This supplemental information was prepared by members of the Veterinary Task Force to Advance Spay-Neuter (VTFASN) as a companion piece to the Association of Shelter Veterinarian's Veterinary Medical Care Guidelines for Spay-Neuter Programs (Guidelines).

**Anesthesia and Analgesia Guidelines for
High Quality, High Volume Spay/Neuter Initiatives**

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INTRODUCTION

As a recent ad campaign for inhalant anesthesia stated, "There's a lot more to good anesthesia than simply life and death or waking from the event (1)." In other words, the fact that an animal makes it through surgery is no longer a good criterion by which to measure adequacy in our choices of anesthetic drugs, monitoring or stabilization. We understand now that what we have done or failed to do pre-, intra- or postoperatively has sometimes caused animals to succumb to perioperative disease within weeks or months of the surgery. Our historical presumptions of successful anesthesia, indicated by animals that appear stable under anesthesia or wake up quickly or well, are no longer adequate.

Why is this so? The answer is relatively simple. Despite all our advancements within the fields of both human and veterinary anesthesiology, and regardless of whether we use simple mask inhalants or potent premeds such as Xylazine, anesthesia remains a profound cardiorespiratory depressant event which is capable of causing disease and death. When we depress the life-essential body systems to the point that a patient is unable to feel or respond to pain, we hope that the resulting disturbance in organ function is transient; it is transient if it is minimized by proper fluid and pressure balance, minimal blood loss and vigilant monitoring. However, if anesthesia is not done properly, this transient dysfunction can cause permanent damage. Poor cardiac output can create unhealthy, low perfusion cascades of organ dysfunction which may manifest as renal insufficiency, pancreatitis, hepatic and myocardial dysfunction and sepsis well after the anesthesia and surgery event.

Fortunately, veterinary anesthesia has come a long way over the past decade. The simple fact that we understand and acknowledge the possible long term health effects from anesthesia gives us the opportunity to determine more effective methods to anesthetize our patients. Now, routine anesthesia events allow us to balance analgesia, unconsciousness, muscle relaxation and immobility without patient compromise. In high-quality, high-volume spay/neuter (HQHVSN) programs, surgical anesthesia provides a unique opportunity to develop the safest *general* protocols – in the areas of drug selection, perioperative care, monitoring and overall technique – for the benefit of large numbers of animals being sterilized within a short time-frame.

This document provides detailed guidelines for anesthesia and analgesia used in high-quality, high-volume spay/neuter initiatives, which in recent years have been advanced out of necessity and fueled by creativity in an attempt to reduce the unnecessary euthanasia of companion animals and feral cats. Whether you're working in a stationary or mobile clinic, a MASH-style operation, a shelter or feral cat program, a veterinary school, or private practice, these guidelines are meant to assist you in your efforts to achieve successful anesthesia.

PREOPERATIVE CONCERNS

Patient Selection
Patient selection will vary depending on clinic staffing and anesthetic capabilities, as well as differing locales, technical training and economics. A veterinarian should make the final decision regarding acceptance of any patient for surgery based on historical and physical examination findings and the practice's surgical schedule. The surgeon should use discretion regarding minimum and maximum patient age, weight, health status, and anesthetic risk, taking into account the availability of staff expertise and necessary equipment to care for patients. Owned pets may best be served by scheduling surgery at four months of age (or older) to allow time for the development of immunity through vaccination. Sterilization prior to sexual maturity is strongly recommended to prevent the births of unintentional litters, which commonly occur when surgery is delayed (2-6). In adoption settings, pediatric animals are generally best served when spay/neuter surgeries are performed prior to adoption as early as six weeks of age in order to ensure compliance (5-7) and improve the likelihood of retention in the home, since being sexually intact is the leading risk factor for owner relinquishment of cats and dogs (8-12).

Veterinarians 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 the experience of the Veterinary Task Force to Advance High-Quality, High-Volume Spay/Neuter (13), the opportunity to perform surgical sterilization on an individual animal within a shelter, feral or trap, neuter and release (TNR) population may not present itself again in the future; thus the benefit of performing sterilization at the time of initial presentation outweighs the increased risks posed by such medical conditions.

In the case of complex ovariohysterectomy, the task force's experience indicates that spays are routinely performed on pregnant and estrual animals, in contrast to daily general practice where these higher risk surgeries may wait until post-delivery or diestrus. In addition, animals with pyometra may be spayed in HQHVSN programs.

Client Communications

Clients must be asked about patient history (including such information as current medications, medical history and allergies) and instructed on preoperative fasting requirements (see *Fasting*, p. 3). Individual patient risk assessment should be thoroughly discussed with the client before securing their consent. In the case of shelter, rescue and feral animals, blanket consent may be established based on the individual guidelines of the programs and humane organizations involved.

Pre-surgical consent forms should always be reviewed and signed by the client or their agent prior to anesthesia. While specific topics of consent will vary by program, recommended subjects for the consent form include:

- Client confirmation of the patient's health whenever possible;
- Acknowledgement of the risk of infectious disease exposure, including increased risk if the animal has not received prior vaccination;
- Acknowledgement of anesthetic and surgical risk (including death);
- Acceptance of responsibility for the patient once discharged from surgical setting;
- Authorization for surgery;
- Recommendation for ongoing health care by a full-service veterinary clinic;
- Client contact information (including emergency contact telephone numbers); and
- A description of fees (if any).

Records

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. A medical record should be prepared for each animal and should include:

- Owner, guardian, or caretaker contact information;
- Signalment;
- Brief history, if known;
- Physical examination and vital parameter findings;
- Body weight;
- The dosages and routes of all drugs administered and/or prescribed, including vaccines, supportive care (antibiotics and fluids), sedative, analgesic and anesthetic agents, and postoperative treatments;
- Notation of responsible monitoring during anesthesia;
- The surgical procedure performed, including any abnormalities; and
- Any other pertinent information regarding the animal's condition.

Vaccination
Vaccination is recommended prior to surgery, but perioperative (immediately pre-, intra- or postoperative) vaccination is acceptable when necessary. Rabies vaccination should be required or administered as mandated by state regulations. All vaccination protocols should follow current guidelines published by the American Association of Feline Practitioners and the American Animal Hospital Association (14-15).

Fasting
Preoperative fasting for dogs and cats is ideal, but withholding water is neither necessary nor recommended. Prolonged fasting for greater than four to six hours is not warranted, especially for pediatric animals. Prolonged fasting increases chances of renal, myocardial, and thromboembolic disease. Subclinical dehydration is rampant in shelter populations, especially if animals are housed for more than one to two days prior to the surgery; dehydration is typically worse in animals experiencing stress from a new environment.

Pediatric animals should be fed a small liquefied or easily digestible meal two to four hours prior to surgery and should not be fasted for more than four hours prior to surgery (16-19). Juvenile and adult animals should be fasted for a minimum of four hours (20-24). Exceptions for preoperative fasting may be made for feral cats in traps due to the safety risk of removing uneaten bait.

