A Protocol for Cerebral Function Monitoring in the NICU

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The cerebral function monitor provides information on global cerebral activity. An abnormal CFM trace in the first six hours of life, after an asphyxial insult, is predictive of abnormalities on acute neurological testing and long term neurodevelopmental outcome. The CFM also provides information on duration, intensity and frequency of neonatal seizures that may be helpful in diagnosis and treatment.

1.0 Purpose:
To outline the clinical indications, setup process, application, and analysis a cerebral function monitor can provide to patients of a NICU.

2.0 Description:
An amplitude-integrated EEG, or Cerebral Function Monitor (CFM), is a device used to measure background electrocortical activity in the brain. Using a single lead, consisting of three wires placed over the biparietal or frontal region; it filters, rectifies and compresses a signal to indicate the generalized level of electrical activity occurring across the entire brain. The signal is displayed on an x-y axis, using a very slow chart speed representing a generalized view of brain activity.

CFM technology was initially developed in the 1960s for adults suffering from neurological depression or injury or undergoing surgery. However, due to technical constraints and the need for constant recalibration, the technology did not gain wide acceptance. The technology was reintroduced in the mid 1980s by neonatologists. Research showed it could be a sensitive tool for predicting severity of hypoxic-ischemic encephalopathy, if applied in the first 6–12 hours following perinatal asphyxia. The CFM has also demonstrated itself as a valuable detection tool for neonates experiencing clinical or subclinical seizures. As an analogy, a CFM provides quick, general information of a patient's brain activity like oximetry provides information on a patient's blood oxygenation; or an ECG provides information on a patient’s cardiac status.

3.0 Indications:
- Hypoxic – Ischemic Encephalopathy
- Seizures or clinical scenario mimicking seizure disorders (e.g., apnea, hypertension, tachycardia)
- Significant neurological disorders (e.g., congenital brain malformations, vascular lesions)
- Post cardiac arrest
- Inborn error of metabolism (e.g., urea cycle disorders, hypoglycaemia, hypocalcaemia)
- Neonatal abstinence syndrome (e.g., alcohol/opiate withdrawal)

4.0 Pitfalls:
- Requires proper lead stabilization to reduce or eliminate artefact caused by high frequency oscillation.
## 5.0 Setup Guidelines:

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<th>Special Direction</th>
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<tr>
<td>1. Obtain Doctor’s order to initiate monitoring.</td>
<td>Diagnostic tests require a doctor’s order.</td>
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<td>2. Connect the cable to the cable input on the front of the CFM.</td>
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<td>3. Plug CFM into A/C outlet and turn power switch to ON in rear of device.</td>
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| 4. Obtain CFM Hydrogel Electrodes, EEG abrasive skin preparing gel (NUPREP), 2×2 gauzes. | - CFM hydrogel leads: room supply carts  
- 2×2 gauze: Room supply carts  
- NUPREP: CFM drawer in RT room |
| 5. Establish where the three leads will be placed on the head.            | - Black wire lead (ground): placed in centre of forehead  
- Red wire lead (left): placed 3.75 cm left of midline as close to the coronal plane as possible.  
- Yellow wire lead (right): placed 3.75 cm right of midline as close to the coronal plane as possible.  
- A high forehead location is acceptable but parietal positioning will get a more accurate, global representation of brain activity. |
| 6. Using wet 2x2 gauze, scrub 3 areas to remove some of natural skin oils. | *** USING ALCOHOL SWABS WILL LEAVE A THIN FILM ON SKIN AND IMPAIR IMPEDANCE OF THE LEADS. JUST USE STERILE WATER. |
| 7. Apply a small amount of NUPREP to a 2×2 gauze and scrub each lead area with circular motion for 30 seconds. |                                                                                   |
| 8. Wipe excess NUPREP off lead sites with dry 2x2 gauze.                 |                                                                                   |
| 9. Securely fasten the three hydrogel leads to prepared areas.            | Ensure there are no air bubbles and the leads are not lifting off skin.            |
| 10. Connect lead wires to CFM cable module.                               | - Red lead wire to Red cable module input.  
- Yellow lead wire to Yellow cable module input.  
- Black lead wire to Black cable module input.  
- Consider shaving the area if the lead contact is poor or the impedance is high (> 10 ohms). |
| 11. Press RECORD button on CFM screen.                                    | Small cursor arrow on right will begin to move up and down on CFM tracing indicating recording. |
| 12. Press PATIENT button on CFM screen and fill in the name, birth date and ID number of the patient. | Please enter patient data in order that the CFM tracing can be easily recalled from the device’s hard drive if monitoring is later discontinued. |
6.0 Application Guidelines

The main screen is divided into 2 main graphing strips. The top strip is the cerebral function graph that measures electrical brain activity [(µV), semi-logarithmic y-axis] versus time [(hr:min:sec), x-axis]. The bottom strip measures impedance of the leads and evaluates the connection of the leads to the patient’s scalp. The impedance strip should show a relatively flat line that is less than < 20 µΩ to ensure accuracy of the CFM tracing. An increasing level of impedance means the leads are lifting off the scalp and must be reapplied. If the lead lifts off enough, an alarm condition will sound.

