Pain in The Brain

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Substance Use and Chronic Pain

- 32%: chronic pain patients who may have addictive disorders
- 56%: people ages 20+ who report pain lasting 3+ months
- 36%: people experiencing disabling pain in previous year
- 57%: people 65+ experiencing pain lasting 12+ months
- 19%: people 12+ who report initiating SUD with pain relievers
- 29 – 60%: people with opioid addiction and chronic pain
• The #1 cause of preventable deaths in America: prescription drugs.
• “Pharm Parties” are widespread.
• Afghanistan’s opium harvest supplies 92% of the world’s heroin.
• More than 4 billion prescriptions for drugs were written in 2012.
• Most illicit users take opiate/opioid drugs to avoid emotional or physical pain, to experience euphoria, and to suppress withdrawal symptoms.
CNS 101
A lot going on inside

WHAT THE DIFFERENT PARTS OF THE BRAIN DO

FRONTAL LOBE
1. Eye and head movements
2. Behaviour and emotion
3. Speech

PARietal LOBE
5. Basic movements
6. Sensation

OCCIPITAL LOBE
7. Visual recognition
8. Vision

TEMPORAL LOBE
4. Hearing

CEREBELLUM
9. Balance and muscle coordination

Nervous System

Central Nervous System (processes, interprets, stores information; issues orders to muscles, glands, organs)
- Brain
- Spinal Cord (bridge between brain and peripheral nerves)

Peripheral Nervous System (transmits information to and from the CNS)
- Somatic Nervous System (controls skeletal muscles)
- Autonomic Nervous System (regulates glands, blood vessels, internal organs)
  - Sympathetic Nervous System (mobilizes body for action, energy output)
  - Parasympathetic Nervous System (conserves energy, maintains quiet state)
The Nervous System

Peripheral Nervous System
-the major Somatic (sensory and motor pathways to the extremities are labeled below)

- Cervical
- Brachial plexus
- Musculocutaneous
- Radial
- Median
- Ulnar
- Sciatic
- Femoral
- Common peroneal
- Tibial
- Saphenous
- Superficial peroneal
- Deep peroneal

Central Nervous System

- Cerebrum
- Cerebellum
- Cervical vertebrae
- Thoracic vertebrae
- Lumbar vertebrae
- Sacrum

Sensory input → Integration

Motor output
The types of synapses

**Synapses with another neuron**
- Neuron 1
  - Collateral branch
  - Dendrites
  - Axolemma
- Neuron 2
  - Synapses with another neuron

**Neuromuscular junctions**
- Neuron
  - Collateral branch
  - Neuromuscular junctions
  - Telodendria
  - Synaptic terminals
- Skeletal muscle fibers

**Neuroglandular synapses**
- Neuron
  - Neuroglandular synapses
  - Gland cells

Direction of impulse
- Transmitting neuron
  - Cell body (soma)
  - Axon terminals
- Receiving neuron
  - Nerve impulse
  - Receptor sites
  - Neurotransmitters
  - Synaptic cleft
  - Dendrite of receiving neuron
  - Vesicle
Stress Shrinks Brain Networks
Opiate Receptors In The CNS

Thalamus
Hypothalamus
Pituitary glands
Periventricular nuclei
periaqueductal grey
RAPHE MAGNUS: Enkephalin (\(\delta\))

\(\beta\) - endorphin (\(\mu\) & \(\delta\))
Morphine
Dynorphin (\(\mu\))

SPINAL CORD: Dymorphinergic neuron with \(\kappa\) receptors

Presynaptic inhibition of both III and IV fibres by enkephalins

Pain inhibitory complex: enkephalin (\(\delta\))
Definitions
- pain is most common reason people seek medical attention

- pain is a subjective sensation

- International Association for the Study of Pain defines pain as “an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage”
• Addiction: primary, chronic, neurobiological disease with genetic, psychosocial and environmental influencing factors in its development and manifestations

• Addictive substance: anything that leads to dysfunctional reward seeking behaviors

