Recording of Physiological Parameters and Electrical Safety

Robertson Chapter 6

Recording Physiological Parameters

- Sleep studies fall into 2 categories:
  - Diagnostic
    - Confirms or rules out sleep disorders
    - Montage consists of EEG, EOG, EMG, ECG, airflow, respiratory effort, and SpO2
  - Therapeutic
    - Treatment study
      - Implementation of PAP therapy or oral appliances
    - Montage same as diagnostic except adds PAP pressure or oral appliance adjustment

Recording Physiological Parameters

- Split-night PSG combines diagnostic and therapeutic into one study
- Measurements are derived from electrodes and sensors
- Need to know what signal is being recorded and how to measure the signal

Baseline Patient Info

- Most labs use a predetermined montage
  - But ordering physician may want additional parameters
- Must verify physician orders prior to study
  - Standing orders = Predetermined physician orders

Machine Calibrations

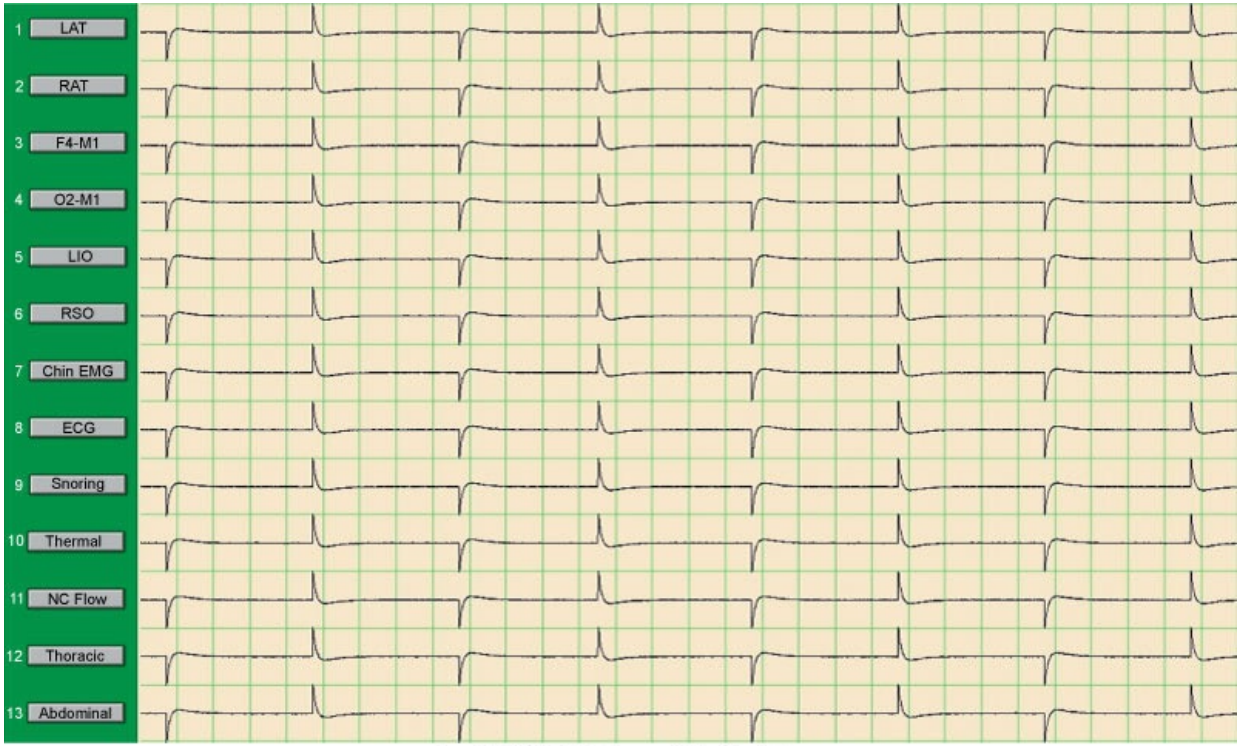
- Machine calibrations are recorded before and after a sleep study to confirm amplifier function and amplifier control response for each channel
- Montage calibration serves as visual documentation of initial amplifier settings
  - Performed by inputting a calibration signal of known voltage, typically 50 uV
- Must make sure like channels display the same during calibrations

Machine Calibrations

- Amplitude, morphology, and decay time constant
  - Signal amplitude is result of input voltage
    - Gain or sensitivity setting
  - Morphology is result of HFF and LFF
  - Decay time constant is result of LFF or time constant setting
    - Time it takes for square wave to return to 37% of original amplitude
    - Longer time constant = Lower LFF setting

