Chapter 3
Managing Pain with Therapeutic Modalities

Objectives
- Define pain and its purpose
- Review the anatomy & physiology of pain
- Identify and discuss the common theories associated with pain control
- Identify and discuss the various tools for assessing pain
- Identify and discuss general guidelines and strategies for managing pain

What is pain?
- One of the body's defense mechanism
- Warns the brain that tissue is going to be, or has been damaged
- Pain can also occur without any tissue damage.

Types of Pain
- Acute
- Chronic
- Referred
- Radiating (radicular)

Pain Perception
- 2 distinct categories
  - Pain threshold
    - level of noxious stimulus required to alert the individual to a potential threat to tissue
  - Pain tolerance
    - how much pain an individual can or will withstand

Pain influenced by:
- Extent of tissue damage
- Past experiences of pain
- Emotional state
- Social/cultural background
  - ethnicity
  - socioeconomic status
The Anatomy of Pain

- Central & peripheral nervous system
  - Neurons (individual nerve cells)
    - Dendrites – transmit impulses toward a cell body
    - Axon – transmit impulses away from a cell body

- Nerve impulses start in the dendrite
- From the dendrite, the impulse is passed to the nerve cell body
- From the nerve cell body, the impulse is passed to the axon

- The conduction of impulses along the length of a neuron occurs through the process of depolarization

- Neurons (individual nerve cells)
  - Synapse
    - the connection between one neuron and the next

- From the axon, the impulse is transmitted to the presynaptic dendrite
- Impulse crosses synapse to postsynaptic dendrite of the next neuron

- Resting potential
  - All nerves have a different electrical charge between the inside of the cell membrane and the outside
    - positive outside
    - negative inside
The Anatomy of Pain

Action Potential

Step 1: When a stimulus is received that exceeds the nerve’s threshold, the nerve depolarizes.

Step 2: Sodium ions (Na+) rush in, causing a sequential reversal of the membrane’s polarity.

Step 3: This sequence continues along the length of the nerve, until the impulse reaches the synapse.

Step 4: The nerve repolarizes.

The speed of conduction along the nerve is influenced by several factors:

- Size of neuron
  - Large diameter neurons transmit impulses faster than small diameter impulses.
- Myelinated vs. unmyelinated
  - Myelinated neurons transmit impulses faster than unmyelinated impulses.

Myelinated nerves

The axons are covered by a fatty myelin sheath that is interrupted by gaps where the nerve cell membrane is exposed (nodes of Ranvier).

Depolarization only occurs at the nodes of Ranvier. Impulses jump from node to node. Transmission is:

- Faster
- More efficient
- Requires less energy.
The Anatomy of Pain

- Unmyelinated nerves
  - the axons have no covering
  - depolarization occurs along the whole length of the axon
  - transmission is:
    - slower
    - less efficient
    - requires more energy

The Anatomy of Pain

- Speed of transmission
  - Large diameter nerves transmit faster than small diameter nerves

The Anatomy of Pain

- Speed of transmission
  - Myelinated small diameter nerves transmit faster than unmyelinated large diameter nerves

The Pain Process

- Initiated by stimulation of nociceptors causing depolarization of the nerve
  - nociceptors – specialized nerve fiber sensitive to mechanical, thermal, and chemical energy
  - nociceptors – also respond to superficial heat and cold, massage, & analgesic balms
The Pain Process

- Two types of nociceptors
  - mechanosensitive nociceptors
    - mechanical deformation (tissue damage, swelling, spasm)
  - chemosensitive nociceptors
    - chemical irritation (inflammatory process: presence of histamine, serotonin, bradykinin, prostaglandins)

Pain transmission pathways

- afferent pathway (ascending) — transmit impulses from PNS to CNS (dorsal horn of spinal cord & thalamus where the brain interprets the impulses as pain)
- efferent pathway (descending) — transmit impulses from CNS to PNS

The Pain Process

- 3 types of peripheral afferent nerve fibers
  - A-delta
  - C
  - A-beta

A-delta afferent fibers
- small diameter, thinly myelinated
- sensitive to strong mechanical pressure or intense heat
- 10-25% activated by noxious stimulus
- localized pain sensation
  - sharp
  - stinging
  - burning

C afferent fibers
- small diameter, unmyelinated
- 50-80% activated by noxious stimuli
- triggered by thermal, mechanical or chemical stimuli
- produce diffuse, nagging sensation
  - achy
  - throbbing

A-beta afferent fibers
- large diameter, myelinated
- very sensitive to light touch and low intensity mechanical impulses
- can inhibit transmission of pain impulses
The Pain Process

Following injury
- A-delta & C fibers transmit noxious stimuli from PNS to the dorsal horn of the spinal cord

The Pain Process

Spinothalamic tract
- 1st order (primary) afferents (ascending)
  - Transmit impulses from the sensory receptors to the dorsal horn of the spinal cord

The Pain Process

Spinothalamic tract
- 1st order (primary) afferents (ascending)
  - 3 main types
    - A-beta
    - A-delta
    - C

The Pain Process

Spinothalamic tract
- 2nd order afferents (ascending)
  - 2 types or categories
    - Wide dynamic range
      - Receive input from A-beta, A-delta, & C fibers
    - Nociceptive specific
      - Receive noxious stimuli only (A-delta & C fibers)
  - Carry sensory messages from the dorsal horn of the spinal cord to the brain

