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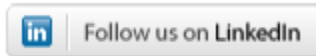
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Total Intravenous Anesthesia in Horses

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Preanesthetic Sedation

Routinely a 14g 5inch catheter is placed without sedation within the patient's jugular vein. This allows easy access for premedication and induction agents and avoids multiple venous punctures as when a catheter is not utilized. Subcutaneous infiltration of 2% lidocaine may be used to desensitize the area and is administered before the catheter attempt. Allow the patient to be undisturbed for 10-15 minutes post catheter placement to return back to a normal resting calm state.

Premedications for general anesthesia

Common premedications used in equine practice include α2 adrenoceptor agonists, opioids, and acepromazine (Table 1). Routinely, xylazine (α2 agonist) and butorphanol (κ-opioid agonist) are administered in combination and the expected result is moderate sedation and muscle relaxation. Significant bradycardia and bradyarrhythmias (2nd° AV block) can occur and therefore it is important to always check pulse rate approximately 3-5 minutes' post intravenous premedication and prior to induction. Head twitching may be observed after butorphanol administration. Desired sedation/muscle relaxation includes dropped head to the level of the carpus, unresponsive to surrounding stimuli, decreased menace response, and standing ataxia.

Induction for general anesthesia

Horses can be induced in the field or in an induction stall. In an induction stall head and tail ropes or a "swing-gate" can be used to ensure a smooth induction process for both the horse and personal attending. To maintain safety precautions, drugs should never be pushed prior to notifying all personal within close proximity to the horse. Common drugs used to induce equine anesthesia are found in Table 2. Ketamine is the most common anesthetic agent to induce anesthesia in horses. Due to its effect on muscles (extensor muscle rigidity) it is combined with muscle relaxants such as midazolam, diazepam, or glyceryl guaiacolate (GG or guaifenesin). Drugs are administered as a fast bolus to avoid a partially excited anesthetized animal that can occur with slow administration. GG is administered in a fluid bag and is given to effect until ataxia and/or buckling of the knees is observed. Most often GG is placed in a pressure bag or is squeezed by the anesthetist to increase its rate of delivery. Greater than 5% concentrations of GG have been known to cause hemolysis and phlebitis in various species and therefore a concentration of 2.5-5.0% is recommended.

Intubation

An equine trachea can be intubated via nasal or oral route. It is considered a "blind technique" as the anesthetists cannot visualize endotracheal tube placement. Purposes of intubation include: maintaining a patent airway, preventing aspiration of contents (blood, oral cavity fluids, and surgical flush solutions), minimizing airway resistance in respiratory compromise (laryngeal hemiplegia, nasal trauma), and facilitating inhalant anesthetic administration or assisted and controlled mechanical ventilation. The anesthetist should avoid endotracheal cuff pressures that exceed 20 to 30mmHg as this can result in

ischemic tracheal damage. A lubricated tracheal tube is inserted into the mouth through a PVC pipe or mouth gag and advanced into the pharynx. Care must be taken not to rub the tube against the cheek teeth as this may cause rupture of the tracheal cuff. The tube should smoothly pass through the pharynx and larynx and into the trachea. Minimal to no resistance should be felt when passing the endotracheal tube otherwise this may indicate the tube has been placed into the esophagus. If a failed attempt occurs the whether it be from entering the esophagus or pressing against the pharyngeal wall the tracheal tube is retracted 10-15cm, rotated 90° in a clockwise direction and re-advanced. This may be repeated if necessary in a smooth quick fluid motion. Horses are obligate nasal breathers and therefore if an airway obstruction is evident and intubation is impossible the patient should undergo an emergency tracheostomy. Intubation is not routinely required in horses undergoing total intravenous anesthesia (GKX).

Maintenance of anesthesia

Total Intravenous Anesthesia (TIVA): TIVA is the most commonly used technique to anesthetize equids in general practice. Advantages of TIVA include ease of use, reduced cost, field anesthesia, no requirement for scavenging, better cardiovascular function, less stress response, and smoother recovery. Disadvantages can also be seen and include cumulative effects and poor-quality recoveries when patients receive TIVA for >1 hour, difficult to determine anesthetic depth, requires liver metabolism, and availability of IV drugs may be limited. Short term (20-30 minutes) TIVA can be accomplished with an α2 agonist and ketamine. If needed, anesthesia can be extended by administering one-third to one-half of the original dose. Caution with multiple dosing as it may prolong recovery. For longer procedures (up to 60 minutes) an infusion of drugs is used to maintain anesthesia. This provides plasma steady state concentrations and avoids peaks (toxicity) and troughs (inadequate anesthesia) that may be seen with intermittent boluses. The most commonly used infusion for long-term TIVA is "triple drip" or "GKX". This is a mixture of 1000mg ketamine, and 250mg xylazine added to 500mL of 5% guaifenesin. This combination is then administered at a rate of 1-2ml/kg/hr. Xylazine can be substituted with 10mg detomidine or 40mg romifidine. Monitoring depth of anesthesia during TIVA can be difficult. Eye position and palpebral reflexes can remain during TIVA and tear production and blinking is common. Increases in respiratory rate, increasing activity of the eyeball (slow to fast nystagmus), increasing palpebral reflex response, and gross movement of the limbs are good indicators of a light anesthetic plane. Deep anesthetic planes can result in Cheyne-Stokes breathing patterns (short shallow breaths followed by periods of apnea), poor pulses, and dull eye signs.

Recovery

Recovery is the most dangerous, problematic, and unpredictable phase of equine anesthesia. Every attempt to be proactive rather than reactive can help in reducing morbidity and mortality. Complications in recovery include prolonged emergence, post anesthetic myopathy, neuropathy, myelomalacia, injury of orthopedic repair, fracture, hypoxemia, hypotension, respiratory obstruction resulting in non-cardiogenic pulmonary edema, syncope, epistaxis, and cardiopulmonary arrest. Six phases occur during an equine recovery and each of them should be detailed in the anesthetic record as they occur. These phases include: 1) transition from anesthesia to recovery 2) first movement 3) movement to sternal recumbency 4) first attempt to stand 5) initial standing 6) completed recovery. Duration of recovery is dependent on several factors such as anesthetic drugs, procedure length, and health status. Recovery duration with injectable (ketamine or GKX) anesthesia can range from 30-45 minutes, with generally one attempt to stand. During

the recovery phase sedation is administered to smoothen and improve the recovery quality. Patients can undergo an involuntary excitement phase which coincides with muscle weakness and incoordination. However, this phase is less pronounced in patients undergoing TIVA rather than inhalant anesthesia. Drugs such as acepromazine (0.01-0.02 mg/kg IV), xylazine (0.1-0.4 mg/kg IV), or romifidine (0.008-0.01 mg/kg IV) can calm or sedate the horse during recovery. Ideally, the patient will remain in lateral or sternal recumbency until the ketamine is metabolized and then attempt to stand calmly with coordination. Different modalities have been used in equine practice during the recovery period. Traditionally cases recovering from field anesthesia are allowed to "free recover" which is where the horse does not receive any physical assistance to stand. Chemical assistance may still be provided. Assisted recoveries are more commonly used in hospital settings through the use of head and tail ropes, slings, air mattresses, purpose-built tilt tables, and pools.

Extubation: Horses can be extubated when spontaneous ventilation is present and a swallowing reflex is maintained. Always ensure the cuff is deflated prior to extubation. If nasal edema or an upper airway obstruction is present, the endotracheal tube can be left in place until standing. Additionally 0.25% phenylephrine can be sprayed within the nostrils through a long 5 inch catheter to decrease nasal edema. Nasal airflow should always be checked immediately after extubation to ensure a patent airway. Care should be taken to avoid excessive chewing as it could damage the tube and potentially break and get lodged in the trachea. Tape connecting the tube to the halter or mouth can be used to fasten the endotracheal tube in place in times when the anesthetist decides to leave the tube in during the entire recovery period.

Common Recovery Complications

Upper airway obstruction: Acute upper airway obstruction (AUAO) is seen after endotracheal tube extubation. Visualizing head and ocular edema is a good indicator that nasal edema has also occurred and that a problem may ensue post-extubation. Nasal congestion is enhance with patients in dorsal recumbency and through the use of α2 agonists in the recovery period. Maintaining the patient in a head down position increases the development of edema. A strong swallowing reflex or patient standing should occur prior to extubation so that adequate neuromuscular function is present to replace the epiglottis to its normal position above the soft palate. Clinical signs associated with AUAO include dyspnea, retraction of the nares and fascial muscles, tachycardia, sweating, thrashing, kicking, stridor, syncope, and convulsions. Pulmonary edema can be a sequela from AUAO due to alveolar damage from intense bouts of increased inspiratory pressures generated during the obstruction. A partial obstruction associated with nasal edema can be alleviated with the administration of phenylephrine intranasally. If a complete AUAO is determined immediate re-intubation is required. This may require induction of anesthesia for endotracheal intubation or heavy sedation and regional anesthesia for an emergency tracheostomy. Oxygen should be supplemented and furosemide (1 mg/kg IV) can be administered when pulmonary edema is present.

Myopathy or rhabdomyolysis: This is a consequence of poor tissue perfusion and has been linked to hypotension. Clinical signs may be similar to those patients with radial and femoral neuropathies as it produces weakness, reluctance to stand, and inability to support weight. Hardened muscles, extreme pain, and myoglobinuria (coffee-colored) are specific to myopathies. Treatment is directed towards increasing

muscle perfusion via dobutamine, intravenous fluids, muscle relaxants, and alkalinizing the urine. These techniques will improve skeletal muscle blood flow and promote diuresis, limiting the precipitation of myoglobin in the renal tubules. Tranquilization, muscle relaxants, analgesics, and use of slings can be beneficial as well.

Neuropathy: Facial, radial, or femoral nerves paralysis can occur in horses after anesthesia. Typically these patients are non-painful. Improved padding, removal of the halter during surgery, and placing the dependent limb forward when in lateral recumbency all reduce the incidence of post-operative neuropathy in horses. Neurological deficits may take up to 48 hours to resolve while lameness may last for several days. Fluids, slings, massage, and analgesics may be used until full function returns. Radial nerve damage results in a dropped elbow and inability to bear weight. Femoral nerve paralysis results in a flexed hock and fetlock with inability to fix the stifle. Facial nerve paralysis can cause a dropped ear and eyelid and distortion of the nose.

Table 1. Common premedication agents used in horses.

Drug	Dose (IV)	Comments
Xylazine	0.5-1 mb/kg	Ataxia at high doses
Detomidine	0.01-0.02 mg/kg	Ataxia at high doses
Butorphanol	0.01-0.03 mg/kg	Twitching may occur
Acepromazine	0.02-0.05 mg/kg	Mild sedation

Table 2. Common induction agents used in horses.

Drug	Dose (IV)	Comments
Diazepan or midazolam	0.02-0.1 mg/kg	Provides muscle relxation for ketamine
Guaifenesin	50 mg/kg to effect	Provides muscle relxation for ketamine
Ketamine	2.0-3.0 mg/kg	Muscle rigidity

Point of Care Testing in the Emergency Setting
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Point of care testing (POCT) has long been used in veterinary patients to make diagnoses and treatment decisions in the emergent patient. The advantages to POCT can include ease of use, instrument portability or availability, small sample volume, and rapid results. More recently, the use of patient-side tests has come under scrutiny in both the human and veterinary medical professions

Abbreviations	
AFAST	*Abdominal focused assessment with sonography for trauma*
FAST	*Focused assessment with sonography for trauma*
HCT	*Hematocrit*
PCV	*Packed cell volume*
POC	*Point of care*
POCG	*Point of care glucose*
RBC	*Red blood cell*
PulseOx	*Pulse oximetry*
TFAST	*Thoracic focused assessment with sonography for trauma*
TP	*Total protein*
WBC	*White blood cell*

because of the lower standards for quality control and precision that are common in POC instruments. While we know there are flaws to the POCTs we utilize, they remain a vital part of our evaluation of the emergent pet.

Definition

Point of care testing is a nonspecific term that indicates that a test is performed outside the traditional clinical laboratory setting. Testing devices can be categorized as non-instrumental (e.g. ketone strips), hand held or portable (e.g. glucometers), or tabletop analyzers (e.g. in-house laboratory machines). Point of care (POC) devices can be intended for use with blood, fluids, suspensions, or smears of samples, whose results are interpreted in a patient-side environment.

PCV/TP

A spun packed cell volume (PCV) is a technically simple method of evaluating the percentage of whole blood that is made up of red blood cells (RBC). A capillary tube is filled with anticoagulated whole blood, centrifuged, and then the percentage of the volume that is made up of RBCs is determined by a visual scale or a digital meter. Both methods have a small amount of inter-reader variability (meaning that two people may read the same sample within a few percentage points). Hemolysis (RBC lysis), lipemia (fat in the blood), and high white blood cell (WBC) counts can make interpretation difficult. Hematocrit (HCT) is very similar to a spun PCV, but the percentage is determined by machine and is calculated based on cell counts and cell volume or hemoglobin concentration. The results of PCV and HCT should be very similar, and it is the author's opinion that both should be performed and evaluated together.
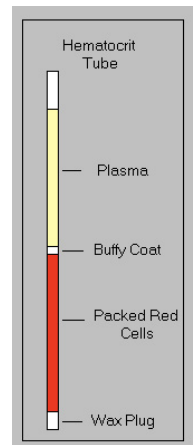
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A refractometer can estimate the total protein (TP) present in a plasma sample. After a microhematocrit tube is centrifuged and the PCV is measured, the tube can be broken above the buffy coat within the plasma column, and a plasma sample is tested with a refractometer and reported in g/dL. Total protein levels that are below the expected reference range could indicate protein losing diseases or blood loss. Elevated levels could indicate certain types of neoplasia (e.g. multiple myeloma) or viral diseases (e.g. FIP).

PCV/TP should always be read together, and bear in mind that TP is going to change first in patients with hemorrhage- so don't overlook the TP!

Glucose

Point of care glucometry can be performed with a reagent strip and handheld unit, a blood gas analyzer, or serum/plasma chemistry machine. Hand held point of care glucometers (POCG) are ubiquitous, affordable, and technically simple for use in both human and veterinary patients. Each batch of test strips is coded to allow for calibration of the handheld unit to the strips' performance. Until relatively recently, we have been limited to POCGs designed and validated on human capillary blood, but veterinary POCGs are now available and validated in dogs and cats. Human POCGs have largely shown acceptable clinical results in cats, but they have proven less reliable in canine studies. It has been suggested that accuracy of human POCG is improved when serum or plasma is sampled, rather than whole blood.

Most POCGs are designed for use on immediately obtained capillary blood. In practice, they are used to evaluate a variety of blood sample types, including whole blood, capillary blood, anticoagulated blood, serum, plasma, and effusions. Veterinary POCGs tend to be less accurate in anemic dogs (<20%), and human POCGs tend to be less accurate when HCT exceeds 50%. Patient factors including lipemia (including parenteral nutrition), bilirubinemia, blood oxygen concentration, uremia, or alterations in pH can affect the results of some POCGs. Adequate studies to evaluate the impact of patient factors in veterinary patients do not exist.

Lactate

Lactate monitoring has become increasingly available to the veterinary clinician by both hand-held point of care lactate meters and cage-side chemistry analyzers. L-Lactate is a byproduct of mammalian anaerobic metabolism, and it is commonly elevated in shock, systemic disease states, intoxication, neoplasia, and in patients with inborn errors of metabolism. Hyperlactatemia is defined as elevations in blood lactate (>2 mmol/L).

Possible confounding factors of lactate measurements such as juvenile patients, underlying disease, sample handling, venipuncture site, and patient struggling have been debated. Prompt sample separation from red blood cells is very important, since red blood cells continue to metabolize glucose into lactate after venipuncture, potentially interfering with both measured lactate and glucose levels. Investigations have also found that administration of racemic lactated Ringer's solution (LRS) does not affect lactate measurement.

Pulse Oximetry

The pulse oximeter (PulseOx) is a POC patient-side test that is used to measure the percentage oxygenation of circulating hemoglobin. It works by passing light through a thin portion of tissue and then detecting the absorption of two different wavelengths of light, which are then interpreted to determine the ratio of oxygenated to deoxygenated hemoglobin in the blood. This test is related to but does not measure the dissolved oxygen in the blood or yield any information regarding the effectiveness of a patient's ventilation. When the patient is breathing room air, PulseOx can suggest or help rule out hypoxemia. On room air, a normal PulseOx reading is >95%. When patients are receiving oxygen supplementation, a low PulseOx reading simply reflects the severity of oxygen hypoxemia. "Normal" PulseOx readings while a patient is breathing oxygen-enriched air does not rule out hypoxemia, and the greater the oxygen supplementation, the less sensitive the pulse oximeter. While PulseOx meters are painless and relatively convenient, their readings are adversely affected by motion, hypotension, vasoconstriction, severe anemia, ambient light, fur, and pigmentation. Inevitably, one or more of these factors affect nearly every patient in the veterinary emergency department. The PulseOx is an effective screening tool to rule out a suspicion of hypoxemia, but it is a non-specific and often-flawed tool. Accurate assessment of oxygenation and ventilation requires an arterial sample and measurement of blood gasses

Electrolytes and Blood Gasses

There are several POC options for the measurement of blood gasses and electrolytes. Most produce accurate results in minutes and can alter the course of treatment in the emergent patient. The term "blood gasses" refer to the pH, dissolved oxygen, dissolved carbon dioxide, and dissolved bicarbonate in the blood. A venous sample can give practitioners information about pH balance, while arterial samples allow interpretation of oxygenation, ventilation, and acid-base status of patients. Rapid reporting of the electrolytes sodium (Na), potassium (K), and chloride (Cl) can identify significant derangements and allow further interpret acid-base abnormalities. Some machines also report glucose, ionized calcium (iCa), and renal values (BUN & CREAT) Most POC tests are designed to perform as screening tests and are not as accurate as results reported by a commercial lab. This means that they are intended to use on the emergent patient to help guide treatment but are not intended for continuing monitoring or trending.

FAST Scans

Figure 2: Depiction of the 4-point abdominal focused assessment with sonography for trauma, triage and tracking (AFAST), protocol performed in right lateral recumbency beginning at the diaphragmatico-hepatic (DH) view, followed by the spleno-renal view (SR), the cysto-colic view (CC), and completed at the hepato-renal view (HR). Direction (arrows) and order of AFAST exam (numbered ultrasound probes) are illustrated.

From Liscandro JVECC 21(2) 2011 pp 104-122

Focused assessment with sonography for trauma (FAST) is a systematic ultrasound examination designed to specifically identify fluid accumulation. FAST scans are commonly used in the absence of trauma and are a mainstay of emergency patient evaluation. Evaluation of the thoracic cavity (TFAST) allows for the detection of pleural effusion and pericardial effusion. The skilled practitioner may be able to detect increased lung water (pulmonary edema, pneumonia, etc.) and pneumothorax. Abdominal FAST (AFAST) evaluation uses a systematic scanning pattern to identify the presence of fluid in various regions of the abdominal cavity. AFAST and TFAST scans have become a vital portion of the initial assessment of emergent patients, but they are not intended to be a substitute for diagnostic ultrasonography, radiography, or advanced imaging.
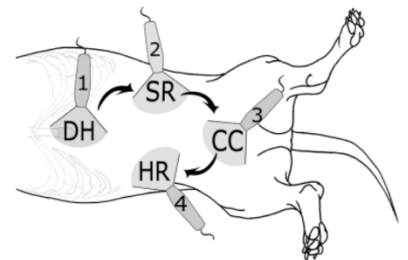
The Respiratory Distress Patient
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External evaluation of the dyspneic patient is a vital skill for initial treatment of delicate patients that could be harmed by the stress of phlebotomy, invasive diagnostics, and/or restraint for imaging. The experienced clinician should be able to evaluate a patient in distress and localize their lesion to help

Inspiratory vs Expiratory Distress

While it seems simple, just determining whether a patient has primarily inspiratory or expiratory respiratory distress can be very challenging and is the cornerstone of localizing a lesion. As silly as it seems, I often breathe along with a patient to decide which section of the respiratory cycle is MORE abnormal (i.e. prolonged or labored). Recognize that a normal respiratory cycle should be ~1s active inspiration, ~2s passive exhalation, and ~1-2s rest (1:2:1). Keep in mind that some variations in times will occur due to the size, level of excitement, and condition of your patient, but the prolonged cycle is often the abnormal one. It is also important to note that patients in distress often skip the rest phase. Another unique property of the dog is panting, which is not seen in human medicine. Panting is a 1:1 respiratory cycle that can go as fast as 300 breaths/min, and panting patients can make localization very difficult. Clues such as body position, abdominal effort, respiratory noises, and thoracic auscultation can also help clinicians decide what phase of the respiratory cycle is most affected.

Nose and Pharynx

Upper airway diseases typically display a predominantly inspiratory distress, often accompanied by increased respiratory noise. Cats with nasal obstruction can look remarkably destressed due to their significant dislike of mouth-breathing. Nasal airflow can be investigated by holding a glass slide near the nares. You should also make note of any ocular discharge, nasal discharge, or nasal/facial malformations. Cats can be affected by congestion, foreign bodies, or oropharyngeal polyps. Dogs with upper airway disease are commonly affected by foreign material, masses, elongated soft palate, laryngeal paralysis, upper airway edema, and pharyngeal collapse. Patients with upper airway disease are commonly hyperthermic and may even heatstroke. Sedation, cooling, and oxygen supplementation are often adequate until a controlled airway examination can be performed, but rapid intubation and/or tracheostomy may be required for some patients.

Tracheal Distress

Patients with tracheal disease tend to be small-breed dogs with a chronic history of cough and exercise intolerance. Obesity, heat, brachycephalic conformation, and humidity can complicate tracheal disease, pushing them into distress. As a patient breathes harder, the forces of air movement increase in the trachea, making the trachea more likely to collapse, and making it harder for a patient to breathe. This is a self-reinforcing cycle that leads to patient distress, fatigue, and worsening clinical condition.

Tracheal disease patients tend to have a predominantly inspiratory dyspnea with harsh coughing efforts. Noncardiogenic pulmonary edema, upper airway and/or large airway swelling, and small airway collapse can also contribute to the overall condition. Sedation, cooling, and oxygen supplementation are imperative to reduce the work of breathing (and thus decrease airway forces) in the short term, but clinicians should note that rapid intubation may be required.

Lower Respiratory Tract Disease

Alveolar disease in both the dog and cat manifests as inspiratory dyspnea. Crackles, pops, snaps, or absent lungs sounds are common findings in these patients. Alveolar disease in dogs and cats has unpredictable oxygen responsiveness, but the presence of a heart murmur or known cardiovascular disease may lead a clinician towards diuretic therapy prior to diagnostics.

Expiratory dyspnea with an abdominal push and wheezes or harsh-gravel sounds is indicative of small airway disease. Asthma is the common small airway disease of cats, and patients can be in marked distress. Small airway disease in dogs is more of a chronic bronchitis, and patients are rarely dyspneic without comorbidities. Other possible causes of small airway diseases include migrating dirofilariasis, intestinal parasites, and inhaled irritants. Patients with an expiratory respiratory distress may benefit from a bronchodilator and should be oxygen responsive in the absence of complicating factors.

A paradoxical abdominal respiratory pattern is pathognomonic for pleural space disease. The absence of dorsal or lung sounds may make a clinician more suspicious for pneumothorax or pleural effusion. Patients with significant distress and pleural space disease are at significant risk for arrest during restraint for imaging. Diagnostic thoracocentesis can improve ventilation and allow the clinician time to determine the next steps for a patient. Patients with pleural space disease are minimally oxygen responsive and are dependent on management of their disease for improvement. It is important to note that patients with a recent history of trauma (especially roll-over vehicular trauma) could have diaphragmatic hernia and would not benefit from thoracocentesis. The absence of abdominal viscera should prompt clinicians to consider if thoracocentesis is in a patient's best interest.

Summary

Localizing the lesion of a patient with respiratory distress can not only help limit a clinician's differential list prior to diagnostics, but it may help direct initial therapy if the patient is too unstable for handling. Patient signalment, history, response to empiric therapy, and response to oxygen can also help complete a patient's clinical picture and support clinical decision making if diagnostic results are indistinct or conflicting.

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Vascular Access and Maintenance
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Fluid therapy is probably the most common medication that we prescribe and administer to our veterinary patients. This lecture is intended to discuss the routes and endpoints (goals) that we use to determine fluid plans.

List of Abbreviations	
BW	*Body Weight*
SQF	*Subcutaneous Fluids*
IVC	*Intravenous Catheter*
CVC	*Central Venous Catheter*
IOC	*Intraosseous Catheter*

FLUID SPACES

Maintenance: The term "maintenance" is a bit of a misnomer, since it's really an educated guess at how much fluid a patient needs to maintain normal hydration and circulating volume. While we use formulas to calculate this rate, our calculation is based on the normal, healthy patient, which is rarely the patient population we are treating. Patients with increased fluid losses (e.g. GI losses, endocrine disease, excessive panting, infection) will have needs that can't be directly predicted. At minimum, a daily body weight and hydration assessment must be performed to ensure that our fluid therapy is appropriate. Patients with more severe derangements, losses, or complexities require more frequent monitoring to assess whether adjustments to the fluid prescription are necessary.

Dehydration: When a patient is dehydrated, it means that they have inadequate fluid content in their tissues (cells and interstitial spaces). The tissues contain about 90% of the water in the body, and the fluid in the tissues can account for over 50% of total body weight (BW). We use indicators like dry mucous membranes, skin tent, and sunken eyes to assess hydration in a patient. Replacement of hydration deficits requires larger volumes of fluid and is performed over a longer period of time 6-24 hours.

Hypovolemia: This term refers to when a patient has a decrease in vascular volume. It is possible to have both dehydration and hypovolemia, but vascular volume/circulation is preserved as long as possible. Hypovolemia is typically the result of acute volume loss (e.g. hemorrhage, severe vomiting) or severe dehydration that has overcome the body's preservation efforts. Despite it's critical importance, the circulating volume makes up <10% of the fluid in the body. Fluid added to the vascular space will equilibrate (leak) from the vasculature within 15-30 minutes, necessitating a faster replacement rate, or "bolus." Circulating volume replacement is typically a smaller volume of fluid than dehydration, and it is typically given over 15-20 minutes, followed by a "maintenance" fluid rate any "rehydration" fluids deemed necessary.

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ROUTES

Subcutaneous: Subcutaneous fluids (SQF) are a popular choice because they are technically easy to perform and well-tolerated by patients. The best application of the subcutaneous fluid route is in support of hydration. This is **not** the same as rehydration or fluid resuscitation. Patients that receive subcutaneous fluids should be cardiovascularly stable and able to maintain their current state of hydration by eating and drinking. Typical examples of the SQF patient are the chronic kidney patient or patients with clinically normal hydration that have had a resolved/treated acute fluid loss (e.g. acute and resolved vomiting or diarrhea). It is important to note that SQF are NOT appropriate for patient in shock, hypovolemic states, severe dehydration, or electrolyte/metabolite correction. As you can imagine, the subcutaneous space does not receive much blood flow in shock states, and so the fluids sit idle under the skin without helping the patient.

Intravenous Catheter: Giving fluids through a peripheral intravenous catheter (IVC) is the most common route of fluid administration. The cephalic veins and lateral saphenous veins are the most common sites for vascular access, but ear veins, pedal veins, medial saphenous veins, interdigital veins, and even facial veins can be accessed in some patients. Sterile technique for venous access should include clipping of fur, sterile preparation of the site, and sterile bandaging, and sterile handling the insertion point. Catheters should be flushed with saline every 4-6 hours if not being used for continuous fluid administration. They must be inspected twice daily to evaluate for damage, patient discomfort, limb swelling, and ensure the catheter bandage is clean and dry. Fluids through an IVC can be used for correction of hypovolemia, dehydration, and most electrolyte/metabolic derangements. Hypertonic or hyperosmolar fluids (e.g. hypertonic saline, >7% dextrose) can cause vascular inflammation and patient discomfort if given repeatedly or continuously through a peripheral catheter. Phlebitis (vessel inflammation), thrombosis, and insertion site infection are the most common complications of IVC placement. Patients can exhibit pain on injection, unstimulated pain, fever, lethargy, and/or limb swelling if a catheter site becomes irritated or infected. The solution is to remove the IVC, prevent the pet from licking the site, and administering antibiotic therapy if indicated. It is typical for IVCs to remain in place for a maximum of 3-5 days.

Central Venous Catheter: A central venous catheter (CVC) differs from an IVC because it terminates in a central vein, such as the cranial or caudal vena cava. These are typically larger gauge, longer catheters than IVCs. In human medicine, these are also called PICC (peripherally inserted central catheter) lines. In veterinary medicine, CVLs are typically inserted in the jugular or medial saphenous veins. These lines are used in situations where peripheral catheters are difficult to place or maintain, when high tonicity/osmolarity fluids need to be administered, when repeated blood sampling is anticipated, or when longer-term catheterization is anticipated. CVLs can often be maintained for up to 3 weeks but are susceptible to the same risks of infection and thrombosis that IVCs are. They must be monitored, and the ports flushed in the same way that an IVC is maintained. CVLs are convenient for clinicians, as they can be used as blood sampling lines, they can have multiple separate ports, and they can be heparinized to allow less frequent maintenance flushing.

Intraosseous Catheter: Intraosseous catheters (IOC) are often used when attempts to place IVCs and CVLs are unsuccessful. IOCs are easiest to place in neonates, who still have soft bones, but it is possible to place them in adult animals of most species. While IOCs can be placed in any cancellous bone (a bone that contains marrow), the most common sites are the femur and the humerus, though the sternum and tibial tuberosity can be used in large patients. Placement is evaluated with a radiograph, and while fluid administration is slower than through a vein, any fluids or medications given through the IOC end up rapidly in the venous circulation. In the neonate, an 18G hypodermic needle or spinal needle can be used. Adult animals have thicker bones, and a bone needle (Cook/Jamshidi/Illinois) or EZIO needle are required. A local anesthetic is required to place an IOC, as bones are very sensitive, and the procedure can be painful. Any medication that can be administered through a peripheral IVC can be given through an IOC, but IOCs are difficult to secure, uncomfortable for the patient, and typically only used for patient resuscitation until a peripheral or central IV access can be achieved. IOC can be very helpful in the resuscitation of the small or exotic pet. It is important to remember that birds have pneumatic humeral bones, so IOC placement should be limited to the ulna, tarsus, and femur in these species.

Anesthetic Monitoring and Indicators
Veterinary Technician Conference 2019
Elizabeth Radcliff

Outline
I. Introduction

- Risk Factor Increases: Without proper monitoring, patient risk increases exponentially as it is harder to catch an anesthetic event in its early stages.

- Quality of Care: In order to ensure the highest quality of care of the patient being maintained under anesthesia or sedation, use best available monitoring equipment.

- IGNORANCE IS NOT BLISS!

II. Basic Monitoring Equipment

- Pulse Oximeter: The pulse oximeter measures oxygen saturation in the patient's blood. If hypoxemia occurs, it can have catastrophic results!

- Blood Pressure Monitor: We measure blood pressure to measure cardiovascular homeostasis. How hard is our patient's heart working?? How much strain is being put on other organs due to low blood pressure?

- ECG: Measuring heart rhythm and electrical activity early on is key! This can help to evaluate how well your heart will tolerate anesthesia and indicate likelihood of arrest. You should always know a patient's "normal."

- ETCO2: End tidal CO2 monitoring may be used to indicate a captured airway at intubation. In addition, during CPR this is important for ensuring adequate breaths. Know effects of hypercapnia and hypocapnia. We use a capnograph to evaluate CO2 and its corresponding waveform.

- Arterial Line: Arterial blood pressures are a more accurate way to monitor continuous direct blood pressure. Knowing how to operate and place an arterial line is half the battle! These are relatively inexpensive but can be difficult to place, especially in an awake patient.

III. What Can We Actually Get Away With (or without)

- ASA Statuses: Knowing the physical status of a patient is the best way to determine what monitoring is necessary. Keep in mind, you should still treat an ASA 1 with the same care you would treat an ASA 4! Complacency is the enemy when managing a patient under anesthesia.

- Situational Dependencies: Every case is different! You will clearly use different equipment when in a disaster situation vs in a full hospital.

-In an ideal world, you would use ALL equipment on hand to ensure highest rate of success under anesthesia.

IV. Normal Ranges

-Pulse Ox: Aim for 97% or better post-extubation. Anything below 90% requires intervention. You CANNOT always rely on patient membrane color!