Simple blood glucose testing once under anesthesia is advocated for animals at risk of glycemic control (sick, poor body condition, elderly, recently post-weaning females) or for those animals undergoing prolonged capture, restraint, stress and fasting. If blood glucose testing is unwarranted or impossible, if it causes further undue stress to the patient, or if the patient is pediatric or neonatal, supplementation with 50% dextrose (0.5ml/10 kg administered either intravenously (IV) or buccal mucosally), or Karo syrup/molasses administered via bucaal mucosa is suggested. If IV fluids will be given to the possibly hypoglycemic patient, supplementation with 2.5% dextrose in the fluids will similarly improve outcome.

Physical Examination
Animals must be screened as thoroughly yet efficiently as possible. Physical examination should ideally be performed by the veterinarian who will be performing the surgery and should always be attempted prior to anesthesia, but anxiety, aggression or feral behavior may often prevent a thorough pre-anesthesia examination. In these cases, whether physical examination is performed prior to or after pre-medication or induction should be at the discretion of the attending veterinarians. In the event that the veterinarian is not available, a licensed and/or trained veterinary technician can perform an initial triage preop exam and vital parameter assessment and then, as soon as possible perioperatively, the veterinarian can perform a more complete physical exam, including body system assessment. Within vital parameters, temperature assessment and pre-anesthetic diagnostic testing may be performed at the attending veterinarian's discretion, but it is important to note that temperature assessment is especially helpful in determining appropriateness of surgery in animals with respiratory, GI or cardiac disease.

Within the physical exam, specific attention should be paid to:
- Pulse rate and rhythm;
- Respiratory rate and pattern;
- Hydration status;
- Anticipated cardiorespiratory problems;
- Body condition score;
- Body weight;
- Sexual status (intact female, spayed female, intact male, castrated male);
- Neurologic status; and
- Abdominal palpation.

Thoracic auscultation and abdominal palpation are necessary aspects of this exam. If applicable, a baseline subjective pain and anxiety score should be assigned during preop exams or visual evaluation of trapped animals; this score can be a simple subjective or visual analog scale with 0 = no pain to 5 = very painful, and 0 = no anxiety to 5 = very anxious.

Either hand washing or changing gloves between patients is recommended to minimize disease transmission.

Body Weight
Body weight should be determined as close to the time of surgery as possible to guide selection of drugs and dosages. When weighing an individual animal is not feasible, e.g. intractable or feral animals, body weight should be estimated as carefully as possible. More important than body weight in adult animals is body condition score. A fat animal should be dosed on lean weight. A thin animal is probably best anesthetized without the use of heavily fat soluble drugs. Accurate weight taken immediately pre-surgery is especially important for pediatric and neonatal animals, as well as exotics, all of whom can alter their weight dramatically within hours. A gram, mail, or exotics scale should be utilized for patients under 1 kg. A scale accurate to the 0.1 kg should be utilized for patients under 5 kg. If scales are utilized, they should be zeroed and calibrated/tested at least once daily in busy operations.

Regardless of body weight, extreme body condition scores dictate changes in drug dosages, including inhalants, and may be predictable of surgical depth/monitoring difficulties (25).

At Risk Patients
Stabilization prior to surgery is critical for at risk patients experiencing:
- Extreme stress and overhandling;
- Trauma;
- Extreme dermatologic conditions;
- Severe dehydration;
- Malnourishment;
- Severe parasitism;
- Toxicity; and/or
- Upper-respiratory disease

All at risk animals may benefit from postponed surgery if possible, and if postponement is not feasible, modified anesthesia protocols, use of fluids, extra warmth and glucose control based on their disease severity is recommended.

Heavily parasite ridden, dehydrated pets should be administered fluids and dewormed prior to anesthesia. Surgery need not be delayed in upper respiratory disease cats and dogs unless their condition truly causes hypoxia or respiratory distress, includes severe pyrexia or disease transmission potential or if their condition deteriorates. Traumatized animals, specifically head and thoracic trauma, should not undergo anesthesia or surgery prior to their stabilization in regards to neurologic, cardiovascular and respiratory status respectively.

Bloodwork
Though not often available in a shelter situation, bloodwork or minimum data base (Big 4, QATS, chemistry, urine sp.grav.) can be performed if deemed necessary by physical exam findings or patient history. Age should not be a determinant in deciding whether bloodwork is necessary for a particular animal, rather, health status or disease potential and risk of anesthesia/surgical complications resulting from such should dictate necessity of this testing.

Patient Housing
In order for patients to be safe and comfortable, appropriate housing should be provided for each animal, as follows:
- All tractable dogs and cats should be provided with a sturdy, waterproof form of ID, which remains on them for the duration of their stay at the facility. Intractable or feral animals should have identification on their traps or cages and be provided with identification on their bodies only for the time they are out of confinement.
- Housing should allow for adequate temperature, ventilation and stress reduction.
- Housing should be properly cleaned and disinfected between patients.
- Adult tractable animals should be housed in individual cages or runs that allow for good visibility and adequate turnaround space, as well as for safety at various stages of sedation and anesthesia.
- At the discretion of the attending veterinarian, pediatric littermates or housemates may benefit from being housed together (16-19).
- Intractable or feral animals should be housed in traps or other enclosures to allow for the administration of anesthesia without extensive handling and to minimize stress on the animal.
- Intractable or feral animals should be removed for surgery only after sedation and returned to the holding enclosure when considered adequately recovered.
- Depending on the length of patient stay, additional space within the cages/enclosures may be also be needed for food and water containers, and/or litter boxes.
- Exotic pets should not be housed next to predator species for any period prior to their anesthesia and surgery; certainly, elective surgeries in these species warrant early, not delayed surgery.
- If possible, dogs and cats should be separated prior to and following anesthesia.

- If possible, the most anxious animals should be afforded "cool down periods" prior to their anesthesia or, at a minimum, should be separated from other preanesthetic patients to avoid pheromone and other inhalant or visual stimuli that is not conducive to anesthesia or surgery.

Infectious Disease Control

As is typical for any surgery, standard procedures for controlling potential infectious diseases should be practiced. In particular, HQHVSN programs should include the following when possible:

- Examination surfaces and equipment should be cleaned and disinfected between patients using agents known to be effective against common veterinary pathogens.
- All anesthesia equipment that has direct patient contact (e.g., endotracheal tubes, laryngoscope blades, pulse oximeter clips, esophageal stethoscope, thermometer, etc.) should be thoroughly cleaned in mild soap and water, and disinfected between patients (26, 27).
- Breathing circuits should be thoroughly cleaned, disinfected, rinsed and dried one to two times per week at minimum.
- Anesthesia machine, dome and one-way valves, and absorbent canisters, should be disassembled, cleaned, and left open to dry once per week at a minimum (28).
- Staff should wash their hands or sanitize between patients and litters.
- Surgery of infected animals should follow healthy animals within the day's schedule.

