Clinical Neurology and Neurosurgery 171 (2018) 95–99

Contents lists available at ScienceDirect

Clinical Neurology and Neurosurgery

journal homepage: www.elsevier.com/locate/clineuro

Non-convulsive seizures and electroencephalography findings as predictors of clinical outcomes at a tertiary intensive care unit in Saudi Arabia

Youssef A. Al-Said[a], Saleh S. Baeesa[a,b], Zaitoon Shivji[a], Husam Kayyali[a], Khalid Alqadi[a], Ghada Kadi[a], Edward J. Cupler[a], Ahmad R. Abuzinadah[c,*]

[a] Department of Neurosciences, King Faisal Specialist Hospital, and Research Center, Jeddah, Saudi Arabia
[b] Division of Neurosurgery, Faculty of Medicine, King Abdulaziz University, Jeddah, Saudi Arabia
[c] Division of Neurology, Department of Internal Medicine, Faculty of Medicine, King Abdulaziz University, Jeddah, Saudi Arabia

ARTICLE INFO

Keywords:
Seizure
Status
Non-Convulsive
Outcome
Death
Independent

ABSTRACT

Objective: Electroencephalography (EEG) in the intensive care unit (ICU) is often done to detect non-convulsive seizures (NCS). The outcome of ICU patients with NCS strongly depends on the underlying etiology. The implication of NCS and other EEG findings on clinical outcome independent from their etiology is not well understood and our aim to investigate it.

Patients and Methods: We retrospectively identified all adult patients in the ICU who underwent EEG monitoring between January 2008 and December 2011. The main goals were to define the rate of NCS or non-convulsive status epilepticus (NCSE) occurrence in our center among patients who underwent EEG monitoring and to examine if NCS/NCSE are associated with poor outcome [defined as death or dependence] with and without adjustment for underlying etiology. The rate of poor outcome among different EEG categories were also investigated.

Results: During the study period, 177 patients underwent EEG monitoring in our ICU. The overall outcome was poor in 62.7% of those undergoing EEG. The rate of occurrence of NCS/NCSE was 8.5% and was associated with poor outcome in 86.7% with an odds ratio (OR) of 5.1 (95% confidence interval [CI] 1.09–23.8). This association was maintained after adjusting for underlying etiologies with OR 5.6 (95% CI 1.05–29.6). The rate of poor outcome was high in the presence of periodic discharges and sharp and slow waves of 75% and 61.5%, respectively.

Conclusions: Our cohort of ICU patients undergoing EEGs had a poor outcome. Those who developed NCS/NCSE experienced an even worse outcome regardless of the underlying etiology.

1. Introduction

Electroencephalography (EEG) monitoring for patients in the intensive care unit (ICU) is indicated in patients with a decreased level of consciousness of unclear etiology [1]. EEG monitoring is indicated for patients with a decreased level of consciousness, without prior clinical seizures or after the convulsion has ceased, or with non-convulsive seizures (NCS) or non-convulsive status epilepticus (NCSE). EEG confirmation is needed to diagnose NCS and NCSE in the appropriate clinical context [2,3]. The incidence of NCSE in comatose patients ranges from 8% to 19% [4–6]. Patients with NCSE experiences poor outcomes with a 20% to 30% mortality rate [7,8]. However, this poor outcome is strongly influenced by the underlying etiology [3,9–11]. Patients with NCSE have a higher mortality rate (27%) if they were associated with acute medical conditions compared to patients with epilepsy (3%) [8]. Shneker et al. and Power et al. found that NCSE carries a worse outcome in patients without prior epilepsy [8,9]. What is unknown is whether the presence of NCSE in adults add to the poor outcome independent from the underlying etiology or not. The seizures burden on EEGs were associated with a poor outcome in the pediatric population [12]. However, similar studies are lacking in adults.

Lack of knowledge about the contribution of NCSE to the poor outcome independent of the underlying condition created part of the uncertainty regarding how aggressively NCSE should be treated. In fact,

Abbreviations: EEG, Electroencephalography; ICU, intensive care unit; NCS, Enon-convulsive status epilepticus; OR, odds ratio; KFSHRC-J, King Faisal Specialist Hospital and Research Center, Jeddah; NCS, non-convulsive seizures

* Corresponding author: King Abdulaziz University, Internal Medicine Department, Neurology division, P.O. Box 55967, Jeddah, 21544, Saudi Arabia.
E-mail addresses: yalsaid@kfshrc.edu.sa (Y.A. Al-Said), sbaeesa@kau.edu.sa (S.S. Baeesa), zaitoonglobal@hotmail.com (Z. Shivji), hkayyali78@yahoo.com (H. Kayyali), dr.k.alqadi@gmail.com (K. Alqadi), gkadi@kfshrc.edu.sa (G. Kadi), ecupler@kfshrc.edu.sa (E.J. Cupler), neuroahmad@gmail.com (A.R. Abuzinadah).

https://doi.org/10.1016/j.clineuro.2018.06.002
Received 6 January 2018; Received in revised form 2 May 2018; Accepted 4 June 2018
Available online 05 June 2018
0303-8467/

several recent studies have raised the question of possible detrimental effects from aggressive management [1,13–16]. Sutter et al. found that there was a three folds increase in a mortality chance when intravenous anesthetics were used to treat NCS/NCSE [13]. The argument for aggressive therapy is supported in part by the observation of a lower mortality rate (10%) in patients with NCSE duration lasting less than 10 h compared to a high mortality rate (85%) if NCSE duration lasted more than 20 h [17]. Knowledge of the impact of NCSE on outcome after accounting for underlying etiology effect may provide insight with regard to the treatment of NCSE.

