Anesthesia and Pain Management For Spay/ Neuter (TNR Clinics)

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INTRODUCTION

The primary goal of high-quality/high-volume trap-neuter-return (HQHVTNR) programs is to provide humane population management of community cats. Of equal importance is how we go about achieving that goal. The primary objectives in achieving our goal are to minimize the stress of our patients and to maximize the safety of the humans who are providing care.

However, HQHVTNR programs have unique anesthesia and pain management challenges:
Pre-anesthetic exams cannot be performed to assess patient health status or anesthetic risk.
Adequate patient fasting may not be achieved.
Providing extensive patient follow-up is not feasible.
Vigilant patient monitoring can be difficult due to sheer caseload.

These notes discuss these challenges and provides updates on how to address these challenges.

PATIENT CARE

Minimize patient stress by always keeping traps covered with a clean, dry sheet and by keeping patients in quiet, low traffic areas. Never attempt to handle a patient unless it has been sedated.

PRE-SURGICAL EXAMINATION & PATIENT SELECTION

Although patients cannot be examined thoroughly before being anesthetized, overt abnormalities such as improper mentation, severely poor body condition score, or signs of infectious disease such as upper respiratory infection can be noted through a brief exam while the patient is in its trap. Record these findings in the patient's paperwork and relay them to the veterinarian. Once a patient is anesthetized and thoroughly examined, it is up to the veterinarian to make the final decision regarding acceptance of a patient for surgery. The veterinarian must weigh the risks and benefits of selecting patients with mild infectious or noninfectious medical conditions, such as upper respiratory infection, parasite infestation, and asymptomatic heartworm disease. While some conditions may theoretically increase anesthetic risk and pose infectious disease risk to others, the benefits of surgical sterilization likely outweigh these risks. In addition, the opportunity to perform surgical sterilization on an individual cat in a TNR population may not present itself again in the future.

Confirmation of sexual status (intact female, spayed female, intact male, castrated male) should be done prior to surgery. In-heat, pregnant, and pyometra ovariohysterectomies, as well as cryptorchid castrations, can all be routinely and safely performed in HQHVTNR programs.

PRE-MEDICATION / INDUCTION PROCESS

Pre-medication/induction occurs via a single intramuscular injection while the patient is in its trap. The trap can be tipped on its side to facilitate injecting the patient. Alternatively, a trap fork can be used to gently squeeze the patient to one end of the trap. Administer the intramuscular injection into the lumbar muscles. After administration of the agent, re-cover the trap with the sheet, replace the trap so that is faces outwards, and frequently check on the patient. Monitor closely to ensure that the patient's trachea is not kinked or blocked. When the patient no longer moves its head, remove it from its trap.

PRINCIPLES OF ANESTHETIC PROTOCOLS

From the 2008 *Anesthesia and Analgesia Guidelines for High Quality, High Volume Spay/Neuter Initiatives*, "[a] balanced anesthetic [protocol] is essential and includes analgesia, unconsciousness, muscle relaxation, and immobility without patient compromise." In the HQHVTNR setting, whatever anesthetic protocol is

selected must benefit a large number of animals being sterilized within a short time frame. As noted above, however, HQHVTNR programs face multiple challenges associated with anesthesia.

From Ko and Berman's 2010 review article, *Anesthesia in Shelter Medicine,* the ideal anesthesia protocol should meet the following criteria:
Have a wide margin of safety.
Provide rapid induction of reasonable immobilization or unconsciousness.
Produce excellent muscle relaxation.
Provide intraoperative and postoperative analgesia.
Be effective and predictable for animals with a wide variety of ages, medical histories, body sizes, and conformations.
Provide easy dose calculation and drug preparation for intravenous or intramuscular administration.
Provide small volume for drug administration, especially for fearful or feral animals.
Be reversible with minimal side effects.
Induce a wide range of anesthetic responses ranging from sedation to complete immobilization and a surgical plane of anesthesia.
Allow rapid and smooth recovery.
Be economical.
Minimally use controlled substances.
Be commercially available with a long shelf life.

Based on these criteria, the use of injectable anesthetics is necessary in HQHVTNR programs because our patients cannot be handled. Inhalant anesthesia can be utilized as a supplement if needed.

