Continuous Bedside EEG-DIAGNOSTIC YIELD: The RIGHT Patient, The RIGHT Clinical Profile, The RIGHT Intervention

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Overview

Continuous Bedside EEG-DIAGNOSTIC YIELD

- EEG vs. cEEG vs. Neurotelemetry
- Why cEEG/NT in the ICU?

The RIGHT Patient

- Which patients benefit

The RIGHT Clinical Profile

- Critical Values
- How do they work?

The RIGHT Intervention

- Case Studies
- Missed Interventions

http://bupsaa.in/bupsaa-overview/
EEG, cEEG and Neurotelemetry

- Routine EEG (Electroencephalogram): a test that records the electrical activity of your brain-usually ~30 minutes

- Continuous EEG (cEEG): records electrical activity continuously for hours/days
  - More reliable than routine EEG to pick up intermittent disturbances, but findings missed until data is reviewed-hours/days later

- Neurotelemetry (NT) provides a real-time, eyes on, look at the brain function 24/7/365, using cEEG monitoring performed remotely by highly credentialed specialists

Why cEEG?

Teleb, et al\textsuperscript{1}, reviewed 778 stat 20 minute EEGs

- Combined Seizure/Status Detection Rate of 5%

Claassen\textsuperscript{2}, reviewed 570 cEEGs, recorded for 24+ hours
- Combined Seizure/Status Detection Rate of 19.3%

\textsuperscript{1}Teleb, et al (2012) Neurodiagnostic Journal
\textsuperscript{2}Claassen, (2004) Neurology
Increasing Seizure Detection with Length of cEEG

- Minimum for Non-comatose patients = 24hrs$^1$
  - 95% of seizure activity detected in Non-comatose patients - may monitor longer for seizure control
- Minimum for Comatose patients = 48hrs$^{1,3}$
  - 87-90% of seizure activity detected in Comatose patients - may monitor longer for seizure control
- 72hrs+ hypothermia protocol for cardiac arrest$^2$

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$^1$Hirsch, L., & Kull, L. (2004). cEEG in the ICU. AJET Journal 44(3)
Payne, et al\(^1\) showed a significant difference in neurologic decline (per Peds Cerebral Performance measure) for increasing lengths of “Seizure Burden”

- Seizure Burden=\% time/hour pt having electrographic seizure
- At \(~2\%) no decline; by \(~16\%) (9 min) decline in 174/259 (67\%) patients

At 20\% (12 min.) Seizure Burden/hr, Odds of neurologic decline increased by 1.13 for every 1\% increase in Sz Burden across all diagnoses (p=0.0016)

Why Neurotelemetry (NT)

- Increases positive outcomes\(^1\)
    - 34,996 pts had routine EEG only
    - 5,949 pts had cEEG
  - cEEG is favorably associated with inpatient survival in mechanically ventilated patients, as compared to those who had only routine EEG
  - Routine EEG inpatients = 39% mortality
  - cEEG inpatients = 25% mortality

Why Neurotelemetry (NT)

UCLA TBI Patients before, then after cEEG

LOS (days)  | Cost %
---|---
24.3  | 100%
13.6  | 56%

The RIGHT Patient

Which patients benefit?
Which Patients Benefit from NT?

- Consider ordering NT for patients with the following conditions
  - AMS or unexplained coma
  - CNS infection or tumor
  - Acute stroke or hemorrhage
  - Traumatic brain injury (TBI)
  - Toxic or metabolic encephalopathy
  - Sepsis
  - Comatose patients post cardiac arrest, especially hypothermia pts
  - Questionable events, spells, or seizures
  - Suspected status epilepticus (SE)