The aims of this study are to define the rate of NCS or NCSE occurrence in our center among patients who underwent EEGs and to examine if NCS/NCSE is associated with poor outcomes after adjusting for underlying etiologies. We also investigated the rate of poor outcomes among different EEG categories.

2. Patients and methods

We identified all patients who underwent EEG monitoring between January 2008 and December 2011 in the adult ICU at King Faisal Specialist Hospital and Research Center, Jeddah (KFSHRC-*J*). All patients aged 14 years and above who underwent routine and continuous EEG monitoring were included.

All referred patients had at least a 30-minute routine EEG recording. Continuous EEG (cEEG) recordings were performed during drug titration for the control of the status epilepticus, subclinical seizures, and during clinical changes, which warranted further monitoring after the initial routine EEG.

The EEG was performed according to the international 10–20 system of scalp electrode placement. The recording was reviewed by a neurologist specialized in neurophysiology who was aware of the patient's location, history, and the reason for referral.

The Institutional review board at King Faisal Specialist Hospital and Research Center, Jeddah (KFSHRC-*J*) approved this retrospective cohort study.

2.1. Patient selection for EEGs

At our center, patients were selected for EEGs based on the following criteria:

1 All patients admitted to the ICU with an unexplained altered level of consciousness including post-operative patients.
2 Patients admitted to the ICU with seizures who failed to return to baseline after treating the clinical seizures.
3 Any activities such as motor jerks or staring spells that are suspicious for seizures.

Patients were selected for cEEG monitoring in the following situations:

1 Any suspicious activities for seizures such as motor jerks or starring spells.
2 Electrographic activities associated with a higher chance of developing seizures such as periodic discharges.
3 In order to monitor the response to treatment.

2.2. EEG categorization

We categorized EEG patterns according to the American Clinical Neurophysiology Society's standardized critical care EEG terminology [18], which is shown in Table 1.

The electrographic seizures were defined according to Young's criteria as either rhythmical discharge with a definite beginning and an end with evolution concerning location, frequency, and amplitude lasting for more than 10 s or having a continuous spike or spike and slow-wave discharges of more than three cycles per second [17]. The distinction between convulsive and non-convulsive seizures or events was based on the clinical history, the technologists' notes made during EEG recording, and from the technologist's worksheet. EEG reports and the technologist worksheet are necessary patients' charts reviewed for clinical information.

Table 1
EEG categories.

Category	ACNS equivalent terms
Normal	Normal
Slowing and asymmetry	Rhythmic Delta Activities (RDA) Generalized Bilateral independent focal Non-Rhythmic theta/delta slowing Asymmetry
Sharp and wave (SW)	Spike and wave Polyspike and wave Sharp and wave (with or without triphasic morphology)
Periodic Discharges	Generalized periodic discharges (GPDs) Lateralized periodic discharges (LPDs) Bilateral independent lateralized periodic discharges (BILPDs)
Ictal patterns	Electrographic seizures Non-convulsive status epilepticus
Burst suppression	Burst suppression
Electrocerebral silence	Electrocerebral silence

We collected patient data such as ICU admitting diagnosis (seizures were considered the admitting diagnosis if another identifiable cause for admission was lacking), the level of consciousness at the time of EEG, history of clinical seizures on admission, and history of epilepsy.

Patients' outcomes were determined upon discharge from the hospital and divided into three categories including independent (discharged home), dependent (long-term care), and death.

2.3. Outcomes

The main outcomes in this study were to determine the rate of NCS or NCSE among patients who underwent an EEG recording in the adult ICU and the association between NCS/ NCSE and poor outcome with and without adjustment for underlying etiologies. The other explored outcomes were related to the rate of poor outcome and the association between different EEG categories and a poor outcome among our cohort.

2.4. Statistical analysis

Sample characteristics were presented through descriptive statistics using proportion and means (range) as appropriate. We presented the rate of a poor outcome stratified by the EEG category on bar graphs. To investigate if different EEG categories were associated with a poor outcome including NCS/NCSE, we performed logistic regression and data presented as an odds ratio. To investigate if adjustment for etiology will affect the EEG prediction of the outcomes, we included etiology in the logistic regression model. Statistical testing was performed using STATA version-13 (Stata-Corp, College Station, TX).

3. Results

A total of 177 adult patients were included. The various indications for admission to the ICU are summarized in Table 2.

3.1. Sample characteristic

Of the 177 patients, 117 were male (66%) and 60 (34%) were