

Novell EEG in Diagnose of Status Epilepticus

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Paper bonded to the lecture of Dr. Sami Myllymaa (Univ. Of Eastern Finland) about ***"Novell EEG: a new concept of brain electrical activity recording for emergency and clinical appraisal"***.

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Summary. The best way to quickly diagnose SE is with EEG of the brain. It is important to diagnose as soon as possible in order to act and prevent brain damage. The Novell EEG claims that it is possible to easily and rapidly diagnose the SE with their product (BrainStatus). They develop a rapid and simple-to-use disposable forehead EEG electrode set. The Novell EEG equals or improves noise, MRI compatibility, facility of usage, contact skin impedance in comparison with other commercial electrodes.

1. Introduction

Despite of the advancements in brain imaging technology, the most ancient techniques, specifically electrophysiological (EEG) ones, still play an important role in functional imaging of the brain. EEG used to reveal electrical abnormalities in epileptic patients, and is crucial in patients with unexplained states of confusion or altered consciousness. EEG reveals information about epileptic activity of the brain that cannot be observed with other techniques.

The EEG is not commonly included in the emergency departments, because a fast use of the instrumentation is difficult.

However, in cases as Status Epilepticus, the diagnoses are delayed because of this, and the patient is submitted into risks that should be preventable. Delays in diagnoses of status epilepticus could provoke neurological damage.

Brain-related injuries cause high costs to society. It is necessary to use all the available tools for preventing them.

2. Status Epilepticus [1]

Status epilepticus (SE) is a common, life threatening neurologic disorder that is essentially an acute, prolonged epileptic crisis. An epileptic crisis is considered status epilepticus when the duration of the crisis exceeds the half hour or the patient has two or more crisis in a row without recover consciousness in between. This conditions could bring brain damage.

Signs and Symptoms

- Focal visual changes, usually characterized by flashing lights
- Focal or unilateral paresthesias or numbness
- Focal visual obscuration or focal colorful hallucinations
- Olfactory or gustatory hallucinations
- Atypical rising abdominal sensations

3. **Diagnose**

The best way to quickly diagnose SE is with EEG of the brain. It is important to diagnose as soon as possible in order to act and prevent brain damage.



*Figure 1: Focal status epilepticus.
Electroencephalograph (EEG) in a patient with
epilepsia partialis continua [1]*

4. **Solution**

The Novell EEG claims that it is possible to easily and rapidly diagnose the SE with their product (BrainStatus). They develop a rapid and simple-to-use disposable forehead EEG electrode set. *Figure 2* shows how the forehead EEG electrode set were implemented.

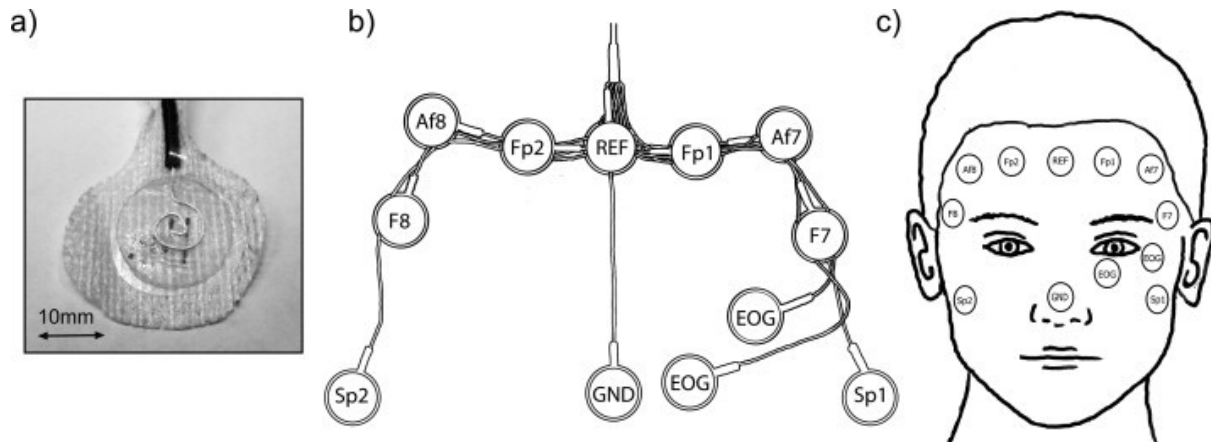


Figure 2: A close-up view of a single electrode (Sp2) of the forehead EEG electrode set (a). The spiral-shaped silver wire is covered with a round-shaped piece of hydrogel membrane ($\varnothing 18$ mm), attachment was ensured with Omnifix medical grade tape (Hartmann Inc., Rock Hill, SC, USA). A schematic figure of the whole electrode set consisting of ten recording electrodes, a ground electrode and a reference electrode (b). The sites of electrode placements on the patient's head (c). [2]

5. Features, electrical performance comparison

The electrode set is made of non-ferromagnetic and biocompatible materials. The set consists of ten recording electrodes, a ground electrode and a reference electrode.

