

Association of Neurophysiological Technologists of
Australia Inc
(also known as ANTA)
ABN: 80 872 615 302
www.anta.org.au



Routine EEG Recording Guideline

1. Purpose of the Guideline
 2. Introduction to the Guideline
 3. Limits of the Guideline
 4. Electrodes
 - (i) Electrode Placement
 - (ii) Electrode Choice
 - (iii) Electrode Impedance
 5. Pre-test Checks
 - (i) Calibration
 - (ii) Biological Calibration
 - (iii) All Electrode Check
 6. Recording
 - (i) Patient Information
 - (ii) Annotations
 - (iii) Montages
 - (iv) Length of Recording
 - (v) Machine Settings
 - (vi) Additional Physiological Recording Measurements
 - (vii) Video EEG Recording
 7. Activation Procedures
 - (i) Responsiveness (eyes open and closed)
 - (ii) Hyperventilation
 - (iii) Photic Stimulation
 - (iv) Drowsiness/Natural Sleep
 - (v) Sleep Deprivation
 8. Post-recording Checks
 - (i) Calibration
 - (ii) Biological Calibration
 9. Report Writing
 - (i) Patient History
 - (ii) Factual Report
 10. References
- Appendix 1 – Stakeholders
- Disclaimer and Copyright

1. PURPOSE

These guidelines have been prepared to offer guidance towards best practice for recording a routine EEG within Australia.

2. INTRODUCTION

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 Inc. and have been presented to stakeholders within the field of Clinical Neurophysiology in Australia (see Appendix 1). A review of international guidelines was made to ensure that this ANTA guideline is consistent with worldwide standards.

3. LIMITS OF THE GUIDELINE

This guideline relates to the routine EEG in clinical practice for children and adults only. It does not relate to full-term babies and neonates with a conceptional age (CA) of up to 50 weeks ⁽¹⁾. This guideline does not relate to the EEG performed in the clinical setting of electro-cerebral silence or recording in the operating theatre.

4. ELECTRODES

(i) Electrode Placement

Electrodes should be placed in accordance with 'The 10-20 Electrode System of the International Federation' ⁽²⁾. A minimum of 21 electrodes should be used including a ground and reference electrode 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. The electrodes used should also be of the same material preferably silver / silver chloride (Ag/AgCl) or gold / gold plated due to the inherent time constant of each material ^(3, 4).

(iii) Electrode Impedance

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

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⁽⁵⁾.

(ii) Biological Calibration

Where possible a biological calibration of no less than 10 seconds should be recorded and stored with the EEG⁽⁵⁾.

(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⁽⁶⁾.

6. RECORDING

(i) Patient Information

Each EEG recording should have minimum patient information stored with it. Minimum patient information should include but is not limited to:⁽⁷⁾

- Patient name
- Patient identification number
- Date of birth
- Recording date
- Referring doctor
- Identify recording technologist
- Recording time
- Clinical details (last seizure, handedness, last meal, and behavioural state)
- Relevant family history
- Current medications including any sedation given prior to or during the test
- Site of skull defects and or surgical wounds if present
- Details of intracranial pathology and lateralisation, if known
- Description of clinical events including time of last noted clinical event, detailed features of events, circumstances or precipitants
- Metabolic disorders
- Results of relevant investigations (MRI, CT etc).

(ii) Annotations

Throughout the recording regular annotations should be made to mark any changes in the EEG or the patient's state and behaviour. This includes but is not limited to any movement of the patient, any external stimuli, artefacts, instructions given, clinical events and electrographic findings (ictal or interictal)⁽⁸⁾.

