Pain Recognition & Management in Critical Care Patients

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Pain management is crucial in critical care patients. Pain has multiple negative effects that can delay or prevent healing, and veterinary technicians play a central role in pain management. Understanding pain, its consequences, and how it can be addressed increases veterinary technicians' ability to work with veterinarians to ensure that patients are comfortable both during hospitalization and when they go home.

PHYSIOLOGY OF PAIN

Nociceptors are unmyelinated peripheral neurons sensitive to noxious stimuli. They are found throughout the body and are triggered by mechanical, chemical, or thermal stimuli.[1]

When a stimulus activates a nociceptor, a nerve impulse is produced. This impulse is transmitted to the dorsal horn of the spinal cord, where it causes the release of neurotransmitters (e.g., aspartate, glutamate γ-aminobutyric acid [GABA]) and neuropeptides (substance P). Some of these are excitatory and continue to send the signal up the spinal cord to the brain, while others are inhibitory and inhibit the signal from traveling further. Inflammation causes an increase in excitatory neurotransmitters while reducing inhibitory neurotransmitters.[2]

There are three types of nerve fibers: A-delta, A-beta, and C fibers. A-delta fibers are medium to small, thinly myelinated, and conduct at a speed of 6 to 30 m/sec. A-beta fibers are larger, myelinated, and conduct at a speed of 30 to 70 m/sec. C fibers are small, unmyelinated, and conduct at a speed of 0.5 to 2 m/sec.[1] A fibers are sensitive to thermal or mechanical stimulation, causing a sharp, localized pain, while C fibers can be sensitive to thermal, mechanical, or chemical stimuli, causing a dull, aching pain that is more diffuse.[1,3]

PATHOPHYSIOLOGY OF PAIN

Pain, whether from injury or surgery, can have many detrimental effects if left untreated. The release of catecholamines in response to a painful stimulus results in tachycardia, hypertension, and an increase in oxygen consumption by the myocardium. If prolonged, this can lead to left ventricular dysfunction, ischemia, and possible infarction. An increase in the release of cortisol and glucagon can cause insulin resistance and hyperglycemia. Stress caused by pain increases the activity of clotting factors, leading to an increased risk for developing a coagulopathy. Stress also suppresses the immune system, leading to an increased risk for infection.[4]

If thoracic pain is present, the patient may be unwilling to breathe normally, leading to atelectasis. Decreased gastrointestinal motility and the development of ileus and urine retention after abdominal surgery (secondary to pain and an

unwillingness to posture to urinate) can cause decreased bladder function. The patient may also be anxious, agitated, and unable to rest, prolonging the recovery period.[4]

RECOGNITION OF PAIN

Recognition of pain has always been difficult in veterinary patients. Some patients are stoic and do not demonstrate obvious signs of pain, while others are very sensitive and will react to the slightest touch. The patient may be hunched, splint (stiffen its muscles) with abdominal palpation, vocalize (growl, hiss), refuse to lie down, stretch (FIGURE 1), be restless or agitated, be tachycardic or hypertensive, refuse to rise, or walk stiffly. If measures taken to relieve pain seem unsuccessful, it is helpful to ask the owner about the patient's normal behavior and attitude.

While pain management is a team effort, the veterinary technician plays a large role in recognition and treatment of pain. The patient should be assessed at the beginning of the shift so that any changes can be noted throughout the day.

Pain Versus Anxiety

It is important to be able to distinguish between pain and anxiety because both can cause tachycardia, hypertension, and changes in posture. Removing the patient from its kennel or taking it out for a short walk may alleviate some anxiety. If an outside area is available, it is often advantageous to assess the patient outdoors to see if it is more relaxed out of the hospital environment.

Patient comfort while in the kennel is equally important to reducing anxiety; however, individual preferences vary. A soft, thick bed can keep older patients more comfortable, while other patients prefer a thin blanket and refuse to lie down if the bed is too thick or soft. Cats often prefer a bed, although occasionally they prefer to lie in the litterbox. Cats that will not use a standard bed may be happier with a blanket placed in a second litterbox or no bed at all.

Some canine breeds are normally vocal (e.g., beagles, Northern breeds). Veterinary technicians should be able to differentiate between normal vocalization and vocalization secondary to pain or discomfort.

