Cerebral Function Monitoring
The contents of this booklet were originally produced for the website

http://www.azzopardi.freeserve.co.uk/CFM

by

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Training Manual
Lectromed Cerebral Function Monitor System

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EQUIPMENT

Calibration of the CFM

• Connect the coloured leads provided with the machine to the cable connector on one end and to the sockets on the front of the CFM on the other end. The connections are colour coded: connect yellow-to-yellow, red-to-red, and green-to-green.

• On the front panel of the CFM above the three sockets is a switch that reads 100 microvolts at one side and 25 kilohms on the other side. With the power switched on turn the switch to the side marked 100 microvolts. The needle that displays the amplitude should now be on the 100 microvolt mark on the scale printed on the printer paper. Use the
needle adjusting dial to adjust as necessary. Be careful to use the correct adjustment dial: 2 dials control each needle; one sets the needle temperature and the other the needle position.

- After calibrating the voltage turn the switch to the 25 kilohms mark. The needle that displays the impedance should rise a distance of 5 large squares on the printer paper. Adjust the needle-adjusting dial if necessary.
- Disconnect the leads. The equipment is now calibrated.

**Attaching the Electrodes**

Three electrodes are attached to the scalp, as shown in the instructions and diagram written on the front of the amplifier box. The electrode connected to the connector marked with the red dot is attached to the left parietal side and the electrode connected to the yellow marked connector is attached to the right parietal side of the head. The third electrode is used as a ground and can be connected to the front or back of the head in the midline, avoiding the anterior fontanelle.

**Disk Electrodes:**

- Clean the surface of the scalp with an alcohol swab.
- Gently rub the scalp using an abrasive skin paste.
- Apply EEG contact paste.
- Apply the adhesive electrode.
- Fix using a skin adhesive such as Collodion followed by adhesive tape.

**Needle Electrodes**

Needle electrodes can be easily applied with minimal preparation. The needle electrodes do not appear to cause discomfort and no anaesthetic is required for insertion. Care must be taken if the infant is moved to avoid dislodging the electrodes.

- Clean the application site with an alcohol swab.
- Insert the needle subcutaneously.
- Fix using a skin adhesive such as Collodion followed by adhesive tape.

After inserting the electrodes attach the leads to the appropriate connections on the cable connector following the colour code: left parietal electrode to the red connector, right parietal electrode to the yellow connector and the ground electrode to the green connector.
Recording Speed

The printer should be set to print at 6 cms per hour by pressing the appropriate switches located on the front of the CFM (1mm/min).

Note: Be sure to press the printer “on” switch when starting the CFM, as this does not come on automatically.

At the normal printer speed of 6 cms per hour the paper moves very slowly and it is difficult to recognise if the printer is accidentally switched off. It is not helpful to use other print speeds as all the published data refers to a record speed of 6 cms per hour.

Common Problems

The CFM is remarkably simple to use and practical problems rarely occur unless the equipment is damaged.

1. Impedance or overload alarm light on: The impedance alarm may illuminate if the impedance is very high as may occur if there is poor electrode contact. Check electrode contact and if necessary reapply. The overload alarm illuminates when an electrode has become disconnected or there is a major fault such as a broken cable or amplifier box.

2. Printer paper not running. The printer does not automatically start when the CFM machine is switched on. The printer switch must also be switched on. If during a period of recording the CFM is accidentally switched off, the printer will not start automatically when the machine is switched on again. You will always need to press the printer start button after switching the CFM machine on.
READING CFM TRACINGS

Overview

The CFM (Cerebral Function Monitor) records a single channel of EEG; the signal is filtered and rectified and the range of amplitude of the signal in microvolts is displayed on an integral printer. Frequencies <2 and >15 Hz are selectively filtered to reduce artefacts caused by movement, ECG and other electronic equipment. The signal is recorded from 2 electrodes placed on either side of the head. A third electrode acts as a ground. The printer speed is usually set at 6 cms per hour. This makes every major division equal to 10 minutes.

CFM vs EEG

Since the CFM records the amplitude of the EEG signal, continuous EEG activity is manifest on the CFM as a trace varying from about 10-40 microvolts. Discontinuity results in a wider band and the voltage of the lower margin of the trace depends on the degree of discontinuity. The more discontinuous the EEG activity the wider the trace will be. Severely disorganised EEG activity such as burst suppression or very low voltage activity is manifest as a suppressed low voltage trace that may be accompanied by bursts of higher voltage activity.