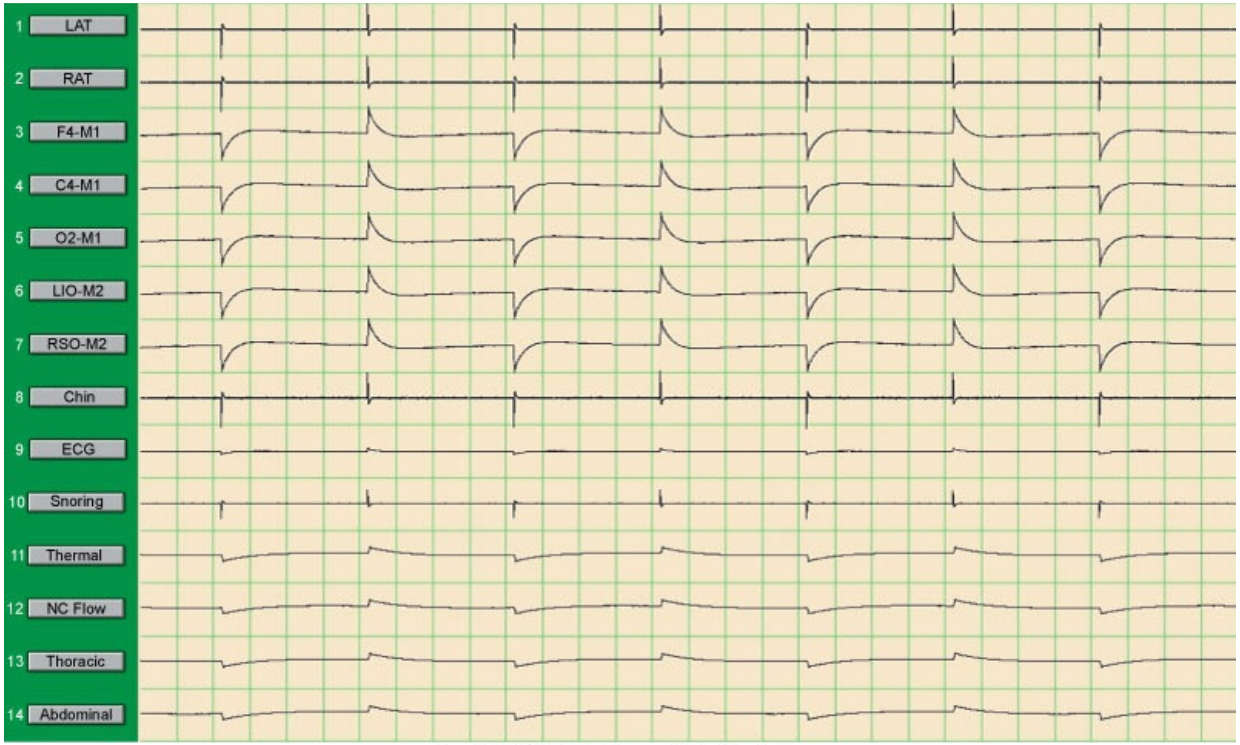
Machine Calibrations

- All-channel calibration



Machine Calibrations

- Montage calibration



Signal Calibrations

- Verify that DC output of ancillary devices are correctly processed by PSG software
- Defined by manufacturer and PSG software vendor

Physiologic Calibrations

- Also known as biocalibrations or biocals
- Series of instructions to patient that serve as tech's first test of signal quality
- Provide a baseline recording of patient data
  - Reference for scoring
- Should be recorded before and after every sleep study

Physiologic Calibrations

- Typical commands
  - Eyes open for 30 seconds
    - Baseline for waking EEG, blinks and eye movements
  - Eyes closed for 30 seconds
    - Baseline for alpha activity
  - Eye deflections
    - Blink 5 times
    - Look left and right without moving head
      - Baseline for REM
    - Look up and down without moving head
      - Baseline for rolling eyes

Physiologic Calibrations

- Typical commands
  - Grit command
    - Grind teeth or clench jaw
    - Baseline for bruxism
  - Limb movements
    - Flex feet like pushing a gas pedal
    - Baseline for PLMs during sleep
    - Should have separate leg lead channels if possible

