

Local Guideline



EEG(amplitude integrated) monitoring in NICU

Sites where Local Guideline applies	Neonatal Intensive Care Unit. JHCH
Target audience:	NICU clinical staff, who provide care to neonatal patients
Description	Guideline for procedure and equipment requirements to monitor brain function of an infant in NICU
This Local Guideline applies to:	
1. Adults	No
2. Children up to 16 years	No
3. Neonates – less than 29 days	Yes
Keywords	amplitude, frequency, HIE, seizures, trace
Replaces Existing Local Guideline and Procedure	Yes
Registration Number(s) and/or name and of Superseded Documents	Bedside monitoring of brain function with BrainZ [®] BRM2 /3 Monitor in NICU 5.6.8
Related Legislation, Australian Standards, NSW Health Policy Directive, NSQHS Standard/EQuIP Criterion and/or other, HNE Health Documents, Professional Guidelines, Codes of Practice or Ethics:	
<ul style="list-style-type: none"> NSW Health Policy Directive 2007_079 Clinical Procedure Safety http://www0.health.nsw.gov.au/policies/pd/2014/pdf/PD2014_036.pdf NSW Health Policy Directive 2010_006 Whole Body Cooling - Neonates Suspected Moderate or Severe Hypoxic Ischaemic Encephalopathy (HIE) http://www0.health.nsw.gov.au/policies/pd/2010/PD2010_006.html NSW Health Policy PD 2005_406 Consent to Medical Treatment http://www.health.nsw.gov.au/policies/PD/2005/pdf/PD2005_406.pdf NSW Health Policy Directive PD 2007_036 Infection Control Policy http://www.health.nsw.gov.au/policies/pd/2007/pdf/PD2007_036.pdf 	
Prerequisites (if required)	Nil
Local Guideline Note	This document reflects what is currently regarded as safe and appropriate practice. The guideline section does not replace the need for the application of clinical judgment in respect to each individual patient but the procedure/s requires mandatory compliance . If staff believes that the procedure/s should not apply in a particular clinical situation they must seek advice from their unit manager/delegate and document the variance in the patient's health record.
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Date authorised	31/10/14
This Local Guideline contains advice on therapeutics	No
Date of Issue	15/12/14
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Note: Over time links in this document may cease working. Where this occurs please source the document in the PPG Directory at: <http://ppg.hne.health.nsw.gov.au/>

RISK STATEMENT

This local guideline has been developed to provide guidance to clinical staff in NICU when an infant requires bedside monitoring with the Olympic Brainz Monitor (OBM) or BRM2/3. It ensures that the risks of harm to infants and staff during the procedure are identified and managed.

Any unplanned event resulting in, or with the potential for injury, damage or other loss to infants or staff as a result of this procedure must be reported through the Incident Information management System and managed in accordance with the Ministry of Health Policy Directive: Incident management PD2007_061. This would include unintended injury that results in disability, death or prolonged hospital stay.

RISK CATEGORY: *Clinical Care & Patient Safety;*

OUTCOMES

1	OBM® & BRM3 monitor is applied correctly to those infants requiring monitoring.
2	Suspicious OBM® & BRM3 trace is recognised and staff alerted for full interpretation
3	Anti-convulsive and other therapies are administered where required and the effect of the therapy on the aEEG is monitored

ABBREVIATIONS & GLOSSARY

Abbreviation/Word	Definition
AC	Alternating current
Amplitude	is a measurement of the level of electrical brain activity detected, measured in microvolts peak to peak
Artifact	is any electrical signal detected by an EEG machine from an extra cerebral source, for example, electrode or cable movement, AC supply noise, ventilator noise.
aEEG/EEG	Amplitude-integrated electroencephalography
BRM3	Brainz™ Monitor No 3 version
CPAP/HPCPAP	Continuous Positive Airway Pressure/Hudson Prong
CT	Computerised Topography
DAB/DAU	Data Acquisition Box/Unit
Frequency/Hz	is the number of complete cycles of repetitive waves in one second, measured in hertz (Hz)
HF/HFOV	High Frequency/Oscillation Ventilation
HIE	Hypoxic Ischaemic Encephalopathy
ID	Identification
IV	Intra venous
LED	Light emitting diode-used as indicator lamps

MRI	Magnetic Resonance Imaging
MRN	Medical Record Number
NEST	Neonatal Electrography Seizure trial
NP	Nurse Practitioner
OBM	Olympic Brainz™ Monitor
SaO2	Oxygen Saturation monitoring
SWC	Sleep wake cycle
USB	Universal Serial Bus-communication portal between computers and electronic devices
uV	Unit of voltage

EEG(amplitude integrated) monitoring in NICU- One Page Summary and Checklist

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GUIDELINE

This Guideline does not replace the need for the application of clinical judgment in respect to each individual patient

RATIONALE

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This guideline is to assist staff in the NICU using the Olympic Brainz[®] Monitor (OBM) and BRM3 monitors. The OBM & BRM3 monitor provides a method for a continuous monitoring trend of brain function to aid bedside clinicians to measure the activity of the brain and assess for seizures by amplitude-integrated electroencephalography (aEEG).

aEEG is based on filtered and compressed EEG that enables evaluation of long-term changes and trends in electrocortical background activity by relatively simple pattern recognition.

In term infants the aEEG is a good method for evaluating brain function and brain recovery after hypoxic-ischemic insults such as perinatal asphyxia and apparent life threatening events (Hellstrom-Westas et.al 2007). Some studies have shown that an aEEG recorded within 6 hours after birth can be a useful predictor of long term outcome after perinatal asphyxia for normothermic term babies. Recovery of aEEG background activity by 24 hours & early return of SWC's further refine the ability to predict outcome. Hypothermia treatment changes the predictive value of an early aEEG (Thoresen, 2010).

In preterm infants the normal aEEG changes with gestational age and seizures may be noted. Also shown is the emergence of the sleep-wake cycle (SWC) which demonstrates increasing brain organisation. Seizures can be detected with aEEG in preterm infants.

Use of the OBM[®] & BRM3 monitor and analysis of the trace complements other neurological assessment tools such as clinical assessment, multi-channel EEG and neuroimaging MRI or CT scan.

This guideline includes instruction on how to apply the electrodes and provide a basic understanding of the tracings.

FUNCTION

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The OBM[®] monitor is a two channel electroencephalograph (EEG) that detects and records small electrical signals from each hemisphere of the patient's brain and assists the clinician to monitor seizure activity and response to therapy.

The monitor allows the following to be undertaken:

- Continuous monitoring of normal and abnormal EEG activity;
- Monitor, identify and review cerebral seizure activity for infants with definite or questionable seizure (clinical or subclinical)
- Monitoring the effects of therapies on cerebral function. In moderate-severe HIE the incidence of seizure is >50% (Gluckman 2005). Only around 20% of electrographic neonatal seizures provoke obvious clinical signs and some infants may only have subclinical seizures (Mizrahi 2001)
- *The continuous EEG (aEEG) is to conventional multi-channel EEG as Sao2 monitoring is to arterial blood gases. It allows continuous real time monitoring which conventional EEG can't provide.*

INDICATIONS

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The following infants should be considered for cerebral function monitoring using the OBM[®] & BRM3 monitors:

- Infants who have had an hypoxic event around the time of birth
- Muscle relaxed infants at risk of seizures that may not be clinically apparent
- Any infant suspected or at high risk of having seizures
- Infants receiving cooling for hypoxic ischemic encephalopathy (HIE)
- Unexplained apnoea
- May be preterm or term infants

Monitoring should be commenced when directed by a medical officer or nurse practitioner. However if not in use nursing staff should consider its use and instigate a discussion with the MO/NP to commence monitoring the aEEG.

HOW TO APPLY THE OBM & BRM3 MONITOR (see appendix 3 for BRM3)

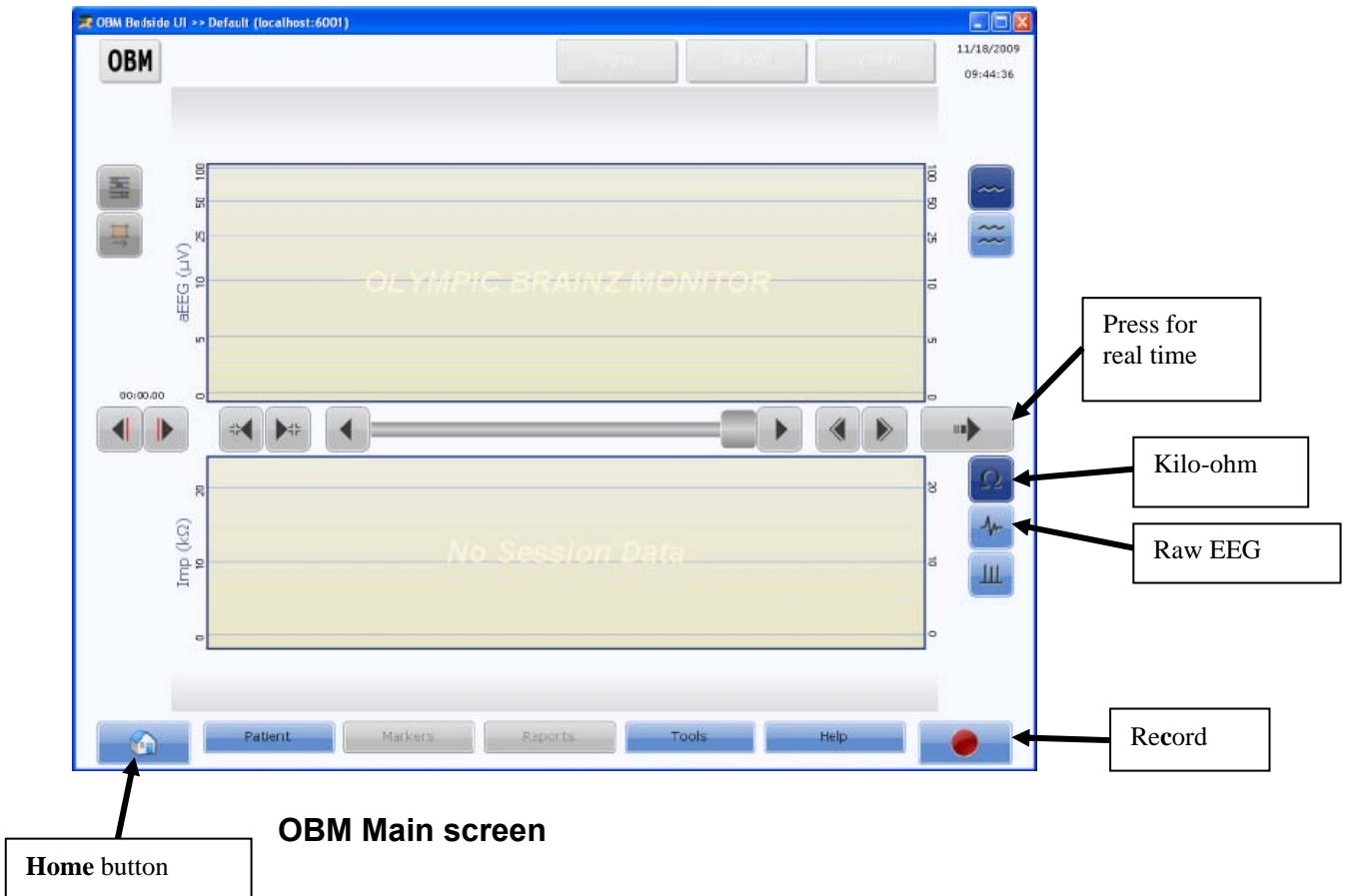
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Power switch (if needed) is located at the back of the monitor as shown. **Switches on automatically once plugged into the wall.** Navigation- the OBM aEEG main screen has touch screen capability.

