name (protocol code/number)	EMAS	%
1	Falls (17)	27,463	15.5%
2	Chest pain (non-traumatic) (10)	18,187	10.2%
3	Breathing problems (6)	12,842	7.2%
4	Sick person (specific diagnosis) (26)	10,288	5.8%
5	Unconscious / fainting (near) (31)	8,505	4.8%
6	Overdose / poisoning (ingestion) (23)	5,539	3.1%
7	Convulsions / fitting (12)	5,139	2.9%
8	Haemorrhage / laceration (21)	4,899	2.8%
9	Stroke (CVA) (28)	4,812	2.7%
10	Traumatic injuries (specific) (30)	3,811	2.1%
	Total	**177,715**	

Table 2 Determinant descriptors for the suspected seizure incidents

Determinant descriptors	Determinant code	Code Call	Category Response times	Number	%
Not breathing (after key questioning)	12-D-01	Red 1 (A)	Response in 8 min	12	0.2
Convulsion/Fitting Delta Override	12-D-00	Red 2 (A)	Response in 8 min	1	0.0
Continuous or multiple fitting	12-D-02	Red 2 (A)	Response in 8 min	2273	44.2
Agonal/ineffective breathing	12-D-03	Red 2 (A)	Response in 8 min	21	0.4
Effective breathing not verified ≥35	12-D-04	Red 2 (A)	Response in 8 min	647	12.6
Focal fit (not alert)	12-C-01	Red 2 (A)	Response in 8 min	44	0.9
Pregnancy	12-C-02	Red 2 (A)	Response in 8 min	28	0.5
Diabetic	12-C-03	Green 1 (C)	Response in 20 min	187	3.6
Effective breathing not verified <35	12-B-01	Green 1 (C)	Response in 20 min	282	5.5
Not fitting now and breathing effectively (verified)	12-A-01	Green 2 (C)	Response in 30 min	1587	30.9
- - -	-	Green 3 (C)	Tel assess within 60 min	-	-
Focal fit (alert)	12-A-02	Green 4 (C)	Tel assess within 60 min	23	0.5
Impending fit (aura)	12-A-03	Green 4 (C)	Tel assess within 60 min	34	0.7
			Total	**5139**	**100%**

Table 3 Demographic characteristics of patients with a chief complaint of convulsions/fitting. Index of Multiple Deprivation: 1 most deprived, 5 least deprived.

Demographic variable	Category	Treated and Transported: No 1433 (29.3%)	%	Yes 2894 (59.3%)	%	Missing 557 (11.4%)	%	N = 4,884	Total %
Gender	Female	653	45.6%	1217	42.1%	226	40.6%	2096	42.9%
	Male	691	48.2%	1565	54.1%	315	56.6%	2571	52.6%
	Missing	89	6.2%	112	3.9%	16	2.9%	217	4.4%
Ethnicity	Asian	16	1.1%	30	1.0%	0	0.0%	46	0.9%
	Black	6	0.4%	7	0.2%	0	0.0%	13	0.3%
	Mixed/other	8	0.6%	21	0.7%	0	0.0%	29	0.6%
	White	888	62.0%	1847	63.8%	0	0.0%	2735	56.0%
	Missing	515	35.9%	989	34.2%	557	100.0%	2061	42.2%
Age group (years)	16-29	472	32.9%	767	26.5%	162	29.1%	1401	28.7%
	30-39	287	20.0%	507	17.5%	91	16.3%	885	18.1%
	40-49	243	17.0%	564	19.5%	115	20.6%	922	18.9%
	50-59	172	12.0%	382	13.2%	64	11.5%	618	12.7%
	60-69	115	8.0%	245	8.5%	56	10.1%	416	8.5%
	70-79	71	5.0%	200	6.9%	20	3.6%	291	6.0%
	80+	73	5.1%	229	7.9%	49	8.8%	351	7.2%
	Missing	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Number of incidents per patient	1	1023	71.4%	2228	77.0%	0	0.0%	3251	66.6%
	2	81	5.7%	175	6.0%	0	0.0%	256	5.2%
	3	22	1.5%	49	1.7%	0	0.0%	71	1.5%
	4	28	2.0%	17	0.6%	0	0.0%	45	0.9%
	5	2	0.1%	8	0.3%	0	0.0%	10	0.2%
	6	4	0.3%	5	0.2%	0	0.0%	9	0.2%
	7+	4	0.3%	3	0.1%	0	0.0%	7	0.1%
	Missing	269	18.8%	409	14.1%	557	100.0%	1235	25.3%
Index of Multiple Deprivation	1	245	17.1%	479	16.6%	0	0.0%	724	14.8%
	2	118	8.2%	199	6.9%	0	0.0%	317	6.5%
	3	74	5.2%	154	5.3%	0	0.0%	228	4.7%
	4	76	5.3%	142	4.9%	0	0.0%	218	4.5%
	5	42	2.9%	71	2.5%	0	0.0%	113	2.3%
	Missing	878	61.3%	1849	63.9%	557	100.0%	3284	67.2%

