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Additional Physiological Measurement Recording Guideline

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1. PURPOSE

These guidelines have been prepared to offer guidance towards best practice for recording additional physiological measurements in conjunction with EEG recordings in clinical practice within Australia ⁽¹⁾.

2. INTRODUCTION

The following guidelines should be considered as minimum standards to record additional physiological measurements in conjunction with EEG recordings in clinical practice and other neurophysiological recordings where appropriate. These physiological measurements include Electrocardiogram (ECG), Electro-oculogram (EOG), Electroretinogram (ERG), Electromyogram (EMG) and Respiration (Resp) on adults, children and babies. They have been prepared by a subcommittee 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 Inc. Guideline is consistent with worldwide standards.

3. LIMITS OF THE GUIDELINE

This guideline is a supplement to and should be used in conjunction with the ANTA Inc. Routine EEG, Non-Routine EEG and Neonatal EEG Test Guidelines and other ANTA Inc. neurophysiological test guidelines where appropriate.

4. ELECTRODES

(i) Electrode Placement

Additional physiological recording electrodes should be applied according to ECG, EOG, ERG, EMG and respiration placement requirements.
(See section 6 for further detail on each measurement)

(ii) Electrode Choice

Most additional physiological measurements can be recorded using standard EEG recording electrodes.
Refer to the ANTA Inc. Routine EEG Recording Guideline ⁽²⁾

(iii) Electrode Impedance

Refer to the ANTA Inc. 'Routine EEG Recording Guideline' ⁽²⁾.

5. PRE-TEST CHECKS

(i) All Electrode Check.

Additional physiological measurement electrodes should be included in the all electrode check prior to the EEG recording.
Refer to the ANTA Inc. 'Routine EEG Recording Guideline' ⁽²⁾.

6. RECORDING

(i) Electrocardiogram (ECG)

ECG should be recorded simultaneously with the EEG in routine practice ⁽¹⁾ to assist in differentiating ECG and/or pulse artefacts ⁽³⁾ as well as help to identify possibly cardiovascular events such as syncope or arrhythmia.

a) Referential recording: Some EEG apparatus are configured to record the ECG in referential mode. For this apparatus the ECG active electrode should be placed on the left side of the chest and referred to the EEG recording reference electrode or as per machine specifications. (Figure 1)

Bipolar recording: Other EEG apparatus allow for true bipolar recording of the ECG. For this apparatus the ECG electrodes should be placed on both sides of the chest with the active electrode on the left and the reference electrode on the right ^(3, 4). (Figure 1)

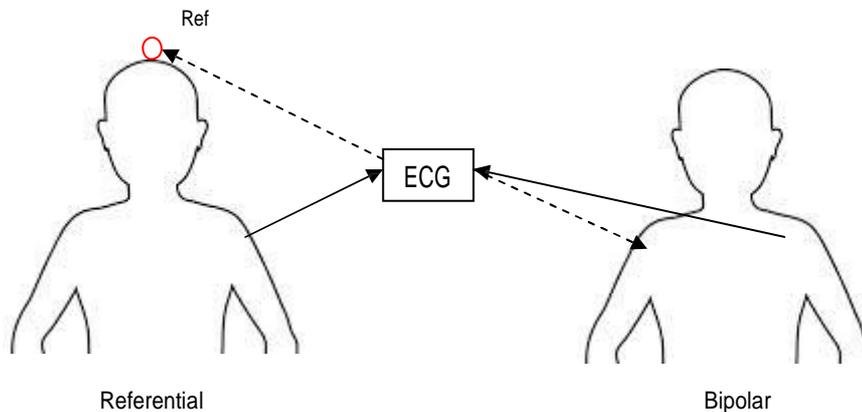


Figure 1. ECG electrode placement

b) Settings

The ECG should be recorded within the range of the following parameters ⁽³⁾:

Sensitivity – 50-100 μ V/mm of trace deflection

LFF – No higher than 1Hz (TC 0.16s)

HFF – No lower than 70Hz

c) Montage – Lead 1 ECG ^(3,4).

ECG – Reference or

ECG left – ECG right

(ii) Electromyogram (EMG)

EMG recording can be used during an EEG to record superficial EMG, specific muscle contractions or general limb or body movement^(3,4).

