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Mariama Runcie, Neal Nolan, Olivia Yoo, Robert Silbergleit, Fábio A. Nascimento, Maura Kennedy, M. Brandon Westover & Joshua N. Goldstein

EEG in Patients with Altered Mental Status in the Emergency Department

Mariama Runcie [1]*, Neal Nolan [2]*, Olivia Yoo [3], Robert Silbergleit [1], Fábio A. Nascimento [4], Maura Kennedy [5], M. Brandon Westover [6], Joshua N. Goldstein [5]

[1]Department of Emergency Medicine, University of Michigan Hospital, University of Michigan Medical School, Ann Arbor, MI USA

[2]Department of Neurology, Brigham and Women's Hospital, Harvard Medical School, Boston, MA USA

[3]Harvard College, Harvard University, Cambridge, MA USA

[4]Department of Neurology, Division of Epilepsy, Washington University School of Medicine, St. Louis MO, USA

[5]Department of Emergency Medicine, Mass General Hospital, Harvard Medical School, Boston, MA USA

[6]Department of Neurology, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, MA, USA

* These authors contributed equally.

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***Corresponding author:**
Mariama Runcie MD
Department of Emergency Medicine
University of Michigan
1500 E. Medical Center Drive
Ann Arbor, MI 48109-5301
runciema@med.umich.edu

Abstract

Background: Altered mental status is a common chief complaint in the emergency setting, and the initial evaluation often fails to find an etiology. Subclinical (electrographic) seizures and nonconvulsive status epilepticus (NCSE) are potential causes of delirium and altered mental status, but require electroencephalogram (EEG) for diagnosis. It is not clear how often subclinical seizure or NCSE is present in those with undifferentiated altered mental status, nor which patients are most likely to benefit from emergent EEG.

Methods: We performed a retrospective review of patients presenting to a single academic medical center emergency department (ED) over a one-year period with the chief complaint of "altered mental status" who had an order placed for EEG while in the ED.

Results: During the study period 112 patients met inclusion criteria. Of the 112 patients, 10 (8.9%) had seizures observed on EEG. Of these patients with EEG-observed seizure, 4 (40%) had clinical correlates, whereas the remaining 6 (60%) had no clinical manifestation of seizure. Five (50%) had a final diagnosis of status epilepticus, all of which had subtle or absent clinical correlates qualifying for NCSE. Eighty-one (72%) patients had abnormal EEG findings, 27 (24%) of whom had epileptiform EEG findings without definitive seizure. The median times from ED presentation to EEG being ordered and completed were 6.4 and 20.9 hours, respectively.

Conclusion: EEGs obtained in patients with undifferentiated altered mental status are typically abnormal and are frequently of clinical importance. Seizure was observed in a substantial portion of these, often without clinical signs. The average time until EEGs were ordered and completed were about 6 and 20 hours respectively; as a result, time sensitive clinical decisions that need to be made within 20 hours may often be made without information from the EEG. More urgent EEG may benefit patients with altered mental status of unclear etiology in the ED.

Introduction

Altered mental status (AMS) on initial presentation to a hospital emergency department (ED) is a common and nonspecific chief complaint with a broad differential diagnosis. AMS is found to be present in 4-10% of ED patients, and up to 30% of persons 65 years and older in the ED.[1] Often, the initial evaluation fails to find an etiology.

Subclinical electrographic seizures and nonconvulsive status epilepticus (NCSE) are severe and under-recognized disorders.[2] The prevalence of NCSE amongst ED AMS patients is unknown. One academic medical center found NCSE in 5% of AMS patients in their ED who received electroencephalograms (EEG),[2,3] but this finding has not yet been validated as generalizable or replicated by any outside study. Furthermore, this rate is as high as 16.9% amongst EEGs for pediatric emergency pateints.[4] The prevalence of non-seizure abnormal EEG findings that may indicate increased risk for seizure amongst ED AMS patients is also unknown.