Physiologic Calibrations

- Combined leg EMG

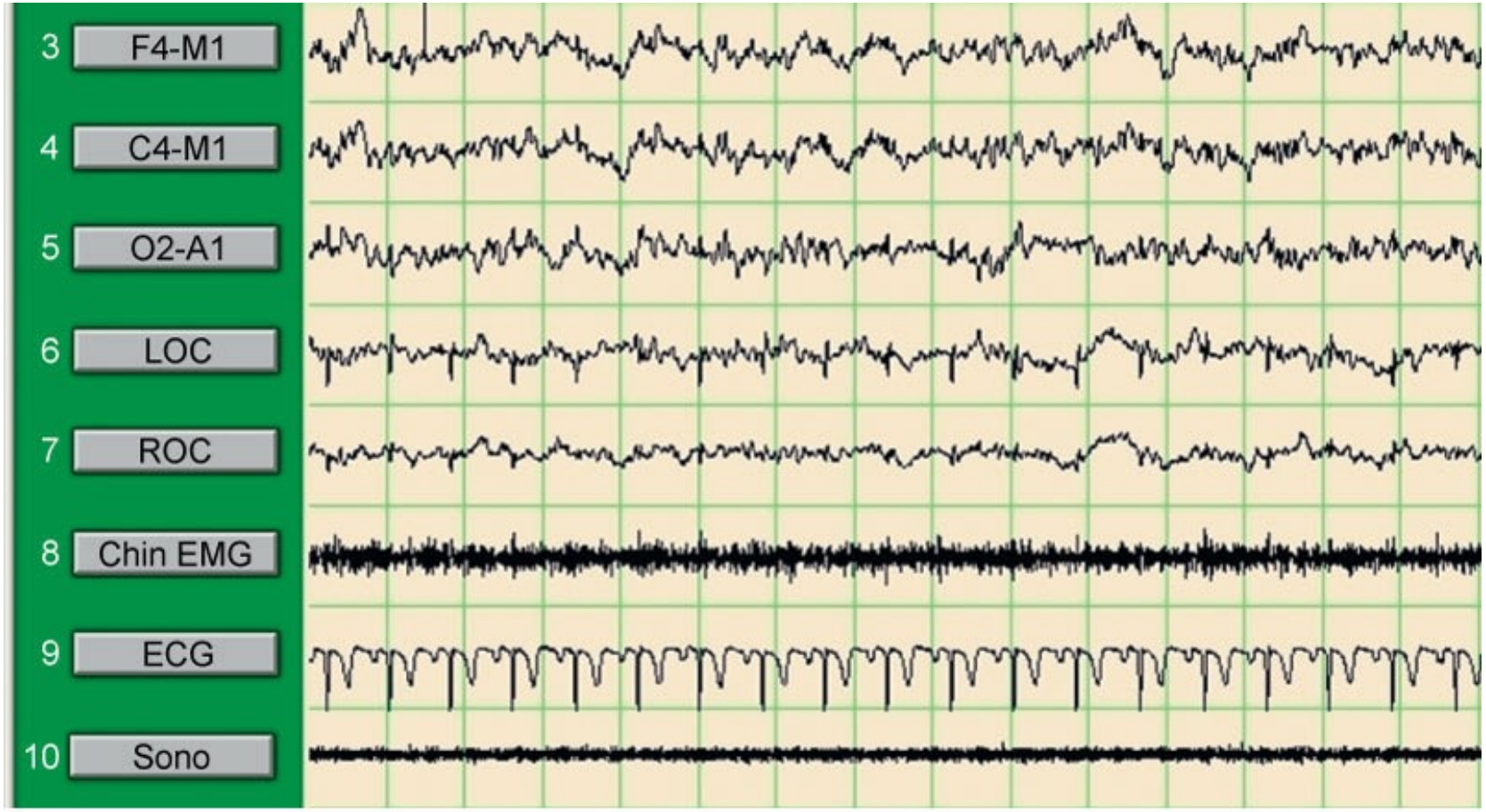
Physiologic Calibrations

- Typical commands
  - Breath commands
    - Take 3 deep breaths in and out
      - Baseline for respiratory channels
    - Hold breath for 10 seconds
      - Baseline for central apneas
    - Hold breath while moving stomach muscles in and out
      - Also known as paradoxical breathing
      - Baseline for obstructive apneas

Physiologic Calibrations

- ECG
  - Check for correct amplitude, polarity, and morphology
    - P wave should be upright
- Lights out
  - Starts the study
    - Formal beginning of TRT
- Lights on
  - Ends the study
  - Formal end of TRT

Physiologic Calibrations



Documentation During Recording

- Comment on physiologic changes and document any changes to recording parameters
- Must correct artifacts as it can lead to misdiagnosis if not done
- Some systems automatically notate all changes, while others require manual notes
- See Box 6-2 and Box 6-3 in textbook for AASM recommended documentation

Artifacts

- Must eliminate artifacts
  - Artifacts can be physiologic or environmental in nature
    - Physiologic = EMG artifact from bruxism, EKG artifact
    - Environmental = 60 Hz artifact
    - Sweat artifact is physiologic and environmental