Assessing Pain

Gentle palpation of the abdomen can reveal abdominal pain. Some patients become tense immediately on being touched, and it is helpful to place your hands on either side of the abdomen, wait for the patient to relax, and then slowly palpate the abdomen. If the patient tenses, leave your hands where they are until the animal relaxes again; then continue palpating. If the patient does not relax or is vocal, pain is likely present, and the veterinarian should be notified.

If the patient is tachycardic when auscultated, it is advantageous to leave the stethoscope in place for a minute or two to give the patient a chance to relax and the heart rate to normalize. Pain is only one cause of tachycardia and other causes (e.g., hypovolemia, anxiety, excitement) should be ruled out.

Painful patients are reluctant to move and often refuse to lie down or stand up because they anticipate pain associated with changing position (FIGURE 2). If a patient does not appear painful but refuses to lie down, it may be

FIGURE 1. This type of stretch, called *prayer posture*, can be a sign of pain. This dog presented for vomiting. He was later taken to surgery and underwent foreign body removal.

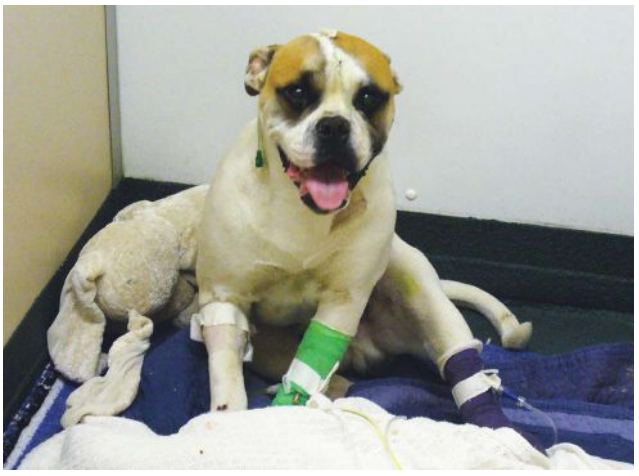

FIGURE 2. This dog was admitted to the hospital after being hit by a car. He is showing signs of pain, including refusing to lie down, panting, and an anxious expression. After receiving a bolus of fentanyl, he lay down and slept for several hours.

anticipating pain. It is often helpful to physically lay the patient down and sit with it until it has relaxed.

Pain scales can be used to ensure pain assessment remains consistent. Colorado State University has developed pain scales for dogs and cats that assess behavior as well as response to environment and palpation (see pages 44 and 45).

Cats

Cats are often difficult to assess. They may be fractious by nature, and so hissing or growling may not indicate pain. Tachycardia and increased respiratory rate may be signs of anxiety rather than pain, and hiding, while a possible sign of pain, can also be caused by simple fear. To decrease stimuli that may contribute to fear and anxiety, covering the cage with a blanket may be beneficial. If possible, keeping feline patients in quieter surroundings (e.g., away from noisy dogs) may also help.

A painful cat may be quiet while refusing to move or may become aggressive and growl or hiss while rolling in its kennel.[5] It is worthwhile to try observing the cat from a distance in case your presence causes anxiety. When palpating for pain, it is recommended to palpate the area several times and watch for a repeatable pain response. If you are unsure whether the patient is painful, it is always best to assume that it is and administer analgesics.

Team Communication

If the veterinary technician believes a patient is in pain, he or she should approach the clinician to discuss additional pain management. It is in the patient's best interest to obtain as much information as possible before going to the clinician with concerns (BOX 1). When talking to the clinician, technicians should be ready to discuss observed signs of pain, what has been done to address other possible causes of discomfort (e.g., walking the patient, checking the bedding, ensuring the intravenous catheter is patent), and what analgesics the patient is receiving, including the dose, frequency, and time of last administration.

Of equal importance is communication between veterinary technicians. Rounds at the end of the shift should include information on the patient's pain status as well as any concerns and opinions, including whether the patient is more anxious than painful or how it is responding to new analgesics. The same information given to the clinician should be given to the technician taking over care.