• Behavioral health: substance use issues + mental health issues

• Chronic non-cancer pain: not caused by ongoing tissue pathology

• Chronic pain syndrome: intractable pain for 6+ months with marked alteration in behavior, depression, anxiety, restriction in daily activities, frequent use medication, not rooted in organic disorder
✓ Hyperalgesia: abnormally intense response to normal noxious stimulus
✓ Opioid-induced hyperalgesia: from effects of opioids on CNS
✓ Pain: unpleasant sensory or emotional experience associated with actual or potential tissue damage – subjective
✓ Physical dependence: withdrawal induced by cessation
✓ Pseudoaddiction: aberrant drug-related behaviors (clock watching, drug seeking) resulting from inadequate treatment of pain
✓ Tolerance: adaptation in which exposure to substance induces diminishing effects of substance over time
• **Hyperalgesia** – excess sensitivity to pain – NS over-amplifies the sensory signal to the brain

• **Hyperpathia** – abnormal increase in pain as a result of a repetitive or damaging stimulus – pain persists even after nociceptive pain stimulus removed or healed

• **Allodynia** – painful response to normally innocuous stimulus – often happens with those who abuse opioids

• **Hyperkatifeia** – opioid misuse in the context of pain management – leading to hypersensitivity to emotional distress
✓ **Nociceptor:** is a receptor of a sensory neuron (nerve cell) that responds to potentially damaging stimuli by sending signals to the spinal cord and brain

✓ **Nociception:** the process of sending messages – usually causes the perception of pain

✓ **Substance P:** a neurotransmitter and neuromodulator – released from terminals of specific sensory nerves – found in brain and spinal cord – associated with inflammatory processes and pain
1. Pain receptors (nociceptors) in the skin are activated by tissue damage.

2. A signal travels up the peripheral nerve to the spinal cord.

3. Within the spinal cord, chemical messengers (neurotransmitters) are released. These activate other nerves that pass signals to the brain.

4. The thalamus relays the signals onto the somatosensory cortex (sensation), frontal cortex (thinking) and limbic system (emotional response).
Nociceptive pain is caused by stimulation (thermal, mechanical, chemical) of peripheral nerve fibers that respond only to stimuli approaching or exceeding harmful intensity.

- Visceral pain: diffuse, difficult to locate
- Deep somatic pain – in ligaments, tendons, bones, blood vessels, muscles, etc.
- Superficial pain: minor cuts and wounds
✓ Pain Threshold: the point at which pain begins to be felt

✓ Pain Tolerance: the maximum level of pain that a person is able to tolerate

✓ Conditioning: the ability to handle increasing levels of pain

✓ for some: the greater exposure to pain will result in more painful future experiences – learned responsive at the synaptic level
• **Phantom Pain** – pain in areas of body that no longer exist; neuropathic pain – typical of amputees

• **Psychogenic Pain** – somatoform pain: due to mental, emotional or behavioral factors

• **Breakthrough Pain** – transitory acute pain not alleviated by pain management schedule

• **Incidental Pain** – arises due to activity (arthritic, stretching…)

• **Pain Insensitivity** – may feel no pain for hours; diminished ability to feel pain
• **Radiating Pain** – perceived at the source of the pain and extends into neighboring tissue

• **Referred Pain** – felt in a part of the body that is considerably removed from the root source

• **Intractable pain** – chronic pain resistant to attempts to cure

• **Neuropathic pain** – arises due to alcoholism, amputation, back-leg-hip problems, diabetes, facial nerve problems, HIV, AIDS, multiple sclerosis, Parkinson’s, drug addiction, surgery
✓ nocebo effect: delivering verbal suggestions of negative outcomes so person expects clinical worsening

✓ placebo effect: delivering verbal suggestions and inert substances so person expects clinical improvement

✓ distraction or expectancy for either increased or decreased pain perception is associated with activation of brain regions proposed to contribute to descending pain modulatory circuits
Neuropathic pain: caused by damage or disease affecting any part of the nervous system