Due to the slow charting speed of the CFM, it takes approximately 20 minutes before the clinician can preliminarily analyze the strip. Therefore, seizure treatment should never be delayed if clinical symptoms are observed. Doctors should make a habit of reviewing the CFM every 2–3 hours.

Markers should be labelled on the CFM tracing if the RN observes any clinical symptoms of seizures or administers any sedation or anticonvulsant therapy. If repositioning or stimulating the patient causes disturbances in the tracing, these events should be labelled as well (x rays, etc.). Markers are placed by pressing the MARKER button, tapping the CFM strip at the appropriate time, and then typing or selecting the appropriate marker from the window that pops up.

The CFM functions nicely as a long-term monitor and can be left in place for several days of constant recording. Within 12 hours of starting a CFM trace, a patient should be evaluated using a standard EEG, which may detect focal seizures or localize lesions that cannot always be detected with CFM alone.

If recording is stopped on a patient at any time and is to be restarted, the operator should reapply leads (if not already on), press TOOLS, select the patient’s name from the list and press ACCEPT to display file. RESUME will continue the recording.

7.0 Steps to Wave Analysis

Observe the impedance graph and ensure the line is relatively flat and preferably below 10 kΩ. This indicates an accurate CFM tracing.

NORMAL TRACING

Examine the CFM strip as a whole.

- Is it a gentle wave? YES
- Do the lower and upper margins seem to flow in parallel? YES
- Is the lower margin above 5 µV? YES
- Is the upper margin above 10 µV? YES
- Is their regular widening & narrowing of the trace, within the above margins (Sleep Wake Cycling)? YES

This is classified as a normal trace and in most cases is a good prognostic sign. Early return of sleep wake cycling (SWS) after an asphyxial insult is also a good prognostic sign.
MODERATELY ABNORMAL TRACING

- Is the lower margin below 5 µV? YES
  Moderately abnormal function present.
  Keep in mind that anti-convulsant therapy may shift the wave downward.

![Moderately abnormal trace; Upper margin is > 10 µV & lower margin is < 5 µV throughout the trace. There is no SWS.]

SEVERELY ABNORMAL TRACING

- Is the upper margin below 10 µV? YES
- Does the thickness of the wave appear thinner? YES
- Has the wave appeared to flatten out? YES
  Severely abnormal function present. This may correspond with burst suppression or continuous low voltage on a regular EEG.

![Severely abnormal trace; Upper margin is < 10 µV & lower margin is < 5 µV throughout the trace. There is evidence of SWS. Periodic bursts of electrical activity are seen.]

SEIZURES

- Is there a rising and narrowing pattern in the CFM tracing? YES

![Moderately abnormal trace with multiple seizures; Upper margin is > 10 µV & lower margin is < 5 µV throughout the trace. There is no evidence of SWS. Frequent and prolonged periods of elevation in both the lower and upper margins are seen that coincide with a repetitive rhythmic pattern on the EEG. This is characteristic of seizure activity.]

- In the gaps of the rising and narrowing (lower margin becomes suddenly raised for several minutes), does the EEG tracing show a distinct repetitive pattern? YES
  Seizures are present.
7.1 Analysis and Prematurity

aEEG is feasible for monitoring cerebral activity in preterm infants and normative values have been suggested. SWS can be clearly identified on the trace from around 30 week’s gestation although a cyclical pattern emerges in some babies at 25-26 weeks gestation. A scoring system has been suggested by Burdjalov et al based on continuity, presence of cycling, amplitude of the lower border and bandwith (see bibliography).

This scoring system has not yet been tested in terms of its ability to recognise pathological states and is somewhat subjective; however it may be useful as a guide for interpretation. This scoring system is recommended when aEEG is applied to premature infants to facilitate trace interpretation. Extremely low voltage patterns or burst suppression should be easily recognisable. There are no definitive reports on seizure patterns in preterm infants. Pathological patterns should be confirmed by more formal EEG evaluation.

8.0 Responsibilities of Health Care Team Members During Cerebral Function Monitoring

All health care professionals (i.e. physicians, nurses, RT’s, nurse practitioners) involved in the care of critically ill newborn infants will participate in CFM monitoring. Their roles must be clearly defined to ensure this technology is used correctly when indicated and analyzed in a timely fashion thus ensuring optimal care is provided. Early identification of disturbances in global cerebral brain wave activity may lead to earlier therapeutic interventions, ultimately improving patient outcomes. Each unit must designate an individual (s) who will take responsibility for ensuring all staff understand the importance of this technology and that the designated responsible health professionals are educated in equipment troubleshooting and trace interpretation. This will ensure optimal usage of the technology.

Respiratory Therapist or Nurse

- Sets up the equipment
- Operates the equipment
- Troubleshooting of technical difficulties
- Helps facilitate interpretation

Nurse

- Observe for clinical signs of seizures
- Track times of when procedures are done and when anti-convulsant and sedative therapy is given.
- Communicate problems or questions to the RT
- Informs RT of alarms or major trace changes

Physician or Nurse Practitioner

- Orders when to commence and discontinue CFM using prescription sheets and CFM requisition
- Interprets the tracing
- Medical management of abnormalities detected on CFM trace
- Informs ancillary staff and other physicians
- Documents abnormal traces in patient chart with subsequent medical intervention

For further reading and training (includes many test samples):
http://www.azzopardi.freeserve.co.uk/CFM

Reference List