- (iii) **Montages**
 Although digital acquisition allows the data to be stored in its referential format and it can be reformatted upon analysis, it is not recommended to use one single montage for the duration of the recording. A selection of montages should be used during the baseline EEG. A minimum of anterior-posterior bipolar, transverse bipolar and a referential montage should be used. Additional reference montages such as average and source should also be incorporated in the routine EEG where appropriate. The montages used should represent all recording electrodes at some time during the recording ⁽⁹⁾.
- (iv) **Length of Recording**
 The routine EEG should be no less than 20 minutes of technically satisfactory recording with the addition of activation procedures where applicable ^(5, 10).
- (v) **Machine Settings - Display**
 The routine EEG in clinical practice should be recorded within the range of the following parameters:
 Sensitivity – 5-10 μ V/mm of trace deflection ⁽⁹⁾
 LFF – No higher than 1Hz (TC 0.16s) ⁽⁹⁾
 HFF – No lower than 70Hz ⁽⁹⁾
 Notch filter – Should not be used in the routine setting and should only be used when all technical means have been employed to reduce 50Hz interference ⁽⁹⁾.
 Paper speed 30mm/sec or a minimum of 10 seconds per page/screen ⁽⁹⁾
Machine Settings – Recorded
 The digital EEG recording settings should be such that all required display settings are feasible. Recommendations for minimum settings requirements of a digital EEG recording system are as follows ^(3, 11):
- | | |
|--|--------------------------------------|
| Number of channels | min 24 EEG plus polygraphic channels |
| Sampling rate | min 512Hz |
| Sampling accuracy | min 16bit |
| Screen resolution | min 1296x1024 |
| Sensitivity range | 100nV – 2mV |
| Frequency band | 0.3 – 128Hz |
| CMRR | min 100dB |
| Synchronised video capture and storage | |
- (vi) **Additional Physiological Recording Measurements**
 During the routine EEG it may be necessary to record from additional polygraphic channels generally with the purpose of distinguishing artefact from cerebral potentials.
 ECG – Electrocardiogram (heart beat) shall always be recorded in conjunction with the EEG and displayed on all recording pages.

In certain cases the following additional electrodes are required as minimum standards to the Routine EEG:

EOG – Electro-oculogram (eye movement) ⁽⁴⁾.

EMG – Surface Electromyogram (muscle activity) ⁽⁹⁾

Refer ANTA Inc. Additional Physiological Measurement Guidelines.

(vii) Video Recording

Concurrent real time video recording is recommended and should be maintained with the EEG recording.

7. ACTIVATIONS

(i) Eyes Opening and Closure

At some time during the recording there 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 a minimum of two, ten 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 5-10 second periods of eye closure (passive or assisted) ⁽⁵⁾.

(ii) Hyperventilation

Hyperventilation is performed by asking the patient to breathe deeply in and out through their mouth ensuring as much air is expelled during expiration as possible, with the usual rate being one breath every three seconds ⁽¹²⁾.

Hyperventilation should be performed for at least 3 minutes. The procedure should be extended to 5 mins if the patient has been referred to investigate for childhood / juvenile absence epilepsy if no response is seen earlier. The recording post hyperventilation should extend for one to two minutes after cessation of hyperventilation ⁽⁵⁾. There should be a minimum period of 3 minutes separating the performance of hyperventilation and intermittent photic stimulation ^(14, 19) Hyperventilation should not be the last procedure performed during the EEG recording. During this period the background EEG should be monitored for the persistence of any changes produced by the hyperventilation response ⁽¹²⁾.

Relative contraindications for hyperventilation include recent (use professional judgement or seek advice from medical officer where appropriate) –

- Cerebral vascular accidents (CVA)
- Transient ischaemic attacks (TIA)
- Myocardial infarction (MI)
- Acute respiratory distress syndrome (ARDS)
- Surgery.

Patients that have a history or known diagnosis of –
Asthma

- Chronic Obstructive Pulmonary Disease (COPD)
- Moya-Moya disease
- Sickle-Cellanaemia.
- Pregnancy (Third Trimester >24weeks/6months)
- Increased intracranial pressure (ICP)
- On supplemented oxygen (O₂).

Professional judgement should be used to ascertain the patient's ability to perform adequate hyperventilation for the required time. If there are any doubts, a medical opinion should be sought. The results of this should be documented in the patient's notes, the EEG technical notes and as an annotation on the record.