- a) EMG activity can be recorded by placing the active and reference electrode 25mm apart over the belly of the desired muscle⁽³⁾. (Figure 2)

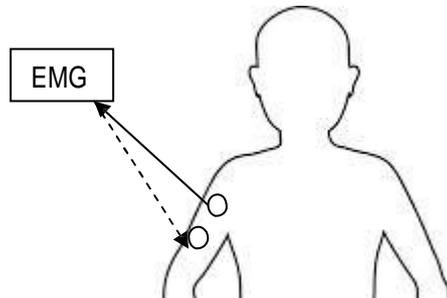


Figure 2. EMG electrode placement

Submental EMG

Submental EMG is used in conjunction with the EEG for the purposes of recording changes in muscle tone during sleep or atonic seizures⁽³⁾.

Submental EMG can be recorded by placing electrodes on the chin 20mm above and below the point of the chin respectively⁽³⁾.

Alternatively electrodes can be placed under the chin over the submental muscle 1-2 cm either side of the midline^(5,6).

A third chin EMG electrode is useful for backup and can be placed at the midline of the chin 1cm above the inferior edge of the mandible⁽⁷⁾. (Figure 3)

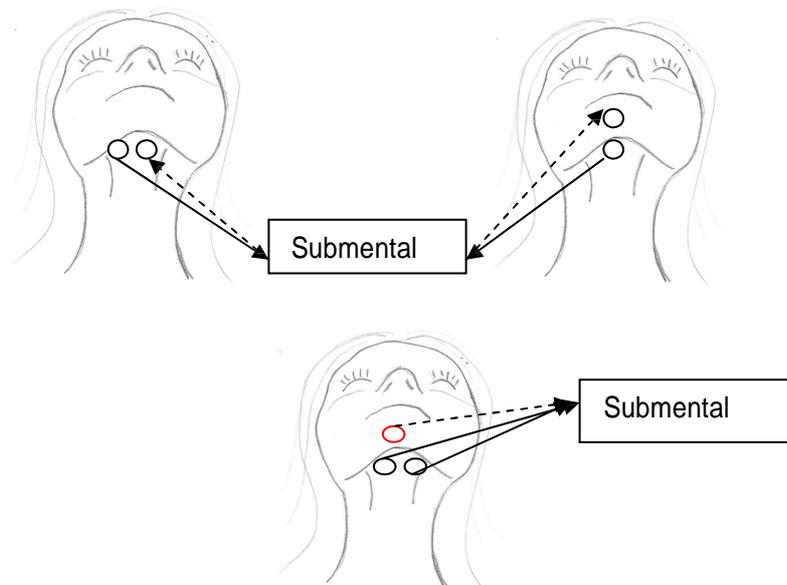


Figure 3. Submental EMG electrode placement

b) Settings

The EMG should be recorded within the range of the following parameters^(3, 8):

Sensitivity – 2-10 μ V/mm of trace deflection

LFF - Up to 5-10Hz (TC 0.016s)

HFF- No lower than 70Hz

c) Montage

Active (right or below the chin) Submental EMG electrode – reference (left or above the chin) Submental EMG electrode.

or

Right Submental (active) – mandible (reference)

Left Submental (active) – mandible (reference)⁽⁷⁾

(iii) Eye Movement / Electro-oculogram (EOG)

Eye movement monitoring can be recorded in conjunction with the EEG to assist with differentiating frontal slow cerebral activity from eye movements and/or for the purposes of recording changes to the eye movements in different stages of sleep^(3, 8).

a) Lateral Eye Movements

Outer canthus electrodes can be used to record a combination of lateral and vertical eye movements with one bipolar recording channel⁽⁸⁾.

Electrodes can be placed 1cm above the right outer canthus (active) and 1 cm below the left outer canthus (reference) (Figure 4). Alternatively an electrode placed at the nasion can be used for the reference for a unilateral EOG recording⁽⁹⁾ (Figure 5). Mastoid electrodes can be used as reference electrodes to configure ipsilateral or contralateral recording to enhance the eye movement^(5, 7) (Figure 6).