Table 4 Clinical variables for patients with a chief complaint of convulsions/fitting (including parameters for National Early Warning Score (NEWS) elements). Variables indicated with * are part of the National Early Warning Score (NEWS) system.

Clinical variable	Value (NEWS score)	N =4,884	%
Respiratory rate *	12-20 (0)	3552	72.7%
	9-11 (1)	10	0.2%
	21-24 (2)	303	6.2%
	≤8 or ≥25 (3)	227	4.6%
	Missing	792	16.2%
Oxygen saturation *	≥96 (0)	2884	59.0%
	94-95 (1)	399	8.2%
	92-93 (2)	52	1.1%
	≤91 (3)	187	3.8%
	Missing	1362	27.9%
Supplemental oxygen *	Not administered (0)	4497	92.1%
	Administered (2)	387	7.9%
	Missing	0	0%
Temperature (^{0}C) *	36.1 -38.0 (0)	1906	39.0%
	35.1-36.0 & 38.1-39.0 (1)	347	7.1%
	≥39.1 (2)	26	0.5%
	≤35.0 (3)	47	1.0%
	missing	2558	52.4%
Systolic blood pressure (mmHg) *	111-219 (0)	3386	69.3%
	101-110 (1)	341	7.0%
	91-100 (2)	96	2.0%
	≤90 or ≥ 220 (3)	81	1.7%
	Missing	980	20.1%
Heart rate (beats/minute) *	51-90 (0)	1871	38.3%
	41-50 or 91-110 (1)	1376	28.2%
	111-130 (2)	658	13.5%
	≤40 or ≥131 (3)	247	5.1%
	Missing	732	15.0%
Conscious level (AVPU) *	Alert (0)	2653	54.3%
	Voice (3)	815	16.7%
	Pain (3)	286	5.9%
	Unresponsive (3)	301	6.2%
	Missing	829	17.0%
Glasgow Coma Scale	15	2420	49.5%
	14	552	11.3%
	13	209	4.3%
	≤12	799	16.4%
	Missing	904	18.5%
Blood glucose (mmol/l)	Normal (4-20)	2512	51.4%
	Low (<4)	100	2.0%

	High (>20)	5	0.1%
	Missing	2267	46.4%
Airway	Clear	511	10.5%
	Noisy	9	0.2%
	Obstructed	4	0.1%
	Vomited	4	0.1%
	missing	4356	89.2%
ECG	Not taken	4749	97.2%
	Taken	135	2.8%
	Missing	0	0%
Diazepam	Not administered	4810	98.5%
	Administered	74	1.5%
	Missing	0	0%
Time on scene (hours)	<0.5	595	12.2%
	0.5-1.0	578	11.8%
	1-1.5	1819	37.2%
	> 1.5	1892	38.7%
	Missing	0	0%
National Early Warning Score	0	4198	86.0%
	1	28	0.6%
	2	75	1.5%
	3	583	11.9%
	Missing	0	0%

Table 5 Outcome of each incident of convulsion/fitting and associated costs. Calls (C); Hear and treat or refer (HTR); See and treat and convey (STC); See and treat or refer (STR); - missing.

Outcome	n	%	Tariff band	Total cost
Cancelled on route	0	0.0%	C (£5.57)	0
Deceased and Transported	0	0.0%	STC (£197.99)	0
Deceased not Transported	1	0.0%	STR (£229.00)	229
No Patient Found	0	0.0%	STR (£229.00)	0
No Treatment Required	192	3.9%	STR (£229.00)	43,968
Not Treated, Transferred Care	12	0.2%	STR (£229.00)	2,748
Other	41	0.8%	-	-
Own Transport	8	0.2%	STR (£229.00)	1,832
Patient Refused Care	34	0.7%	STR (£229.00)	7,786
Patient Refused Transport	559	11.4%	STR (£229.00)	128,011
Record created in error	0	0.0%	-	-
Referred to Other Agency	27	0.6%	STR (£229.00)	6,183
Referred to Primary Care	71	1.5%	STR (£229.00)	16,259
Treated and Discharged	481	9.8%	STR (£229.00)	110,149
Treated and Transported	2894	59.3%	STC (£197.99)	572,983
Missing	564	11.5%	-	-
TOTAL	**4884**	**100%**	**-**	**890,148**

