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Routine EEG Recording Guidelines

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1. PURPOSE

   These guidelines have been prepared to offer guidance towards best practice for recording an EEG in the routine clinical setting within Australia.

2. INTRODUCTION

   ANTA recognises that there are numerous methods to record EEG in the routine setting. The following guidelines should be considered as minimum standards to record a routine EEG in clinical practice. They have been prepared by a sub committee governed by ANTA and have been presented to many individual bodies within the industry of Clinical Neurophysiology of Australia (see Appendix 1) Consultation to other international guidelines was made to ensure these guidelines are consistent with world wide standards.(see Appendix 2).

3. LIMITS OF THESE GUIDELINES

   These guidelines are prepared with respect to the routine EEG in clinical practice for children and adults only. They do not relate to the very young babies and neonates. These guideline do not relate to the EEG of suspected isoelectric recordings, nor to recording in the operating theatre.

4. ELECTRODES

   (i) Electrode Placement

   Electrodes should be placed in accordance to the International 10/20 System of Electrode Placement System (Appendix3). A minimum of 21 electrodes should be used as well as ground and reference electrodes where applicable.

   (ii) Electrode Choice

   Electrodes used to record a routine EEG should allow undistorted recordings of no less than a frequency range of 0.5 – 70Hz.

   (iii) Electrode Impedance

   Electrode impedance should be measured prior to each recording and at any time during the EEG where an electrode has be altered or adjusted. Impedances of all electrodes should measure below 5kohms and of a similar value no more than 3kohm range of each other.

5. PRE TEST CHECKS

   (i) Calibration

   A square wave calibration signal of known input should be recorded for a minimum of 10 seconds prior to the EEG recording and should be stored with the EEG. The square wave calibration should represent machine parameters (filters and sensitivity settings) used during the EEG recording.

   (ii) Biological Calibration

   Where possible a biological calibration of no less than 10 seconds should be recorded and stored with the EEG. Note: Biological Calibration is not always relevant in the digital EEG recording systems. (see Appendix 4)

   (iii) All electrode Check

No less than 10s of recording with the primary reference montage (digital EEG recording systems) displaying all recording electrodes should be stored with the EEG. (Appendix 3 Digital Calibration references – Ebersole & Pedley; Gorney)

6. RECORDING

(i) Patient Information

Each EEG recording should have minimum patient information stored with it. Minimum patient information would include and be no less than Patient's name, DOB, recording date, referring Dr and technologists initial.

Additional information may also be included such as recording time, clinical details (last seizure, handedness, last meal, behavioural state), medications and factual report.

(ii) Montages

A selection of recording montages should be used during the baseline EEG. A minimum of anterior-posterior bipolar and transverse bipolar montages should be used. Additional reference montages (common, average and source) can also be incorporated in the routine EEG. The montages used should represent all recording electrodes at some time during the recording.

Even with the option of re-montaging with digital EEG recording systems, recording on one single montage throughout the whole recording should be discouraged to avoid m recognition of poor connections.

(iii) Length of Recording

The routine EEG should be no less than 20 minutes of technically satisfactory baseline recording with activation procedures in addition to this. Eye opening and closure can be included in the 20 minute baseline recording.

(iv) Machine Settings - Display

The routine EEG in clinical practice should be displayed for the most part within the range of the following parameters

Sensitivity – 5-10uV/mm of trace deflection

LFF – no higher than 1Hz (TC 0.16s)

HFF no lower than 70Hz

Careful use of high and low frequency filters with appropriate annotation can clarify certain patterns but must be used with care.

Notch filter – should be avoided where at all possible

Paper speed of 30mm/sec or 10 seconds per page/screen

Machine Settings – Recorded

Digital EEG recording apparatus may record on a different setting to those on display. The digital EEG recording settings should be such that all required display settings are feasible. Recommendations for digital EEG recording settings can be obtained from the International Organisation of Societies for Electrophysiological Technology (OSET) – Guidelines for Digital EEG, Gregory and Cross 1999. These recommendations include a wide bandwidth of 0.1 -100Hz and a recording dynamic range of + and – 2 mV.

(v) Additional physiological recording measurements

ECG – Electrocardiogram should be recorded in conjunction with the EEG and displayed on all recording pages. The purpose of this recording is to assist with recognition of cardiac related artefacts (ECG and pulse artefact) as well as assist in diagnostic classification of changes to the EEG. This ECG recording alone is not recommended to diagnose cardiac anomalies.

EOG – Electro-oculogram (eye movement) recordings can included in the routine EEG recording although not essential. Eye movement monitoring can assist with sleep stage recognition as well as differentiation between cerebral frontal slow wave activity and corneal/retinal potentials.

7. ACTIVATIONS

(i) Eyes opening and closure

At some time during the recording their should be a period of no less than 10 seconds with eyes open and a period no less than 10 seconds with eyes closed. The usual procedure for a compliant patient would be to record most of the baseline EEG with eyes closed with two or three 10 second periods of eye opening. For a less compliant patient such as a small child the baseline EEG may be performed with most of the recording with eyes open and two or three 5-10 second periods of eye closure, passive or with assistance.

(ii) Hyperventilation is performed to restrict oxygenated blood to the brain for a short period in order to place the brain under stress in hope to enhance or evoke any abnormality. Hyperventilation is obtained by asking the patient to breath deeply in and out through their mouth ensuring as much air is expelled on each expiration as possible. The usual rate would be about 1-2 breaths per second.