The advantages of using injectable anesthetics compared to inhalant anesthesia include:
Decreased cost due to requirement of less equipment needed to administer the agents.
No human exposure to waste gases.

The disadvantages, however, include:
Increased risk for overdose (especially in patients who we cannot be weighed beforehand).
Possible need for repeated injections of anesthetics to extend duration of anesthesia, which can result in prolonged recovery.
Inability to rapidly manipulate a patient's anesthetic plane if needed.
Some injectable agents cannot be reversed.

PRINCIPLES OF PAIN MANAGEMENT PROTOCOLS

Adequate pain management is not only a professional obligation, but it also contributes to successful patient outcomes, including optimum anesthetic recovery and enhanced quality of life. However, HQHVTNR programs face multiple challenges associated with pain management, including:
Observation of behavior is the best way to assess the degree of pain experienced by cats, however adequately assessing behavior in HQHVTNR patients is challenging.
Patients may not be ideally hydrated perioperatively, which can predispose them to adverse side effects of certain anesthetic/analgesic agents.
Providing extensive and prolonged postoperative monitoring of patients is not possible.
Tailoring analgesia to an individual patient's needs can be difficult since the inventory of analgesics on-hand is limited and is selected based on what is optimal for the most number of patients.
Analgesics can only be administered once perioperatively.
Once administered, analgesics cannot be modified or discontinued based on the patient's response to the agent.

In the HQHVTNR setting, we are primarily targeting nociceptive and inflammatory pain related to surgery. Accordingly, pain management in HQHVTNR programs should be multimodal and pre-emptive. Specifics of pain management include:

Patients require preemptive administration of analgesics based on the severity of the proposed surgical procedure rather than based on their behavior.

Gentle tissue handling and techniques that minimize trauma should always been utilized during surgery.

When handling/moving even an anesthetized patient, avoid painful areas such as surgical sites, to avoid inflicting a painful stimulus that can begin a new pain cascade.

Ensure that traps are outfitted with soft bedding or copious newspaper to help prevent additional postoperative pain.

If inflammation is present, such as with pyometra, the degree of pain experienced during and after ovariohysterectomy may be greater than that associated with the routine procedure and may warrant higher dosing of analgesics.

Specific Components of the Anesthetic & Pain Management Protocols

The components of an injectable anesthetic protocol in a HQHVTNR program should include: a tranquilizer/sedative (such as an alpha 2 adrenoceptor agonist or acepromazine), an analgesic (such as an opioid), an induction agent (such as ketamine or Telazol). An additional analgesic (such as an NSAID) is recommended. Local anesthetics should be used, as well, whenever possible. Anticholinergics are no longer routinely used in HQHVTNR programs.

Sedatives/Tranquilizers

Alpha 2 adrenoceptor agonists (xylazine, medetomidine, or dexmedetomidine) are considered analgesic adjuvants as they can supplement analgesia while reducing the stress response. The dose of an alpha 2 agonist required for analgesia is much higher than the dose required for sedation. Accordingly, this class of drugs is not typically used for their analgesic effect alone because of the profound sedation and cardiovascular depression that accompany their use. These drugs can be used at lower doses when combined with an injectable dissociative and/or an opioid to provide more intense analgesia and enhanced sedation. These agents have significant injectable and inhalant anesthetic-sparing effects.

Acepromazine is a phenothiazine tranquilizer that causes mild to moderate sedation for several hours. It is anesthetic-sparing and is an anti-emetic, as well. It causes vasodilation and can therefore result in hypotension.

Dissociatives

Dissociatives such as ketamine and tiletamine are sympathomimetics that provide anesthesia and somatic analgesia. They are typically used with a sedative and additional analgesic to improve muscle relaxation, to enhance antinociception, and to improve the quality of anesthetic recovery. These agents have a rapid onset of action when given intramuscularly. Tiletamine, the dissociative component of Telazol (a combination of tiletamine and zolazepam), is more potent and provides a longer duration of anesthesia compared to ketamine. The longer duration of action of tiletamine, however, results in prolonged recovery time.

Anticholinergics

Unless specifically indicated, an anticholinergic agent is not considered to be a requirement in cats. Concurrent administration of an anticholinergic with an alpha 2 agonist is typically not recommended due to the possibility of cardiac dysrhythmias and increased myocardial oxygen consumption. Concurrent administration is only appropriate in cases of severe bradycardia and hypotension. If coadministering an anticholinergic with an alpha 2 agonist, pharmaceutical companies recommend administering the anticholinergic 20 minutes before the alpha 2 agonist to avoid cardiac dysrhythmias.