The Olympic Brainz™ Monitor aEEG Main Screen default will display the aEEG trace on the top portion of the screen and impedance histogram on the lower section of the screen. The raw EEG may also be displayed by touching the EEG display icon. To return to the Impedance Display, simply touch the kilo-ohm icon.





ENTERING PATIENT INFORMATION PRIOR TO STARTING A RECORDING (OPTIONAL)

- The clinician has the option to enter patient information prior to starting the recording, or at any time during the patient study.
- To enter patient information prior to beginning a recording, select RECORD (red circle) on the right of the Main Taskbar. Onscreen keyboards will pop-up for Patient Record MRN, Last Name, and First Name. Type the patient information in the appropriate field.
- Touch NEXT to proceed to the electrode configuration screen. If the clinician prefers not to enter patient information, simply omit patient entry steps and touch NEXT to proceed to the electrode configuration screen.

PATIENT INFORMATION -CAN ENTER AFTER STARTING A RECORDING

Touch **Patient** on Main task Bar

- Add whatever further information is required e.g.
- Weight
- Gender
- Comments
- Clinician initials
- Study ID

Press **Accept changes**

ELECTRODE EQUIPMENT AND APPLICATION

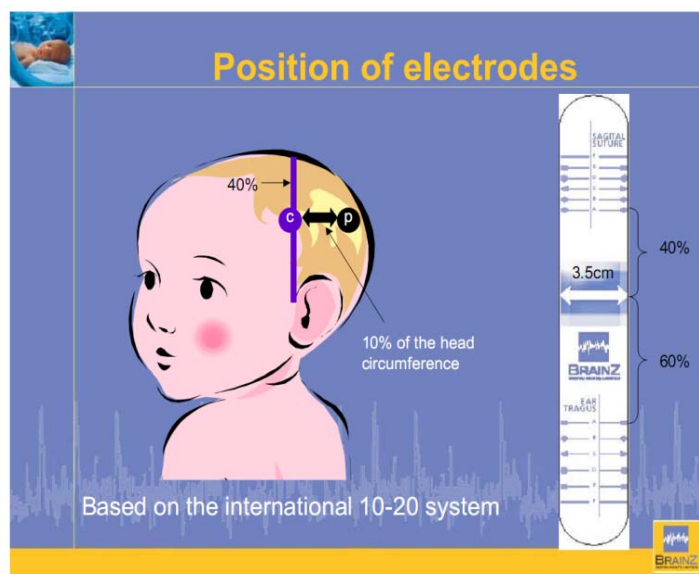
See pictorial guide to application of sub-dermal needles, wrap hat and hydrogel electrodes in appendix (1&2)

- The blue plastic housing is a safety mechanism so that the needles can be handled easily & with minimal risk of needle stick injury.
- Squeezing distal end of the blue safety cover opens "protective shield" & allows the needle & black hub to glide right out in one pass
- Pull plastic housing to the end of the cable wire (away from the needle)
- When needles are removed the blue housing should be advanced over the needle & disposed of in a 'sharps' container.
- Low Impedance Needle Electrodes (29G) *no bevel*



- Connecting sensors to the Data Acquisition Box (DAB)
- Use the head graphic to connect the sensors into the appropriate receptacles on the DAB
- Check impedance of the first 2 electrodes before inserting the remaining 2.
- Left anterior sensor goes into C3 & Left posterior goes into P3
- Right anterior sensor goes into C4 & Right posterior goes into P4
- Connect DAB into available USB port.
- Hang the DAB from the convenient hook or handle on the incubator cot

Positioning and attaching the sub-dermal needle electrodes



Measure position of electrode sites using Sensor Positioning Aid

Ear Tragus to Sagittal Suture



- Visual Inspection (to check for any scalp injuries or oedema)
- Locate anatomical landmarks: Sagittal suture & Ear Tragus
- Align sensor positioning aid Vertically on the head & Parallel to the face
- Match the letters or symbols on positioning aid until **same** letter or symbol in both locations
 - Central and parietal placement-covers the watershed area where most of the research has been done (between anterior, posterior and middle cerebral arteries)
 - 80-90% of seizures will show up in this area

Do not rush this procedure. Make sure the infant's head and hair are clean and dry before beginning.

1. Open the Sensor Adaptor set package to access the two positioning aids and the sensor adaptor set.
2. If a Canberra Hat (infant on HPCPAP) is to be used, position under the infant's head. Otherwise use a wrap hat to stabilize the electrodes (see Appendix 1).
3. Place the appropriate sensor positioning aid (term or preterm) against one side of the infant's head. Hold the positioning aid vertically, using the forward edge to line up against matching letters (A to H – term positioning aid or A to F preterm positioning aid) against the *ear tragus* and *sagittal suture*. On a small infant, the latter "A" might match both the *ear tragus* and *sagittal suture*, while larger infants will use higher letters.
4. Once the positioning aid is correctly sited, mark the sites with a surgical marker on either side of the central arrow. These positions are the insertion points for each sub-dermal needle electrodes.
5. Exercise extreme care when handling needles to avoid needlestick injuries.
6. Clean the scalp around each insertion point (it may help to create a vertical part in the hair).
7. Insert a needle electrode sub-dermally at one of the insertion points with the wire lead towards the top of the infant's head.
8. Secure the needle electrode to prevent it from being pulled out (see Appendix 1)
9. Repeat steps 6 & 7 for the other insertion site. Try to achieve a separation distance of 25 mm for a preterm infant and 35 mm for a term infant.
10. Connect the black wire on the sensor adaptor set to the electrode at the back site, and the purple wire to the electrode at the front site (*black is back*). Remember to use the correct side of the sensor Adaptor set (left or right).
11. Select a site with intact skin and no hair for the hydrogel reference sensor, on or near the infant's shoulder.
12. Using a small amount of skin preparation gel on a cotton applicator, clean the skin at the selected site, by using repeated back and forward motions. Take care not to damage immature skin.

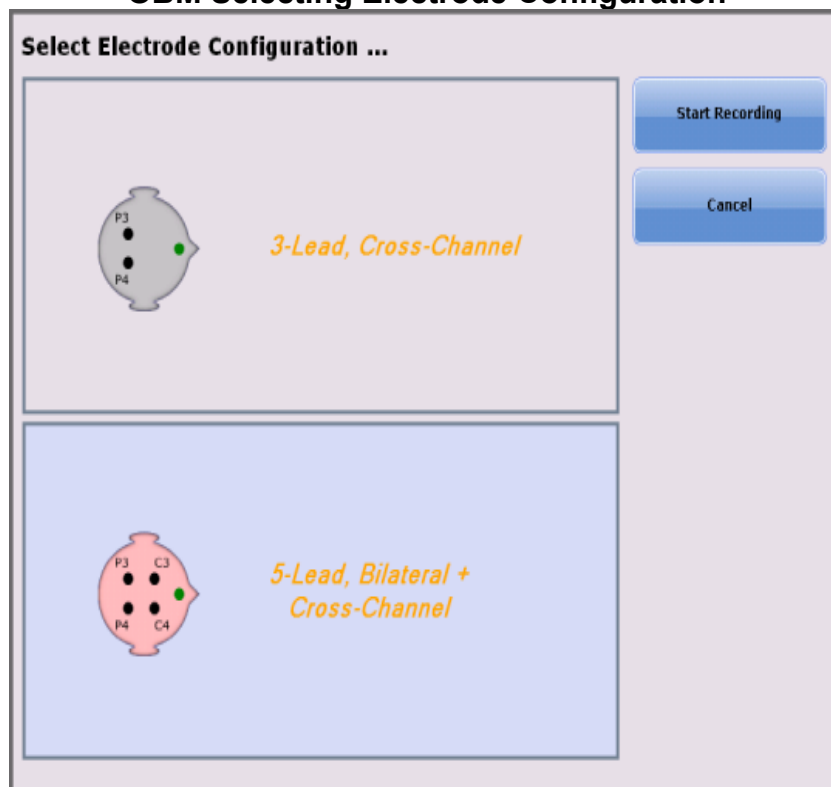
13. Rinse and dry the area using sterile water and gauze pads, then apply the hydrogel reference sensor directly over the cleaned area, running the green lead up the back of the infant's head.
14. Cup your hand over the sensor and apply gentle pressure for 20 to 30 seconds, to warm and seat the sensor gel.
15. Using the hat wrapping to stabilize the needle electrodes, gently turn the infant to expose the other side of the head. Repeat steps 3 to 9 to apply remaining electrodes.
16. Route the cables away from the top of the infant's head and out of the incubator or cot, out of the infant's reach.
17. Connect the sensor adaptor set to the OBM Data Acquisition Unit, making sure the arrows on the connectors are aligned to prevent damage to connectors. Check for satisfactory electrode contact (green indicator) for all electrodes, using the OBM Brain Monitor *Signal Status* screen.
18. Fold the Canberra hat (if used) or wrap hat around the infant's head, over the electrode sites, and secure.

