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OPTIMIZATION OF THE DIAGNOSIS AND THERAPY OF PAIN IN DIFFERENT SPECIES

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Abstract

Pain represents an essential component of modern veterinary practice, significantly influencing diagnosis, clinical progression, and patients' quality of life. Recognized as the fourth vital sign, pain requires accurate and systematic assessment to establish a precise diagnosis and implement appropriate treatment. This article analyses the neurophysiological mechanisms of pain, methods for its recognition and evaluation across different species, as well as current therapeutic strategies used in the management of acute and chronic pain. The behavioural characteristics of pain in dogs, cats, and cattle are presented, along with the advantages of multimodal analgesia, which combines pharmacological and non-pharmacological approaches. Understanding the complexity of pain and applying therapeutic protocols tailored to each patient contribute to improving animal welfare and increasing the effectiveness of veterinary medical practice.

Key words*: pain, nociception, multimodal analgesia, animal welfare.*

INTRODUCTION

Pain, according to the International Association for the Study of Pain (I.A.S.P.), is an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage (Gaynor & Muir, 2014). The correct identification of pain has a considerable impact on diagnostic accuracy, therapy planning, as well as the patient's healing and recovery. In modern veterinary medicine, pain is recognized as the "fourth vital sign", alongside temperature, pulse, and respiration, emphasizing the need for its systematic evaluation in clinical practice. Untreated pain leads to stress, suffering, and physiological changes that may worsen the progression of the disease. The correct detection of pain contributes to establishing an accurate differential diagnosis and to identifying the primary condition. A detailed clinical examination, combined with modern paraclinical methods, allows for the localization of the source of pain and helps avoid diagnostic errors (Mathews et al., 2014).

MATERIALS AND METHODS

In this research, a structured review of scientific studies was conducted with the aim of highlighting the importance of optimizing pain assessment and therapy across different animal species. A total of 33 bibliographic sources were analyzed, selected according to well defined criteria to ensure the relevance and up to date nature of the information used. Studies published between 1987 and 2026 were analyzed in order to cover both foundational research and the most recent scientific advances in the field. The databases used to identify relevant literature included PubMed, ScienceDirect, Google Scholar, and Wiley Online Library, as well as textbooks and guidelines published by recognized veterinary organizations (Allweiler, 2023). The keywords used in the search process also included pain transmission pathways, pain in animals, multimodal analgesia, and non-pharmacological approaches. The selection criteria included scientific articles published in peer reviewed journals, specialized textbooks, and guidelines issued by recognized veterinary organizations, written in English. The selected works focused on pain transmission pathways, recognition of pain in different species, and the optimization of pain management protocols.

RESULTS AND DISCUSSIONS

Pain acts as a crucial built-in protective mechanism capable of having a significant impact on the quality of life. Understanding the

physiological impact of pain is crucial for developing new therapies. Nociceptor neurons are central to the processes of pain and inflammation. Interactions between nociceptors and the immune system take place both at the injury site and within the central nervous system. Targeting chemical mediators and modulating nociceptor activity present promising strategies for pain management.

Essentially, the sensory nervous system is crucial for adapting the body's protective response, making the understanding of these interactions essential for identifying new pain treatment strategies (Karcz et al., 2024).

Pain is a multifaceted experience, encompassing both physical and physiological aspects that affect the whole organism.

To facilitate the understanding of the neurophysiological process of pain, it is divided into five consecutive processes, beginning when the painful or nociceptive stimulus comes into contact with the organism (Muir & Woolf, 2001)

Transduction: the transmission of pain begins with the stimulation of the physiological receptors known as nociceptors, which are extensively located in the skin, mucosa, membranes, deep fascias, connective tissues of visceral organs, ligaments, and articular capsules, as well as in the periosteum, muscles, tendons, and arterial vessels. These receptors are associated with free nerve endings and constitute the more distal segment of a first-order afferent neuron made up of small-diameter fibers. The nociceptive stimulus is converted into an electrical signal within nociceptors (Lamont et al., 2000).

Transmission: it refers to the transmission of the electrical signal produced by nociceptors along the axons of first-order neurons, which form synapses with second-order neurons in the dorsal horn of the spinal cord (Muir, 2009). The message of "pain" is encoded within the pattern and frequency of impulses transmitted through the axons of primary afferent nociceptors. A direct correlation exists between the intensity of the stimulus and the discharge frequency of nociceptors (Osterweis et al., 1987).

Modulation: the process by which excitatory and inhibitory mechanisms alter the transmission of the nerve impulse (Lamont et al., 2000).

