An Introduction to the Principles of Anesthesia and Surgery of Birds

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Anesthesia and surgery is a large and comprehensive subject – one well beyond this introductory paper and presentation. With correct use of proper equipment and safe anesthetic agents, anesthesia is a much more practical and safe consideration today. An awareness of current anesthetic procedures, products, monitoring equipment and surgical procedures positions veterinarians in a more optimal to discuss and recommend appropriate procedural options for their patients and clients, and potentially refer them for needed levels of expertise and care. Awareness of and expertise in these same areas allow veterinarians to recommend and perform them with confidence for their patients and clients. Additionally, when the surgical procedure is completed, the optimal balance of comprehensive health care delivery is far from complete. Pain management, critically optimizing supportive care procedures and details, and delegating and empowering nursing care are all very important in the immediate postoperative period. Furthermore, the details of medical record management and client communication, and decisions regarding the timing and criteria for discharge from the hospital are also keys to optimal patient care. Following release from the hospital, follow-up by telephone and scheduled repeat physical evaluations are used strategically to effectively close the case management of the surgical problem, and to ultimately transition from the specific procedure performed to a more complete plan of wellness care delivery.

Presurgical evaluation

Patient evaluation prior to anesthesia and surgery includes history, physical examination findings, tentative diagnosis list, and laboratory evaluation findings. A patient's clinical history, combined with physical examination findings, remain the foundation of good quality avian medicine and surgery. It is this information that helps to guide the veterinarian towards further considerations, diagnostically or therapeutically that can influence choices of anesthetic procedure(s), surgical procedure(s) or even influence a decision to not perform a procedure at any one given time. Laboratory diagnostic tools that can help clarify the state of patient health pre-surgically may include hematology, biochemistries, radiography and ultrasonography. Not all patients must have all laboratory diagnostics performed prior to anesthesia and surgery. In some settings, immediate surgical need, patient stability or client financial limitations may lead towards anesthesia and surgery being a more logical step towards treatment over a factual, detailed pre-surgical documentation of patient health status.

Surgical suite preparation

Prior to inducing anesthesia, the surgical suite should be fully prepared in anticipation of any and all anticipated needs. Emergency drugs that may be needed should be pre-calculated and available. Surgical equipment, suture materials, bandaging materials and any other potentially needed supplies should be anticipated, and made available. The anesthetist should have no distractions away from their ability to focus on the patient and supporting the needs of the surgeon. Potential distractions from these tasks, including running to get needed drugs, supplies or equipment, should be avoided with careful preparation prior to induction of anesthesia.

Pre-induction considerations

Common fasting periods typically range from three hours to eight hours or greater. In pediatrics, shorter periods may be needed. When considering gastrointestinal surgery, longer periods may be even be needed. Pre-operative analgesia is an important component of pre-induction procedure, as is the comfort and degree of fear experienced by the bird. Pre-oxygenation may have value in many patients, prior to anesthetic induction.

Induction of anesthesia

Induction of anesthesia in most companion bird species is most commonly accomplished by mask with isoflurane. Clear plastic facemasks, designed for dogs and cats, allow excellent visualization of the patient during induction, and are comparatively inexpensive to purchase in a variety of sizes. Some species, such as toucans, may require specially designed facemasks. Most birds will be induced at a 5% vaporizer setting, although some may be induced at a lower concentration. Sevoflurane and Desflurane are just now beginning to be used more frequently in avian anesthesia, and seem to carry a low risk factor and some benefits associated with rapid induction and recovery. Endotracheal intubation is recommended for most procedures in patients over approximately 100 grams. Below this weight range, intubation may be challenging if not impractical for some, but not all patients. Intravenous injectable anesthetics including ketamine, diazepam and xylazine can be used in combination for anesthetic induction for some larger bird species, such as anseriformes, large galliformes and ratite species. For those patients where there may be surgery of the trachea planned, or where there is a suspected upper airway obstruction, cannulation of the abdominal or caudal thoracic air sac may be needed to maintain anesthesia. A non-rebreathing system should be used for most companion bird species. A Bain's or Ayre's T are common equipment choices for delivering gas anesthesia. Oxygen flow rates of 0.5 – 1.5 L/kg/min are commonly used.