BOX 1 Pain Assessment Checklist

- → Observe the patient for behaviors associated with pain, such as anxious expression, restlessness, panting, and reluctance to move/change position.
- → Obtain the patient's heart rate, blood pressure, and respiratory rate.
- → Palpate the patient to identify signs of abdominal pain or the need to urinate. Elevated heart rate, respiratory rate, and blood pressure and signs of anxiety may all be caused by the need to urinate and the patient's unwillingness to soil its kennel.
- → Ensure that the intravenous catheter is patent and that the patient is receiving its prescribed analgesics at the proper dose.

TECHPOINT

Pain has multiple negative effects that can delay or prevent healing, and veterinary technicians play a central role in pain management.

PAIN MEDICATIONS

It is vital that veterinary technicians be knowledgeable about the different types of pain medication available and the mechanism of action for each drug. TABLE 1 lists the most common pain medications used in veterinary medicine, the level of pain relief they provide, and their standard dosages.

Opioids

Several opioids are used in veterinary medicine. Opioids are classified based on the receptor they bind to as well as the effect of binding on receptor activity.[6] Some opioids bind to only one receptor, while others bind to multiple receptors. There are three primary opioid receptors[6]:

- → **Mu**—located in multiple areas, including the brain (thalamus and cortex) and spinal cord
- → **Delta**—located in the brain
- → **Kappa**—located in the brain and spinal cord

When an opioid binds to a receptor, it may cause increased receptor activity with a maximum effect (agonist), increased receptor activity that plateaus at an effect lower than maximum (partial agonist), or decreased receptor activity (antagonist).[6]

TABLE 1 Common Analgesics Used in Dogs and Cats[6,7]

DRUG	PAIN LEVEL	CANINE DOSAGE	FELINE DOSAGE	COMMENTS
Opioids				
Tramadol	Mild to moderate	2–4 mg/kg PO BID–TID	2–4 mg/kg PO BID–TID	→ Synthetic analog of codeine that acts as a weak mu receptor agonist → Potency: 0.10 → Often used for pain management in the home setting → Dogs: Analgesic properties are assumed secondary to serotoninergic and noradrenergic effects because of inability to convert to active metabolite[8] → Cats: Opioid effects[8]
Morphine	Severe	0.5–2.0 mg/kg IV q2–4h	0.2–0.5 mg/kg IV q3–4h	→ Mu receptor agonist → Potency: 1 → Can cause histamine release leading to vasodilation, hypotension, and pulmonary edema; also may cause cardiac and respiratory depression[8] → Contraindicated in patients in shock or undergoing mast cell tumor removal
Butorphanol	Mild to moderate	0.1–0.4 mg/kg IV/IM q1–4h	0.1–0.4 mg/kg IV/IM q2–6h	→ Mu receptor antagonist → Kappa receptor partial agonist → Potency: 5 → Duration of action: 30–45 min[9] → Can be used to reverse sedation and respiratory depression associated with pure mu agonists
Hydromorphone	Severe	0.05–0.2 mg/kg IV q1–4h	Contraindicated in cats because of potential for hyperthermia[10]	→ Mu receptor agonist → Potency: 5 → Does not cause the histamine release associated with morphine → Dogs: Can be given on presentation at 1 mg/kg
Oxymorphone	Severe	0.05–0.4 mg/kg IV q2–4h	0.2–0.5 mg/kg IV q3–4h	→ Mu receptor agonist → Potency: 7 → Does not cause the histamine release associated with morphine → May cause bradycardia, increased sensitivity to sound, and decreased ability to thermoregulate[8]
Buprenorphine	Moderate to severe	0.005–0.02 mg/kg IV/IM q6–8h	0.005–0.02 mg/kg IV/IM/PO q8–12h	→ Mu receptor partial agonist → Kappa receptor antagonist → Potency: 33 → Dogs: PO administration is ineffective and not recommended in this species[11] → Cats: Transmucosal administration provides 100% bioavailability and quick onset of action in this species[12]
Fentanyl	Moderate to severe	2–5 mcg/kg/h CRI	2–5 mcg/kg/h CRI	→ Mu receptor agonist → Potency: 100 → Short duration of action → Has few cardiovascular effects → Can have mild respiratory effects → May lower body temperature through decrease in temperature set point[6]
Alpha-2 Agonist				
Dexmedetomidine	Adjunct	0.0005 mcg/kg/h CRI	0.0005–0.0008 mcg/kg/h CRI	→ Exerts effects in brain and dorsal horn of the spinal cord → Works well in conjunction with opioids → Higher doses are associated with notable cardiovascular and respiratory effects[13]
N-Methyl-D-Aspartate (NMDA) Agonist				
Ketamine	Adjunct	20 mcg/kg/min CRI	5–10 mcg/kg/min CRI	→ Decreases sensitization of the central nervous system and increases activity of inhibitory neurons[14]
Local Anesthetic				
Lidocaine	Adjunct	25–75 mcg/kg/min CRI	10–40 mcg/kg/min CRI, but use with caution in this species	→ Sodium channel blocker → Dogs: Can be used systemically in dogs to block neuropathic pain and pain associated with inflammation[15] as well as to decrease hyperalgesia and required opioid dose[16] → Cats: Has been shown to cause cardiac depression without any benefit[17,18]
Oral Analgesics				
Gabapentin	Moderate	2.5–10 mg/kg PO q8–12h[17]	2.5–5.0 mg/kg PO q12h[17]	→ Binds to voltage-gated calcium channels that are upregulated in response to a noxious insult to inhibit calcium influx, thereby inhibiting release of excitatory neurotransmitters → Can be used while the patient is still on injectable analgesics to provide a smooth transition from intravenous to oral analgesics
Carprofen	Mild alone; moderate with opioid	2.2 mg/kg SC or PO BID 4.4 mg/kg SC or PO q24h	Contraindicated in cats	→ NSAID

