Why Pain Really IS All In Your Head

Perception is Reality

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Disclosures

none

Learning Objectives

The participant will:

1) **Recognize that pain is actually a disease affecting the central nervous system**

2) **Realize that chronic pain causes structural changes in the brain**

3) **Develop an understanding of how the brain is involved in pain perception and how that understanding can impact the management of patients with chronic pain**

4) **Gain an appreciation of the concept of Opioid Induced Hyperalgesia and how this phenomenon should impact opioid prescribing**

5) **Learn ways to utilize this knowledge in practice**

- **Pain is a subjective individual experience composed of sensory, affective, and cognitive dimensions**

- **Nociception is a survival mechanism**

- **Pain motivates decisions and actions**

From: "Pain is an unpleasant sensory and emotional condition" **IASP (International Association for the Study of Pain)**

To: Pain is a disease affecting the central nervous system, influenced by a variety of biological and psychosocial factors such as…

Genetics,
hormones,
emotions,
memories,
social expectations

Borsook D, Becerra L.(2007)
Phenotyping central nervous system circuitry in chronic pain using functional MRI: considerations and potential implications in the clinic
Curr Pain Headache Rep. Jun;11(3):201-7.

LIFE WITHOUT PAIN

Ashlyn Blocker: the girl who feels no pain

SCN9A mutations

“Her life story offers an amazing snapshot of how complicated a life can get without the guidance of pain. Pain is a gift, and she doesn’t have it.”

Dr. Roland Staud,
University of Florida

Pain Transmission

- **Myelinated**

A delta fibers

•Non-myelinated

C fibers

Lorimer Moseley

“Body in mind-the role of the brain in chronic pain”

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Emotions Modulate Pain Perception

Emotions related to pain were induced in healthy volunteers using hypnosis

- •negative emotions produced robust increases in pain
- •pain-related anger and sadness were found to increase pain
- •hypnotic suggestions specifically designed to increase and decrease the desire for relief produced increases and decreases in pain, respectively

Rainville P[1], Bao QV, Chrétien P. (2005)
Pain-related emotions modulate experimental pain perception and autonomic responses.
Pain. Dec 5;118(3):306-18. Epub 2005 Nov 14.

Mood Influences Pain

fMRI used to directly compare the neurocircuitry involved in mood- and attention-related pain modulation

Pleasant odors

- •induced positive mood changes
- •decreased pain unpleasantness
- •decreased pain-related activity within the anterior cingulate (ACC), medial thalamus, and primary and secondary somatosensory cortices.
- •separate neuromodulatory circuits underlie emotional and attentional modulation of pain

Chantal Villemure and M. Catherine Bushnell.(2009).
Mood Influences Supraspinal Pain Processing Separately from Attention
The Journal of Neuroscience, 21 January, 29(3): 705-715; doi: 10.1523/JNEUROSCI.3822-08.2009

Placebo Effect

The mere belief that one is receiving an effective analgesic treatment can reduce pain

- **placebo manipulations decrease neural responses in brain regions that are pain sensitive**
- **the magnitude of these neural decreases correlates with reduction in reported pain**
- **a major portion of the placebo effect may be mediated centrally by changes in specific pain regions**

Placebo Induced Changes using fMRI

Placebo analgesia is:

•related to decreased brain activity in pain-sensitive brain regions

•associated with increased activity during anticipation of pain in the prefrontal cortex

Wager TD[1], Rilling JK, Smith EE, Sokolik A, Casey KL, Davidson RJ, Kosslyn SM, Rose RM, Cohen JD.(2004) **Placebo-induced changes in FMRI in the anticipation and experience of pain.** Science. Feb 20;303(5661):1162-7.