-Blood Pressure: While knowing what is normal or ideal for blood pressure ranges, you should also keep in mind a patient's normal. If a patient is typically hypertensive, hypotension could be even more catastrophic. Age may also play a role in considering blood pressure.

-ECG Waveforms: Before anesthesia, you should be familiar with normal waveform, as well as the patient's "normal" ECG waveform.

-ETCO2: Ideally, a normal patient should have an end tidal CO2 of 35-45. In case of concern in regards to intracranial pressure, we may reduce this to 25-35 depending on the doctor's preference.

V. The BIG Picture

-Case Examples

VI. Questions and Thoughts
    A. Final Considerations - Environment and necessity will often deem what is used for monitoring. Patient safety always comes before willingness to "drag out" extra equipment. Preparation and diligence are key to a positive outcome for patient anesthesia. Knowledge is power and assumptions are fatal. Acting quickly can often produce the best outcome.

Treating Companion Food Animals
Evelyn MacKay, DVM
Texas A&M University
Technician CE Conference, June 22nd 2019

Treating companion food animals can be confusing and challenging due to the unique problems created by legal regulations, owner expectations, financial constraints, and emotional attachment. They require knowledge and respect for the production purpose of the animal as well as the owner's bond with the animal.

Food animals are categorized into major (cattle, pigs, turkey, chickens) and minor (goats, sheep) species, which often determines the legality of the drugs we can use on these animals. Although pet food animals are unlikely to enter the food supply, we still have to treat them as if they may one day be slaughtered and consumed to abide by current government regulations. This means we should not be using drugs like gentamicin and other aminoglycosides, and we absolutely cannot use drugs like metronidazole, chloramphenicol, or off-label utilization of fluoroquinolones and cephalosporins. When off-label medications are used, FARAD should be consulted for withdrawal times to ensure that owners are advised appropriately.

Despite these limitations, we can still provide empathetic and modern veterinary care to these animals. Part of the value we give to clients is our ability to respect the human-animal bond, which owners are often especially sensitive to in these species. Sometimes these animals maintain a production role (show animals, dairy cows, favorite beef cows), but owners will be willing to invest financially and emotionally beyond the "market value" of the animal. Offering the gold standard of care as well as more financially-conscious options without judgement is important when working with these clients, as the decision should be left up to them as to how they want to proceed financially. Additionally, offering referral just as you would for financially-able small animal clients is important and often overlooked when treating these species.

Treating companion animals often involves working with rescues, which can present additional challenges. Often the rescuers are not knowledgeable about the production systems that yield the rescued animals, and do not recognize signs of illness or understand appropriate routine care for food animal species. Education is important when working with these clients, as is maintaining a non-combative demeaner when discussing inflammatory issues (veganism, animal rights, traditional animal agriculture). Focusing on the shared goal of improving animal health helps everyone stay on track and optimize outcomes for the animal. Referring difficult clients like animal rescuers is often wise.

Additionally, common diseases of companion animals such as rumen acidosis/dietary indiscretion, urolithiasis, neoplasia, and routine care of pet pigs are discussed in this lecture.

Pig Anesthesia
Evelyn MacKay, DVM
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Technician CE Conference, June 22nd 2019

       Pigs can be intimidating to handle and treat due to their temperament, shape, and unique species differences. Treating pigs is well within the scope of mixed practitioners, and can be achieved with some tricks, patience, and determination. Anesthesia can be intimidating, but accomplished.

       Before anesthesia, a thorough physical examination should be performed to ensure the pig is healthy and no unforeseen circumstances may increase the risk of anesthesia. The question of if anesthesia should be used must be asked as well. For short procedures such as quick hoof trims, blood draws, and ultrasound, sometimes physical restraint will be adequate on smaller or more tolerant pigs. Some tractable pigs enjoy belly rubs and treats, and non-invasive procedures such as ultrasound or neurological examination can be performed this way.

       Gaining venous access can be challenging in pigs, as peripheral limb veins are usually not visible under thick skin, and the jugular is frequently quite deep. Placing small gauge (22-20g) IVCs in the ears is often the most reliable solution, and can be done in very sick pigs or in anesthetized pigs.

       Inhalant anesthesia via mask is often adequate for short procedures such as hoof/tusk trims, biopsies, and castrations. Typical canine masks can be used for maintenance of anesthesia, but sometimes larger masks need to be made to initially induce larger pigs. Cut-off gallon jugs can be adapted for this purpose. This method is frequently used for cesarean sections, and often combined with lumbosacral epidural to provide local anesthesia and minimize use of inhalant and anesthesia of the piglets.

       Intubation poses some challenges, as pigs may have long oral cavities with a pharyngeal diverticulum that can make intubation challenging. Careful use of a stylet can help with entering the trachea, but has been associated with pneumothorax in our experience. Use of a long laryngoscope, lidocaine for laryngospasm, and careful visualization of the larynx has yielded successful results in our hospital. Endotracheal tubes should be tied behind the head instead of around the snout to prevent nasal edema. Intubation offers the best control and safety for longer procedures, and is recommended when performing spays. Spays are complex and challenging procedures due to the highly vascular broad ligament and large uterus, and many practitioners prefer to refer these cases to hospitals with additional equipment.

       Injectable anesthesia is useful in pigs, and can provide adequate restraint, though the variable recovery makes it less desirable in some situations. Doses of alpha-2 agonists (xylazine, dexmedetomidine) are similar to those used in dogs, and much higher than horses and ruminants. Ketamine is a useful drug in pig anesthesia, but some pot-bellied pigs appear to have reactions to it while recovering, which can include frantic behavior and excitability. Some owners are aware of this, and specifically request gas anesthesia exclusively for their pigs. These effects can be minimized if pigs are given another drug that will outlast the ketamine and they are not

prematurely reversed from use of alpha-2 agonists. Midazolam can be used at doses similar to other species. Injectable anesthesia administration can be stressful for the pig and handler, so quick reflexes are necessary. Use of pig boards, snares, and extension sets on needles can help make the process easier.

Cause for Alarm! CBC and Chemistry Values that are Alarming in the Equine Patient.
Gwendolyn J. Levine, DVM, DACVP (Clinical Pathology)

I. Overview

With the increased availability of bench-top analyzers, a minimum database that includes a complete blood count (CBC) and a chemistry panel has become much more common-place. This is a wonderful thing for our patients because it allows early detection of abnormalities (no more waiting 12-24 hours on send out laboratory results) and it also allows us to monitor trends in parameters over time. When a value is far out of the reference interval, it is important to first make sure that the value is representative of the patient's status and not the result of pre-analytical or analytical laboratory error. Consider whether the value is compatible with life. A PCV of 100% or a potassium of 18 mmol/L are not. Common scenarios where evaluation of an equine patient's bloodwork can give important information that will impact treatment or prognosis include: colic, exertional rhabdomyolysis, sepsis, and uroabdomen.

II. Complete Blood Count

The CBC gives us information about erythrocytes, leukocytes, and platelets which have roles in oxygen delivery, host defense, and coagulation respectively. Erythrocytes can be evaluated with something as simple as a spun packed cell volume (PCV) or a hematology instrument can give us information about the number of erythrocytes, their size, and their hemoglobin content as well as a calculated hematocrit which is generally equivalent to a PCV. Leukocytes are examined in two important ways, we can get an idea of the total number of leukocytes with our hematology analyzer and it is critically important to perform a blood smear examination to evaluate the distribution and morphology of leukocytes. Platelets are evaluated with a platelet count and an estimate can be made from a well-spread blood smear provided there is no clumping/clotting of the sample.

Values of Concern:

Anemia: Thankfully, truly severe anemia is not common in equine patients. When a patient's PCV is less than 20% it is of concern and may require a blood transfusion or other supportive care depending on the patient's severity of clinical signs. Foals suffering from neonatal isoerythrolysis can have critically low PCVs and require blood transfusions to allow adequate oxygen delivery to tissues. A horse with a severe injury to an artery can also have a decreased PCV. In general, animals tolerate a decreased PCV better if it has happened over a long period of time as they can gradually acclimate to it – for example, animals producing decreased amounts of erythropoietin because of kidney disease will have PCVs less than 20% but will not act in distress.

Special RBC Morphology: On a peripheral blood smear, erythrocyte morphology can and should be evaluated at through the 100x objective in the monolayer. Horses suffering from certain toxins or exposure to smoke can have eccentrocytes on their blood smear, which indicate oxidative damage to red blood cells. Heinz bodies may also been seen in these cases. Horses with hemolytic anemia, which can be seen secondary to severe oxidative damage or sepsis, may have ghost red blood cells and possibly schistocytes. Horses with immune mediated destruction of red blood cells may exhibit agglutination which is best appreciated through the 10x or 20x objective. Neonatal isoerythrolysis in foals is the prime example of a disease with agglutination. Red blood cells exposed to snake venom will exhibit echinocytosis and this can be looked for to aid in determination of whether it was a dry bite or not. The echinocytes in snake bite envenomation are slightly different from those seen with dehydration or electrolyte abnormalities. Snake bite envenomation echinocytes have very fine regular spikes and spikes can even be seen on the top of the red blood cell as dots. *Babesia equi* or *Babesia caballi* are important red blood cell parasites that can be seen within red blood cells. These are known as piroplasms and are the protozoal agents of Equine Piroplasmosis which is a reportable disease. If you are suspicious of Equine

Piroplasmosis in a patient, there are cELISA tests available at approved laboratories which are more sensitive than a blood smear examination.

Leukopenia: A decreased number of white blood cells (leukopenia) is seen with early and/or severe inflammation or infection. The body is sending these cells into a cavity or tissues to deal with an infection. In some cases, this can be your first clue of a severe infection. The failure to produce white blood cells due to damage to the bone marrow can also happen but this is less common. Usually, the decreased white blood cell count is due to a decreased number of neutrophils and lymphocytes will be spared. While a leukopenia is concerning, there is a chance that if given some time, the patient will be able to produce enough neutrophils to overcome the deficit and deal with the infection so a recheck CBC can be very informative on the next day or the day after to develop an idea of the trajectory of the illness.

Leukocytosis: An increased number of white blood cells is also important, although it is usually less concerning than a decreased amount. Generally, the infection is not so severe that it overwhelms the ability of the bone marrow to produce neutrophils or the infection has been going on long enough that the bone marrow has been able to step up production to keep up with demands. If the white blood cell count is greater than 50,000 cells/ul and is composed of lymphocytes, a lymphoid leukemia is possible. Thankfully, leukemia (and cancer in general) is uncommon in horses.

WBC Morphology: Although an automated hematology analyzer can enumerate many more than 100 cells, they do not typically maintain their accuracy when there is abnormal white blood cell morphology such as toxic change. Toxic change are abnormalities seen in neutrophils which indicate their early release from bone marrow before full maturation has taken place. Finding toxic changes in neutrophils supports the diagnosis of an inflammatory response. A left shift to band neutrophils (these are immature neutrophils with no segmentation of the nucleus), can be seen accompanying inflammation and many hematology analyzers will be unable to enumerate these cells accurately and they may be classified as monocytes or neutrophils. Examination of a blood smear will help you decide whether there is toxic change in the neutrophils, look for band neutrophils, and also double check the differential count provided by the analyzer.

Thrombocytopenia: A decreased platelet count in horses is uncommon but is a cause for concern. When the platelet count decreases below 25,000 platelets/ul, the patient is at increased risk of bleeding following injury to blood vessels (this can include aspiration of structures, injections, or venipuncture). Sometimes, platelets will be artificially decreased due to clotting of the sample and these clots can be seen grossly or you may be able to see platelet clumps on the feathered edge of the blood smear.

III. Chemistry Panel

Important chemistry abnormalities are those that would impact immediate treatment of the patient or give you an idea of the prognosis for the patient. Or, possibly, give you some clues about what disease is effecting the patient if the clinical signs are not supportive or suggestive of a specific illness. If you are performing a chemistry analysis using plasma or serum, be sure to evaluate the color and turbidity of your sample as abnormalities in these qualities can give you clues about diseases or result in interference that can affect results. Turbid plasma is seen with elevated triglycerides which is seen in equine hyperlipidemia syndrome – this occurs in anorexic or inappetent overconditioned ponies and miniature horses and can result in severe illness. Red plasma can indicate hemolysis – which can occur in the blood stream due to red blood cell destruction or can occur due to lysis of red blood cells during sample handling. An anorexic horse can have an elevation in bilirubin that will cause the plasma or serum to be a deeper yellow color.

An elevated blood lactate can be seen with colic (although it can be even higher in the peritoneal fluid with a severe strangulating lesion). And a persistent or increasing elevation in lactate despite fluid therapy can be even more concerning for the animal and may indicate the need for surgery.

Increased blood glucose is often seen in horses suffering from pain or excitement. Thankfully, diabetes mellitus is not common in horses. A decreased blood glucose, if seen in a properly handled,

promptly measured sample, can indicate sepsis or severe infection/inflammation. An animal with a peripheral blood glucose of less than 50 mg/dL are at risk for seizure activity.

Elevations in potassium are concerning for a uroabdomen (this is seen more in foals than adult horses). Creatinine in the abdominal fluid can be measured as well to aid in diagnosis.

Increased enzyme activities such as AST and LDH can be associated with damage to the liver or skeletal muscle. Usually, damage to skeletal muscle will be associated with an increased CK as well. The liver is responsible for the production of proteins important for the function of the body, maintenance of blood glucose levels through the breakdown of glycogen, and the elimination of toxins and waste products. Indicators of decreased liver function would include hypoglycemia and hypoalbuminemia.

An elevation in creatinine can be seen with dehydration or due to renal failure. Unlike in small animals, where kidney disease/failure will result in an elevation in BUN and creatinine, horses will often just have an elevation in creatinine. This occurs because BUN can be utilized by the microbes in the cecum which would prevent or blunt its elevation above the reference interval.

A decrease in total and/or ionized calcium can be seen with colic. Severe decreases will accompany blister beetle toxicity. When calcium drops below a critical level, muscle function of the horse will be affected and you can see weakness.

IV. Other Tests

In a patient suspected of having colic, peritoneal fluid analysis is performed as part of the workup. These can involve gross inspection of the fluid, nucleated and red blood cell counts, protein measurement, and measurement of glucose and lactate and comparison to the levels in the peripheral blood. Most horses have enough peritoneal fluid in health that it can be sampled (this is different than in dogs and cats). Normal peritoneal fluid in the horse has fewer than 5,000 nucleated cells/ul and less than 2.5 gm/dL in protein (measured by refractometer). Cytologic evaluation of peritoneal fluid is very helpful and important. It is possible to find bacteria or even intestinal protozoa. It is important to rule out inadvertent sampling of an intestinal loop as the source of protozoa. Usually, if there are white blood cells – especially neutrophils – you can be confident that the protozoa are there secondary to rupture. The more severe the intestinal disease, the lower the peritoneal fluid glucose and the higher the lactate compared to the peripheral blood.

Emergency Management of the Colicking Horse
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Outline
This presentation is going to address emergency management of the acutely colicking horse from the perspective of a referral facility. During colic work-up there is an order of operations. There are many diagnostics and factors that go into the work-up. Understanding the "why" of each diagnostic tool and drugs used, can help veterinary technicians be better prepared to safely manage a colicking horse. Safety is of the utmost importance for everyone involved, including the equine patient. It is important to make timely decisions, as it can make or break the prognosis.

How is Colic defined?
Colic is a general term that refers to abdominal pain in the horse. This can be due to distention, inflammation, or ischemia. Colic in the horse is more of a clinical sign than a diagnosis. Some symptoms of acute colic are pawing, rolling, kicking at belly, flank watching, and posturing. Many horses respond to colic differently, so its not always apparent when a horse is experiencing discomfort.

Initial history
When you receive a phone call about a colicking horse, there are many questions to ask. Before the horse arrives, it is important to know the signalment of the horse. This is important because horses of different breeds, ages, and sex can be at risk for different diagnoses related to colic. For example, stallions can suffer inguinal hernias, whereas pregnant mares may colic due to discomfort associated with pregnancy. It is important to know duration of colic and what symptoms the horse is exhibiting. Often, horses are seen by an ambulatory vet, who has already done diagnostics or the client has administered some sort of pain management drug; knowing what diagnostics have been performed, if any drugs have been administered and the response to them, can help when preparing for the colic work-up. When forming a treatment plan, the extensive history can give insight and assist in further decision making. Lastly, knowing when the horse will arrive is important because you have all your diagnostic tools ready and if it seems like a surgical candidate, operating room staff and anesthesia can be prepared as well. There are other questions that can be asked, but most of the time, people want to get their horses into the clinic fast, so the rest of the history can be taken upon arrival.

The Work-Up
When the horse arrives, you should finish gathering the more extensive history which can include questions relating to the recent eating, urinating, defecating, etc. habits of the horse. It is also important to get a temperature, pulse, and respiration rate before anything else is done. After obtaining a TPR, sedation can be given without affecting accuracy of the vitals. At this time, blood can be drawn for a Packed Cell Volume/Total Solids/Lactate. This will give good information pertaining to hydration status and how well the horse is perfusing. Next, checking capillary refill time, by firmly pressing a finger against the gums and observing how long it takes to refill can also be a good indicator of hydration status. As a part of the physical exam, the abdomen should be auscultated. This is done best with a stethoscope to each of the four quadrants of the abdomen. The categories of gut sounds are Increased, Normal, decreased, or not present. Along with auscultation, percussing the abdomen can be helpful to check for excess gas.

Drugs that are commonly used
During colic work-up chemical restraint can be used to make it safer for everyone involved. Xylazine is amongst one of the most commonly used sedatives. It is short acting and can help with short term pain management. Detomidine may also be used, which is longer acting and can be a heavier sedative when xylazine isn't enough. Butorphanol is commonly used as pain relief during colic work-up or as part of a treatment. It is often given alongside xylazine or detomidine. Lastly, buscopan is often used for rectal palpation, as it is a smooth muscle relaxer. One other drug that can be used for diagnostics such as abdominocentesis, is lidocaine or carbocaine. It is used as a local anesthetic for abdominocentesis and is also often infused into the rectum to act on the receptors that control contractions, making rectal palpation more comfortable for both horse and veterinarian.

Diagnostics tools for Colic Work-up
Nasogastric Intubation
When a horse presents with colic, they are checked for reflux via nasogastric intubation. If the horse presents with heart rate over 60, it is important to pass an nasogastric tube immediately because the horse may have a distended stomach from a blockage and need to let fluid and/or gas off so that rupture doesn't occur. While passing the tube, one should consider that the tube is placed in the ventral part of the nasal passages. This makes nosebleeds less common because the tube should pass under the ethmoids. When bumped, the ethmoids can cause a nosebleed, making some owners uneasy. It is also important that the tube is definitely placed in the esophagus and stomach and not in the trachea. After the tube is placed in the stomach, the horse will be checked for reflux. When checking for reflux, any amount over 1-2 liters is considered 'net reflux' and is clinically relevant. For this reason, it is important to catch the reflux in a container where it can be measured. At this time, if the horse has no reflux, oral fluids +/- mineral oil are sometimes given through the tube. It is important not to give more than 5-7 liters at one time due to the capacity of the equine stomach.

Abdominocentesis
This is performed any time there is suspicion of free abdominal fluid, or if the horse has acute abdominal pain, unidentified cause of fever or clinical signs of shock. With regards to colic, a primary marker is lactate. As a general rule, abdominal fluid should not have more than twice the normal serum levels. if it is, the horse will need surgery. A consideration when testing for lactate from abdominal fluid is that it must be collected into a "red top" or "green top", because the EDTA in "purple top" tubes may alter reading accuracy.

Rectal Palpation is often performed to feel for blockages or potential organ displacement but, not all structures in the equine abdomen can be palpated rectally. Many veterinarians administer Buscopan, intravenously, beforehand to relax the smooth muscles or locally infuse lidocaine into the rectum which is thought to be absorbed by the mucosa, desensitizing the receptors associated with the contraction. Other supplies necessary for rectal palpation are adequate amounts of lubrication and a rectal sleeve.

Ultrasound
Most horses that present for colic will receive at minimum a Fast Localized Abdominal Sonography of Horses (FLASH exam)
In this exam, the following areas are imaged.
 1. ventral abdomen 2. gastric window 3. splenorenal window 4. Left middle third of abdomen 5. right middle third of abdomen 6. duodenal window 7. thoracic window
Ultrasound is used to evaluate placement, motility and contents, presence of free peritoneal fluid, & distention

Bloodwork
Upon arrival, blood should be drawn, and a PCV/TS/lactate should be performed. PCV/TS can be an indicator of hydration status. Complete Blood Count and Chemistry panels are often performed but more specific tests may also be required.

Restraint
Safely handling a colicking horse is an important aspect of the care process that can lead to potential harm for the patient or handler, if handled incorrectly. Proper handling should generally include paying attention, not standing in front of the horses' legs and standing on same side as the person performing an exam; if the horse is stable then use stocks if available, if not and they are trying to go down, stocks are not a good option. When handling them in a stall you must maintain an exit. A few examples of restraints that are used include; a Twitch, Lip chain, Shoulder twitch or Chemical restraint (i.e. xylazine, detomidine, butorphanol).

Treatments
Some common treatments used for colic are oral fluids, mineral oil via NG tube, heavy doses of sedation, IV fluids, jogging/rolling with epinephrine, surgery and as a last resort, euthanasia. However, there are several factors to consider when deciding your treatment plan. The most immediate factor would be cost, it is important to be up front and realistic with owners about cost and prognosis of treatment options. They should be informed and made aware of quality of life, risks involved with medical management, and when surgery is the only option, anesthetic and post-operative risks. Something to ask might be; Will all the money in the world fix this horse? The care team needs to make them feel comfortable in the decision-making process and not make the wrong decision out of fear of being judged. Sometimes cost will make the difficult decision of medical management vs. surgery.

Conclusion
As a technician in part of a colic work-up, it is most important to be informed and prepared. Knowing certain information ahead of time, finding out the rest upon arrival of the horse, and having tools and supplies ready, will make the work-up more efficient overall. The goal while managing colic, is to make the right decisions in a timely manner, use the diagnostic tools effectively, come up with a treatment plan based on several factors, and get the horse back in good health. Its important that the client be well informed of the big picture to be realistic about cost and overall prognosis of their horse. When managing a colic, sometimes clear cut decisions must be made rather than trying to immediately reach a diagnosis.

Cardiopulmonary Cerebral Resuscitation in Veterinary Medicine
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Cardiopulmonary arrest (CPA) is common in veterinary emergency and critical care and immediate intervention is required to obtain return of spontaneous circulation (ROSC). Despite advances in knowledge and techniques, less than 6% of veterinary patients experiencing arrest in-hospital will survive discharge, emphasizing the necessity preparedness. Many of the recommendations and procedures performed in veterinary CPR are adapted from the human field; however, several important differences exist.

Cardiopulmonary Arrest

Cause	Clinical Signs
Hypoxemia (36%)	Agonal Breaths (38%)
Other (21%)	Apnea (32%)
Anemia (13%)	Collapse (21%)
Malignant Arrhythmia (8%)	Fixed Gaze (14%)
Multi-Organ Dysfunction Syndrome (6%)	No Pulse (13%)
Cerebral Trauma (5%)	Decreased EtCO2 (13%)
Anaphylaxis (1%)	Other (6%)

Arrest is a state of total body energy and oxygen deprivation. CPA occurs when there is inadequate oxygen supply to vital organs secondary to cessation of normal cardiac contractions. Respiratory arrest occurs when there is inadequate failure of any component of the respiratory system. Dogs and cats experiencing respiratory arrest on have 28% and 58% survivability to discharge.

Systemically, within 20 seconds of the onset of arrest, the electrical activity of the brain decreases secondary to the failure of high-energy metabolism. Five minutes after arrest, there is complete depletion of body energy stores, resulting in failure of cell membrane pumps and electrolyte disturbances: increases in potassium and decreases in calcium. Irreversible histologic changes can be identified as early as 30 minutes following death.

Unlike in human medicine, the most common arrest rhythm in veterinary patients is asystole, which accounts for approximately 72% of cases. Asystole is complete cessation of the heart function, both electrically and mechanically. This is due to higher vagal tone found within cats and dogs. Pulseless electrical activity, electrical activity of the heart with no mechanical activity, is the second most common arrest rhythm. Ventricular fibrillation is a rare occurrence in veterinary patients and the only rhythm in which defibrillation is indicated. During ventricular fibrillation adequate diastolic filling cannot occur, result in decreased cardiac output despite a significant tachycardia.

Cardiopulmonary Cerebral Resuscitation (CPCR)

Basic Life Support

Preparedness is key to successful ROSC in CPCR. Required materials include endotracheal tubes, ambu-bag, electrocardiogram (ECG), CO2 monitor, epinephrine, and atropine.

If unresponsive, compressions should be initiated immediately. While compressions can result in pulmonary contusions and rib fractures, delaying resuscitation by even seconds significantly decreases the chance of ROSC. Traditionally, the ABCs (airway, breathing, circulation) have been taught as a means of assessing a potential arrest patient; however, given that pulse palpation is not specific (1/3 of rescuers identify a pulse when none is present), assessing circulation is considered less crucial.

Compressions should be performed at a rate of 100-120 per minute and should incorporate 1/3-1/2 of the width of the chest. The chest must be allowed to recoil completely before the next compression is performed to allow for diastolic filling to occur. Coronary and cerebral blood occurs during diastole and will decrease if the chest does not recoil completely. Small to medium sized animals should be placed in lateral recumbency. Cardiac compressions should be performed directly over the heart. This is called the **cardiac pump theory**, in which direct external compressions simulate cardiac contractions. Large to giant breed patients with keel chests should also be placed in lateral recumbency. Cardiac compressions are performed at the highest point on the chest. This is called the **thoracic pump theory**, in which increases in intra-thoracic pressure is translated to the heart simulating a contraction. Barrel chested dogs (ie: bulldogs) should be placed in dorsal recumbency. The compressor should be rotated every 2 minutes. Roughly 25-30% of normal cardiac output is produced with adequate chest compressions, which is why rotating rescuers is important. Human studies have documented that compression efficacy decreases after 2 minutes, even if the rescuer does not perceive fatigue.

Endotracheal intubation is the preferred method of obtaining an airway in arrest patients, especially brachycephalic breeds. Patients should be intubated in lateral recumbency. Palpation of 2 tubes in the cervical neck, gastric odors through the tube, lack of production of EtCO2, and abdominal distention are all indications of esophageal intubation. Breaths should be administered at a rate of 10 per minute with a 1 second inspiratory time. Increased breath rates are associated with increased intra-thoracic pressure and decreases in venous return. Lower ventilation rates are associated with hypocapnea resulting hypotension. This produces cerebral vasodilation and increases intra-cranial pressure. In the event that an airway cannot be obtained, mouth-to-snout ventilation is recommended. The patient's mouth is closed tightly and the rescuer's hands are placed over the snout to form a seal. Breaths are delivered into the nares at a rate of 2 per 30 compressions. An EtCO2 of >15 mmHg is consistent with adequate compressions.

Advanced Life Support

Epinephrine is a sympathomimetic that has effects on peripheral vasculature and the heart. Administration will result in peripheral vasoconstriction and subsequent increase in vascular tone. Epinephrine has positive chronotropic and inotropic effects, which may be detrimental during CPCR as this results in increased myocardial oxygen consumption. As the pH of the blood decreases (becomes more acidic), epinephrine will be less effective. For this reason low-dose epinephrine (0.01mg/kg IV) is recommended in the initial cycles of CPCR. High-dose epinephrine (0.1mg/kg IV) is reserved for

prolonged CPCR; this dose is associated with higher ROSC, but increased mortality. Administration of epinephrine is recommended every other cycle to prevent overdosing.

Vasopressin acts directly on peripheral vasculature to improve motor tone, without potentially detrimental effects on the heart. Additionally, vasopressin is not negatively affected by acidic pH that occurs commonly in arrest states. Vasopressin can be used in conjunction with epinephrine at a dose of 0.8IU/Kg IV. This medication is non-superior to epinephrine; for this reason and cost, vasopressin is not commonly recommended.

Atropine is a parasympatholytic given to reduce vagal tone in arrest states in veterinary patients. At this time, there are no clear detrimental or beneficial effects of atropine administration in CPCR; however, atropine is still recommended at a dose of 0.04mg/kg IV at alternating intervals with epinephrine. Higher doses have been associated with a decreased ROSC.

Defibrillation is not commonly performed in veterinary patients due to the low prevalence of ventricular fibrillation in this population. Biphasic defibrillation is performed at a dose of 2-4 J/kg with 50% increase in dose if the first shock is unsuccessful. A 2-minute cycle of compressions and ventilation is recommended between doses. Immediate defibrillation is recommended in cases where ventricular fibrillation has occurred for less than 4 minutes. If arrest has occurred for a longer period of time, a 2-minute cycle of compressions and ventilation is recommended prior to defibrillation.

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INVESTING IN HIGH DOLLAR EQUIPMENT: HOW CAN YOU MAKE IT PAY?
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INTRODUCTION

Many factors are essential to the practice of quality medicine and surgery including having an appropriate range of high-quality equipment for both diagnostics and treatment. If this equipment is missing or of substandard quality, patient care will suffer. While practices sometimes buy equipment just because it contributes to high-quality care, most of the time, the doctors and management team also expect it to pay for itself.

Most veterinarians make their most comprehensive purchase of equipment at the time they buy or start a practice. However, any successful hospital must continually replace and upgrade equipment as well as purchase new technology if they are to continue offering the highest quality of care to their clients and their patients.

Whether a doctor is buying one piece of equipment or several, the principles are the same.

It must first be understood what the goal of the acquisition is. Will the new equipment improve patient care? For example, the purchase of an ultrasound machine may allow for more accurate diagnoses. Will the new equipment lower the operating costs related to the provision of services? A new blood chemistry unit may lower the direct costs incurred in running a blood profile because less maintenance is required for the unit. Will the new equipment increase revenues? Use of a laser surgery unit may allow a practice to increase the surgical fees charged. Often, more than one of these goals is met with the acquisition of a single piece of equipment. For example, an IV fluid pump will often reduce staff costs related to monitoring fluid administration as well as improve patient care by more accurately insuring patients receive the volume of fluids needed.

If a practice buys a piece of equipment that doesn't meet one of the above goals, the purchase usually falls into either the coat rack or toy category. The first category includes all the equipment purchased which is never used, sits in a corner, gathers dust and is used to hang coats on. The second category includes all the equipment purchased and used occasionally, but never consistently or profitably. Coat rack equipment purchases are a failure in all regards. Toy equipment may provide much enjoyment and satisfaction to the purchaser and is not necessarily a bad decision, but the purchaser must understand that instead of making a wise, profit-generating business decision, he or she is instead using part of his or her profits to purchase a fun item, much in the same way as they might use those profits to purchase a lake house.

As noted earlier, the most significant purchase of equipment in dollar terms often comes when a veterinarian buys or starts a practice. However, this may not be the time during which the buyer can exercise total choice in type of equipment, brand, or features. The buyer of the practice doesn't usually have much choice in what equipment he or she will receive as part of the practice purchase. Generally the purchase is a package deal, though there may be some room for purchase price negotiation if certain equipment is seriously outdated or in need of repair.

Veterinarians starting their own practice from the ground up theoretically have total flexibility in purchasing equipment; however, most doctors cannot purchase everything they'd like to have at the outset due to lender restrictions and limited personal capital. In these cases, it is necessary to decide which equipment and of what quality is essential to the start-up of the practice and which items can remain on the wish list until further money is available. The purchase of used equipment from veterinary or human medical companies or on an internet auction site can help reduce the initial capital outlay. However, the quality of these items may vary greatly and care should be taken in selecting the vendor, particularly with a high-dollar piece of equipment.

The decision to purchase an individual piece of equipment by a practice with a reasonable cash flow is often the time when the veterinarian can exercise the most choice in selection. "Selection" doesn't just mean picking the equipment one is most interested in learning to use with the features most desired. Selection also includes performing the financial analysis necessary to determine if the equipment purchase will likely increase the profits of the practice.

There are many considerations, financial and managerial, associated with planning and implementing the purchase of assets of this kind. The decision to purchase some capital assets may be an easy one—for example, it may be clear that the practice needs a new anesthetic machine and even though this is a long term asset, its cost is not too great and the practice already uses this type of equipment daily therefore the decision is clear cut.

The purchase of more expensive assets and those not previously used in the practice, however, requires more planning and forethought than does the purchase of equipment or supplies with a much shorter life. As with any asset, it is important to understand why the new equipment is necessary. Mentioned earlier were the most common reasons: to improve patient care, to lower operating costs (either direct costs or via increased staff efficiency), or to increase revenues.