The potency of each opioid is compared with that of morphine (TABLE 1).[6] The greater the potency, the smaller the dosage required for the drug to be effective.

NSAIDs

Nonsteroidal anti-inflammatory drugs (NSAIDs) inhibit cyclooxygenase (COX), an enzyme involved in the production of prostaglandins, some of which are mediators of the inflammatory response. There are two forms of COX: COX-1 and COX-2. COX-1 produces prostaglandin E_2 (PGE_2), which plays a role in several functions involving the gastrointestinal system, such as increasing mucus and bicarbonate secretion, decreasing gastric acid secretion, and increasing the rate of turnover of gastric mucosa cells. COX-1 is also indirectly involved in coagulation processes.

In addition to PGE_2, COX-2 produces prostacycline (PGI_2), which causes vasodilation, inhibits platelet aggregation, and is involved with inflammation. PGE_2 and PGI_2 also decrease blood flow to the kidneys.

Carprofen is a COX-2 specific NSAID, meaning it inhibits COX-2 without blocking the activity of COX-1. As a result, it has fewer gastrointestinal side effects, is less likely to cause bleeding secondary to platelet inhibition, and is less likely to cause renal disease.[19]

Dose Calculation

Veterinary technicians are usually the ones calculating drug dosages and constant-rate infusions. It is important for technicians to be comfortable with these calculations and to be able to perform them accurately. Often, multiple calculations are required for a single drug, as shown in the case example on page 42.

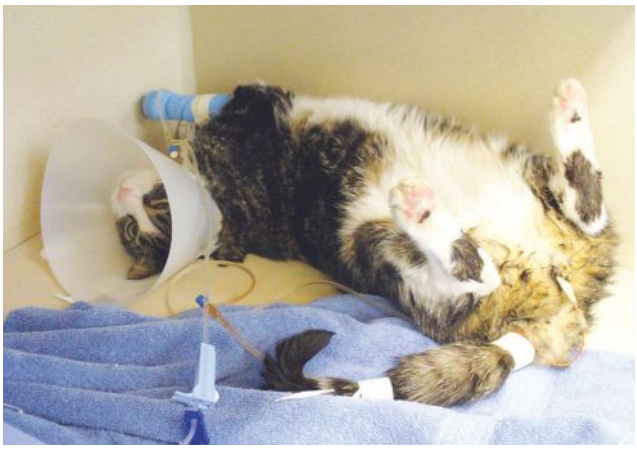

FIGURE 3. This cat presented for a urethral obstruction 24 hours earlier. He is on oral buprenorphine and is very comfortable. When approached, he rolls over on his back, and he purrs when his belly is rubbed.

TECHPOINT

Understanding the physiology and pathophysiology of pain, as well as being aware of the options available, can only serve to elevate patient care.

If the patient is on a constant-rate infusion (such as with fentanyl), a dose range allows the veterinary technician to make adjustments based on the patient's pain level. This gives technicians the freedom to address pain quickly.