Peripheral neuropathy: burning, tingling, electrical, stabbing, numbing, pins & needles
### Acute vs Chronic Pain

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Acute Pain</th>
<th>Chronic Pain</th>
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<tbody>
<tr>
<td>Cause</td>
<td>Generally known</td>
<td>Often unknown</td>
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<tr>
<td>Duration of pain</td>
<td>Short, well-characterized</td>
<td>Persists after healing, ≥3 months</td>
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<tr>
<td>Treatment approach</td>
<td>Resolution of underlying cause, usually self-limited</td>
<td>Underlying cause and pain disorder; outcome is often pain control, not cure</td>
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### What Is Pain? Parallel Processing

- Emotional/motivational
- Autonomic
- Cognitive processes
- Motor/reflex

Spinal inputs → Emotional/motivational → Autonomic → Cognitive processes → Motor/reflex
ARE YOU STRUGGLING WITH EMOTIONAL PAIN?

People who were abused as children are twice as likely to suffer from depression, new research shows.

1 in 3 people who have depression and a substance abuse problem at some point in their lives.
self-harm

NEGATIVE EMOTIONS
- Frustration
- Sadness
- Jealousy
- Sadness
- Shame
- Doubt
- Fear
- Envy
- Despair
- Guilt
- Grief
- Depression

Depression
Pain
Anger
Anxiety
Pain
Myths & Misconceptions

- pain is a part of aging
- if a person is asleep, they are not in pain
- if pain is relieved by non-pharmaceutical pain relief techniques, the pain was not real
- real pain has an identifiable cause
- very young or very old people do not have as much pain
Myths & Misconceptions

- all clients lie about the existence or severity of their pain
- addiction occurs with use of morphine or morphine derivatives
- the same physical stimulus produces the same pain intensity, duration & distress in different people
- people only experience severe pain when they have been in an accident or have had major surgery
Myths & Misconceptions

• health care professionals are the authorities regarding a patient’s complaint of pain
• visible or physiological or behavioral signs accompany pain and can be used to verify its existence
• chronic pain can be cured – it is common to be completely pain-free
Pain

- an unpleasant sensory and emotional experience associated with actual or potential damage to body
- a personal private sensation of hurt
- a harmful stimulus that signals current or impending tissue damage
- a pattern of responses to protect the organism
Neurobiology of Pain

Pain and Response are shaped by:

- culture
- temperament, psychological state, genetics
- memory, cognition, beliefs & expectations
- co-occurring health conditions and SUDs
- gender, age, other biopsychosocial factors
Genetic Associations & Risk Factors

• pain field of research has advanced significantly
• need to identify and measure key environmental exposures
• need to study genetic associations and potential genetic risk factors:
  – enzymes that genetically encode serotonin receptor 2A
  – enzymes genetically-encoded to regulate levels of catecholamines (dopamine, epinephrine, norepinephrine)
  – others: glucocorticoid receptors, etc.
  – substance P
Pain and Addition Co-Occur

• both are neurobiological conditions with evidence of disordered CNS function
• both are mediated by genetics and environment
• both may have significant behavioral components
• both may have serious harmful consequences if untreated
• both require multifaceted treatment
• neither are static conditions – fluctuate in intensity over time
• treatment of one can support or conflict with treatment of other
<table>
<thead>
<tr>
<th>Drug</th>
<th>Mu</th>
<th>Delta</th>
<th>Kappa</th>
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<tbody>
<tr>
<td><strong>OPIOID PEPTIDES</strong></td>
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<tr>
<td>Enkephalins</td>
<td>Antagonist</td>
<td>Agonist</td>
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<tr>
<td>Beta-endorphins</td>
<td>Agonist</td>
<td>Agonist</td>
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<tr>
<td>Dynorphins</td>
<td>Weak Agonist</td>
<td></td>
<td>Agonist</td>
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<tr>
<td><strong>AGONISTS</strong></td>
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<tr>
<td>Codeine</td>
<td>Weak Agonist</td>
<td>Weak Agonist</td>
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<tr>
<td>Fentanyl (Sublimaze)</td>
<td>Agonist</td>
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<td>Meperidine (Demerol)</td>
<td>Agonist</td>
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<td>Methadone (Dolophine)</td>
<td>Agonist</td>
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<td>Morphine</td>
<td>Agonist</td>
<td>Weak Agonist</td>
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<tr>
<td><strong>AGONIST-ANTAGONIST</strong></td>
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<tr>
<td>Buprenorphine</td>
<td>Partial Agonist</td>
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<tr>
<td><strong>ANTAGONIST</strong></td>
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<tr>
<td>Naloxone (Narcan)</td>
<td>Antagonist</td>
<td>Antagonist</td>
<td>Antagonist</td>
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**Opiate Receptor Subtypes**
Side effects of Vicodin