Equipment

Recommendations for checkout of veterinary machines have been published and are available in a variety of anesthesia manuals and text. An equipment safety and checklist prior to the day's anesthesia should be performed on a regularly scheduled basis and should include the following (28-31):

1. General Machine Inspection
   - ☐ *Vaporizers* - Fill vaporizers at the end of the workday when fewer personnel are present to avoid vapor inhalation and spills. Tighten filler caps post-filling and ensure that control dials are set to off, vs. "0" position pre- and post-filling.
   - ☐ *Circle Breathing System* - Confirm proper function of one way valves in circle breathing system. To check the expiratory circuit valve the expiratory valve should respond to your breath through the breathing circuit. To check the inspiratory valve in the circuit, with the pop off valve closed, the inspiratory valve should move with the compression of the rebreathing or reservoir bag.
   - ☐ *Ventilators* - If a ventilator is utilized, safety and function checks should be performed according to the manufacturer's suggestions.

2. Confirmation of Oxygen Supply
   - ☐ Medical oxygen tanks are green colored and color of tank should be checked at minimum weekly or upon changing of tanks.
   - ☐ Check on cylinder pressure and amount of gas.

☐ Confirm cylinder or gas line connection to machine through correct hanger yoke, reducing and regulating valve.

☐ Listen for leaks as the cylinder is opened.

☐ Check for a full emergency cylinder and the presence of hand wrench if one is used to open cylinder.

☐ Check on central supplies of oxygen if present; pressure should be at 50psi.

3. Verification of Proper Flowmeter Function

☐ Bobbin or float should move freely throughout the length of tubing.

☐ When the flowmeter is on, air should be felt moving through the patient end of the rebreathing circuit.

4. Breathing Circuit Check – In addition to the regular inspections, the breathing circuit should also be checked every three to five patients.

☐ Make sure the machine and ET tube end fittings are proper and tight.

☐ To check for leaks in circle systems, close the pop-off valve, occlude the patient end of the *Y* piece, fill the system with oxygen from the flow meter (not the flush), and turn the oxygen flow to 5L/min. As the pressure in the system reaches 20 cm of water, reduce the flowmeter flow to 0. The pressure should hold for at least ten seconds at 20 cm of water; if it doesn't, a leak is present. To finish the test, open the pop-off valve slowly (vs. releasing the occlusion on the patient end of the circuit) and observe the release of pressure.

☐ To check for leaks in non-rebreathing systems, make sure the patient port is occluded, the relief valve is closed, and the reservoir bag distended. The bag should remain distended for two to three seconds; if it doesn't, a leak is present. Additional testing of the inner tube of coaxial systems is required and is done by occluding the inner tube at the patient end (using a pen or pencil tip) while oxygen is flowing at approximately 1-2 L/min. During this short period of occlusion, the float in the oxygen flowmeter should fall; if it doesn't, a leak is present within the system.

☐ Check to be sure the pop off valve turns appropriately and is OPEN.

☐ If a possible leak is identified, troubleshoot by applying soapy water around connections and joints; bubbles indicate the site of the leak. If the leak is not found, patient should not be placed on the circuits or machines; anesthesia waste gases may contaminate the environment and the staff.

5. Waste Gas Scavenging System Check

☐ Confirm that the scavenging system is connected to the exhaust valve of the machine.

☐ If an active system is utilized, turn on the vacuum pump; if a passive system is utilized, verify patency.

☐ If a charcoal canister is used, confirm its date and starting weight. Gains of 50g or more usually constitute disposal of the canister.

6. Carbon Dioxide Absorbent

☐ Check adequacy of carbon dioxide absorbent. Note that color change is not a reliable indicator for exhausted use in most brands of absorbent; the violet color associated

with use may revert to white during non-use. Rather, the hardness of the granules indicates expended chemical trapping potential and serves as a more reliable indicator of the need to change the absorbent.

Organizing and Cleaning Equipment Sets
- ☐ Laryngoscope blades, breathing circuits, endotracheal tubes, and bottle or tube brushes should be divided into sets and color or number coded. Sets should be rotated through weekly uses. Ideally, multiple sets would be rotated and the set that is utilized for each patient should be noted on the anesthesia record.
- ☐ If a hospital or shelter infectious agent issue is suspected, color or number coding should assist in identifying possibly contaminated blades, tubes, breathing circuits, and brushes, and patient contact can be traced from the records.
- ☐ Regular culturing of rebreathing valves, breathing circuits, sodasorb canisters and rebreathing bags should be performed for both bacterial and fungal contaminants.
- ☐ One way valves and pop-off apparatus should be opened and dried regularly to prevent humidity and moisture buildup.
- ☐ A reasonable hot water and soap cleaning should be performed on all circuits and tracheal tubes prior to the nightly soaking in diluted chlorohexidene acetate. Washing and scrubbing of the endotracheal tubes with dishwater soap and water is as or more critical than antiseptic soaking. Following the soaking, it is critical to rinse all circuits and tracheal tubes with water. In addition, drying both circuits and tracheal tubes is highly recommended. Cuffs of the endotracheal tubes should be inflated during these processes and care should be taken to examine all cuffs daily. Endotracheal tube cuffs should be inflated prior to use to check for patency, but deflated prior to insertion.

Preoperative Thermoregulation
Proactive thermoregulation, even preoperatively, is the best way to control heat loss in animals which will undergo general anesthesia. If separate premedication of patients is utilized prior to induction of general anesthesia, it is imperative that the patients not be placed on cold surfaces post-administration of the premedicant. Place patients on paper or cloth towels in their holding cages to help retain heat, which will lend to more uniform surgical planes of anesthesia, and improve cardiovascular function and recovery. If animals are kept in traps or other holding containers, try to assure normal body temperature and adequate ventilation as much as possible prior to induction of anesthesia.

ANESTHESIA

Balanced anesthesia is essential and includes analgesia, unconsciousness, muscle relaxation and immobility without patient compromise. Because of the very nature of the high-volume aspect of these spay/neuter programs, surgical anesthesia in this setting provides a unique opportunity to develop the safest general protocols – in the areas of drug selection, perioperative care, monitoring and overall technique – for the benefit of large numbers of animals being sterilized within a short time-frame.

Peri- and Intra-Operative Thermoregulation
As with any surgery, thermoregulation is critically important (32, 33). In most HQHVSN events, hypothermia is a common occurrence with anesthesia. Warmth should be consistent and continual, since contact with any cold(er) surface after pre-medication allows decreases in body temperature not easily reversed during surgery. Warmth is best preserved by reduced contact with cold surfaces, limited body cavity exposure, circulating hot water and protected (stand off) contact with heated containers. Forced hot air or convective warming is the most efficient and useful for maintaining intra-operative body temperature (34), but appropriate equipment and disposables must be utilized because these warmers are capable of severe burns if they're not used with manufacturer specified blankets.

Direct contact with electric heating pads, inappropriately close blow dryers or heat lamps, drying cages and direct (vs. stand off) contact with hot water containers *must* be avoided to prevent thermal injury. This is especially important in pediatric, debilitated and frail geriatric patients whose low total protein and/or low fat stores may easily result in burns (35).