Interpreting the record

The CFM record consists of a dense trace that can vary in width. Two features of the trace should be assessed: the amplitude of the trace, and the presence of seizure activity. The amplitude of the trace can be assessed by measuring the upper and lower margins of the trace against the scale printed on the printer paper. The position of the lower margin can usually be eyeballed, or a ruler can be used to draw a line along the margin of the trace disregarding brief spikes. The intention is to measure roughly the voltage of the upper and lower margins of the trace.
Points to Note

- The CFM does not give information about EEG frequency.
- Focal lesions may not be identified because the signal is obtained from a single channel. Following asphyxia the occurrence of a moderately or severely abnormal trace has a positive predictive value for abnormal outcome in the order of >70%.
- Medications may affect the record. Anticonvulsants or sedatives such as morphine or chloral hydrate may transiently suppress the CFM record. Administration of drugs or other clinical events should be noted on the CFM record to facilitate interpretation of the record.

Normal Trace

In healthy full term infants the trace alters in width according to the state of the infant. The trace is narrower when the infant is awake and widens during sleep. These changes in the width of the trace with infant state are called sleep/wake cycling. In normal infants the width of the trace varies from approximately 10-40 microvolts.

A sample of a normal trace is given below:
**Moderately Abnormal Trace**

A moderately abnormal trace has an upper margin that is greater than 10 microvolts and a lower margin less than 5 microvolts. The trace therefore appears wider than in normal infants. This appearance can be seen in infants with moderately severe encephalopathy, or immediately after administration of drugs such as anticonvulsants and sedatives. This pattern may also be seen in pre term infants (below 36 weeks gestation).

A sample of a moderately abnormal trace is shown below:
Severely Abnormal Trace

A severely abnormal trace is characterised by a general suppression of amplitude so that the trace appears narrow and of low voltage. The upper margin of the trace is less than 10 microvolts. The lower margin is usually less than 5 microvolts (on occasion the lower margin may be transiently greater than 5 microvolts whilst the upper margin is less than 10 microvolts). This pattern may be accompanied by brief bursts of higher voltage spikes, which appear as single spikes above the background activity. This appearance is sometimes called “burst suppression”. A severely abnormal trace is usually seen with severe encephalopathy and is often accompanied by seizure activity.

Two examples of severely abnormal traces are shown here:

Sample 1
Seizures

Seizures may only be identified if they are sufficiently prolonged, i.e. more than 2-3 minutes. Shorter lasting discharges may be missed since the CFM is recorded at a very slow speed. Two main seizure patterns may be seen.

1. There is a sudden rise and narrowing of the trace (reflecting the increase in EEG voltage).

2. A narrowing of the trace without a rise in voltage may be seen. The trace returns to the previous appearance when the seizure activity stops.
Note:

- It may be difficult to distinguish burst suppression from brief seizures in a severely abnormal trace - but the distinction is not important.
- An isolated sudden change in the trace suggestive of seizure may be difficult to interpret in the absence of any clinical observation. Artefact due to touching the infant may cause diagnostic difficulty.
- It may not be possible to comment on the background of the trace if seizures are very frequent.
- Continuous seizure activity may be difficult to recognise because the trace may appear to be of normal voltage. However, with long term recording it may be possible to identify when seizure activity stops.

Samples of seizure patterns are shown below:

This sample demonstrates a saw-tooth appearance of the trace when seizures occur in a regular frequent manner:
This trace demonstrates both burst suppression and seizures:

This trace shows borderline normal amplitude with seizure developing towards the end of the trace:
FURTHER SAMPLE TRACES

1 Normal trace:
Note change in width of trace with sleep/awake state.

2 Normal trace:
Note suctioning abolishes sleep/wake changes for several minutes.
3 Effect of sedatives:
Note effect of sedative (chloral hydrate) on amplitude.

4 Borderline normal trace:
Mild/moderate asphyxia: note normal amplitude but no sleep/wake cycling.
5 Moderately abnormal 1: 
Note lower margin of trace less than 5 microvolts and single seizure.

6 Moderately abnormal 2: 
Note lower margin less than 5 microvolts and upper margin greater than 10 microvolts.
7  Moderately abnormal trace 3:
Note wide trace with lower margin less than 5 microvolts.