EEG in the emergency setting is essential to the early diagnosis of NCSE and subclinical seizure. Given that NCSE is associated with substantial morbidity and a case fatality rate of approximately 20%,[5] determining which patients are in NCSE is important for initial AMS evaluations. Furthermore, the consensus that status epilepticus becomes more difficult to terminate the longer it persists[5,6] makes it clear that prompt diagnosis and effective treatment initiation is a key clinical priority. Moreover, EEGs performed within 24 hours after event onset and ED arrival are associated with a substantially higher rate of abnormalities.[7,8]

EEG in the ED setting also plays an important role in providing impactful diagnostic findings outside of NCSE. Firstly, subclinical electrographic seizures not meeting NCSE criteria are detected in a substantial portion – 14%, in one recent cohort[9] – of EEGs obtained in the emergency setting. Outside of epileptic seizure, EEG in the emergency setting can also help characterize otherwise unclarified AMS in several common scenarios: estimating sedation, cerebral dysfunction, encephalopathy, toxidromes,[10, 11] hypoxic-ischemic injury,[12] or supporting the diagnosis of nonepileptic events such as functional seizures.[13] These early insights from ED EEG may accelerate identification of AMS mechanisms and appropriate correction of underlying causes, and reduce non-indicated antiseizure medication exposure and potentially morbid interventions such as endotracheal intubation.[14]

Building on previous studies, we evaluated the yield of EEG in the ED for patients with AMS. We conducted a retrospective review of ED patients undergoing EEG for AMS to determine frequency of EEG abnormalities, including NCSE.

Methods

Study population

This was a retrospective observational analysis of patients presenting to an urban academic ED between January 1 and December 31, 2019. Patients were included if they had an electroencephalogram (EEG) ordered (even if not completed) in the ED and had a chief complaint of altered mental status. For patients who presented multiple times during this time frame, only their first visit was analyzed (subsequent visits were excluded). This cohort is a mixed population of both adult and pediatric patients ages 2-89. This study was performed with the approval of the Institutional Review Board. Need for consent was waived for retrospective review.

Clinical Data

Patients were identified from the electronic health record system as described above. Medical records were reviewed by MR and OY, and interrater assessment discrepancies were resolved in discussion with JG, NN, and FN to ensure accuracy. Data abstracted included: demographic data, chief complaint, neurological imaging, EEG results, time of symptom onset, clinical diagnosis, disposition, and clinical outcomes. EEG is available

24/7 including nights and weekends. EEGs were typically ordered when there was clinical suspicion for seizure activity. Clinical variables collected included age, sex, race/ethnicity, antiseizure medication (ASM) prescription history, Glasgow Coma Scale (GCS) score on arrival, ED intubation, ED neurology consultation, and history of witnessed seizure activity. The patient's GCS on first assessment after ED arrival was obtained from nursing documentation or, when not found there, abstracted from the narrative and exam of the ED responding clinician and attending note(s), in that order. Clinical case times and features of the patients' evaluation and management were obtained from the electronic medical record as described below.

For patients who received multiple EEGs, only the EEG ordered in the ED was considered. EEGs were typically placed by dedicated EEG technologists. The length of time it took the patient to receive an EEG was calculated as the number of hours between the EEG ordered and the EEG end time. EEG read time was determined as the time the read was published in the electronic medical record. EEGs were rarely performed with accompanying video and so this information was not captured.

EEG Analysis

EEG findings were obtained from the clinical EEG report and divided into three categories: electroclinical seizures (with the described presence of any clinical correlates), electrographic (subclinical) seizures, or no seizures. EEG reports were further categorized based on presence of epileptiform discharges, EEG background abnormality and their frequency (delta, theta, or delta-theta), as well as the presence of any burst suppression. EEG findings were considered epileptiform if there were epileptic seizures (electroclinical or subclinical electrographic), ictal-interictal continuum, periodic discharges (lateralized or generalized), spikes or sharp wave epileptiform discharges (focal or generalized, unless with explicit mention of “triphasic morphology” felt to be non-epileptiform in clinical context, as the best classification of triphasic morphology is long contended and remains undecided),[15] lateralized rhythmic delta activity (LRDA), or otherwise as detailed explicitly in the EEG report as ‘epileptiform’ or based on 2021 ACNS criteria.[16]