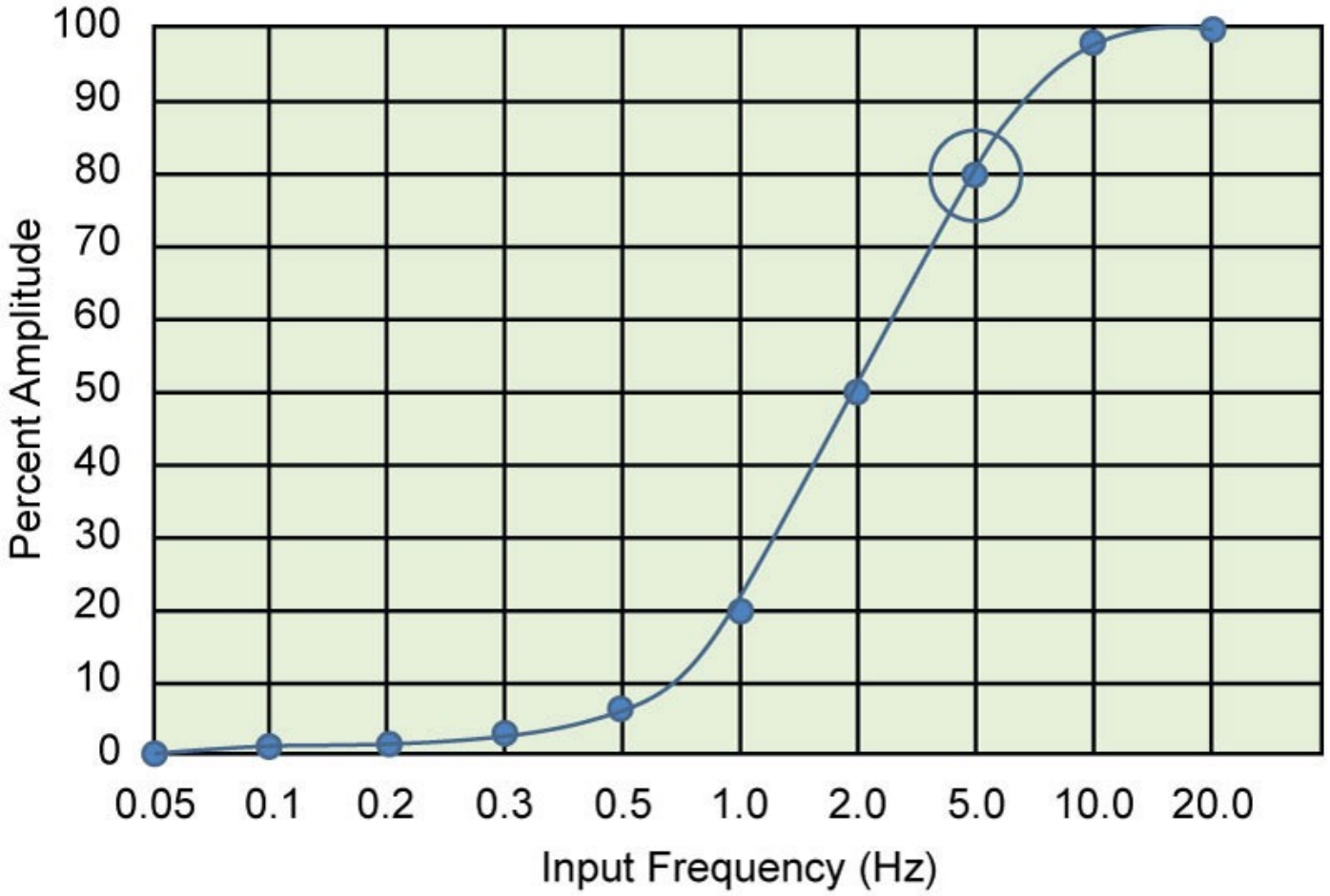
Medical Record Documentation

- Documentation often needs to be made in more than one place
  - Known your facility's guidelines
- Tech notes during study become medical documentation that may be subject to legal review
  - Use appropriate and accurate language
  - Report any inappropriate patient behavior to supervisor but not in tech notes

Frequency Response

- Each amplifier is designed with degree of attenuation that is applied to input signals at varying frequencies when an LFF or HFF is set
  - Plotted graphically as a frequency response curve
    - Represents % of attenuation for frequencies as they approach, reach, and surpass the frequency cut-off, or filter setting
- Complicated because there is no standard amplifier control design

Frequency Response



Placement of Electrodes

- Spectral power = Analysis of dominant waveform frequencies
- While specific brainwave patterns may be more prominent in a certain area of the brain, each electrode will pick up many frequencies at the same time

Gain

- Process of basic amplification similar to volume control on audio equipment
- Size of the signal affected by dynamic range and scale
  - Dynamic range = Amount of voltage the channel will be able to display in screen space allotted
  - Scaling often controlled by user increasing or decreasing size of display window
- Typically used for respiratory parameters

