NeuroTrace Study Guide

Domain: Domain II – EEG Procedures & Data Acquisition
Section: Amplifiers, Impedance & Grounding
Style: Technical but applied, exam-oriented

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1. Core Principles (Must Know)

EEG Signals Are Low Amplitude (µV Range)

- **EEG signals are low amplitude (µV range):** Very small signals
- Typical EEG amplitude: 10–100 µV
- Much smaller than ECG (mV range)
- Requires amplification to be visible
- Susceptible to noise

Amplifiers

Increase Signal Amplitude

- **Increase signal amplitude:** Make signals visible
- Amplify microvolt signals to displayable levels
- Essential for EEG recording
- Without amplification, signals are invisible
- Standard amplification: 10,000–100,000x

Reject Common Noise

- **Reject common noise:** Remove environmental interference
- Differential amplification rejects shared noise
- Common-mode rejection ratio (CMRR) is critical
- Poor CMRR allows noise into recording
- Essential for clean signal

Impedance Balance Is Critical

- **Impedance balance is critical:** More important than absolute values
- Balanced impedance reduces artifact
- Unbalanced impedance creates noise
- Large differences cause problems
- Must maintain balance across electrodes

Key Principle

- **Signal quality depends more on impedance balance than absolute values**
- Balance is more important than low impedance alone
- Large differences cause artifact
- Even "acceptable" values can cause problems if unbalanced
- Must check balance, not just values

Practical Application

- Always check impedance balance
- Maintain balanced impedance across electrodes
- Verify grounding
- Understand amplifier function

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2. EEG Amplifiers

Differential Amplifiers Compare

Active Electrode vs Reference

- **Active electrode vs reference:** Differential comparison
- Amplifier compares two inputs
- Active electrode: Signal of interest
- Reference electrode: Comparison point
- Difference is amplified and displayed

Common-Mode Rejection Ratio (CMRR)

Ability to Reject Shared Noise

- **Ability to reject shared noise:** CMRR function
- Noise affecting both electrodes is rejected
- Only differences are amplified
- High CMRR = better noise rejection
- Low CMRR = more noise in recording

ABRET Emphasis

- **Poor CMRR allows environmental noise into the EEG**
- Environmental noise (50/60 Hz) enters recording
- Creates artifact
- Reduces signal quality
- Must maintain good CMRR

Amplifier Characteristics

- **High input impedance:** Does not load the signal
- **Low output impedance:** Drives display effectively
- **Wide frequency response:** Captures all EEG frequencies
- **Low noise:** Minimizes internal noise

Best Practice

- Understand differential amplification
- Know CMRR importance
- Maintain good amplifier function
- Recognize amplifier-related issues

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3. Electrode Impedance

Measured in Ohms (Ω)

- **Measured in ohms (Ω):** Standard unit
- Impedance = resistance to AC current
- Different from DC resistance
- Measured at specific frequency (typically 10 Hz)
- Standard unit: kilohms (kΩ)

Typical Acceptable Range

< 5–10 kΩ

- **< 5–10 kΩ:** Standard acceptable range
- Ideal: < 5 kΩ
- Acceptable: < 10 kΩ
- Problematic: > 10 kΩ
- Must check before recording

Balanced Impedance Is More Important Than Low Impedance Alone

- **Balanced impedance is more important than low impedance alone**
- All electrodes should have similar impedance
- Large differences cause artifact
- Even if values are "acceptable"
- Balance is critical

Impedance Measurement

- **Impedance measurement:** Standard procedure
- Measure before recording
- Check all electrodes
- Verify balance
- Document values

ABRET Trap

- **Large impedance differences cause artifact even if values are "acceptable"**
- Example: 3 kΩ vs 8 kΩ (both "acceptable")
- Large difference creates artifact
- Must maintain balance
- Check differences, not just values

Best Practice

- Target < 5 kΩ for all electrodes
- Maintain balanced impedance
- Check differences between electrodes
- Re-prep if unbalanced

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4. Grounding

Ground Electrode Stabilizes System

- **Ground electrode stabilizes system:** Essential function
- Provides reference point
- Stabilizes amplifier
- Reduces interference
- Essential for quality recording

Reduces Environmental Electrical Interference

- **Reduces environmental electrical interference:** Noise reduction
- 50/60 Hz line noise
- Electromagnetic interference
- Equipment noise
- Environmental electrical noise

Poor Grounding Increases 50/60 Hz Noise

- **Poor grounding increases 50/60 Hz noise:** Common problem
- Line frequency noise enters recording
- Creates 50/60 Hz artifact
- Reduces signal quality
- Must ensure good ground

Ground Electrode Placement

- **Ground electrode placement:** Standard location
- Typically on forehead (Fpz) or mastoid
- Must have good contact
- Low impedance essential
- Check ground impedance

Best Practice

- Always verify ground electrode
- Check ground impedance
- Ensure good contact
- Recognize grounding-related noise

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5. Impedance-Related Artifacts

Excessive Noise

- **Excessive noise:** High impedance artifact
- High impedance increases noise
- Unbalanced impedance creates noise
- Environmental noise enters recording
- Reduces signal quality

Drifting Baseline

- **Drifting baseline:** Impedance instability
- Unstable impedance causes drift
- Electrode movement
- Poor contact
- Creates baseline artifact

Channel Instability

- **Channel instability:** Impedance-related
- Fluctuating impedance
- Intermittent contact
- Electrode movement
- Creates unstable channel

Corrective Actions

Re-prep Scalp

- **Re-prep scalp:** Improve contact
- Clean scalp thoroughly
- Remove oils and products
- Abrade gently if needed
- Reapply electrode