However, because the cost of certain capital assets is high, the positive results may not be seen immediately and other aspects of a practice may also be impacted by the purchase, the risk associated with their purchase is much greater. Clearly, a $500 piece of equipment that sits in the corner and gathers dust is not nearly as much of a problem as a $15,000 such item. For example, a veterinary practice may want to purchase a piece of diagnostic equipment costing $75,000. This clearly is much more expensive than an anesthesia machine and if this is the first such item to be owned by the practice, it may not be clear if there will be enough usage to justify the purchase. Many questions need to be addressed.

- What kinds of cases will benefit from a test?
- Are all the doctors in the practice committed to using the machine?
- How will the doctors be trained in its usage?
- Will outside interpretation of the results need to be made during the early months of usage? How much will this cost?
- Will additional support staff be needed if the equipment is used frequently?
- How will clients be educated as to the benefits of the new diagnostic tests?
- How will the machine be financed?
- Are there timing issues to consider in the acquisition?
- What fees will be charged for the tests?

There are a number of capital budgeting techniques that are extremely useful in analyzing the purchase of new equipment. These techniques can be used in contemplating the purchase of just one asset or in comparing the benefits of two different assets.

As with any analysis, good data is critical to good results. A number of variables will be used in these calculations such as the cost of the equipment, the additional annual costs associated with the asset (such as a service contract or supplies), the expected cost savings to be obtained from usage and the anticipated increase in revenues. If these items are not accurately estimated, the results of the acquisition analysis may be erroneous. For example, cost of equipment does not just include the sticker price. Other components of cost include tax, installation, training, and interest costs if the asset is financed.

Some of the more commonly used financial techniques are payback period analysis and breakeven analysis.

The <u>payback period</u> is the number of years necessary to breakeven on the purchase of the asset. After this point, the practice will start to realize a profit on the acquisition assuming the figures used in the analysis are accurate and reality conforms to the assumptions made in the analysis.

The payback period is calculated as:

<u>Total purchase price</u>

Annual net income (i.e. revenue minus operating costs for a year)

The payback period is not the only tool that should be used in analyzing an asset purchase. Acquisitions with the shortest payback period may not be the ones that are ultimately the most profitable to the practice. It is also important to remember that the time value of money has not been factored into this calculation.

<u>Breakeven analysis</u> is a very useful tool for studying the relationships between revenues, fixed costs, and variable costs. It is particularly helpful in analyzing the consequences of starting or expanding a business or when acquiring significant pieces of new equipment.

The breakeven point is the level of sales that will just cover all costs, both fixed and variable. Variable costs are those that fluctuate directly with revenue. For example, variable costs in a veterinary practice would include anesthesia, drugs and supplies. If no patients are seen, none of these items are used and there is no associated cost.

Fixed costs are those that do not fluctuate with revenue over some range of this revenue. For example, the rent paid to lease the building a veterinary practice is located in is a fixed cost. Even if no clients come in the door and no revenue is generated by the practice, the business still has to pay rent. Very few fixed costs, however, are fixed forever over the life of the business. A 2-exam room veterinary hospital may spend $1500/month in rent payments for the facility. This amount will be the same whether the practice generates $300,000 or $600,000 in revenue per year. There will come a point; however, at which the building is simply too small to accommodate any more clients or any more revenue growth. In order to continue growing the business, facility expansion will have to occur and this cost will increase. Rent is a fixed cost over a very wide range of revenue (in this case from $0 to perhaps $900,000) but at some

point the cost will change. It is important recognize that if there were no fixed costs, there would be no breakeven point. A practice would have no costs if it had no revenue.

Some costs that don't fluctuate directly with revenue but must be increased over shorter ranges of revenue than an item like rent are often called semi-variable costs—staff salaries would be an example in a veterinary clinic.

At the breakeven point: Revenue = fixed costs plus variable costs or Revenue = total costs.

While breakeven analysis is very useful in understanding the relationships between transaction volume, prices and costs, it does have some weaknesses. As with all analyses, reasonable estimates are essential. The linear assumptions made may not hold true in all cases; for example, as the volume of transactions increases, variable costs may increase or decrease on a per unit basis.

FINDING AND HIRING THE BEST TEAM
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INTRODUCTION

Selecting the right team is number one on everyone's wish list. Creating an efficient, productive and polished team starts with the interview process; 80% of employee turnover is attributed to poor hiring. Key techniques leading to effective hiring include understanding the unique employee qualities needed by the practice, behavioral interviewing, and how to make the final selection.

WHY IS HIRING DIFFICULT?

No matter what other issues we have to deal with in veterinary medicine—a changing economy, a declining pet population, pet owners who believe everything they read on the Internet—finding and keeping great employees remains critical to providing outstanding patient care and financial success in the practice.

Effective hiring is the starting point. A practice can offer great pay, have highly skilled managers and a terrific training program, but if they didn't hire the right people to start with, those things aren't going to overcome the poor hiring decisions.

Hiring is difficult because the skills that really determine whether a person will be successful in a job are hard to evaluate. Most people focus on determining the quality of an applicant's technical skills and yet only 11% of employees fail because they don't have the technical competence to perform the job. Instead, people fail because they aren't coachable (26%), they lack emotional intelligence (23%), they aren't motivated (17%) or they lack the temperament needed for the job (15%.)[1] If the hiring process doesn't focus on non-technical competencies, then it will fail.

KEY STEPS IN HIRING

In order to hire the right people, the practice hiring process must be systematic and disciplined. Key steps include: defining the skills and traits valued by the practice and needed for the job, determining what the pay scale needs to be to get the right people, conducting structured, in depth interviews (telephone screens, in-person, working), verifying outside information (references, degrees, licenses/certifications) and making a careful hiring decision based on the skills and traits needed for the job.

The first step in effective hiring is to define both the technical and non-technical competencies valued by the practice and needed for the specific position for which hiring is being done. Hiring managers tend to focus on knowledge, work experience and technical skills because these tend to first come to mind when defining a job and its often easier to determine if a candidate has them; for example, by giving a typing or spelling test or asking the person to demonstrate how they put in a catheter. However, it is even more important to define the critical non-technical competencies the person must have to be successful in the job. For example, if it's a position that has contact with the public, such as a receptionist, the candidate must have a friendly and sympathetic manner and the ability to both accurately gather data from clients and communicate back recommendations and other information. If the practice has well defined, current

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[1] http://www.leadershipiq.com/why-new-hires-fail/

job descriptions, use these as a starting point for defining these critical competencies. If not, the process used to define these skills and traits as part of the hiring process can be used to update the job descriptions.

Once you know what the position you are hiring for is, you need to think about the salary range. As with most of life, you get what you pay for. Money isn't the only reason candidates accept a particular position, but the salaries offered must be competitive; generally not less than the 75th percentile to get the kind of people you want. Other aspects of the work environment (recognition, training, a good corporate culture) won't replace a poor salary, but they will enhance the value of a salary that is good but not great. Information about the compensation and benefits typically seen in veterinary hospitals is readily available from the AAHA Press "Compensation and Benefits" and the Veterinary Hospital Managers Association "Compensation and Benefits Survey." The Internet is also a great resource for salary information for both veterinary specific jobs (such as a technician) and non-veterinary specific jobs (such as a receptionist.) Sites such as Salary.com, CareerOneStop.org and the Bureau of Labor Statistics (BLS.gov) have pay information not just for particular jobs but within certain cities or other geographic areas.

INTERVIEWING

Interview questions should be designed using the traits and skills the practice has decided are critical to the position—the goal is to use these questions to identify if the job applicants are right for this particular position and practice. The competencies list and these questions will also help interviewers evaluate telephone interviews and working interviews.

Behavioral interviewing is widely recognized as the best technique to use in identifying how prospective employees will behave in certain situations. In behavioral interviewing, the interviewer asks questions about how the job candidate has handled situations in prior jobs that are similar to what they will see in this job. A couple of examples are shown below:

Necessary job skill:	Must be able to communicate well with clients in often stressful situations.
Interview question:	"Give me an example of a time in your last job when a client/customer was angry at you or your business and what you did."

Not all job candidates will have had some of these situations occur in previous jobs so you can also use hypothetical versions of these questions when that happens.

SELECTING THE BEST CANDIDATE

A critical component of making the final evaluation of a candidate is to make sure you are capturing all the necessary information during the various steps of the hiring process. If you don't do this, you won't be able to remember who said what or what your real time impressions were of the candidate. Use a form designed for this purpose and take notes throughout the process—while reviewing the application or resume, during the phone screen, and while conducting in-person interviews. Include the interview questions you ask of everyone on the form and leave room for documenting other questions/comments that come up during the meeting. Using the same interview questions for each candidate will help you better evaluate their answers and compare one to the other.

Always check references. Ask as many questions as the person on the other end of the phone will

tolerate. End with an open-ended question such as "Is there anything else you think would be helpful for me to know in making a decision? Listen not only to what is said during the entire conversation but what isn't said as well and the tone of voice or manner in which comments are made.

Once you've gathered all the information about the various applicants, it is time to make a decision about whom to hire. You should have a fair amount of input at this time—information gathered from the job application, cover letter and resume, the telephone screen and working interview (if done), the in-person interview, reference checking and the verification of degrees and licenses/certifications.

Often the most difficult task is keeping the candidates straight and remembering who said what. Before you even start the hiring process, set up a standard form to evaluate each candidate and use this throughout the process. Make notes about key strengths and weaknesses noted in the application, resume and correspondence. Do the same for all interviews. List all the interview questions and the answers each candidate gave. Remember, of course, to only include information and observations related to the duties of the job (nothing about the candidates' age, sex, race, religion, country of birth, disabilities, or other non-job related items.)

When making the final evaluation, remember to use the same requirements to judge everyone and make sure the evaluation is based on the competencies needed in the job. Don't overemphasize technical competencies; spend as much time evaluating non-technical strengths and weaknesses. Be specific about why a particular candidate is the right person. It's not enough to say about the best candidate: "I just liked them and thought they'd be a good fit in the job;" this may mean enough time has not been spent evaluating specific skills and attributes and that the candidate is being selected simply because the hiring manager found them easy to talk to. Instead, think through the exact strengths this person has and whether they fit the practice and the job: "This candidate is a certified veterinary technician, has 3 years' experience in other general practices, was appropriately dressed for the interviews, was friendly and professional on the phone and her references checked out."

Once a decision has been made, notify both the individual to be hired as well as those who are not chosen. It's not necessary to contact every person that submitted an application but certainly do so with those who spent some time in the process. Looking for work is difficult for everyone and letting people know what the decision is not only polite but it lets the candidate move on. Don't forget as well that this person could be a potential client or a potential employee in the future. Delivering this news by phone is awkward and could result in a longer conversation and more information being given than is wise. Send a letter or an email; the latter has made this notification process much simpler than it used to be. Keep the letter or email short and non-specific; don't get into the reason's the person wasn't chosen. Consider phrases such as:

- "Thank you very much for taking the time to send us your resume (interview with us, etc.) for the veterinary technician job."
- "We have since filled that position" or "We have decided to offer the position to another candidate."
- "….but will keep your resume on file should another opening become available."
- "Good luck in your job search!"

Hiring is tough and no practice is going to get it right every time, even when using an effective, structured hiring process. The last thing to remember is that when you do have to terminate someone, analyze

carefully what went wrong. Many managers say that, in hindsight, there were clues during the interview process that indicated potential trouble but in a rush to get someone onboard, they were ignored. Learn from your mistakes and the next time will be better.

BETTER INVENTORY CONTROL
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INTRODUCTION

Drugs, medical supplies and food costs are some of the biggest expenses a practice incurs and these costs are increasing in most practices. What should the practice do if these costs are too high? First of all, it is important to drill deeper into the accounting and PIMS records to truly understand whether the costs are too high and WHY this is so. Secondly (and most importantly), changes need to be made in the practice to improve inventory efficiency and costs. Effective inventory management is key to keeping these costs under control. Inventory control is sometimes seen as a boring and tedious task, but it can have a huge impact on your profitability and is actually one of the easier things to do well in a practice.

HOW TO KNOW IF INVENTORY COSTS ARE TOO HIGH?

Most practices use a cash basis of accounting for internal purposes. This means that when the bill is paid, the expense gets recorded in the financial statements. In order to know what the cost of inventory really is, the expense in the income statement needs to represent what was sold to clients or used in the hospital during the month, quarter or year under review, NOT what was purchased. This means an accrual system of accounting needs to be used and the figure for total inventory shown on the balance sheet MUST equal what is really on the shelves and not some number that is purposefully or accidentally wrong. If the balance sheet is wrong and the Practice Information Management System (PIMS) inventory reports are wrong, then the practice really has no idea what their costs are. If the practice doesn't want to switch to accrual accounting a separate calculation of inventory usage needs to be made when analyzing inventory.

WHAT CAUSES INVENTORY COSTS TO BE TOO HIGH?

Inventory costs can be high for a number of reasons including:
- Too much is paid for particular products
- Too much inventory sits on the shelves without being used—this can occur because the practice carries too many products in a certain category, carries too much of a particular product given the short time period it takes to order and receive the product or keeps products on the shelves that are almost never used
- Product is stolen by either clients or employees
- Product is accidentally given away

Paying too much for product isn't usually the biggest issue in a practice although those doing the ordering should regularly check product costs across vendors. There must be a balance between the time it takes to price-shop every product and the cost savings. There is also an advantage to working regularly with just 1-2 vendors as long as, on average, their costs are competitive or the practice is getting some other added value that is worth paying more for.

The owners and managers in practices should try to carry as few choices as possible in each product category. It may be necessary to have one or more doctor meetings to talk through these choices and reach a consensus that is a balance between carrying a minimal number of products and insuring the

practice has the drugs and supplies necessary to provide optimal care. It is often better to write a prescription for products which are rarely used rather than stock them.

The vast majority of practices can get almost all products within just a few days of ordering; therefore there is no reason to keep vast quantities on the shelves (unless a genuinely good deal was available.) And yet, many practices have several months' worth of products on the shelves instead of just a couple of weeks. Keeping too much on the shelves as well as product theft and accidental dispensing of product without charging the client are the most common reasons for high costs. All of these problems can be mitigated with better inventory control.

GOOD INVENTORY CONTROL

Good inventory control is easy to obtain but it takes a system and the right people administering that system for this to happen. It is necessary to define the critical steps in the process and see if these are being done in your hospital at all times. Physical control of inventory is one of the first areas to review.

A critical component of the physical control of inventory is regular counting of the products on the shelves with comparison to the PIMS records. Most practices do not count their inventory on a regular basis. At best, they do it once a year for tax purposes. The count done for tax purposes is not sufficient to make sure that the inventory system is working effectively. All items need to be counted on a more regular basis.

If the practice has not been using its PIMS inventory module effectively, there may initially be many discrepancies between the PIMS and what is on the shelves. Before implementing regular counting of certain products, it may be necessary to first count everything in the hospital and update the PIMS records. This project should generally be done when the practice is closed and it is essential that all inventory is counted. Going through every room of the hospital and making a list of all storage places (shelves, drawers, etc.) will help.

Once the actual inventory in the clinic equals the PIMS, a regular counting system can be initiated. The items most susceptible to theft are food, heartworm preventative and flea/tick products; these should be counted at least monthly to make sure they are not being given to clients without being charged for or stolen. In the beginning, it may be necessary to count them more frequently if the practice is having problems keeping track of the inventory. Make a list of all of these items (list each size individually) and then divide it by four so that each item is counted once a month.

Count the product on hand and immediately check the balance indicated in the computer for this product. It is critical to do these two steps right after each other so that the comparisons are between "apples and apples." If the product is counted and the computer balance checked later, product could be sold or received and added or deducted from the computer balance which would then not agree with the amount counted.

The counts and computer work should initially be done by a practice owner and should be "visible"; i.e. done during business hours so that the staff is aware that this procedure is taking place. The counts should not be done before or after hours and they should be done when several staff members are around. The counts shouldn't be treated as an unusual procedure nor should it be suggested that they are being implemented due to the possibility of staff theft, but do let it be known that this is a new procedure that will be done regularly. If asked why the counts are being implemented it should be said that the cost of inventory is one of the biggest expenses in the hospital and with the growth of the practice, the owners

want to control this cost a little better by improving the inventory system.

If there are discrepancies in the counts, ask the appropriate questions of the staff people:
- Are there any product purchase invoices that haven't been entered into the inventory module?
- Was any product used in-house that hasn't been recorded in the inventory module? (I.e. through a dummy client account?)
- Was any product sent home with either clients or employees that hasn't yet been recorded on an invoice? This is more often a problem with hospitalized or boarding patients than with out-patients.
- Was any product returned to the manufacturer that hasn't been deleted from the inventory module?
- Was product used for any other reason and not deleted from the inventory module?
- Is product stored in some other location which may not have been counted?
- Does the staff have any other ideas as to why the discrepancies exist?

Depending on the level of the discrepancies and whether or not reasonable explanations can be found for the discrepancies, it may be necessary to institute more stringent inventory control procedures until the problem can be found.

Once this part of the system is in place for food, heartworm preventative and flea and tick products, expand the counts to include other products. Unless the practice is experiencing a problem, the counts on the other products usually do not need to be done as frequently. Frequency will be determined by the $ value of the item, its likelihood of being stolen or given away and your experience with this product in your clinic. Don't forget that controlled substances should be counted much more frequently.

Good physical control of the inventory is important for several reasons:
- Helps insure inventory is properly stored based on its physical requirements; i.e. temperature and light
- Inventory that is well organized and easy to find makes it easier for you to assess how much is on hand, facilitates keeping track of short-dated product and allows for quicker and more accurate physical counts
- Proper organization and storage is a deterrent against theft and makes it easier to keep track of in-house usage
- Sensible organization facilitates good record-keeping

In general, good physical control requires:
- A locked central storage area with limited access—even here only small quantities of product should be kept
- Small quantities of products kept in exam rooms, pharmacy, lab area and other areas easily accessible to employees
- Empty boxes displayed in public areas

While setting up and administering this system can seem daunting at first, good inventory is actually one of the easiest things to achieve in a practice.

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SUCCESSION PLANNING
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INTRODUCTION
Selling a veterinary practice can be difficult logistically, financially and emotionally and the hardest part is often just knowing where to start. In this session, the attendee will learn how to prepare for a practice sale whether to another veterinarian or to a corporate group, how practice values are determined, what drives profitability and value and some of the common pitfalls to avoid.

WHY DO YOU WANT TO SELL?
Practice sellers should think through why they want to sell and, more importantly, be sure that this action will accomplish their goals. Understanding why you want to buy or sell will help you make the best choices. Common reasons to sell include: being ready to fully retire, wanting to decrease workload, a desire to change careers, management frustrations and a desire to practice more medicine, health issues, divorce or wanting to bond an associate to the practice.

WHO TO SELL TO?
One of the primary choices a seller will need to make is whether to sell to a corporate group or to an individual veterinarian (either an associate or an unknown veterinarian.) Corporate groups typically want practices in urban/suburban areas with a minimum of $1,000,000 in revenue and at least 2 veterinarians in the practice. If a practice doesn't meet these criteria; a corporate sale may not be an option.

Some key characteristics of either a full or partial sale to an associate are:
- Common transaction type-easiest to complete
- Greatest opportunity to know if buyer/seller are right fit and have right skills
- Some financial investment from the purchaser is good, but seller shouldn't count on it—associates often have limited financial resources
- Seller must be willing to provide full disclosure during the sales process
- Usually lock in timeframe for rest of practice purchase (if applicable) as well as real estate purchase at time of initial transaction
- Usually best option for C corps because is generally a stock sale (assuming only selling part of the practice)
- Seller often carries note on partial sales because doesn't want to give lender lien on 100% of practice assets
- Need to do all the same documents that would done if seller didn't know the buyer or wasn't doing the financing (if owner-financed)—don't get lax because it's a friendly deal—these can go sour
- If this is a partial buy-in, both buyer and seller need to be sure they can work together as owners and have similar goals for the future

Selling an entire practice to an unknown veterinarian is similar to selling to an associate in a number of ways although it is generally harder for the seller to find a buyer. Using a broker is often the best way. The seller should NOT finance a sale to an unknown buyer due to the high risk and the seller will have less control over what will happen to practice after the sale.

Key characteristics of selling to a corporate group are:

- Generally need to have a profitable practices with minimum of 2-3 doctors and over $1,000,000 in revenues in good location
- If they want your practice, seller may get a great price and mostly in cash
- Corporate buyers are very sophisticated and knowledgeable; agreements are complex and seller must have a good attorney to help them through the process
- Seller needs to understand the employment provisions—usually can't leave right away
- Corporate buyers often don't purchase real estate but may work with real estate investment groups who do; lease rates may be low
- Deals can be quick
- Generally asset purchases
- Will have to adapt to corporate expectations—this is not easy for all sellers

The seller will also need to make a decision regarding the real estate—options include: keeping it and leasing it to the practice buyer, selling it to the practice buyer or selling it to a real estate investment group who will lease it to the practice buyer.

FINDING A BUYER/SELLER
If you are a seller, finding a non-corporate buyer can be difficult and time-consuming. Use as many options as possible when looking for this person. Speak with your own associates, advertise in various publications, contact brokers and use networking wherever possible. Consider non-veterinarians if your state allows it. Determine what buyers are looking for and then set about creating a plan for marketing the practice.

ADVISORS
Both sides will need advisors to help with the process; expertise needed includes financial, practice appraisal, legal and sometimes brokerage.

A valuation of the practice is essential if you are selling to an individual; if you are selling to a corporate group an appraisal is not as useful although an analysis of the practice's financial situation and a profitability calculation is still critical.

PURCHASE/SALE STRUCTURE
The seller will also need to determine exactly what will be included in the sale and how will the sale be structured. Is this a stock or an asset sale? Are you also selling the real estate where the clinic is located? In a stock sale, the buyer is buying a % of the business as a whole, not part of the individual assets and liabilities and the buyer becomes responsible for known and unknown past liabilities of organization. In an asset sale, the buyer purchases individual assets—tangible or intangible and DOES NOT purchase liabilities. In general, sellers want to sell stock because of better tax advantages and buyers want to buy assets, both because of better tax advantages and the fact that they don't inherit the liabilities of the old business. From a practical perspective, however, if the sale is a partial sale to an associate, it will be a stock sale. Almost all sales of 100% of a practice will be asset sales, whether to an individual or a corporate group.

Obtaining the real estate associated with the practice is a critical issue for most individual buyers that must be resolved at the time of purchasing the practice. When and at what price will they get to buy it? If the seller is going to lease the real estate to the practice for a while, the seller must deal with these issues: FMV rent, term (renewal options, total of 15-20 years) and who pays for taxes, maintenance, insurance, and major repairs.

LEGAL DOCUMENTS

An attorney can advise both the buyer and seller on the preparation of legal documents, from the pre-purchase agreement through the sales contract. Do not skimp on legal services. Common documents include: pre-purchase confidentiality agreement, letter of intent, letter of offer, memorandum of understanding, the purchase agreement, and a buy-sell agreement.

PROFITABILITY

The profitability of the practice is almost always the most important driver of practice value. Whether you are 2 years or 30 years away from selling your practice, this is a critical metric to understand and yet most practices don't know what that number is. Improving your profitability will improve your practice's value at the time of sale and increase your cash flow in the years before. This is true whether you sell to another veterinarian or to a corporate consolidator.

Calculating the true operating profits of a practice is, however, not a simple task. None of the standard financial or management reports a practice usually gets includes this figure. Neither the taxable income from the tax return nor the net income from the profit and loss statement represents true profitability. This doesn't mean those reports are improperly prepared; it simply means the reports required by the IRS or accounting standards for small businesses weren't designed to determine profitability.

The operating profit is the difference between the operating revenues and expenses of a practice. Operating revenue and expenses include only items normally and necessarily seen in the day-to-day operations of the practice such as fees for professional services and drugs and medical supplies expense. These items should be stated at fair market value rates. For ease of comparison with other practices, the profit margin is generally stated as a percentage—this is calculated as practice profits divided by gross revenue. Some of the items that must be calculated differently to determine operating profit versus taxable income or net income include: practice owner payments, facility and equipment rent if these items are owned by the practice owner and leased to the practice, services provided by family members to the practice, depreciation, interest on debt and perks.

The resulting percentage is the true operating profit of the practice—how does it compare to other investments you have? And to other practices? 20% or above would be considered superior, 12-13% average and less than 6% poor.

The above may sound a little daunting but there are resources available to help. If you work with a veterinary financial advisor, this person should be able to calculate your profitability. VetPartners also has "The No-Lo Practice" available for download at www.VetPartners.org. Within this document is a worksheet to help guide you through this calculation process.

A lack of profitability either comes from revenues that are too low, expenses that are too high, or a combination of the two. Until the practice has an idea of the root causes of the problem, it is difficult to determine what the correct solution is. Working with a financial advisor or practice consultant may help in not only gaining a greater understanding of the issues impacting profitability but in identifying and implementing solutions.

Biographical Sketch
Kati Glass, DVM
Diplomate, American College of Veterinary Surgeons- Large Animal Surgery

Dr. Kati Glass is originally from Shreveport, Louisiana. She obtained both a bachelor's degree in Biomedical Sciences and a Doctor of Veterinary Medicine from Texas A&M before completing an internship at the Equine Medical Center of Ocala in Ocala, Florida. She returned to Texas A&M for a large animal surgery residency and after its completion became a clinical assistant professor in large animal surgery seeing patients predominantly through the Equine Sports Medicine & Imaging and Equine Orthopedic Surgery Services.

Description of the Presentations

Lecture
Bandaging and splinting techniques are critical skills for large animal technicians. The attendee will become familiar with the materials required and principles of application. A case based discussion will introduce appropriate splint application for musculoskeletal injuries in the large animal patient.

Lab
The laboratory participant will gain hands on experience and guided practice in bandage and splint application as discussed in lecture. Participants will make recommendations for bandaging and splinting application based on case simulations then perform the task on live horses.

ANESTHESIA FOR PATIENTS WITH RESPIRATORY DISEASE

Katy W. Waddell, LVT, VTS (ECC, Anesthesia)

Anesthesia is not without complications and is too often taken for granted and performed without adequate planning or preparation. A safe and successful course of anesthesia requires an anesthetist to have a diverse overall knowledge of physiology, pharmacology, anesthesia equipment and monitors. Proper preparation and a plan for dealing with potential complications are important factors in a successful anesthetic event involving a patient with respiratory compromise. Every effort should be made to get the patient as stable as possible before anesthetic agents are administered.

Ideally, a complete physical exam with auscultation of the upper airway and lungs is indicated. As complete a patient history, blood work and other indicated laboratory testing should be completed prior to induction when possible. Thoracic radiographs are indicated for patients with lower airway symptoms to help determine the cause of the compromise and three views will help rule out or assess the pulmonary system for metastasis when there is cause to suspect mass or tumors. Unfortunately, with cases of acute respiratory/airway compromise, this is not always possible.

Our veterinary patients require anesthesia for many therapeutic and diagnostic procedures. These procedures all have a variety of anesthetic requirements and the potential to generate complications for the patient. Hypotension, hypoxia, hypothermia, hemorrhage and pain are just a few complications that may arise during anesthesia. Once the pre-anesthesia patient assessment is complete, and you understand the physiological risks for the patient, you can develop effective contingency plans to deal with the complications associated with the both anesthesia and the proposed procedure.

There are times when the simple act of restraint and positioning for radiographs can be injurious. Patients with respiratory compromise that are not ventilating adequately are usually extremely anxious and are working very hard to simply breathe. Oxygen consumption in these patients increases and a vicious cycle presents. The more air hungry the patient is, the more anxious they become. The more anxious they become, the more effort they put into the work of breathing.

These patients are often hyperthermic and near exhaustion depending on the severity of the disease or trauma. In these patients, often the best thing to do is to induce anesthesia and capture the airway as soon as possible. Further work-up can follow once the patient has a patent airway, is intubated and stabilized. In all cases supplemental oxygen should be supplied in some way.

Pre-oxygenation of any patient is never a bad idea as long as it is tolerated and doesn't add to pre-existing stress levels. Pre-oxygenation is a technique that can "buy time" before the onset of hypoxemia. In cases where intubation may be difficult or prolonged or if the patient may be become apneic due to induction drugs, preoxygenating increases the oxygen content within the functional residual capacity of the lungs. It takes only 90 seconds for a patient that has not been pre-oxygenated to become hypoxemic in the event of an airway obstruction as compared to 3-4 minutes in a pre-oxygenated patient. It's a simple technique that is highly recommended.

Most anesthetic agents cause respiratory depression to some degree. The anesthetist must consider the side effects of any potential premedication drug before it is given in order to anticipate potential worsening of hypoventilation and hypoxemia. The pure agonist opioids (oxymorphone, hydromorphone, morphine and fentanyl) are potent analgesics but also dose dependent respiratory depressants. Although the effects are

dose dependent in the most critical cases where patients are having difficulty ventilating adequately, they might not be the best option for administration prior to induction. In non-painful patients, opioids can cause vomiting. For the respiratory challenged patient where aspiration is a big concern, this should be a consideration prior to administration. The opioid agonist-antagonist butorphanol causes minimal respiratory depression and fair sedation but it will not provide adequate analgesia for thoracic surgery.

If the patient is critical but stable and ventilating adequately a neuroleptanalgesic technique can be used for premedication. Usually this entails using a benzodiazepine such as diazepam or midazolam, along with an opioid. This combination can be given IM or if the patient has an IV catheter already in place, the two drugs can be titrated separately, IV, to effect. Benzodiazepines have minimal effects on the respiratory system at therapeutic doses and so are considered good choices for use in respiratory compromised patients. When used alone in otherwise healthy dogs excitement can be seen. For that reason, in the healthy dogs, it is best to titrate a bit of the opioid dose in first, flush it in and then administer the benzodiazepine. In critical patients and those exhausted from the work of trying to maintain ventilation, titrating to effect makes sense as much lower doses of each drug may be needed to reach the desired effect.

Acepromazine is the most commonly used phenothiazine tranquilizer used in veterinary medicine. It has minimal effects on ventilation although higher doses can have depressant effects. Acepromazine can lower the respiratory rate in some patients but minute volume usually remains unchanged because tidal volume increases. Low doses (0.02-0.04 mg/kg) can be useful in patients that are anxious and distressed over acute respiratory dysfunction. The side effects of acepromazine include vasodilation which can exacerbate hypotension. It can be ideal, however, in patients that are anxious at being hospitalized or those whose distress from the effort of maintaining ventilation worsens their upper airway obstruction. It can also be an ideal drug to use for post-operative anxiety in these patients.

The αlpha-2 agonists (xylazine, dexmedetomidine) have variable effects on the respiratory system depending on the dose and the patient. Some patients will have only slight respiratory depression while others show a marked effect. These drugs cause vasoconstriction and therefore can cause mucous membranes to blanch or appear bluish in color. This can be mistaken for cyanosis when in fact arterial partial pressure of oxygen is normal or near normal. Alpha-2 agonists also cause a degree of hypotension and cardiovascular depression. Although the effects of these drugs can be reversed with atipamezole, they are not recommended for use in the critical patient.

The anticholinergic drugs atropine and glycopyrrolate work by blocking stimulation of the vagas nerve reversing parasympathetic effects. In patients with high existing vagal tone, such as the brachycephalic breeds, anticholinergic use as part of the premedication protocol is recommended. These drugs also decrease salivary and bronchial secretions which can be beneficial in some patients as well. In the critical or highly stressed animal administration of anticholinergics is contraindicated. Usually these patients are already tachycardic or cardiovascular compromised and the increase in myocardial work and subsequent increase in oxygen consumption caused by anticholinergics can be detrimental.

Regardless of the premedication chosen, respiratory compromised patients should not be left unsupervised once the drugs have been given. Premedication can cause muscle relaxation of the upper airway muscles which can lead to worsening obstruction or the compensatory mechanisms employed by patients with airway compromise may be obtunded requiring immediate induction and intubation. In most cases, the benefits of premedication out way the risks as long as careful supervision and monitoring take place.
Any induction agent that allows for rapid intubation should be used in a respiratory compromised patient. As always, the side effects of each drug need to be considered especially in patients that are surgical candidates. Propofol induces anesthesia quickly but can cause transient apnea and hypotension following

induction. If there is any indication that intubation may be difficult or prolonged it may be best to look to another induction agent. Ketamine/midazolam (or diazepam) may be a good choice because the ketamine can indirectly support the cardiovascular system and provide some analgesia and the midazolam provides good muscle relaxation. Etomidate may not be a good choice when quick airway control is the goal as it can also cause transient respiratory depression and apnea. Unless the patient is well sedated, or the drug is combined with a benzodiazepine for induction, excitement is sometimes seen. Etomidate may be the drug of choice, however, in a fragile patient with cardiovascular compromise.