Cold surface contact, such as that with stainless steel or other metal tables, is best avoided. During clipping and prepping, care should be taken to minimize conductive heat loss from heavily sedated or anesthetized animals by placing paper or cloth between the patient and the cold surface. The use of excessive clipping, moistening of the hair coat around the surgical site, "soaking or standing" alcohol and aggressive scrubbing should be avoided in order to preserve the patient's body temperature (36). Heat can be conserved by using low oxygen flow rates with rebreathing circuits, but most non-rebreathing circuits are inappropriate for low oxygen flow rates. If used with low oxygen flow rates, many non-rebreathing circuits will likely cause significant hypercarbia and mild hypoxia (37).

Oxygen Supplementation and Ventilation
Oxygen supplementation is especially helpful to debilitated, dehydrated, nutritionally poor or traumatized patients. Mask rates of oxygen supplementation range from 2-5L/min depending on the size of the animal, the breathing system being employed and mask closure (38). Caution should be exercised when using oxygen in an environment where electrocautery is utilized due to explosion or fire potential.

Ventilation is the process whereby the body exhales or is otherwise rid of carbon dioxide; this is a very different process from oxygenation, although the two are often surgically grouped together. Ventilation is accomplished in an ***awake animal*** by assuring the patency of the patient's airway, maintaining proper room air temperature and humidity, using loose fitting masks if applied preoperatively and ensuring appropriate housing and cleaning of animals through waste disposal. Ventilation is accomplished in an ***anesthetized animal*** in two ways: either through an anesthesia machine using a rebreathing circuit with functional carbon dioxide absorbent (Sodasorb, Baralyme, Sodalyme) or through a non-rebreathing circuit with appropriate oxygen flow rates. Ventilation is compromised when carbon dioxide absorbent is saturated or when inappropriately low oxygen flow rates are used in the context of non-rebreathing systems (39).

Fluid Therapy
When hydration is needed, subcutaneous (SQ) or IV fluid therapy is best administered either during surgery or immediately post-operative. The goal is to avoid the stress, pain and chill from preoperative administration while the animal is awake. Fluids should be mildly warmed prior to administration, particularly with pediatric, sick and geriatric animals (40, 41).

Monitoring
The most reliable means of patient assessment and safety during anesthesia is the essential task of vigilant monitoring, which should be performed on each patient to ensure an adequate plane of anesthesia (42). In general, monitoring several variables is required to accurately assess the anesthetic plane. The determination and assessment of trends in vital parameters is critical to accurate assessment (43). Reliance on any single variable can lead to inadequate planes of anesthesia or, conversely, to increased depth of anesthesia with accompanying risk and emergencies. Similarly, focus on trends of variables (e.g., heart rate decreasing over last ten minutes, respiratory rate increasing over last five minutes) is more apt to detect appropriate anesthesia plane and safety versus focus on any one variable at any one time. Anesthesia vital and monitored variables should be checked and recorded regularly in each surgery; how often monitoring and recording of variables occurs will depend on speed of surgery, number and ability of technical or nursing staff and available monitoring equipment. Vigilance is required, and monitoring equipment should never replace an educated, hands-on observer. In addition to assessing the anesthetic plane and facilitating informed, flexible and timely responses to changes in patient status, monitoring also provides reliable data for judging the quality (or lack thereof) of anesthesia so that we can continually assess appropriateness of drug usage and improve our techniques.

Cleaning all monitoring equipment patient probes with soap and warm water and according to manufacturer's directions between patients is essential.

Monitoring can be accomplished by any combination of the following means:

Pulse Quality, Rate and Rhythm
Manually palpate the pulse at the radial artery, dorsal metatarsal artery, femoral artery, chest, lingual artery, facial artery and/or jugular furrow.

Pulse oximetry, as opposed to an electrocardiograph, allows accurate measurement of both pulse rate and patient oxygenation status (44). A pulse oximeter is one of the most affordable monitors for all types of surgical settings, and is simple to use, portable, often battery operated, and non-invasive.

Electrocardiographs are not considered suitable monitoring devices because they can demonstrate normal electrical conductance in a mechanically dead heart. Older models of electrocardiographs may also frequently calculate the heart rate inaccurately and as such can be misleading.

Esophageal stethoscopes have limitations because they allow pathways for esophageal reflux, provide false security of heart sounds without peripheral pulse perception, and include the possibility of abnormal pressure or impaired airflow in a patient with an unprotected airway. However, if positioned appropriately in an intubated patient, they do afford one inexpensive means of ausculting heart valvular function. Esophageal stethoscopes should *not* be used in a patient with an unprotected airway.

Respiratory Rate and Pattern
Respiratory rate and pattern monitoring is a means of diagnosing early anesthetic problems. Assess respiratory rate by observing chest excursions or ausculting breaths through a stethoscope positioned on both sides of the chest. Respiratory or apnea monitors may provide for early detection of decreased breathing rate or apnea, but may allow for false flow impedance changes more indicative of surgical abdominal intervention (false diagphragmatic motions) vs. effective respiration (45). In-stream respiratory or apnea monitors may also add resistance to expiration as well as increased dead space, and are a potential source of contamination between patients. Likewise, for the same reason, reliance solely on rebreathing bag movement to assess ventilation may result in inadequate assessment of respiration or breathing rate and character due to false movements such as abdominal cavity exam by the surgeon, diaphragm "hiccups," etc.

Along with visual or simple manual respiratory rate counting, monitoring of respiratory pattern is a clear and effective means of diagnosing early anesthetic difficulties which may lead to true anesthetic emergencies. For instance, tachypnea with shallow breathing may imply pain of surgical manipulation vs. tachypnea with deep, lengthy breathing, which may imply hypoxia or hypercarbia.

Jaw Tone
Loosened jaw or weakened masticatory muscle strength often indicates deep planes of anesthesia, while tight tone of same muscles may indicate light or inadequate planes of anesthesia. Moderately relaxed tone is indicative of a more appropriate surgical plane of anesthesia.

Eye Position and Pupil Size
In general, central eye position with dilated pupils indicates a potentially life-threatening depth of anesthesia. However, central eye position and pupillary dilation can occur in dogs and cats anesthetized with high doses of ketamine and may not be associated with complications (46, 47). Moderately ventrally rotated strabismus in both eyes often indicates adequate surgical plane of anesthesia in most species, but is also dependent on drug combinations utilized (29).

Palpebral Reflex
A mild, sluggish or slow palpebral reflex indicates an adequate surgical plane of anesthesia in most surgical patients. Brisk palpebral reflex indicates light planes of anesthesia which may be inadequate for surgical manipulation. The palpebral reflex, however, may be absent with the use of some injectable protocols, especially those including ketamine as an anesthetic agent (29, 47).

Capillary Refill Time and Mucous Membrane Color
Mucous membrane color and capillary refill time (CRT) are inadequate for assessing depth of

anesthesia or recovery from anesthesia. While many animals have slow CRTs during slow recoveries, normal CRTs and mucous membrane colors can be observed in recently arrested individuals dependent on age, pre-existing health, sex, and temperature (48, 49).

Anesthetic Protocols

Selecting anesthetic protocols for each high-quality, high-volume spay/neuter program depends on many factors, including the number and type of patients, the skill and efficiency of available technical assistance, the timing and competence of surgical/anesthetic technique and financial/medicolegal considerations within the program itself.