# Patients at Risk by Diagnosis

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>NCS (570 patients)</th>
<th>NCSE (570 patients)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epilepsy-related seizures</td>
<td>11%</td>
<td>20%</td>
</tr>
<tr>
<td>CNS Infection</td>
<td>9%</td>
<td>17%</td>
</tr>
<tr>
<td>Subarachnoid Hemorrhage</td>
<td>5%</td>
<td>13%</td>
</tr>
<tr>
<td>Brain Tumor</td>
<td>11%</td>
<td>12%</td>
</tr>
<tr>
<td>Intracerebral Hemorrhage</td>
<td>4%</td>
<td>9%</td>
</tr>
<tr>
<td>Status Post Neurosurgery</td>
<td>15%</td>
<td>8%</td>
</tr>
<tr>
<td>Toxic-metabolic encephalopathy</td>
<td>13%</td>
<td>8%</td>
</tr>
<tr>
<td>Traumatic Brain Injury</td>
<td>10%</td>
<td>8%</td>
</tr>
<tr>
<td>Acute Ischemic stroke</td>
<td>2%</td>
<td>7%</td>
</tr>
<tr>
<td>Altered Mental Status</td>
<td>10%</td>
<td>5%</td>
</tr>
</tbody>
</table>

Table: Percentage of patients (based on diagnosis) who will have Non convulsive seizures (NCS) or Non convulsive status epilepticus (NCSE)

Therapeutic Hypothermia Patients

- Used for comatose, post CA patients\(^1\)
- Cool patient 30-32 C\(^1\)
- Keep in hypothermic state for 12-24 hours\(^1\)
  - NMB is used to prevent shivering
- Rewarm slowly normothermia


The RIGHT Clinical Profile

Critical Values

How do they work?
Critical Values in Neurotelemetry

Safe Practice Recommendations Published in the February 2005 issue of the *Joint Commission Journal on Quality and Patient Safety*:

- **Critical Values** or (*Critical Test Results* in the case of EEG), are defined as any values/interpretations where delays in reporting may result in serious adverse outcomes for patients (MA Coalition for Prevention of Medical Errors) [www.macoalition.org/document/CTRPractices.pdf](http://www.macoalition.org/document/CTRPractices.pdf)

Examples of Critical Values in Neurotelemetry

- What cEEG patterns may cause harm due to delays in result reporting?

- Patient admitted with a subdural hematoma.

- Patient had mental status changes and right upper extremity twitching when Propofol was turned off.

Patient was on no seizure medications.
• Patient admitted with cardio-pulmonary arrest.

• Patient unresponsive with lip twitching.

• R/O seizure vs. myoclonus.

Patient was on no seizure medications.
• Patient post-op from a thoracic abdominal aneurysm repair.

• Postoperatively, patient was noted to have right sided weakness.

• Patient somnolent and ventilated.

• MRI revealed an acute left hemispheric infarction.

Patient was on no seizure medications.
• Patient with hypoxic encephalopathy from near drowning.

• Comatose, unresponsive, no outward presentation of seizures.

• Subclinical seizures noted (Several episodic events with build up to this activity seen).

Patient was on no seizure medications.
cEEG Impact on AEDs

300 consecutive cEEGs led to AED changes in 52% of patients

Questions So Far?

✓ Continuous Bedside EEG-DIAGNOSTIC YIELD
  ✓ EEG vs. cEEG vs. Neurotelemetry
  ✓ Why cEEG/NT in the ICU?
✓ The RIGHT Patient
  ✓ Which patients benefit?
✓ The RIGHT Clinical Profile
  ✓ Critical Values
  ✓ How do they work?
The RIGHT Intervention
  • Case Studies
  • Missed Interventions
The RIGHT Intervention

Case Studies
Case Presentation #1

Neurotelemetry and “Unusual Episode” Detection
Case Presentation

• History
  – 73 year old patient was admitted with “unusual episodes”
  – No clinical signs of distress
  – No previous seizure history
  – No recent falls or head trauma
  – No weakness, slurred speech or sensory changes
Case Presentation

• History
  – 73 year old patient was admitted with “unusual episodes”
  – No clinical signs of distress
  – No previous seizure history
  – No recent falls or head trauma
  – No weakness, slurred speech or sensory changes
Day 1: Initial Hookup

Patient resting comfortably—decreased beta and periodic discharges seen on left
Neuro Tech reports an increase of left central discharges (no clinical signs)
Day 1-Tx initiated after Critical Value Reported

Discharges evolve to seizure—only sign, patient less responsive. Neuro tech calls floor, nurse notified and Ativan given
After Ativan, patient becomes more responsive, now post-ictal
Case Presentation - Outcome

- Patient was diagnosed with L CVA and Seizures and eventually discharged to home with medication
Case Presentation #2

Neurotelemetry and Detection of Significant Event during Hypothermia
Case Presentation- History

• 43 yo man with ESRD went home after HD and had episode of feeling ill, then shaking and unresponsive. EMS responded, found the patient in full arrest and had to shock him multiple times to resuscitate him, then transported him to the hospital, intubated and unresponsive.

