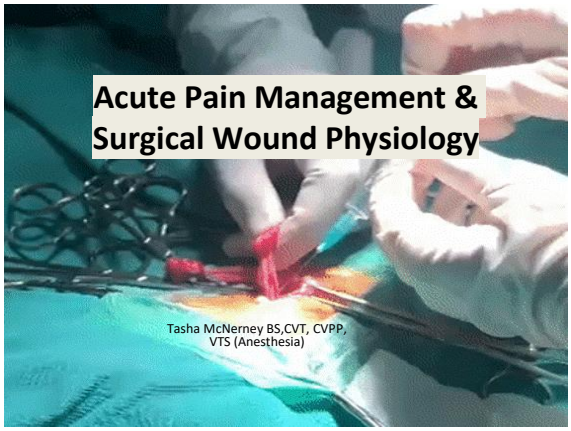

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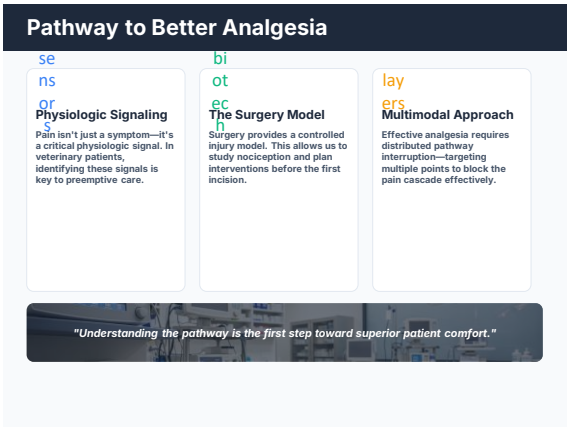

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What is Acute Pain?

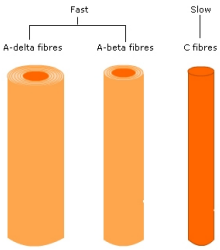
- A protective, normal physiologic response

It begins with activation of peripheral nociceptors—specialized sensory neurons that detect mechanical, thermal, and chemical injury.

These signals are transmitted through the dorsal horn of the spinal cord and ultimately processed in the brain as pain perception.

3

C fibers and A fibers



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Two major fiber types:
A-delta fibers: fast, myelinated → sharp, localized pain

Examples: Burns, surgical incisions

A-delta fibres carry sharp pain, high temperature (>45oC), hair follicle sensation and localisation.

A fibres (-delta and -beta) are the first fibres to be blocked by LA.

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C fibers: slow, unmyelinated → dull, burning, aching pain
'slow' dull aching pain, position sense, vibration, and temperature.
They are sensitive to a wide range of tissue inflammatory mediators.

Examples: Deep visceral pain, burning neuropathic pain

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Surgical Wound = Controlled Injury

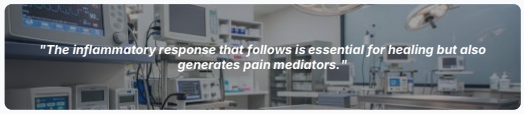
A surgical incision is a standardized, predictable injury. Unlike trauma, the tissue insult is:

Clean
Minimal contamination compared to trauma or chronic wounds.

Time-Defined
The onset of injury is precise, allowing for preemptive intervention.

Controlled
The extent of tissue insult is surgically determined and managed.

Key Distinction: Inflammation here is appropriate and necessary for healing.
However, it still activates nociceptors and sensitization pathways.



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Inflammatory Cascade

- Biochemical drivers of pain

Tissue injury triggers a biochemical cascade:

- **Arachidonic acid pathway → prostaglandins (COX-mediated)**
- **Bradykinin release → direct nociceptor activation**
- **Cytokines (IL-1, TNF-alpha) → sensitization of pain receptors**

These mediators do not just signal injury—they **lower the threshold for activation of nociceptors**, meaning normal stimuli feel painful.

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Pain Pathway Transmission

01. Activation & Peripheral Travel: Once nociceptors are activated, signals travel via peripheral nerves into the spinal cord dorsal horn.

02. Key Processing (Spinal Cord Dorsal Horn)

Synaptic Transmission
Between primary and secondary neurons

Signal Integration
Blending excitatory and inhibitory signals

Initial Modulation
Dynamic adjustment of signal strength

03. Ascending Transmission: Signals ascend via spinothalamic tracts to the brain for conscious perception.

9

Central Sensitization Prevention

- Wind-up is preventable!

Central sensitization occurs when repeated nociceptive input causes:

- Increased NMDA receptor activity
- Reduced inhibitory neurotransmission (GABA, glycine)
- Hyperexcitability of dorsal horn neurons

Clinically:

- Lower pain thresholds
- Increased opioid requirements
- Pain out of proportion to stimulus (in later stages)

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Multimodal Analgesia Targets

Blocking pain at multiple levels
Each drug class targets a different anatomical or biochemical level:

NSAIDs
Peripheral inflammation via COX inhibition.