Brain Activity
Acute vs. Chronic Pain

Comparison of back pain-related brain activity using fMRI imaging

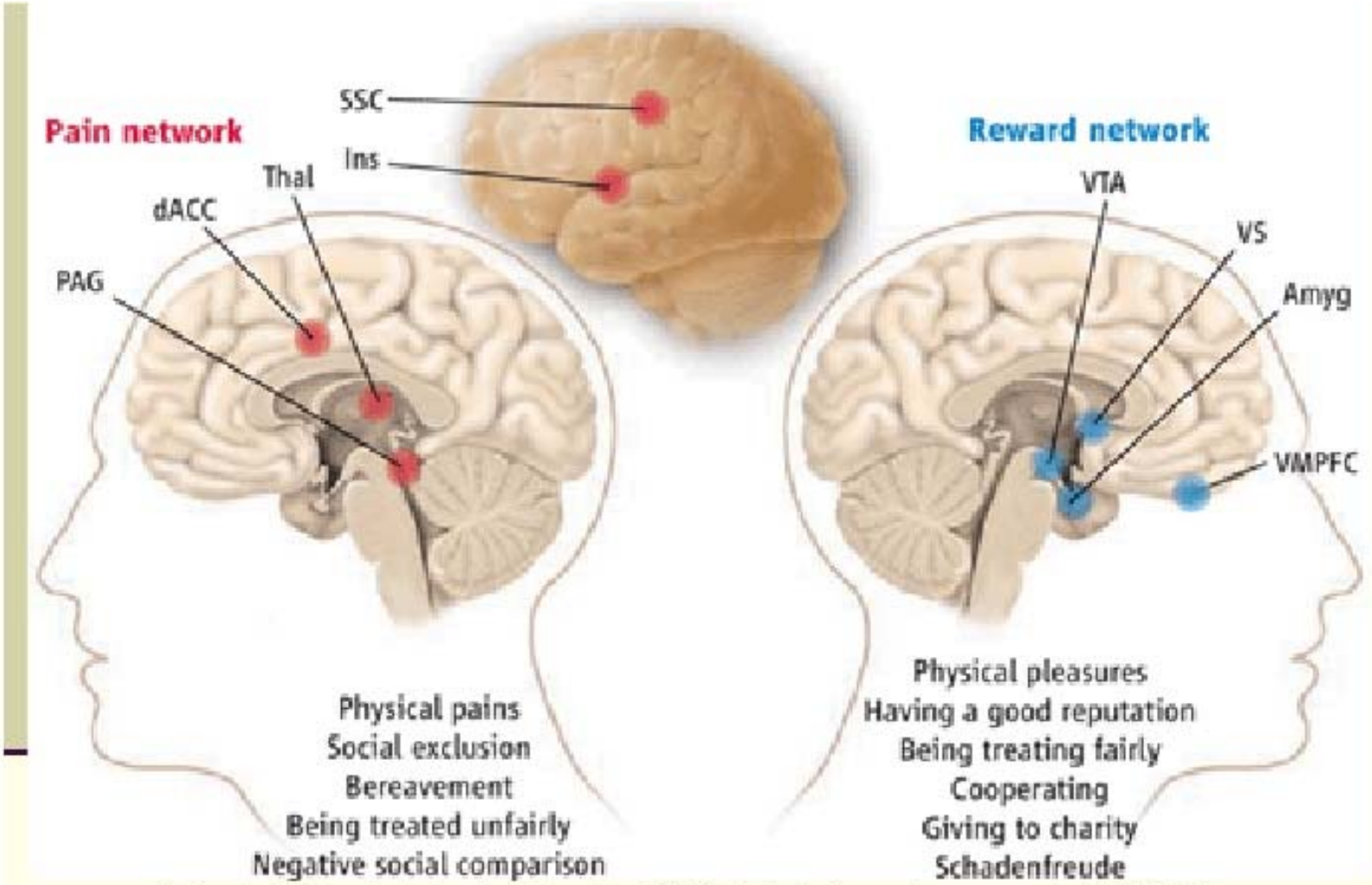
Back pain <2 months with no prior history for 1 year

- Activity is limited to regions involved in acute pain and reward circuitry (thalamus and insula)

Back pain for >10 years

- activity is confined to emotion-related and reward circuitry (amygdala and medial pre-frontal cortex)

Hashmi JA[1], Baliki MN, Huang L, Baria AT, Torbey S, Hermann KM, Schnitzer TJ, Apkarian AV. (2013).
Shape shifting pain: chronification of back pain shifts brain representation from nociceptive to emotional circuits.
Brain, Sep;136(Pt 9):2751-68. doi: 10.1093/brain/awt211.



Pain network: Dorsal anterior cingulate cortex (dACC), insula (Ins), somatosensory cortex (SSC), thalamus (Thal), and periaqueductal gray (PAG).

Reward network: Ventral tegmental area (VTA), ventral striatum (VS), ventromedial prefrontal cortex (VMPFC), and amygdala (Amyg).