Clinical events and ratings were defined as follows. Epileptic seizure semiology including generalized tonic-clonic, focal-to-bilateral tonic-clonic, focal aware, and focal impaired awareness were defined according to International League Against Epilepsy 2017 classification criteria.[17,18] EEG abnormalities including electrographic seizure and electrographic status epilepticus were defined according to the American Clinical Neurophysiology’s 2021 Standardized Critical Care EEG Terminology.[16] Electroclinical seizure was defined as clinical ictal event coinciding with electrographic abnormality, whether or not the observed EEG finding independently met strict electrographic seizure criteria, also per ACNS guidelines.[16]

Time Points

Pertinent clinical time points and time intervals were obtained from the electronic medical record. Reported time from symptom onset to ED arrival was defined as the number of hours between the documented last seen well time and arrival to the ED. Time of symptom onset was collected from the electronic medical record, first referencing the narrative (History of Present Illness/ HPI) written by the ED responding clinician (RC). If the time of symptom onset was not available in the RC note, then the attending note, admission note, or inpatient discharge summary report were used, in that order. ED length of stay (LOS) is defined as the time between ED arrival and ED departure; therefore this may include boarding time. Inpatient LOS is hospital LOS minus ED LOS. If the patient was intubated, the time of intubation was obtained from the timeline in their chart recorded by ED nurses or, if unavailable, from the documented administration time of rapid sequence intubation (RSI) medications.

Antiseizure Medications

Prescription use of antiseizure medications (ASMs) prior to the AMS course and ED arrival, and whether any home ASM doses were adjusted or new ASMs were prescribed during the AMS presentation, were determined based on the patient's list of home medications contained in the discharge summary document for the same encounter which began with the considered ED presentation or, if not found there, then was obtained from the ED responding clinician or attending documentation. Where indication was unclear, any medication conventionally used to treat seizure was considered an antiseizure medication, without consideration of whether it may be used for non-seizure indication (e.g., pregabalin for neuropathic pain or lamotrigine for mood stabilization). Only current ASM use at ED presentation, (not prior use documented elsewhere in the EMR that was since discontinued), was considered.

Neuroimaging

Neuroimaging was defined as computed tomography (CT) or magnetic resonance imaging (MRI) obtained during the AMS presentation.

Statistics

Descriptive statistics were used to summarize the study data. Categorical variables are presented as counts and percentages. Continuous time-based variables are presented as median values with interquartile ranges (IQRs), given anticipated non-normal distribution.

Results

During the study period, there were a total of 683 ED patient encounters with an EEG ordered in the ED. Of these, 566 were excluded because they did not have the chief complaint “altered mental status” or “AMS”. 5 presentations were excluded for being a repeat patient encounter, leaving 112 AMS encounters for analysis (Figure 1).

Table 1 shows the demographics, clinical characteristics, and EEG findings of this cohort. Notably, only 4 patients (3.6%) were intubated, and 73 (65%) involved Neurology consultation. Fifty-seven percent of patients presented within 6 hours of symptom onset, 22% between 6 and 24 hours, and 21% greater than 24 hours after symptom onset. Median times from presentation to EEG being ordered and completed were 6.4 and 20.9 hours, respectively; the duration of most EEGs was 30-60 minutes. Median length of stay in the ED was 14.9 hours (IQR (7.2, 22.1)), following which 83% were admitted to the hospital, 3.6% were discharged from the ED, and 13% were sent to the ED observation unit (EDOU) and then discharged. No patients who were sent to the EDOU were ultimately admitted. The median hospital LOS was 115.8 hours (IQR (53.5, 196.0)). Fifty-five patients (49%) had an ASM started and/or adjusted.