Hyperventilation should be performed for 3 minutes. The procedure should be extended to 5 mins if the patient has been referred to identify an absence seizure disorder and no correlative EEG changes have been noted up to this point.. The post EEG recording should extend for at least 90seconds after exercise. Contraindications for hyperventilation include recent cerebral vascular accidents (CVA), transient ischaemic attacks (TIA), myocardial infarction (MI), respiratory distress or Moya Moya disease. Age alone should not be considered a contraindication. Hyperventilation should not be the last procedure performed during the EEG recording in the event of delayed EEG changes from this procedure. (Changes as a result of Moya Moya disease can occur up to 2-3minutes post exercise)

(Appendix 3 – HV procedure references- Zweiner, Lobel, & Rother et al; Binnie; Ebersole & Pedley)

(iii) Photic Stimulation

Photic stimulation is the technique of presenting to the patient a series of flashing lights at varying frequencies from a strobe light. The strobe light should be place 30cm from the patient's face. Varying flash frequencies from 1-30Hz should be presented with periods of eyes open and closed for each frequency presented.

(Appendix 3 - PS procedure references Binnie and Panayiotopolous)

Contraindications to photic stimulation include medically induced photosensitivity such as migraine, meningitis or encephalitis. Epilepsy and in particular a

photosensitive induces seizure disorder should not be considered a contraindication for photic stimulation. It is recommended that the strobe light be immediately stopped if generalised photo paroxysmal activity is seen during a particular train of flash presentation. Caution should then be made to proceed to other flash frequencies.

(iv) Drowsiness/sleep

Drowsiness and light sleep (stage I and II sleep) is well known to enhance focal abnormalities particularly those related to focal epilepsy disorders. It is recommended that sleep be encouraged in all routine EEG recordings and can often be attained without sleep deprivation. To encourage sleep it is suggested to record the EEG in a dimly lit, warm room with comfortable seating/bed. Minimal eye opening and interacting with the patient can often result in drowsiness and light sleep within the time restraints of the routine EEG in clinical practice.

(v) Sleep deprivation

Sleep deprivation can enable the recording of sleep during an EEG without the use of sedatives. A sleep deprived EEG is often performed as a 'non-routine' EEG but can be performed in similar clinical practice as the 'routine' EEG provided sleep deprivation preparation instructions are followed. Sleep deprivation preparations vary for different age groups and clinical practices. Hours of sleep deprivation may range from 1-2 hours less sleep for a small child, no more than 4 hours sleep for the older child to adult or even no sleep at all the night prior to the recording. (Appendix 3 SD procedure reference - Ong , Lim, Low & Low)

8. POST RECORING CHECKS

(i) Biological Calibration

Where possible a biological calibration of no less than 10 seconds should be recorded and stored with the EEG. Note: Biological Calibration is not always relevant in the digital EEG recording systems.

(ii) All electrode Check

No less than 10s of recording with the primary reference montage (digital EEG recording systems) displaying all recording electrodes should be stored with the EEG.

(i) Calibration

A square wave calibration signal of known input should be recorded for a minimum of 10 seconds at the end of the EEG recording and should be stored with the EEG.

Appendix 1 - Contributions

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Justin Stent
Ruth Bundy
Angela Borbelj
ANTA Executive Committee
Circulated to all ANTA Members for feedback
Accepted and endorsed by ANTA Inc members at 31st National AGM 2009 29/8/09

Appendix 2 – Consultation

Guidelines consulted in preparation of these guidelines

- International Organisation of Societies for Electrophysiological Technology (OSET) – Guidelines for Digital EEG (Deuschl and Eisen, 1999)
- American Clinical Neurophysiology Society – Guideline 1: Minimum Technical Requirements for Performing Clinical Electroencephalography.

Appendix 3 – References

Electrode Placements

- **Report of the committee on methods of clinical examination in electroencephalography : 1957**
  Electroencephalography and Clinical Neurophysiology, Volume 10, Issue 2, May 1958, Pages 370-375
- **A Manual of Electro-encephalographic Technology,** *CD Binnie, AJ Rowan, TH Gutter,* Cambridge University Pres 1982 pages 127-131

Hyperventilation

- **Quantitative topographical analysis of EEG during non-standardised and standardised hyperventilation,** *U Zweiner, S Lobel, M Rother et al,* J Clin Neurophysiol 1998; 15:521-528
- **A Manual of Electro-encephalographic Technology**, CD Binnie, AJ Rowan, TH Gutter, Cambridge University Pres 1982 pages 190-192
- **Current Practice of Electroencephalography**, JS Ebersole, TA Pedley, Lippincott Williams & Wilkins 2003 pages 247-253

Photic Stimulation

- **Effectiveness of Photic Stimulation on Various Eye States in Photo-sensitive Epilepsy**, *Panayiotopolous CP.* J.Neurol.Sci 1974 Oct 23(2)"165-73
- **A Manual of Electro-encephalographic Technology**, CD Binnie, AJ Rowan, TH Gutter, Cambridge University Pres 1982 pages 192 - 196
- **Current Practice of Electroencephalography,** *JS Ebersole, TA Pedley,* Lippincott Williams & Wilkins 2003 pages 253-262

Sleep Deprivation

- **Simple instructions for partial sleep deprivation prior to pediatric EEG reduces the need for sedation**
  Clinical Neurophysiology, Volume 115, Issue 4, April 2004, Pages 951-955
  Hian-Tat Ong , Karen J. L. Lim , Poh-Chan Low and Poh-Sim Low

Digital calibration

- **Current Practice of Electroencephalography**, JS Ebersole, TA Pedley, Lippincott Williams & Wilkins 2003 (page 76)
- **Digital EEG in Clinical Practice**, Wong PKH.. Philadelphia: Lippincott-Raven, 1996
- **The Practical Guide to digital EEG,** David S Gorney, R. EEG T. *Am. J. EEG Technol.* Volume 32,Issue 4. 1992 p260-289