Assessing Response to Medication

Veterinary technicians play an important role in pain management. Often, because technicians monitor patients through their hospital stay, they are more able to recognize changes in patients' behavior and can quickly tell if a patient is showing signs of pain or appears more comfortable.

Changes in patient attitude, such as willingness to lie down or a decrease in anxiety, indicate whether pain management is adequate (FIGURE 3). Normalized heart rate, respiratory rate, and blood pressure are also signs that pain is well controlled.

OTHER METHODS OF MINIMIZING PAIN

It is also helpful to combine treatments so the patient is disturbed as little as possible. Bloodwork can be scheduled during normal treatment times, as can subcutaneous or intramuscular injections. If the patient is recumbent, taking it outside on a gurney can brighten its spirits. Depending on the cause of the pain, warm or cold compresses can be helpful.

CONSIDERATIONS IN SPECIAL PATIENT POPULATIONS

Patients with Thoracostomy Tubes

Thoracostomy tubes are known to cause severe pain that prevents the patient from fully expanding its lungs, which can lead to atelectasis. These patients are also reluctant to lie down and unable to rest. While systemic analgesia (primarily opioids) does address this pain, these patients benefit greatly from additional analgesia, including intercostal blocks or intrapleural analgesia.

Case Example: Pain Management After Foreign Body Surgery

Emma, a 22-kg, 6-year-old, spayed mixed-breed dog, presented with a 3-day history of vomiting and anorexia. On physical examination, Emma was tachycardic, panting, and anxious. When her abdomen was palpated, she splinted and whined. To address her pain, an intravenous (IV) catheter was placed and 0.1 mg/kg of hydromorphone was administered IV. Abdominal radiographs were highly suspicious for a foreign body.

Emma was admitted to the hospital and started on a constant-rate infusion (CRI) of fentanyl (50 mcg/mL) to control her pain. The clinician ordered a CRI of 2 to 4 mcg/kg/hr. The CRI was started at a rate of 3 mcg/kg/hr. The delivery rate was calculated as follows:

$$\textbf{22 kg} \times \textbf{3 mcg/kg/hr} = \textbf{66 mcg/hr}$$

$$\frac{\textbf{66 mcg/hr}}{\textbf{50 mcg/mL}} = \textbf{1.32 mL/hr}$$

Emma's CRI was delivered at a rate of 1.3 mL/hr.

Emma required an intestinal resection and anastomosis. Surgery went well, and the fentanyl CRI was continued postoperatively at 3 mcg/kg/hr.

The following morning, the veterinary technician caring for Emma noted that she was quiet and reluctant to leave her kennel. She had urinated in her kennel and had not moved away from the soiled bedding. Once Emma was up, she moved slowly and was disinterested in her surroundings. When walked outside, Emma was unwilling to posture to urinate and consistently adopted a prayer posture, which allowed her to stretch her abdomen in an attempt to relieve her pain (FIGURE A).

FIGURE A. Emma in prayer posture.

When the attending clinician palpated her abdomen, Emma splinted (arched her back) and tried to look around at her abdomen. She was tachycardic, panting, and appeared anxious.

To address her pain, the clinician ordered an additional CRI of lidocaine at a rate of 25 mcg/kg/min. He asked that the lidocaine be placed in a 1 L bag of 0.9% sodium chloride and delivered at a rate of 25 mL/hr. The infusion rate was calculated as follows:

$$\textbf{22 kg} \times \textbf{25 mcg/kg/min} = \textbf{550 mcg/min}$$

Because the CRI would be delivered as mL/hr, the dose had to be converted to mcg/hr:

$$\textbf{60 min/hr} \times \textbf{550 mcg/min} = \textbf{33,000 mcg/hr}$$

Intercostal blocks are performed by injecting bupivacaine (0.5%) caudal to the head of the ribs surrounding the insertion site of the thoracostomy tube. The bupivacaine dose should not exceed 5 mg/kg. If the patient and the volume of the dose are both small, the dose can be diluted with 0.9% saline. The total amount can be divided between several injection sites and can be given every 6 to 12 hours.[20]

Intrapleural analgesia may be more effective because the medication is injected directly into the pleural space. At the author's hospital, bupivacaine at a dose of 1 mg/kg is injected into the thoracostomy tube, followed by 0.9% saline to ensure the drug reaches the pleural space. This is followed by injection of 1 mg/kg of lidocaine into the thoracostomy tube, and the tube is again flushed with 0.9% saline. This procedure is performed every 6 hours until the thoracostomy tube is removed.

