Biofeedback

Information provided from some measuring instrument about a specific biologic function

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

• 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

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.

- 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.

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(μ)-ohm units.

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
Review of a Muscle Contraction

- 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

Muscle Contraction

- Skeletal muscle, also called striated muscle, is made up of a series of sarcomeres.
- A sarcomere consists of myosin and actin filaments that overlap upon contraction.

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
Biofeedback Equipment & Treatment Techniques

• Contraindications
  • Any musculoskeletal condition in which a muscular contraction might increase the symptoms of that condition or would be contraindicated

• 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