Even taking program differences into account, there are four criteria that are common to the safest, most efficient, humane, most timely and financially feasible anesthetic protocols:
1. Analgesia or lack of pain;
2. Anxiolysis or stress reduction;
3. Immobility or muscle relaxation; and
4. Safe, controlled, reversible depression of the central nervous system (CNS) providing unconsciousness.

Multiple combinations of agents and anesthesia protocols utilizing both injectable and inhalant anesthetics exist for both pediatric and adult populations of small animals (18, 19, 50-57). Some clinicians are reluctant to use different classes of drugs together because they fear inter-action adverse effects, while better pain relief with fewer adverse drug reactions are often the benefit of multimodal or combination regimens. A thorough discussion of the variety of agents available for provision of analgesia, stress relief, immobility and CNS depression is well beyond the scope of this summary; however, multiple veterinary anesthesia and veterinary technical texts exist (and are listed in endnotes) which should suffice to give the reader a better understanding of drug combinations and multimodal safe, effective anesthesia protocols. Specific suggestions and useful doses of agents used to provide pain relief or analgesia, stress reduction or anxiolysis, immobility and muscle relaxation, and CNS depression within the HQHVSN operations follow. The Appendix A lists several commonly utilized protocols with such operations and should also provide reference for the reader seeking multimodal agent use.

Analgesics

Analgesic agents are required for all patients. One of the most effective ways to assure good pain control with any of the protocols listed below is to use what is known as multimodal analgesia, which implies several agents used together in small dosages instead of one agent at a high dose. This approach often avoids side effects common to the use of one agent and greatly improves pain and stress control in HQHVSN programs (58-60). Readily reversible agents as well as preemptive analgesia prior to surgical incision are commonly used for safe and humane patient care in high-volume settings. Surgical technique is also capable of influencing postoperative pain (61). Acceptable analgesics and common dosages are as follows:

1. *Nonsteroidal Anti-Inflammatories (NSAIDS)*
   Injectable forms of many NSAIDS now exist; acceptable choices of injectable agents include Flunixin, Ketoprofen, Carprofen, Meloxicam (62-78). In a majority of patients, presurgical administration of these agents (following anesthesia induction) is advocated.

In patients with questionable health status, however, these agents are probably best reserved for late intraop or postoperative administration.

NSAID dosages for feline and canine patients:

Flunixin Meglumine:	1mg/kg IV, SQ
Ketoprofen:	0.5-1mg/kg IV, SQ
Carprofen:	2.2-4.4mg/kg SID-BID IV, SQ
Meloxicam:	0.1-0.2mg/kg SID IV, SQ

2. *Local Anesthetics*

Lidocaine and/or Bupivicaine can be used as local blockades (injection of spermatic cords, lineas or scrotal/prescrotal and linea incisional splash blocks). Commonly used dosages for both these agents in cats and dogs are noted below; the addition of saline can be utilized to dilute for the necessary area of coverage and the increased spread of the agent, and to reduce the sting of administration.

Lidocaine:	2mg/kg
Bupivicaine:	0.3-0.5mg/kg

For most dog spay incisions, a common combination of agents employed is 0.3mg/kg Bupivicaine, 1-2mg/kg of Lidocaine, and 1-2ml of saline; this commonly amounts to 1ml of Bupivicaine 0.5%, 1ml of Lidocaine 2%, and 1-2 ml of saline for the incision of a 40-pound or 18-kg dog. This mixture is "sprayed" with a small gauge (22-25g) needle or "splashed" onto a sutured linea prior to subcutaneous or subcuticular tissue closure; it can be "sprayed, splashed, or dripped" into scrotal or prescrotal incisions prior to subcutaneous or skin closure or even if skin is not closed.

Likewise, a common combination of local anesthetic agents employed for cat spay or neuter incisions is a 0.1-0.2ml of Bupivicaine 0.5% (0.5-1mg), 0.1-0.2ml of Lidocaine 2% (2-4mg), and 0.1-0.2ml of saline per 6 to 10-pound (3-5kg) cat, dripped onto the closed linea or into the scrotal incisions of the surgical patient.

Having the surgeon pre-load a sterile syringe of adequate volume for the number of surgical patients per setting can avoid the necessity of drug calculation, preparation, and administration per individual animal.

Splash, spray or topical drip of local anesthetics are easier than injectable local anesthesia in these HQHVSN patients and will avoid excessive needle usage and inadvertent vascular or peritoneal injection of agents. If injection of local anesthetics are used instead of splash anesthesia, then care should be taken to avoid direct vascular injection of either Lidocaine or Bupivicaine into spermatic cord vessels.

3. *Opioids*

Acceptable choices of opioids include Butophanol, Buprenorphine, Morphine, Oxymorphone, and Hydromorphone.

Use Morphine and other pure Mu agonist opioids (Hydromorphone) to provide for more potent and more economical analgesia than mixed agonist antagonist opioids (Butorphanol). Many of the opioids are capable of causing emesis or vomition in healthy patients, especially if not combined with a form of anxiolytic agent (alpha two agent) or sedative/tranquilizer (Acepromazine, Benzodiazepines). Dosages of commonly used agents are given below. Preoperative and postoperative doses are similar amongst the opioid agents.

Butorphanol:	0.2-0.3mg/kg IV, IM, SQ
Buprenorphine:	0.02-0.03mg/kg IV, IM, SQ
Hydromorphone:	0.05-0.1mg/kg IV, IM, SQ
Oxymorphone:	0.05-0.1mg/kg IV, IM, SQ
Morphine:	0.1-0.3mg/kg IM, SQ

4. *Alpha 2 Agents*
Acceptable choices of alpha 2 agents include Medetomidine, Dexmedetomidine, and Xylazine. Alpha 2 agents constitute a unique class of agents that have both analgesic (pain relieving) and stress reducing (anxiolytic properties). These agents are thus known as "sedative analgesics" and have become a center point for multimodal anesthesia because they provide two essential features (pain relief and stress reduction) of well-balanced regimens with one drug. Additionally, alpha 2 agonist drugs provide synergistic analgesia with all opioids, including Butorphanol. Xylazine, Medetomidine and Dexmedetomidine not only provide for analgesia but obtund anxiety, blunting the neurohormonal release of stress hormones non conducive to quality anesthesia, surgery and recovery

Medetomidine and Dexmedetomidine
Premedication (mini dose):	3-10mcg/kg dogs and 5-15mcg/kg cats IM
Postmedication (micro dose):	1-3mcg/kg both cats and dogs IV or IM

Xylazine
Premedication:	0.2-0.3mg/kg IM

Anxiolysis
Anxiolytic agents for stress reduction include minor or major tranquilizers (Acepromazine, Midazolam, and Diazepam) and alpha 2 agents (Medetomidine, Dexmedetomidine, and Xylazine); these can be delivered with other analgesics separate from the induction agent, which is knows as a "premed (79-84)." Advantages of premedication include stress reduction, provision of pain control other than deep inhalant cerebral depression, muscle relaxation and anxiolysis, which are all aspects of solid, well balanced general anesthesia. Dosages for commonly used minor and major tranquilizers for use as part of multimodal anesthesia regimens are given below:

Diazepam:	0.2-0.5mg/kg IV
Midazolam:	0.2-0.5mg/kg IV, IM, SQ
Acepromazine:	0.02-0.05mg/kg IV, IM, SQ

Often, administering a single injection of multiple drugs combined while the patient is awake significantly reduces patient pain and stress response. As such, combining a "premed" and an "induction" agent into a single injection is advised. For example, a single injection may include an analgesic, anxiolytic and induction agent. Recommended combinations for such multimodal yet single injection "anesthesia" combinations include alpha 2 agents, opioids and dissociative drugs, such as Ketamine (85-94).