Replace Electrodes

- **Replace electrodes:** If damaged
- Check for damage
- Replace if necessary
- Ensure good contact
- Verify impedance

Check Connections

- **Check connections:** Verify wiring
- Check electrode connections
- Verify cable connections
- Test amplifier connections
- Fix loose connections

Best Practice

- Recognize impedance-related artifacts
- Apply corrective actions
- Verify improvement
- Document issues

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6. Common ABRET Exam Traps

Trap 1: Confusing Impedance with Resistance

- **Reality:** Impedance includes resistance and reactance
- **Trap:** May think impedance = resistance only
- **Solution:** Understand impedance is AC resistance
- **ABRET focus:** Impedance vs resistance distinction

Trap 2: Ignoring Impedance Balance

- **Reality:** Balance is critical
- **Trap:** May only check absolute values
- **Solution:** Always check balance between electrodes
- **ABRET focus:** Impedance balance importance

Trap 3: Assuming Noise Is Always Muscle Artifact

- **Reality:** Noise can be technical
- **Trap:** May call all noise "muscle artifact"
- **Solution:** Check impedance and grounding first
- **ABRET focus:** Technical vs physiologic noise

Trap 4: Forgetting the Role of Grounding

- **Reality:** Grounding is essential
- **Trap:** May not check ground electrode
- **Solution:** Always verify ground
- **ABRET focus:** Grounding importance

Trap 5: Not Understanding CMRR

- **Reality:** CMRR is critical for noise rejection
- **Trap:** May not understand CMRR function
- **Solution:** Understand differential amplification

- **ABRET focus:** CMRR and noise rejection

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7. Clinical Correlation

ICU Environments Increase Electrical Noise

- **ICU environments increase electrical noise:** More interference
- Multiple electrical devices
- Increased 50/60 Hz noise
- More electromagnetic interference
- Requires careful impedance management

Pediatric EEGs Require Careful Impedance Management

- **Pediatric EEGs require careful impedance management:** Special considerations
- Smaller head size
- More movement
- Higher impedance often
- Must maintain balance

Good Impedance Improves Diagnostic Confidence

- **Good Impedance improves diagnostic confidence:** Quality matters
- Clean signal = reliable interpretation
- Artifact can mimic pathology
- Good impedance reduces artifact
- Essential for accurate diagnosis

Best Practice

- Adjust for environment (ICU vs routine)
- Special care for pediatric EEGs
- Maintain good impedance for quality
- Recognize environmental factors

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8. Case-Based Example

Scenario

Clinical Setting: Routine EEG recording
Problem: EEG shows excessive 60 Hz noise
Observation: Noise present in all channels
Question: What could cause this?

Root Cause

- **Poor grounding and unbalanced impedance**
- Ground electrode may have high impedance
- Impedance may be unbalanced
- Both contribute to noise
- Technical issues, not physiologic

Correct Action

- **Recheck ground and rebalance electrodes**

- Check ground electrode impedance
- Verify all electrode impedances
- Rebalance if needed
- Re-prep if necessary

Teaching Point

- **Technical issues must be corrected before interpretation**
- Cannot interpret noisy EEG
- Must fix technical issues first
- Quality recording is essential
- Technical problems must be addressed

ABRET Application

- Given noisy EEG → check impedance and grounding
- Given 60 Hz noise → check ground electrode
- Given artifact → consider impedance balance
- Must know troubleshooting steps

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9. Exam Readiness Checklist

Use this checklist to verify your understanding:

- ☐ Can explain amplifier function (differential amplification, CMRR)
- ☐ Can apply impedance standards (< 5–10 kΩ, balanced)
- ☐ Can identify grounding issues (60 Hz noise, instability)
- ☐ Can troubleshoot noisy EEG (impedance, grounding, connections)
- ☐ Understand that EEG signals are low amplitude (μV range)
- ☐ Know that amplifiers increase signal and reject noise
- ☐ Recognize that impedance balance is critical
- ☐ Know that signal quality depends on balance, not just values
- ☐ Can identify impedance-related artifacts
- ☐ Know corrective actions (re-prep, replace, check connections)
- ☐ Understand CMRR and noise rejection
- ☐ Can apply clinical correlation (ICU, pediatric)

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10. Internal Cross-Links

Workflow

- **Filters & Sensitivity:** Other technical settings
- **Electrodes & Impedance:** Detailed impedance information
- **Recording Procedures:** Pre-study checks

Patterns

- **Artifacts:** How impedance affects artifacts
- **Noise patterns:** Technical vs physiologic noise

Standards

- **Patient Safety:** Electrical safety considerations

- **Quality Assurance:** Equipment checks

Cases

- **Technical noise cases:** Cases involving impedance/grounding issues
- **Noisy EEG cases:** Cases requiring troubleshooting

Quizzes

- **Amplifier & impedance MCQs:** Questions on amplifiers and impedance
- **Grounding questions:** Questions on grounding
- **Troubleshooting questions:** Questions on fixing noisy EEG

Study Tips

1. **Memorize impedance standards:** < 5–10 kΩ, balanced
2. **Learn amplifier principles:** Differential amplification, CMRR
3. **Understand grounding:** Ground electrode function, 60 Hz noise
4. **Know the principle:** Balance is more important than absolute values
5. **Remember the traps:** Impedance vs resistance, ignoring balance
6. **Know troubleshooting:** Re-prep, replace, check connections
7. **ABRET focus:** Expect questions on impedance standards, CMRR, grounding, and troubleshooting

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End of Study Guide

For additional practice, complete quiz questions tagged: amplifier, impedance, grounding, cmrr, noise