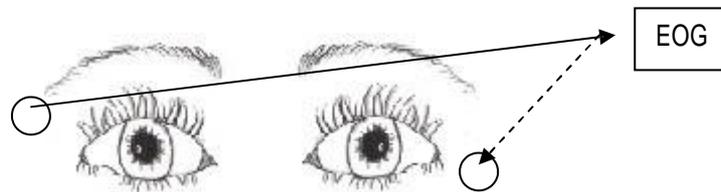


Figure 4. EOG electrode placement - combined vertical and lateral eye movement

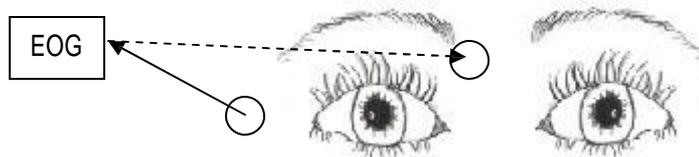


Figure 5. EOG electrode placement – unilateral combined lateral and horizontal eye movement

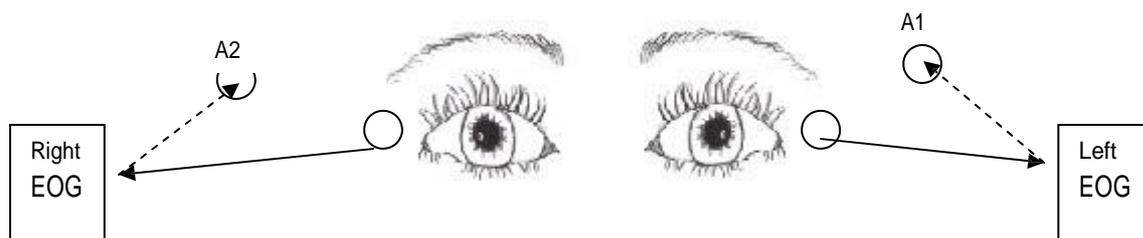


Figure 6. EOG electrode placement - lateral eye movement

Vertical Eye Movements

An electrode placed under each eye can be used to record vertical eye movements⁽¹⁰⁾. This configuration assists with differentiating between slow frontal cerebral activity (in phase) and subtle eye (blinking) movement (out of phase)^(11, 12). Electrodes can be referred to the prefrontal EEG electrode above the eye⁽¹¹⁾ or ipsilaterally or contralaterally to the ears⁽¹³⁾. (Figure 7)

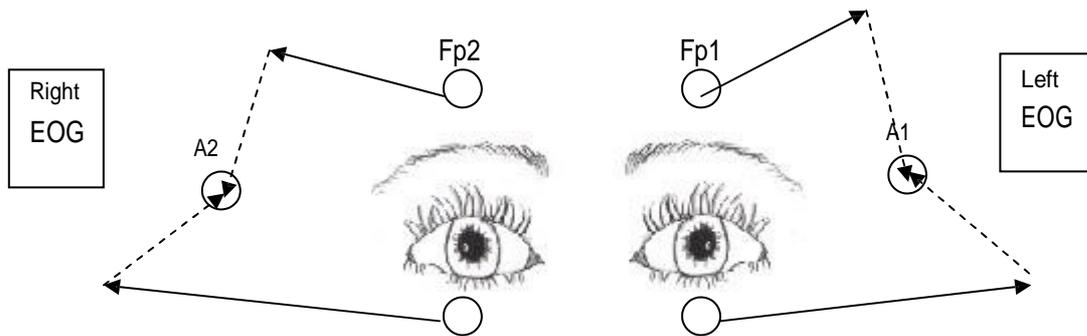


Figure 7. EOG electrode placement - vertical eye movement

b) Settings

The EOG should be recorded within the range of the following parameters⁽⁸⁾:

Sensitivity – 5-10 μ V/mm of trace deflection

LFF – No higher than 1Hz (TC 0.16s)

HFF – No lower than 70Hz

c) Montage

Lateral Eye movements -1 channel recording.

- Right upper outer canthus – left lower out canthus^(3,8)
- Right outer canthus to mid-nasion⁽⁹⁾.
- Refer outer canthus to mastoid either ipsilaterally or contralaterally⁽⁸⁾.

Vertical Eye Movement⁽¹³⁾

Below right eye – A2

Fp2 – A2

Below left eye – A1

Fp1 – A1

(iv) Electroretinogram (ERG)

ERG can be recorded in conjunction with the VEP to assist with differentiating retinal abnormalities from visual nerve dysfunction or in conjunction with the EEG to differentiate eye movement from cerebral activity.

a) A number of different types of electrodes can be used but the most practical and least invasive type is a leaf electrode that can be placed on the lower eyelid and tethered at the nasal canthus and lower outer canthus of the eye ⁽¹⁴⁾.