Note: If the infant is on respiratory support, you may have to rearrange the respiratory device while you clear access to each side of the head. Remember to re-stabilize the respiratory device at the end of the application procedure.

SPECIAL CONSIDERATIONS

- Infant on CPAP: use Canberra hat
- Phototherapy -shouldn't interfere: consider leaving a wrap hat off.
- Scalp Injury/Scalp Lacerations: do not place electrodes over any open cuts
- Cephalohaemotoma: **Do not use** needle electrodes-trace may be dampened
- Scalp IV: depending on insertion site it may interfere with electrode placement

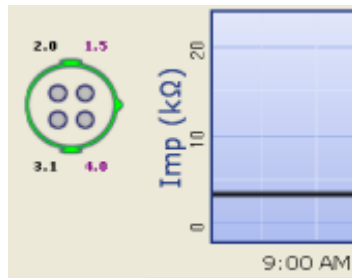
OBM Selecting Electrode Configuration



- Select 5 lead, bilateral +Cross-Channel
- **Press Start Recording and** OBM starts live monitoring mode
- OBM performs a system self-check each time it is placed into recording mode
- The self-check verifies that the Data Acquisition Box (DAB) is correctly calibrated
(Takes 15 seconds)

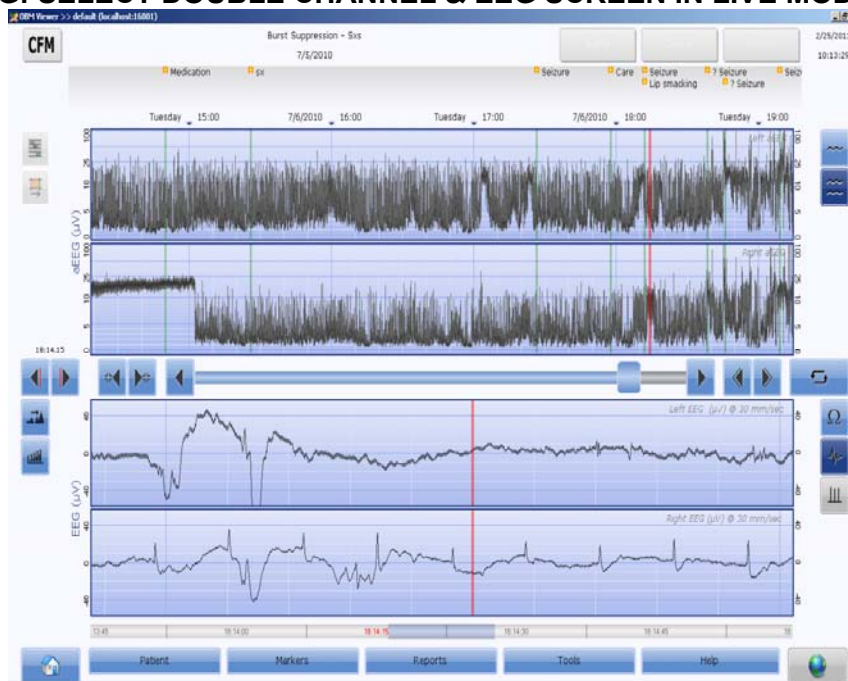
OBM DISPLAYS 3 VISUAL CUES AS TO ELECTRODE CONTACT QUALITY

- The Olympic Brainz Monitor displays three visual cues as to electrode contact quality. First, an indicator of the signal quality appears in the status bar. If the SIGNAL icon is green it indicates good quality electrode contact. If the SIGNAL icon is amber, it indicates marginal contact and if it is RED it indicates poor contact
- Second, the Electrode Impedance View may be accessed by touching the Electrode Impedance View icon on the right side of the screen. This view displays a graphic picture of the head with the actual impedance value for each electrode.



- In the graphic display, the head will appear green if all electrodes are below 7.5 kΩ indicating electrode contact is good. The head will appear yellow if one or more electrodes is above 7.5 kΩ, yet below a 15 kΩ threshold, indicating the electrode contact is marginal. If any single electrode exceeds 15 kΩ, the head will appear red, indicating the contact quality has severely degraded to the point where signal quality will most certainly be affected.

RECORDING: SELECT DOUBLE CHANNEL & EEG SCREEN IN LIVE MODE



- If you move timeline cursor backward or touch aEEG screen while you are in **Live Monitoring mode** OBM automatically switches to **Review mode**
- Recording continues in the background.
- OBM automatically returns to Live monitoring after approximately **three minutes** of user interface inactivity

OLYMPIC BRAIN MONITOR MAIN TASK BAR- PROVIDES THE USER WITH ACCESS TO ESSENTIAL WORKFLOW FUNCTIONALITY

Home takes you back to main screen

Patient

- Update patient information for the current session.
- Resume a previously recorded session
- Create a new session
- Examine previously recorded sessions

Markers

- Add markers
- Navigate through a session to specific markers (*list of markers*)
Use manual scoring tools to mark regions
- Just press **Markers** if timeline already in place
- Press one of the predefined events to automatically place the marker at the timeline cursor position.
- If you'd like to place a customized marker, touch the MARKERS icon on the Main Taskbar and touch CUSTOM EVENT. Use the keyboard to type in a one-time event. The ADD button will become highlighted. Touch ADD to accept the custom marker.
- Once a marker is placed in the aEEG timeline, it cannot be moved or deleted.
- You can edit it to change the **Event tag** and description
- To edit a marker, touch LIST to display the marker list history. Touch the marker requiring editing and touch EDIT.
- You can add multiple markers at a single timeline cursor position.
- Use the keyboard to change your marker event tag and note other changes. Note – touching any marker on the LIST view will automatically take you to that exact marker position on the aEEG graph.

THE 6 S'S OF SYSTEMATIC REVIEW

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Story/Situation

Signal quality

Strength of brain activity & the Background Pattern (aEEG traces)

Sleep- wake cycles

Symmetry

Suspicious areas

Story

- Clinical assessment
- Gestational age
- Delivery history
- Medications
- Ask yourself? *Does the tracing fit with the clinical picture?*

Signal quality

- Signal is a measure of the quality of electrode contact.
- Anything that "impedes" or interferes with the devices ability to read the brain signal i.e. (hair, dry skin, Vernix)

- **Strength (Voltage)**

Interpretation is based on:

- Pattern recognition of the bandwidth (*called amplitude*) produced by the compressed signals
- The voltage measurement (μV) of the upper and lower limits of this bandwidth

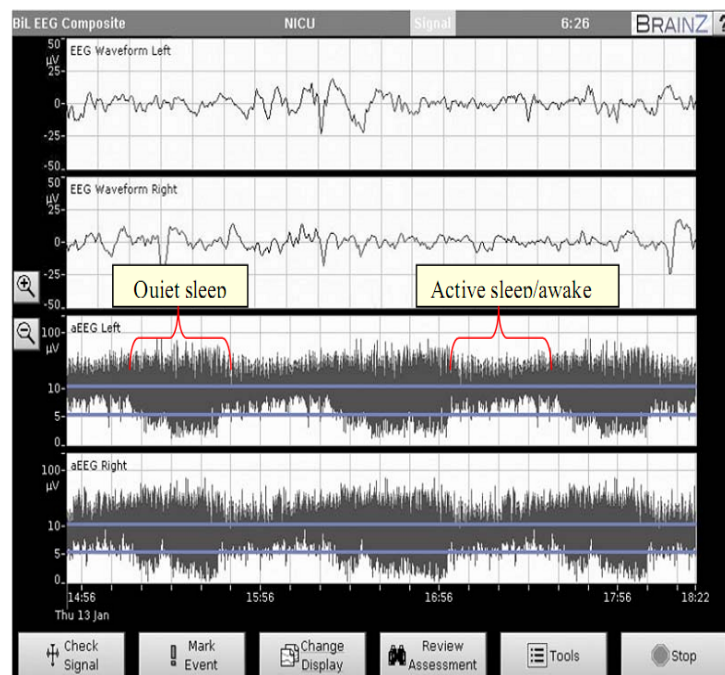
Looking at a combination of both: **Strength** of the signal (*voltage*) & **Pattern Recognition** seems to be much better because voltage can be affected by:

- Scalp oedema
- Interelectrode distance
- Artifact (*any electrical activity other than the brain's electrical activity, movement, monitors, IV pumps, HF ventilators, etc.*) as can persistently elevate the lower margin

Sleep Wake Cycles

- Represented by a wavy pattern with periods of bandwidth widening (quiet sleep)
- Followed by bandwidth narrowing (active sleep/awake).
- SWC is normal in general occurs approx. every 60-90 minutes
(*Lasts about 20-40 mins.*)

Sleep wake cycles can be seen on EEG and aEEG after 32 weeks gestation.