The presence of diffuse epileptiform discharges should not be an absolute contraindication to the performance of hyperventilation⁽¹³⁾.

(iii) Intermittent Photic Stimulation (IPS)

Intermittent photic stimulation requires the patient to look at a series of flashing lights of varying frequency with periods of eyes open and eyes closed⁽⁸⁾.

The strobe light should be placed approximately 30cm from the patient's face and the ambient lighting decreased for the duration of IPS. Flash frequencies from 1-50Hz should be utilised for a minimum of 10 seconds each, with periods of eyes open and eyes closed for each frequency presented. For example, some texts recommended the use of the following IPS sequence –

1,2,3,4,6,8,10,12,14,16,18,20Hz, immediately followed by 50, 40, 30,25Hz. A minimum of 7 seconds with no stimulus should separate each flash frequency^(14, 15).

Relative contraindications to photic stimulation include photophobia associated with conditions such as migraine, meningitis or encephalitis and inability to perform the procedure (such as can be seen in some agitated patients or some patients with intellectual impairment).

As with hyperventilation, the patient's ability and willingness to perform IPS to the required standard should be assessed using professional judgement. Any modifications to the IPS procedure shall be annotated on the recording and also within the patient's notes.

Epilepsy and photosensitive seizure disorders should not be considered a contraindication for photic stimulation; however the patient (and/or carer) should be made aware of the risk of provoking a seizure during IPS where possible^(14, 16).

IPS shall be stopped immediately if generalised photo-paroxysmal activity is seen during a particular train flash frequency. This stimulus frequency should be repeated to demonstrate that the epileptiform discharge is reproducible and therefore a result of the stimulus⁽¹⁴⁾.

The range of photic frequencies assumed to result in a photo-paroxysmal response should be ascertained⁽¹³⁾. This is done by stimulating at the highest frequency available (i.e. 50Hz) then reducing the frequency used (following the process outline

above in reverse) until evidence of a photo-paroxysmal response is obtained. This range should be noted in the technical notes of the EEG report ⁽⁷⁾.

(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 a period of drowsiness / sleep be encouraged in all routine EEG recordings and this can often be attained without sleep deprivation. To encourage sleep it is suggested to record the EEG in a dimly lit, warm room with a comfortable reclined seating / bed. Minimal eye opening or interaction with the patient can often result in drowsiness and light sleep within the time restraints of the routine EEG in clinical practice ⁽⁹⁾.

(v) Sleep Deprivation

Sleep deprivation preparations can vary depending on the patient's age and routine, however adult patients should be advised to remain awake for 24 hours prior to the Sleep Deprived EEG appointment. The patient shall also be advised to arrange transportation to and from the appointment (with a well rested, responsible adult) and to refrain from any stimulants such as caffeine during the period of sleep deprivation.

Partial sleep deprivation can be used in children or in circumstances where it is judged necessary, by reducing the patient's normal sleep time by 1-2 hours ⁽¹⁷⁾.

8. POST-RECORDING CHECKS

(i) Biological Calibration

Where possible a biological calibration of no less than 10 seconds should be recorded and stored with the EEG ⁽⁵⁾.

(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 ⁽⁶⁾.

(iii) 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 ⁽⁵⁾.

9. REPORT WRITING

(i) Patient History

An accurate patient history should be taken at the time of the recording and can be obtained during patient setup. Information that should be obtained should include but is not limited to:

- Description of events including precipitating factors or triggers
- Relevant medical history such as previous head injury or brain surgery
- Current medication
- Family history of epilepsy
- The time of the last event
- Frequency of events
- Temporal occurrence of events
- Handedness

(ii) Factual Report

A concise descriptive factual report can be prepared covering the procedure employed, neurophysiologic findings and clinical events but must be without a clinical interpretation ⁽⁸⁾. This can include but is not limited to:

- Background activities (frequency, amplitude, symmetry, distribution, temporal occurrence, presence of normal variants/rhythms, presence of background abnormality, relationship to age using standard terms to describe the data ^(8, 18).)
- Comment on artefacts identified during the recording
- Effects of stimulation/activation procedures
- Interictal abnormalities
- Ictal events (clinical description, EEG features)
- Non-ictal events (clinical description, EEG features)
- ECG.