Anticholinergics
Although historically part of premedication regimes, the routine use of anticholinergics (Atropine and Glycopyrolate) has decreased due to their induction of increased myocardial work, myocardial oxygen consumption, hypertension, tenacity of many body fluids (urinary, gastric, pancreatic and salivary secretions), mydriasis and delirium and anxiety (atropine) (95-99). Atropine is best reserved for CPR use only; Glycopyrolate can be utilized if absolutely necessary but it is better to avoid anticholinergics entirely or, if they *are* utilized, it's best to use lower than published doses, especially in debilitated, cardiovascular unstable patients, and cats. An anticholinergic such as Glycopyrolate might still be included in most protocols for neonatal vs. pediatric (pre-weaning or under 3 weeks of age) patients, as their cardiac output is more dependent on increased heart rate (100-101). If utilized, the suggested dose of glycopyrolate is 0.003-0.005mg/kg IM.

Inhalant Gas Induction and Maintenance
While it is recognized that there will be times in which masking with inhalant anesthetics is required for HQHVSN patients, ideally the use of inhalant agents through both mask induction and mask maintenance should be minimized. Mask induction of patients differs from mask maintenance or supplementation. Definitions are as follows:
- *Mask induction* brings about general anesthesia from consciousness through inhalant delivered via mask on a face of a patient (this is used at the commencement of general anesthesia);
- *Mask maintenance* or *supplementation* continues a previously attained level of anesthesia for a period of time through inhalant delivered via mask (this is used during general anesthesia).

<u>Mask induction</u> should not be routinely performed because of unnecessary stress to the patients, uncontrolled entrance into unconsciousness, and unnecessary waste gas contamination to the staff and environment. Masking awake patients into anesthesia, termed mask induction, is considered to be very sympathomimetic and bronchoirritating (if isoflurane is used), risks inspiration of gastric contents through an unprotected airway, and often creates potentially high inhalant concentrations that may be deleterious for the patient and the staff. When performed correctly, mask induction also requires a high oxygen flow rate, which can be expensive and cause significant waste gas accumulation, a major source of environmental contamination (102-110).

<u>Chamber induction</u>, a corollary to mask induction is, is even more likely to result in prolonged and excessive excitement as well as potentially lethal high inhalant concentrations. Chamber induction results in the most significant waste gas environmental contamination known within the veterinary profession (103, 106).

Mask maintenance or *supplementation* during the surgical procedure should also be minimized to avoid aspiration of gastric contents in an unprotected airway, dangerously high concentrations of inhalants, environmental contamination, and bronchoirritation (104-110).

Within a busy environment, such as that encountered in a HQHVSN operation, mask inhalant supplementation on a few animals for *short* periods is often necessary and appropriate, but if mask supplementation becomes too frequent or regular, these other options should be considered for patient and staff safety:

- Instead of masking, utilize an anesthesia protocol that requires intubation, which is safer for the patient (it bypasses the bronchoirritation receptors and cells in the nose, nasopharynx, and trachea, and inhibits aspiration of gastrointestinal contents) and avoids environmental contamination.
- Consider alternative anesthesia protocols that employ better analgesics and sedatives, thus steadying the plane of surgical anesthesia and avoiding the need for additional anesthesia or mask inhalant supplementation.
- For consistent intraoperative lightness in plane of anesthesia, consider additional analgesics via sublingual or intravenous route to smooth the plane of anesthesia (microdose = small, titrable dose of opioids, Ketamine or alpha 2 agents).
- Eliminate issues that contribute to unsteady states of anesthesia, including hypothermia, hypoxia, hypotension, hypercarbia and hypoglycemia.

Injectable and Inhalant Protocols
The reference list of endnotes and Appendix A provides studies which detail protocols that have been reported via publication for use in HQHVSN environments. Most of these protocols are currently improved in both private practice and many shelter operations with the addition of a NSAID and/or a local anesthetic as indicated earlier in this section. The author refers the reader to each reference in order to better discuss the pros and cons of each regime. These guidelines do not support the use of any one particular protocol nor do they condone the use of any of the given reference protocols. It is simply the intention of these guidelines to identify commonly utilized protocols. Again, the choice of protocol used in each program will greatly depend on time constraints, staff training and number, number of surgical patients, financial status of the program and environmental concerns. The safest of these protocols appear to utilize readily and safely reversible agents, (opioids and alpha two agent Medetimidine and Dexmedetomidine), microgram or milligram per kg dosing vs. standard ml per cat or dog dosing, use of lowest possible doses of both alpha agents and dissociatives necessary to accomplish the surgery, reduced or no anticholinergics, avoidance of mask inhalant only protocols and avoidance of "hub" (highly inaccurate) dosing.

High Risk Patients
A separate protocol for higher risk patients necessitating sterilization during illness should be considered to afford safe and humane surgeries. This protocol might include the selection of highly safe and reversible agents, less reliance on cardiorespiratory depressant agents, supplementation of oxygen and fluids, and intubation if airway patency is questionable (111-113).

The following are sample protocols which can be utilized for patients with increased risk in terms of cardiopulmonary function, renal and hepatic function, and those with poor body condition scores:

Sample Feline Protocol for ASA Status II/III Patients
Premedication with Buprenorphine (0.02mg/kg IM, SQ) and Midazolam (0.2-0.5mg/kg IM, SQ), establish IV access, preoxygenate, induce with Midazolam 0.2mg/kg IV, followed immediately by Propofol 2-4mg/kg IV, intubate, place on isoflurane or sevoflurane in oxygen; during surgery administer IV fluids at 5-10ml/kg/hr, provide warmth and maintain oxygenation and ventilation via monitoring. Use of local anesthetics on the closed linea or scrotal incisions intraoperatively is highly suggested. Postoperatively, administer Buprenorphine (0.02mg/kg IM, IV, SQ) or Morphine (0.1-0.2mg/kg IM) for analgesia. NSAIDS should also be administered unless gross evidence of renal dysfunction is present.