K. Sutliff, in Lieberman & Eisenberger, 2009, *Science*, 323:890-891

Acute Pain Perception

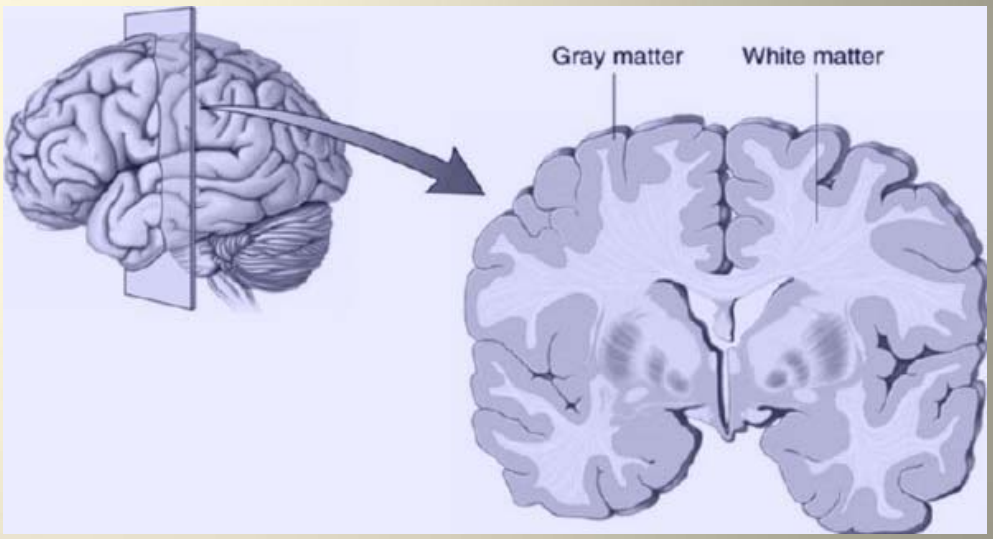
Persistent Pain Perception

In Persistent Pain the Brain Pain Map Expands up to 5 Times

The Brain Learns Pain

Structural Brain Changes in chronic pain

Loss of gray matter in specific brain areas



Phantom pain, chronic back pain, irritable bowel syndrome, fibromyalgia, and frequent headaches

May A . (2008).**Chronic pain may change the structure of the brain,** Pain. Jul;137(1):7-15

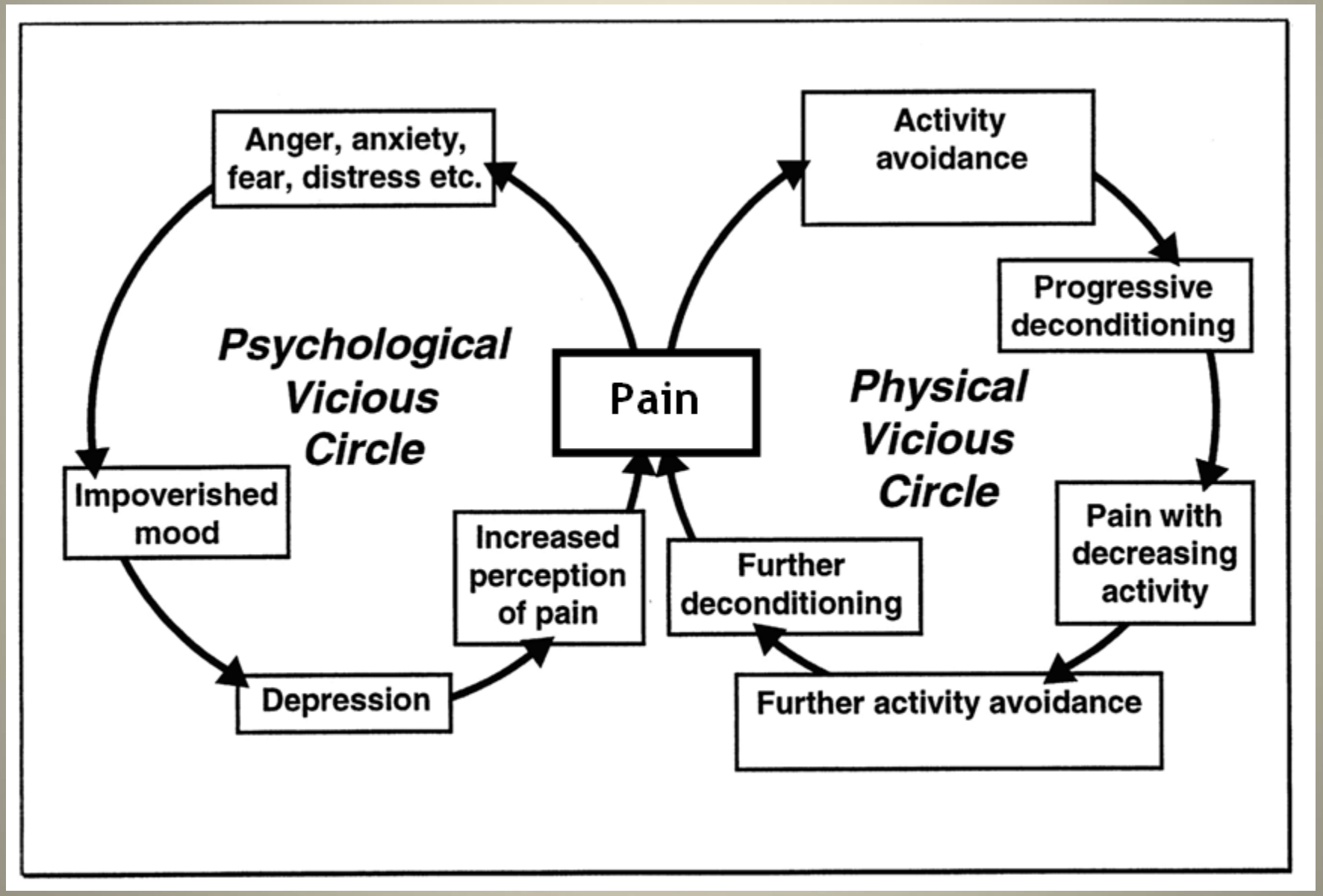
Is it possible to increase the gray matter once pain is relieved?