Mask or chamber inductions are a very risky and poor choice for the respiratory compromised patient. They can add to the stress level of an already compromised pet and don't allow for rapid capture of the airway.

What specific concerns are there for providing safe anesthesia for the brachycephalic breed?

Many brachycephalic breeds have anatomic abnormalities:

Brachycephalic airway syndrome, which is the presence of stentotic nares, elongated soft palate, everted laryngeal saccule and hypoplastic tracheas. In addition, the patients have smaller and more narrow upper airway anatomy. Increased resistance and work of breathing result from these narrow and smaller upper airway anatomical differences. Stress in these patients exacerbates the challenge as the respiratory rate increases as does the work of breathing.

The goal of premedication in brachycephalic dogs is to provide enough sedation and anxiolysis to allow intravenous catheter placement with minimal stress. Always be prepared to intervene during the premedication and recovery period with an oxygen source and appropriate endotracheal tubes. Brachycephalic breeds should be closely monitored after receiving any premedication as well as throughout the anesthesia event and into the recovery period.

What can we do to try to control or eliminate regurgitation or reflux with these patients? While not 100% assured to prevent, agents such as maropitant may be given the evening before orally or IV/IM the day of surgery, one hour in advance. Metoclopramide may also be incorporated into the premedication plan as well as considering centrally acting antiemetics, ondansetron or dolasetron.

Signs of regurgitation are not always obvious and many of these dogs are silently refluxing without owners being aware that there is a problem. Look out for subtle signs such as snorting, swallowing and excessive lip licking which can be indicative of regurgitation. Breed-specific prevalence for regurgitation and vomiting for French bulldogs was 93%, English bulldogs 58% and pugs 16% in one study (Kaye et al 2018).

The use of anticholinergics must be considered carefully. Brachycephalic breeds often have higher vagal tone than other breeds and can become bradycardic. The benefits of increased heart rate, decreased airway secretions, bronchodilation, and reduced saliva production can be outweighed by such negative side effects as tachyarrhythmias, decreased myocardial perfusion, reduced GI motility, and decreased esophageal sphincter pressure allowing for potential reflux and esophagitis.

The proper sedation should allow the patient to breathe slowly and calmly without causing excessive respiratory depression. Many brachycephalic dogs respond well to sedatives such as acepromazine or dexmedetomidine in conjunction with an opioid, but the sedative dose should be half of what is used in the non-brachycephalic dog. Full mu opioids can be used but may cause excessive respiratory depression so a reversal agent should be available. Butorphanol, a kappa agonist and mu antagonist opioid, can be used and provides reliable sedation but short acting analgesia. Buprenorphine, a partial mu agonist, provides moderate analgesia and minimal sedation and can also be used as part of the premedication. Dexmedetomidine, an alpha-2 agonist, may be used in these dogs if no cardiovascular disease exists but

due to the presence of high vagal tone the dose used should be reduced. Dexmedetomidine when used in lower doses provides good sedation, is fully reversible, and provides analgesia (6). Acepromazine, a phenothiazide sedative, is commonly used in many brachycephalic breeds due to its anxiolytic properties. Acepromazine provides reliable sedation in these dogs but is not reversible so should be used in low doses. There are several websites stating that acepromazine cannot be used in French bulldogs but these websites are not backed by any reliable scientific evidence or studies and should be followed with caution. In fact, French bulldogs are often highly stressed and excited when presenting for anesthesia and can actually benefit from the addition of acepromazine to the protocol. The induction agent chosen should allow for smooth rapid induction and intubation thereby protecting the airway and providing a source of oxygen as quickly as possible. The induction agent should also allow for rapid loss of consciousness and rapid return of consciousness. There are several induction agents that can be chosen including propofol or alfaxalone. Preoxygenation is always recommended before induction of dogs with BAS. Preoxygenation with 100% oxygen delivered via a facemask for 3to 5 minutes before induction of anaesthesia increases the time to desaturation. This can increase fraction of inspired oxygen (FiO_2), which may improve partial pressure of oxygen ($PaO_{2)}$. If the dog is stressed, then flow-by oxygen can be provided. With existing airway compromise plus challenges associated with tracheal intubation preoxygenation adds a safety factor during this period. Oxygen should be available during the recovery period should desaturation occur and the use of pulse oximetry in this period is recommended. Intubation should be performed as rapidly as possible and mask inductions should be avoided. Due to the everted laryngeal saccules and small tracheal size, most BAS breeds require a smaller size endotracheal tube than would be expected for a patient of the same weight so it is important to have a large variety of sizes of endotracheal tubes available during induction. Due to the common occurrence of obesity in brachycephalic breeds, controlled or mechanical ventilation is often necessary. It is not uncommon for regurgitation to occur during the induction period and it is of good practice to have active suction available for rapid suction of the airway. The intra-operative period is usually similar to that of other breeds, although if surgery is to be performed on the airway itself it may be indicated to administer an injectable steroid such as dexamethasone to reduce post-operative swelling.

Most problems occur during the induction and recovery periods and this is a particular problem in the recovery period when patients are poorly monitored. It is important to postpone extubation until the patient is bright, alert, swallowing, and even chewing on the endotracheal tube. If extubation is attempted while the patient is sedate and groggy from anesthesia there is an increased risk for upper airway obstruction. If an upper airway obstruction does occur, the patient may need to be reintubated so extra laryngoscopes, induction agent, and tubes should be available. Once extubation occurs the patient should be observed for breath sounds and signs of obstruction such as inflation of the abdomen with collapse of the thorax on inspiration and lack of breath sounds. The patient should be placed in sternal recumbency during recovery and pulse oximetry should be monitored as long as possible. The airway may also be opened by extending the head, opening the mouth and pulling out the tongue of the patient. It is often enough just to prop up the head of the patient maintaining a patent airway while they are still groggy. If reversible sedatives were used then the antagonist can be given to try and lessen the sedation levels. Once the patient is taking good breaths and awake they should be monitored closely for the next few hours or transferred to the intensive care unit. Brachycephalic patients should never be left alone in the recovery period. Avoid overly aggressive initial stimulation, which may trigger movement and/or swallowing

followed by a relapse into unconsciousness when the stimulation is removed. Make sure additional induction agents and endotracheal tubes are available if an airway obstruction occurs and reintubation is needed. Recovering brachycephalic patients in an oxygen chamber is advisable; however, if an oxygen chamber is unavailable at the practice, nasal oxygen via a red rubber catheter can be an alternative.[11] A nasopharyngeal tube can be placed and connected directly to an oxygen source to allow delivery of oxygen to the oral cavity during recovery.

The key to a successful anesthetic recovery is a calm, comfortable patient and a calm, prepared anesthetist. Although sedation and anesthesia of BAS patients can be difficult and stressful, with proper precautionary steps and drug choice it can be done safely and successfully.

Did you know that brachycephalic dogs have a higher incidence of corneal ulceration and protection under anesthesia is essential. When preoxygenating your patient, be aware of any contact made with the mask and the eyes.

Close attention is required to avoid hyperthermia and hypothermia. Brachycephalics have a limited ability to dissipate heat and are prone to stress-induced hyperthermia. Conversely, these dogs should not become hypothermic as this will impair ventilation in the recovery period and could increase the risk of complications.

<center>**Senior Anesthesia**</center>

<center>Katy W. Waddell, LVT, VTS (ECC) (Anesthesia/Analgesia)</center>

One of my favorite sayings is that old age is not a disease. Yes, there are physiological changes associated with the aging process. These physiological altered responses should always be taken into consideration when developing an anesthetic protocol tailored for each individual patient. Advanced age can increase anesthetic risk because of changes in cardiovascular and respiratory function. Disease processes occur more commonly in older patients. Many of our senior patients have comorbidities to consider when making our anesthesia plan. As veterinary medicine continues to advance, we are better able to lengthen the life span **and** improve the quality of life for our aging patients.

Perform a complete and thorough physical examination, including assessments of weight, temperature, pulse, respirations, and pain. In our facility each patient has a body conditioning score as well as a pain score assigned with each visit. We all know that food equals love and our senior pets are often spoiled with food and very often have a decreased level of physical activity. Obesity can then further alter drug disposition, particularly with respect to the lipid soluble drugs.

When creating an anesthetic protocol, it is important to consider factors that can affect the choice of anesthetics.

1)Species, breed, age and relative size of the patient, health status and concurrent medication, temperament of the patient, and the presence of pain (acute and/or chronic) or distress.
2)Length and type of operation or procedure to be performed.
3)Possible effect of the anesthesia on the scientific objectives of the study.
4)Special facilities and equipment required (e.g., volatile anesthetics).
5)Personal knowledge, experience, preference and skill with available agents.

Premedicants

Patients should be given preanesthetic sedatives, which can contribute to a smoother recovery from anesthesia. To prevent patients from becoming anxious before surgery, they should be handled gently and kept in a quiet environment.

The use of preoperative sedatives, with or without analgesic agents, may alleviate stress and potentially reduce the amount of induction agents and provide a MAC sparing effect.

Avoid stress which can exaggerate arrhythmias, a careful choice of premedications is advised. Avoid drugs that potentiate arrhythmias. A working knowledge of clinical pharmacology and the contents of your pharmacy cabinet will aid you in developing the best protocol for your patients. Long-lasting premedication, however, should be avoided to allow patients to return quickly to a normal activity level

Cardiovascular System

Cardiac muscle becomes less efficient with age. Blood volume, cardiac output, and auto regulation of blood flow, as well as baroreceptor activity are all reduced to some level in geriatric patients. These

<center>48</center>

changes translate into a reduction in cardiac reserve capacity, which renders the patient unable to compensate for cardiac changes. If any of you have ever taken a cardiac stress test, you know that your target heart rate is determined by your age.

As the body ages, the ability to increase heart rate may be decreased because the heart muscle itself is showing a decrease in muscular ability. Some studies suggest that there is a decrease in responsiveness of the myocardium to endogenous catecholamines and an exaggerated responsiveness to exogenously administered catecholamines.

Acquired cardiac valve disease is very common in the smaller dog breeds. As this disease progresses, it increases the chance of arrhythmias due to atrophy of the myocardial fibers as well as potential changes of the conduction system.

Cardiac medications should be administered normally the day of any scheduled procedure requiring anesthesia. The cardiovascular system must be kept stable while these patients are under anesthesia. Hypotension, hypertension, tachycardia and bradycardia should be avoided and a plan should be in place to manage any changes outside of normal parameters. A good way to stabilize these patients is to take action at the first signs of change, not waiting for dramatic changes in heart rate, or blood pressure. Correct any abnormalities that you can prior to inducing the patient. It is desirable to pre-oxygenate older patients with flow by oxygen prior to induction if it is at all tolerated. If it does cause undue stress to the patient, I would recommend that older patients be induced with an ECG in place to obtain real time information during the induction process.

Respiratory System

Normal aging changes include the decrease of lung elasticity. This is referred to as decreased lung compliance. Muscle strength declines overall which includes the muscles of the diaphragm which work to aid breathing. And let's throw in findings that there is also some evidence that protective laryngeal and pharyngeal reflexes are reduced. Geriatric patients typically have a decreased rate of respiration, and a decrease in tidal volume which leads to a decrease in minute volume. It is known that awake dogs consume 4-7 ml/kg/minute of oxygen while dogs under anesthesia consume 3-14 ml/kg/minute.

The variance is based on body weight - surface area, smaller patients = higher metabolic rate. Additionally, some anesthetic agents will cause respiratory depression (dose dependent) which is evidenced by decrease tidal volume, minute volume, as well as potentially causing a depression of both central and peripheral chemoreceptor response to carbon dioxide and oxygen. It is of utmost importance that geriatric patients are under observation after the administration of any sedative or anesthetic agent as the changes in the respiratory function may result in a further decrease of respiratory functional reserve thus leading to mild to moderate respiratory depression. This monitoring/observation may include recording respiratory rate and effort, pulse oximetry, capnography and if available and deemed appropriate by the patient and situation, arterial blood gas assessment. Here again, pre-oxygenation will support the patient and give a decreased opportunity for hypoxia between induction and intubation.

Neurological function

This can be a very difficult area for many of us to assess and relies heavily on owner input during the history taking period. In human medicine, many of the age related central nervous system changes are related to changes in sensory and cognitive function. But it does appear that as aging progresses, there is an apparent increased sensitivity to anesthetics and many anesthetic adjuncts. This has been most clearly demonstrated as a decrease in the MAC of an inhalant anesthetic with increasing age. Studies report that there **may** be progressive neuron loss and a depletion of central neurotransmitters that may explain the increased sensitivity. May is the key word as this has not been conclusively determined.

There is also a decrease in cerebral perfusion, however, this appears to be an appropriate response related to the decrease in cerebral mass and oxygen demand. Peripherally, there is a loss of motor, sensory and autonomic nerve fibers.

Geriatric patients have a poor ability to maintain body temperature during anesthesia and consequently can be expected to be mildly hypothermic if active re-warming is not practiced intraoperatively.

Senior dogs and cats may become more anxious in unfamiliar surroundings and cognitive, sensory motor as well as autonomic responses may be blunted or altered. Changes which may occur within the central and peripheral nervous system in these older patients should remind us to potentially decrease the dose calculation for sedative, analgesic and anesthetic agents.

Hepatic and Renal function

As we age and our cardiac output decreases, the blood flow to both the liver and kidneys may as well. This may lead to a decrease in drug metabolism and clearance. Hepatic metabolism of drugs is dependent on two main systems– hepatic enzymes and hepatic blood flow. Preoperative blood work is indicated for any procedure requiring sedation or general anesthesia to best determine the agent or combination of agents to provide the safest anesthesia/sedation for the patient. Keep in the back of your mind that any patient with hepatic compromise may have hypoproteinemia, impaired clotting function and/or hypoglycemia. Based on each individual patient, should this patient have fresh frozen plasma prior to a scheduled procedure? Should a clotting profile plus or minus a buccal mucosal bleeding time be preformed? Do you have a dextrose supplemental plan ready if the patient has a glycogen storage issue with impaired gluconeogenesis? Are you prepared to support the patient during a prolonged recovery due to increased time for the patient to metabolize any anesthetic agents?

No one anesthetic drug or drug combination is better for renal disease; most important is to maintain blood pressure and adequate renal perfusion.

With a decrease in functional organ reserve, older patients may not tolerate standard fluid therapy rates. Studies suggest that 15-20% of geriatric cats and dogs will have renal insufficiency as renal mass, renal blood flow and glomerular filtration rate are all reduced. The decreases in GFR and active tubular secretion can have significant effects on drugs requiring renal excretion for elimination. The changes associated with renal blood flow and microvasculature may make the geriatric kidneyless able to respond to nephrotoxic or ischemic insults.

The kidneys receive 20-25% of the cardiac output. This is more blood per gram of tissue weight than any other organ in the body. As this is the case, the kidney has a high oxygen requirement which makes it very susceptible to any decrease in renal blood flow. It is vital that when we are monitoring these patients, that every effort is made to maintain the mean arterial pressure at 70mmHg or above to ensure adequate perfusion. Additionally, patients with known or suspected pancreatitis also fall into this recommendation. The lowest MAP acceptable for other patients is a reading of 60 mmHg.

Constant Rate Infusions: Indications, calculations and applications in pain management
Katy W. Waddell, LVT, VTS (ECC) (Anesthesia/Analgesia)

Systemic administration of analgesic agents is the most common route of delivery during the perioperative period. These routes would include delivery by transdermal, subcutaneous, intramuscular, intra-articular and intravenous. Intravenous administration of analgesic agents may be timed to be given intermittently or by constant rate infusion. It is often most desirable for patient management to achieve and maintain a steady rate of delivery to prevent the "roller coaster" effect of intermittent bolus administration as well as maintain a therapeutic concentration. Ideally, all CRIs should be administered via a syringe pump to ensure accurate dosing.

Some disadvantages of CRI analgesic management would include the very obvious reason that any agent being given intravenously must be under constant supervision of an attending veterinary nurse as the IV lines might become kinked, disconnected or the IV catheter may loose patency due to patient interference. Further study is ongoing for dome of the agents used in CRIs to determine the best protocol for prolonged use (over 24 hrs of administration). Syringe pumps at this time are still fairly expensive.

Constant rate infusions may include multiple agents for a multimodal approach to analgesia or a single analgesic agent.

☐ **Metric system:**
The majority of drug dosages are calculated in either milligram (mg) or microgram (mcg) per kilogram (kg) of body weight. This information provides concentration of the drug.
1000mg = 1 gram (gm)
1000mcg = 1 mg
Ergo there are 10,000 mcg per gram

Volume Equivalents
Liter (L) = 1,000 milliliters (ml)
500ml (0.5L) = 1 pint (473ml) = 2 cups = 16 ounces
(Weight = 1 pound)
 15 ml = 1 tablespoon
   5 ml = 1 teaspoon
 30 ml = 1 ounce
240 ml= 1 cup = 8 ounces

Percentages

☐ **Agents with doses written as % concentration represent grams per 100ml**
For example: Furosemide = 5% solution =50 mg/ml
                        Lidocaine = 2% solution = 20mg/ml
                        Dextrose 50% = 500mg/ml

Calculating agent based on body weight

Lidocaine 2% to be given at a one time 2mg/kg dosage.
Body wt (kg) x dose of agent concentration =
    lidocaine = 20mg/ml
    dose = 2mg/kg
    body weight = 10kg
Dose x BW (kg) = 20mg
Dose/concentration = 20mg/mg = 1 ml

Calculating fluid drip rate (gravity flow)

There are three standard IV administration sets available for use with gravity flow vs. the specialty administration tubing required for some fluid pumps.

Microdrip sets are calibrated to equal 60 drops per ml
Standard drips sets (called by some macrodrip) are calibrated to equal 15 drops per ml
Flashball drip sets (again called macrodrip by some) are calibrated to equal 10 drops per ml.

To calculate the desired volume to be delivered over a set time period:

          Volume (to be infused) x drip set rate
Divide by   length of time in minutes
Equals   drops per minute

For example:
Class I patient for IV administration during surgery
LRS to be given at 10ml/kg/hr for the first hour of anesthesia
Patient weighs 12 kg
Standard drip set is available for use (15 drops/ml)

10 (ml) x 12 (kg) = 120ml divided by 60 (minutes) = 8 ml per minute

To obtain drops per minute:
Divide mls/minute by drops/ml of drip used

8 (ml) divided by 15 = 0.53 drops per second

KEEP IT SIMPLE SWEETHEART RULE:

Desired mls to be delivered over 1 hour x #drops/ml (drip set dependant) divided by 3600 (60 minutes x 60 seconds)

Class I patient for IV administration during surgery
LRS to be given at 10ml/kg/hr for the first hour of anesthesia
Patient weighs 12 kg

120mls x 15drops (standard drips set) = 1800 drops
divided by 3600 = 0.5 drops per second

120mls x 60drops (microdrip set) = 7200 drops
Divided by 3600 = 2 drops per second

I find this formula to be an easier method to calculate fluid administration. For the second or subsequent hours if the rate is to be cut by half simply divide by 2 to determine hourly rate as well as drops per second.

CRI Calculations

Example if delivered via a syringe pump:

Fentanyl CRI following a Fentanyl bolus at 2 mcg/kg/hour
Mcg (dose) per kg (patient body weight) per hour
2mcg/kg = mcg/hour divided by concentration = mls/hour
2mcg x 12kg = 24 mcg/hour divided by 50 mcg/ml = 0.48 ml/hour

Lidocaine CRI following a Lidocaine bolus at 25 mcg/kg/min
25mcg x 12kg = 300mcg/minute x 60 minutes =18,000 mcg/hour
18,000mcg. (18mg.) divided by 20mg = 0.9ml/hour

Example if delivered via gravity flow administration set:
Hourly dose (dose x weight/kg)
Drug concentration

Desired fluid rate (LRS, etc.) volume of bag divided by mls/hour.
Multiply hours x patient's dose (number of mgs to be added to the volume)
Divide the total dose by the drug concentration

Fentanyl at 2mcg/kg/hour – 2mcg x 12 kg = 24mcg.
Divided by 50 mcg = 0.48ml Fentanyl/ hour

15mls LRS/hour divided by 250mls =16.6 hours

Sample dosages for single agent analgesic CRIs

Fentanyl	2-6 mcg/kg/hr
Lidocaine	20-30 mcg/kg/hr
Medetomidine	1 mcg/kg/hr
Morphine	0.24 mg/kg/hr
Hydromorphone	0.02 mg/kg/hr
Ketamine	0.5 mg/kg/hr

Multimodal combination CRIs

The following listed multimodal combinations may be added to IV crystalloid fluids and delivered at either 10ml/kg/hr or 5ml/kg/hr using the following table adapted from Dr. W. Muir, Chapter 9, Small Animal Anesthesia and Analgesia, Dr. G. L. Carroll, editor, Blackwell publishing, 2008

Drug	mg added to 1L crystalloid @ 10ml/kg/hr	mg added 1 L crystalloid @ 5ml/kg/hr
drug CRI		
Morphine	24mg	48mg
0.24mg/kg/hr		
Hydromorphone	2mg	4mg
0.02mg/kg/hr		
(Replaces morphine)		
Lidocaine w/o epinephrine	300mg	600mg
3mg/kg/hr		
Ketamine	60mg	120mg
0.6mg/kg/hr		

Alpha 2 agonists

Used in veterinary medicine to produce:
sedation, analgesia, anxiolysis

Dexmedatomadine

Alpha 2 agonist

Profound sedation and analgesia
Significant cardiovascular effects
Increase in total peripheral resistance due to vasoconstriction
Bradycardia
Decreased cardiac output (due primarily to bradycardia)
Reversal: Antisedan

Current thinking for CRI dosage administration:
Loading dose of 1 mcg/kg with a CRI of 1 mcg/kg/hr
This agent should be used cautiously in the canine patient and I would not recommend it for any patient with existing cardiovascular disease or the trauma patient that would be susceptible to traumatic myocarditis and its potential for arrhythmic activity.

Mu opioids

Fentanyl

Pure mu agonist
Causes dose dependant bradycardia (increase in vagal tone)
Bradycardia is responsive to anticholinergics – atropine/glycopyrrolate
Single dose IV is very short acting – up to 20 minute duration.
Loading dose for CRI administration – 2-5 mcg/kg IV and a management rate of 2-6 mcg/kg/hr.

This CRI can be utilized with several other agents for the management of moderate to severe pain management as well in combination with a benzodiazepine for MAC reduction for critical or cardiac anesthetic management as it can reduce MAC settings when used in combination with an inhalant anesthetic agent. Anesthetic adjunctive dosages for intra-operative administration may range from 10-48 mcg/kg/hr as these patients have airway and ventilatory support provided. Higher rates of administration of fentanyl will cause a dose related permissive hypercapnea. It is recommended that at the intra-operative dose rates of fentanyl CRIs that respiratory monitoring include the use of a capnograph to prevent inadvertent hypoventilation/hypercapnea.

Hydromorphone:
morphine-like agonist, primary activity at the mu receptors.
Cardiovascular effects:
bradycardia due to central vagal stimulation,
alpha-adrenergic depression causing peripheral vasodilaiton, decreased peripheral resistance
 Baroreceptor inhibition.
A loading dose of 0.05mg/kg given IV and followed by a CRI dosed at 0.01-0.04 mg/kg/hour may be administered for intra as well as post-operative analgesic management.

Oxymorphone

Similar effects to hydromorphone
Case management of side effects the same
Morphine
No direct myocardial effect
Dose dependent bradycardia – responsive to anticholinergics. Regardless of the route of administration whether IM or IV as a CRI, morphine can result in hypothermia and panting.
To avoid histamine release, which may have a profound effect of systemic blood pressure causing hypotension, morphine when intended as a CRI should have a loading dose calculated at 0.15-0.5 mg/kg diluted with saline and given over a minimum of 5 -10 minutes. CRI management when used in combination with other agents, the dosage is typically 3.3 mcg/kg/minute.

Mixed agonist/antagonists

Butorphanol
Partial agonist/antagonist. Similar to buprenorphine in cardiovascular/respiratory effects.
Loading dose of 0.1-0.2 mg/kg followed by a CRI management dose of 0.1-0.2 mg/kg/hour.
Good management of mild to moderate pain in post-operative cats if a CRI is indicated.

Dissassociative agents
At accepted dosage for restraint or anesthetic induction, these agents will indirectly stimulate the cardiovascular system by increasing sympathetic tone thereby causing an increase in heart rate, cardiac output, mean arterial pressure, pulmonary arterial pressure and central venous pressure.

Additionally, due to the increase in heart rate, they will cause an increase in myocardial work and oxygen demand/consumption.

Ketamine

Does not produce a true anesthetic state – dissociation from the environment with analgesia and sensory loss. NMDA antagonists are useful to prevent "wind up" (central hyper sensitization) of the NMDA receptors found in the dorsal horns of the spinal cord. Chronic pain, surgery or trauma can stimulate these receptors to the point where the response threshold is decreased and neural transmission to the brain causes an increase in pain perception. Ketamine is an excellent addition for management of chronic diseases leading to surgical repair both intra-opearative and for post-operative analgesic management.

By decreasing the dosage for CRI administration, undesirable side effects such as dysphoria/hallucinations do not seem to occur.

Dosage for CRI administration:
Loading dose of 0.5 mg/kg IV followed by a CRI of 10 mcg/kg/minute is an excellent choice intra-operatively for patients with chronic pain experiencing the "wind up" phenomenon.
Post –operative CRI dosing is reduced to 2 mcg/kg/minute.

Lidocaine without epinephrine

Lidocaine without epinephrine may be administered as a CRI both intra-operatively as an adjunctive agent to provide a MAC (mean alveolar concentration) sparing effect on inhalants anesthetic agents, provide a free radical scavenging benefit, protection against cytokines during reperfusion events as well as provide some control of ventricular arrhythmias. Consider this addition for management of the acute abdomen patient or those withlumbar sacral disease. The lower dosage used in typical analgesia management ranges from 25-50 mcg/kg/minute. A loading dose of 1-2 mg/kg IV should be given over a 2 minute period to avoid transient hypotensive effects. This should not be used in patients that are shocky, hypovolemic or those having SA or AV nodal disease. Not recommended for use in feline patients due to the lower toxic dose.

A word about alfaxalone CRI for maintenance, IF this is used in conjunction with another agent, the dose range may be lower. Alfaxalone provides no analgesia.

Maintenance	CRI
Dogs	4 – 7 mg/kg/hr (2 – 3.5 mg/lb/hr)
Cats	5 – 8 mg / kg / hr (2.5 – 4 mg/lb/hr)

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WOUND DRESSINGS AND ADDITIONAL THERAPIES
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Moist wound healing

A moist wound environment facilitates healing of the wound by preventing dehydration, enhancing angiogenesis and collagen synthesis and increasing break down of dead tissue and fibrin. Moist wound healing improves aesthetics of wound and decreases pain. Also, it does not increase the risk of infection when compared to dry therapies.

Moist wound healing was introduced in the 1960s. A landmark study was performed showing that pigs epithelialized wounds twice as fast in a moist environment than when allowed to dry (Winter 1962). A human study was performed in 1963 with similar findings (Hinman and Mabach 1963). Moist wound healing is now the standard of care in human medicine. All dressings selected should facilitate moist wound healing.

Dressings

No single wound dressing is best for every wound or required for a specific wound. Each dressing agent has its own indications including the stages of healing present in the wound. Many "old" wound dressings are still popular and have many potential uses. Additionally, many "new" wound dressings and wound management systems have been introduced with a great deal of success.

Electroceutical (energy-based technologies) dressings are becoming more popular in human wound care and starting to be used in veterinary wound care. Electroceutical dressing has been reported as a treatment in non-healing wounds. In a case report, a novel wireless electroceutical dressing was applied with a hydrogel. The wound went on to completely heal (Salyer 2018). Targeted pulsed electromagnetic field therapy is also available for veterinary patients.

Negative pressure wound therapy (NPWT) therapy was introduced in the early 1990's as a treatment modality for managing open fractures in humans and has since been used to treat a large variety of acute and chronic wound conditions afflicting human and veterinary patients. The principle of NPWT is microdeformation of the cells. NPWT is a non-invasive, active, wound management system that exposes a wound bed to local sub-atmospheric pressure contained within a closed environment. By creating this closed, negative pressure environment, NPWT removes fluid from the extra vascular space, improves circulation, and enhances the proliferation of granulation tissue.

NPWT bandaging systems are available commercially. These systems are able to sense wound pressures and adjust the vacuum accordingly. Other systems, or homemade systems are also available but lack the ability to sense wound pressures. If a vacuum seal cannot be maintained, air can be drawn over the wound leading to wound desiccation. Systems made for NPWT bandaging will alarm if a leak is detected but homemade systems will not. The NPWT bandage should be changed every 3 days to prevent ingrowth of granulation tissue into the open cell foam.

Honey has been used as a wound dressing for thousands of years, likely beginning in 2000 B.C. Honey leads to a decrease in inflammatory edema, stimulates macrophage migration, accelerates sloughing dead

tissue, provides an energy source for cells, and speeds the development of a healthy granulation bed. Honey is effective against a variety of bacteria, including multi-drug resistant *Staphylococcus* species. Honey for wound care should be unpasteurized. Gauze can be soaked in honey and then placed in the wound. The wound should be bandaged to hold the honey in the wound and protect the wound.

Hydrogel, hydrocolloid and alginates are all hydrophilic wound dressings. As mentioned above, they can be used to assist in autolytic debridement. Hydrocolloids can be used in the inflammatory and repair phases of wound healing. Hydrocolloids should not be used in very heavy exudate because the tissue may become macerated. Hydrocolloids should not be used in infected wounds.

Hydrogels are beneficial in dry wounds as they can help to rehydrate the wound. Hydrogels may be soothing and cooling to the wound thereby decreasing wound pain. Hydrogel alone is not appropriate to use in infected wounds.

Alginates are used in the early phases of healing and help to promote granulation tissue formation. Alginates are calcium rich and can help to provide hemostasis in mildly bleeding wounds. Alginates are now available with honey or silver.

Acemannan is derived from the aloe vera plant. Acemannan stimulates healing by stimulating interleukin and tumor necrosis factor production. Acemannan can be used in the early inflammatory phase and can continue into the repair phase.

Silver is a useful wound dressing. Elemental silver bandages (such as Acticoat by Smith and Nephew) are useful as antimicrobials and promote healing. Elemental silver dressings contain a silver salt. The salt must be converted to a silver ion in order to be active. This is usually accomplished by moistening the dressing. The silver has long acting effects and some silver dressings can be left in place for up to a week. Silver sulfadiazine works in a similar way but in ointment form. Silver sulfadiazine can lead to a decrease in wound contraction; this may be beneficial in locations in which contraction is not desirable (for example over joints).

Fish skins have been in the media for treatment of wounds recently. The concept behind using fish skins as bandage is (in part) the high omega-3 fatty acids found in the skins. When placed on wounds, the fish skins supply this anti-inflammatory fatty acid. A scaffold made from fish skins is an innovative concept to promote wound healing. These decellurized fish skins provide a scaffold upon which the body's cells can grow. In a human study, a reduction of analgesic intake was noted in people managed with the fish skin matrix (Dorweiler b, 2018).

Insulin has been shown to effect wound healing in various animal wound models. The mechanism is not completely understood but insulin accelerates the migration of keratinocytes and vascular endothelial cells. The insulin "turns on" cellular signaling proteins called kinases and a protein that binds portions of DNA that regulate the production of cholesterol.

ADDITIONAL THERAPIES

Before assuming that additional therapies are needed to get a wound to heal, an assessment of the wound should be performed.

Surgical Wounds / Underlying Conditions:

Many surgically created clean or clean contaminated wounds, like spay or laparotomy incisions can be simple to manage. Good technique in wound closure including substantial bites of fascia and closure of dead space will often yield a good result.

Traumatic wounds are diverse. Wound management in these cases may include identifying and treating the underlying cause, for example draining tracts. An atypical or highly resistant infection may cause chronic draining tracts. Also, foreign bodies, tumors, or sequestra may cause draining tracts. Radiographs, cultures, fistulograms, computed tomography, or instillation of methylene blue 24 hours prior to surgery may aid in diagnosis and removal.