Sample Canine Protocol for ASA Status II/III Patients
Premedication with Hydromorphone or Oxymorphone (0.1mg/kg IM, SQ) *or* Morphine(0.3-0.5mg/kg IM) and Midazolam (0.2-0.5mg/kg IM, SQ), establish IV access, preoxygenate, induce with Midazolam 0.2mg/kg IV, followed immediately by Propofol 2-4mg/kg IV, intubate and place on isoflurane or sevoflurane in oxygen. During surgery, administer IV fluids at 5-10ml/kg/hr, provide warmth and maintain oxygenation and ventilation via monitoring. Use of local anesthetics is highly recommended. Postoperatively, administer Hydromorphone or Oxymorphone (0.1mg/kg IM, SQ) *or* Morphine (0.3mg/kg IM) for analgesia. NSAIDs should be administered unless gross evidence of renal dysfunction is present.

Preparation for Emergencies
Several important practices must be considered to prepare for any emergency that might occur during high-quality, high-volume spay/neuter surgeries. Standard emergency drugs and reversal drugs must be in ample supply and easily accessible, and frequent/regular perusal and documentation of expiration dates and volumes remaining is important.

To complement this preparation, a simple weight and volume emergency chart should be clearly posted or readily available to allow for the "quick draw" of drugs in emergent situations. A useful chart can be accessed quickly from the following website: http://www.cvmbs.colostate.edu/clinsci/wing/emdrughp.html; if standard weights (1, 2, 3-5kg, 7-10 kg, 15, 20 and 30 kg) are entered, print offs can be obtained which allow instantaneous ml volumes of emergency drugs for each weight class patient. Other additional charts are available for cost through http://www.aahanet.org, http://www.ivecss.org, or simple CPR drug weight dosage charts can be designed from scratch.

Technical and assistant staff should be fully prepared; regular drilling or "rounds" is necessary, particularly in regard to identifying true arrests versus respiratory and cardiovascular depression. Rounds may also include equipment checks, the institution of the ABCs of CPR, record keeping for emergencies, review of difficult cases and morbidity/mortality rounds (114-116).

Various emergency equipment and drug lists exist but the following is recommended, at a minimum:

Equipment List
- Supply of ET tubes;
- Means of larynx evaluation (laryngoscope or working penlight);
- Oxygen supply (E tank with proper reducing and regulating valve, necessary tubing to provide flow by oxygen);
- Ventilatory equipment such as an Ambu bag or rebreathing circuit;
- Emergency drug administration records to record arrest events, CPR institution;
- Standard dosing charts for weights of patients and appropriate drug volumes (attention should be paid to reduction in many historically high doses of agents such as Epinephrine if used proximal to a cardiorespiratory arrest); and
- Suction apparatus (even one that's rudimentary, such as bulb syringe and catheter).

Recommended Reversal and Emergency Agents
- Reversal agents for the drugs commonly used in both premeds and induction: Atipamezole, Naloxone, Butorphanol, and Flumazenil;
- Atropine;
- Epinephrine and/or Vasopressin; and
- Lidocaine or Xylocaine spray for larynx immobilization and successful intubation.

Emergency Agents NO LONGER *Recommended*
- Parenteral Lidocaine is not recommended for occasional abnormal cardiac rhythms. Rather than react to an abnormal beat or many abnormal beats (rhythm) with administration of IV Lidocaine, the suggestion would be to check true pulse rate, warmth, volume and hydration status and oxygenation, correcting all these prior to administration of any anti-arrhythmic agent for any abnormal cardiac or pulse rhythm.
- Doxapram is not recommended for decreased respiratory effort or abnormal respiratory pattern. Rather than administer a stimulant, which ironically further lowers carbon dioxide levels (thus increasing respiratory depression), check anesthesia equipment for faulty technical errors, reverse or partially reverse respiratory depressant agents, including inhalants, oxygenate and ventilate the patient, and provide further monitoring for hypoxia, hypotension, hypothermia and hypoglycemia.
- Bicarbonate and calcium are no longer recommended for CPR events.

Accurate Drug Calculation and Administration
Given the high-volume nature of these sterilization programs, veterinarians may be tempted to use pre-determined or standard drug doses, a "one size fits all" approach that does not take individual patient weight or health into consideration. These types of predetermined doses can overdose small patients while being insufficient for large patients. For example, using 0.25ml of Medetomidine per cat is not recommended in place of dosing at 60mcg/kg per estimated body weight. However, categorized doses of drugs for various size patients (such as X mcg/kg of drug for patients weighing 1-2 kg, Y mcg/kg for patients weighing 2-4 kg, etc) may be utilized for programs with very high volumes of patients and inexperienced technical personnel.

Additionally, the administration of "hub" volumes of drugs should be avoided. Drugs should be of appropriate concentration and volume for patients within the program. If manufacturer's drug concentrations do not accommodate accuracy of drug dosing, a more diluted concentration of drug can be created via dilution of the parent compound with saline within the surgical setting for the days' cases; this will improve accuracy of preparation and administration. Diluted stock concentrations allow for easily and accurately measured dosing and administration.

That said, it is clearly understood that there are programs in which accurate weight cannot be obtained prior to drug administration, such as TNR, feral cat programs, etc. For these circumstances, safety is increased by using readily and safely reversible agents and by less frequent use of cardiorespiratory depressant drugs. Safety is further increased by obtaining best guess estimates of body weight to facilitate a compensatory increase or decrease of anesthetic doses. Use of a drug dose vs. weight chart may be helpful in preventing calculation errors.

Intubation
Intubation does not necessarily need to be a part of all HQHVSN anesthesia regimens but should be a possibility for all surgical patients if needed for emergency. If intubation is chosen as part of an anesthesia protocol, having an anesthesia team skilled in this area is critical (114, 117).

Intubation does not necessarily imply the use of oxygen or inhalant anesthesia; rather intubation simply implies that the patient is provided with a usable, patent and artificial airway. Although intubation with a cuffed endotracheal tube was historically the classic "gold standard" for maintaining a protected airway in the surgical patient, obtaining this airway on every patient requires training, practice, time, patience and the proper anesthetic depth. In fact, with some HQHVSN anesthetic regimens, intubation may complicate the routine and even compromise patient care if it is not performed with skill, care and efficiency (118, 119). Hence the pros and cons of intubation must be weighed against the historical benefits of "airway protection."

Understanding the Pros and Cons of Intubation
The benefit of intubation is that a protected airway is always maintained. This is important since general anesthesia, regardless of whether it is administered via injectable or inhalant (or both) agents, causes severe obtundation in reflexes, most importantly in esophageal and gag reflexes, which are protective reflexes for preventing airway obstruction. With intubation, regardless of the plane of anesthesia, the airway is protected, especially if a cuffed endotracheal tube is utilized.

However, the drawbacks of intubation are evident. This "protected airway" may give a false since of security; gastric contents can be regurgitated and still "leak" into the trachea, even around the cuff, and cause damage. Also, intubation can be difficult; unless the proper plane of anesthesia is present, gagging can occur, which not only makes it difficult for intubation to occur, but also stimulates stress hormone release, increased intracranial and ocular pressure and increased vagal tone, all of which can cause significant problems intra- and postoperatively. Intubation therefore also requires a relatively deep plane of anesthesia capable of obtunding this gagging reflex; deep planes of anesthesia can often be deleterious for the patient. Finally, intubation is not an easy task to master, especially for the inexperienced technical staff. If not

done properly, tracheal damage, lacerations and strictures can occur, threatening the life of the patient weeks to months post surgery.