Table 2 shows the characteristics of patients stratified by EEG findings. Overall, 72% of patients had abnormal EEG findings. EEG was diagnostic in

10 cases (8.9%) for seizure, of which only 4 had clinical correlate (Table 3). These four patients' clinical correlates were variable, with more overt and easily recognized epileptic seizures (unilateral upper extremity tonic-clonic movements, truncal stiffening with bilateral tonic arm extension) in two patients, but more subtle clinical features (subtle but coincident attentional deficits on exam, eyelid fluttering) in the other two. Notably, no patient was observed to have generalized tonic-clonic seizure during their EEG. 5 patients (4.5% of the cohort) were diagnosed with status epilepticus, all nonconvulsive, and only two with any clinical features, both of which were subtle and more likely to be overlooked – coincident attentional deficits, eyelid fluttering – than generalized convulsion. Clinical details about the 10 seizure cases can be found in Table 4.

Regarding non-seizure EEG abnormalities, 24% of patients had epileptiform discharges and 71% had background abnormalities. Two of four patients with electroclinical seizure were female, whereas four of six patients with electrographic seizure were female. All ten patients diagnosed with seizure activity on EEG were admitted from the ED to the hospital.

Ten of twelve patients with witnessed convulsions in their History of Present Illness had ASM medication initiated or adjusted, including patients for whom EEG would ultimately show non-epileptiform findings (Table 5). Similarly, for those four patients who were intubated, although none of them had frank seizure on EEG, three of four had epileptiform findings and either started a new ASM or had their existing ASM regimen adjusted

(Table 5). Similarly, 4 of 5 patients with a presenting GCS of 3-7 (for whom medication information was available, of n = 7 with GCS 3-7 in total) either started a new ASM or had their existing ASM dose adjusted (Table 5).

Discussion

The overall number of EEGs ordered in the ED is low. For an ED with a volume of over 100K annual visits, EEGs were performed in only 117 for AMS. Half of EEGs were performed in individuals on an ASM, and 11% had witnessed convulsions prior to EEG. This underscores that the true prevalence of subclinical seizures and NCSE in individuals with AMS is unknown.

Our cohort had a high occurrence of seizure: Overall, we found that when patients with altered mental status had EEGs ordered in the ED, 8.9% had seizure on EEG. Twenty-four percent of our cohort had epileptiform discharges and no seizures; in these patients, seizure activity could be the cause of AMS, or alternatively, these patients could have underlying epilepsy and their AMS presentation could be secondary to a non-seizure etiology. Seventy-two percent of our cohort had some abnormality, of which 46% (33% of total) was either seizure or another epileptiform finding that might prompt a change in ASM in the appropriate clinical context. These findings suggest a high level of electrographic abnormalities among ED patients classified as having otherwise-undifferentiated AMS, despite notably excluding those with chief complaints of ‘seizure’ or related terms from the cohort. EEG may be particularly informative in this patient cohort.

Interestingly our cohort was relatively young, with an average age of 64.5, despite the fact older adults are more likely to have delirium/AMS. This may be because older adults are less likely to have seizure as the underlying etiology of their AMS, or that healthcare providers are less likely to have seizure high enough on their differential to order EEG in this patient population.

A high rate of seizure amongst patients where clinicians have a high enough index of suspicion to order EEGs is consistent with prior studies: Our observed rates of seizure and other epileptiform findings are generally in-range with other observations in literature describing EEG in the acute care setting, both for those with specific clinical concern for seizure as well as more undifferentiated cases of altered mental status.[3,19-24] Prior studies suggest that patients where there is clinical suspicion for seizure have a higher incidence of electrographic seizure than other patients with AMS even if the seizures are subclinical.[22] All of our patients with seizure had a history of epilepsy or brain mass, and 9 out of 10 were on ASM prior to ED arrival. This is a patient cohort where clinicians would maintain a high index of suspicion for seizure. The yield of EEG may potentially be quite high in this population.