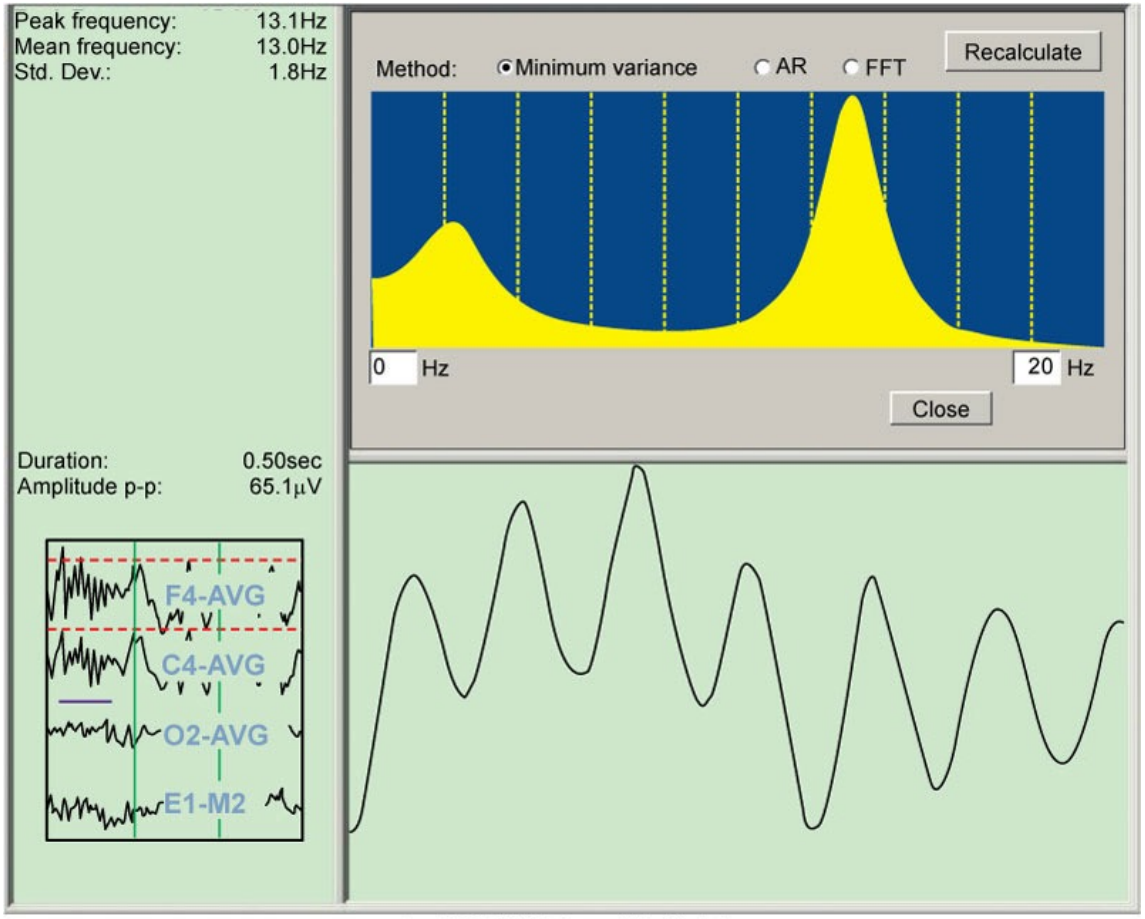
Sensitivity

- Expressed in uV/mm
- Formula = Sensitivity = Voltage ÷ Amplitude
- Sensitivity is a dated concept stemming from the paper age of polysomnography

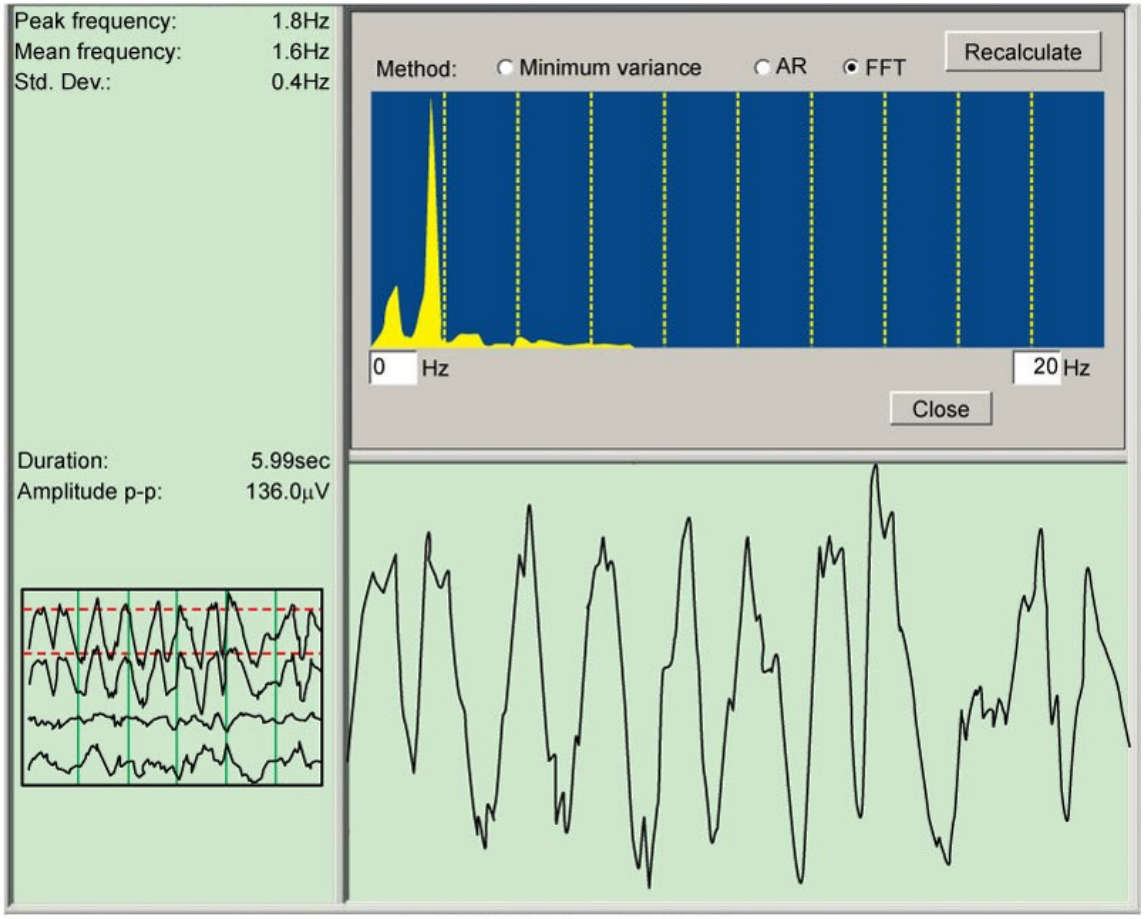
Waveform Ruler

- Two AC channels with scoring rules with specific amplitude criteria:
  - EEG
  - Leg EMG
- Typically used for detecting delta waves, sleep spindles, alpha waves, and PLMs