The Pain Process

Spinothalamic tract
- 3rd order afferents (ascending)
  - Carry impulses from the 2nd order afferents to the brain centers
    - Integrated
    - Interpreted
    - Acted on
The Pain Process

- Pain transmission pathways
  - efferent pathway (descending) – transmit impulses from CNS to PNS

The Pain Process

- Spinal reflex arc
  - Step 1
    - Noxious stimulation of nerve

The Pain Process

- Spinal reflex arc
  - Step 2
    - Nerve de polarizes

The Pain Process

- Spinal reflex arc
  - Step 3
    - Pain impulse is transmitted along peripheral nerve to the dorsal horn of spinal cord

The Pain Process

- Spinal reflex arc
  - Step 4
    - Within the dorsal horn of the spinal cord, the nerve impulse is split

The Pain Process

- Spinal reflex arc
  - Step 5a
    - Part of the impulse travels to the anterior horn of the spinal cord, where it is sent to the motor nerve for a response
The Pain Process

- Spinal reflex arc
- **Step 5b**
  - part of the impulse travels to the spinothalamic tract where it is sent to the brain for interpretation

Modulation of Pain

- **Primary hyperalgesia**
  - Initiated by chemical stimulus (prostaglandins & bradykinins)
  - occurs immediately after injury
  - lowers threshold to noxious stimulation
  - magnifies the pain response

Modulation of Pain

- **Secondary hyperalgesia**
  - occurs within hours of the injury
  - chemicals diffuse into the surrounding tissues, creating hypersensitivity
  - increases the size of painful area

Pain Control Theories

- Gate control
- Presynaptic inhibition theory
- Descending inhibition
- β-Endorphin & Dynorphin modulation

Gate Control Theory

- Proposed by Melzack & Wall in 1965
- Landmark discovery
- Led to the development of the TENS
- A non-painful stimulus can block the transmission of a painful (noxious) stimulus
Gate Control Theory

- Input along large-diameter afferent fibers (A-beta) can block the transmission of noxious input at the dorsal horn of the spinal cord.

Gate Control Theory

- Blocking the nociceptive pathways in the dorsal horn prevent transmission to sensory centers in the brain and prevent and/or reduce the perception of pain.

Gate Control Theory

- Substantia gelatinosa [SG] (located in dorsal horn of spinal cord) acts as gatekeeper for transmission of pain impulses.

- A-beta fiber afferents
- A-delta and C fiber afferents

Gate Control Theory

- Step 1: without any stimulation, both large & small nerve fibers are quiet; the gate is closed – therefore no pain transmission.

Gate Control Theory

- Step 2: with non-painful stimulation, large nerve fibers are primarily activated; both the SG and T cell are activated; activation of SG closes gate – no pain.

Gate Control Theory

- Step 3: with painful stimulation, small nerve fibers are primarily activated; the SG is inhibited and T cell are activated; inhibition of SG opens gate – pain transmitted to brain.
Gate Control Theory

- Rubbing the skin stimulates large diameter nerves, exciting the SG, closing the gate. Result: reduction of pain.

TENS units depolarize large diameter nerves that excite the SG, closing the gate. Result: reduction of pain.

There are multiple gates in the dorsal horn of the spinal cord.
- Closing one gate reduces pain
- Relatively impossible to close all gates

Brain stimulates dorsal horn, blocking pain transmission

β-endorphins released from pituitary causing break-down of prostaglandins and blocking of dorsal horn
Pain Control Through B-Endorphin Release

- B-endorphins released from pituitary causing break-down of prostaglandins and blocking of dorsal horn

Assessing Pain

- Visual Analog Scale (VAS)
- McGill Pain Questionnaire
- Pain Charts
- Activity Pain Indicators Profile
- Numeric Pain Scales

Visual Analog Scale (VAS)

- 10 cm horizontal line
- anchors of no pain – worst pain possible
- widely used in research

McGill Pain Questionnaire (pgs. 31-32)

- locates pain
- VAS
- pain rating index
- Takes longer to complete (10-20 min.)
Assessing Pain

- Numeric Pain Scales
  - the patient is asked to rate his/her pain on a scale from 1 to 10
  - can easily be used to assess pain pre- and post-treatment and from one day to the next
  - most widely used in the clinical setting

Assessing Pain

- Activity Pain Indicators Profile
  - 64 item questionnaire
  - measures patient activity
  - assesses functional impairment due to pain

Assessing Pain

- Pain Charts
  - Patients are asked to draw or shade in the location of and the type of pain they are experiencing on diagrams provided on a chart

Management of Pain

- General guidelines
  - Stimulate large diameter A-beta afferent fibers
    - TENS
    - massage
    - analgesis balms

Management of Pain

- General guidelines
  - decrease conduction velocity of pain fibers
    - ice
    - ultrasound
Management of Pain

General guidelines
- stimulate small diameter afferent fibers and descending pain control mechanisms
- accupressure
- deep massage
- TENS over trigger points

Management of Pain

Other strategies
- minimize degree of tissue damage by immediate application of first aid & immobilization

Management of Pain

General guidelines
- stimulate a release of BEP or other opioids through prolonged smaller diameter fiber stimulation with TENS

Management of Pain

Other strategies
- maintain effective communication with patient
  - explain to patient what to expect
  - a patient’s level of anxiety can affect their perception of pain

What questions do you have?