There is no decision-making tool to guide when EEG should be ordered in the ED, therefore the impetus for ordering EEG is poorly understood. One hypothesis is that EEG is driven by neurology consult recommendations, but only 65% of our patient encounters involved Neurology consultation. The reasoning behind the 35% of EEGs ordered without neurology consult and their relative yield is unknown.

The semiology of these seizures makes them extremely difficult to diagnose in the ED setting underscoring the need for emergent EEG in these patients: Six out of seven seizures that met strict electrographic criteria did not have a clinical correlate. Furthermore, all seizures observed on EEG were either subclinical/electrographic, nonconvulsive, focal, or otherwise dissimilar to typical GTC semiology in our cohort, suggesting that EEG was particularly valuable in diagnosis. These findings suggest that in our AMS patient cohort, seizure would likely have been more difficult to diagnose in the ED setting without EEG.[25] Therefore, a delay in EEG completion could be associated with a delay in diagnosis which has been associated with increased mortality in prior studies.[26] This may be consistent with previous studies which showed EEG is associated with favorable hospitalization outcomes for critically ill patients when compared to those who did not receive EEG.[27]

The time between ED presentation, EEG order time, and EEG completion was long. Prior studies have found that the longer the duration of seizure, the more difficult it is to terminate, with brain injury occurring as early as 45 minutes into the seizure [5,6]. We found that the average time to ordering and completing EEGs after patient presentation were around 6 and 20 hours respectively, which is substantially past the time frame where brain damage can start to occur. Particularly for patients with nonconvulsive status epilepticus, it is possible that some AMS patients could have had ongoing prolonged seizures prior to diagnosis, and may have benefited from earlier treatment if they had EEG sooner, as consistent with prior reports.[27,28]

Prior studies at our institution[29] observed time from illness onset to EEG initiation at 16.7 hours. Our finding of 20 hours from ordering to completion of EEG is slightly longer and may indicate additional difficulty completing EEGs when ordered in the ED as opposed to ICU setting. However, at least one study did not identify a significant delay in obtaining EEG in the ED compared to the ICU setting.[28] Other studies suggest that the first 2 hours of EEG completion are important for identifying which patients are at highest risk of seizure and would most benefit from long term EEG monitoring, and that patients that ultimately have seizure on LTM EEG within 72 hours typically have epileptiform features apparent during the initial two hours of recording,[30] supporting the usefulness of even brief EEG recordings during the ED stay, at least prior to an ICU admission (the setting of the referenced study). Times from EEG order to completion at other institutions have ranged from 3-12 hours, but there are no studies prior to this one that examine times from EEG order to completion amongst ED patients with AMS[31,32,33]. Point of care EEG, reduced montage EEG, AI-assisted automated real-time interpretation, tele-EEG networks with remote review, and template-based caps for ED staff electrode application, are potential future solutions to facilitate EEG collection in the ED in a faster time frame.

Limitations: The current analysis has several limitations. First, the study is limited by its single-center, observational, retrospective design. The study was conducted at a tertiary care referral center, which may reduce its external validity. Furthermore, the study could be perceived as limited in its ability to comment on the overall yield of EEG in the ED given the focus on one particular chief complaint, 'altered mental status.' However, this focus on AMS further strengthens the conviction that even in cases of undifferentiated AMS ED presentation, yield of EEG is quite high and often reveals frank seizure and epileptic activity that may not have been obvious. Second, this analysis also excludes those with AMS who did not receive

EEG, which limits ability to compare clinical features, medical management, and outcomes between those with and without EEG. Furthermore, there may be limitations with capturing patients with AMS based on chief complaint alone. Third, preliminary EEG interpretations may have been provided verbally between EEG readers and primary team staff, but the occurrence or timing of these preliminary reads was unknown and therefore not analyzed here. Along these lines, we were unable to abstract the initial considerations of the care team, such as initial differential diagnosis; future prospective studies are necessary to capture these data. Fourth, some time points are missing including the timing of the start of the EEG which was inconsistently documented, therefore EEG end time was used; most EEG were less than 1 hour in duration and median times were analyzed. Fifth, given the low frequency of EEG use in this population, our sample size was too small for robust multivariable analyses that could evaluate factors associated with time to EEG. Sixth, limited follow-up and clinical outcomes data limit the ability to make conclusions about the broader utility of ED EEG for the patient's hospital stay, and qualitative data from providers would be required to assess if the delay in EEG result delayed treatment.