Local Anesthetics
Sodium channel blockade; stops signal initiation.

Opioids
μ-receptor activation; spinal & supraspinal inhibition.

Ketamine
NMDA receptor antagonism; prevents wind-up.

The key principle is horizontal blocking of the pain pathway, not vertical escalation of one drug.

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Local Anesthetics

Lidocaine and bupivacaine, provide immediate, targeted pain relief by blocking nerve conduction in a specific area.

Membrane-stabilizing, working by reversibly inhibiting the generation and propagation of action potentials along nerve fibers.

Their mechanism of action involves binding to voltage-gated sodium channels in the nerve membrane. By blocking these channels, they prevent the necessary influx of sodium ions for nerve depolarization, thereby stopping the transmission of pain signals before they reach the brain.

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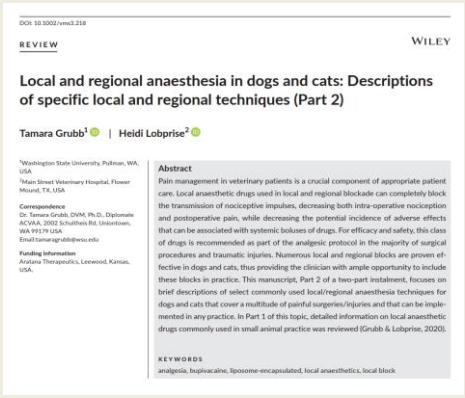

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REVIEW

WILEY

Local and regional anaesthesia in dogs and cats: Descriptions of specific local and regional techniques (Part 2)

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Abstract

Pain management in veterinary patients is a crucial component of appropriate patient care. Local anaesthetic drugs used in local and regional blockade can completely block the transmission of nociceptive impulses, decreasing both intra-operative nociception and postoperative pain, while decreasing the potential incidence of adverse effects that can be associated with systemic boluses of drugs. For efficacy and safety, this class of drugs is recommended as part of the analgesic protocol in the majority of surgical procedures and traumatic injuries. Numerous local and regional blocks are proven effective in dogs and cats, thus providing the clinician with ample opportunity to include these blocks in practice. This manuscript, Part 2 of a two-part instalment, focuses on brief descriptions of select commonly used local/regional anaesthesia techniques for dogs and cats that cover a multitude of painful surgeries/injuries and that can be implemented in any practice. In Part 1 of this topic, detailed information on local anaesthetic drugs commonly used in small animal practice was reviewed (Grubb & Lobprise, 2020).

KEYWORDS
analgesia, bupivacaine, liposome-encapsulated, local anaesthetics, local block

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Opioids

Opioids are cornerstone analgesics in veterinary acute pain management

They exert effects by binding to opioid receptors—mu (μ), kappa (κ), and delta (δ)—which are distributed throughout the central and peripheral nervous systems.

Opioid receptors are G-protein-coupled receptors that, upon activation, inhibit adenylyl cyclase activity.

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veterinary sciences

MDPI

Review

Long-Acting Opioid Analgesics for Acute Pain: Pharmacokinetic Evidence Reviewed

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Simple Summary: Pharmacokinetic (PK) studies measure the time for a dose of a drug to reach therapeutic levels in a patient's blood or tissues. This data provides a simple and precise method to compare the response to drugs made by different manufactures or the same drug provided in different delivery formats; for example, oral tablets, intravenous infusions, or subcutaneous (SC) injections. The present study provides the first review of PK data for buprenorphine, an opioid analgesic, in animals dosed with the drug in a lipid or polymer carrier. The PK data from studies using the polymer carrier system illustrate greater variability, an outcome probably related to the different manufacturing conditions of the supplying vendors. The lipid product was produced by a single vendor.

Abstract: Long-acting injectable (LAI) opioid formulations mitigate the harm profiles and management challenges associated with providing effective analgesia for animals. A single dose of a long-acting opioid analgesic can provide up to 72 h of clinically relevant pain management. Yet, few of these new drugs have been translated to products for veterinary clinics. Regulatory pathways allow accelerated drug approvals for generic and biosimilar drugs. These pathways depend on rigorous evidence for drug safety and pharmacokinetic evidence demonstrating bioequivalence between the new and the legacy drug. This report reviews the animal PK data associated with lipid and polymer-bound buprenorphine LAI formulations. Buprenorphine is a widely used veterinary opioid analgesic. Because of its safety profile and regulatory status, buprenorphine is more accessible than morphine, methadone, and fentanyl. This review of PK studies coupled with the well-established safety profile of buprenorphine suggests that the accelerated approval pathways may be available for this new family of LAI veterinary pharmaceuticals.