Snakebites or other forms of envenomation may lead to extensive tissue necrosis. This tissue necrosis may progress for days. More importantly, snakebites are necessary to diagnose as they can cause life threatening systemic disturbances.

Underlying diseases are important to diagnose and treat. Cushing's disease, steroid therapy, neoplasia, immunosuppression, chemotherapy and radiation therapy are a few of the underlying conditions that should be considered when managing wounds.

Wounds that won't heal:

Some wounds are frustrating and refuse to heal. When a wound refuses to heal despite proper management, several steps should be taken.

Infection should be considered. Even if the wound has been previously cultured and the patient managed appropriately, infection with a different bacteria should be considered. The wound should be re-cultured. The culture should not be a swab, but should be a tissue culture if at all possible. When the culture is submitted to the bacteriology lab, the lab should be notified of any clinical suspicion of "strange bugs". The tissue should be submitted for a variety of "special" cultures such as fungus, mycobacteria, anaerobes, as indicated. Titers may also be appropriate for diseases such as coccidiomycosis.

At the same time as the tissue culture is obtained, the wound biopsy should be performed. Difficult to heal wounds may not be wounds at all. Instead, Pythium could be considered based on geographical location. Neoplasia or other dermatologic diseases should also be considered and ruled out based on biopsy.

Imaging should be performed as appropriate. Foreign bodies, tumors, or sequestra may cause draining tracts. Radiographs, cultures, fistulograms, computed tomography, or instillation of methylene blue 24 hours prior to surgery may aid in diagnosis and removal.

Finally, the veterinarian's concept of "proper management" should be assessed. Is excessive motion present and the patient needs a splint? Are the principles of moist wound healing being adhered to with a covered wound and prevention of desiccation? Is the wound appropriately protected?

Low level laser:

Laser therapy has become popular with suggested benefits including promotion of wound and incision healing, fracture healing, and pain relief. Low level laser therapy is purported to accelerate healing based on biomodulation of the cells. Promising results pertaining to wound healing have been reported in studies using rat models. Other studies have found no difference in wound contraction or epithelization between

laser treated and non-treated wounds. Two dog studies have been performed in recent years involving both open wounds and surgically created wounds (Kurach 2015; Gammel 2018). Both studies found no detectable difference in wound healing between wounds treated with low level laser therapy and those treated by traditional methods.

Hyperbaric Oxygen Therapy:

Hyperbaric oxygen therapy allows patients to inhale 100% oxygen. They are placed in a chamber with an elevated atmospheric pressure in order to increase levels of dissolved oxygen in the bloodstream. The increase in dissolved oxygen in the blood can result in increased oxygen perfusion to tissues. In humans, hyperbaric oxygen treatment of diabetic ulcers, skin grafts, burns and other wounds have been shown to facilitate healing. A recent study was published on the use of hyperbaric oxygen therapy on uncomplicated incisional and open wound healing in dogs (Latimer 2018). This study did not show a difference in healing between dogs undergoing hyperbaric oxygen therapy and those undergoing routine wound management. This finding has been reported before in uncomplicated wounds. Although the hyperbaric oxygen therapy did not speed wound healing in these patients, there is a chance that it could facilitate healing in animals with compromised blood flow / ischemic wounds. In fact, a study performed in rats has shown that hyperbaric oxygen therapy accelerated wound closure of ischemic wounds but idd not influence the healing of uncomplicated wounds (Andre-Levigne, 2016). Therefore, hyperbaric oxygen therapy cannot be discounted for treating complicated wounds in small animals.

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WOUND MANAGEMENT AND HEALING

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Managing wounds can be frustrating, challenging and (hopefully) rewarding. We will cover different types of wounds, different wound dressings, and potential treatments for wounds.

Before discussing specific wounds, we should review wound healing, as this is similar between all wounds and helps to dictate appropriate wound management.

STAGES OF WOUND HEALING

There are four phases to wound healing. These include coagulation/immediate wound reaction, inflammation/debridement, repair and maturation. Different books include different names for the same processes.

Coagulation/ immediate wound reaction:

Coagulation begins immediately after injury. During the coagulation phase, the wound is flushed and cleansed by blood and lymph that are released by damaged vessels. Soon after the wound is flushed by blood and lymph, the damaged vessels vasoconstrict. Tissue mast cells release vasoactive compounds that trigger vasoconstriction. Vasoconstriction is important to minimize blood loss but lasts only about 5-10 minutes. Vasodilation occurs following vasoconstriction. The vasodilation allows intravascular cells and fluid to pass through the vessel wall and into the extravascular space. Platelets arrive at the site of injury and interact with wound fluid and form a blood clot in the wound. During clot formation, a provisional extracellular matrix is formed. This extracellular matrix has binding sites for migrating neutrophils, macrophages and connective tissue cells. Therefore, the clot is important not only for hemostasis and as a barrier to infection, but also as a substrate for reorganization of the wound. During this phase of wound healing, the clot stabilizes the wound edges but the fibrin within the clot provides minimal wound strength. The scab itself does not provide any wound strength and eventually sloughs. The arrival of leukocytes into the wound signifies the inflammatory phase of wound healing.

Inflammatory:

The inflammatory phase of wound healing begins within 6 hours of injury and often partially overlaps with the coagulation phase. Mediators within the extracellular matrix promote margination, adhesion and extravasation of neutrophils into the wound. The neutrophil phagocytizes bacteria and extracellular debris. During phagocytosis of necrotic tissue, proteinases are released by neutrophils. The proteinases attract more neutrophils to the wound. While the neutrophil is abundant in both sterile and infected wounds, it is not essential for wound healing. Neutrophils are short lived and predominate in early inflammation. In older wounds, the monocyte predominates.

The monocyte migrates into the wound with neutrophils in the same proportion as peripheral blood. Monocytes are essential to wound healing and become wound macrophages once they have migrated into the tissues. The macrophage is an important source of growth factors. Macrophages present later in the

wound are important in modification of the provisional extracellular matrix. The provisional extracellular matrix is modulated to become granulation tissue.

Repair:

The repair phase is marked by the invasion of fibroblasts and increased collagen content in the wound. Angiogenesis, fibroplasia, epithelialization and wound contraction occur during the repair phase. Additionally, new endothelial structures are formed within the wound. New capillaries, fibroblasts and connective tissue form the characteristic red granulation tissue of the repair phase. The granulation tissue protects the wound, provides a barrier to infection and provides a surface for epithelial advancement. Granulation tissue also contains myofibroblasts, which are important in wound contraction.

The transition from provisional extracellular matrix to granulation tissue occurs approximately 3-5 days following injury. For this reason, the first 3-5 days are often called the "lag phase" of wound healing. The lag phase indicates a lag in the development of wound strength. The wound strength arrives with fibroblasts and increased collagen content.

Maturation*:*

During the maturation phase of wound healing, the extracellular matrix is remodeled to scar. The cellularity of the wound is decreased as cells die. The collagen bundles are reorganized into thicker bundles with increased cross-linking and orientate themselves specific to the lines of tension. This process of wound maturation can last for months to years.

Wounds never regain their pre-injury strength. At maximal strength, the scar is approximately 70%-80% as strong as normal tissue.

TYPES OF WOUNDS

In veterinary medicine, we manage a myriad of different wound types ranging from surgical wounds and trauma to chronic draining tracts. These wounds can be categorized based on the amount of contamination or infection present. Some of the most commonly seen wounds are surgically created. Surgically created wounds that do not involve a contaminated organ system are considered clean wounds. These wounds were created under sterile conditions and can be closed immediately. Clean contaminated wound can also be immediately closed. These wounds are also surgically created but involve operating a contaminated organ system such as respiratory, alimentary, or urogenital. Contaminated wounds are wounds with significant or gross contamination. They may have 6-12 hours or more of contamination. These include open traumatic wounds. Many of these wounds need some degree of wound management before they are ready for closure. Dirty wounds are considered infected. Dirty wounds include old traumatic wounds, or wounds with active infection. These wounds need wound management before they are ready for closure.

INITIAL PATIENT WOUND ASSESSMENT

The patient must be assessed and emergent conditions must be addressed before wound management or further assessment. Hemorrhagic wounds should have pressure applied with a gloved hand or with a pressure bandage. Once the patient is stabilized, a thorough physical examination should be performed and the wound should be evaluated and covered. A protective bandage, topical wound dressing or adhesive bandage can be used to prevent further wound contamination.

Analgesics should be provided to the painful patient before much manipulation of the wound occurs. A neurologic examination should be performed before administration of analgesics if possible. Analgesics may cause respiratory depression.

The wound can typically be assessed within 24 hours. When the patient is stabilized and thorough wound assessment can be performed, the initial bandage is removed. Analgesics and sedation may be administered depending on patient condition and temperament. Open wounds are filled with sterile, water-soluble jelly to protect the wound from further contamination. A large area around the wound should be clipped. The wound is lavaged with sterile saline or a dilute 0.05% chlorhexidine solution. If the wound is near the eye or a mucous membrane, sterile saline should be used and eye lubricant should be applied to the globe. The wound is lavaged with a copious amount of lavage solution. Ideally, the lavage solution is pressurized to approximately 8 psi. Many methods of lavage pressurization have been examined. A syringe with needle has been shown to develop approximately 16 psi. Excessively pressurized lavage solution is avoided as it can drive hair and debris into tissues. A bottle with holes in the lid creates approximately 4 psi. A bag of fluid in a pressure cuff (cuff pressurized to 300mmHg) generates approximately 8 psi regardless of needle size. This is the most reliable method of creating ideal lavage pressure. When gross debris is present, often quantity of lavage is more important than pressure (as long as the pressure is not too high). In these cases, normal tap water can be used or modified lavage bottles.

Ideally, systemic antibiotics are not administered until a wound culture has been obtained. The culture is obtained following lavage of the area and from deeper structures (after superficially contaminated tissue is debrided / lavaged). A tissue culture is preferred to a swab of the wound. Once the culture has been obtained, broad-spectrum antibiotics may be commenced if indicated.

Once the wound is cleaned, it should be probed to assess the extent of injury and to detect pockets or extension of injury. Aseptic technique and sterile instrumentation should be used. The probing should be performed carefully as to not damage deeper structures. Communication of the wound with body cavities and the degree of deep tissue involvement must be determined.

DECISION TO CLOSE

The decision to close a wound is one of the most difficult of wound management. If the wound is already infected or if any question exists about the degree of contamination, tissue viability or vascular compromise, the wound is not closed and instead managed open. A good example of contaminated wounds with questionable tissue viability that should be left open are bite wounds – these are rarely appropriate to close at the time of presentation. Open wound management will allow time for questionable tissues to declare themselves. Additionally, wound management will allow for the wound to be bandaged, debrided and cleaned, if appropriate.

Options for wound closure include: Primary closure; Delayed primary closure; Secondary closure; and Second intention healing. Primary closure is almost always used with surgical wounds. Primary closure is closure within 24 hours of wounding. Primary closure is appropriate with minimal tissue damage, minimal contamination, and adequate local tissue available for closure. Delayed primary closure is performed within 3-5 days of wounding and before the appearance of granulation tissue. Delayed primary closure is appropriate when minimal to moderate tissue damage exists, and minimal to moderate contamination has occurred. The delayed primary closure is performed after the wound has been dressed and debrided for several days. Secondary closure is performed 5 days or longer after wounding. At this time, granulation tissue has formed. The closure timing is chosen when a healthy granulation bed has formed. Second

intention healing is when the wound is allowed to granulate and epithelialize. Any option other than primary closure requires wound debridement, wound management and wound dressing.

WOUND MANAGEMENT

Moist wound healing:

A moist wound environment facilitates healing of the wound by preventing dehydration, enhancing angiogenesis and collagen synthesis and increasing break down of dead tissue and fibrin. Moist wound healing improves aesthetics of wound and decreases pain. Also, it does not increase the risk of infection when compared to dry therapies.

Moist wound healing was introduced in the 1960s. A landmark study was performed showing that pigs epithelialized wounds twice as fast in a moist environment than when allowed to dry (Winter 1962). A human study was performed in 1963 with similar findings (Hinman and Mabach 1963). Moist wound healing is now the standard of care in human medicine.

Debridement*:*

Often, the first step in wound management is debridement of devitalized, dead, necrotic, or infected tissues and foreign debris. Surgical debridement is often utilized for wound debridement. Sedation, general anesthesia or a local nerve block will be required for any debridement beyond very superficial debridement.

Surgical debridement can be performed as en bloc or layered debridement. Layered debridement is the most common approach to wound debridement. The most superficial devitalized tissues are removed and debridement proceeds into deeper tissues as indicated. The decision to debride or leave tissue is based mainly on color of the tissue with black, grey, green or very pale tissues being removed. Bleeding cut edges may indicate survivability. Typically, multiple debridments are performed and questionable tissue can be left for later assessment. En bloc debridement is complete excision of the wound with a border of normal tissue. This is more often used when sufficient local tissue will be present for wound closure.

Mechanical debridement and interactive dressings are other commonly used mechanisms of debridement. Forms of bandaging that can help with debridement are wet-to-dry bandages, hydrogels, hydrocolloids, and alginates. A main benefit of hydrogels, hydrocolloids and alginate bandages over wet-to-dry is that they maintain moisture over the wound. These wound dressings enhance autolytic debridement of wounds and, by keeping the wound moist, stimulate healing. Unfortunately, excessive moisture can lead to tissue maceration.

Mechanical debridement is most often performed with a wet-to-dry bandage. Wet-to-dry bandages are usually changed daily before there is "strike through" of wound fluid. The wet-to-dry bandage is easy and inexpensive to construct. A moistened gauze sponge is placed onto the wound. Then, layers of gauze and bandaging material are placed over the top. The bandage can be made a tie-over bandage if the wound is located on the trunk. It can be incorporated into a modified Robert Jones bandage if the wound is located on a limb. The wet gauze dries with time. Debris and necrotic debris adhere to the gauze sponge and are removed when the bandage is changed. The wet-to-dry bandage is non-selective, will damage granulation tissue as it forms, and is painful. Therefore, once a healthy granulation bed is formed, wet-to-dry bandages are no longer needed.

Enzymatic debridement methods are used less often. Enzymatic debridement uses proteolytic enzymes to removed necrotic tissue and debris. There is little advantage over surgical or mechanical debridement.

Further Treatment:

Drains have a place in wound management but are not necessary in many wounds. Drains are avoided if not necessary because they are associated with disadvantages/complications including: increased infection (the drain allows a retrograde conduit for bacteria to enter the wound), erosion of adjacent structures, adhesion to adjacent structures, increased incidence of dehiscence / incisional hernia when exiting the primary incision, premature loss or retention (chewed off by pet), obstruction of drain, pain. There are situations where drains are indicated such as a large amount of dead space that cannot be closed, draining abscesses, puncture wounds with pockets that cannot be opened, etc. In clean wounds (either surgically created or a healthy granulation bed) in which dead space can be adequately closed, drains are often unnecessary. Two main types of drains exist: active and passive. Active drains apply negative pressure drawing fluid out while passive drains rely on gravity to draw fluid out.

In general, drains should not be placed be placed immediately beneath the incision. The drain can irritate the incisional site, interfere with healing, and may accidentally become entrapped in one of the skin sutures making removal of the drain difficult. Drains should not exit through the incision site; instead they should exit through separate stab incisions. Penrose drains act by capillary action, allowing fluid to flow over the outer surface of the drain. The penrose drain works with the help of gravity and the exit for the penrose must be placed in the most ventral portion of the wound. Penrose drains must be bandaged as they allow direct communication with the wound and are an excellent "bridge" for bacteria to use.

Closed suction drains are more effective drains than penrose. As the name implies, the closed suction drains are a closed system between the reservoir and the wound. Because of this closed system, the risk of ascending infection is less than with penrose drains. A negative pressure is applied to the drain to assist in fluid removal and reduction of dead space. The pet should always wear an E-collar when any drain is in place to prevent premature dislodgement or, worse, fracturing of the drain with a portion remaining within the pet.

Simple tube drains are those that are most often used in the thorax. The flow from these drains is mostly intraluminal. These drains can be aspirated intermittently or attached to a suction system (PleuraVac). Red rubber tubes are more inflammatory than other tube types and polyethylene or silicone is preferred.

Many different wounds occur in dogs and cats. Some form of trauma causes most of the wounds we see – whether it is snakebite, burn, car accident, dog bite or surgical wound. All of these wounds must be treated but require consideration of many different wound factors.

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Rumen Anatomy and Physiology
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The ruminant forestomachs are a big living fermentation vat that allow ruminants to convert low-quality roughage into high quality protein and energy for maintenance growth and production. This ability allows ruminants to graze untillable land and utilize feedstuffs not suited for human consumption to produce high quality protein for human food.

I.   Pre-ruminant period (birth to 6 months)
     A.   Gradual transition from monogastric to ruminant
        1.   Proportions of parts of the stomach

	Newborn Calf	Mature Cow
Rumen/reticulum	34%	64%
Abomasum	56%	11%

     B.   Esophageal groove
        1.   Directs milk from the esophagus directly to the abomasum
        2.   Lips in the reticulum contract and form a groove stimulated by milk in the mouth and pharynx -vagal reflex
        3.   Copper sulfate and sodium bicarbonate (10% solutions) cause transient groove closure.
        4.   Stomach tube and esophageal feeders do not cause groove closure

II.   Microflora - Faunation of the forestomachs begins immediately and occurs by contact with mature ruminants
     A.   Bacteria - 10,000,000 to 1,000,000,000,000/ml of fluid
        1.   Gram negative anaerobes predominate especially on a roughage diet
        2.   Types
            a.   Cellulose digesters - gram negative anaerobes
            b.   Starch digesters e.g. *Strep bovis*
            c.   Hemicellulose digesters
            d.   Sugar digesters
            e.   Acid utilizers - esp. lactic acid
            f.   Methanogenic
            g.   Proteolytic
            h.   Lipolytic
            i.   Most B-vitamins are produced by rumen bacteria

Gram positives increase as grain increases *Streptococcus bovis* and *Lactobacillus spp*. are important in ruminal acidosis.

B.   Protozoa
      1.   Isotrichs - cilia all around
      2.   Oligotrichs - cilia on one end
      3.   Variation in size and type signifies a healthy rumen.
      4.   Functions -
            a.   Buffering, detoxifying, digesting
      5.   Protozoa are not essential, but are beneficial

Remember: most of the protein that gets to the intestine of ruminants for digestion is bacterial and protozoal protein. Essentially <u>no</u> sugar gets to the intestine (some starch is broken down there). Most of the energy that cattle use comes from volatile fatty acids (VFA=s) which are produced by rumen fermentation and absorbed through the rumen wall. They are used in gluconeogenesis.

Is the resting blood glucose of a mature ruminant higher, lower or the same as a monogastric?
Do mature ruminants experience a post-prandial hyperglycemia?

III.   Rumen motility
    A.   Functions
        1.   Mixing
        2.   Movement to omasum
        3.   Rumination (regurgitation)
        4.   Eructation (gas)
    B.   Primary Contraction
        1.   Function
            a.   Mixing of contents
            b.   Stratification of contents
        2.   Control
            a.   Under control of the gastric center in medulla oblongata
            b.   No pacemaker - medulla processes inputs to determine rate, strength, usually 2 in 3 minutes
            c.   Biphasic reticular contraction │dorsal ruminal sac │caudoventral ruminal sac │caudodorsal ruminal sac │ventral ruminal sac
            d.   Mixes contents, stratifies and facilitates fermentation and passage of particles
            e.   Stimulants of primary contractions
                (1)   low tension stretch receptors in reticulum
                (2)   cold
                (3)   eating and chewing
            f.   Depression of primary contractions
                 (1)   systemic disease
                (2)   absence of stimulators
                (3)   failure of vagal pathways
                (4)   increased inhibitor inputs - pyrexia, pain, moderate to severe distension, VFA=s, endotoxin, hypocalcemia
    C.   Secondary Contractions
        1.   Associated with eructation. Cardia is cleared.

<div style="margin-left:2em">

2. Frequency 1 every 2 minutes (about every other contraction). Frequency increases with distension.

D. Rumination
1. Cud chewing begins by a month of age
2. Regurgitation, remastication, resalivation, deglutition
3. Occurs up to 8 hours a day - more roughage, more rumination
4. Sign of a happy healthy cow.

E. Movement of feed to omasum
1. Course fiber floats until it is broken down
2. Heavy material (grain) and small fiber sink and is moved into omasum
3. Omasum sieves ingesta and squeezes out water

</div>

IV. Other factoids
A. Normal bovid secretes 100-190 L of saliva/day. Rich in Na bicarbonate. Buffers rumen.
B. Normal rumen pH is 5.5 - 7.0. More grain, more acid.
C. Anorexic cattle have alkaline rumens.
D. Much of the previous discussion applies to horses to some extent, in that the cecum and colon are organs of hindgut fermentation.

Rumen Fluid Lab
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What now?

Once collected, the following tests can be performed to gather information:

Fluid pH – dry chemical analysis (strips). Depending on diet, between 6 and 7.6

Wet mount - microscopic exam – put a drop on a slide and a coverslip over it. Should be lots of activity of all sizes of protozoa

Lugol's iodine test – put one drop of Lugol's iodine on a slide with one drop of rumen fluid and mix gently – examination of a wet mount under a microscope reveals protozoa have "taken up" the dye if they are functioning normally.

Sedimentation rate – put 4-5 mL in a red-topped tube and let it set for 3 to 5 minutes. It should take only 3-5 minutes for layers to form if activity is normal and depending on diet

Redox potential test – put 1 mL of methylene blue dye into 9 mL of fluid in a red-topped tube and shake vigorously….let stand to watch for color removal

Gram stain – to determine the dominant bacterial population (positive or negative)

When the rumen is abnormal, there are changes based on how the environment has changed. When grain overload occurs, the following changes are observed:

    a.   pH becomes acidic (5.5 or below)
    b.   Wet mount: the protozoa are dead, largest species are first, smallest species are last!
    c.   Lugol's – protozoa fail to uptake the dye
    d.   Redox potential – prolonged to clear the color
    e.   Sedimentation rate – prolonged
    f.   Odor is a pungent "foul, soured" smell.

Ruminants that are "off feed" or anorexic for long periods of time usually have a rumen fluid that becomes more basic. The bacterial and protozoal populations do not tend to change much however.

Capnography for Beginners
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Capnography & EtCO2

Capnography is a graphical representation of EtCO2. End tidal CO2 is a measurement of the amount of carbon dioxide leaving the body during exhalation. Along with pulse oximetry, it is a measurement of ventilation. The two parameters should be used in conjunction with each other.

Why monitor?

Capnography is extremely important in appropriately monitoring the anesthetized patient. It provides "real-time" information regarding the ventilation status of the patient, allowing changes to be made in a timely manner. Capnography can also provide a wealth of other information about the patient. The use of this piece of equipment can provide the anesthetist information about the patient's cardiac output and metabolism, as well as an early warning system for equipment malfunctions such as a leak in the system or rebreathing carbon dioxide. It can also be used as an indirect indication of anesthetic depth and even of impending cardiac arrest.

Normal Waveform
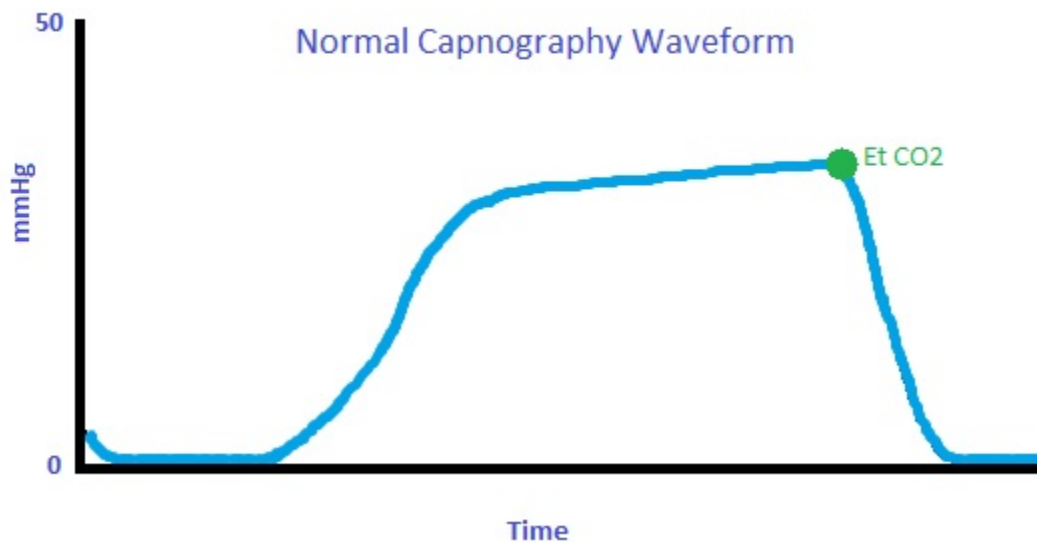
A capnograhy waveform consists of three distinct phases: a baseline, a rise and a plateau. A normal capnogram has a baseline starting at zero, followed by a sharp rise. This rise ends in a plateau with a gradual positive slope. The highest level, EtCO2, is followed by a sharp, almost perpendicular drop and returns once more to a baseline at zero. The area under the waveform represents exhalation and the release of carbon dioxide, while the area above the wave form represents inhalation, when there is no release of carbon dioxide.

The normal range for a healthy patient is considered an EtCO2 between 35 – 45 mmHg. This range may be adjusted based on the individual patient. For example, pediatric patients typically have a slightly higher EtCO2 output due to a faster metabolism. As such, pediatric patients tend to be much more difficult to ventilate and maintain in the 35 – 45 mmHg range. Higher readings are expected and tolerated in these patients (~40 – 50 mmHg). At the other end of the spectrum, patients with known or suspected increased intracranial pressure should be slightly hyperventilated and kept in a lower range (~28 -32 mmHg). Hyperventilation causes the blood vessels in the brain to vasoconstrict, thus preventing further increase in intracranial pressure. Care must be taken to avoid driving the EtCO2 too low. An EtCO2 below ~25 mmHg can actually cause ischemia to the brain due to poor tissue perfusion resulting from extreme vasoconstriction of the blood vessels.

Wave Forms/Trouble shooting

Hyperventilation

In a waveform showing hyperventilation, the wave will plateau at an increasingly lower level. This indicates a decreasing EtCO2. If providing positive pressure ventilation, breathing should be decreased, whether by giving smaller breathes and breathing less often. In a patient allowed to breath on its own, a decreasing EtCO2 coupled with an increase in breath frequency could indicate a pain response. If the respiration rate and size of breath given, or taken, is consistent, a decrease in EtCO2 can indicate a decrease in cardiac output and may correspond to a decrease in body temperature or blood pressure.

Hypoventilation

Hypoventilation is the opposite of hyperventilation. The wave forms plateau at a rising level. This indicates an increased EtCO2. If providing PPV, breathing should be increased, either by giving larger or more frequent breaths. A patient that is breathing on its own maybe "too deep" if the respiration rate is also decreased. Anesthetic plane should be lightened in this patient. If respiration rate and tidal volume is consistent, an increase in EtCO2 can indicate in increase in cardiac output and may correspond to an increase in blood pressure or body temperature.

Cardiac oscillations

Cardiac oscillations are commonly seen in a patient allowed to breath on its own. With this waveform, the decrease to baseline looks like a stair step. This is caused by motion of the heart beating. When the heart beats, it applies pressure to the lungs and forces out a small amount of carbon dioxide. The stair steps coincide with the heart rate. Cardiac oscillations are un-concerning.

Obstruction

The waveform of a patient with a bronchospasm or other partial airway obstruction is characterized by a shark-finned appearance. Instead of a sharp increase and plateau, the wave is a logarithmic function followed by a vertical drop back to base line. When this is seen, the anesthetist should check for a "kink" in the endotracheal tube or breathing circuit. In the instance of a bronchospasm, a puff of albuterol should help.

Rebreathing CO2

A patient that is rebreathing CO2 will have a waveform that does not return to a base line of zero. The most common cause of rebreathed CO2 is because the sodalime in the anesthesia machine has been exhausted and needs to be changed. Another common cause of rebreathing in an inappropriately sized breathing circuit, either the volume or the resistance of the circuit is too great for the patient to overcome.

The patient is unable to fully clear the circuit of carbon dioxide with each breath. A solution for this is to switch to a small breathing circuit or provide the patient with positive pressure ventilation. This waveform may also be seen on an anesthesia machine with malfunctioning flutter valves. Large amounts of condensation can cause the flutter valve on the expiratory side of the machine to stick.

Leak

A capnograph can also indicate a leak in the anesthetic system. A slow downward slope at the end of a breath instead of a sharp decline indicates a leak. The leak maybe in the anesthesia machine itself or at the patient (cuff needs to be inflated). Small blips instead of a normal wave indicate a much larger leak. A sudden drop in the waveform can indicate the f-circuit has been disconnected or the patient has been inadvertently extubated. This is an immediate indication of a potentially serious and deadly situation that otherwise might remain unnoticed until it is too late.

Curar Cleft

A curar cleft or "bucking the vent" is an indication that a patient is being mechanically ventilated has now began trying to breathe on their own. This is shown by a distinct notch in the middle of the plateau portion of the waveform. It is an indication that the patient's plane of anesthesia has lightened or the patient is experiencing a painful stimulus. If a paralytic has been used, this means the medication is wearing off.

Cardiac arrest

The most useful and live-saving benefit of capnography is in its ability to predict a cardiac arrest before it occurs. A sudden drop in EtCO2 can indicate an impending cardiac arrest due to decreased cardiac output. It is important to remember that it may take several minutes for cardiac arrest to show up on an ECG (think pulseless electrical activity) or pulse oximeter, so a capnograph is often the first warning sign that something might be wrong. Because of this, it is imperative to have a capnograph when performing CPR to determine if compressions are adequate and when there is return to a normal rhythm (cardiac output has returned).

ECG for Beginners
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What is an ECG and why monitor?

An electrocardiogram (ECG or EKG) is a recording of the electrical activity of the heart. It is useful as a diagnostic tool in detecting electrical conduction abnormalities in a patient. An ECG is also important as a screening tool to monitor an anesthetized or sedated patient. Monitoring an ECG can give the anesthetist information about the patient's well-being and can alert one to early complications, thus preventing serious injury or even death.

As you remember, the mammalian heart has four chambers. Deoxygenated blood flows from the vena cava to the right atrium through the tricuspid valve into the right ventricle, through the pulmonary valve through the pulmonary artery to the lungs, where it is oxygenated. Oxygen rich blood then flows through the pulmonary vein into the left atrium, through the mitral valve into the left ventricle. Blood is then pumped from the left ventricle through the aortic valve in the aorta. Blood then flows through the aorta to the rest of the body. Similarly, the electrical conduction system of the heart also has a pathway. Conduction starts with an electrical impulse at the sinoatrial (SA) node then goes to the atrioventricular (AV) node. The current then passes to the Bundle of His and finally down the Purkinje fibers.

Using an ECG

Correct placement of leads is important in obtaining a diagnostic ECG. A quick way to remember correct placement for a 3 lead machine is "white on right, smoke over fire" – i.e. the white lead goes on the right forelimb, the black lead on the left forelimb and the red lead on the left hind limb. For a 4 lead machine, remember "snow on the trees", placement is the same as for a 3 lead monitor, but the additional green lead goes on the right hind limb. This arrangement is vital for procuring a diagnostic ECG. When reading ECGs, ensure the monitor is on always on lead II. Lead II crosses the largest portion of the heart and picks up the full rhythm, even if there is an axis shift. When monitoring the anesthetized or sedated patient, the goal is for a screening ECG, not a diagnostic ECG. Because of this, if the normal arrangement is not possible, due to surgery for instance, the position of the leads maybe changed. The important thing to remember is the leads must triangulate the heart. Placing the black and white leads on a patient's ears and the red lead on the front foot will not work because the heart is not crossed. In this case, the red lead may be placed on a hind limb, on the abdomen or even on the patient's tail. Keep in mind that if a lead is placed on a patient's thorax or abdomen, interference from respiration will be seen. It is important to remember placement of the leads, as a deviation from the standard placement can change the appearance of the waveform. If the leads are flipped (the white and black leads placed on the hind limbs with the red lead on a forelimb) the waveform will be upside down.