Waveform Ruler



Waveform Ruler



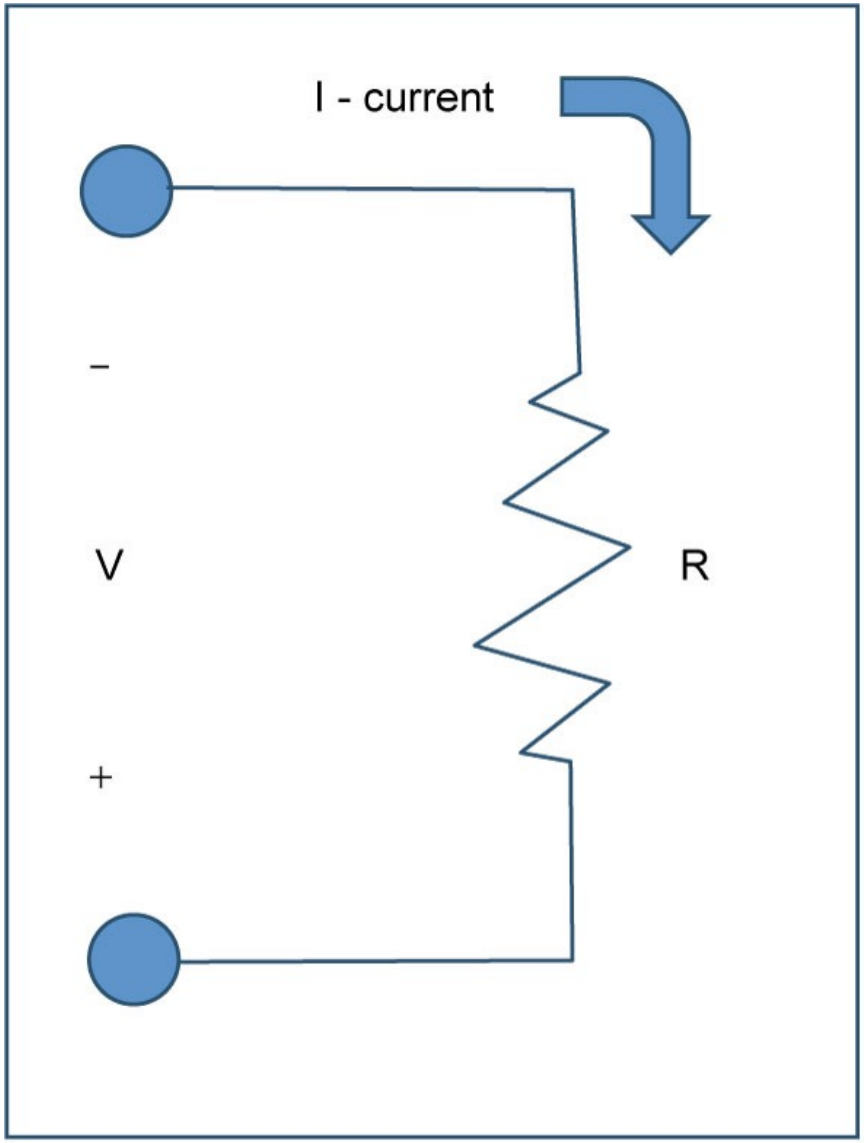
Current, Voltage, and Resistance

- Current = Movement of charged particles through a circuit
  - Measured in amperes (amps)
  - Produced when electrons begin moving through the circuit
  - Electrical current types = Alternating current (AC) and direct current (DC)
    - DC = Movement of charged particles in 1 direction
    - AC = Electrons flow in both directions at a known frequency
      - “Hot” black terminal, “neutral” white terminal, and “earth ground” green terminal

Current, Voltage, and Resistance

- Voltage = Electrical force or “push” within a circuit
  - Difference in electrical potential between 2 points
- Resistance = Property of materials to restrict current, which is measured in Ohms
- Ohm’s Law = I (current) = V (voltage) ÷ R (resistance)