Keywords: analgesia; buprenorphine; harm reduction; long acting; pharmacokinetic; extended release

Check for updates

Citation: Tyler, B.M.; Guarnieri, M. Long-Acting Opioid Analgesics for Acute Pain: Pharmacokinetic Evidence Reviewed. *Vet. Sci.* **2023**, *10*, 373. https://doi.org/10.3390/...

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NSAIDs

NSAIDs manage the inflammatory component of acute pain.

Their mechanism involves inhibiting cyclooxygenase (COX) enzymes, specifically COX-1 and COX-2, which are responsible for converting arachidonic acid into prostaglandins.

Since prostaglandins are potent mediators of pain, swelling, and fever, reducing their production via COX inhibition diminishes nociception and inflammation associated with tissue injury.

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Ketamine

Ketamine works by blocking NMDA receptors in the brain and spinal cord.

Relevant to acute pain because nerve injury can lead to an increase in spinal glutamate, which activates the NMDA channel and causes central sensitization, or "wind-up" pain.

By blocking these receptors, ketamine prevents the amplification of pain signals, which reduces hyperalgesia and allodynia, making it valuable for severe pain and trauma cases.

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The Veterinary Journal
Volume 312, August 2025, 106350

A systematic review of the use of peri-operative systemic ketamine in cats and dogs for analgesia

Francesca Wickstead [a], Miguel Martinez [b]

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Highlights

- Ketamine is a non-competitive NMDA antagonist widely used in veterinary medicine for analgesia peri-operatively.
- This systematic review provided an overview of the literature on ketamine administration for analgesia in dogs and cats.
- Ketamine may influence pain scores > 12 hours post operatively. Ketamine does not influence rescue analgesia requirements post-operatively.
- Plasma concentrations > 200ng ml^{-1} correlate with nociceptive threshold changes

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Preventing Wind-Up

- Timing is everything

Timing is critical in pain management. If nociceptive input is allowed to persist untreated:

- Spinal neurons become increasingly excitable
- Pain thresholds decrease
- Analgesic requirements escalate

Preemptive analgesia aims to:

- Block input before central changes occur
- Reduce postoperative pain intensity
- Improve recovery trajectory

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Cryotherapy

- Gel cold packs applied immediately after surgery and then left in place for ~15-20 minutes to help reduce inflammation.

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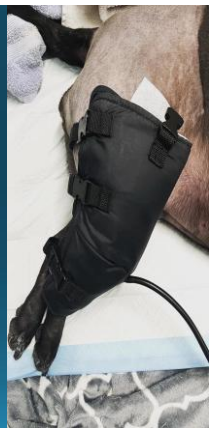
Cryotherapy for knee/elbow surgery

- These automated systems give a hands-free approach, your staff can efficiently administer cryotherapy, with the added clinical benefit of intermittent compression, to elevate your post-operative treatment compliance.
- Study of 34 dogs showed:
- No complications were observed, and all dogs tolerated CCT. Use of CCT resulted in lower values for the visual analogue scale and Glasgow pain scale and lower pain threshold scores; lower lameness scores; less swelling; and an increased range of motion 24 hours after surgery.



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Physical Therapy Exercises

- In a passive range-of-motion exercise, the therapist creates the motion.
- An example is using gentle flexion and extension of the stifle in a postoperative anterior cruciate ligament repair patient.
- Keep in mind that it may or may not be possible to restore a "normal" range of motion depending on the lesions affecting the joint.

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Clinical Outcome Comparison

Evaluating the impact of pain control on patient recovery

check_circle

Effective Analgesia

Clinical Benefits:

- Stable parameters: HR, BP, and RR remain within normal limits.
- Faster Recovery: Quicker return to normal physiological function.
- Stress Reduction: Significantly reduced release of cortisol and catecholamines.

error

Inadequate Analgesia

Clinical Risks:

- Nociceptive Signaling: Persistent, untreated pain pathways.
- Sympathetic Surge: Increased activation of the fight-or-flight response.
- Delayed Healing: Stress-mediated immunosuppression slows recovery.

Providing good vs poor pain control directly dictates the success of clinical outcomes in veterinary patients.

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At home comforts

- Ensure clients understand the medications to go home.
- Give clients tools/handouts so they can recognize and evaluate pain behaviors
- Clients can make up a recovery area in their homes that has soft comfortable bedding, access to an area to eliminate
- Limit patients access to stairs and slippery floors.

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Client Follow Up

- Call client back the next day to check the status of the patient.
- Set up rehabilitation or laser therapy appointments
- Assign a specific technician to follow up with the pet.
- Change analgesics as needed.

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Take-Home Algorithm

- Acute pain is predictable

Acute pain management follows a predictable structure:

1. Anticipate pain (before injury occurs)
2. Block multiple pathways early (multimodal approach)
3. Reassess frequently (adjust based on response)
4. Prevent escalation into sensitization states

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