10. REFERENCES

1. De Weerd, A., Despland, P., Plouin, P. (1999). Neonatal EEG. Recommendations for the Practice of Clinical Neurophysiology: Guidelines of the International Federation of Clinical Physiology (EEG Suppl. 52).
2. Klem, G., Luders, H., Jasper, H., Elger, C. (1999.) The ten-twenty electrode system of the International Federation. Recommendations for the practice of Clinical Neurophysiology: Guidelines of the International Federation of Clinical Physiology. EEG Suppl. 52.
3. Nuwer, M., Comi, G, Emerson, R., Fuglsang-Frederiksen, A., Guerit, J., Hinrichs, H., Iked, A., Luccas, F., Rappelsberger, P. (1999). IFCN standards for digital recording of clinical EEG. Recommendations for the practice of Clinical Neurophysiology: Guidelines of the International Federation of Clinical Physiology. EEG Suppl. 52.
4. Cooper, R. (1963). Electrodes. American Journal of EEG Technology. 3(4), 91-101.
5. American Clinical Neurophysiology Society Guideline 1: Minimum Technical Requirements for Performing Clinical Electroencephalography. (2008). <http://www.acns.org> .
6. Ebersole, J., Pedley, T. (2003). Current Practice of Electroencephalography. p 76. Lippincott Williams & Wilkins.
7. Cooper, R., Binnie, C., Billings, R. (2005). Techniques in Clinical Neurophysiology: A Practical Manual. Elsevier, Amsterdam, The Netherlands.
8. International Organisation of Societies for Electrophysiological Technology. (2007). Recommendations for Minimum Standards for the Education and Training of Neurophysiological Practitioners EEG Unit: Record and Report conventional electroencephalograms, EEGs in adults, including polygraphy. <http://www.oset.org/img/guidelines/> .
9. Flink, R., Pedersen, B., Guekht, A., Malmgren, K., Michelucci, R., Neville, B., Pinto, F., Stephani, U., Ozkara, C. (2002). Guidelines for the use of EEG methodology in the diagnosis of epilepsy. International League Against Epilepsy: Commission report. Commission on European Affairs: Subcommission on European Guidelines. Acta Neurol Scand. 106.1-7.
10. Pillai, J., Sperling, M. (2006). Interictal EEG and the diagnosis of epilepsy. Epilepsia; 47(suppl 1). 14–22.
11. The Association of Neurophysiological Scientists UK. (2008). Recommendations, guidelines and minimum standards for the practice of Clinical Neurophysiology in the United Kingdom. ANS Working Party. <http://ansuk.org/> .