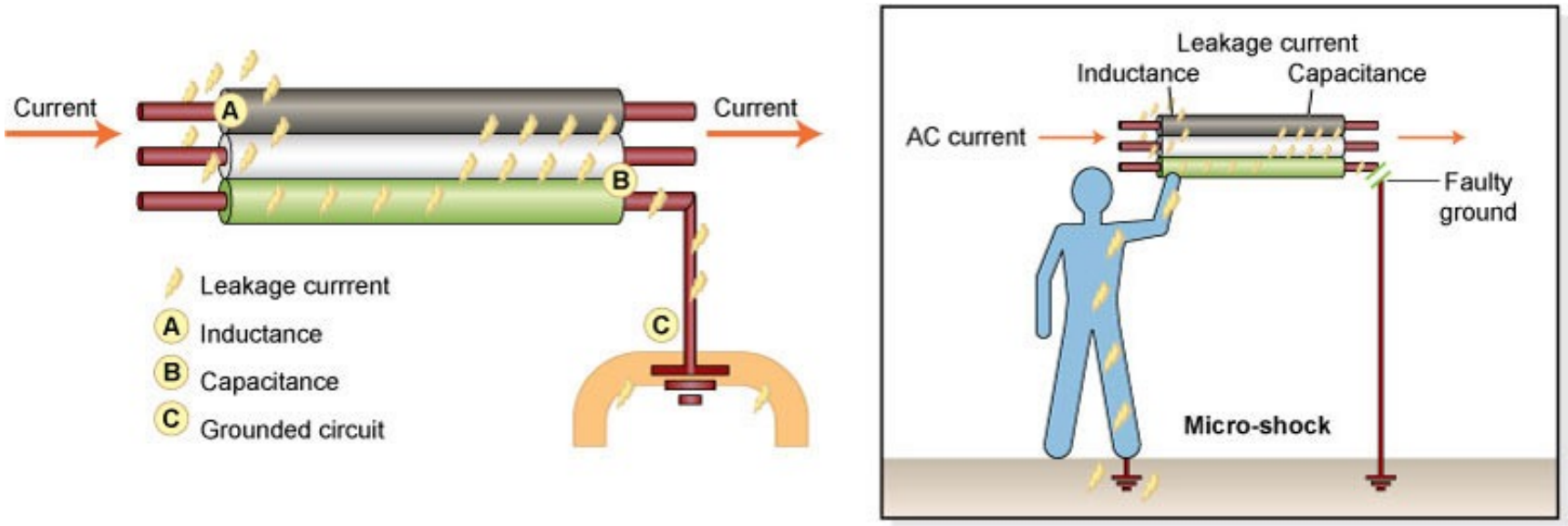
Ohm's Law



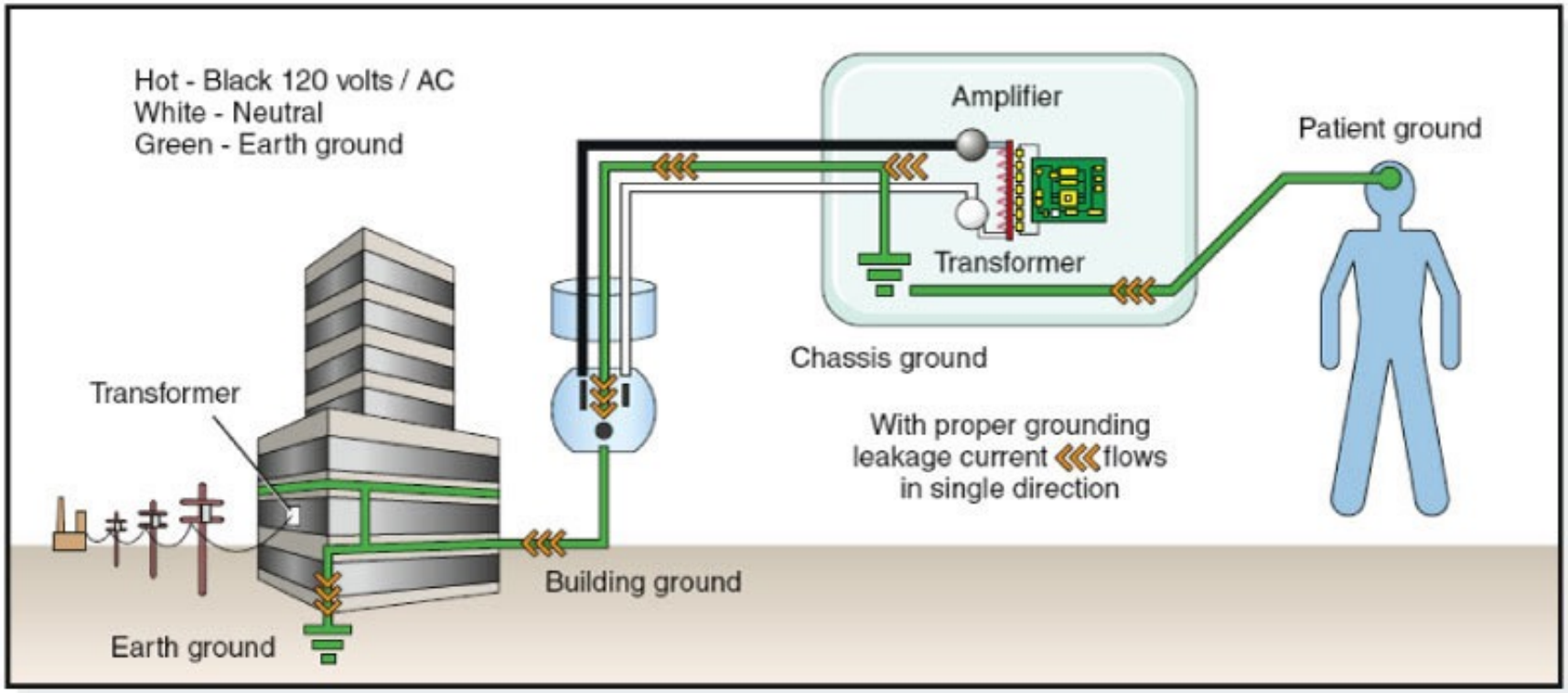
Grounding and Leakage Current

- Leakage originates from stray capacitance and stray inductance
  - Stray capacitance = Process that results in leakage of stored electrical energy
    - Most common source of leakage current
  - Stray inductance = Process that results in electrical inductance of energy
- Earth ground creates pathway for stray electrons in leakage current