Conclusion

Our cohort of AMS patients for whom an EEG was ordered in the ED had a high occurrence of seizure. A high rate of seizure amongst patients where clinicians had a high enough index of suspicion to order EEGs is consistent with prior studies. The semiology of seizures in our cohort makes them more difficult to diagnose in the ED setting, underscoring the benefit of emergent EEG in these patients. Despite this clinical need and the benefits of EEG, there remained substantial time between EEG order and completion for this cohort of AMS patients.

Declarations:

Ethics approval and consent to participate: This study was conducted with approval from our Institutional Review Board in accordance with the Declaration of Helsinki. The authors declare that they have no competing interest or funding relevant to this analysis. Consent to participate is not applicable.

Disclosures: The authors have no competing interests relevant to this analysis. Dr. Nolan is an employee of Rapport Therapeutics. Dr. Goldstein has received consulting fees from Astrazeneca, CSL Behring, Octapharma, Cayuga, Takeda, Wellumio, and PurpleAI.

Consent for publication: Not applicable

Availability of data and materials: The data that support the findings of this study are available from Mass General Hospital ED but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of Mass General Hospital.

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Author contributions: Mariama Runcie, Neal Nolan, Olivia Yoo, and Joshua N. Goldstein contributed to the project design, data extraction and analysis and manuscript writing. Fábio A. Nascimento and M. Brandon Westover contributed to EEG characterization and analysis as well as data interpretation and manuscript development. Robert Silbergleit and Maura Kennedy contributed substantially to the interpretation of this data and manuscript development.

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TABLES AND FIGURES

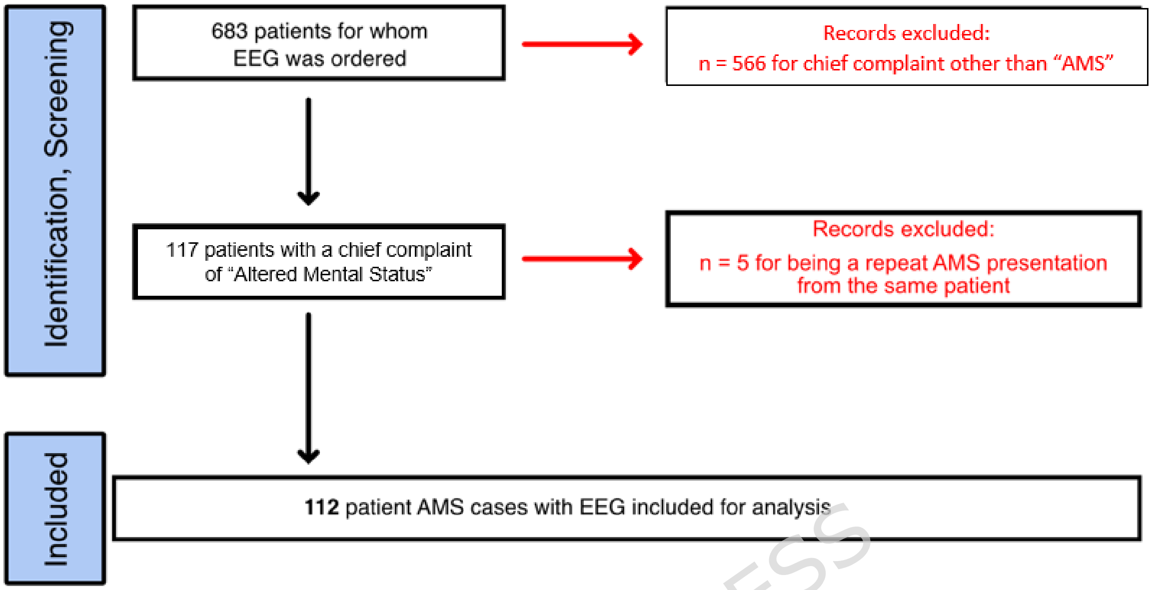

Figure 1: Patient enrollment flowsheet. Altered mental status (AMS)