Symmetry

Differing amplitude & variability between (R) & (L) hemispheres (*Asymmetry*)

Asymmetry should be investigated

Potential causes:

- Scalp electrodes touching on one side
- Sensor spacing not symmetrical
- Localised increased scalp oedema
- Unilateral cerebral injury

Solutions:

- Replace electrodes
- Reposition baby's head
- Reposition sensors symmetrically over less oedematous area
- Rule out unilateral injury

Suspicious Areas

Seizures & Artifacts

- Review **marked** events & (**RecogniZe (seizure detection software) if activated**)
- Investigate areas that are different from the rest of the tracing
- Carefully review the **Raw EEG** in areas where the upper & lower margin have shifted up
- **Seizures**: spiky repetitive pattern that last longer than 10 seconds

Seizure vs. Artifact

Is there any associated clinical seizure activity?

Is raw EEG activity: Rhythmic & different from normal background patterns

Is the raw EEG activity a similar pattern to previous definite seizures?

Are there artifacts that may be contributing to elevation in aEEG baseline or EEG rhythm?

- e.g. movement, HFOV, ECG
- Look at behavior of the baby (e.g. gasping)
- Chest percussion, baby sucking
- Electrical artifact from incubators, infusion pumps etc.

NOTE: Mark any care/procedures, movements, medications etc.

Important to mark aEEG trace as will facilitate later interpretation & identification of artifact

RecogniZe SETTINGS

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- RecogniZe algorithm has been factory-set to a default low amplitude detection threshold of 5 μV p-p.
- This setting provides the best balance of sensitivity and artefact rejection over a wide range of environments and circumstances.
- In individual cases, however, clinicians may choose to raise the detection threshold in order to make the algorithm less sensitive to low-amplitude artefacts (*for example, ECG interference and high-frequency*)
- Once the detection threshold is changed, it remains fixed until it is changed again
- Poor impedance can lead to a heightened sensitivity to various artefacts. The Olympic Brainz Monitor automatically disables RecogniZe during periods of high impedance.
- Impedance values below 5000 Ω are recommended for superior signal quality.

RecogniZe SEIZURE DETECTION ALGORITHM

This detects events that may correspond with seizure activity in a patient.

The algorithm is based on wave-sequence analysis and operates in near real time, **marking sections** of the recording containing events that may correspond with seizure activity.

This software has been designed to **alert bedside clinicians** to areas of EEG which require review and should only be used to help obtain the attention of clinical staff.

A trained clinician can then **review marked sections** of the EEG trace and quickly **confirm activity** that may be interpreted as a seizure.

The RecogniZe product **does not provide any diagnostic indication** of the patient's condition

During recording, a RecogniZe alarm/alert (*Clinical LED at the top of the screen*) appears in the status bar indicating events that may correspond with seizure activity in the patient.

Flashing amber

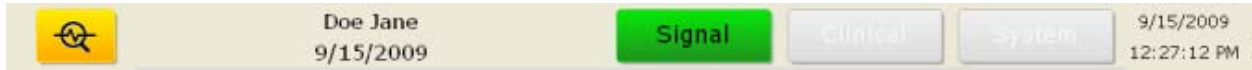
- Indicates RecogniZe is in the process of detecting an event.
- The **CLINICAL LED** flashes amber until the event ends

Solid amber

- Indicates that the RecogniZe module has detected an event that may be related to seizure activity

Once the event has ended, the clinical LED will remain amber until it is touched to reset it to its normal **green colour**.

TOUCH THE CLINICAL LED



- A dialogue box will appear asking the user to either snooze or dismiss the event
- If LED is still flashing when touched:
- Snoozing or dismissing an active event changes the clinical LED to a **solid amber colour** and silences the auditory tone (*if one is selected*)
- **SNOOZE**- A snoozed event will return to the flashing alert state after several minutes
- If, during the snoozed period, the event ends, the alert will clear from the systems, returning the LED to its **Green colour**.
- **DISMISS**- A dismissed event will change to solid amber.
- Once the event ends, the alert will clear from the system returning the LED to its **Green colour**

See appendix (12) for hiding the RecogniZe technology for NEST trial

EEG IN PRETERM INFANTS

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Advances have been made in the practice of EEG monitoring in preterm infants and in the future this monitoring may be used commonly to determine prognosis and outcome. It has been observed that background activity in the first 2 weeks of life has been found to correlate with neurological outcome (Schettler,2012).

Pattern	24-25wks	26-27wks	28-29wks
Burst suppression (discontinuous low voltage)	55.6%	34%	7.1%
Discontinuous (discontinuous high voltage)	33.3%	56.4%	51.8%
Continuous	0%	5.9%	16.9%

Median percentiles of normal EEG values in preterm infants 24-29 weeks indicated as % of time in the background pattern.(Adapted from Schettler,2012)

Brain activity matures more quickly extrauterinely after the infant is born, (Klebermass K et al 2006, Sisman J et al 2005). Drugs like caffeine accelerate maturation further by increasing the cortical activity (Supcun S,2010). It is unknown whether this accelerated maturation is an advantage or not to the infant (Schettler,2012).

Seizures can be recognized in EEG comparably to term infants as an increase in the lower amplitude margins and sometimes the upper margins. However this may be more difficult to recognize due to the discontinuous activity with periods of burst suppression (Schettler,2012).

In very preterm infants there are many periods 'high voltage activity' which includes bursts with periods of low amplitude height.

Sleep wake cycles are observed in infants from 24 weeks and although initially immature they are fully formed in the 29-30th week, (Kuhle S 2001).

Pathological changes in a preterm infant EEG

- Flattening of the amplitude height
- ↑discontinuity or burst suppression pattern
- Loss of sleep wake cycles
- Seizure activity
- Difference in background activity

REMOVING THE ELECTRODES

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1. The recommended maximum usage period for the needle electrodes depends on the manufacturer's recommendation and the infection control policy.
2. Dispose of the used Sensor Adaptor set in accordance with Infection Control Policy – place sub-dermal needles in sharps container.
3. To remove the hydrogel sensor, carefully lift one edge of the sensor and wipe underneath it with a damp gauze pad to wet gel. Remove the sensor as the gel releases. Never try to pull the sensor free quickly or without water.
- 4.

TROUBLESHOOTING TIPS

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If any sensor is indicated as yellow or red on the *Signal Status* screen:

- Check that the corresponding needle electrode has not been partly or totally pulled out.
- If necessary, re-stabilize the existing needle electrode or reinsert a new needle electrode, following the manufacturer's instructions.

Troubleshooting Interference

- Increase the separation between the OBM or the BRM3 and other devices
- Re-route the device cabling
- Plug the devices into AC supply outlets on a separate circuit

Troubleshooting Impedance

- Check the electrode that shows a red or yellow dot (on the "check signal" screen) and re-prepare the site (Hydrogel electrodes or reference sensor)
- A small drop of water on the electrode gel may improve contact

DOCUMENTATION

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- The interpretation of Brainz aEEG activity should be documented in the notes by medical staff / nurse practitioner each shift. Documentation should include description of the background pattern and the presence of sleep wake cycle or seizures according to the classification provided in Appendix 1.
- The bedside nurse should note the infant's activity in relation to 'RecogniZe' identified events.
- Alert medical officer/ NP if 'RecogniZe' detects a seizure.

PARENTS

- Provide explanation and support to parents.

APPENDIX 1: Applying a sensor adaptor set-needles

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Applying a Sensor Adaptor Set



Warning: Do not apply the Sensor Adaptor Set to a patient until you have read the instruction sheet supplied with the Sensor Adaptor Set, or received specific training in this procedure.

1



Lay out all the materials, including the Sensor Adaptor Set and Positioning Aid (in the Sensor Pouch). Place the wrap hat under the head, aligning the head with the body.

2



Keep the Positioning Aid **vertical and parallel to the face**. Align it so that the letter at the ear tragus is the same as the letter at the sagittal suture. The forward edge of the Positioning Aid should touch the tragus.

3



Mark the two sensor sites, one on each side of the Positioning Aid, at the ends of the arrow.

4



Use a cleansing solution to clean the site where the first sub-dermal needle electrode will be inserted.

5



Insert the first sub-dermal needle electrode with the sensor wire upwards. Ensure that all of the metal is under the dermal layer. Check the Left or Right label on the cable.

6



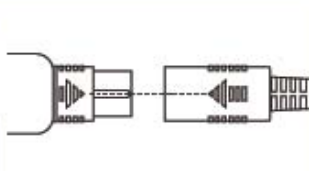
Secure the sub-dermal needle electrode in place. Repeat the previous steps for the second sub-dermal needle electrode.

7



Prepare a site for the Reference sensor on the shoulder, neck or behind the ear (choose a site with no hair). Refer to page 3 for site preparation instructions.

8



Connect the Sensor Adaptor Set to the DAU (Data Acquisition Unit) and check the contact quality of the sub-dermal needle electrodes. When OK, turn the head.

9





Prepare the sites and insert the sub-dermal needle electrodes to the second side, as before. When the contact quality is OK for all the sub-dermal needle electrodes, fold the wrap hat around the head and secure it with tape.


APPENDIX 2: Applying a sensor adapter set-gel sensors


[Top](#)

Applying a Neonatal Sensor Set

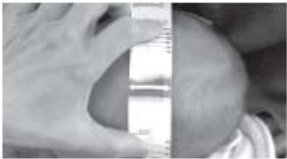





 **Warning:** Do not apply the Neonatal Sensor Set to a patient until you have read the instruction sheet supplied with the Neonatal Sensor Set, or received specific training in this procedure.

1 


Lay out all the materials, including the Sensor Set and Positioning Aid (in the Sensor Pouch). Place the wrap hat under the head, aligning the head with the body.

2 


Keep the Positioning Aid **vertical and parallel to the face**. Align it so that the letter at the ear tragus is the same as the letter at the sagittal suture. The forward edge of the Positioning Aid should touch the tragus.

3 


Mark the two sensor sites, one on each side of the Positioning Aid, at the ends of the arrow.

4 


Part the hair vertically at the first mark with a damp gauze pad, so that a small 'bald' spot is created at the site.