Opioids

Opioids are widely used in the perioperative setting as part of multimodal analgesic protocols. They provide preventative analgesia when given preoperatively and improve muscle relaxation. They are also

anesthetic-sparing. When combined with NSAIDs and local anesthetics, opioids may have a synergistic analgesic effect. Buprenorphine and butorphanol are common opioids used in HQHVTNR programs.

Local Anesthetics

Due to their safety and significant analgesic benefits, the Task Force for the 2015 *AAHA/AAFP Pain Management Guidelines* supports the use of local anesthetics insofar as possible with every surgical procedure. Local anesthetics are easy to administer, inexpensive, extremely effective, anesthetic-sparing, are reported to be antimicrobial and immunomodulating, and they do not appear to delay tissue healing. Bupivacaine 0.5% when used at 1 mg/kg in cats and given preoperatively (as an incisional line block or an intratesticular block) can provide local anesthesia for 6 hours. Lidocaine 2% at 2–4 mg/kg can also be utilized in cats as a local anesthetic. Lidocaine has a more rapid onset of action but a shorter duration of action compared to bupivacaine.

Non-Steroidal Anti-Inflammatory Drugs (NSAIDs)

Preoperative administration of NSAIDs has been found to be superior in analgesic efficacy compared to postoperative use in anesthetized dogs. Although similar studies have not been performed in cats, it is thought that the same principle applies. However, the general concern of using NSAIDs perioperatively is that it can induce adverse effects in anesthetized patients with hypovolemia, hypotension, or coagulopathies, particularly in patients who are not on intravenous fluid support of the cardiovascular system. NSAIDs may also exacerbate or contribute to renal and/or gastrointestinal disease. Patient parameters such as renal chemistry values, blood pressure, and coagulation factors are not typically assessed or monitored in the HQHVTNR setting. Accordingly, the Task Force for the 2015 *AAHA/AAFP Pain Management Guidelines* recommends limiting the use of NSAIDs to postsurgical administration only in such settings.

Specific Combination Protocols

Different HQHVTNR programs utilize different anesthetic protocols. There is no "one size fits all" answer, and your program's protocol will depend on a variety of factors, including:
Patient safety
Finances
Skill and efficiency of technical assistance
Timing and competence of surgical/anesthetic technique
Number/type of patients

Some examples of HQHVTNR anesthetic protocols include:
TKX = telazol, ketamine, and xylazine
MKB = medetomidine, ketamine, and buprenorphine
TTD = telazol, torbugesic (butorphanol), and dexmedetomidine
MKDM = morphine, ketamine, dexmedetomidine, and medetomidine

These protocols all have varying reversals and additional analgesics administered during recovery. Different anesthetic-related patient factors are affected based on what protocol is utilized, therefore each protocol has advantages and disadvantages. For example, TKX is relatively inexpensive and requires only a small volume of drug to be injected to rapidly induce anesthesia; however, it also results in prolonged recovery time, hypotension, hypothermia, and hypoxemia. MKB, conversely, is more expensive per patient and requires a larger volume of injected drug; however, it is more reversible and provides better cardiovascular support than TKX. TTD is more expensive than TKX and patients are more prone to stimulation when on this protocol; however, it requires a smaller dose of injected drug than MKB and is also more reversible and provides better cardiovascular support than TKX.

UPDATES ON SPECIFIC OPIOIDS

Buprenorphine, a partial mu agonist, is a popular analgesic in cats due to its relatively long-acting, moderate analgesic properties with few adverse effects. Butorphanol, a weak mu antagonist and a kappa agonist, is also commonly used due to its relative inexpensiveness and its efficacy for inducing sedation. However, in a comparison study, buprenorphine administered before surgery and during wound closure provided adequate analgesia for 6 hours following ovariohysterectomy in cats, whereas butorphanol did not. Butorphanol, then, should not be used to provide analgesia in any kinds of significant or prolonged states of pain.