20 patients unilateral primary hip OA investigated 4 times

- **Before surgery (pain state)**
- **6-8 weeks post arthroplasty**
- **12-18 weeks post arthroplasty**
- **10-14 months post arthroplasty**

RESULT: Partial increases in gray matter after surgery is nearly in the same areas where a decrease in the gray matter has been seen before surgery

Rodriguez-Raecke R[1], Niemeier A, Ihle K, Ruether W, May A. (2013).
Structural brain changes in chronic pain reflect probably neither damage nor atrophy
PLoS One. ;8(2):e54475. doi: 10.1371/journal.pone.0054475. Epub 2013 Feb 6.


Anger, anxiety, fear, distress etc.
Activity avoidance
Progressive deconditioning
Psychological Vicious Circle
Pain
Physical Vicious Circle
Impoverished mood
Increased perception of pain
Further deconditioning
Pain with decreasing activity
Depression
Further activity avoidance

Australian pain society video

Australian pain society video

STRESSED INDUCED NEUROPLASTICITY

•Exposure to stress triggers hypothalamic-pituitary-adrenocortical (HPA) axis activation and associated neurochemical reactions following glucocorticoid release from the adrenal glands

•Stimulation leads to actvation of specific brain regions, including the hippocampus, amygdala and prefrontal cortex which are enriched with glucocorticoid receptors (GRs)

•activation of GRs mediates the regulation of the brain-derived neurotrophic factor (BDNF). BDNF is crucial for neural plasticity, as it promotes cellular growth and synaptic changes

•exposure to extreme, traumatic or chronic stressors is a risk factor for psychopathologies which are associated with memory impairment and cognitive deficits such as posttraumatic stress disorder (PTSD).

Deppermann S, Storchak H, , Fallgatter AJ, Ehlis AC, . (2014). Neuroscience, Dec 26;283:166-

Neurons that Fire Together, Wire Together

Donald Hebb, 1949

Limbic System Dysfunction

- **Reactivate dormant neural pathways or rebuild new pathways**
  - **Decrease amygdala hyperactivity and normalize anterior cingulate cortex activity**

Yoga and Meditation

Mindfulness Meditation: participation in MBSR is associated with changes in gray matter concentration in brain regions involved in learning and memory processes, emotion regulation, self-referential processing, and perspective taking

Yoga improves functional disability, pain intensity, and depression in adults with CLBP.
There was also a clinically important trend for the yoga group to reduce their pain medication usage compared to the control group.

Williamss, K et al (2009). Evaluation of the Effectiveness and Efficacy of Iyengar Yoga Therapy on Chronic Low Back Pain, Spine. Sep 1: 34(19): 2066–207

Hölzel Bk, et al (2011) Mindfulness practice leads to increases in regional brain gray matter density. Psychiatry Res. 2011 Jan 30; 191(1): 36–43.

