Biofeedback

Information provided from some measuring instrument about a specific biologic function

Biofeedback

• What do you do when you want to know how you look in the morning?
Biofeedback

• What do you do when you want to know how much you weigh?

Biofeedback

• What do you do when you want to know what your temperature is?
Biofeedback

• What do you do when you want to know what your blood pressure is?

Electromyographic (EMG) Biofeedback

• The use of electronic or electrochemical instruments to accurately measure, process, and feedback reinforcing information via auditory or visual signals.
Electromyographic (EMG) Biofeedback

- To help the patient develop greater voluntary control in terms of either neuromuscular relaxation or muscle re-education following injury.

Muscle relaxation can be a learned response, not that these puppies need to learn how to relax any more!

Electromyography

- A clinical technique that involves recording of the electrical activity generated in a muscle for diagnostic purposes.
  - Uses either surface or needle electrodes for measuring electrical activity in the muscle and nerve conduction.
Electromyography

• Electromyogram
  • Graphic representation of those electrical currents associated with muscle action

The Role of Biofeedback

• “Biofeedback” can be looked at as a form of coaching.
  • Providing the patient with information so that he/she can make small changes in performance that are immediately rewarded and noted, ultimately leading toward improved functional outcomes.
Biofeedback Instrumentation

- Designed to monitor some physiologic event, objectively quantify these monitorings, and then interpret the measurements as meaningful information.

- The biofeedback equipment is designed to record some aspect that is highly correlated with the physiologic event.

Biofeedback

- **Instruments can be used to measure:**
  - Peripheral skin temperature
  - Finger photo-transmission
  - Skin conductance activity
  - Electromagnetic activity
  - **Other applications**
Biofeedback Equipment

- There are other types of biofeedback equipment available also that include:
  - Electroencephalographs (EEGs)
  - Pressure Transducers
  - Electrogoniometers

Peripheral Skin Temperature

- This is an indirect measure of the diameter of peripheral blood vessels.
- As vessels dilate, more warm blood is delivered to a particular area, thus increasing the temperature in that area.
Peripheral Skin Temperature

- This effect is easily seen in the fingers and toes where the surrounding tissue warms and cools rapidly.
  - Associated with affective states
    - Decreases with response to fear or stress

Skin Conductance Activity

- Sweat Gland activity can be indirectly measured by determining electro-dermal activity, most commonly referred to as the “galvanic skin response.”
  - Sweat contains salt that increases electrical conductivity.
  - Sweaty skin is more conductive than dry skin.
Skin Conductance Activity

• Instrumentation:
  • Applies a very small amount of voltage across the skin, usually on the palmar surface of the hand or the volar surface of the fingers where there are a lot of sweat glands, and measures the impedance of the electrical current in micro(\(\mu\))-ohm units.

Skin Conductance Activity

• Measuring skin conductance is a technique useful in objectively assessing psychophysiologic arousal and is most often used in “lie detector” testing.
Electromyographic Biofeedback

• The most commonly utilized form of biofeedback in the clinical setting.
  • EMG Biofeedback

Review of a Muscle Contraction

• Synchronous contraction of individual muscle fibers that make up the muscle
  • Muscle fibers are innervated by nerves that collectively comprise a motor unit
Review of a Muscle Contraction

- The axon of the motor unit conducts an action potential to the neuromuscular junction where a neurotransmitter is released.

- As the neurotransmitter binds to receptor sites on the sarcolemma, depolarization of that muscle fiber occurs,
  - moving in both directions along the muscle fiber.

Direction of depolarization
Electromyography of Muscle Contraction

- Creating movement of ions and thus an electrochemical gradient around the muscle fiber
  - Changes in potential difference or voltage associated with depolarization can be detected by an electrode placed in close proximity.
Motor Unit Recruitment

- The amount of tension developed in a muscle is determined by the number of active motor units.
- As more motor units are recruited and the frequency of discharges increased, muscle tension increases.
- Motor units are recruited based on the force required in an activity and not on the type of contraction performed.

Measuring Electrical Activity

- Biofeedback is used to determine the muscle activity.
  - It does not measure the muscle contraction directly.
  - It measures the electrical activity associated with the muscle contraction.
Biofeedback Equipment & Treatment Techniques

- Indications
  - Regaining neuromuscular control
  - Increasing isometric and isotonic strength of a muscle
  - Decreasing muscle guarding
  - Improving pain reduction
  - Improving the psychological relaxation response

- Contraindications
  - Any musculoskeletal condition in which a muscular contraction might increase the symptoms of that condition or would be contraindicated
Biofeedback Equipment & Treatment Techniques

• Electrodes
  • The size of the electrodes will have no impact on the amplitude of the signal
  • The size of the electrodes should be appropriate for the size of the treatment area and ranges from 4mm to 12.5mm for larger muscles.

• Conductive Interface
  • Regardless of the size or type of electrodes, there needs to be a highly conductive gel, paste or cream in between the electrode and the patient’s skin

Biofeedback Equipment & Treatment Techniques

• Skin Preparation
  • Remove oils, dead skin and excessive hair to help reduce impedance
  • Cleaning with an alcohol pad may help reduce oils and the presence of dirt, thus helping with conduction
Biofeedback Equipment & Treatment Techniques

• Electrode Placement
  • As close to the muscle being monitored as possible
  • Parallel to the direction of muscle fibers to ensure that a better sample of muscle activity is monitored

Biofeedback Equipment & Treatment Techniques

• Visual Feedback
  • There are a variety of options that are dependent upon the manufacturer of the device
    • Selection will be dependent upon the preference of the patient
      • Line traveling across an oscilloscope
      • Light or series of lights that go on and off
      • A bar graph that changes dimension in response to the incoming information
      • Video games
      • Meters
        • Analog with a needle
        • Digital with numbers
Biofeedback Equipment & Treatment Techniques

- **Audio Feedback**
  - Dependent upon the manufacturer
  - Selection for a patient is dependent upon the preference of the patient
    - A tone
    - Buzzing
    - Beeping
    - Clicking
  - An increase in the pitch of a tone, buzz, or beep, or an increase in the frequency of clicking indicates an increase in the level of electrical activity
  - Conversely, decreases indicate a decrease in the level of electrical activity

Clinical Applications for Biofeedback

- **Muscle re-education**
  - Regaining neuromuscular control and increasing muscle strength
    - Hemiplegia following CVA
    - Spinal cord injury
    - Spasticity
    - Cerebral palsy
    - Facial paralysis
    - Urinary and fecal incontinence
  - Relaxation of muscle guarding
  - Pain reduction