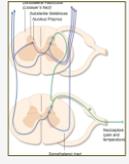


### Understanding Pain and Pain Management in the Patient with Neurologic Disease



CW Dewey, DVM, MS, CVA, CVCH  
DACVIM (Neurology), DACVS

---

---

---

---

---

---

---

---

### Why Are We Discussing Pain?

- An integral facet of treating dogs and cats with neurologic disorders, not just in the ICU setting, but often chronically
- Pain is experienced by many of our patients and is likely undertreated in veterinary medicine
- This is an overview-there is just way too much information!
- Hopefully, this will inspire you to delve deeper into pain management



---

---

---

---

---

---

---

---

### Review of the Neuroanatomy and Neurophysiology of Pain

- What is "pain"?
- Nociception is the sensory modality
- Pain is our assessment of a subjective reaction
- Patients react differently to nociceptive stimuli
- Hyperesthesia, dysesthesia, allodynia



---

---

---

---

---

---

---

---

### Buddy

- 3 y.o. MC Dachshund
- Severe neck pain
- Progression to non-ambulatory tetraparesis over 3 days
- History of recurrent back pain in TL region



---

---

---

---

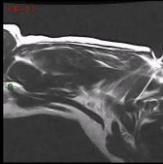
---

---

---

---

### Buddy's MRI



---

---

---

---

---

---

---

---

### Buddy Immediately Postoperatively



- SI 3
- BL 62
- BL 10
- Jing Jia Ji
- BL 20-23
- GV 14
- GV 20



---

---

---

---

---

---

---

---

## Buddy One Day Postoperatively



---

---

---

---

---

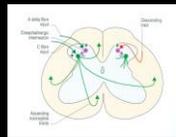
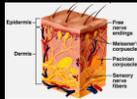
---

---

---

## Neuroanatomy of Nociception

- Nociceptors
- GSA and GVA
- Spinal cord
- Brain



---

---

---

---

---

---

---

---

## Neuroanatomy of Pain Transmission: Simplified Version

- Three neuron system
- Primary nociceptive neuron
- Spinal cord projection neuron
- Thalamic relay neuron



---

---

---

---

---

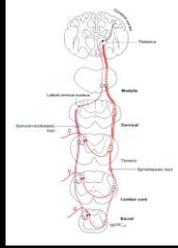
---

---

---

## Nociceptive Neurons: GSA, GVA

- Axons travel through peripheral nerves, spinal nerves, dorsal nerve roots
- Reach spinal cord at dorsolateral sulcus
- Synapse on projection neurons or interneurons in dorsal gray matter




---

---

---

---

---

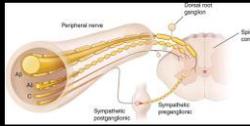
---

---

---

## Nerve Fiber Classification

- **A $\alpha$** -Group Ia and Ib (muscle spindle and Golgi tendon organ)-80 to 120 m/sec
- **A $\beta$** -Group II (cutaneous tactile, static bag, nuclear chain)-35-90 m/sec
- **A $\delta$** -Group III (sharp, pricking, "fast" pain)-5-40 m/sec
- **C**-Group IV (dull, aching, throbbing, "slow" pain)-0.5-2.0 m/sec




---

---

---

---

---

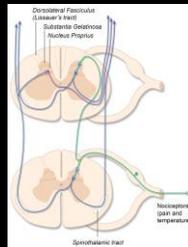
---

---

---

## Ascending Nociceptive Pathways

- Spinothalamic tract
- Spinocervicothalamic tract
- Spinomesencephalic tract
- Spinoreticular tract




---

---

---

---

---

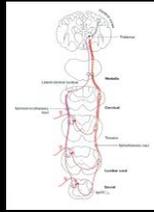
---

---

---

## Spinothalamic Tract

- The “classic” contralateral pain pathway described in people
- Suspected not as contralateral in dogs and cats
- Projection neurons synapse in thalamus, some collaterals to reticular formation
- Thalamic neurons project to cerebrum




---

---

---

---

---

---

---

---

## Spinocervicothalamic Tract

- May be more important pain transmitting tract in dogs and cats
- Projection neurons relay at lateral cervical nucleus
- LCN neurons cross to opposite thalamus
- Contralateral tract




---

---

---

---

---

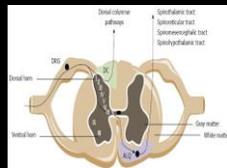
---

---

---

## Spinoreticular Tract

- Projection neurons ascend bilaterally in ventral funiculi
- Provides sensory information to reticular formation of brain stem (mainly pons and medulla)
- Serves to activate cerebrum via ARAS




---

---

---

---

---

---

---

---

## Spinomesencephalic Tract

- Projection neurons ascend in ventral funiculus, terminate in midbrain nuclei
- Some projection nuclei terminate in thalamus
- Involved in activation of descending inhibitory PAG neurons