Reference electrodes are placed at the ipsilateral outer canthus (iOC) of each eye ⁽¹⁴⁾. A ground electrode can be placed anywhere on the head. (Figure 8)

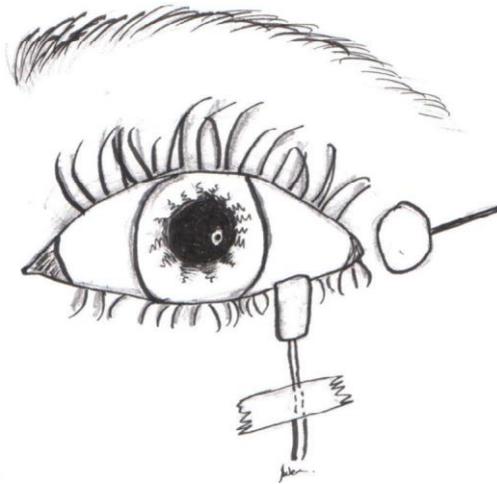


Figure 8. ERG electrode placement - leaf electrode

b) Settings

For the purpose of incorporating the ERG in the VEP test set up the VEP stimulating visual arc, luminance, contrast and reversal rate parameters are used.

See ANTA Inc. VEP Guideline 2014 ⁽¹⁵⁾.

If the ERG is recorded in conjunction with the EEG it should be recorded within the range of the following parameters as per EOG above ⁽⁸⁾:

Sensitivity – 5-10 μ V/mm of trace deflection

LFF – No higher than 1Hz (TC 0.16s)

HFF – No lower than 70Hz

c) Montage ⁽¹⁵⁾

ERG – iOC

(v) Respiration (Resp)

Respiration can be recorded in conjunction with the EEG to determine sleep stages, monitor apnoeic events or differentiate respiratory movement from slow cerebral activity that may be encountered in the non-routine EEG recording in Critical Care or in suspected Electro-cerebral Silent EEG recordings ^(3, 8).

a) Respiratory transducer recording thoracic and or abdominal movements ^(3, 9) should be placed two centimetres above umbilicus on an infant ⁽¹⁶⁾ or just below the armpit (thoracic) and at the lower edge of the ribcage (abdominal) on an adult ⁵ or two electrodes can be placed 2cm apart on either side of the same rib ⁽⁷⁾ at the base of the ribcage over the diaphragm. (Figure 9)

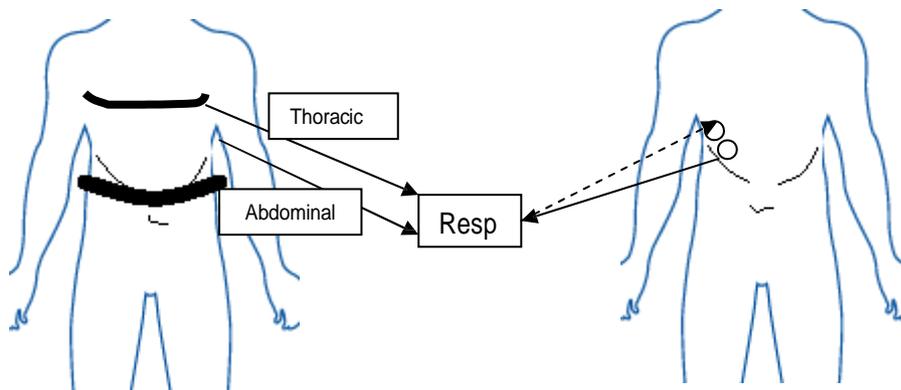


Figure 9. Resp electrode placement

b) Settings

Respiration should be recorded within the range of the following parameters ⁽³⁾:

Sensitivity – 5-10 μ V/mm of trace deflection

LFF – Up to 10Hz (TC 0.016s)

HFF – No lower than 15Hz

c) Montage

Active Resp – Reference Resp

7. POST-RECORDING CHECKS

(i) All Electrode Check

Additional physiological measurement electrodes should be included in the all electrode check prior to the EEG recording.

Refer to the ANTA Inc. Routine EEG Recording Guideline⁽³⁾.

8. FACTUAL REPORT

Additional physiological measurement recording should be included in the factual report. Correlation of the additional physiological measurement should be made with the EEG.

Refer to the ANTA Inc. Routine EEG Recording Guideline⁽³⁾.

9. REFERENCES

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Appendix 1 – Stakeholders

Stakeholders

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

Original Document

Document Development Committee

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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.

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