REWIRING THE BRAIN

Moseley G L, Wiech, K. (2009). The effect of tactile discrimination training is enhanced when patients watch the reflected image of their unaffected limb during training . Pain, Aug;144(3):314-9.

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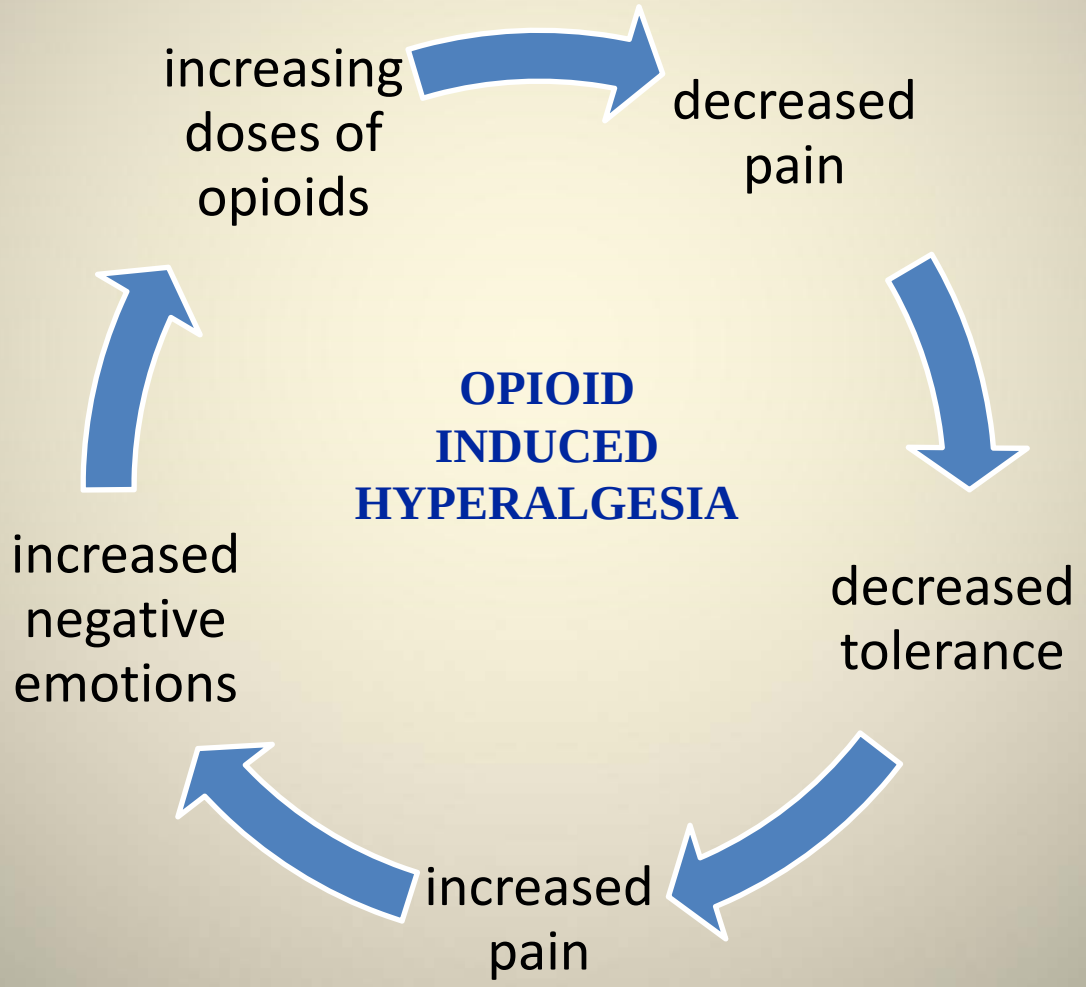
Opioid Induced Hyperalgesia

Characterized by a heightened perception of pain related to the use of opioids in the absence of disease progression or opioid withdrawal

Opioids contribute to pain

- **Opioids may directly facilitate pro-nociceptive pathways**
- **NMDA receptor may play a pivotal role**

D. Eric Brush. (2012).
Complications of Long-Term Opioid Therapy for Management of Chronic Pain: the Paradox of Opioid-Induced Hyperalgesia
J Med Toxicol.; 8(4): 387–392


increasing doses of opioids
decreased pain
decreased tolerance
increased pain
increased negative emotions
OPIOID INDUCED HYPERALGESIA

Patient encounter video