Psychological
- Anxiousness
- Dizziness
- Drowsiness
- Headache
- Mood changes
- Fainting
- Confusion
- Fear
- Unusual thoughts or behavior
- Loss of appetite

Skin
- Hives
- Itching
- Yellowing

Lungs
- Difficulty breathing
- Shallow breathing

Intestinal
- Constipation
- Clay-colored stools

Urinary
- Problems urinating
- Dark urine

Ears
- Ringing sound

Throat
- Swelling

Face, lips or tongue
- Dryness
- Swelling

Eyes
- Blurred vision
- Yellowing

Muscular
- Seizures

Heart
- Slowed heart rate

Stomach
- Nausea
- Vomiting
- Distress
- Pain

Blood
- Increased clotting tendency

Lungs
- Bronchospasm

Muscular
- Tremor
- Pain

Gastrointestinal
- Nausea
- Dry mouth
- Dyspepsia
- Diarrhea
- Heartburn

Joints
- Pain

Endocrine
- Hyperinsulinemia
- Insulin resistance

Side effects of Nicotine

Central
- Lightheadedness
- Headache
- Sleep disturbances
- Abnormal dreams
- Irritability
- Dizziness

Heart
- Increased or decreased heart rate
- Increased blood pressure
- Tachycardia
- More (or less) arrhythmias
- Coronary artery constriction

Blood
Assessment
Ethics

✓ right of patient for accurate assessment & treatment
✓ right to access care – including multidisciplinary care team
✓ right to autonomy, nonmaleficence, beneficence, justice
✓ cultural sensitivity: racial, ethnic, sociodemographic
✓ to understand the use of “controlled substances”
✓ informed consent – release of information documents
Assessment of Pain-Related Problems

- daily activities – functional disability
- sleep
- quality of life
- energy/fatigue
- mood/anxiety
- social and familial stressors
- employment
- legal engagements
Clinical Assessment of Pain

• valid clinical pain measure (self-report; scaling measures)
• sensory, affective, cognitive dimensions
• qualitative versus quantitative characteristics
• measures of pain sites and diffuseness of pain
• pain dimensions – least, worst, usual, temporal, activity-based
• pain diaries
• assessment neuropathic pain
• facial expressions and motor behaviors
Clinical Assessment of Pain

- pain beliefs, appraisals, and coping strategies
- MH history: i.e., anxiety and mood disorders
- physical health history: i.e., diabetes
- assessment for PTSD – trauma history
- assessment for SUD and ABD
- psychosocial stressors - work issues
- personal and family history
- cultural issues in pain experience, pain behaviors, health care seeking, disability
Licit and illicit drugs with abuse potential:
- Cannabis (marijuana, hashish)
- Depressants (such as barbiturates, benzodiazepines)
- Hallucinogens (such as LSD, PCP, and mescaline)
- Opioids (such as codeine, fentanyl, morphine, opium, oxycodone) with attention to use related to pain
- Stimulants (such as amphetamines, cocaine, methamphetamines, methylphenidates)

Nicotine  Caffeine  Alcohol

- Last use
- Frequency
- Quantity

Binge drinking
Men: 5 or more on one occasion
Women: 4 or more on one occasion
Drugs that Suppress Pain (Analgesic Effects)