Monitoring and patient support

Anesthetic depth is monitored most accurately by physical observation by the anesthetist. Respiratory rate, depth and character are closely observed. Subtle changes in character can be very significant in the anesthetized avian patient. Respiratory monitors are available that will help monitor heart rate are available and can have value as an aid in patient monitoring, but cannot serve as a sole substitute for constant observation by the anesthetist. Heart rate is monitored for rate, regularity. An esophageal stethescope can aid the anesthetist in monitoring the anesthetized patient. A Doppler pulse monitor is a very helpful helpful aid in heart rate, and for the purpose of monitoring indirect blood pressure. ECG can also be helpful in cardiac monitoring of the anesthetized patient. Patient temperature can be monitored with the use of a digital thermometer, either from an esophageal stethescope or a cloacal probe that is placed prior to surgery. Clear surgical drapes offer the surgeon and the anesthetist the benefit of seeing the entire patient, and these drapes are an accepted standard in companion bird surgery.

Fluid support for the surgical / anesthetic patient is maintained either via an intravenous or intraosseous catheter. The jugular, basilic, or medial metatarsal veins can be used for intravenous catheterization. Intraosseous catheters can be placed in the distal ulna or the proximal tibiotarsus. The generic maximum fluid administration rate that can be infused to healthy birds is 90 ml/kg/hr. In those patients where blood loss is of concern, whole blood or oxyglobin should be available. Hetastarch is particularly helpful and important to have available for those patients where total serum solids or protein levels may be subnormal prior to surgery, or where there has been a precipitous drop in blood pressure noted. Thermal support is most optimally provided for avian patients using radiant overhead heating sources, with circulating heated air devices another effective option. Heated water pads, electric pads and heated water balloons or bags are less effective at maintaining body temperature than radiant or circulating heated air. Intermittent positive pressure ventilation is helpful for some avian patients, at a rate of 20-40 breaths per minute.

Surgical procedure

At surgery, speed and efficiency is important. Body temperature can be rapidly lost from an open body cavity. When coelomic surgery is being performed and/or air sacs are incised, there can be a loss of capacity for normal ventilation, loss of anesthetic gasses from the air sacs. Stability of a patient can change rapidly and sometimes unpredictably. Good communication between surgeon and anesthetist during the procedure is important to allow optimal coordination between surgical procedure and anesthetic support.

Recovery from anesthesia

With the more common companion bird species, most veterinarians prefer and recommend "hands-on" recovery post operatively. During this period, careful observation of respiratory rate, auscultation of the heart and physical stimulation of the patient all combine to assist in the "art form" of bringing these patients back to the conscious world safely. An increasing and deepening rate and character of respiration should indicate that the patient is becoming 'lighter", and recovering. Sternal excursions of most bird species should be monitored (lateral rib movements in ratites, some anseriformes) for increases in depth and frequency. Heart rate and quality should also be monitored. Decreases or changes in heart rate are often mirrored and preceded by changes in respiration. During your patient's recovery, smell the endotracheal tube for isoflurane fumes; as full recovery is approaching, this odor should diminish. Mechanical stimulation of the bird's legs, wings and scratching the pectorals help to increase the rate and depth of respiration, speeding up recovery.