• After initial work-up in ER patient was placed on hypothermia treatment protocol and transferred to the ICU.

• During re-warming the next day, the patient was noted to have some intermittent shaking episodes and Neurotelemetry was initiated.
  – (Case was prior to the 2010 AHA Guideline release making NT a standard of care at this facility.)
Neurotelemetry Baseline

Findings at Initial hookup
No clinical signs except the patient is unresponsive to any stimuli
Critical Value Reported, Ativan Given
Case Presentation—Outcome

• Neurotelemetry was continued for 4 days until the seizures were felt to be controlled

• The patient was placed on long-term AEDs and eventually D/C’ed to long term care

• He was eventually D/C’ed to home with essentially normal mental status; his seizures were well controlled.
Case Presentation #3

Neurotelemetry and “Abnormal Eye Movements”
Case Presentation -- History

• 24 y.o. female with a previous medical hx of tethered cord, lipomeningocele, kidney stones, enteric-renal fistula, chronic low back pain and multi organ failure, but no seizure history.

• Patient has spinal cord stimulator to control spasticity

• Her parents brought her to the hospital due to recent episodes of "abnormal movements" in which she would fall and at other times have "abnormal eye movements"

• She was admitted for evaluation of eye movements/seizures.
Day 1 Initial Hook Up
Nurse reports eye-fluttering “seizures”
Has a Critical Value Been Detected?
Evolution of Nurse and Family reported “seizures”

Eye Blink Artifact Seen, no Seizure on EEG
Case Presentation– Outcome

• When eye rolling was found not to be seizure activity, NT was D/C’ed and the decision was made to remove her spinal cord stimulator to obtain an MRI.

• The MRI showed the patient had multiple infarcts in the caudate nuclei, lentiform nuclei, and hippocampal regions bilaterally. Similar changes were noted in a gyroform pattern in the cingulate gyrus, insular cortex, temporal cortex and gyrus rectus.
Case Presentation #4

Neurotelemetry for Lethargy and “Increased Sleeping”
Case Presentation—History

- 9 y.o. patient was admitted to hospital due to what mother describes as “lethargy” and an increased need to sleep over a period of days
- Patient has known history of hydrocephalus and seizures
- Upon hooking the patient up for Neurotelemetry, she appeared to be resting and comfortable
- She was somewhat interactive, with no clinical signs of distress
Detection of status epilepticus
Case Presentation

• Technologist’s action
  – Reading Physician notified, confirmed status epilepticus and placed call to ICU Physician
  – Bedside nurse called, and informed of patient’s condition and actions of Reading Physician
  – ICU Physician contacted Neuro Consult Team to follow/treat patient for status
  – Patient was placed in a medically induced coma
9 days later, patient is in total suppression, patient remains on Propofol, Pentobarb, and Ativan
Day 12

- Pt underwent a metabolic work up
- Possible mitochondrial disorder diagnosed
- Started on Carnitine
- Wean of Pentobarbital, Propofol, Ativan planned
Day 15: burst suppression with generalized spike and wave, weaning patient from Propofol
Day 16: Meds being decreased, cEEG more continuous
Day 21 Patient Becomes Responsive

Day 21: Patient opens her eyes. EEG continuous with intermittent polyspike and wave
Case Presentation - Outcome

• On DAY 64 patient was finally D/C’ed from the Rehab floor to home 😊
Case Presentation #5

Neurotelemetry for “Speech Arrest”
Case Presentation--History

• 17 year old admitted to hospital after new onset of episodes of speech arrest
Day 1: Pt shows no clinical changes
NT called into room and asked father to interact—pt could not speak.
End of episode
Case Presentation—Outcome

• MRI showed a left frontal brain tumor

• The decision was made to perform an awake craniotomy with language mapping for tumor resection
Case Presentation #6

Neurotelemetry for treatment of Status Epilepticus
Case Presentation—History

- 17 year old patient arrived at hospital via Lifeline helicopter after being admitted to an outside hospital with seizures and unresponsiveness.