What does the complex mean?
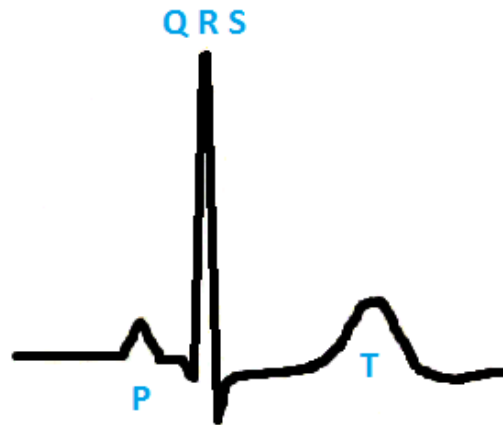
The first wave in the complex, the P-wave, is the depolarization of the atria in response to the SA node. The PR interval, the space between the P wave and the QRS complex, is the delay between the firing of the SA node and the AV node. This delay allows for the ventricles to fill. Next is the QRS complex, this complex is the depolarization of the ventricles which triggers the contractions of the ventricles. The ST segment then follows. This is the beginning of ventricle repolarization. Finally, the T-wave, which shows the actual ventricular repolarization.

Common Rhythms & Arrhythmias

With a normal sinus rhythm, complexes are identical and equal distances apart. Every P wave has a QRS complex and every ORS complex has a P wave. The P wave and the QRS complex are associated. Bradycardia is a slower than normal heart rate, while tachycardia is a faster than normal heart rate. Bradycardia can be seen with certain drugs (such as alpha 2s or opioids), anesthesia or certain illnesses. Tachycardia can be a response to an anticholinergic, pain, poor oxygenation, hypovolemic shock or cardiac conditions.

A commonly seen arrhythmia is a respiratory arrhythmia. With this arrhythmia, the heart rate increases when a patient inhales and returns to normal when a patient exhales. The pressure from the inflated lungs pushes on the vena cava and compromises venous return. To compensate for this, the heart rate increases to maintain adequate blood pressure. This arrhythmia is extremely common with a healthy, athletic dog. It is not common, and worrisome, for cats. This arrhythmia must correlate with respiration.

Atrial premature contractions (APCs) are a premature beat that arises from the atrium. An APC is characterized by a different morphological P wave and a slight compensatory pause. APCs are usually benign occurrences. Ventricular premature contractions (VPCs) are another commonly seen arrhythmia. As the name suggests, this is an early ventricular beat. VPCs can be right sided or left sided, depending on which ventricle the beat comes from. Causes of VPCs include: heart disease, ischemia, pain, neurologic disease, electrolyte imbalances, inflammation and neoplasia. VPCs and ventricular rhythms are commonly seen in patients undergoing a splenectomy or patients with a GDV. Unifocal and multifocal VPCs are possible. Unifocal VPCs look the same because they are coming from the same part of the heart. Multifocal VPCs, which look different from each other, are more worrisome. A heart that is throwing multifocal VPCs is an unhappy heart. Treatment for VPCs is dependent on the cause. While antiarrhythmics, such as lidocaine and procainamide, a used to treat all types of VPCs, a patient that is having VPCs as a response to pain would benefit from the addition of an opioid. It is important to know the difference between a VPC and a ventricular escape beat. Both are ventricular in origin and look

similar, but they are extremely different. A VPC is an early beat, while an escape beat is a late beat. An escape beat occurs in conjunction with an AV block or a sinus arrest. This is a lifesaving beat that allows the ventricles to contract providing blood flow to the body, even when the atria are not firing correctly. Both a VPC and an escape beat will respond to an antiarrhythmic, lidocaine with stop both. Lidocaine will suppress the lifesaving escape beat and the patient will die. Escape beats may also be junctional. In this case, the impulse is supraventricular. The QRS complex is not associated with any atrial rhythm that may occur.

Atro-ventricular blocks (AV blocks) are another commonly seen arrhythmia. This type of block is a disruption in the communication between the atria and the ventricles. There are three degrees of AV blocks, with the second degree block having both a type 1 and a type 2. 1st degree AV block is an elongated PR interval. This block is easy to miss, the ECG looks strange but it is hard to figure out why. This block is not treated and typically does not progress. 2nd degree AV blocks are associated with a "naked P-wave", a P-wave that is not followed by a QRS complex. This is a dropped beat. 2nd degree AV block Type 1, also called Wenckebach, is a gradual increase in the PR interval followed by a dropped beat. This block is commonly seen in patients with increased vagal tone, such as a patient with a neurological disease or a brachycephalic patient. A 2nd degree AV block Type 1 is treated with an anticholinergic such as atropine or glycopyrrolate. 2nd degree AV block Type 2 is a predictable pattern. The PR interval stays the same and a beat is dropped in a regular interval. This is usually related to structural damage in the conduction system of the heart. Sometimes this block is responsive to atropine, if so, the block is due to increased vagal tone and a pacemaker is not necessary. A high grade block will require a pacemaker. 3rd degree AV block is the final, and scariest, AV block. In this block, there is no association between the atria and ventricles. It is a string of naked P-waves with the occasional escape beat (ventricular or junctional) thrown in to keep the heart beating. The only treatment for this type of block is the placement of a pacemaker. The patient in 3rd degree AV block is at risk for sudden death.

Bundle branch blocks can be left sided or right sided. A bundle branch block is characterized by a wide ORS complex. A left bundle branch block has a positive R wave, while a right bundle branch block has a negative R wave. Bundle branch blocks looks similar to VPCs, with a left BBB resembling a right sided VPC and a right BBB resembling a left sided VPC. Bundle branch blocks can be distinguished from VPCs by the presence of a P wave. Bundle branch blocks can result from cardiac disease or changes. A right bundle branch block is seen in a patient who has undergone a ballooning procedure for pulmonic stenosis.

Atrial fibrillation occurs when the atria contract at an abnormally high rate. This can decrease cardia output because the atria are contracting too quickly to allow adequate ventricular filling. The arrhythmia is characterized by narrow QRS complexes with the absence of P waves with an irregular rate. This type of arrhythmia is usually associated with cardiac disease.

Ventricular tachycardia is defined as runs of ventricular beats at over 160 beats per minute. Ventricular tachycardia should be treated with anti-arrhythmic medications. This arrhythmia can progress to ventricular fibrillation which is a fatal arrhythmia.

Surgical Techniques in Exotics and Pocket Pets
Part I –From Presentation to the OR
Mark Stickney

POCKET PETS

Pocket pets (rodents, hedgehogs, ferrets, rabbits) may present for elective and non-elective surgery. Examples of elective procedures include ovariectomy/ovariohysterectomy, castration, and anal sacculectomy.   Examples of non-elective surgery include foreign body removal, enucleation of a proptosed eye and repair of traumatic injuries. Diagnostics that may be performed prior to surgery include the physical exam, bloodwork, radiographs, ultrasonography, CT and/or MRI.

Proper physical restraint is necessary to prevent harm and minimize stress to the patient and safety to the doctor performing the exam. Docile rats and mice may require only minimal restraint by firmly grasping the base of the tail and allowing the animal to rest in the opposite palm. Alternatively, the patient can be restrained by gently grasping the neck immediately caudal to the head between the index and middle finger and wrapping the rest of the hand across the dorsal surface of the animal. Larger exotic pets like ferrets and guinea pigs may be picked up with one hand around the thorax while the other hand supports the hind end. Less tractable patients may be wrapped in a towel initially to gain control and then examined in sections as they are uncovered. Rabbits can be held behind the front legs while the rear legs are supported. Rabbits must not be allowed to kick into the air due to the risk of vertebral trauma. Hedgehogs that will not unroll may be placed in a shallow pan of warm water. Take care that the nose and mouth remain above water. Once unrolled, allow the hedgehog to walk across a towel and lift the hind legs off of the towel. The hedgehog will continue to grasp the towel with the front legs and be unable to roll up.

 Normal vital signs for select small exotic pets:

Species	Temperature	Heart rate	Respiratory rate
Rat	96.5-99.5 F	300-550	70-120
Guinea pig	101.5-103 F	230-380	42-104
Rabbit	99.1-102.9 F	135-325	30-60
Ferret	101-103 F	180-250	30-40
Hedgehog	95.7-98.6 F	180-280	25-50

Blood may be difficult to draw from most pocket pets without anesthesia or sedation. Most small exotics find blood sampling very stressful. Sedation should be considered.

Venipuncture sites for representative species are:

ferrets	Cephalic, lateral or medial saphenous, jugular, cranial vena cava	Cranial vena cava only when sedated
rabbits	Jugular, cephalic, lateral saphenous, cranial vena cava, marginal ear vein	Cranial vena cava only when sedated; ear tip may slough when using ear vein
rodents	Tail vein, jugular, cranial vena cava	Cranial vena cava only when sedated

Accurate body weight of the patient is essential. Body weight will determine the maximum amount of blood that can be collected. Blood samples of 0.5ml per 100g is considered safe (10 drops per 100g). Collected blood should be placed in green-top micro-blood collection tubes. These contain lithium

heparin and the sample may be used for both hematology and chemistry analysis. Abaxis chemistry analyzers are designed to provide blood results with small volumes in exotic species.

An intravenous catheter is necessary for administering medications and fluids prior to, during, and after surgery. Subcutaneous fluids may be required to increase vascular volume to facilitate IV catheterization. Effective catheter sizes range from 23 to 25 gauge. Rabbits, ferrets, and guinea pigs can usually have a catheter placed in a cephalic vein. Jugular veins can be difficult to maintain catheter placement. The auricular vein of the rabbit is located on the lateral edge of the ear and may be useful for catheter placement. However, this may cause the tip of the ear to slough. Rats, mice, and other species may not be able to accommodate an intravenous catheter. In these cases, an intraosseous catheter may be placed. Placement of an IO catheter is painful and stressful for the patient. The animal should be heavily sedated or anesthetized at the time of placement. IO catheters may be placed in the femur, humerus, or tibia. Spinal needles are useful for IO catheters because the stylus prevents a bone plug from occluding the catheter.

Sedation and premedication reduce stress in the exotic patient, provide analgesia, and decrease the amount of inhalant or induction agent required to induce anesthesia. A midazolam/buprenorphine combination can provide excellent sedation

hedgehogs	Midazolam 0.25 -0.5 mg/kg sq	Buprenorphine 0.01-0.5 mg/kg SQ
ferrets	Midazolam 0.25-0.5 mg/kg sq	Buprenorphine 0.01-0.05 mg/kg SQ
rodents	Midazolam 1-2 mg/kg sq	Buprenorphine 0.05-0.2 mg/kg SQ
rabbits	Midazolam 0.5-2 mg/kg sq	Buprenorphine 0.05 mg/kg SQ

Intravenous fluids will help to maintain blood pressure under anesthesia, correct underlying dehydration and some electrolyte abnormalities in an emergency setting. Fluid administration will also aid in keeping a small gauge catheter patent.

Intubation of pocket pets can be challenging and may not be possible in particular patients. Intubation can be assisted using a rigid urinary catheter and sliding the endotracheal tube over the catheter. If intubation is not possible, a tight fitting mask can be used to maintain anesthesia. Unlike intubation, anesthesia via mask does not allow for controlled breaths of the patient. Delivery of inhalant is entirely dependent on the respiratory rate of the patient in these cases. A V-gel® is made specifically for rabbits. It is designed to occlude the oral cavity facilitating controlled breathing and eliminating loss of inhalant around the device. Pediatric f-circuits or Bains systems can be used to facilitate delivery of gases from the anesthesia machine. Because of the high flow rates required with Bains systems, hypothermia is likely to be an issue throughout surgery. A surgical plane of anesthesia can usually be achieved setting the vaporizer at 2-3% with isoflurane and 3-5% with sevoflurane. Local blocks can help reduce the amount of inhalant needed to maintain a surgical plain of anesthesia.

Vital signs may be monitored with common instrumentation. Blood pressure is best measured using a Doppler unit in order to obtain accurate readings. A mean arterial pressure greater than 60 mm Hg is necessary to ensure tissue perfusion.

Food should be withheld for 2 hours prior to surgery. Water should be available at all times.

Strict attention to asepsis is absolutely required to minimize the risk of post-operative infections. A WIDE clip of the surgical area is essential to eliminate hair contamination of the surgical site. When clipping, special care must be taken not to abrade or lacerate the skin. Perioperative antibiotics are

indicated and will vary depending on the species and specific procedure. Clear adhesive drapes allow for the formation of a continuous sterile field and maximize visualization of the patient for surgical landmarks and anesthetic monitoring.

REPTILES

Snakes, lizards, turtles and tortoises present unique challenges when preparing for surgery. Most of these challenges relate to physiological factors that make reliable sedation and anesthesia difficult. Diagnostics that may be performed prior to surgery include the physical exam, bloodwork, radiographs, ultrasonography, CT and/or MRI. Proper physical restraint is necessary to prevent harm and minimize stress to the patient and safety to the doctor performing the exam. Small lizards can be restrained by gently grasping the neck immediately caudal to the head between the index and middle finger and wrapping the rest of the hand across the dorsal surface of the animal. Larger lizards may be wrapped in a towel initially to gain control and then examined in sections that can be uncovered. Snakes may be examined by gently grasping immediately caudal to the head and supporting the remainder of the body. Chelonions may be difficult to examine until sedated or anesthetized. Normal vital signs for reptiles are highly variable and dependent in part on environmental factors.

Blood may be drawn from most reptiles without the need for anesthesia or sedation. Reptiles can tolerate blood loss of 0.4 ml to 0.8 ml per 100g of body weight.

snakes	Ventral tail vein, cardiocentesis
lizards	Ventral tail vein
Turtles/tortoises	Jugular vein, femoral venous plexus, dorsal tail vein

Placement of an intravenous catheter is rarely achievable. Intraosseous catheters must often be relied upon. Placement of an IO catheter is painful and stressful for the patient. The animal should be heavily sedated or anesthetized at the time of placement.

Soaking reptiles is an effective means of increasing fluid volume as the water is absorbed through the cloaca. Water should be warm, but not hot.

Sedation and premedication are important for reducing stress in the exotic patient, analgesia, and lowering the amount of inhalant or induction agents required to induce anesthesia. Injections given to reptiles must be given in the cranial half of the body to prevent first pass metabolism by the renal portal system and loss of efficacy.

Intubation of reptiles is generally uncomplicated. The glottis is separate and rostral to the esophageal inlet making it easy to visualize. Endotracheal tubes should be non-cuffed or the cuff should not be inflated to prevent tracheal trauma. Pediatric f-circuits or Bains systems can be used to facilitate delivery of gases from the anesthesia machine. Because of the high flow rates required with Bains systems, hypothermia is likely to be an issue throughout surgery. Reptiles usually become apneic during anesthesia. Ventilate the patient 3-6 times per minute to maintain a stable plane of anesthesia. Anesthesia can be maintained at 1-3% isoflurane or 3-5% of sevoflurane at a flow rate of 1 liter per kilogram of body weight.

Surgical Techniques in Exotics and Pocket Pets
Part II –From the OR to Recovery
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Careful, accurate and attentive monitoring of vital signs is paramount during and after surgery. Maintaining normal physiological parameters to the highest degree possible will minimize anesthetic complications during the operative period and hasten post-operative recovery.

POCKET PETS

Vital signs may be monitored with common instrumentation. Blood pressure is best measured using a Doppler unit in order to obtain accurate readings.   A mean arterial pressure greater than 60 mm Hg is necessary to ensure tissue perfusion.

Adjustments to the level of inhalant is one of the most effective means of correcting bradycardia and hypotension. However, changes to inhalant gas will require up to 5 minutes to produce a noticeable change. Fluid boluses may be effective in improving blood pressure, but might be limited in effectiveness due to catheter size or type (IV vs IO).

Hypothermia is a leading cause of adverse anesthetic events in pocket pets. Pocket pets have a greater surface area to body weight ratio compared to larger domestic species. As a result, they will experience changes in body temperature more rapidly. Prevent hypothermia by using external warming devices such as warming blankets and warm air circulators. The operating room should be kept at a warmer temperature to help offset hypothermia in the patient.

TABLE

Useful items for exotic animal surgery include:

Small balfour retractor	Small/ophthalmic instruments
Transparent drapes	Light sources
Magnifying loupes	Electrocautery, CO2 laser, radiocautery
hemoclips	Tenotomy scissors
Lonestar retractor	3-0 and 4-0 suture

Patients must be carefully monitored for signs of pain and dysphoria following surgery. Inadequately controlled pain is a cause of morbidity and mortality secondary to anorexia and GI stasis. Pain also decreases the speed of tissue healing and increases susceptibility to infections secondary to catecholamine release through the hypothalamic-pituitary-adrenal system. Patients should be recovered in a warm, dark, confined space and offered food and water within 2 hours after surgery if appropriate. Incubators are ideal for recovering pocket pets because they are difficult for patients to escape from, can be controlled for temperature and humidity, dampen ambient sound, and can be covered to reduce stress. The patient should be eating within hours after surgery.

Analgesics for select species

SPECIES	MELOXICAM	BUPRENORPHINE
hedgehogs	0.08-0.2 mg/kg SQ,PO q24h	0.01-0.5 mg/kg SQ,IM q6-8h
ferrets	0.01-0.05 mg/kg oral,SQ,IM,IV q6-12h	0.1-0.3 mg/kg PO,SQ,IM q24h

rodents	1-2 mg/kg PO,SQ q24h	0.05-0.1 mg/kg PO,SQ q12h
rabbits	0.2 mg/kg PO,SQ,IM q24h	0.01-0.05 mg/kg SQ,IM,IV q6-12h

Self-trauma is a possibility with any patient. Intradermal (subcuticular) sutures should be placed when closing skin. Small rigid e-collars or soft recovery collars are effective for many pocket pets. Vests/shirts made of stockinette and cast padding are useful for flexible animals such as ferrets. In extreme cases, the e-collar can be sutured to the homemade vest.

REPTILES

Reptiles are poikilothermic and body temperature will be dictated by the temperature of the surgical suite and the efforts of the technical staff during surgery. A temperature goal should be the upper limit of the preferred temperature of the particular species.

When operating on lizards, incisions made off of the ventral midline avoid the ventral abdominal vein. In cases where a midline incision is preferred care must be taken to identify the abdominal vein and gently retract it laterally. Incisions in snakes may be made between the first and second rows of lateral scales. A paramedian incision also helps to prevent contact of the incision with substrate. The coelomic cavity is closed in 2 layers; the musculature and the skin.

Reptiles are able to absorb most suture materials. Polydioxanone, Polyglactin 910, and Poliglecaprone 25 are excellent absorbable suture choices in these animals. Where appropriate hemoclips are preferred for permanent ligation as they save time and reduce the risk of hemorrhage. Skin must be closed in an everting pattern to allow the dermis on either side of the incision to be in direct contact. Surgical staples may be used in place of suture because they have a tendency to evert the skin edges. Due to the slower metabolism and rate of healing compared to mammals, suture placed during surgical procedures should not be removed for at least 6 weeks. Any suture that remains after 2 sheds should be removed.

 Assisted ventilation must continue post-operatively until the reptile is able to spontaneously breathe. This may take hours and can be hastened by placing the patient in a warm environment.

Reptiles heal at the fastest rate when maintained at the upper limit of their preferred temperature. Reptiles rarely self-mutilate, but the surgical site must be kept clean and dry and should be checked for signs of infection daily.

Meloxicam (0.1-0.5 mg/kg PO,SQ, IM q24-48h) and morphine (0.5–2 mg/kg SQ, IM) have been shown to provide effective pain control in reptiles. Doses of morphine higher than 1 mg/kg may cause profound sedation. Injections should be given in the cranial half of the body to avoid the first pass effect of the renal portal system.

Intramuscular injection locations

Turtles, tortoises	Front limb
snakes	Epaxials in cranial half of body
lizards	Front limb

POST OPERATIVE MANAGEMENT OF THE AVIAN PATIENT

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INTRODUCTION

Surgery in the avian patient is a stressful experience for all involved, the owner, the veterinarian and the bird. Every aspect of the experience is critical to a positive outcome. The initial history, the physical exam, pre-operative work up, fasting, choice of anesthesia and last but not least post-operative care. It is a frustrating situation to have performed a great surgical feat, to then not have the bird wake up or to mutilate or injure the site post-operatively or to develop an infection post-operative because the owner could not medicate the bird properly. Depending on the bird and the surgery needed and the abilities of the owner, every case should be looked at on an individual basis There are many things you can do both before surgery and after to maximize your post-operative success. The species of bird is a critical factor; a chicken is much less likely to chew off a bandage than a parrot. A hand raised parrot who steps up will typically be easier to medicate than a raptor or a canary, water fowl may have to be removed from the water for extended periods of time. Even different parrots behave differently in stressful situations. An African grey parrot or Meyers parrot is often a much more nervous and phobic bird than many macaws and cockatoos. Many owners can do almost anything with a hand raised cockatoo, but an Amazon parrot is much more difficult to handle. A detailed well thought out plan is necessary when you're planning a surgery on a bird.

Things to consider include: species, overall health, nutritional status, is it a captive or wild, does it live with other birds or is it housed alone, is it a water bird, is it flighted, will it need to be bandaged, and can the owner handle or medicate the bird? I have divided the post-operative period into 3 stages: the immediate post-operative period (recovery from anesthesia), the second stage of post-operative care (in hospital) and the third stage of post-operative care (at home).

IMMEDIATE POST-OPERATIVE PERIOD

The immediate post-operative period when the bird is waking up from anesthesia is a critical time for monitoring. A very significant number of surgical deaths occur during this immediate post-operative period- after your surgery has been completed and the last suture placed. The bird should not be left alone at this time. Patients should be recovered in a quiet area (away from loud animals, other birds, and multitudes of people). I prefer a hands on approach to recovery in birds. Respiratory rate and heart rate should increase as the birds anesthetic depth lessons. As the bird gets lighter monitoring equipment may be removed along with its intravenous (IV) or interosseouss c (IO) catheter if they will not be needed for fluid therapy post surgically. As the bird continues to recover and begins to open its eyes, it may also go through an excitatory stage where it may begin to flap its wings or bite. At this time the endotracheal tube should be pulled and the oral cavity and glottis examined for excess mucous or regurgitated food. A towel may be wrapped gently around the bird to prevent the bird from injuring itself. As they awaken they may pull at their IV or IO catheter if it's been left in or bite at their surgical site or bandage if they have one. The bird should be monitored directly until fully awake and standing and at all times monitoring for the presence of pain. Signs of acute pain may include vocalization, aggression (biting, attacking) or rapid respirations. Once they have recovered from the anesthesia and are standing they should be in a visually secure area and kept warm (temperature dependent on species). Then the second stage of the post- operative care begins.

SECOND STAGE OF POST-OPERATIVE CARE (IN THE HOSPITAL)
The second stage of post-operative care includes fluid therapy, nutrition, monitoring bandages to be sure they are placed appropriately, and monitoring the bird for chewing or mutilating the bandage or surgical site. A collar may be necessary short term, but only after all other attempts have failed to decrease mutilation or damage to a surgical site or bandage. The author has found that most birds do not chew at their incisions postoperatively if their pain is managed and minimal tissue trauma has occurred. Other factors that may influence post- operative care is choice of suture, with smaller, softer suture such as polyglactin 910 (vicryl) being less reactive. Although collars may be necessary in some instances, they are an added stress, they may affect the birds' ability to eat normally and result in abnormal behaviors due to the collar itself which may make assessing the bird post-operatively for pain more difficult. For example birds with collars may be quieter, less active and more depressed. Conversely, they may be highly agitated and thrashing about on the cage floor. Either situation makes monitoring for pain more challenging.

Post-operative medications are a critical component of the recovery process. Analgesics, antibiotics, antifungals may all need to be given. At this stage the bird may not be eating and drinking normally so offering favorite foods or tube feeding may be necessary to maintain their nutritional needs. Adequate intake of fluids is important, especially if giving non-steroidal anti-inflammatories which can cause renal damage in dehydrated animals. Signs of dehydration include decreased skin turgor, sunken eyes, dry oral mucous membranes and weight loss. Turgor and filling of the basilic (wing) vein can be helpful in assessing hydration. The normal filling time of the basilic vein is less than ½ second. Maintenance fluid requirement for most birds is 50-100ml/kg/day, although it is generally acknowledged that there is a significant variation amongst species with desert species needing less and species from the rainforest needing more. Oral fluids can be offered or gavaged or subcutaneous (SQ), IV or IO fluids may be necessary for adequate hydration. SQ fluids are most commonly utilized in birds due to ease and rapid absorption. The author's administration site of choice is the inguinal skin web between the knee and body wall, as this is typically the site where the largest amount of fluid can be administered (up to 5% of body weight). Warm lactated ringer's solution or Normasol are commonly used fluids in birds. If at all possible I do not like to leave IV or IO catheters in place post-operatively, but occasionally it is necessary and may require bandaging of the catheter site or a collar to protect the catheter till it's removed. Maintaining a continuous flow rate can be challenging, unless the bird is recumbent they will often bite any excess tubing present. Boluses of up to 10ml/kg may be given over 5 to 10 minutes to rehydrate. IO catheters are a quick and easy way to administer fluids and can be placed in even severely dehydrated patients, and uptake from the bone marrow is comparable to that of an IV catheter. But IO administration is painful especially if fluid is administered rapidly or if the catheter is used for over 24 hours.

During this stage of the post-operative period the bird will continue to need to be monitored for evidence of pain. Post-operative pain management is critical for the bird's mental and physical well-being. Adequate analgesia will decrease potential picking at the surgery site and mutilation and will encourage the bird to resume normal behaviors such as preening and eating. Options for pain medications include injectable and oral solutions. Depending on the surgery, pain management may require only a non-steroidal anti-inflammatory or if a more painful procedure (such as bone surgery) an opioid may also be warranted. For most birds I prefer to give oral analgesics if possible. A combination of non-steroidal anti-inflammatory drugs (NSAID's) and an opioid are my first choice. If there is potential for neurogenic pain (like an amputation), I will give gabapentin.

ANALGESIA IN THE POST- OPERATIVE PATIENT
Determining the presence of pain in birds can be challenging. Different species of birds may respond differently. Most birds are prey animals and as such tend to mask signs of pain and illness. Increased heart rate and respiratory status may be indicators of pain, but can also be indicators of fear and stress. Also the personality of the bird and its comfort level with new people may result in a quieter or more aggressive bird rather than pain being a factor. Acute pain is typically more easily recognized: vocalization or withdrawal when a painful limb or lesion is touched. Trembling of the affected limb can be an indicator of pain and often occurs post orthopedic procedures. Biting or chewing at the affected limb or lesion or the bandage may indicate discomfort. Anorexia and decreased grooming may also be present in painful situations, but again may also occur during times of stress and fearfulness. Because it is so difficult to interpret whether a specific behavior is pain or stress or fear it is generally recommended that if a procedure is considered painful in humans and requires pain management, we should assume that it is also painful and requires pain management in birds.

NON-STEROIDAL ANTI-INFLAMMATORIES
NSAID's interfere with eicosanoid synthesis by inhibiting cyclooxygenases (COX) enzymes resulting in a reduction of prostaglandins and thromboxanes which decreases inflammation at the site of an injury. NSAID's are commonly used in conditions associated with acute and chronic pain. NSAID's are often used in combination with other forms of analgesia (opioids, gabapentin, or local anesthetics) to provide a synergistic analgesic effect.

OPIOIDS
Opioids work by binding reversibly to specific receptors in the peripheral and central nervous system. Opioids are classified by the type of receptor to which they bind (Mu, Kappa, and Delta). Mu opioids (morphine, fentanyl, buprenorphine) are most commonly used in mammals. But studies in pigeons have revealed that pigeons have more kappa receptors in their forebrain and additional studies have revealed that parrots respond to the analgesic effects of kappa opioids but not to Mu opioids. Butorphanol has been the Kappa agonist most studied and has provided the most reliable analgesia in the parrot to date. Recent data supports raptors may respond better to mu agonists such as buprenorphine. Tramadol is a relatively new opioid that provides analgesia by opioid (Mu), serotonin and norepinephrine pathways, with minimal adverse effects that has anecdotally provided pain relief in birds. Tramadol has the added advantage in that it comes in an oral suspension.

LOCAL ANESTHETICS
Local anesthetics interrupt the transmission of pain impulses by blocking ion channels. Preoperatively, local anesthetics can block the site of tissue manipulation, trauma, helping to prevent central sensitization. Lidocaine and bupivacaine are applied through regional infiltration, local line blocks and/or "splash' blocks. Remember that lidocaine is absorbed and has systemic effects. The author only uses local anesthesia in conjunction with other forms of sedation or anesthesia (injectable or inhalation) due to the stress associated with the restraint necessary for a procedure done utilizing only a local block. Although as more and more birds are being trained to accept medical treatments such as injections thru positive reinforcement training, local anesthetics may become more practical as the sole source of anesthesia for simple procedures in the future.

OTHERS
Gabapentin is a gamma-Amino butyric acid (GABA) agonist. It has been used to relieve neuropathic pain

in mammals and more recently in birds. Although there have been no controlled studies on this drug in birds, anecdotally there have been positive clinical responses.

Drug	Action	Dose
Carprofen (Rimadyl)	NSAID	1-2 mg/kg IM, SQ, PO q12-24h
Meloxicam	NSAID	0.5-1.0mg/kg PO or IM q12-24h
Celecoxib	NSAID	10-15mg/kg PO q24h
Piroxicam	NSAID	0.5mg/kg PO q12h
Ketoprofen	NSAID	2 mg/kg IM q8-24h
Butorphanol	Opioid (kappa agonist)	Parrots: 1-3mg/kg IM q4h Raptors: 0.5mg/kg IM q4h
Buprenorphine	Opioid (mu agonist)	Raptors: 0.1-0.6mg/kg IM q6h
Tramadol HCL	Opioid (mu agonist)	5-10mg/kg PO q6-12h
Gabapentin	GABA agonist	10-25mg/kg PO q12h
Lidocaine	Local anesthetic	1-3mg/kg (dilute 1:10)
Bupivacaine	Local anesthetic	1mg/kg infused SC

THIRD STAGE OF POST-OPERATIVE CARE (AT HOME)

Once the bird is eating, drinking and taking medications in the hospital it is time for the third stage of post- operative care. This is when the owner takes the bird home. At this point the owner has to be taught how to monitor the incision site or the bandage and keep the bird from picking at the site or damaging its bandage. The owner also has to be able to medicate the bird safely for both the owner and the bird. The owner needs to know how to handle the medications, are they refrigerated? Do they need to wear gloves? The owner needs to know how to handle the bird without injury and also without stressing the bird and affecting their long term bond. Can the bird be out of its cage, does it need to be in a smaller cage for recovery? Can it be housed with its mate or does it need to stay alone?

A different post-operative home cage is often necessary. The owner needs to be advised of this prior to surgery if possible or at least while the bird is in the hospital so the owner can have it ready for the bird at discharge. In some cases a smaller wire cage is adequate; if you do not want the bird climbing a solid wall cage (plexiglass) may be needed. Lower perching may be needed and repositioning of food bowls for easier access may be necessary. If the bird is difficult to handle a smaller cage with few perches may help with handling and medicating. This is even more important when you're dealing with raptors, chickens or water fowl who may be housed outdoors and who need to be housed indoors post-surgery. Housing raptors, chickens and waterfowl even short term in nontraditional caging can lead to bumblefoot issues, so flooring and perches have to be padded and kept clean. If the birds do have to be housed outdoors, the caging has to be fly proof or the wounds may become infested with maggots. When caring for flighted birds such as raptors that will be released back into the wild or captive birds who are housed in flight cages, protecting the flight and tail feathers is important. Birds should be maintained in proper caging with perching that doesn't allow feathers to be damaged by bars and tail sheaths should be placed on raptors.

Enrichment may be helpful in distracting the bird from its discomfort and from the stress of not being in its regular enclosure. In an ideal situation the bird will already have been exposed to a variety of enrichment items prior to surgery, but if not, there are still things that can be done to improve the post-operative experience. Offer favorite foods and treats, including novel things to chew on: pine cones, phone books, paper towel rolls, branches.

Birds, overall do not like bandages, so if possible I do not use them. If the bird has a history of plucking, mutilating or begins to pick at the surgery site or at the sutures, I will place a bandage and if absolutely necessary a short term collar. I prefer the tube collars to the Elizabethan collars. If a tube collar is not sufficient, the leather E. collars seem to be better tolerated than the wide plastic ones. Birds with bandages should be checked by the veterinary staff or veterinarian twice a week or sooner if there are any problems: swelling of the limb, discharge around the bandage, damage to the bandage. For fracture repair surgeries and associated bandaging, passive range of motion will need to be done two to three times a week. Depending on the bird and surgical site, sedation or general anesthesia may be necessary for physical therapy. Physical therapy may be necessary for other surgical procedures that may involve a joint or limb that could lead to loss of range of motion. Passive range of motion should be performed 2 to 3 times a week, for waterfowl swimming may be the best form of physical therapy. Ultrasound therapy has been used to reduce contractures in wings from bandaging and surgical repair.