As their significance in monitoring the recovering patient decreases, all anesthesia monitoring and supportive devices should be progressively removed. These include the Doppler pulse monitor, blood pressure cuff, ECG leads, endotracheal tube, supplemental oxygen and ultimately the IV or IO catheter, unless this is needed post operatively for continued fluid support or venous access. Immediately before or after extubation, examine the patient's oral cavity and glottis and the endotracheal tube itself for any regurgitated food, blood or mucus that may be present, and clean as needed. Most companion birds are wrapped lightly in a towel during recovery to help control any delirious flapping or struggling, but it is very important to continue to pay close attention to respiratory rate and character, and not lose ability to monitor. Most birds experience some degree of delirium during recovery and following anesthesia. This delirium usually occurs shortly after discontinuing anesthetic gas delivery, and can result in vigorous wing flapping, vocalization and chewing or biting behaviors. Injectable anesthetics, if used, may produce more severe post-anesthetic delirium. The patient should be directly monitored until it is fully awake.

Once an apparent full anesthetic recovery has been achieved and the bird is stable enough to stand, return bird to a warm environment, and progressively relax your monitoring. Many, but not all birds should have auxiliary heat provided in the immediate peri-operative period until such time as they are homeothermic. Generally, food may be offered within 30 minutes to one hour for most birds; possibly sooner for some smaller species. Food and/or water are more often provided later and in modified forms for gastrointestinal surgical patients. Air sac breathing tubes that have been placed should be evaluated for patient comfort and patency. Patency of these tubes can be verified by holding a small contour or down feather to their opening as the patient breathes, watching for exhaled air to move the feather. Pharyngostomy tubes that have been placed during the surgical procedure should be evaluated for patency as well as patient comfort.

Post operative patient support

Although they are somewhat of a common practice in canine and feline practices, the "routine" use of Elizabethan or other types of collars in a routine post-operative situation is probably much less indicated in common companion avian species. In this author's experience, it is comparatively uncommon for birds to damage their post-surgical incisions, when their comfort and levels of stress are attended to optimally. Large size suture that is rigid in the skin polydioxanone (PDS), polypropylene (Prolene) may be much more irritating than a smaller suture size of the same material or a softer choice such as polyglactin 910 (Vicryl). Traumatic tissue handling technique may result in more inflammation, pain, and potential for chewing at an incision site. Bandages that are excessively heavy, uncomfortable or constricting can also result in increased attention and chewing. With many bandaging techniques in avian species, when one considers effectiveness combined with patient comfort, "less may be best", and lighter weight, comfortable bandages that minimally compromise function should be applied. If the post-operative analgesia is inadequate, irritating suture material used, bandaging techniques are cumbersome or uncomfortable to the bird, or the surgeon's tissue handling skills have resulted in increased amounts of tissue trauma and inflammation, a bird may show more focus at its surgery site and increased potential for bandage or incision trauma. If a bird shows increased attention to these sites, a collar or sedative may be recommended or applied by many veterinarians. This may not necessarily be the most appropriate or balanced decision in many cases. It is common for these uncomfortable birds to be labeled as a "mutilator", thereby justifying the need for applying collars and or other restraint devices. Ideally, a restraint device is only used when absolutely needed, which should overall be much less common than is probably generally accepted. If the behaviors of the post-operative patient are assessed as indicators of comfort, pain, fear, or anxiety, a more appropriate balance of immediate post-operative care can be achieved, often, without the use of restricting devices. Furthermore, collars, due to their stressful and intrusive nature, can mechanically impede the bird's ability to eat normally, to forage, interact, and perform many self-comfort behaviors. The bird that has become apathetic to the presence of a collar and "tolerates" its' presence should not necessarily be viewed as a good thing. In essence, the use of collars post operatively or therapeutically should be evaluated along the lines of "best practice"; with a goal of being least intrusive, but most effective. Considerations should be made about the short and long term benefits and risks of the use of a collar to the patient, with an understanding that wound mutilation or bandage chewing may be a clinical sign of discomfort, rather than a diagnosis unto itself.