- Pt has CP and a known seizure history
Pt is found to be in gen. Sp/wave status. Attempts at adjusting medications are made in the first 24 hours and after 106 recorded seizures, a decision is made to place the patient in a medically induced coma.
# Neurotelemetry Reporting System

**Navigator**

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Neurotelemetry Reporting System

* Final Report *

**Patient State:** Comatose

**EEG Background Description:** medically induced burst suppression, bursts approximately every 1-2 seconds, bursts consists of focal and generalized spike and wave discharges and very frequent runs of left and right focal and generalized spike and wave spike discharges. No clinical signs have been noted.

**Significant Event:** Yes, patient continues to have break through runs of generalized spike and wave discharges.

Dr. McGuire has been informed of patients EEG status. At this time the patient is on 3mg Versed.
Neurotelemetry Reporting System

Document Type: Neurotelemetry Technical Report
Result date: Friday, November 07, 2008 06:09
Result status: Auth (Verified)
Document Subject: MORNING STATUS REPORT
Performed By: Burhenn, Jodi L, REEG on Friday, November 07, 2008 06:16
Verified by: Burhenn, Jodi L, REEG on Friday, November 07, 2008 06:16

* Final Report *

Patient State: Comatose

EEG Background: Patient was placed in a burst suppression pattern due to generalized status seizure activity. Patient was started on Pentobarbital, burst of EEG activity occurs approximately every 1-2 1/2 seconds consisting of spike discharges. Intermixed with the burst suppression are runs of generalized spike and wave discharges.

Significant Event: Yes, patient EEG throughout the night continued to show generalized and focal spike and wave discharges. Dr McGuire is aware of EEG status. Patient was placed on Versed, Keppra, and at 4am Pentobarbital.
* Final Report *

Patient State: Comatose

Posterior Dominant Rhythm: Patient remains in a burst suppression pattern

EEG Background Description: Bursts of moderate voltage delta activity (with faster frequencies superimposed) lasting 2-5 seconds, separated by 2-5 seconds of suppression. Earlier in the night, the patient’s activity had increased to bursts lasting more than 10-12 seconds, separated by brief periods of suppression lasting only 1-2 seconds. At this time, the pentobarbital was increased to 2 mc/kg/min per the resident to keep the patient in burst suppression. The patient is to remain in burst suppression for 24-48 hours per Dr Patel.

Significant Event: No
• Patient is now in medically induced burst/suppression
Day 6: A failed attempt is made to reduce propofol/pentobarbital infusions
Day 11 patient is weaned off propofol successfully and eventually discharged to home.
Are There Legal Consequences to Unreported Critical Values in this Patient Population?
Legal Consequences?

• Seizures following a reaction to angiogram dye were monitored with serial EEGs and treated unsuccessfully

• Patient was eventually transferred to Mayo where they were successfully treated for status epilepticus, but suffered permanent brain injury

• Patient (a physician) received 4 million dollars from suit claiming negligent failure to properly treat status epilepticus
64 y.o. Charles Gray entered an EMU and was taken off nearly all his meds to be evaluated for surgery.

The EEG Tech left Gray unattended for about an hour to take a break and tend to other patients on day 4.

He had a recorded seizure, then respiratory and cardiac arrest and was found dead when the tech returned.

The hospital accepted responsibility.

Legal Consequences?

6 year old Christian Padilla

– 2005 had successful cardiac surgery but was slow to wake up afterwards
– Caregivers failed to recognize that the patient was having seizures, describing him as “acting fidgety” in the medical notes
– Christian was having seizures as a result of the brain swelling that killed him
– After Christian’s death his parents were awarded $1.25 million in liability compensation


This Children’s hospital now has a Neurotelemetry Program
Summary

• Neurotelemetry has multiple indications, uses and benefits over routine EEG

• What we don’t know can hurt us...
  – Many ICU patients have seizures that are undetectable without real-time video EEG monitoring
  – Undetected seizures go untreated, cost of care goes up, and patient outcomes decline
What We Covered-Questions?

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http://imgkid.com/question-marks-images.shtml