Projection: nociceptive information is conveyed to the brain via nerve tracts originating in the dorsal horn, particularly through spinothalamic and supraspinal structures. The dorsal columns transmit somatic sensory information to the brain. The intermediate column comprises sensory motor and autonomic nerve fibers that descend from the brain, as well as sensory pathways that ascend to the brain (Gainor & Muir, 2014).

Perception: the processing and integration of information occurring in multiple specific brain regions, such as the thalamus and cerebral cortex, where sensory characteristics including onset, location, and type of the nociceptive stimulus are defined (Hernandez-Avalos et al., 2019).

Acute pain is common as a result of surgery, illness or injury and it is undeniably unpleasant, it is typically linked to actual or potential tissue damage and plays a crucial role in quickly altering an animal's behavior to prevent or reduce injury, while creating optimal condition for healing.

The treatment of acute pain aims to address the underlying cause and to interrupt nociceptive signaling at multiple levels throughout the nervous system, whereas therapeutic approaches to chronic pain must be based on a multidisciplinary strategy and a holistic management of the patient's quality of life (Mathews et al., 2014).

Chronic pain is defined as pain that persists beyond the normal period of tissue healing, usually longer than 3-6 months. Unlike acute pain, it is maladaptive in nature and it is associated with neuroplastic changes in the central nervous system, including central sensitization, reorganization of neuronal circuits, and altered processing of nociceptive signals.

Chronic pain may have inflammatory, neuropathic, or mixed components and it is commonly encountered in conditions such as osteoarthritis, degenerative diseases, neoplasms, or nerve injuries (Costea, 2016).

Recognition of pain in animals is not intuitive and involves the assessment of behavioral and physiological signs, including the use of pain scales, however physiological parameters do not always distinguish pain from other physiological stimuli such as stress or anxiety.

Physiological parameters (e.g., changes in heart rate, respiratory rate, blood pressure, or pupil

dilation) can be used to assess responses to an acute noxious (painful) stimulus, especially during anesthesia, and to evaluate pain in specific clinical scenarios (Allweiler, 2023).

Pain evaluation in veterinary medicine must rely on a multimodal framework that extends beyond physiological and endocrine biomarkers, reflecting the subjective and multidimensional character of pain (Walsh et al., 2024; Mota-Rojas et al., 2025). Efforts to standardize pain assessment criteria have led to the development of various guidelines used to recognize pain based on physical and biological changes, such as behavioral alterations (Holton et al., 2001), facial expression, chemical mediators, and physiological parameters.

Behavioral changes to be considered in animals include social interaction aggression, vocalization, self-mutilation, sleep disturbances, restlessness and lethargy (Wiseman-Orr et al., 2006).

Body language changes involve variations in posture, limb positioning, gestures, and facial expressions (Ponzio, 2006). Importantly, these behavioral and postural modifications are species-specific and have been consistently documented in animals exposed to noxious or painful stimuli (De Grauw et al., 2016).

In cats, reports describe reduced activity levels, reduced appetite, a tendency to hide or avoid interaction, and excessive licking of the affected area, which interferes with normal grooming behavior (Reid et al, 2018). Cats experiencing pain may manifest through subtle behavioral changes, including increased aggression, hiding, reduced appetite, weight loss, inappropriate urination and decreased activity.

In dogs, the behavioral manifestation of pain varies by species and it is influenced by factors such as age, breed, individual temperament, and the presence of additional stressors like anxiety or fear (Mathews et al., 2014). Behavioral signs of pain in dogs include changes in posture or body position, altered behavior, vocalization, altered response to touch, modified interaction with humans (e.g., reduced interaction, aggression), impaired mobility (e.g., lameness, reluctance to move), and decreased appetite (Mathews et al., 2014).

Pain management in farm animals is commonly evaluated through alterations in clinical parameters accompanied by behavioral disturbances (Abrahamsen, 2008).

Affected animals may exhibit signs such as expiratory grunting, teeth grinding, reduced appetite and rumination, increased vocalization, prolonged periods of lying down, or diminished grooming behavior.

In sheep, elevations in respiratory and heart rates represent sensitive, non-invasive indicators for the assessment of mild to moderate pain (Cohen et al., 2024). Animals experiencing pain may also withdraw from the group and appear apathetic, depressed, or lethargic.

Inadequate analgesic management can lead to decreased feed and water intake, resulting in reduced daily weight gain and milk yield, diminished locomotor activity, endocrine disturbances, a catabolic metabolic state, fever, leukocytosis, and the development of behavioral abnormalities (Costea et al., 2024).