Treatments and medications administered both pre and post-operatively

A variety of medications may be administered pre and post operatively, depending on the specifics of the patient's case management and health status. Common in-patient treatments include analgesics, anti-inflammatories, antimicrobials, and fluid therapy. The types and nature of these treatments will, by sheer volume, be impossible to discuss completely in this paper. It is, however, important to remember that balanced patient care requires not only the "rubber stamp" use of these drugs, but critical thought is necessary as to their true indication in each patient, and careful consideration regarding their potential adverse effects should be made. Just as critical evaluation of the numbers and types of diagnostic tests performed as compared to their factual merit is important, more drugs are not necessarily better either. Potential or real adverse effects of treatments administered should be evaluated in not only in terms of the individual drugs themselves and in combination, but also by observed and quantifiable behavioral criteria of the patient day-to-day. Evidence of pain, increases in escape / avoidance behaviors, aggression, apathy all require recognition in order to be able to help guide alterations in treatment methods.

Analgesia

Recognizing the presence of pain in birds is challenging. Clinical signs of pain are not necessarily universal, are often species dependent, and are individually variable amongst birds. Although heart rate, respiratory rate and blood pressure can increase during pain, these parameters can also be influenced by perceived fear, light and temperature. As a result, these parameters, alone, may not be reliable alone as quantifiable measurements of pain in a patient. Many of these clinical signs are vague, and as a result, they can be challenging to clearly correlate with pain in many individual patients. As a result, it is generally recommended that we err on the side of over-estimation of the presence of pain, and assume that conditions that would be painful to humans are equally painful to birds. Generally, observed behavioral criteria are the primary traditional "tools" utilized to help assess pain in birds and other animals, as there typically will be a change or absence of one or more normal behaviors for that animal. Acute pain is often more easily recognizable as compared to chronic pain.

Acute pain should be more readily recognizable through demonstrated rapid withdrawal reflexes or aggression when a painful body part is stimulated or touched. Although these behaviors correspond to the conscious perception of the stimulus, their interpretation requires that the bird be fully cognizant of its environment and physically capable of reacting. There also is a requirement that the hospital personnel take the time to observe and carefully interpret what they see in regards to the pain and comfort of the patient. A reduction in social grooming behaviors, decreased activity, agitation, or removal of oneself from the flock can be seen in many bird species that are experiencing chronic pain. Chickens experiencing arthritic can most predictably demonstrated an absence of dust bathing behaviors. Progressive removal of feathers from chickens caused marked changes in behavior, ranging from an initial alert and agitated response to periods of crouching immobility following successive removal. Pigeons, after orthopedic surgery, showed trembling of the wings and body as the behavior that correlated most frequently with pain.

Aggression can be seen in some birds with pain; either in an effort to remove a painful stimulus from its environment or non-specifically manifested in some individual cases. Feather grooming behaviors may either be increased or decreased in frequency for an individual bird that is experiencing pain. In a circumstance where there is general withdrawal from daily activities due to pain, a decrease in preening behavior can be seen. Some birds may show feather damaging behaviors either non-specifically or regionally directed to a painful location of their body. Appetite and feeding behaviors can be decreased, resulting in weight loss or a potential failure to gain weight. Birds may display similar tonic immobility postures post operatively or under chronically painful conditions. Tonic immobility (cataplexy) is an innate fear response that is characterized by a profound and reversible state of motor inhibition.

Local anesthetics

Local anesthetics are used to produce regional anesthesia and analgesia by blocking the transmission of noxious impulses. When used preoperatively, local anesthetics block the site of tissue manipulation, which helps prevent central nervous system sensitization. Both lidocaine and bupivicaine act by blocking sodium channels in the nerve axon, interfering with the conduction of action potentials along the nerve. These anesthetics are applied through regional infiltration, local line blocks or "splash" block methods. In general, the total dose of lidocaine administered should not exceed 4 mg/kg, and a maximum dosage of 1 mg/kg of bupivicaine has been suggested. It is recommended that when using the common dosage range for lidocaine at 1 to 4 mg/kg, the commercially available concentration should be diluted at least 1:10. Overdosage of lidocaine has been reported to cause seizures and death in small birds. In mammals, analgesia from bupivicaine (4-10 hours) lasts much longer than lidocaine (1-3 hours), but the duration of analgesia from these drugs in avian species is not known. Intra-articular administration of bupivacaine (3 mg in 0.3 ml saline) was shown to be effective for treating musculoskeletal pain in chickens. Toxic side effects of these drugs can include fine tremors, ataxia, recumbency, seizures, stupor, cardiovascular effects and death.