Table 1 Cohort Demographics and Case Characteristics:

Characteristic	**N = 112**[1]
Age (years)	64.5 (48.0, 72.5)
Sex assigned at birth	
Male	62 (55%)
Female	50 (45%)
Race/ethnicity	
White	88 (79%)
Black/African American	12 (11%)
Asian	2 (1.8%)
Hispanic or Latino	1 (0.9%)
Other/Unavailable/Declined	9 (8.0%)
Prior ASM use	56 (50%)
GCS on arrival	
3-7	7 (6.3%)
8-12	25 (22%)
13-15	80 (71%)
Witnessed convulsion before EEG	12 (11%)
Intubated	4 (3.6%)
Time between symptom onset and ED arrival (hrs)	4.5 (1.0, 20.0)
Time between symptom onset and ED arrival, binned:	
<=6h	64 (57%)
>6, <=12h	16 (14%)
>12, <=24h	9 (8.0%)
>24h	23 (21%)

Characteristic	N = 112[1]
Neurology consulted	73 (65%)
Neuroimaging performed	105 (94%)
Ceribell POC EEG used	1 (0.9%)
EEG type	
Routine (Portable) EEG	72 (64%)
Long-term EEG (LTM)	24 (21%)
Routine (Portable) beginning LTM	16 (14%)
Time from ED arrival to EEG order (hrs)	6.4 (2.2, 11.5)
Time from EEG order to EEG completed (hrs)	13.7 (5.5, 27.7)
Time from ED arrival to EEG completed (hrs)	20.9 (14.9, 38.8)
Home ASM Rx adjusted	28* (25%)
New ASM Rx started	39* (35%)
Disposition after ED	
Hospital admission	93 (83%)
ED Observation	14 (13%)
Home or Self Care	4 (3.6%)
Psychiatric Hospital	1 (0.9%)
Disposition after ED-Observation	
Home or self care	9 (64%)
Hospital admission	5 (36%)
Died during hospitalization	20 (18%)
Length of stay, hospital (hrs)	115.8 (53.5, 196.0)
Length of stay, ED (hrs)	14.9 (7.2, 22.1)
Length of stay, ED-Observation (hrs)	21.7 (17.7, 63.6)
Length of stay, Inpatient Admission (hrs)	111.9 (55.1, 191.2)

Characteristic	N = 112[1]
Length of stay from ED arrival to death (hrs)	60.0 (17.4, 260.8)

[1]Median (Q1, Q3); n (%)

* 12 patients appear in both groups

Table 1: Cohort demographics and case characteristics. Anti Seizure Medication (ASM), Glasgow Coma Scale (GCS), Electroencephalogram (EEG), Emergency Department (ED), Point of Care (POC), Long Term Monitoring (LTM), Prescription (Rx)

Table 2 EEG Findings:

Characteristic	N = 112[1]
EEG category	
Seizure	10 (8.9%)
Epileptiform but not seizure	27 (24%)
Other abnormal EEG	44 (39%)
Normal EEG	31 (28%)
EEG abnormal	81 (72%)
Status epilepticus*	5 (4.5%)
Seizure semiology type	
Electrographic	6 (60%)
Electroclinical	4 (40%)
Seizure onset type	
Focal	6 (60%)
Generalized	4 (40%)
Background abnormality	79 (71%)

Characteristic	N = 112[1]
Theta slowing, non-focal	57 (52%)
Delta slowing, non-focal	60 (55%)
Theta or delta slowing, focal	41 (37%)
Burst suppression	1 (0.9%)

[1]n (%)

* Of note, all were non-convulsive status epilepticus (NCSE)

Table 2: Cohort stratified by EEG findings.