8  Persistent abnormal trace 1:
Persistent abnormally wide trace for several days may indicate cerebral malformation or metabolic disease.
9  Persistent abnormal trace 2:
Persistent extremely wide trace suggestive of metabolic disease.
Note upper margin greater than 100 microvolts.

10 Persistent abnormal trace 3
Another example from an infant with a neurometabolic condition.
11 Persistent abnormal trace 4: Trace from sibling of previous example.

12 Borderline suppression: Trace initially borderline severe suppression with partial recovery towards end of trace.
13 Borderline severely abnormal trace:
Borderline severely abnormal trace with possible seizures.

14 Suppressed trace 1:
Another example of a severely abnormal trace with burst suppression initially; note movement artefact due to chest Xray at end of trace.
15  Suppressed trace 2:
Another severely abnormal trace with burst suppression; note transient elevation of lower margin with movement of infant.

16  Suppressed trace 3:
Another example of a suppressed trace commonly observed following severe asphyxia.
17 Moderate/severe suppression:
Abnormal trace varying between moderate and severe suppression and probable seizures.

18 Severe suppression 1:
Note frequent seizures and very suppressed background.
19 Severe suppression 2:
Note suppressed amplitude.

20 Severe suppression 3:
Note severe suppression of amplitude and elevated lower margin at beginning of trace. Transient elevation of lower margin sometimes above 5 microvolts may be observed but the upper margin is less than 10 microvolts in suppressed traces.
21 Severe suppression 4:
Note severely suppressed trace, seizures and effect of phenobarbitone.

22 Severe suppression 5
Another example of severe suppression with bursts and seizures; again note effect of phenobarbitone: seizures stop for a while and amplitude falls.
23  Movement artefact:  
Note movement artefact abolished following pancuronium in infant with severely suppressed trace.

24  Burst suppression:  
Severely abnormal trace with burst suppression and probable seizures. It may be difficult to distinguish between bursts and seizures but both are often present in severely abnormal traces.
Seizures 1:
Infrequent seizures may be difficult to recognise unless there are clinical correlates. Note effect of phenobarbitone on amplitude.

Seizures 2:
Note seizures and transient effect of phenobarbitone.
Seizures 3:
Note two seizures on otherwise normal amplitude.

Seizures 4:
Infant with seizures. Note effect of recording at different speed.
29  Seizures 5:
Seizures may be missed when amplitude remains elevated as in this example.

30  Seizures 6:
Note single seizure and effect of phenobarbitone.
Seizures 7:
Another example of frequent seizures; often some of the seizures are not recognised clinically.

Effect of anticonvulsant 1:
Note effect of anticonvulsant on amplitude: trace becomes suppressed.
Effect of anticonvulsant 2:
Reduction in seizures following increase in anticonvulsant.
The aEEG may be performed from one hour of age. If subsequently an abnormal aEEG were recorded the infant would then become eligible for enrolment (if randomisation can take place before 6 hours of age). The aEEG should not be performed within 30 min of IV anticonvulsant therapy as this may cause suppression of EEG activity. In particular, high dose anticonvulsant therapy (eg. >20mg/kg phenobarbitone) should not be given prior to performing the aEEG.

**CFM SET UP**

**Pen Heat/Calibration**

- Connect amplifier and cables to Test Signal socket
- Turn on rear panel switch
- Set Chart Speed to 50 and mm/min
- Press Chart ON/OFF so light is on and chart is moving
- Adjust CFM and Impedance Heat controls
- Start with control pointing straight up (12 o’clock)
- Adjust to get a single fine line under the pen
- Adjust pen position controls so CFM and impedance trace pens are at zero
- Set the Test Signal switch to 100 microvolts
  - Impedance pen stays at zero, CFM pen should go to 100. Use pen position control to ensure this as necessary.
- Set the Test Signal switch to 25 kilohms
  - CFM pen goes to zero. Impedance pen goes to middle of chart
- Change Test Signal switch once or twice to demonstrate proper calibration
- Press Chart ON/OFF button. Chart stops
- Set the Chart speed to 1 and mm/min
- Apply electrodes to infant
- Disconnect cable from Test Signal socket
- Connect the infant electrodes to CFM
- Press the Chart ON/OFF button to turn the light on

Make sure the paper is moving by checking it regularly.
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