Medicating birds is another critical component of post-operative care. In some species like raptors, ducks and chickens medication in the foods may be successful. Parrots may take medications in some foods and treats, but often they need to be given the medications directly. If at all possible, teaching parrots and other birds to target and take oral medications from a syringe will make medicating less traumatizing for the bird and the owner. Other medical training behaviors that can be taught in a reasonable length of time that may make post-operative care less stressful are teaching the bird to accept a towel being wrapped around it and stepping onto a scale. In a personal experience with my own bird that had a fungal granuloma in his sinus, I was able to use positive reinforcement techniques to teach him to accept a sinus flush prior to his surgery to make his post-operative care less stressful.

COMMUNICATION WITH CLIENT

An important aspect of postoperative care is a detailed discharge summary, with all medical and therapeutic guidelines discussed, the medications, potential side effects and recheck times recorded. Following up with the owner at home to check on the bird is also important, often owners think things are going well, when something said in a phone conversation may determine that there is a problem. Communication with the owner cannot be over emphasized in the successful postoperative plan.

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RABBIT AND RODENT DENTAL DISEASE

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Rabbit Dental Disease

Dental disease in pet rabbits is a commonly seen manifestation. Etiology is considered by most to be congenital or acquired. Congenital disease includes jaw malformation and occurs most commonly in the brachiocephalic breeds. Acquired disease is often related to nutrition or trauma. Nutritional issues include lack of fiber (Hay) resulting in inadequate wearing of the teeth and inadequate diets (seed, nuts, too many fruits) leading to metabolic bone disease. Trauma includes chewing on inappropriate items (metal bars, wood in cage) and falling and breaking teeth.

Anatomy

Familiarity with the normal anatomy and physiology of rabbits is critical for proper diagnosis and treatment. Rabbits have continuously growing, open rooted (elodont) incisors and cheek teeth. The dental formula is I 2/1 C 0/0 P 3/2 M 3/3. The molars and premolars in rabbits are indistinguishable and are commonly called "cheek teeth" There are two pairs of upper incisors (maxillary) and one pair of lower (mandibular). The second pair of incisors are small "peg teeth' and sit behind the upper incisors. The space in between the incisors and cheek teeth is the diastema.

Clinical signs

Clinical signs of dental disease in rabbits include decreased food intake or anorexia, dysphasia, excessive salivation, epithelia, exophthalmos, facial swellings, inability to fully close mouth, pain on manipulation of mouth or jaw, respiratory signs (nasal discharge or dyspnea), and changes in feces (size, consistency, quantity). Rabbits that develop dental disease are often obese, although the disease process can lead to rapid weight loss.

Dental disease can lead to secondary disease processes which include: dewlap dermatitis, ocular diseases, gastric stasis and impaction, bloat and periapical abscesses. Rabbits being a prey species will often hide signs of illness, making early diagnosis difficult. Often on presentation to the veterinary clinic, the rabbit is much sicker and has been sick longer than the owner realizes.

Etiology

Any process interfering with the normal growth or grinding of the incisors, cheek teeth or both can result in dental disease. Dental disease of the incisors can be primary or secondary to cheek teeth disease. Elongation of the incisors can prevent proper occlusion of the cheek teeth and result in overgrowth and formation of points or spurs.

Metabolic bone disease (MBD) has been proposed by some specialists as a potential cause of acquired dental disease. There have been studies that have demonstrated low calcium levels, elevated PTH levels and demineralization of skull bones in severely affected rabbits. The MBD produces demineralization of the bone, resulting in changes in the skull and structure of the teeth, interfering with normal occlusion and wearing of the teeth.

Insufficient wearing of the continuously growing teeth is the most widely proposed theory for acquired dental disease, based on evidence that rabbits on a pelleted low fiber diet do not chew in the

same fashion as wild rabbits or captive rabbits eating large amounts of grass hays. Abnormal wearing results in elongation of the crowns and formation of points on the medial and lateral aspects of the cheek teeth with possible soft tissue damage. Elongated incisors can penetrate into the soft tissues of the lips, the mucosa of the cheeks or the hard palate. Elongated cheek teeth can cause soft tissue damage to the mucosa of the cheeks or the tongue. Pressure on the tooth roots from elongated cheek teeth can cause bending and rotation of the tooth and may result in penetration into cortical bone. This can lead to tooth root abscesses, fractures and bone loss.

Diagnosis

Malocclusion and abnormal wear of teeth is often evident on oral exam. Abscesses may be palpable along the maxillary and mandibular regions of the face. An initial oral exam with an otoscope or vaginal speculum may aid in determining the presence of disease followed by a more thorough endoscopic oral exam, requiring heavy sedation or anesthesia. Radiographs or CAT scan are helpful in identification of malocclusion, fractures, abscessed cheek teeth and osteomyelitis. Multiple radiographic views should be obtained including a lateral, left to right oblique, right to left oblique and dorso-ventral. Rostral-caudal may also be needed.

Treatment

Treatment includes control of inflammation, pain and infection and restoring dental anatomy to as normal as possible. Treatment consists of restoring the normal occlusal surface through grinding down of the elongated teeth and associated points, extraction of loose or abscessed teeth, cultures and sensitivities if warranted, antibiotics and analgesics as needed.

Malocclusion of the incisors should be treated by extraction of the incisors. Any time there are fractures, abscesses or continuous overgrowth of the incisors that requires continuous teeth trims, extraction should be considered. Rabbits are able to chew and eat normally without incisors. If you are trimming the incisors it is important to both reduce the length and restore the normal chisel-point. Trimming should not be performed with nail clippers or rongeurs, as this can lead to fractured teeth, root damage and possible abscessation. Instead, a high speed precision dental hand piece should be utilized, being careful to prevent thermal injury with a water cooling system.

Restoring cheek teeth to the proper occlusal plane requires a moderate speed straight hand piece. Protect soft tissues with a metal tissue protector on the hand piece or with a dental spatula and prevent thermal damage with a saline or water cooling system.

Extractions of cheek teeth may be necessary with loose, abscessed or severely deformed teeth. The goal is retention of as many cheek teeth as possible to aid in crushing and grinding of foods. If a cheek tooth is extracted you do not have to extract the corresponding opposing tooth, as the rostral and caudal jaw motion during chewing should ensure proper grinding of the remaining teeth.

Extraction of cheek teeth can be performed either intra or extra-orally. Intra-orally, a Crossley cheek teeth luxator is used to sever the periodontal ligaments on all four aspects. The tooth is gently extracted again following the natural curve of the tooth and root. Extra-orally is used any time intra-oral is too difficult. Common indications for extra-oral extraction include: retained root tips, dental ankylosis, periapical abscesses, osteomyelitis or severe deformation of the tooth root. Certain teeth are extremely difficult to extract in the rabbit, for example the last maxillary cheek teeth. In these cases maxillotomy may be necessary.

Periapical abscesses are common in rabbits. Successful outcomes require surgical excision, extraction of diseased teeth and /or infected bone and marsupialization of the soft tissues and post-operative debridement as needed. Antibiotics, both topical and systemic will be necessary until healing is complete. Antibiotic impregnated beads may be utilized. Analgesics will also be needed postoperatively.

Supportive care and anesthesia

Most rabbit dental procedures should be performed under general anesthesia. A combination of injectable and inhalant agents works most reliably. Local anesthetics are helpful in reducing the level of gas anesthesia needed for a procedure and offer post- operative analgesia. Intubating rabbits can be difficult especially in some of the smaller types so the rabbit v-gel can be easily utilized in place of intubation. Rabbits can also be easily maintained with a small mask that covers only their nose since they are obligate nasal breathers. Subcutaneous fluids may be given for short dentals (trimming incisors or mild points on cheek teeth). For more extensive dental procedures (severe malocclusion, extractions) an intravenous catheter and fluids is recommended. Pre and post- operative analgesics should be utilized.

Specialized rodent and rabbit dental equipment greatly facilitates examination of the oral cavity. The tabletop mouth gag positions the anesthetized rabbit without additional technical support. The tabletop mouth gag holds the head at a slight incline with adjusting bars to raise the maxilla and lower the mandible. The bars sit behind the maxillary and mandibular incisors, making it difficult to use in rabbits that have had their incisors extracted. Cheek dilators are used to retract the cheeks. There is also a rabbit and rodent adjustable mouth gag combined with cheek dilators, but requires a technician to hold the patients head in position. There are flat and curved spatulas designed to reflect the tongue and soft tissues. The Crossley incisor and molar luxators follow the natural curve of the teeth to aid in extraction. Reducing the length of the incisor and molar crowns should only be done with a moderate to high speed straight hand piece and cutting burs. The rodent and rabbit rasps available are effective for removing points on teeth but should not be used for reduction of tooth height.

Rodent Dental Disease

Rodents have considerable differences in their dental anatomy. Guinea pig, degus and chinchillas are similar to rabbits with both incisors and cheek teeth continuously growing (elodont). Squirrel and rat-like rodents have elodont incisors but their cheek teeth do not grow continuously (anelodont), so overgrown cheek teeth are not a problem in these species.

Guinea pig-like rodents have similar dental problems as the rabbit with both overgrown incisors and elongated cheek teeth. Incisor disease can be a result of trauma or can be secondary to disease of the cheek teeth. Diseased cheek teeth in guinea pigs is most often due to improper wear (acquired disease). Dental disease of squirrel and rat-like rodents is most often related to trauma, chewing on inappropriate items such as wire bars, large nuts or seeds.   Traumatic injuries to incisors can lead to fractures and/or malocclusion. Prairie dogs (squirrel-like) develop pseudo-odontomas. This deformation of the tooth root is mass-like and can occlude the sinuses. Formation of pseudo-odontomas is often the result of trauma, chewing on wire cages or from falling and damaging the incisors.

Clinical signs

Clinical signs of dental disease in rodents include anorexia, diminished food intake, dysphagia, epiphora and weight loss. Abscesses may present as palpable firm masses along the mandible or maxilla. Prairie dogs with pseudo-odontoma may present with upper respiratory signs or dyspnea.

Diagnosis

Affected incisors are apparent on physical exam, affected cheek teeth may require sedation or general anesthesia for evaluation. A small endoscope or otoscope can aid in visualization. Radiographs or CAT scan can help visualize tooth root abnormalities, abscesses or osteomyelitis and pseudo-odontomas in prairie dogs.

Treatment

The goal in treatment is to control infection and pain and to restore anatomy to as close to normal as possible. The same techniques that are used in rabbits are used in rodents. The incisors of most rodents are extremely long and curved and trauma to surrounding structures is possible on extraction, including fracture of the mandible.

Treatment for pseudo-odontomas in prairie dogs can be difficult due to the tooth root mass being adhered to the surrounding tissues. Extraction can be successful if diagnosed early. Often a rhinotomy or excision through the hard palate is necessary to extract the tooth root. Treatment of dental related abscesses is similar to those in rabbits.

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Fluids N' Exotics: Fluid Therapy in Exotic Species

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Introduction

Fluid therapy is a seemingly basic concept in both human and veterinary medicine. However, when treating exotic species, this fundamental concept becomes one of the most essential components of exotic medicine. To provide great supportive care as veterinary technicians, we need to understand our role in providing basic fluid therapy, recognizing the complications associated with dehydration and over hydration and knowing how to correct poor husbandry and nutritional issues that may affect hydration. Other things to consider are acceptable methods of fluid administration that are species dependent, including size, mentation and metabolism. An overview of different types of fluids and their indications will aid in providing effective fluid therapy. While this is a basic presentation of fluid therapy in exotics, it is important to remember that exotic species and their requirements vary greatly. Much of our information is anecdotal and extrapolated from small animal medicine sources.

Indications

When tending to exotic emergencies, it is not uncommon for the patient to present debilitated and in some state of dehydration. First, an observational exam prior to restraint is vital in determining if the patient can tolerate stress related to handling and treatment administration. Once the patient is able to tolerate handling you may find tackiness in the oral cavity of avian and reptile species, and an increased skin turgor in most small mammals. Birds and reptiles will have eyes that appear sunken and in some avian species, a skin turgor can be performed on the eyelid. Indications for fluids may include:

1. Fluid Replacement due to dehydration, hemorrhage, vomiting, and/or diarrhea
   a. Electrolyte and Acid-Base imbalances
2. Gastrointestinal Hypomotility
3. Renal Perfusion related to Disease or Organ Damage
4. Medication Administration
5. Parental Nutrition
6. Anesthetic Fluid Loss Prevention

Fluid Calculations/Formulations

Determining hydration status:

Fluid Deficit = BW (g) X % dehydration

Species	Fluid	Dose IV or IO	Comments
Birds	Crystalloids	50-100 ml/kg/day	Anesthesia rate: 5–10 ml/kg
	Colloids (hetastarch, oxyglobin)	10–15 ml/kg 5 ml/kg +15–40 ml/kg with crystalloids	
Reptiles	Crystalloids	10–30 ml/kg/day *15–25 ml/kg/day intracoelomic & epicoelomic	Over 72–96 h *Warm water baths are effective in partial rehydration with fluid absorption from the cloaca, it also may stimulate drinking
	Colloids (hetastarch)	5 ml/kg, not to exceed 40 ml/kg/day	

Rabbits	Crystalloids	100–150 ml/kg/day	
	Colloids (hetastarch)	5 ml/kg	Repeat doses PRN
Rodents, other small exotic mammals	Crystalloids	60–120 ml/kg/day (Small rodents 60–70)	
	Hypertonic saline	5 ml/kg over 5–10 minutes	The addition of colloids may be indicated
	Colloids (hetastarch)	10–20 ml/kg/day 5 ml/kg for shock over 15 minutes	Do not exceed 20 ml/kg/day

Chart made by Stephen Cital

Subcutaneous and Catheterization Sites
Intravenous and intraosseous catheter placement can be one of the more challenging components when providing fluids for our exotic species. Some of these reasons may include patient size, fragile vessels and/or the location of the vessels. Most exotic patients will require sedation or full on anesthesia for catheter placement. Although IO catheters are easier to maintain in certain species, it is important to remember these sites run a higher risk of nosocomial infections that can lead to osteomyelitis and more severe infections than IV catheters. Special attention should be made to prep these sites aseptically and to keep them as clean as possible. Understanding the risks involved with fluid administration is a key factor in proving the Gold Standard. The most fatal complications to avoid are the risk of flooding air sacs when giving SQ fluids, overhydration, and over distension when administering SQ fluids. Over distension disrupts blood flow and decreases the rate of absorption. Lastly, when administering fluids, the fluids should be warmed unless it is otherwise indicated. Administering warms fluids help our patients regulate their body temperature better, helps with adsorption and also aids in gut movement and digestion.

Avian
Areas to administer SQ fluids for avian species are in the inguinal and lateral folds of the leg and in larger birds, fluids can be given intrascapular. It is especially important to make sure the fluids are creating a fluid pocket that is visible underneath the skin and to ensure the area is not becoming too tight. This can be achieved by using alcohol over your administration site and sweeping the feathers out of your line of view. Over distension should be avoided to decrease the risk of compromised blood supply or tissue necrosis. SQ fluids can comfortably fit 10- 15 mL/Kg, although 25 mL/kg can be given. Birds tend to have fragile vessel under a thin layer of skin. Intravenous catheters mostly require moderate to heavy sedation and even anesthetic gas. IV access is ideal for patients undergoing surgery or an anesthetic event, due to poor ability to maintain the indwelling catheter in the awake bird. IV catheters can be placed in the basilic/ulnar vein, the medial metatarsal vein and even the right jugular. If an avian patient is too small to place an IV catheter or if CRI fluid therapy is preferred, an intraosseous (IO) catheter may be indicated. Sites for IO catheters include the distal ulna and the proximal tibiotarsus bones. IO catheters should **NOT** be placed in the humerus or femur as they are pneumatic bones that will result in the bird drowning if fluids are administered in them.

Reptile
For SQ administration in lizards and snakes, the lateral body can be used. Be careful not to over distend this area as it can be quite uncomfortable and lead to disrupted blood flow. In chelonian species, the medial axillary region can be used for SQ administration. Most reptile species require a cut down to

access their vessels. In chelonian species, the jugular is the preferred method for IV catheter placement. However, like other reptile species, the coccygeal vessels can be used as well. In larger lizards, such as iguanas, the cephalic vein can be accessed with surgical cut down followed by blunt dissecting. IV catheters can be managed better in some reptile species, but when IV access is not available, IO catheters can be placed in the humerus, femur or proximal tibia bone. Intracoelmic is a method of fluid administration if no other route is available. Other methods of fluid therapy in reptiles include soaking in a warm shallow bath for 20-30 minutes. This allows cloacal drinking to occur and will encourage oral drinking and defecation.

Small mammal/pocket pets

Small mammal fluid administration is very similar to that of our common small animals. SQ Fluids can be administered in the loose skin over the shoulder blades of most small mammals. The most common sites for IV access include the cephalic and lateral saphenous. However, the tail and aural vessels can be accessed in some species. Caution should be used when placing auricular IV catheters in rabbits, because sloughing of the tissue can occur. In smaller mammals such as rats, IV catheters can be placed in the lateral tail veins after a quick needle cut down of the skin. In small mammals it is always important to have a 22-20 G needle available for nicking the skin as they tend to have tougher skin especially when they are an older patient, intact and you're using the cephalic vein. If IV access is not available, IO sites for small mammals vary with species but include the proximal tibia or proximal femur in ferrets, the proximal humerus, greater trochanter of the femur or tibial crest in rabbits and the cranial tibia or femur for smaller patients like the chinchilla, guinea pig, etc. These areas should always be surgically prepped and infiltrated with lidocaine prior to catheter placement to help protect against infection and to provide analgesia. Intraperitoneal is acceptable for small rodents as well.

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Canine Rehabilitation For the Primary Veterinary Practice
Sherri Jerzyk, CCRA

This lab is designed to help you know what basic rehabilitation skills are appropriate to institute in your practice and how to integrate a relationship with your local rehabilitation facility. It is not designed to encourage replacing trained rehabilitation professionals for your clients, but to create better flow and care for them.is in no way encouraging

One of the most important things you can do, is to find the closest canine rehabilitation facilities to your practice and contact them. The closest facility may be and hour or more away, but don't let that deter you. Clients frequently travel these distances for rehabilitation. Call that facility and introduce yourself and tell them you are interested in rehabilitation for your patients and would like to discuss it. If possible, make arrangements to go visit and chat with them in person. Why take the time to do this? First, if you are not giving the clients the information they are looking for, they will talk to their trainers, breeders, groomers, barista, DR Google, or neighbor. It only takes a moment to offer them a referral to the rehabilitation facility- I am sure the facility is happy to provide you with cards or brochures. Maybe they just want to know what cart is best, or what harness to use, or what about shockwave?? Instead of digging for answers, you are now a quick call or email away from someone who will give you those answers and advice…..for free!

Having a tool to track progress or decline is imperative. For a long time, we would stand back and glance, and then palpate. Then we would declare that we think he is losing muscle mass. Two weeks later we would either notate that it "appears to be losing more muscle" or "muscle appears to be the same as previous visit" And who hasn't either read or written "decreased range of motion" in a chart? How is that helpful for tracking the patient? In about the same amount of time, you can actually have trackable results to document progress or decline in function and recovery. I suggest your clinic add a few simple tools to its toolbox. You can use a tape measure, but it increases accuracy if you splurge about $30 and get a Gulick. It is a calibrated tape measure so it keeps you from pulling too tight or holding too loose, both of which are relevant when measuring small amounts of muscle mass. The second tool is a goniometer You may already have one, or ten sitting in a drawer as they are a common handout by drug reps. If somehow you don't, ask your drug rep or order a few, preferably a small one, a regular one, and a large one. Once you have these few simple tools, it's time to learn to use them.

Muscle mass measurements are simple to perform. Ideally you need your Gulick, the patient, and 2 people. You can measure the patient in standing or while laying down, just be sure to notate as you need to do it the same way each time. For the rear legs, you first measure the length of the femur (starting distal). Then, at the 70% mark measure all the way around the leg. Example- if the femur is 16cm long, the 70% is roughly 11cm). For the forelimb you would do the same with the humerous. We also measure just proximal and distal to the elbow. On a side note, the Gulick can also be used to measure joint effusion and edema.

Goniometry is a little more challenging and takes some practice. It would great to practice if you have any down time at the clinic. This definitely takes 2 people if the patient is awake. It should be done with the patient in lateral recumbency. You may do it with the patient sedated if they are already sedated for another procedure. Be aware that the values may be slightly different than while awake. Although we are measuring range of motion, if the patient is painful, then they may tighten up and resist full extension or flexion. Learning the landmarks and being able to hold the goniometer in place is imperative. To make it easier, you will be receiving the article from Drs Millis and Levine with a goniometry study, normal values, and landmarks. Whether or not we expect a return to normal range of motion is dependent upon several factors. First, is there a mechanical reason we would not expect it to return? For example, severe OA which interferes with movement. Is it a dog that has had pelvic fractures that alters its ability to extend and flex

its hips normally? If it is not a mechanical reason there may still be factors that affect range of motion such as edema. If a stifle is swollen, the range of motion will be decreased but may actually be normal when the swelling is addressed. If there is a mechanical reason for decreased range of motion, make sure pain is managed well and a referral for rehabilitation for the best longterm outcome and management is appropriate. We generally would check muscle mass and range of motion every 2-4 weeks.

Now that we have our measurements, what can we be doing to improve our patient's outcome? The first thing we should be looking at is hot and cold therapy. A staple of rehabilitation that is often overlooked. Are we using it post-op? Cold for the first 72 hours and then heat? Arthritis should be using it, heat in the am and cold in the pm. Both should be used with caution in patients with decreased sensation or sedated. Neither should be used over open wounds. Heat should not be used over active bleeding. Compliance increases if you actually send a gel pack home with the client. These are cheap and take minimal space.

The next thing we would do is to add in some manual exercises. When deciding on exercises you need to take the patient's condition and temperament into account as well as the owner's capabilities. What is your goal for this patient and what needs to be done to get there. Most clinics do not have the space for equipment and many owners do not want to invest in it. Luckily, you don't need to in order to do some basic rehabilitation. The following exercises are some we will go over that are easily instituted.

1. Passive Range of Motion
2. Weight shifting
3. Stretches
4. Proprioceptive
5. Theraband use

Remember that using these exercises is not a substitute for proper rehabilitation, they are for simple cases that may not need active rehabilitation or to jumpstart the patient's progress pending their rehabilitation consult. The most important thing you can do is develop a relationship with your local rehabilitation team.

Rehabilitation For The Primary Veterinary Clinic -part 2
Sherri Jerzyk, CCRA

This lab is designed to help you know what basic rehabilitation skills are appropriate to institute in your practice and how to integrate a relationship with your local rehabilitation facility. It is not designed to encourage replacing trained rehabilitation professionals for your clients, but to create better flow and care for them.is in no way encouraging

One of the most important things you can do, is to find the closest canine rehabilitation facilities to your practice and contact them. The closest facility may be and hour or more away, but don't let that deter you. Clients frequently travel these distances for rehabilitation. Call that facility and introduce yourself and tell them you are interested in rehabilitation for your patients and would like to discuss it. If possible, make arrangements to go visit and chat with them in person. Why take the time to do this? First, if you are not giving the clients the information they are looking for, they will talk to their trainers, breeders, groomers, barista, DR Google, or neighbor. It only takes a moment to offer them a referral to the rehabilitation facility- I am sure the facility is happy to provide you with cards or brochures. Maybe they just want to know what cart is best, or what harness to use, or what about shockwave?? Instead of digging for answers, you are now a quick call or email away from someone who will give you those answers and advice…..for free!

Many Clinics have equipment that they have purchased -or found in a closet not knowing where it came from- and aren't using it to it's full extent. If you have it, you should be making it earn it's keep and get the benefits of it. We will go over some of the common ones and leave time for special situations and questions you may have.

Therapeutic ultrasound- I have come across many clinics that have one and don't know what to do with it. Also, it is a relatively cheap investment for a clinic that doesn't have $25,000 to invest in a laser. They run in the $2000-$3000 range. Ultrasound can be used for edema, tight tissues, adhesions, bone healing, and my favorite….tendinopathies. Generally, we see better results on tendon with ultrasound than with laser. Ultrasound can have thermal effects so use with caution over bony areas. You can use regular ultrasound gel or you can have a steroid gel compounded and perform phonophoresis. The treatments are should be about twice the size of the head. Duty cycle is the amount of time the unit is on-example a 20% duty cycle means it is on for 1 out of 5 seconds. A 100% duty cycle is continuous and generates more thermal effects. A treatment generally lasts 5-10 mins. Your unit will generally have a 1MHZ and a 3MHZ setting. The 1 MHZ penetrates more deeply and the 3MHZ is very superficial.

Laser therapy is used in a large number of clinics. For our purposes we will discuss class 4 lasers as they are currently the most commonly used. Many people who use the laser are poorly trained in use and safety. They put goggles on and use all the presets. There is more to it than that. First, safety is extremely important. Making sure you are using a proper space, have proper signage, and everyone is using proper eye protection is relevant. Did you know that there is a regulatory board in most states? In some it falls under radiology and requires the same inspections? Do you have a trained and designated Laser Safety Officer? We will go over laser dosing and protocols in lab. Two resources to find more training and information are AIMLA (American Institute of Medical Laser Applications) and Companion Animal Health who has Companion University and has lots of resources as well as free laser CE.

Extracorporeal shockwave therapy is in a handful of clinics and making a comeback. Part of the reason can be attributed to the newer units. Sedation is no longer necessary making it a viable option. It can be used for dysplasia(elbow and hip) , non-healing fractures, OA, and tendon and ligament injuries.

Treatment time depends on the strength of the shockwaves and the number of locations being treated. A common dose is 800-1000 pulses per site, which can be accomplished in under 4 minutes. Patients normally begin to experience pain relief from ESWT after the 2nd or 3rd treatment. ESWT Therapy is recommended every 2-5 days for a total of 5-8 treatments.

TENS and NMES units are cheap, easy to use, and beneficial. They are generally well tolerated in dogs. TENS units are approved for pain and NMES units are used for pain, muscle strengthening, neuromuscular re-education, and edema. Before recommending or sending home with clients, check your state liability laws.

We are not going over underwater treadmill in this lab as it is rare that a facility would have this unless they were actually doing rehabilitation. But we will discuss other modalities that you may have in your facility so bring your questions.

The most important thing I want you to take away from this lab is that patient care is a team effort. Rehabilitation is a part of that team. Knowing what to start with, and when to refer is crucial for your patients to have the best outcome.

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Practical Blood Transfusion Therapy

Transfusion therapy has evolved in the past several years in veterinary medicine. The use blood component transfusion therapy is a common treatment seen in small animal patients in the emergency setting due to trauma, toxicities, neoplasia and immune mediated diseases. Recognizing different blood products and their indications, understanding pre-screening blood tests and administering blood correctly and patient monitoring is paramount for patient safety.

Blood component therapy and indications

There are several blood component products available in the market. These blood component products are harvested from blood donors and are centrifuged to create different products with different uses and indications.

Red Blood Cell Products

Fresh whole blood (FWB)

FWB is blood collected directly from the donor that is used within 8 hours from collection that is essentially unaltered besides the addition of a small amount of anti-coagulant. FWB contains red blood cells, clotting factors, albumin, and functional platelets. After 8 hours, platelets lose function.

Stored whole blood (SWB)

SWB is blood collected from the donor that is beyond 8 hours from collection. SWB is similar to FWB, except it does not contain functional platelets and labile factors, however they have longer shelf life of around 25-30 days.

Packed Red Blood Cell (PRBC)

PRBC are concentrated version of red blood cells, but it does contain a small amount of WBCs and plasma that can still can be antigenic. PRBCS have less volume and thus ideal for patients that have pre-existing cardiac or kidney disease or patients that are adequately normovolemic. PRBC are typically viable between 7-8 weeks from production.

Indications for Red Cell Therapy

The primary indication for red cell therapy is for any symptomatic anemia due to hemorrhage, hemolysis (IMHA), non-regenerative anemia, anemic patients undergoing surgery that is expected to have blood loss.

Plasma Products

Fresh Frozen Plasma (FFP)

FFP is plasma frozen within 8 hours from collection. It contains all clotting factors and viable within 1 year from collection. It can be left thawed for up to 2 weeks and still have the same viable clotting factors. FFP can be thawed and refrozen within 1 hour and still maintain all clotting factors. This is primarily used for treating complex coagulopathies with evidence of bleeding. The use of FFP for hypoalbuminemia, pancreatitis and parvovirus has been controversial and no current studies have shown a clear benefit on the use of FFP in these conditions.

Frozen Plasma (FP)

FFP that is over a year old becomes FP. It has lower concentrations of labile factors but still contain factors II, VII, IX, X. FP is viable for 5 years and is primarily used for warfarin based rodenticides.

Cryoprecipitate

Cryoprecipitate is a concentrated form of plasma that contains high amount of fibrinogen, VIII and vWF. It has a smaller volume and requires less time to administer. Cryoprecipitate is primarily used for hemophiliac A patients (Factor VIII deficiency) or Von Willebrand deficiency patients.

When to transfuse red blood cells?

The decision when to transfuse is multifactorial. When deciding whether to transfuse a patient, consider the following questions: what is the patient's current PCV, what is the onset of anemia?, Is the patient clinical for its anemia? Any other diseases that patient has that transfusion would be beneficial? Is there evidence of blood loss? If the answer to most of these questions is suggestive that a blood transfusion would be of beneficial overall to the patient, then red blood cell transfusion should be considered.

Pre-transfusion testing

Pre-transfusion testing is important to mitigate potential transfusion reactions and to optimize patient safety. These tests include blood typing and cross matching blood if the patient has had previous history of transfusion before.

Blood Typing and Cross matching in Dogs

Dog erythrocyte antigen (DEA) 1.1 is the most antigenic blood type, thus the only type routinely tested for clinically. Dogs do not have naturally occurring alloantibodies to other blood types; hence a non-type specific blood transfusion can be given safely in a dog with no transfusion but it is not encouraged.

Dogs that have had a previous transfusion history or that have received a blood transfusion over 4 days ago or dogs with questionable transfusion history should be cross-matched before receiving another blood transfusion.

Blood Typing and Cross matching in Cats

Cats have two major blood groups: A, B; but AB group is seen occasionally. Unlike dogs, cats have naturally occurring alloantibodies to the other blood type. As such, cats MUST ALWAYS BE BLOOD TYPED prior to its first transfusion and given type-specific red blood cells to avoid significant transfusion reactions.

Similar to dogs, cats should be cross-matched if they have had a prior history of blood transfusion. Some authors advocate the cross-matching cats even without the history of transfusion as to avoid reactions to the other red blood cells antigens.

Crossmatch

Cross-matching identifies the presence of incompatibilities between donor and recipient blood components. Major crossmatch is when patient serum is tested for incompatibilities against the donor red cell, while minor crossmatch is when donor serum is tested for incompatibilities against patient red blood cells. Major crossmatch is most commonly used in the clinic setting, while minor crossmatch has fallen out-of-favor besides certain clinical conditions. A limitation for cross-matching is the presence of auto-agglutination which precludes the use of most commercial cross-matching kits.

Administering The Transfusion

The amount of blood product to be administered is very case dependent but a good general starting point is to administer 10-20 ml/kg of PRBC and FFP over the span of 4-6 hours. Transfusions taking longer than 6 hours increases the risk of microorganism growth in the blood product.

Warming stored red blood cell products is unnecessary and is discouraged. This can lead to protein and clotting factor denaturation and deterioration. It also promotes the growth of bacteria within the blood product. The large surface area of the tubing is adequate in facilitating achieving room temperature before reaching the patient at normal rates.

The use of in-line or separate blood filters is necessary to prevent small clots and other debris from going into the patient. Red blood cell transfusions should be given free flowing under gravity; otherwise use a compatible peristaltic infusion pump. Inappropriate use of fluid pumps may lead to damaged red blood cells due to shearing stress that results in less viable red blood cells given to the patient.

When administering red blood cell transfusions, administering the transfusion in the same intravenous catheter that intravenous fluids are going in should be avoided. This can result in hemolysis of transfused

red blood cells, precipitation and/or clot formation, or RBC clumping. Similarly, no medications should be given in the same intravenous catheter while administering the RBC transfusion.