Opioids

Drugs in this family reversibly bind to specific receptors (Mu, Kappa, and Delta) in the central and peripheral nervous systems. Of these drugs, butorphanol (mixed agonist-antagonist) is the best studied opioid analgesic, with primarily kappa agonist actions. Plasma concentration of 2 mg/kg IM administration of butorphanol in grey parrots has a mean residence time of less than 2 hours, with suggestive analgesia for approximately 4 hours. Butorphanol (1 to 3 mg/kg) is currently recommended for opioid analgesia in birds, and it can be given as a preoperative and postoperative analgesic. It is also recommended for acute, severe pain that often accompanies trauma.

NSAID's

Non-Steroidal Anti-inflammatory Drugs (NSAIDs) interfere with eicosanoid synthesis by the inhibition of cyclooxygenase (COX) enzymes. These enzymes are involved in reactions that result in polyunsaturated acids being converted to eicosanoids such as prostaglandins and thromboxane, which are released at sites of tissue injury and cause inflammation and sensitization of nerve endings. A reduction of prostaglandins and thromboxanes results in a decrease of inflammation at the site of injury and has some modulating effect within the central nervous system. NSAIDs can be used for many forms of acute and chronic pain in birds, and often are used in combination with other analgesics (opioids and/or local anesthetics) to produce a synergistic analgesic effect. Common NSAID drugs used in avian practice include ketoprofen, meloxicam, carprofen, celecoxib, and piroxicam. Ketoprofen exhibits actions similar to that of other nonsteroidal anti-inflammatory agents in that it possesses antipyretic, analgesic and anti-inflammatory activity. Its purported mechanism of action is the inhibition of cyclooxygenase catalysis of arachidonic acid to prostaglandin precursors (endoperoxides), thereby inhibiting the synthesis of prostaglandins in tissues. As an anti-inflammatory analgesic, ketoprofen is dosed at 2 mg/kg IM q 8-24 hours. Meloxicam is also an oxicam NSAID; however, it has greater activity against COX-2, which suggests it may have a wider safety margin in mammalian species. Dosages for meloxicam are commonly used in 0.1-0.5 mg/kg PO or parenterally SID. Analgesic effects of 1.0 mg/kg IM meloxicam BID have been described in Hispaniolan parrots with experimentally induced arthritic pain. Carprofen may be a specific COX-2 inhibitor, and is available in oral and injectable forms. Its primary effect is on inflammation while potentially sparing physiologic prostaglandins. Pharmacokinetic studies with broiler chickens indicated that peak plasma levels of carprofen were reached between 1 to 2 hours after a subcutaneous dose, and pain thresholds were raised for at least 90 minutes after the chickens received 1 mg/kg subcutaneously. Carprofen at this same dose and route of administration has been shown to increase the walking ability and speed of lame broiler chickens. Piroxicam is a NSAID approved for use in humans and used in mammals to treat chronic inflammatory conditions, such as arthritis. It has been administered to treat pain associated with chronic degenerative joint diseases in birds and appears to provide mild to moderate improvement.