In cattle, pain related behaviors are often associated with conditions considered extremely painful, such as acute toxic mastitis, fractures, septic arthritis, and peritonitis (Huxley & Whay, 2006). These pain behaviors include changes in posture (crouching, arched back, lowered head position), severe lameness, attention directed toward the painful area, vocalization, teeth grinding (bruxism), and changes in social behavior (Gleerup et al., 2015).

It should be noted that these behavioral changes are often more noticeable when animals are alone, whereas during interactions with others, their behavior may be barely detectable or they may show no obvious signs at all (Brondani et al., 2013).

Establishing an accurate pain diagnosis requires a detailed evaluation that includes physical examinations, reflex testing, and review of the medical history to identify possible causes or contributing factors to pain.

Studies suggest that multimodal analgesia, which involves combining different classes of analgesics, provides improved pain control while minimizing the adverse effects associated with high doses of single agents.

Pain management protocols often include both pharmacological and non-pharmacological approaches, thus emphasizing the importance of multimodal strategies.

Pharmacological approaches consist of pain analgesia and are divided into three main categories: opioids, non-opioids, and adjuvants. *Opioids* are utilized in the management of moderate to severe pain with high efficacy. However, their use carries considerable risks, including the potential for dependence and a range of adverse effects, thus necessitating careful monitoring (Alorfi, 2023). Opioids attach to opioid receptors in both the central and peripheral nervous systems, reducing the release of excitatory neurotransmitters from afferent fibers in the spinal cord and consequently inhibiting the synaptic transmission of pain signals. Postsynaptically, the increased K^+ efflux causes the neuronal hyperpolarization of spinal projection neurons and inhibits ascending nociceptive pathways (Mathews et al., 2014). *Nonsteroidal anti-inflammatory* drugs (NSAIDs) reduce the production of pain-inducing prostaglandins and are effective in managing inflammatory pain.

Combining nonsteroidal anti-inflammatory drugs (NSAIDs) with opioids can improve overall pain control and allow for reduced opioid dosages, thereby lowering the risk of opioid-related adverse effects (Schwenk & Mariano, 2018). These therapeutic regimens must be tailored to each individual patient, taking into account the performed procedure, the side effects of individual medications, and the patient's pre-existing medical conditions (Buvanendran & Kroin, 2009). *Local anesthetics* utilized in clinical practice impede nerve conduction by disrupting the influx of sodium ions across the nerve cell membrane, provide localized pain relief by inhibiting nerve signals transmission at the administration site and are commonly used for nerve blocks and regional anesthesia.

The Alpha-2 adrenergic agonists activation of these receptors inhibits the release of norepinephrine in the form of a negative feedback loop in both the central and peripheral nervous systems and modulates pain signals in the spinal cord and brain, inducing sedation and analgesia, and they are particularly useful for procedural pain. Alpha-2 adrenergic agonists are indicated for the purposes of anxiolysis, sedation, analgesia, treatment of delirium and shivering, as well as numerous other applications within perioperative medical practice. Alpha-2 adrenergic agonist medications have been shown to reduce the need for anesthetics and analgesics during the perioperative phase.

Adjuvant analgesics (e.g., gabapentin, tramadol, and ketamine) are frequently utilized in small animal practice. Most of these drugs are usually prescribed for outpatient patients when pain does not respond to standard analgesics medications (e.g., local anesthetics, opioids, and NSAIDs) or when the use of other pain-relieving medications, such as NSAIDs, is contraindicated. These drugs should be considered as alternatives intended to reduce or replace opioid use (Ruel & Steagall, 2019). Gabapentin modifies neurotransmitter release and is effective in managing neuropathic pain resulting from nerve injury. NMDA antagonists: NMDA receptors play an essential role in pain sensitization. NMDA antagonists, such as ketamine and amantadine, block these receptors, preventing pain amplification and providing profound analgesia (Ruel & Steagall, 2019).

Non-pharmacological approaches include thermotherapy, cryotherapy massage, therapeutic exercises, aquatic therapy, acupuncture and electrical stimulation (Grubb, 2022).

Thermotherapy consists in applying both heat and cold to manage pain, injuries, and surgical wounds. Superficial heat helps increase blood circulation in the muscles, encourages muscle relaxation, and improves the flexibility of fibrous tissues. It can be delivered through warm compresses or infrared heat lamps (Bockstahler et al, 2004). *Cryotherapy* induces vasoconstriction, counteracts inflammation, provides analgesia, and reduces muscle spasms (Bockstahler et al., 2004).

Massage is increasingly recognized as a beneficial treatment modality (Corti, 2014). Massage, defined as the therapeutic manipulation of soft tissues, produces multiple effects on the muscles, circulatory system, autonomic nervous system, and psychological wellbeing.