The route of administration of buprenorphine has recently been reviewed. The preferred route is intravenous or intramuscular. These routes provide a greater magnitude of antinociception, a more rapid speed of onset, and their duration of action is longer compared to other routes. The subcutaneous route, at typical clinical dosages (0.02 mg/kg), is not recommended, because it is not considered reliable and has not been shown to provide adequate analgesia. Although buprenorphine administered oral-transmucosally (OTM) has been popular, the review article relays that although it may have clinical efficacy, the OTM route may not be **as** efficacious as previously thought. The review goes on to relay that cats who are to receive OTM buprenorphine postoperatively, should be given a dose of a full agonist opioid or an injectable buprenorphine beforehand as premedication.

Regarding duration of action, in general, buprenorphine's duration of action may be shorter than what has previously been published. A recent clinical trial showed that cats undergoing ovariohysterectomy may require a second dose of buprenorphine 4 hours after surgery, especially if an NSAID had not also been given.

A compounded, injectable (subcutaneous) sustained-release formulation of buprenorphine exists (non-FDA approved). The concentration is 3 mg/ml and the dosage is 0.12 mg/kg every 72 hours. Unpublished pharmacokinetic data showed superior maintenance of plasma levels adequate for analgesia over 3 days when compared to repeated OTM dosing. The FDA has more recently approved a concentrated injectable (subcutaneous) buprenorphine product for cats (Simbadol; Abbott), which has been formulated to provide a 24 hour duration of action when administered as directed for up to 3 days. The dosage is 0.24 mg/kg (that is milligrams/kilogram, NOT micrograms/kilogram) and its concentration is 1.8 mg/mL. A recent study suggests that buprenorphine administered subcutaneously to cats at this dosage/concentration is safe and allows for an extended analgesic duration.

Unlike dogs, oral tramadol does appear to be effective in cats. However, dose titration, toxicity and safety data are currently lacking. A practical disadvantage is that the oral formulation is bitter and therefore difficult to administer to cats. Liquid compounds may be more palatable.

UPDATES ON SPECIFIC NSAIDS

Robenacoxib (Onsior; Novartis) is a COX-2 selective NSAID that has been approved for postoperative pain in cats when given orally at 1 mg/kg once daily for up to 3 days. It is labeled for longer duration of use in Europe. It has a rapid onset of action and, although, it has a short plasma half-life in cats (1.7 hours), it accumulates in inflamed tissue for up to 24 hours. In a recent study done on cats undergoing ovariohysterectomy, robenacoxib elicited superior postoperative analgesia compared to meloxicam. In another recent study on cats undergoing ovariohysterectomy, the combination of subcutaneous buprenorphine and subcutaneous robenacoxib did not provide any analgesic advantages compared to subcutaneous robenacoxib alone.

Meloxicam is a COX-2 selective NSAID that is clinically effective for surgical procedures such as ovariohysterectomy and castration. In America, its approval is limited to a single dose (0.1 mg/kg orally) to control pain. Chronic use of meloxicam is approved in several other countries.

NSAIDs with selective COX-1 antagonism (i.e., ketoprofen, aspirin) have been reported to cause inhibition of coagulation. This class of NSAIDs should be avoided preoperatively, and only administered postoperatively when adequate clot formation has occurred.

INTUBATION

Endotracheal intubation is not typically done in the HQHVTNR setting for cats. If it is not performed with skill, care, and efficiency, intubation can actually compromise patient care. Selecting which patients should be intubated, if any (i.e., those with URI or those that are obese), should be determined by the veterinarian. Regardless, endotracheal intubation with oxygen and ventilation should be immediately available and instituted in the event of an emergency.

THERMOREGULATION

Hypothermia associated with anesthesia is a common challenge in the HQHVSN setting largely due to the anesthetic drugs utilized for surgery. Hypothermia leads to, impaired tissue perfusion, increased surgical site infections, impaired coagulation, prolonged anesthetic recovery, and an overall unsteady state of anesthesia related to decreased cardiac output. All of these adverse side effects can result in increased morbidity.

Preventing hypothermia is easier to accomplish than combating it. Thermal support should be started in the preanesthetic period and should be continual and consistent. Body temperature should be maintained above 96°F. Do not use supplemental heat sources that are not specifically designed for anesthetized patients as they can cause severe thermal injury, particularly in pediatric or debilitated patients with low total protein and/or low fat stores who may readily burn (i.e., electric heating pads, blow dryers, hot water containers).