Leakage Currents



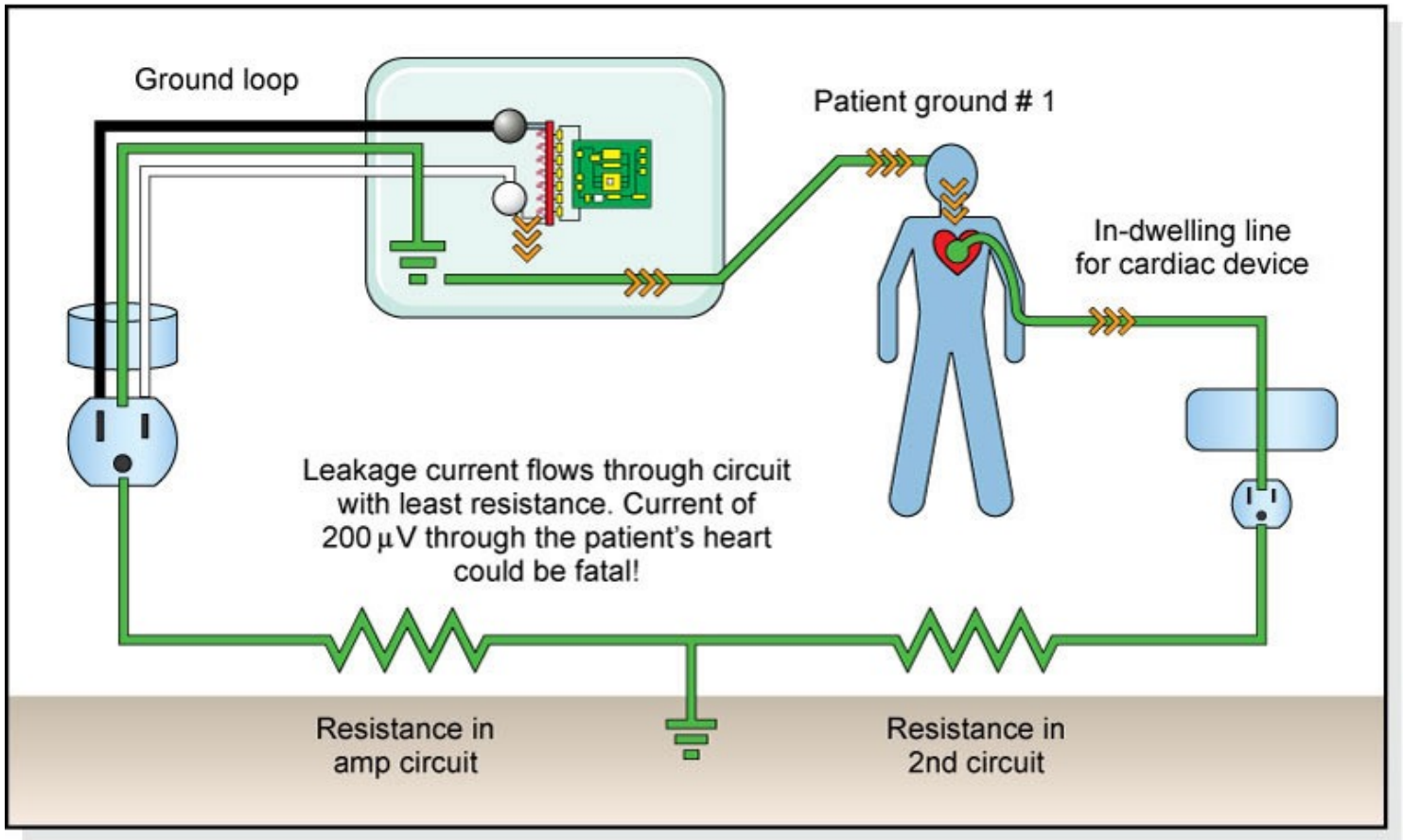
Proper Grounding



Ground Loops

- Created when leakage current from 2 different electronic devices flows through a patient
  - Very dangerous
- All equipment must be approved by FDA
- Can occur when 2 patient grounds are attached to a patient from 2 pieces of medical equipment

Ground Loop



Ground Loops

- Occurs when patient comes in contact with an electrical device with improper or faulty grounding
- Most dangerous is when a patient is connected to secondary monitor with ground wire directly attached to patient (such as ECG machine or cardiac catheter)
  - Leave PSG ground electrode off the patient in this instance
    - This will cause a lot of artifact, so must be documented

Electrical Shock

Not all electrical shocks are lethal

Macroshock = Large currents that pass through the body when the body completes a circuit, as with a ground loop

Microshock = Smaller voltage passes through body