Table 6 Multivariable logistic regression model showing factors which predict transport to hospital. IMD: Index of Multiple Deprivation, 1 most deprived, 5 least deprived. Respiratory rate, breaths per minute. BP, blood pressure. Conscious level (AVPU): A alert, V voice, P pain, U unresponsive. AMPDS, AMPDS determinant descriptor code (see Table 2 for full determinant descriptor name). Covariates not included in the model and reason for non-inclusion: 1) Covariate categories that perfectly predicted transport: diazepam administered, airway inserted, temperature ≥39.1. AMPDS determinant descriptor codes: 12-A-02, 12-A-03, AMPDS 12-C-01, 12-C-02, 12-D-03. 2) Covariate category that perfectly predicted non-transport: respiratory rate (9-11) due to very few patients in this category). 3) Covariates exhibiting collinearity and low frequency: AMPDS 12-D-00, 12-D-01.

Independent Variable	Value	Odds Ratio	(95% CI)	p-value
Gender	Female	Reference		
	Male	**2.11**	**(1.17 - 3.81)**	**0.01**
Age group (years)	16-29	Reference		
	30-39	1.44	(0.64 - 3.25)	0.37
	40-49	**3.32**	**(1.36 - 8.09)**	**0.01**
	50-59	1.5	(0.53 - 4.23)	0.45
	60-69	2.5	(0.7 - 8.9)	0.16
	70-79	3.41	(0.72 - 16.16)	0.12
	80+	**7.21**	**(1.43 - 36.45)**	**0.02**
IMD	1	Reference		
	2	0.5	(0.23 - 1.11)	0.09
	3	1.1	(0.43 - 2.82)	0.84
	4	1.83	(0.67 - 5.05)	0.24
	5	0.21	(0.03 - 1.44)	0.11
Respiratory rate	12-20 (0)	Reference		
	21-24 (2)	1.79	(0.62 - 5.18)	0.29
	≤8 or ≥24 (3)	2.17	(0.32 - 14.87)	0.43
Oxygen saturation (%)	≥96 (0)	Reference		
	<96 (1-3)	**3.00**	**(1.21 – 7.43)**	**0.02**
Supplemental oxygen	Not administered (0)	Reference		
	Administered (2)	5.42	(0.86 - 34.02)	0.07
Temperature	36.1-38.0 (0)	Reference		
	35.1-36.0 and 38.1-39.0 (1)	1.28	(0.53 - 3.08)	0.58
	≤35.0 or ≥ 39.1 (3)	1.8	(0.11 - 29.44)	0.68
Systolic BP	111-219 (0)	Reference		
	101-110 (1)	0.64	(0.23 - 1.78)	0.4
	91-100 (2)	2.6	(0.23 - 29.78)	0.44
	≤90 and ≥220 (3)	0.42	(0.06 - 2.83)	0.37
Heart rate	51-90 (0)	Reference		
	41-50 or 91-110 (1)	**2.03**	**(1.03 - 4.02)**	**0.04**
	111-130 (2)	1.64	(0.68 - 3.96)	0.27
	≤40 or ≥131 (3)	**19.99**	**(2.7 - 148.15)**	**P<0.001**
Conscious level	A (0)	Reference		
	VPU (3)	**2.62**	**(1.24 - 5.55)**	**0.01**
Blood glucose	Normal	Reference		

	<4mmol/l or >20mmol/l	**3.35**	**(0.6 - 18.57)**	**0.17**
Time on scene (hours)	<0.5	Reference		
	0.5-1.0	1.83	(0.73 - 4.61)	0.2
	1-1.5	**2.23**	**(1.05 - 4.73)**	**0.04**
	> 1.5 hr	2.25	(0.9 - 5.64)	0.08
AMPDS	12-A-01	Reference		
	12-B-01	2.25	(0.72 - 6.96)	0.16
	12-C-02	**9.87**	**(1.05 - 93.15)**	**0.047**
	12-D-02	0.98	(0.49 - 1.95)	0.96
	12-D-04	1.33	(0.5 - 3.56)	0.57
Incidents per patient	1	Reference		
	>1	0.71	(0.42 - 1.19)	0.2

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