Various techniques are applied to obtain specific therapeutic results in the management of numerous conditions, including swelling and edema, critical illness and extended periods of immobility, osteoarthritis and chronic pain, as well as in palliative and hospice care (Corti, 2014).

Therapeutic exercises, as part of *physiotherapy*, are designed to enhance pain-free range of motion and active flexibility, encourage the use of the limb while decreasing lameness, increase muscle mass and strength, improve everyday functional ability, and reduce the risk of future injuries (Bockstahler et al., 2004). Therapeutic exercise encompasses passive movements and proprioceptive training, as well as active exercises aimed at enhancing limb function, increasing speed, and building strength (Grubb, 2022).

Aquatic therapy refers to any exercise or manual therapy carried out in a water based environment. The benefits of aquatic therapy include the ability to provide prescriptive, functional exercises without causing pain. Balance exercises can be safely performed in water long before they can be attempted on land. The increased metabolic demand resulting from water resistance helps accelerate weight loss while simultaneously increasing muscle strength (Chiquoine et al., 2018).

Acupuncture is a popular complementary treatment option in human medicine, and increasingly, pet owners are also turning to acupuncture for their animals (Habacher et al., 2006). It is a widely used therapeutic technique that involves the insertion of fine needles into specific points on the body to stimulate the flow of vital energy ("Qi") and support the restoration of both physical and mental balance in the organism (Lindley & Cummings, 2006).

Acupuncture therapy is individualized according to the patient's specific needs, with the goal of targeting the underlying cause of the condition and preventing recurrence by restoring energetic balance (Matern, 2022). In animals, acupuncture aims to reduce pain, promote anesthesia, and treat musculoskeletal conditions (such as arthritis, hip dysplasia, and traumatic nerve injuries), gastrointestinal disorders (including abnormalities of gastric motility and irritable bowel syndrome), inflammation, as well as neurological, respiratory, and reproductive disorders (Rose et al., 2017).

Electrical stimulation has proven beneficial in the management of a wide range of painful conditions and in cases of muscle atrophy (Rushton, 2002). Indications include pain management especially in conditions such as arthritis, spondylosis, and spondylarthrosis as well as during recovery after an orthopedic surgery and in nerve regeneration. Additional uses involve promoting fracture healing, reducing muscle tension, preventing muscle atrophy caused by inactivity, and improving muscle strength (Bockstahler et al., 2004). Therapeutic approaches including neuromuscular electrical stimulation and laser therapy, have been shown to alleviate pain and inflammation, promote tissue repair, and shorten recovery following orthopedic surgery. Treatment modalities include uromuscular electrical stimulation (NMES), transcutaneous electrical nerve stimulation (TENS), and electrical muscle stimulation (EMS). Although these modalities provide a range of frequencies and currents, low-frequency pulsed alternating currents are most frequently applied for therapeutic purposes (Bockstahler et al., 2004).

CONCLUSIONS

Understanding the sequential processes of pain provides a comprehensive framework for interpreting how painful stimuli are generated, processed, and ultimately experienced by animals.

Differentiating between acute and chronic pain is fundamental for effective clinical management. While acute pain serves as an adaptive and protective function by promoting healing and preventing further injury, chronic pain is maladaptive and associated with long term neuroplastic changes that significantly compromise animal welfare and the quality of life.

These findings emphasize the necessity of early recognition and appropriate intervention to avoid the progression of acute pain into chronic pain.

Accurate pain assessment in animals remains a major challenge, as pain expression is often subtle, species specific, and influenced by behavioral, physiological, and environmental factors.

The concealment of pain as a survival mechanism further complicates diagnosis, underscoring the importance of combining behavioral observations with physiological indicators and validated pain assessment tools.

Species specific behavioral changes observed in companion animals and farm animals reinforce the need for tailored assessment protocols.

Effective pain management requires a multimodal approach that integrates medication and non-medication strategies. The combined use of opioids, non-opioid analgesics, adjuvant drugs, and regional anesthesia allows for improved analgesic efficacy while minimizing adverse effects.

Therapies without medication, such as physiotherapy, thermotherapy, aquatic therapy, acupuncture, massage, and electrical stimulation play a crucial complementary role, particularly in chronic pain management and rehabilitation.

Overall, this research underscores that comprehensive pain recognition and multimodal management are essential not only for improving clinical outcomes but also for safeguarding animal welfare.

Continued advancements in understanding pain mechanisms and refining assessment and treatment strategies are critical for the development of more effective, individualized, and humane pain management protocols in veterinary medicine.

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