Neonatal, Pregnant, and Lactating Patients

Drug absorption is disrupted in pregnant animals because of a decrease in gastrointestinal motility, increases in cutaneous blood flow, low-normal serum albumin levels, rapid renal secretion, and increases in total body water.[21] Drugs that are lipophilic will cross the placental barrier. Ionized, polar, or protein-bound drugs are less likely to do this.[21]

Drugs that are highly lipid soluble or non-ionized are excreted in milk and should be avoided in nursing animals. Current estimates state that nursing neonates will receive 1% to 2% of the drug dose.[21]

Pediatric patients may not be affected by some medications (e.g., ketamine) due to their underdeveloped N-methyl-D-aspartate (NMDA) system.[21]

NSAIDs should be avoided in pregnant patients because they block the production of prostaglandins. This can cause fetal abnormalities (orofacial cleft, ductus arteriosus, and underdeveloped kidneys). Fetuses and neonates may also eliminate some drugs more slowly due to their increased body water, increased tissue perfusion, lower plasma protein level, and immature hepatic system.[21]

CONCLUSION

Veterinary technicians must act as patient advocates. Because technicians have the most contact with patients,

A 2% solution of lidocaine was used, meaning the concentration of lidocaine was 20 mg/mL. To calculate the delivery rate, it was first necessary to convert 33,000 mcg to mg:

$$\frac{\text{33,000 mcg/hr}}{\text{1000 mcg/mg}} = \frac{\text{33 mg/hr}}{\text{20 mg/mL}} = \text{1.65 mL/hr}$$

If the lidocaine were to be administered alone, it would be delivered at a rate of 1.65 mL/hr. However, the clinician had asked that it be added to 1 L (1000 mL) of 0.9% saline and delivered at a rate of 25 mL/hr. The veterinary technician therefore had to determine how much lidocaine to add to the liter of saline to deliver 25 mcg/kg/min when the fluids were running at 25 mL/hr. This was calculated as follows:

Calculate how many hours the bag of fluids will last:

$$\frac{\text{1000 mL}}{\text{25 mL/hr}} = \text{40 hr}$$

Then calculate the amount of lidocaine needed to provide 1.65 mL/hr for this period of time:

$$\text{1.65 mL/hr} \times \text{40 hr} = \text{66 mL}$$

For Emma's CRI, 66 mL of lidocaine was added to 1 L of fluids, which was delivered at 25 mL/hr, to deliver 25 mcg/kg/min of lidocaine.

This math can be double-checked by going backward:

$$\text{66 mL of lidocaine} \times \text{20 mg/mL} = \text{1,320 mg}$$

$$\frac{\text{1,320 mg}}{\text{1000 mL}} = \text{1.32 mg/mL}$$

$$\text{1.32 mg/mL} \times \text{25 mL/hr} = \text{33 mg/hr}$$

$$\text{33 mg/hr} \times \text{1000 mcg/mg} = \text{33,000 mcg/hr}$$

$$\frac{\text{33,000 mcg/hr}}{\text{60 min}} = \text{550 mcg/min}$$

$$\frac{\text{550 mcg/min}}{\text{22 kg}} = \text{25 mcg/kg/min}$$

Emma did well with this combination. After 24 hours, her lidocaine CRI was discontinued and the veterinary technician watched her closely for any signs indicating pain (tachycardia, panting, anxiety, restlessness, or an unwillingness to lie down). Emma continued to be pain free.

When it was time to switch Emma to oral pain medications, she was given gabapentin at a dose of 9 mg/kg (200 mg total) PO TID. Her fentanyl CRI was discontinued several hours later, at which time she was started on tramadol at a dose of 4.5 mg/kg (100 mg total) PO TID. She did very well on this combination of drugs and was sent home the following morning.

This case shows how a combination of analgesics can be used to control postoperative pain, as well as the multiple roles veterinary technicians play in pain management.

they are in an ideal position to monitor and address pain. Understanding the physiology and pathophysiology of pain, as well as being aware of the options available, can only serve to elevate patient care. ■

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