5 


Pat the site and the surrounding hair dry, keeping the hair parted. **DO NOT RUB**. Note: Keeping a finger next to the bald spot will help as the pen mark washes off.

6 


With a little NuPrep™, clean the exposed scalp, working up and down the length of the parting. Hold the skin taut as you clean.

7 


Remove the NuPrep™ with a damp gauze pad, working outwards from the center to keep the hair parted.

8 


Pat the site and the surrounding hair dry, as before, maintaining the bald spot.

9 


Apply the first sensor directly over the clean bald spot with the sensor wire upwards. Check the Left or Right label on the cable and remember: "Black is Back".

10 

Repeat the previous steps for the second sensor site. In a similar way, prepare a site for the Reference sensor on the shoulder, neck or behind the ear (choose a site with no hair).

11 

Connect the Neonatal Sensor Set to the DAU (Data Acquisition Unit) and check the contact quality of the sensors. When OK, use the wrap hat to secure the sensors then turn the head.

12 

Prepare the sites and apply the sensors to the second side, as before. When the contact quality is OK for all the sensors, fold the wrap hat around the head and secure it with tape.

APPENDIX 3: Checklist for using BRM3[Top](#)*Start the BRM 3 Monitor*

Step	Action
1	Plug monitor into wall power supply.
2	Ensure power cable and serial cable is connected from monitor to the isolation unit.
3	Connect the data cable from the isolation unit to the DAU.
4	Turn on the AC power switch (at back of monitor).
5	Check that the green light on the DAU comes on.

Log on

Step	Action
1	Touch the white field next to 'user name' to display the onscreen keypad.
2	Type in the word NICU, press enter.
3	Touch the white field next to 'password' to display the on- screen keypad.
4	Type in the word NICU, press enter.
5	Once both user and password are entered touch the 'login button' to display the main menu screen.

Enter Patient Details

Data must be entered before monitoring commences. Once monitoring, patient data can not be altered.

Step	Action
1	On main menu screen touch the 'assess patient' button to display the new patient screen.
2	Touch the first white field to display the on-screen keypad.
3	Typing the appropriate data, touch enter at the end of each entry.
4	Touch the appropriate check box to select the gender.
5	Use arrows to adjust birth weight / current weight.
6	Touch appropriate date on calendar to enter birth date.

Check Contact Quality

Contact impedance is displayed on the 'signal status screen'.

Step	Action
1	On main menu screen touch the 'check signal' button.
2	All 4 dots displayed on the graphics should be green.
3	If dots are yellow or red check the corresponding electrode. Reapply if necessary
4	Once all dots are green press the 'OK' button.

Mark Events

During monitoring Mark events i.e. suctioning, cares, observation of seizure-like movements, administration of anticonvulsants, reapplication of sensors

Step	Action
1	Touch 'mark events' button.
2	Touch white description area to display the onscreen keypad.
3	Enter a brief note
4	Touch enter, then OK
5	A green line and number will appear on the aEEG graphics. To recall the event data touch the green line on the screen.

Turn Monitor Off

Step	Action
1	On main menu screen touch 'shutdown' button.
2	On confirmation screen touch yes.
3	Once screen says shutdown complete, turn AC power off.
4	Remove sensors by dampening the gel with water.

APPENDIX 4: Suggested classification of aEEG patterns in preterm and term infants.

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Table 3. Suggested Classification of aEEG Patterns in Preterm and Term Infants

Background Pattern

Describes the dominating type of electrocortical activity in the aEEG trace.

- Continuous (C): Continuous activity with lower (minimum) amplitude around (5 to) 7 to 10 mcV and maximum amplitude of 10 to 25 (to 50) mcV.
- Discontinuous (DC): Discontinuous background with minimum amplitude variable, but below 5 mcV, and maximum amplitude above 10 mcV.
- Burst-suppression (BSA): Discontinuous background with minimum amplitude without variability at 0 to 1 (2) mcV and bursts with amplitude >25 mcV. BS+ denotes burst density ≥ 100 bursts/h, and BS- means burst density <100 bursts/h.
- Low voltage (LV): Continuous background pattern of very low voltage (around or below 5 mcV).
- Inactive, flat (FT): Primarily inactive (isoelectric tracing) background below 5 mcV.

Sleep-wake Cycling

Sleep-wake cycling (SWC) in the aEEG is characterized by smooth sinusoidal variations, mostly in the minimum amplitude. The broader bandwidth represents discontinuous background activity during quiet sleep (tracé alternant EEG in term infants), and the more narrow bandwidth corresponds to the more continuous activity during wakefulness and active sleep.

- No SWC: No cyclic variation of the aEEG background.
- Imminent/immature SWC: Some, but not fully developed, cyclic variation of the lower amplitude, but not developed as compared with normative gestational age representative data.
- Developed SWC: Clearly identifiable sinusoidal variations between discontinuous and more continuous background activity, with cycle duration ≥ 20 min.

Seizures

Epileptic seizure activity in the aEEG usually is seen as an abrupt rise in the minimum amplitude and a simultaneous rise in the maximum amplitude, often followed by a short period of decreased amplitude. The raw EEG should show simultaneous seizure activity, with a gradual build-up and then decline in frequency and amplitude of repetitive spikes or sharp-wave or activity with duration of at least 5 to 10 sec.

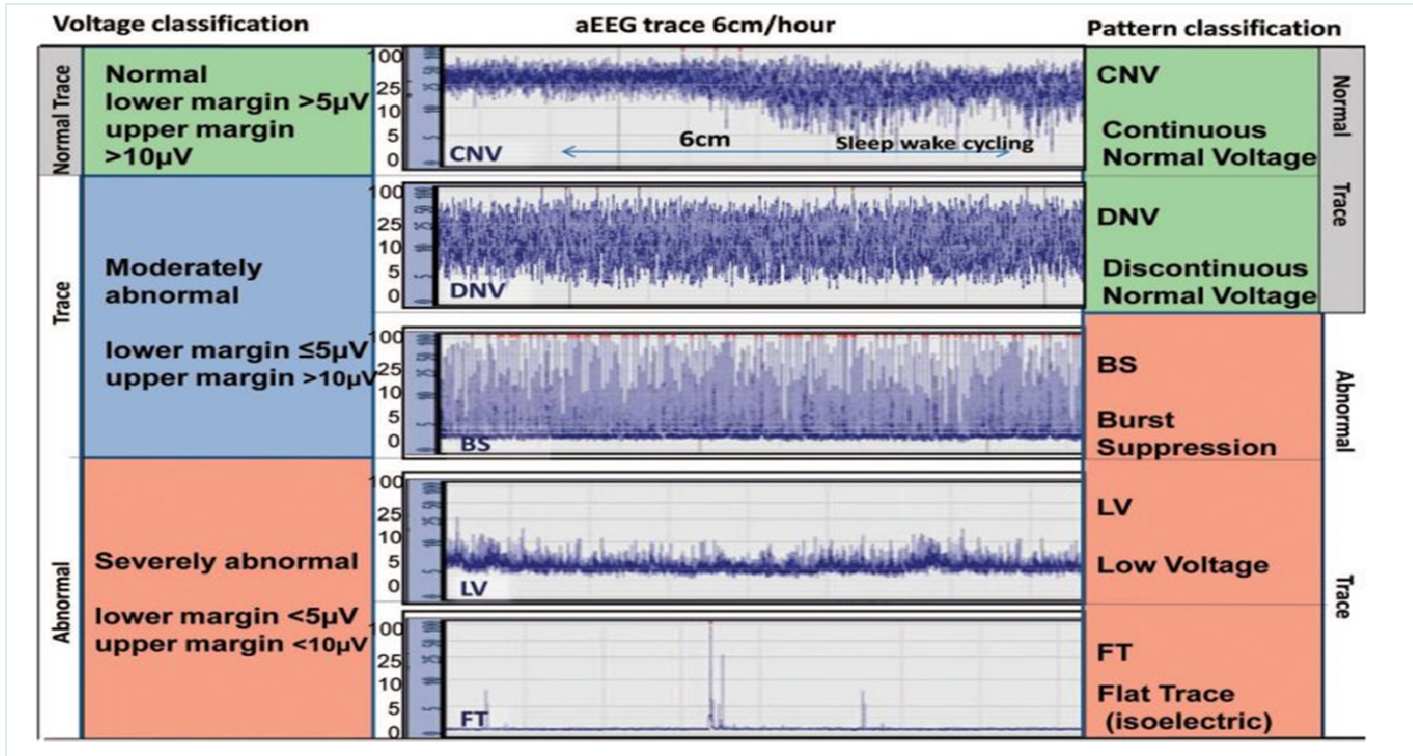
- Single seizure: A solitary seizure.
- Repetitive seizures: Single seizures appearing more frequently than at 30-minute intervals.
- Status epilepticus: Continuously ongoing seizure activity for >30 minutes.

Hellstrom-Westas, L., Rosen, I., de Vries, L S., & Greison, G. 2006. Amplitude-integrated EEG classification and interpretation in preterm and term infants. *NeoReviews*, 7; e76-e87.

