Chapter 5

Electrical Stimulating Currents
Part I

Objectives

- Discuss the general reasons for using electrical stimulation therapeutically
- Discuss the parameters which influence the therapeutic effectiveness of e-stim

Reasons for Using E-stim

- To create muscle contraction
- To stimulate sensory nerves to reduce pain
- The create an electrical field on the skin surface to drive ions into the tissues
- To create an electrical field in biological tissues to stimulate or alter healing [bone stimulator]
Selective Stimulation of Nerves

- During electrical stimulation, different nerve types are stimulated in an orderly, predictable manner.
- A nerve's response to electrical stimulation is based on 3 factors:
  - diameter of the nerve
  - depth of nerve in relation to electrode
  - duration of the pulse

Selective Stimulation of Nerves

- Order of nerve stimulation by e-stim
  - sensory
  - motor
  - pain

Stimulation Levels

- Subsensory
- Sensory
- Motor
- Noxious
**Strength-Duration Curve**

![Diagram showing the strength-duration curve with labels for motor and sensory thresholds.]

**E-stim Current Parameters**
- Alternating vs. direct current
- Tissue impedance
- Current density
- Frequency of wave or pulse
- Intensity of wave or pulse
- Duration of wave or pulse
- Polarity of electrodes
- Electrode placement

**Alternating vs. Direct Current**
- Biggest difference
  - Direct current produces chemical changes
    - Iontophoresis
Tissue Impedance

- Resistance of tissues to the passage of electrical current
- Some tissues provide greater impedance to electrical current than others
  - Skin
  - Fat
  - Bone

Tissue Impedance

- If you don’t take steps to overcome the impedance of the skin, the therapeutic effectiveness will be decreased.

Current Density

- The amount of current flow per cubic volume
- The current density is inversely proportional to the size of the electrode
- As the current density increases, so does the perception of the stimulus
**Frequency**

- Pulses per second (pps)
- < 15 pps – twitch response
- 15 – 25 pps – individual twitches become less distinguishable
- ≥ 50 pps – tetanic contraction

**Intensity (amplitude)**

- As the intensity of the stimulus increases, so does the strength of the contraction.
- The force of the muscle contraction is linearly correlated to the amount of current introduced into the tissues.
- The depth of penetration of the current increases as the peak current increases, thus recruiting more nerve fibers.

**Phase Duration**

- Not adjustable on all machines
- Many e-stim machines are made with preset phase durations
- One of the most important factors that influence the type of tissues that will be stimulated
Phase Duration

- Shorter phase durations require greater intensity (amplitude) to evoke an action potential
- Longer phase durations require less intensity (amplitude) to evoke an action potential

Muscle contraction
- Optimum phase duration – 300-500 µsec
- Stimulation of denervated muscle
  - Optimum phase duration - > 1 msec
Electrode Placement

- One of the most common errors made in the use of e-stim is improper selection and/or placement of electrodes
- Size and location
  - can determine treatment site, current intensity, and the type of tissue stimulated

Electrode Placement

- Certain areas of the skin are more conductive than others
  - motor points
  - trigger points
  - acupuncture points

Electrode Placement

- When electrodes are placed close together, the current flow superficially
- With increased distance between electrodes, the current will reach deeper tissues
Electrode Placement

- If the distance between electrodes is too great, the specificity of the stimulation will be decreased.

Electrode Placement

- Orientation is important – particularly with motor stimulation
  - Muscle fibers are 4 times more conductive when the current flows with the direction of the fibers than when it flows across them.

Electrode Placement

- Configuration
  - Each electrical circuit must have 2 leads from the generator.
Electrode Placement

- Configuration
  - Each electrical circuit must have 2 leads from the generator

Electrical generator
Two channel

Electrode Placement

- Configuration
  - More than 1 electrode can be connected to a single lead

Electrical generator
Single channel

Electrode Placement

- Configuration
  - The total current density of one electrode (or set of electrodes) in relation to the other electrode (or set of electrodes) determines the electrode configuration
    - bipolar
    - monopolar
    - quadpolar
Electrode Placement

**Bipolar Configuration**
- Electrodes are of equal (or near equal) size
- Current density will be equal under each electrode

![Bipolar Configuration Diagram]

**Monopolar Configuration**
- Electrodes are of different sizes
  - Active electrode(s) [smaller]
  - Dispersive electrode [larger] — required to complete the circuit

![Monopolar Configuration Diagram]

**Monopolar Configuration**
- Active electrode(s) — greatest current density — treatment effect
- Dispersive electrode — low current density — little or no sensation is felt from this electrode

![Monopolar Configuration Diagram]
Electrode Placement

- Quadpolar Configuration
  - 2 sets of electrodes
  - Each set originating from its own channel

Electrical generator

Two channels

Polarity

What questions do you have?