The *table 1* shows a comparison with other electrodes commercially available. The Novell EEG equals or improves all features of the commercial electrodes.

The mayor problem of the Novell EEG is that is designed for the forehead, this because is for rapid use, the full-head EEG is not available for emergency because the hair of the patient should block the signals. (See *Figure 2*)

	Novell EEG	Neuroline 700	Neuroline 726	Blue Sensor SU
Use	Easy, not require neurophysiological expertise. Doesn't require the utilization of messy conductives gels or pastes	Difficult, requires to accurattely set all electrodes	Difficult, requires to accurattely set all electrodes	Difficult, requires to accurattely set all electrodes
Noise (ERMS)	5.4-14.2 uV	Higher	Higher	Higher
MRI, CT imaging compatibility	Yes, no visible artifacts	No	No	No
Mass production	BrainStatus	Yes	Yes	Yes
Contact impedance abraded skin (mean \pm SD)	1,8 k Ω \pm 1,3 k Ω	1,0 k Ω \pm ND k Ω	10,0 k Ω \pm ND k Ω	1,0 k Ω \pm ND k Ω
Contact impedance unprepared skin (mean \pm SD)	44.6 k Ω \pm 8.0 k Ω	ND	ND	ND

Table 1: Electrode comparison. Data extracted from [3]

6. Diagnose performance

The *Table 2* shows the results of the study of 100 emergency EEGs recorded between March 2013 and October 2014 in Kuopio University Hospital.

Status epilepticus	Full-head EEG positive	Full-head EEG negative	Total
Forehead EEG positive	2	0	2
Forehead EEG negative	2	96	98
Total	4	96	100

Table 2: Study of 100 emergency EEGs recorded between March 2013 and October 2014 in Kuopio University Hospital [4]

The study shows that the Novell EEG never diagnose a false positive. So the specificity is 100%. Also, the study shows that de forehead EEG was capable of detecting 50% of SE cases in comparison with the full-head EEG.

The study was very limited. To get better results, more representatives samples are needed. However, with the electrode technology presented in this paper, the delay for proper EEG in acute neurological settings can be shortened to minutes; for example, there is no need for trained EEG technicians. Currently, the median delay of EEG in the treatment of SE is reported to be up to 22 hs [4]. This is alarming as the delay in diagnosis of SE is associated with poor response to treatment and worse outcome. Furthermore, duration of SE is an important risk factor for mortality [4]. The present forehead EEG electrode set with solid thick film structure is very easy to use and can be rapidly

attached by any emergency nurse. The concept of the Novell EEG set has been used as the basis of a new commercially available BrainStatus electrode.

7. Conclusions

Studies carried out at Kuopio University Hospital have shown that BrainStatus EEG electrode set enables reliable quick diagnostics [4]. The electrode set significantly speeds up the recording process because there is no need for any special pre-treatment of the patient's skin in any way or to use any separate gels.

Due to the fact that the electrode set is easy and fast to use, it is particularly well-suited to be used in emergency care, in ambulances and even in field conditions. Thanks to the material of the electrode set, there is no need to remove it for computer tomography scans.

The use of EEG recordings in emergency care will benefit many patients. For instance, EEG recordings can be used in emergency, intensive and primary care to diagnose a variety of brain electrical activity disorders associated, for example, with head trauma, serious brain injury, cerebral infarction, cerebral haemorrhage, subarachnoid haemorrhage, states of poisoning and atypical altered states of consciousness.

In many cases, an acutely performed EEG recording and the start of a proper treatment will significantly reduce the need for aftercare and rehabilitation. This, in turn, will drastically improve the cost-effectiveness of the treatment chain.

The key advantages of BrainStatus:

- Enables reliable quick diagnostics
- Speeds up significantly the recording process as there is no need for any pre-treatment of the patient's skin
- The electrodes get automatically placed in their correct places because the headband is flexible and solid
- There is no need to move the patient's head when putting on the BrainStatus electrode set

8. Bibliografía

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