---

---

---

---

---

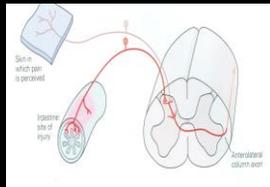
---

---

---

## Visceral vs Somatic Nociception

- GVA axons travel via sympathetic and parasympathetic nerves
- Arrive at dorsolateral sulcus
- Share interneurons with GSA telodendria
- Visceral sensory map overlaps dermatomal sensory map
- Basis of referred pain




---

---

---

---

---

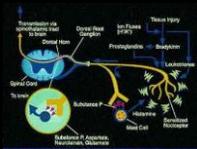
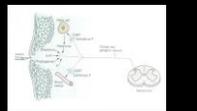
---

---

---

## Neurophysiology of Pain

- Local mediators released
- Activation of A $\delta$  and C fibers
- Peripheral sensitization
- Central sensitization




---

---

---

---

---

---

---

---

## Peripheral Sensitization

- Local inflammatory mediators released
- Bradykinin, prostaglandins, histamine, etc
- A $\delta$  and C fibers activated
- Nociceptors release more inflammatory cytokines
- Other cells induced to release cytokines
- Threshold for nociceptor activation decreased



---

---

---

---

---

---

---

---

## Central Sensitization

- Similar mechanisms as in periphery
- Increased responsiveness in spinal component of nociceptive pathway
- “Wind-up” phenomenon
- Changes in neurochemical environment and cytoarchitectural change with time



---

---

---

---

---

---

---

---

## Neurotransmitters Involved in Nociception in the CNS

- Glutamate
- Substance P
- CGRP
- Others



---

---

---

---

---

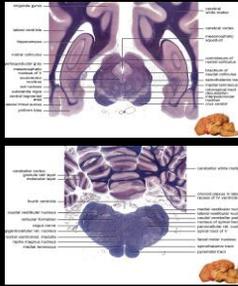
---

---

---

## Endogenous Pain Modulation

- Segmental-spinal cord level
- Suprasegmental-brain level
- Importance of opioid receptors




---

---

---

---

---

---

---

---

## How Can We Manage Pain?

- NSAIDs
- Opioids
- $\alpha$ -2 agonists
- Glucocorticoids
- Gabapentin/Pregabalin
- Local anesthetics
- Tricyclic antidepressants
- Others-ketamine, amantadine
- Electroacupuncture
- Photobiomodulation (PBM) or laser therapy




---

---

---

---

---

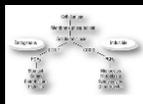
---

---

---

## Non-Steroidal Anti-Inflammatory Drugs (NSAIDs)

- Primarily use preferential COX-2 inhibitors (carprofen, meloxicam, robenacoxib)
- Effective for mild to moderate pain, mainly musculoskeletal
- May have some efficacy for neuropathic pain
- Potential for adverse gastrointestinal and renal effects
- In humans, increased rate of side effects when combined with tramadol




---

---

---

---

---

---

---

---

## Opioids

- Mainstay of perioperative and acute pain management (e.g., fentanyl, hydromorphone, methadone etc)
- Cardiorespiratory depression main concern
- Primarily parenteral use
- Effective for neuropathic pain
- Oral opiates-low bioavailability
- Tramadol-convenient, probably doesn't work, potential toxicity. Not really an opioid




---

---

---

---

---

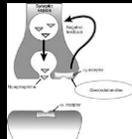
---

---

---

## α-2 Agonists

- Effective injectable analgesic agents (dexmedetomidine most common)
- Synergistic with opioids for analgesia, usually as CRI
- Cardiorespiratory depression main concern
- Also effective for local analgesia




---

---

---

---

---

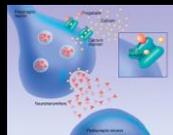
---

---

---

## Gabapentin and Pregabalin

- Target the presynaptic calcium channels, inhibit release of substance P and glutamate
- Very effective oral drug in dogs and cats (in my experience) for neuropathic pain
- Little adverse effects (sedation)
- Gabapentin often underdosed
- Pregabalin is controlled in US




---

---

---

---

---

---

---

---

## Local Anesthetics

- Typically lidocaine or bupivacaine, combined with dexmedetomidine for local analgesia
- Block nerve transmission (Na channels)
- Also used systemically (lidocaine)
- Potential for adverse CNS and cardiac effects



---

---

---

---

---

---

---

---

## Other Drugs and Adjunctive Agents

- NMDA receptor antagonists: ketamine (injectable), amantadine (oral)
- Tricyclic antidepressants (fluoxetine, clomipramine)
- Cannabinoids
- Herbal formulas



---

---

---

---

---

---

---

---

## Electroacupuncture

- Experimental and clinical evidence of efficacy for pain relief
- Local, segmental and suprasegmental effect
- Most effects at opioid receptors
- Different frequencies used during treatment
- Low frequencies most effective



---

---

---

---

---

---

---

---

## Laser Therapy (PBMT)

- Photobiomodulation
- Mechanisms include increased serotonin,  $\beta$ -endorphins, and ACh, decreased NO and bradykinins
- Also direct regenerative effects on damaged nerves
- No appreciable adverse effects of PBMT



---

---

---

---

---

---

---

---

## Questions?



---

---

---

---

---

---

---

---