- Opiates – opium poppy extract (opium, codeine, morphine)
- Semi-synthetic Opiates (hydrocodone, oxycodone)
- Opioids – synthetic opiates (fentanyl, methadone, tramadol)
- Opioid Antagonists (naloxone, naltrexone)
- Alcohol
- Benzodiazepines - sedating
- Methamphetamine & Cocaine
- THC: Cannabis
Purpose of Patient-Centered Assessment

- identification of psychosocial influences on pain
- identification of pain’s impact on quality of life
- identification of associations of pain, sleep, fatigue, mood
- identification of psychological disorders
- identification of deficits and strengths in coping skills
- decision making and treatment planning
- identification of motivation – external and internal
- identification of supports for change
- identification of negative variables towards pain management
Treatment Planning

- biopsychosocial assessment and treatment planning
- include spiritual/emotional/contextual components
- client-centered treatment
- trauma-informed care
- culturally-sensitive care
- motivational strategies
- strategies strengthening commitment to change
- areas for psychoeducation
- operant conditioning - social reinforcement
PAIN MANAGEMENT

Questions to Ask - Options to Consider
Pharmacological Interventions

- Agonists
- Antagonists
- Non-narcotic analgesics
- NSAIDS
- Narcotic analgesics
- Adjuvants/co-analgesics
- Anesthesia & Epidurals
Adjuvant Non-Opioid Medications

- Antidepressants (Effexor, Pristiq, Cymbalta, Prozac, etc.)
- Anti-inflammatory drugs (Naproxen, Ibuprofen, Celecoxib)
- Anticonvulsants (Gabapentin, Topiramate)
- Muscle relaxants (Metaxalone, Baclofen, Methocarbamol)
- Topical analgesics (Capsaicin, Lidocaine, Topical NSAIDs)
Exercise – Movement - Distraction

Continuous exercise contributes to the brain’s release of endorphins

Endorphins reduce the intensity of pain sensed by the brain
Non-Pharmacological Interventions

- Cognitive-Behavioral Therapies
- Psychoeducation and Support Groups
- Acceptance and Commitment Therapy
- Acupressure, Acupuncture, Binders, Cutaneous Stimulation, Chiropractic Tools
- Rest and Sleep
- Counseling to address: trauma (EMDR), abuse, neglect, attachment disorder, abandonment, anger, loss
Cognitive-Behavioral Therapies

- role of feelings, thoughts and actions
- treatment rationale
- cognitive restructuring
- skills training
- exposure in vivo for pain related fear
- mindfulness
- acceptance and commitment therapy
- partner-assisted CBT
- CBT for disease-related pain
Other Treatments

- Biofeedback: EMG, EEG, temperature
- hypnosis
- relaxation therapies
- stimulus desensitization
- art therapy – music therapy – animal therapy
- community support groups
- family therapy – family engagement/support
- counseling for co-occurring disorders (i.e., grief & loss)
Skills Training

• pleasurable and meaningful activity scheduling
• breathing and relaxation techniques
• imagery techniques - meditation
• coping self-statements – self soothing techniques
• behavioral activation – yoga – stretching - movement
• focal point and visual distraction – attention diversion
• problem solving - goal setting
• relapse prevention methods
• homework assignments
20 Alternative Approaches to Stress

1. Yoga, Tai Chi, Qigong
2. Massage
3. Deep Breathing
4. Biofeedback
5. Meditation/Prayer
6. Music/Art Therapy
7. EFT Technique
8. Flower Essences/Oils
9. Homeopathic
10. Light Therapy
11. Crystals or Gemstones
12. Guided Imagery
13. Herbal or Diet Change
14. Acupuncture
15. Self Hypnosis
16. Psychic Healing
17. Energetic or Reiki
18. Counseling
19. Physical Exercise/Sex
20. Chiropractic
✓ nutritional therapy
✓ weight management
✓ chiropractor
✓ physical therapy
✓ cultural methods of pain management
✓ prayer or other spiritual assists