Strategies to avoid hypothermia include:

Reduce contact with cold surfaces (i.e., stainless steel tables) → provide insulation by placing towels/newspapers/blankets between patients and cold surfaces.

Limit body cavity exposure → utilize surgical drapes; keep surgical incisions to a minimum length whenever possible.

Avoid excessive hair removal during surgical preparation → hair removal should be adequate to prevent inadvertent contamination of the sterile surgical field during the procedure and large enough to accommodate extension of the incision when necessary.

Avoid using cold surgical scrub and avoid soaking the body surface with alcohol → warm solutions with ultrasound gel warmers & avoid alcohol.

Reduce loss of body heat from extremities → cover extremities with bubble wrap, saran wrap, or baby socks.

Forced hot air or convective warming is efficient for maintaining intraoperative body temperature → utilize circulating warm-water blankets, warm air circulation systems, or reptile warmers.

Provide insulation → utilize emergency blankets or bubble wrap.

Avoid using cold fluids → warmed fluids should be administered postoperatively.

FLUID THERAPY

Fluids are generally not used for young, healthy animals having short anesthesia and surgery. However, when hydration is needed, subcutaneous or intravenous fluid therapy is best administered either during surgery or immediately postoperatively. Consider fluids in patients predisposed to hypothermia, hyperthermia, or dehydration (pregnant, lactating, small, ill, or geriatric patients). Always utilize mildly warmed fluids.

MONITORING

Prompt recognition and correction of abnormalities that are detected via monitoring are essential to the safe practice of anesthesia. Monitoring begins with determining baseline physiological data during the initial physical examination, even though our patients are already anesthetized. Monitor trends in parameters instead of single values to promptly recognize if a patient starts deteriorating. Earlier recognition of a decompensating patient typically results in a better prognosis. Monitoring equipment should not replace a vigilant, hands-on observer.

What parameters to monitor:
Pulse rate and rhythm
Respiratory rate and pattern
Mucus membrane color
Muscle tone
Eye position
Oxygen saturation

Recovery

One HQHVTNR program discovered that most anesthetic-related deaths occurred in the postoperative period, specifically within the first 3 hours after surgery. Accordingly, the recovery area should be heavily staffed to ensure adequate postoperative monitoring for any signs of respiratory compromise, urination, defecation or abnormal recovery. The recovery area should be quiet, clean, warm, and dry. Ensure that towels or newspapers within traps are dry and clean before replacing the patient.

Emergencies & CPR

Vigilant perioperative monitoring can help prevent anesthesia-related emergencies, but it is important to always be prepared for emergencies. All staff members and volunteers should be trained to promptly recognize respiratory and cardiovascular arrest and differentiate this from depression.

A source (or, ideally, a number of sources) of oxygen with means of ventilation, as well as reversal/CPR drugs should all be readily accessible. Post emergency drug charts that list the volume of drug needed based on body weight within the clinic and keep them available in a crash cart.

In the event of cardiac arrest, ensure that a CPR leader is designated who is recording and directing tasks. Start chest compressions immediately at 100 beats per minute for at least 2 minutes without interruption. Compress the width of the chest by approximately 30%. Each participant should do two minutes of chest compressions before someone else takes over. Secure the airway next and start breathing for the patient at approximately 10 breaths per minute. If patient was on inhalant anesthesia, ensure that the vaporizer is turned off and that the anesthetic system has been flushed with oxygen before the patient is placed on oxygen. For advanced life support, administer epinephrine (1:1000) at 0.01 mg/kg IV every 3–5 minutes. Reversal drugs such as naloxone or atipamezole should be administered accordingly. For familiarity with the crash cart, ensure that all team members review the contents of the cart periodically.

Record-Keeping

Controlled substances require detailed recordkeeping. Record-keeping should comply with state and local practice acts, whichever are most strict, and may also be guided by state and national veterinary medical associations.

Postoperative Care

All HQHVTNR programs should establish policies for handling postoperative questions, complications, & emergencies within at least 48 hours following surgery. Ensure that at least one staff member provides a cell phone number to all clients that will be frequently checked. Establish a relationship with a local veterinarian or emergency hospital who will see patients for recheck, if needed.

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