Needless to say, if you are considering intubation as part of your surgical anesthesia protocol, you should ask the following questions to help aid in discerning the benefits and risks of the technical maneuver:

- How efficient is my technical staff?
- Will intubation cause more damage than not?
- How much time will each intubation require?
- Is the plane of anesthesia appropriate for intubation or will my premed/induction agent dosage need to be modified to accommodate intubation?

Suggested general guidelines regarding intubation in most HQHVSN programs are as follows:
- If a patient has severe respiratory (URT inflammation) or cardiovascular compromise (severe heartworm infection), it's best to intubate before a problem or arrest occurs. It is important to remember that *airway* is the first aspect of the ABCs of CPR. If an airway is in place when a disturbance takes place it will be easy to oxygenate, ventilate and resuscitate. Conversely, if an airway is not in place, it is very difficult to intubate a regurgitating, aspirating, agonal or arresting patient, especially if the patient is in a surgical position not akin to normal intubation.
- Most unfasted or unknown fasting status dogs should be intubated.
- Most adult overweight dogs should be intubated (120).
- Most brachycephalic animals, including Chows, Sharpies, Burmese and Persian cats, should be intubated (120).

Bladder Expression
Caution should be exercised during bladder expression, especially in male cats and dogs. While bladder emptying is conducive to easy surgical manipulation and visualization of pedicles/stumps, bladder expression, especially by untrained staff, can be extremely detrimental to renal function, bladder and urethral integrity, and may also cause or add to abdominal pain postoperatively. If excess pressure is necessary to express the bladder pre-operatively, check urethral patency (often partially occluded in many male cats), wait for deeper planes of anesthesia (when the urethral muscle is relaxed) or wait for intraoperative exam and surgical expression of the bladder.

POSTOPERATIVE CONCERNS

Shepherding a smooth transition for patients from anesthetized state to wakeful comfort for return to their home environments and normal behaviors requires practiced vigilance. Successful recoveries can be measured by minimal adverse patient events, staff contentment and satisfaction of owners and guardians. Prompt attention and open client communication regarding problem cases can minimize negative consequences (121).

Patient Transport
Patient Transport via Transport Vehicle - Safe delivery of patients to and from the facility is essential and should include:
- Ensuring safe, comfortable temperatures with appropriate heat, air circulation and air-conditioning;
- Verifying the appropriate identification on the patients, their crates and their paperwork;
- Securing the crates appropriately; and
- Continual monitoring of patients during transport.

Patient Transport Within the Clinic - Safe delivery to the recovery area is essential and should include ensuring the patient's airway is unobstructed, pain and stress are controlled, bleeding is minimal, and thermoregulation is continuously addressed.

Protecting patients against infectious disease is essential. Patients should be triaged prior to loading and segregated if there are signs of possible contagious disease. Thorough disease control practices including proper cleaning and disinfection should be in place.

Recovery
For proper recovery, use a designated area that allows for continuous, direct observation of each patient and separation of species when possible. The area should be clean, dry and warm and noise should be minimized. Caution is advised when holding animals during recovery to avoid airway restriction (via simple head malpositioning) and sudden emergence delirium with subsequent caretaker injury; for these reasons, it is advisable to instead allow recovery on flat steady surfaces such flooring, or cages. Recovery with siblings is recommended for pediatric patients when possible to provide warmth and familiarity with surroundings

Anesthesia Considerations
Patients recovering from anesthesia should be continuously observed for any signs of hemorrhage, respiratory compromise, pain, stress, complication or discomfort, as well as for urination and defecation. Identified problems should be addressed immediately. Complications of the postoperative period include, but are not limited to: continued cardiorespiratory depression or compromise; continual drop in body temperature or hyperthermia; abnormal recovery including slow, distressed or anxious recovery; and vomiting/regurgitation with risk of aspiration (122-125).

Parameters that should be assessed at a minimum include:
- Heart rate and pulse quality (except for feral animals);
- Protection of airway (make sure nose and mouth are unobstructed by blankets or padding);
- Respiratory rate and character;
- Pain and anxiety;
- Temperature for at risk patients;
- Degree of arousal or sedation; and
- Movement.

If non-steroidal anti-inflammatory drugs (NSAIDs) were not administered pre- or intra-operatively, they can be administered orally or parenterally to either dogs or cats once adequate swallowing reflexes have returned, provided that hydration status is considered as normal as possible in these patients.

Anesthesia Reversal – At the surgeon's discretion, reversal of sedative, analgesic and anesthetic agents may be accomplished if necessary for emergent cases and programs in which the patients must be promptly returned to the owner, caregiver or environment. It should be remembered that the reversal of analgesia and sedative agents may cause pain and anxiety. In fact, intravenous reversal of agents is commonly associated with sudden and severe catecholamine release. Hence, IV administration should be avoided if at all possible except in emergent cases.

Should administration of reversal agents be needed, the following is recommended:
- Only partially reverse the sedative or analgesic agents;
- Utilize careful and slow titration of the reversal agents IV or intramuscular (IM) to avoid sudden anxiety and pain; and
- Utilize only IM administration of reversal agents that characteristically do not enter the circulation as fast to cause sudden pain and stress.

Thermoregulation – Body temperature should be preserved with individual surface and body coverage including paper, towels or blankets. If needed, options for supplemental heat sources include convective warming (warm air), circulating hot water blankets, protected or stand off hot water bottles or rice bags (very carefully monitored) and heat lamps (vigilantly monitored). See cautions specified under *Thermoregulation* beginning on page 8.

Hypoglycemia Prevention – To protect against hypoglycemia, pediatric, geriatric, frail or "at risk" patients should be offered small amounts of food when appropriate as determined by adequate righting and swallowing reflexes. Small amounts of water should be offered as soon as patients are ambulatory (37, 109).

Kennel Environment
Certain details particular to a kennel environment deserve careful attention.

When transporting a patient to an assigned cage, verification of the patient's identification is critical. Patient identification must match the appropriate paperwork and cage. Patients should be continually evaluated for quiet-alert-responsive status, as well as for signs of stress and pain. Cleanliness should also be carefully monitored. Under supervision, recovered patients can be offered food and water as needed. Pediatric patients should be offered food and water under supervision as determined by adequate righting and swallowing reflexes.

Dogs that are ambulatory should be walked to encourage urination and defecation, if not considered to be a behavioral risk. If cats are to be held longer than twelve hours, a litter box should be provided after the patients are ambulatory. Feral cats should be returned to their environments as soon as possible.

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convened in December 2006 to assess and advance high-quality, high-volume spay/neuter. Meeting participants – academics, private practitioners, and spay/neuter program veterinarians – drew on their experiences of teaching and/or performing high-volume spay neuter in order to document the first standard protocols for high-quality, high-volume sterilizations. Standards are forthcoming in the *Journal of the American Veterinary Medical Association.*

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Appendix A

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