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

- Synapse
  - the connection between one neuron and the next

- 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 Anatomy of Pain

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

The Anatomy of Pain

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

The Anatomy of Pain

- Resting potential
  - All nerves have a different electrical charge between the inside of the cell membrane and the outside.
  - Positive outside.
  - Negative inside.

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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.

- [Diagram of depolarization]

The Anatomy of Pain

Action Potential

- **Step 3:** This sequence continues along the length of the nerve, until the impulse reaches the synapse.
- **Step 4:** The nerve repolarizes.

- [Diagram of repolarization]
The Anatomy of Pain

- 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)

Myelinated nerves

- 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 nerves transmit faster than unmyelinated 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)

The Pain Process

- 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
The Pain Process

**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

**The Pain Process**

**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

**The Pain Process**

**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)
    - carry sensory messages from the dorsal horn of the spinal cord to the brain

- 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)

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

Fast

Slow

SG

T cell

Brain
Gate Control Theory

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

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

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.

Gate Control Theory

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

Gate Control Theory

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

Descending Inhibition Theory
- Brain stimulates dorsal horn, blocking pain transmission

β-Endorphin & Dynorphin Theory
- 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
Assessing Pain

- Visual analog scale (VAS)
  - 10 cm horizontal line
  - anchors of no pain – worst pain possible
  - widely used in research

No pain .......................................................... Worst pain possible

Assessing Pain

- Visual analog scale (VAS)
  - some VAS have marked increments

No pain 0 1 2 3 4 5 6 7 8 9 10 Worst pain possible

Assessing Pain

- 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

- You must identify the source of the pain
- There is NO single "best" modality for pain control

General guidelines

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

- 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

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

Management of Pain

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