12. Mendez, O., Brenner, R. (2006). Increasing the Yield of EEG. *Journal of Clinical Neurophysiology*. 23. 282-293.
13. Loiseau, P., Panayioopoulos, C. (2002). Childhood absence epilepsy. *International League against Epilepsy*. http://www.ilae-epilepsy.org/ctf/childhood_absence.html.
14. Trenite, D., Rubboli, G., Hirsch, E., Martins da Silva, A., Seri, S., Wilkins, A., Parra, J., Covanis, A., Elia, M., Capovilla, G., Stephani, U., Harding, G. (2012). Methodology of photic stimulation revisited: Updated European algorithm for visual stimulation in the EEG laboratory. *Epilepsia*. 53(1), 16-24.
15. Rubboli, G., Parra, J., Seri, S., Takahashi, T., Thomas, P. (2004). EEG Diagnostic Procedures and Special Investigations in the Assessment of Photosensitivity. *Epilepsia*. 45(Suppl. 1), 35–39.
16. Kasteleijn-Nolst Trenité, D., Binnie, C., Harding, G., Wilkins, A., (1999). Photic Stimulation: Standardization of Screening Methods. *Epilepsia*. 40(Suppl. 4),75-79.
17. Ong, H., Lim, K., Low, P. (2004). Simple instructions for partial sleep deprivation prior to pediatric EEG reduces the need for sedation. *Clinical Neurophysiology*. 115(4), 951-955.
18. Noachtar, S., Binnie, C., Ebersole, J., Manguiere, F., Sakamoto, A., Westmoreland, B. (1999). A glossary of terms most commonly used by clinical electroencephalographers and proposal for the report form for the EEG findings. *Recommendations for the Practice of Clinical Neurophysiology: Guidelines of the International Federation of Clinical Neurophysiology (EEG Suppl. 52)*.
19. Kasteleijn-Nolst Trenite´,D., Rubboli, G., Hirsch, E., Martins da Silva, A., Seri, S., Wilkins, A., Parra, J., Covanis, A., Elia, M., Capovilla, G., Stephani, U., Harding, G. (2102). Methodology of photic stimulation revisited: Updated European algorithm for visual stimulation in the EEG laboratory. *Epilepsia*. 53(1):16–24.

Appendix1 – Stakeholders

Stakeholders

- ANTA Inc. Members
- Document Development Committee
- Document Development Committee Advisory Group
- Other interested parties

Original Document

Anna Exley, Justin Stent, Ruth Bundy, Angela Borbelj,
2009 ANTA Executive Committee
ANTA Inc. Members

First Revision – 2012

Document Development Committee

Mary Lynch, Joanne Wex, Holly Campbell, Anna Exley, Santhi Chigurupati, Malcolm Corkhill,
Kate Martin, Emma Fetherston, Amy Lofts, Fred Tremayne, Vicky Grant.

Review of QLD Health Routine EEG Guideline 2013.

Advisory Committee

The document development committee identified a group of key stakeholders to view the draft documents for feedback. The advisory group was made up of technologists, scientists and neurologists working in the neurophysiology industry around Australia. The comments from this group were considered, compared against the reference material and included where appropriate.

Members Feedback

On completion of the final draft the document was put out to all members of ANTA Inc. for feedback. The comments from members were considered, compared against the reference material and included where appropriate.

Guideline Acceptance

This Guideline was accepted by members in July 2014.

Amendments

2016 May Disclaimer and Copyright statements added.

Disclaimer

- (i) The use of information and data contained within this guideline is at your sole risk for ANTA Inc. will not be liable
- (ii) If you rely on the information from this guideline you are responsible for ensuring by independent verification its accuracy, currency or completeness. You are also responsible for making sure it meets your specific requirements. ANTA Inc. does not warrant or take responsibility for the accuracy, currency or completeness.
- (iii) You acknowledge that such information and materials may contain inaccuracies or errors and we expressly exclude liability for any such inaccuracies or errors to the fullest extent permitted by law.
- (iv) The information and data in this guideline is subject to change without notice.
- (v) This guideline may include links to websites. These linked websites will have their own terms and conditions of use and you should read and familiarise yourself with these terms and conditions.
- (vi) ANTA Inc. may revise this disclaimer at any time including by updating this page

Copyright ©

- (i) You are welcome to use this guideline and the information contained on it.
- (ii) All material in this guideline is protected in Australia under the *Copyright Act 1968 (Cth)*.
- (iii) You are permitted to either electronically save or print out parts of this guideline for your own information, research or study but are prohibited from using the information for any commercial purpose.
- (iv) You are not permitted to modify copy in any way from the form in which it appears in this guideline.
- (v) You must not republish any material contained in this guideline either on another web site, or in any other medium, print, electronic or otherwise without seeking permission to do so. Subject to *Copyright Act 1968* all such use may only be authorised in writing by the copyright owner (ANTA Inc.)
- (vi) Apart from this provision and uses permitted under the *Copyright Act 1968*, all other rights are reserved.