APPENDIX 5: Recognition of traces

[Top](#)

Classifications of 5 example traces by using the pattern recognition method (right) & voltage method (left) to assess the aEEG background at 3 to 6 hours of age

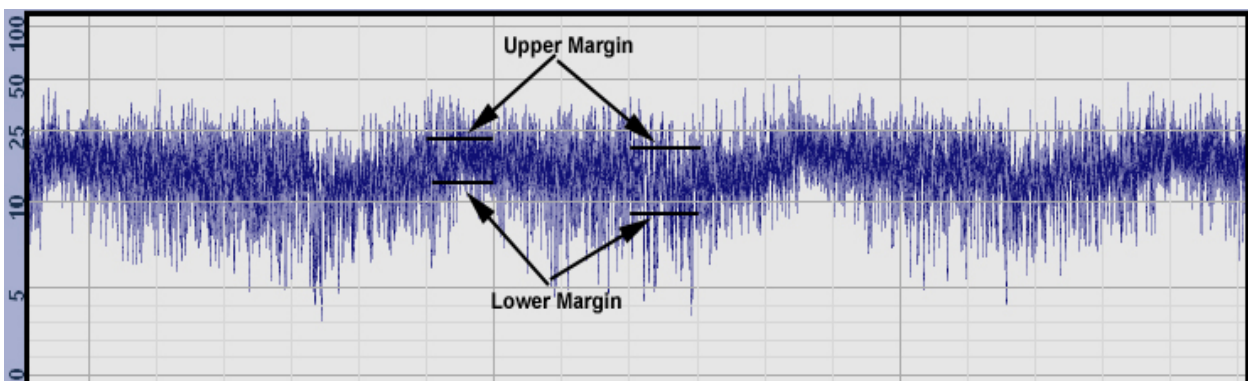


Effect of Hypothermia on Amplitude-Integrated Electroencephalogram in Infants With Asphyxia Marianne Thoresen, Lena Hellström-Westas, Xun Liu and Linda S. de Vries Pediatrics 2010;126:e131; originally published online June 21, 2010;

Background pattern classification can be found in the Help menu of the OBM

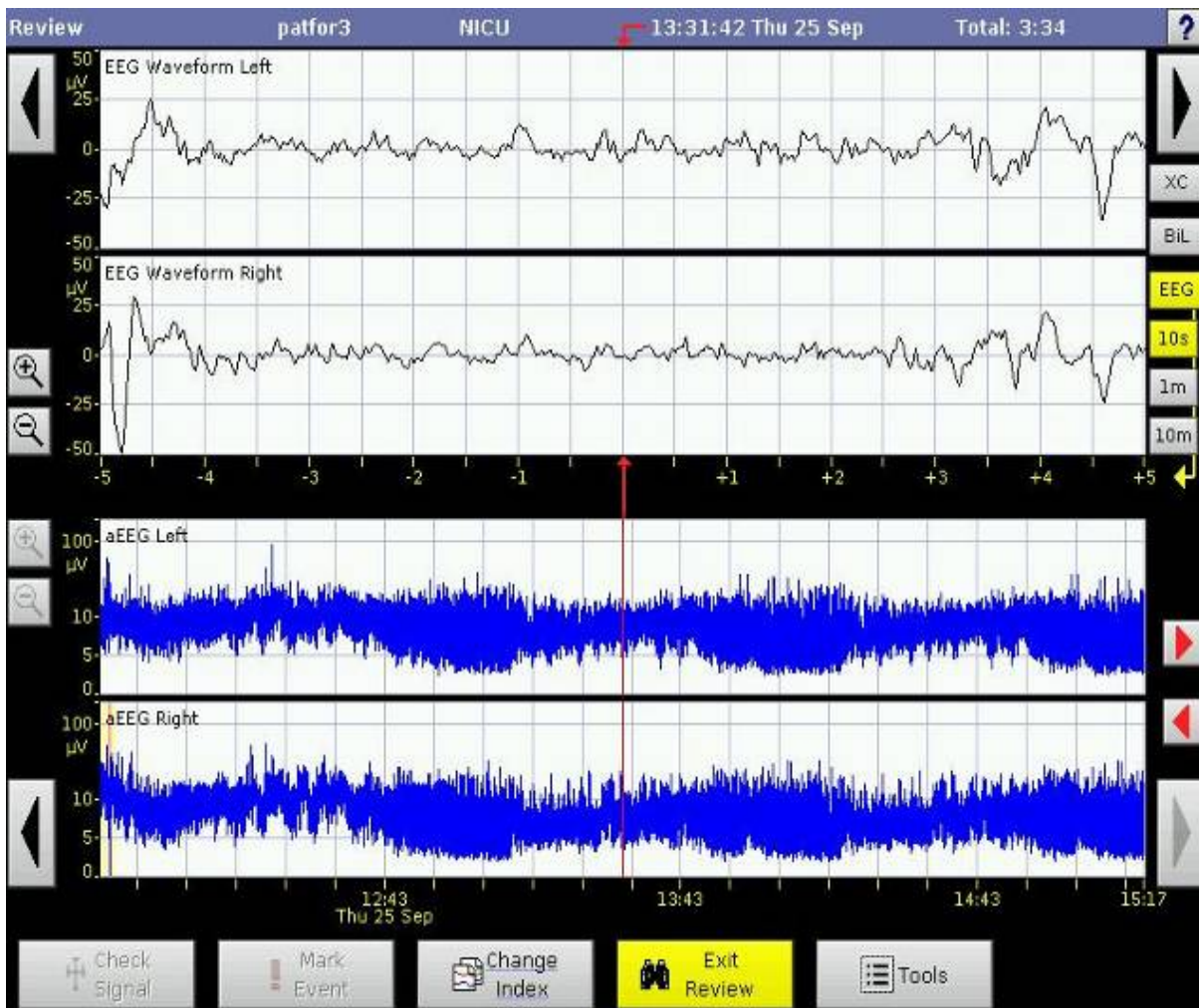
- Search “continuous” for a list of options-able to navigate between patterns whilst tracing continues

Trace interpretation-upper and lower margins



APPENDIX 6: Continuous Normal Voltage CNV

[Top](#)



Raw EEG

$\pm 50 \mu V$

10 seconds

Continuously variable

No repetitive waveforms

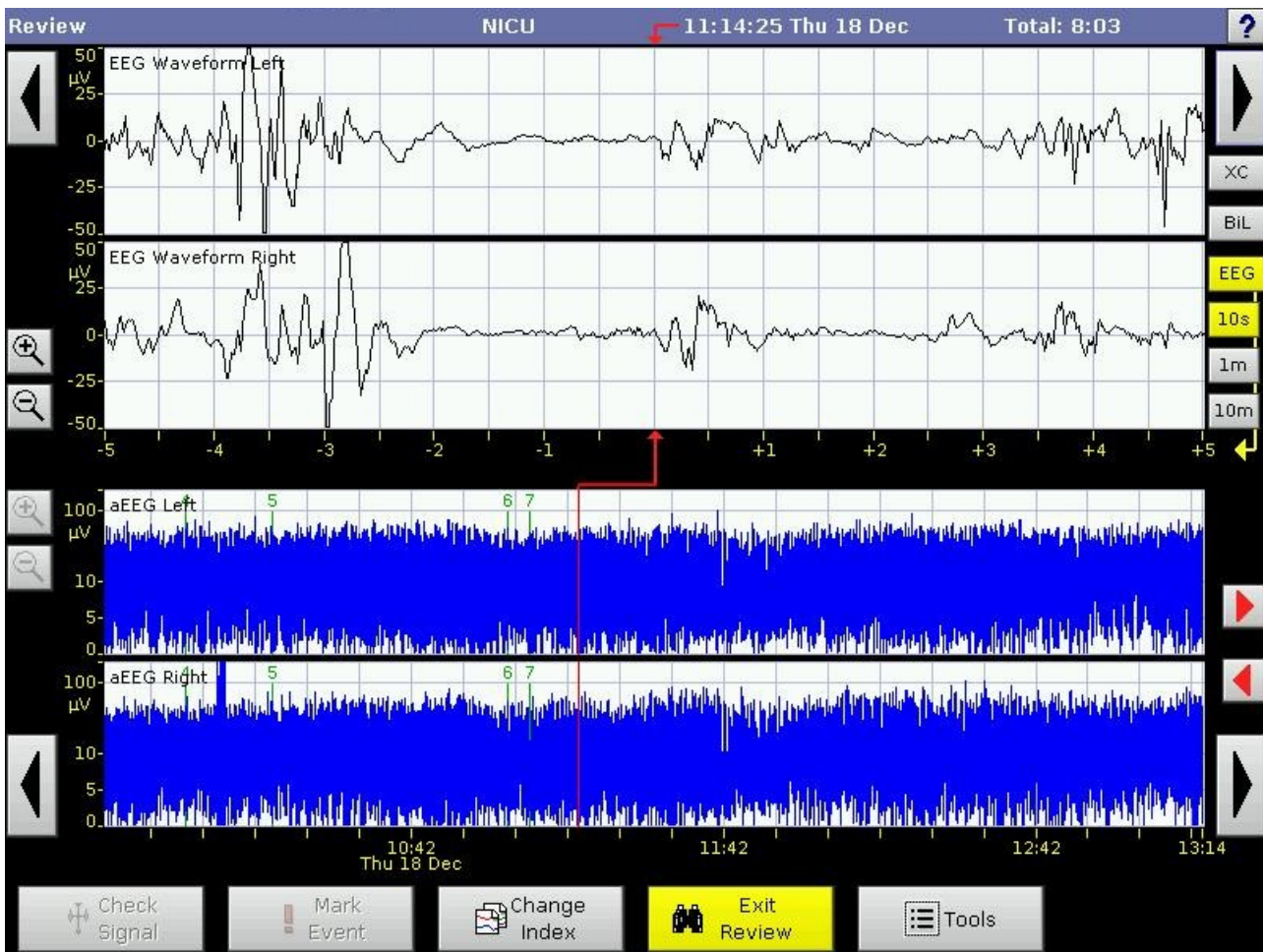
aEEG

Sleep Wake Cycling

- Alternating wide & narrow (wavy)
- Limited variability
- Upper margin $>10 \mu V$
- **Lower margin $> 5 \mu V$**