Table 3 Seizure cases:

Case	Electrographic seizure criteria met	Electroclinical seizure criteria met	Status epilepticus
1	Yes	No	No
2	No	Yes	Yes
3	Yes	No	No
4	Yes	No	Yes
5	Yes	No	Yes
6	Yes	No	Yes
7	Yes	No	No
8	No	Yes	No
9	No	Yes	No
10	Yes	Yes	Yes

Table 3: Electrographic and electroclinical categorization of seizure cases, and presence of status epilepticus.

Table 4 Clinical Information on Seizure Cases:

Demographics	AED medication prior to arrival	GCS upon arrival	Type of seizure	Notes on Case
41-year-old female	Keppra	8	Electrographic	Patient had a brain tumor with 3 generalized tonic-clonic seizures in the ED. On the EEG, had 40 seizures lasting seconds in one day before they changed patient's AEDs. Now deceased.
24-year-old male	Ativan, Vimpat, Trazadone, Zonisamide	15	Electrographic	Patient had brain tumor with frequent seizures and EEG abnormalities. Saw continued discrete seizures.
61-year-old female	Ativan, Keppra	7	Electrographic	Patient had brain metastases. EEG showed nonconvulsive status epilepticus (NCSE). Patient was obtunded and hypoxic, but despite improvement in condition, was still confused and in NCSE while medications were adjusted.
39-year-old female	Briviact, Epidiolex, Zonisamide	15	Electrographic	Patient had a history of childhood epilepsy. She presented to the ED repeatedly saying "I um." She was found to be in NCSE on the EEG.
54-year-old male	Decadron, Keppra	9	Electrographic	Patient had brain tumor. Patient never returned to baseline between two GTCs, so could be NCSE or a prolonged post-ictal state. Now deceased.
26-year-old female	Epidiolex, Ativan, Clobazam,	7	Electrographic	Patient had history of seizure syndrome with a partial lobectomy. Patient was recently

	Diastat, Lamictal, Keppra			started on Epidiolex and was fatigued. The EEG showed improvement of the seizure but increased slowing.
52-year-old male	Ativan, Decadron	14	Electroclinical	Patient had brain tumor and presented with partial motor seizures in status.
5-year-old male	Diastat, Baclofen, Gabapentin	7	Electroclinical	Patient had a history of hypoxic ischemic encephalopathy and cerebral palsy (CP) complicated by a seizure disorder. The EEGs showed seizures with clinical correlates but not status.
56-year-old female	Clonazepam, Trazadone	11	Electroclinical	Patient had a history of mitochondrial encephalomyopathy, lactic acidosis and stroke-like episodes (MELAS) complicated by epilepsy, but did not find out that she had it until her children got it. She only had hearing loss before strokes in 2015, and since then has had many strokes. She has had NCSE twice in the past, and had focal NCSE this presentation as well.
12-year-old female	None	15	Electroclinical	Absence status, subtle attentional issues on exam.

Table 4: Detailing of the patient cases with seizure.

Table 5 Antiseizure Medication (ASM) Modifications:

Characteristic	**Started/Modified ASM** N = 55[1]	**Did not start/modify ASM** N = 57[1]
Prior ASM use	37 (67%)	19 (33%)
Home ASM Rx adjusted	28* (51%)	0 (0%)
New ASM Rx started	39* (71%)	0 (0%)
GCS on arrival		
3-7	4 (7.3%)	3 (5.3%)
8-12	14 (25%)	11 (19%)
13-15	37 (67%)	43 (75%)
Witnessed convulsion before EEG	10 (18%)	2 (3.5%)
Intubated	3 (5.5%)	1 (1.8%)

[1]n (%)

* 12 patients appeared in both groups

Table 5: Cohort stratified by ASM modifications. Electroencephalogram (EEG). Antiseizure medication (ASM)