Fluid administration

Continued fluid support, if needed, may be administered via oral gavage, subcutaneous, intravenous or interosseous routes. Common fluids administered in the post operative period include warm Lactated Ringer's, and isotonic saline. Fluids with 5% dextrose may be given in the oral, IV or IO routes. A generic maintenance fluid requirement for most birds is commonly quoted at 50 ml/kg/day, although it is acknowledged that there should be significant variation amongst species and clinical circumstances. Desert species probably have lower requirements, as do many of the larger avian species. Some small bird species may require as much as 100 ml/kg/day or even higher in some situations. The rates of fluid administration selected are based on patient-specific criteria, including clinical assessment of dehydration. Signs of dehydration in birds include decreased skin turgor, sunken or closed eyes, dry oral

mucous membranes, and thick mucus in the pharynx. The turgor and filling time of the basilic vein can be helpful in assessing dehydration. The normal filling time of the basilic vein is less than ½ second. A filling time of the basilic vein that is increased to 1-2 sec can be interpreted to represent approximately 7% dehydration. Sunken eyes and tacky mucosa occur at approximately 10% dehydration.

The most commonly utilized maintenance parenteral fluid administration route is subcutaneous. Subcutaneous fluid administration sites utilized in birds include the inguinal skin web between the knee and body wall, the interclavicular area, and the proptagial wing web. Comparatively, the largest amount of fluid can be administered in the inguinal skin web (generally up to 5% of body weight), with the other two sites having lower volume capacity. Oral or gavage fluid administration may be effective for maintenance or mild dehydration, but requires knowledge of crop capacity, and a reasonably functional gut transit time and ingluvial emptying time. Oral 5% dextrose in water (D_5W) has been shown to be superior to LRS for oral rehydration. Psyllium may increase water and calcium absorption from the GI tract. Hypertonic fluids are avoided as they will pull fluid into the gut and out of the circulation. Some species of birds lack a crop (ratites, picivores), others have comparatively small crop sizes (passerines, some anseriformes), and others have fairly large ingluvial capacity (psittaciformes, galliformes). Fluids may also be given intravenously or intraosseously. These routes offer the advantage of continual rates of infusion if an infusion pump is utilized, but also bring the potential disadvantages of patient discomfort and stress. Maintenance rates are calculated loosely in a similar manner as with subcutaneous administration. With these two routes of administration (IO or IV), boluses of up to 10 ml/kg may be given over 5 to 10 minutes. Interosseous fluid therapy is a quick and easy method of administering fluids to many companion bird species, offering an access route that is always available even in the most dehydrated animal. IO fluid administration carries a low complication rate, is effective in even the smallest patients, and uptake from bone marrow in mammals is comparable to that of an IV catheter placed in the anterior vena cava. The rate of maximal interosseous fluid administration is related to the diameter of the catheter that is placed. Poiseuille's equation gives factors that change the resistance in tubing, and the most powerful component in this equation for the calculation of resistance is the radius of the tube. Resistance is inversely proportional to the fourth power of the tube radius. As an example; if catheter A has a diameter half the size of catheter B, the resistance in catheter A will be 16 times ($2^4 = 16$) the resistance in catheter B. As a conclusion, the largest possible interosseous catheter than can be used safely should be selected. Clinical experience by many veterinarians suggests that interosseous fluid bolus administration may be painful, and this may need to be considered.

Environmental support

Supportive care is also an important component of the clinical management of pain and discomfort post operatively. Most post-operative birds generally benefit from a warm (85-90°F), quiet environment with easily accessible food and water. Obese birds, or those with some forms of respiratory disease, may need to be maintained at a slightly lower temperature (75°F). With time and observation, as these birds become homoeothermic, the temperature of the environment is progressively lowered to room temperature. This is ideally accomplished prior to the date of discharge from the hospital. Reducing fear and augmenting patient comfort are invaluable. A warm, calm and soothing hospital environment that has no noxious or anxiety-generating stimuli (noise, predators, etc) is very important. Companion birds should benefit from caring and positive human interaction over the course of their hospital stay, with social contact and interaction integrated into their daily treatment regimes. In some settings and with some species, in addition to environmental management changes, drugs may have value to mediate stress and increase feeding behaviors. In wild-caught Hawaiian i'amakihi, the hyperphagic and anxiolytic effects of diazepam administered orally at 1 mg/kg were studied; leading to a conclusion that oral diazepam increased feeding behaviors and movement at least in this species during a short period of captivity.

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