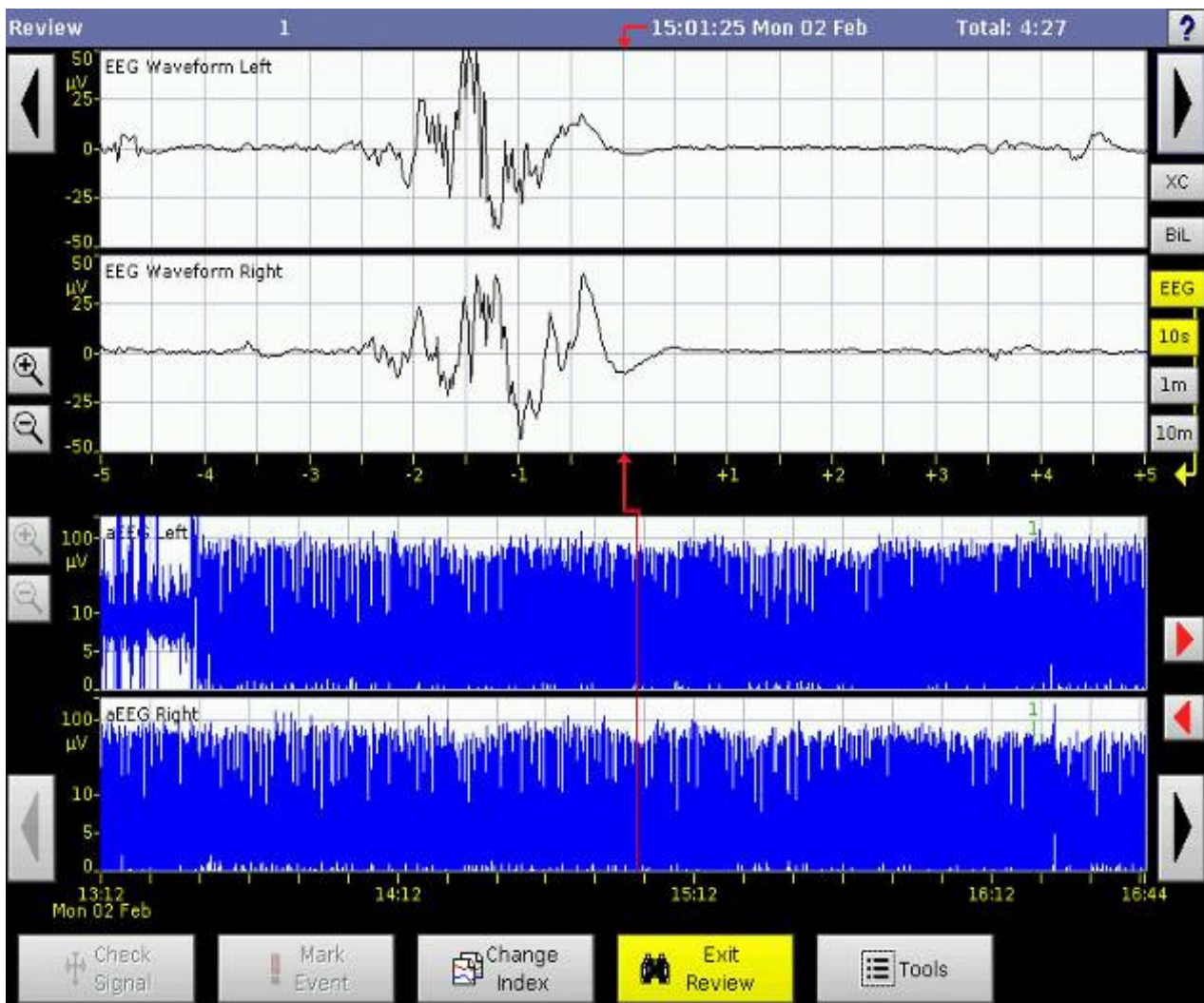
APPENDIX 7: Discontinuous Normal Voltage

[Top](#)



- aEEG**
- No Sleep Wake Cycling
 - Upper margin >10 µV
 - **Lower margin < 5 µV**
 - Increased bandwidth variability
(visually moderately wide trace)
 - **Variability** of lower margin
 - Not a straight line
(important to distinguish from BS)

APPENDIX 8: Burst Suppression (+) high burst density (>_ 100bursts/h) [Top](#)



Raw EEG

Burst activity lasting 1-3 seconds separated by prolonged periods of very low voltage background (<5µV)

aEEG

- No SWC
- Extremely wide band
- Upper margin >10µV

(due to high voltage bursts)

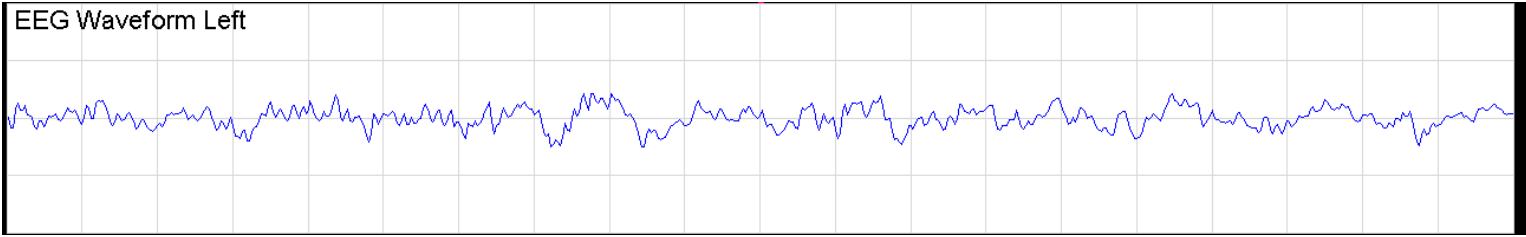
- **Lower margin <5µV (0-2 µV)**
- **Limited to no variability** of lower margin (*almost flat*)
- *Spikes in upper aEEG represent bursts*

Space between spikes = length of suppression

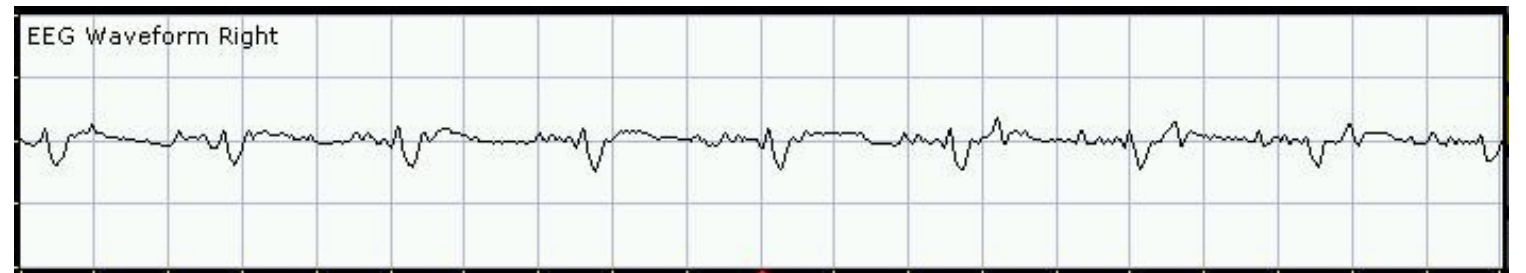
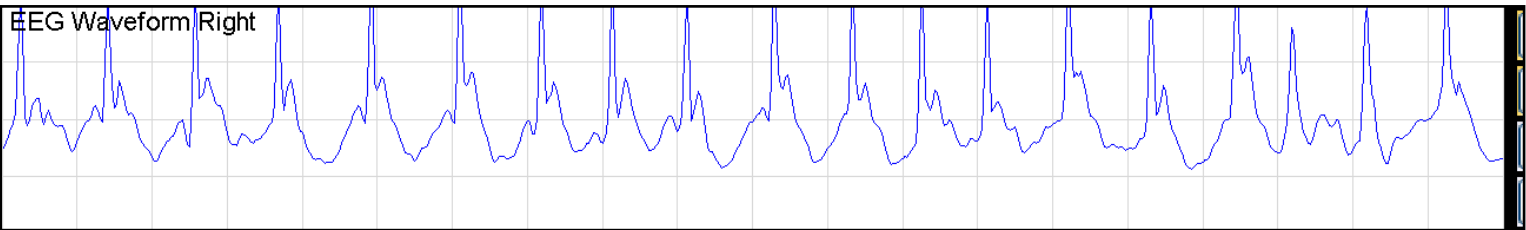
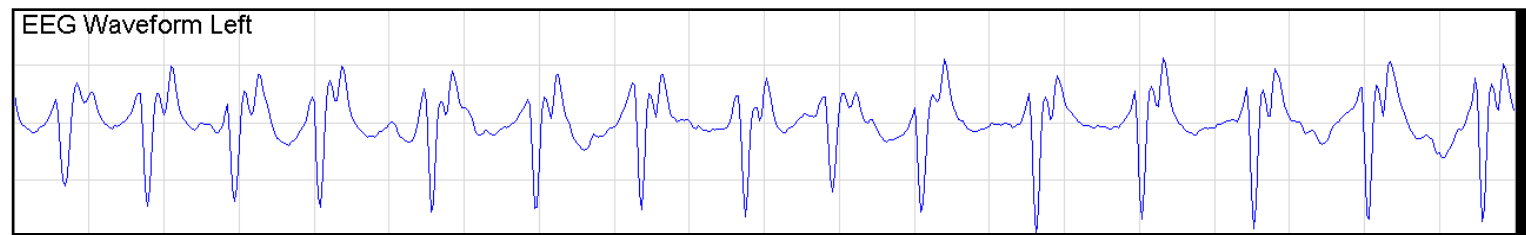
APPENDIX 9: Seizures – raw EEG 10 seconds

[Top](#)

Normal



Regular, rhythmic, spiky waves = seizures



- Always look at similar patterns on EEG if baby has had a seizure before
- Always check for electrical artifact

APPENDIX 10: Single (solitary) & Repeated Seizures

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aEEG:

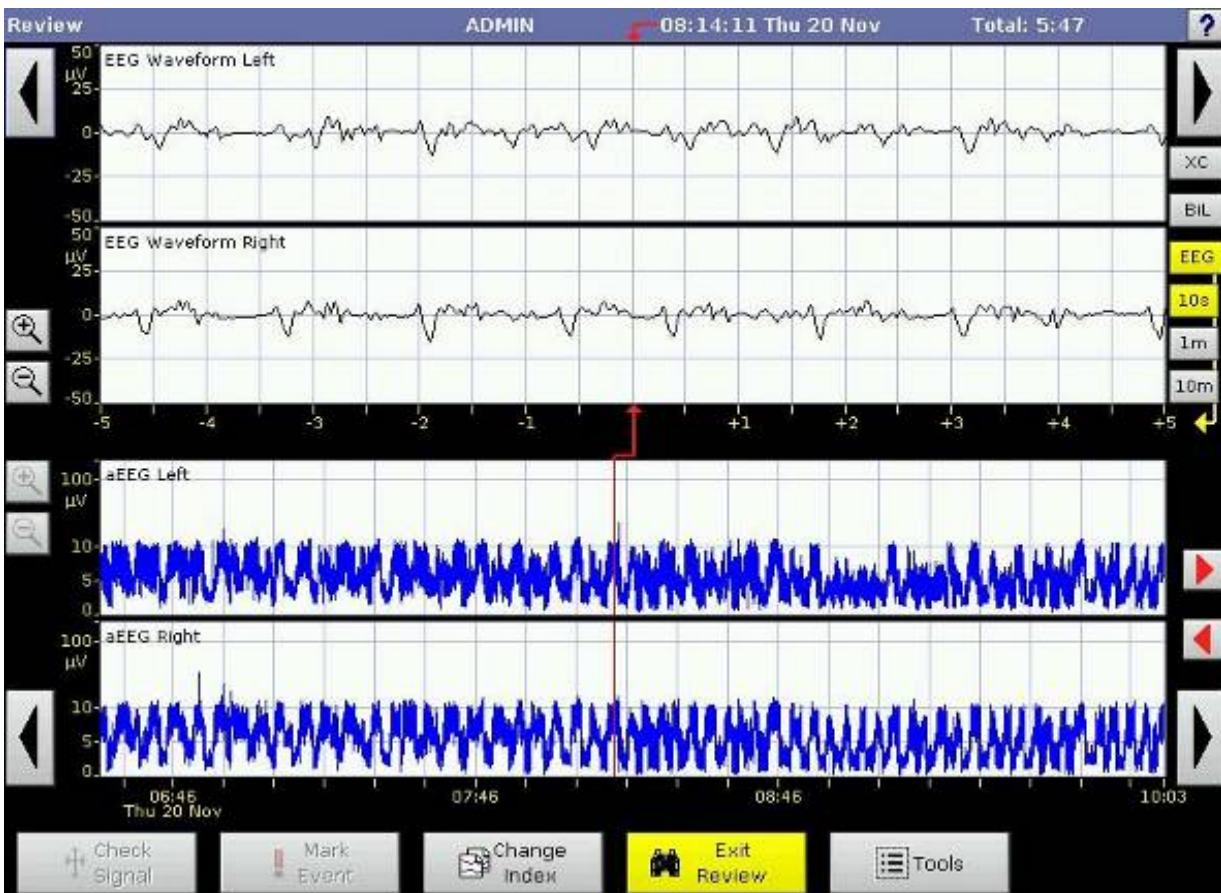
- Have hand print tell tale sign
- Rise in the lower aEEG margin
- Often accompanied by a rise in the upper margin
- Repeating high voltage = margin rises
- Check raw EEG data to help determine artifact & seizure activity

Raw EEG:

- Rhythmic, spike wave pattern lasting > than 10 seconds

APPENDIX 11: Status Epilepticus Continuously ongoing seizure activity for >30minutes

[Top](#)



Raw EEG:

Repeated spike wave forms

aEEG:

Characteristic “Saw-tooth pattern”

Continuous seizures may make it difficult to accurately categorise background activity

APPENDIX 12: Hiding The RecogniZe Marking

[Top](#)

With the new software upgrade for the Olympic Brainz Monitor (OBM), you are now able to effectively 'blind' the traces of those newborns enrolled into the NEST trial.

This is achieved in a few stages:

- Exit to Maintenance, where you can:
 - Blind the aEEG Display
 - Disable the RecogniZe Detectors
- Return to main / home screen, where you can:
 - Verify blinding of aEEG
 - Blind raw EEG by ensuring impedance screen only is displayed

'Exit to maintenance':

*Go to **'Tools'**

*Then **'System'**

*Press **'Exit to Maintenance'**

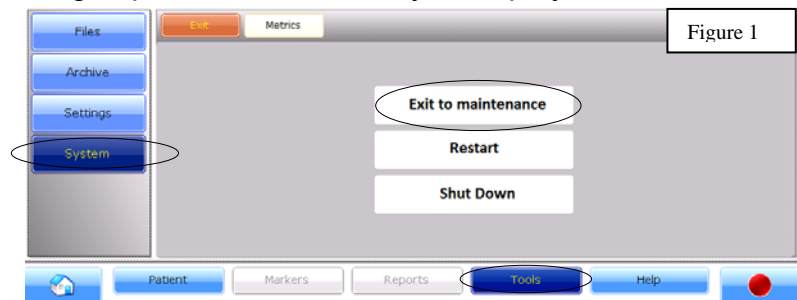


Figure 1



BLINDING THE aEEG DISPLAY:
Blinds the aEEG from view

In maintenance:

*Access **'Login'**

*Then **'Administration'**

*Select **'Blind aEEG display'**

*Press **'Accept'**

Figure 2

Disabling RecogniZe Detectors:

*Exit to **maintenance**

*Under **'Detectors'**

*Click **'RecogniZe'**

*deselect **all** items, from the bottom of the list to the top (in order).

- **Reselect 'Enable Detector'**
- **Reselect 'Detect Poor Impedence'**




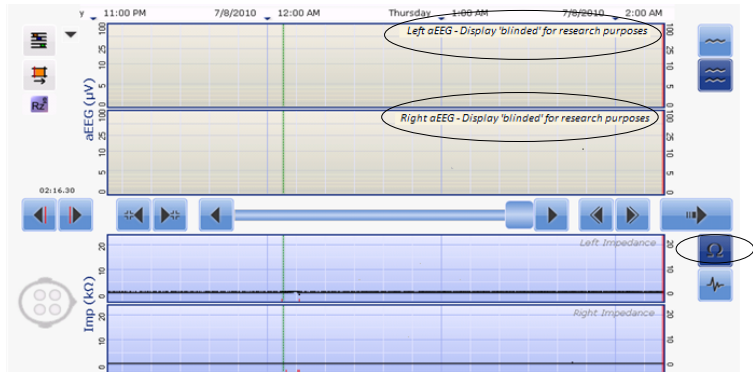
*Press **'Accept'** for the changes to be implemented.

NB: if not deselected in order you will note some will be greyed-out, but a tick will still be present → not truly deselected.

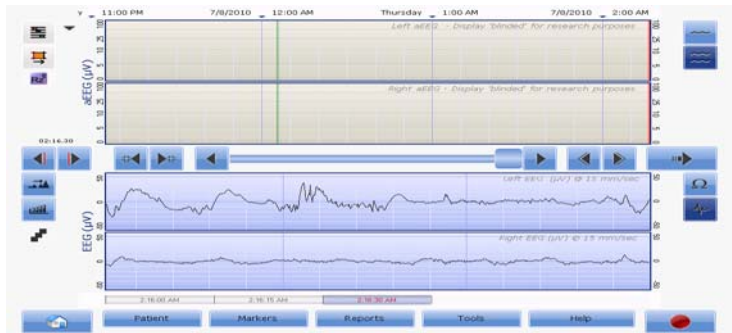
VERIFYING SUCCESSFUL BLINDING:

When returning to the main screen, you will see 'Left/Right aEEG – Display 'blinded' for research purposes' displayed on the top right of both aEEG traces (as shown).

Blind the raw EEG by selecting the Impedance  toggle to the right of the raw EEG traces. This will also blind the raw EEG & provide continual display of impedance levels.



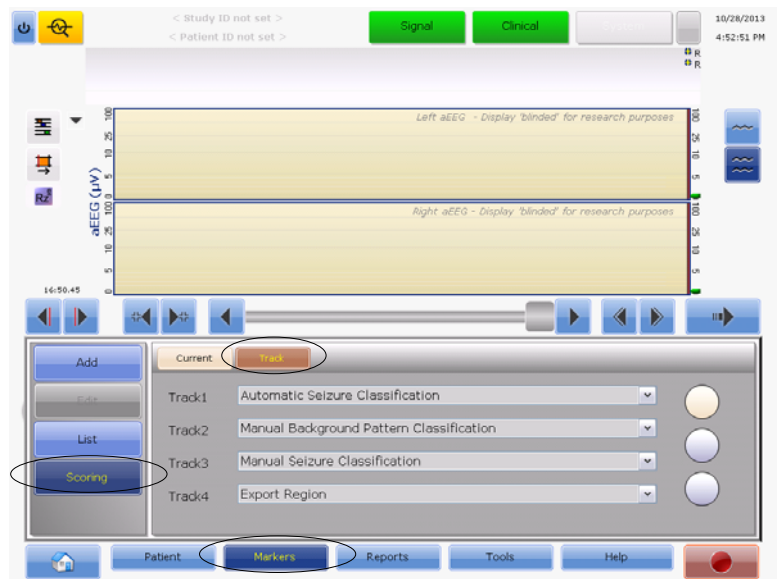
If Impedance button not selected, the raw EEG will be visible to those at the bedside.



As soon as tracing is commenced, access track marking, by selecting:

- 'Markers'
- 'Scoring'
- 'Track'

Ensure all tracks are set to 'None', using the drop-down arrows:



Note that whilst all audible alarms have been disabled, if the Recognize seizure detection software is triggered, the **clinical** button (below) will become a solid amber colour, indicating the possible presence of seizure activity.



Once the event has ended, the clinical button will revert to green.

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Any feedback on this document should be sent to the Contact Officer listed on the front page