Blood transfusion rate start at 0.5-1 ml/kg/hr for the first 15-30 minutes, then 2-10ml/kg/hr to ensure the transfusion is completed in 4 hours.

Transfusion reactions and monitoring for potential transfusion reactions

When administering a blood product, it is paramount that patients are closely monitored. Dedicated personnel should monitor the patient's vital parameters throughout the transfusion: every 15 minutes for the first hour, then every 30-60 minutes thereafter. These vital parameters include temperature, respiratory rate, blood pressure, mucous membranes and mentation. Any abnormalities may indicate an early sign of a transfusion reaction.

Transfusion reactions can due to immunologic or non-immunologic based. Immunologic transfusion reacts are due to RBC, plasma proteins, WBCs or platelet antigens or antibodies. These transfusion reactions can be acute or delayed.

The most common transfusion reactions we encounter is febrile non-hemolytic transfusion reactions (FNHTR) and this is often observed when the patient's temperature increases by 1 degree Celsius. This is due immune reaction with donor white blood cells. FNHTR are self-limiting and treatment is primarily aimed at slowing down the rate of the transfusion.

Acute hemolytic transfusion reactions (AHTR) are the most serious and are potentially life threatening but are uncommon. AHTR are due to antibodies reacting against donor red blood cells causing intra vascular hemolysis. Patients develop signs consistent with shock and often have evidence of abnormal colored urine due to hemoglobinuria. One can also examine the patient's serum for evidence of hemoglobinemia for further evidence of AHTR in the absence of immune mediated disease. This a complication that one can see if a patient receives incompatible blood which emphasizes the importance of pre-transfusion testing. Stopping the transfusion is the first step when dealing with AHTR. Additional support such as intravenous fluid support, oxygen therapy, and steroids may be necessary to further stabilize the patient.

What is Nasopharyngeal Cicatrix and Why Should You Care?
by Stephanie Wertman, LVT, VTS-EVN
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Introduction
Nasopharyngeal Cicatrix Syndrome (NCS) is a condition of the upper airway found in horses residing in the central, southeastern region of Texas, most commonly the areas near the Gulf of Mexico, with isolated cases reported in other areas. NCS was first reported as early as 1972.a NCS can present in both acute and chronic phases, with variable clinical signs dependent upon the location and severity of abnormalities within the nasal passages, pharynx, larynx, and proximal trachea. NCS is a common reason for horses to be examined at Texas A&M Veterinary Medical Teaching Hospital (VMTH) with one or more clinical signs of nasal discharge, coughing, respiratory noise, exercise intolerance, and respiratory distress.

Etiology
Several epidemiological studies have tried to determine an exact etiology of NCS and no known cause has been identified. However, certain risk factors have been identified, which may aid in preventative strategies for this disease. In a recent study at Texas A&M, breed and sex were determined insignificant; however, NCS is more commonly seen in older horses housed on pasture in direct correlation to prolonged or repeated inhalant exposure to a direct irritant, allergen, or other causative agent (bacteria, mold, plant pollen, insects, etc.).b Horses that are housed completely on pasture are at the highest risk of exposure, whereas horses housed exclusively in stalls are at almost no risk. Most cases of NCS seen at Texas A&M VMTH present during the warmer months, with worsening of clinical signs during summer months. This may be due to acute worsening of inflammation and decompensation of respiration and thermoregulation due to decreased airway compliance or may be incidental.c Due to horses commonly relocating due to purchase, showing, and movement with owners, NCS should be a differential for horses with a history of residing in pastures in endemic areas. NCS is a top differential for horses referred to Texas A&M VMTH for exercise intolerance, respiratory noise, or respiratory distress. For added health care benefit, veterinarians and veterinary staff located in other regions where NCS is uncommon, should familiarize themselves with the syndrome.

Table 1. Pre-arrival respiratory questionnaire:
Pre-Arrival Respiratory Questionnaire

What is the overriding concern (complaint) by the owner? _____
Circle clinical signs: fever, nasal discharge, coughing, ↑respiratory rate, ↑effort, exercise intolerance, respiratory noise (standing quietly or while working), respiratory distress Duration or onset of symptoms?
_____ Prior history of respiratory issues?
Yes/No   When? _____ Age of horse? _____ History of travel? _____ Exposure to other horses (showing, training, boarding facility, a new herd mate, etc.?) _____

_____
Any other horses affected? _____
Where is the horse housed? Pasture, stall, or both? _____
Any environmental changes? Feed, housing _____
Vaccination History? _____

Diagnosis

A definitive diagnosis is made by performing upper airway endoscopy. The extent of NCS may be definitively diagnosed by endoscopic examination of the upper airway at rest. In acute or active NCS, the mucosa of the upper airway may appear erythematous (redness) or edematous. In comparison, the chronic presentation of NCS includes the formation of circumferential, web-like scar tissue of the pharynx, larynx, and proximal trachea. Over time this webbing decreases the surface area of the pharynx. This leads to a significant decrease in airway diameter. Other chronic lesions include scarring and deformation of the epiglottis, arytenoids, and "kissing" lesions on the vocal folds, scarring of the salpingopharyngeal openings (guttural pouch openings), and nasal passage plaque formation.d

Treatment

Prior to the horse's arrival at Texas A&M VMTH, a 1M (160mm) endoscope and temporary tracheotomy kit are prepared. Horses in respiratory distress are unloaded directly into the Texas A&M VMTH Large Animal ICU Service. A brief airway endoscopy is performed if the patient allows it. In unstable patients, preparation for a temporary tracheotomy begins immediately, especially if there is scarring and plaques noted on the distal nasal passages. Both the endoscope and temporary tracheotomy are performed without sedation as this may cause relaxation of the pharynx and larynx leading to worsening of clinical signs. A temporary tracheotomy is performed using local anesthetic and is placed in the middle third of the neck, to allow room for a permanent tracheostomy to be placed above it if one is indicated later.

Table 2. Temporary tracheotomy kit supply list
Temporary Tracheotomy Kit

Two/ or three styles of temporary trach tubes	#10 scalpel blade
Sterile Gloves	#3 scalpel handle
Scissors	12ml syringe
Hemostat	20ga needles
1 btl Carbocaine (mepivacaine hydrochloride)	25ga needles
Sterile gauze	Brown gauze

Once the horse is stabilized, a detailed endoscopy examination is performed. Further treatment is determined by the severity of the disease but commonly include intravenous or oral use of NSAIDS (flunixin meglumine) along with topical NSAID & corticosteroid solutions (i.e. Dexamethasone/DMSO/Glycerin). This therapy aids in decreasing inflammation in the acute presentation of NCS. However, due to the risk of laminitis associated with corticosteroid therapy, systemic corticosteroids are commonly avoided. The risk of local corticosteroids should be discussed with the owner. Environmental changes should also be discussed with the owner to minimize reoccurrence. The Texas A&M VMTH Soft Tissue Surgery Service performs approximately 2-4 permanent tracheostomy procedures per month with 99.9% of them due to NCS. If a permanent tracheostomy is deemed necessary, the horse is admitted to the hospital. At the time of surgery an intravenous catheter is placed in the middle or distal third of the neck (with precautions regarding the carotid artery). The surgery is performed in stocks under sedation with the horse standing and its head extended (dental halters work well to stabilize the head). Sedation is most commonly achieved using an alpha-2 agonist and opioid combination. Systemic antibiotics and NSAIDs are administered peri-operatively. The stoma (new opening) for a permanent tracheostomy is placed between the second and fifth (sometimes 6th) tracheal rings and is achieved by removing the ventral 1/3 of the tracheal rings.e The area is maintained by gentle cleaning

post-operatively with the most common complications including dehiscence of the sutures, a small stoma that needs to be revised, and excessive discharge within the early phase postoperatively. Most patients are discharged within 1-4 days after the procedure, with continuation of oral NSAIDs and cleaning of the area. Horses are maintained in a stall or small pen after surgery to limit the patient from traumatizing the surgery site by rubbing on half-stall doors, fences, posts, buckets, etc. until suture removal at 2 weeks. The incision may be gently cleaned to remove mucous and debris (over time, drainage will decrease and become minimal). Again, the long-term restriction of this procedure is ABSOLUTELY NO access to standing water; such as a tank, pond, or river where horses may be able to swim.

Summary

Early detection and intervention of this disease process provides the most benefit. Implementing environmental management changes of the affected horse, especially movement from pasture to dry lots or stalls, has been shown to slow or stop progression; however, the scarring and deformity changes are irreversible. Removal of portions of scar tissue with diode lasers and other methods have been attempted, but reoccurrence is common.f The most effective treatment known to date, and what is commonly performed at Texas A&M VMTH, is a standing permanent tracheostomy. Surgical intervention has shown good long-term outcome for survival and athletic performance with most horses returning to previous work once the incision is healed. This is usually within 4-6 weeks. Short and long-term management of these incisions is horse dependent. It is crucial that the horse is turned out in an area with no standing water as the horses lose their ability to protect their airway.

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An Overview of Parturition, Dystocia and Obstetrics in Cattle and Horses
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I. Signs of approaching parturition
- a. Cow -Very difficult to predict exact time of parturition based on clinical signs
    - i. Progressive relaxation of pelvic ligaments
    - ii. Vulva becomes edematous and flaccid
    - iii. Udder becomes enlarged and edematous
    - iv. Colostrum present in udder immediately prior to parturition; thick, yellow, turbid
    - v. Tenacious mucus discharge from vulva; cervical seal
    - vi. Anorexia and restlessness for a few hours before calving
- b. Mare - Relaxation of pelvic ligaments is not as obvious
    - i. Vulva becomes edematous
    - ii. Udder enlargement during the last one to one and one-half months of gestation
    - iii. Leakage of colostrum seen 24 to 48 hours before

II. Stages of labor
- a. First stage
    - i. Characterized by relaxation of the cervix and contractions of the myometrium
    - ii. Clinical signs -Cow
        1. Some cows may show signs of abdominal pain; more obvious in heifers; anorexia; stand with back arched; occasional mild straining; frequent changes in position; normal length is 6 to 12 hours (up to 24 hours in heifers)
- b. First Stage – Mare
    - i. Clinical signs - Mare
        1. Restlessness; anorexia; colic; sweating; behind elbows and flanks; frequent changes in position; frequent urination and defecation of small amounts; episodes of rolling; normal length is 1 to 4 hours
- c. Second stage
    - i. Cow and Mare - Characterized by uterine contractions, entrance of fetus or fetuses into the dilated birth canal, rupture of the allantoic membrane, abdominal contractions, and delivery of the fetus
    - ii. Clinical signs - Cow
        1. Abdominal contractions begin when fetal feet are present in the cervix or vagina
        2. Following rupture of the allantoic sac, the amnion appears at the vulva as a translucent, fluid-filled membrane
        3. Intermittent straining continues and fetal feet appear at the vulva; amnion usually ruptures as the feet pass through the vulva
        4. Once feet appear outside the vulva, they should remain in that position; disappearance and reappearance with each abdominal contraction is abnormal
        5. Bouts of abdominal straining occur every 2 to 3 minutes and consist of 5 to 8 abdominal contractions; contractions increase and resting time decreases as delivery progresses; reduced number of intensity of abdominal contractions suggests an abnormal delivery and is an indication for assistance

6. Normal length of the second stage is 0.5 to 4 hours; longer in primiparous animals, shorter in pluriparous animals; bovine fetus can survive for up to 8 hours after the onset of the second stage of labor because of the type of placental attachment

   iii. Clinical Signs –Mare
1. Second stage is initiated by rupture of the chorioallantois and release of the watery allantoic fluid
2. Placenta ruptures at the cervical star
3. Amnion is forced through the cervix and should appear outside the vulva within five minutes after rupture of the chorioallantois
4. Abdominal straining begins at the initiation of the second stage; characterized by 2 to 5 strong expulsive efforts followed by 2 to 3 minutes of rest
5. Some mares begin the expulsive stage while standing; most assume lateral recumbency for delivery of the fetus
6. Fetal shoulders enter the maternal pelvis successively, not simultaneously; thus, one foreleg precedes the other by approximately 6 inches; the hoof of one leg is at the level of the fetlock of the other; muzzle lies between the carpal joints
7. Delivery is rapid and violent in mares; mare is exhausted and remains in lateral recumbency for 15 to 30 minutes after delivery; foals hind limbs remain in birth canal;
8. Umbilical cord is long and may not rupture for 8 to 30 minutes if mare or foal do not move
9. Normal length of second stage of labor in mares is 5 to 40 minutes; average is 20 minutes

d. Third stage
   i. Characterized by expulsion of the fetal membranes and involution of the uterus
   ii. Clinical Signs - Cow
1. Expulsion of the fetal membranes
2. Placental villi shrink and maternal crypts dilate to allow separation of fetal trophoblast from maternal placenta
3. Normal time for delivery of the placenta is 0.5 to 8 hours
4. Uterine involution
    a. Maternal caruncles are sloughed after necrosis of the caruncular stalk; sloughing complete by approximately 12 days postpartum; caruncle covered by epithelium by 30 days; intercaruncular epithelium repaired by 20 days postpartum
5. Lochia--postpartum discharge made of mucus, tissue remnants and blood;
    a. Discharge of lochia begins 3 days after calving and continues until 12 days

   iii. Clinical signs – Mare
1. placenta is inverted as it is delivered; fetal side of chorioallantois is outermost when placenta is delivered; maternal side is innermost
2. Normal time to delivery is 0.5 to 4 hours
3. Gross reduction in size not as rapid as cow
4. Lochia discharge is grey to brown; normally persists for a week after foaling
5. Histologic involution is not usually complete at the onset of first postpartum estrus (foal heat), but is by 14-15 days post partum

III. Artificial interference in normal parturition
   a. There is no need to interfere with normal parturition
   b. Indications for interference
        i. If normal time for any stage of labor is exceeded
       ii. If labor is not progressive or if efforts by the dam diminish
   c. Application of traction before birth canal is dilated can result in trauma to cervix, vagina, vulva, and perineum
IV. Dystocia
   a. Prolonged, difficult, or abnormal first or second stage of labor
   b. Maternal dystocia--some defect of the dam which results in stenosis of the birth canal or prevents entry of the fetus into the birth canal
   c. Fetal dystocia--defect of the fetus which prevents or impedes normal passage through the birth canal; may be anatomical defects or abnormalities of presentation, position, or posture
   d. Incidence -(3 to 25% in cows)
        i. More common in primipara and in large breeds
   e. Basic causes of dystocia
        1. Fetopelvic disproportion - Most common cause of dystocia in cattle
        2. Malposture of limb(s) or head - Most common cause of dystocia

Examination for dystocia
   a. History
   b. Examination of dam
   c. Examination of birth canal and fetus
   d. Restraint
   e. Preparation of dam
   f. Examination
   g. Examine birth canal
   h. Examine fetus
   i. Determine if alive - pedal reflex; eye reflex; suckling reflex; anal sphincter; palpate thorax or umbilicus for evidence of heart beat/pulse--may stimulate respiratory attempts
   j. Determine fetal presentation, position, and posture
        ii. Presentation--1) relationship of the spinal axis of the fetus to that of the dam; longitudinal or transverse; and 2) the portion of the fetus that entering the pelvic cavity; head (cranial) or tail (caudal) in longitudinal presentations or ventral or dorsal in transverse presentations
        iii. Position--the relationship of the dorsum of the fetus in longitudinal presentation or the head of the fetus in transverse presentation to the quadrants of the maternal pelvis (sacrum, right ilium, left ilium, and pubis)
        iv. Posture--the relationship of the head, neck, and limbs to the body of the fetus; may be flexed or extended or retained beneath, to either side, or above the fetus
        v. The normal circumstances for delivery in uniparous animals are: cranial longitudinal presentation, dorso-sacral position, with the head resting on the carpus/metacarpus of the extended forelimbs
   k. Differentiate between front limbs and hindlimbs
        vi. If soles of hooves are ventral, fetus is usually in cranial presentation, dorso-sacral position; other possibility is caudal presentation, dorso-public position

- vii. If soles of hooves are dorsal, fetus is usually in caudal presentation, dorso-sacral position, other possibility is cranial presentation, dorso-pubic position
- viii. Hock and elbow may be confused; both have prominence
  1. Front limbs have carpal joint between fetlock and elbow
  2. Hind limbs have no joints between the fetlock and hock

V. Obstetrical operations
  a. Mutation - those operations by which a fetus is returned to normal presentation, position and posture
  b. Repulsion- act of repelling the fetus out of the birth canal and into the uterus to make more space available for correction of malposition or malposture
  c. Rotation -Turning the fetus on its long axis to bring it into dorso-sacral position
  d. Version Rotation of the fetus on its transverse axis into cranial or caudal presentation; used to correct transverse presentations (rare in cattle)
  e. Extension and adjustment of extremities
  f. Forced extraction - withdrawal of the fetus through the birth canal by application of outside traction
     i. Apply traction only when the abdominal muscles of the dam are contracting; thus, the dam's pelvis is pulled cranially and provides maximum room for the fetus
     ii. Intermittent traction allows the fetus to breathe once the thorax is out of the birth cana

INTRAORAL RADIOLOGY

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Veterinary dentistry is immerging as one of the fastest growing "new" disciplines of veterinary patient care. The days of bypassing the oral cavity as the physical examination is being performed are over. Understanding that the condition of the oral mucosa and the dentition can play a significant role in the overall health of the pet is vitally important. Some conditions that begin in the mouth can affect the pet's overall health, i.e. periodontal disease, feline odontoclastic resorptive lesions or lymphocytic-plasmacytic stomatitis. While other systemic conditions may be manifested in the oral cavity, i.e. renal disease, FIV, FELV or autoimmune diseases.

In order to fully appreciate and diagnose conditions of the oral cavity, intraoral radiology is an absolute must. Adequate and proper treatment can only be accomplished when accurate diagnoses are made. Disease isolation, treatment planning and monitoring, evaluating presence or absence of missing teeth, evaluating vitality of teeth, evaluating tumor margins pre-surgically, evaluating fractured or diseased teeth pre-extraction along with accurate record keeping can be accomplished with the assistance of oral radiographs. Equally important are post-treatment radiographs to prove complete extraction and monitoring of endodontic and periodontic therapy.

Intraoral radiographs can be taken with a standard x-ray machine using either standard cassettes or intraoral dental films inserted into the mouth. However, because of logistics of moving the patient from the dental operatory to the radiology table and back, you won't realistically do this more than once.

From 26 years of owning a veterinary practice, I can tell you that the best return-on-investment in equipment is a dental radiographic unit. It should easily pay for itself in 6 months. However, in order for this to be true, you have to use it. Buying one and then not using it because you don't know how or won't spend the time learning how will not prove to be profitable.

The same diagnostic benefits can be derived from either film or digital radiology. The pros and cons of both need to be weighed when making that purchasing decision. The same x-ray unit is utilized for both methods. In reality I would recommend both systems, digital and film. With film, there are 5 different sizes that can be used depending on the patient size and what is being radiographed. The most common size film for cats is size 0 and size 2 for radiographing the dentition. For evaluation of the nasal cavity a size 4 would work best. When working with film, additional supplies needed would be a chairside darkroom, film holders, developer and fixer solutions, drying clips, film mounts, film clips, small view box with magnification, filing envelopes and a storage cabinet. With digital you need only to add the software and sensor, computer and monitor. The learning curve is much faster with digital because it only takes 15 seconds to see your results as opposed to 2 minutes with film. Also, you can take as many exposures as you need without adding to the cost unlike film that has a cost with every exposure. Granted, the initial cost of digital radiology is greater. But over the course of about 1 year you will spend about the same amount of money on chemicals, chairside darkroom, film holders, clips, mounts, and film that you would invest in the digital sensor and software. Those costs continue after the first year if you are using film.

There are times, however, when film is needed. This is why I say you should be familiar with both. Sensors can go bad just like computers can go bad. Sensors are limited to size 1 and size 2. There are times when a size 4 is really needed. So a small supply of film and chemicals will come in handy.

The diagnostic value of a radiograph depends on its quality, and the degree of quality is determined by technique. Patient positioning and film exposure and processing collectively affect the value of a radiograph[2]. With the use of digital radiography, the processing errors are reduced; however, positioning of the film or sensor in the pet's mouth and then the corresponding placement of the x-ray source to expose the film or sensor is extremely important.

There are two basic projection techniques used in radiography. The parallel technique offers the most accurate radiographic representation of the desired tooth or teeth, but it is limited to the lower premolars and molar of our feline patients. All other teeth must be radiographed utilizing the bisecting angel technique.

With the parallel technique the film/sensor is positioned directly behind and parallel to the long axis of the tooth being radiographed and the x-ray beam is directed perpendicular to that tooth and the film (Fig 1 and 2).
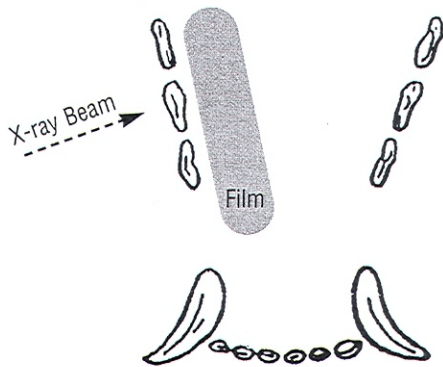

Figure 1

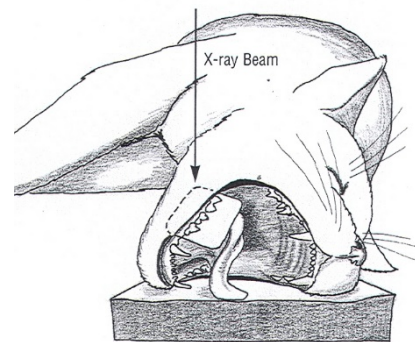(From *Atlas of Canine & Feline Dental Radiography*)

Figure 2

(From *Atlas of Canine & Feline Dental Radiography*)

When the film/sensor and tooth being radiographed are not positioned parallel to each other, the resultant image will probably be elongated, foreshortened, unclear or magnified[3]. A bisecting angle is an imaginary plane that equally divides the distance between the planes of the long axis of the tooth/teeth being radiographed and the film. The tubehead on the x-ray machine is positioned to allow the primary beam to be perpendicular to this imaginary bisecting plane (Fig 3 and 4).

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[2] Mulligan, TW, Aller, MS, Williams, CA. Atlas of Canine & Feline Dental Radiography. Pg 15-22. VLS, 1998.

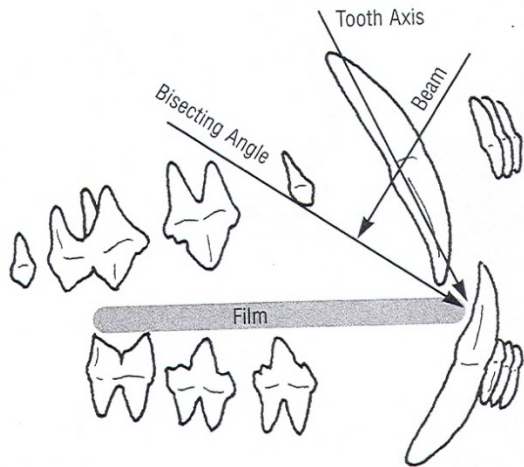[3] Mulligan, TW, Aller, MS, Williams, CA. Atlas of Canine & Feline Dental Radiography. Pg 15-22. VLS, 1998.

Figure 3
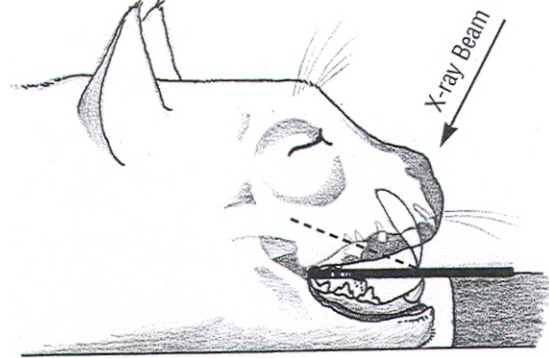
Figure 4

(From *Atlas of Canine & Feline Dental Radiography*)   (From *Atlas of Canine & Feline Dental Radiography*)

I know this is confusing to think about, but it is really not as hard as we try to make it. Think of a tree standing in a field. If you were to try to find shade at high noon, you would have to sit right up next to the trunk. By mid afternoon the shade of the tree on the ground is much larger than at noon and in fact may be equal to the height of the tree. Late in the afternoon there is plenty of shade for all as it is much larger than the actual tree. This concept you understand. Well, what we are doing when we radiograph a tooth is actually casting a shadow of that tooth onto the film or sensor and we want that shadow to be as close to the size of the original object as possible so that we don't get elongation, foreshortening or magnification.

We will be taking radiographs in the lab so that you will become at ease with the techniques and be able to utilize this most important diagnostic tool when you return to your practice.

I would encourage you to purchase and read the radiographic text referenced in this paper.   This book is especially helpful and showing you normal developmental anatomy as well as developmental problems and dental anomalies.

Specialty Bandages
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In veterinary medicine, there are many different types of bandages which can be applied for various reasons. As a technician it is important to know how to apply and care for these bandages. Knowledge of the materials and how they behave is important to help maintain bandages on different types of patients. Why the patient needs a bandage will dictate which type of bandage to use and how long to go between changes. The Modified Robert Jones (aka Soft padded) and the Robert Jones are the most common bandages applied in veterinary medicine. Splints and casts incorporate the Modified Robert Jones. Slings are different as they are mainly used to restrict certain movements. They are composed mostly of elastic tape. Each bandage, splint, cast and sling requires maintenance and care from the client and veterinarian to ensure that it is not doing permanent harm to the patient.

A Modified Robert Jones is very similar to a Robert Jones. The supplies needed are 1" white tape, tongue depressor, cast padding, stretch gauze, bandaging tape and elastic tape. First apply stirrups to the patient. Cast padding is then applied with 50% coverage of the previous roll and from the foot proximally. Usually two to three layers of cast padding is sufficient. Stretch gauze is next and the bandaging tape is last again. The elastic tape is still used to protect the cast padding at the foot.

Careful case selection is required to achieve successful treatment of fractures with external coaptation. Splints are useful for young patients that tend to heal rapidly with transverse or incomplete fractures distal to the elbow or stifle. Molded splints are advantageous because of the low cost and ease of application, however they are preformed and do not necessarily fit all patients so they are usually used as a temporary device to decrease the pain while a patient is being transferred to a surgical facility. Begin by placing a Modified Robert Jones on the patient. For the comfort of the patient, the cast padding should be layered to closely resemble the shape of the given splint. The molded splint should be applied to the bandage after the stretch gauze and before the bandaging tape. The splint needs to go from the carpus/tarsus to the joint above the fracture for proper immobilization. However it is safer if the splint begins at the foot so the patient is bearing weight on the splint and extends to the joint above the fracture. Once the splint is in place, use the stretch gauze to wrap around the limb to keep the splint from moving. Continue with the bandaging tape and elastic tape as described above.

If a patient needs a splint for a long term basis a fiberglass splint can be custom fit. This is more comfortable for the patient if applied correctly. The supplies needed to apply a Modified Robert Jones will be used as well as bathroom tissue, spray bottle filled with water, exam gloves, correct sized fiberglass casting material and disposable plastic to protect the work surface from the casting material. Puppy pads or a plastic bag would work well. Once the stirrups, cast padding and stretch gauze are applied, one layer of bathroom tissue can be placed on the limb when applying the splint the first time. The bathroom tissue will prevent the cast from adhering to the stretch gauze while it is curing. Put on exam gloves and open the casting material, once open there is a limited amount of time to work before the material hardens. Measure the limb with the material and then lay it out on the sprayed plastic. Hint: it is easier to make the splint too long because it can always be cut before it hardens with scissors. After it has cured it can be cut with a cast saw. Create several layers by unrolling the material on top of itself until it is thick enough for the patient. Spray the splint with water to fully activate it. Smooth the splint out and place the smooth side of the splint on the limb. Use stretch gauze to conform it to the limb. It is more comfortable for the patient if the material is removed once it hardens and checked for sharp areas that

could become sores. Trim the splint if needed and re-apply with stretch gauze, bandaging tape and elastic tape.

A Spica splint is a special lateral splint used to stabilize fractures above the elbow or stifle or reduced elbow luxations. The application process is similar to that of the lateral splint except the supplies are doubled because the bandage is wrapped around the body in order to stabilize the shoulder or hip. Affix the stirrups to the patient and wrap the limb with cast padding, once at the proximal limb begin wrapping around the body. Do not wrap too tight, especially around the chest.   On the front limb a chest bandage will help to cover the scapula and stabilize the bandage. Make sure that the padding goes behind the opposite elbow of the shoulder that is wrapped in front of. This way it makes a "cross your heart" bandage. On the hind limb the bandage needs to be wrapped so the patient can urinate without wetting the bandage. This can usually be done by incorporating the opposite limb. Take the stretch gauze and start at the toes and wrap snug until at the body where compression should be minimal. Once again cover the area to be splinted with bathroom tissue to ease removal later. The Spica splint is started at the toes and extended proximally up the limb, across the scapula, and over the spine and to the opposite scapula. The measured piece is placed on the plastic and layered until it thick enough to immobilize the patient. Spray the splint and smooth it out before applying to the patient with stretch gauze. Bandaging tape is place over the gauze, taking care to wrap loosely around the body. Elastic tape is wrapped around the distal aspect and gently around the chest to help support the splint.

Tape hobbles can limit rotational stress on a limb and excessive adduction or abduction. Cast padding and elastic tape should be used for application. The first step is to wrap the metatarsal area with two layers of padding to protect the skin. Next, the elastic tape is wrapped around one metatarsus and stuck to itself on the medial side of the patient while the other end of the tape is placed around the opposite foot and stuck to itself. Usually this will need to be at least two layers to make sure that the tape does not come apart or stretch too much. Larger patients may need more layers and the seams may need to be wrapped so they do not split under pressure.

The 90-90 bandage can be used to maintain the hind limb in a flexed position which will prevent weight bearing. Young patients that have undergone a femur fracture repair can be placed in a 90-90 to possibly prevent quadriceps tie down. This bandage does not need to keep the patient in such as flexed position like the Ehmer. Elastic tape, non-adherent dressing or cast padding are recommended for the 90-90. Before applying the bandage, shave the hair on the medial and lateral side of the affected limb to facilitate better adhesion of the tape to the skin. Cover the metatarsus with the non-adherent dressing before wrapping it with the elastic tape. Flex the hock and stifle to 90°. Wrap the elastic tape from the medial side of the metatarsus proximally to the highest point attainable in the inguinal region. Wrap over the quadriceps laterally. Continue distally, behind the tarsus and then around the metatarsus from medial to lateral. If the wrap is not strong enough the bandage may be continued in the same pattern until it is suitable for the patient. Usually a minimum of two layers is required.

The Ehmer sling is an excellent bandage to immobilize a pelvic limb. This is needed in the case of a craniodorsal hip luxation where it is imperative that the leg maintain a flexed position with the stifle in and tarsus out. It may also be applied for fractures of the femoral head and neck, some acetabular fractures or after open reduction of a hip luxation. Supplies needed are elastic tape, non-adherent dressing or cast padding. As with the 90-90, the limb should also be shaved for the Ehmer. Wrap a non-adherent dressing or cast padding around the metatarsus. Step one: Lay the tape sticky side up. Start close to the tarsal joint with the elastic tape. Make a loop with the tape keeping the long end so it can go to the cranial portion of the quadriceps and stop at the hip joint. Cut the tape and repeat the same process two more times. Moving distal on the metatarsals and changing the location on the thigh. Step two: Wrap around

the metatarsus, from medial to lateral, continue over the lateral aspect of the cranial quadriceps and under the leg and out above the tarsus. Wrap over the distal tibia until the tape can stick to the piece coming from the metatarsal wrap. Cut the tape and repeat the same process two more times. This helps to push the knee in and the hock out. If a patient has a large leg, a belly band may need to be incorporated. Step three: Take the elastic tape from the metatarsal, lateral to the quadriceps, up over the back, under the belly and back to attach just above the metatarsus. For patient comfort and to decrease the amount of skin irritation a non-adherent pad may be used to cover the abdominal skin before the elastic tape is placed on the patient. If using a belly band the two extra layers from step two can be changed to the belly band method instead.

The bandage, slings, splints and casts described above may all be different but they all need to be cared for in a similar fashion. It is important to maintain them so minimal side effects occur. All of the signs that may show up if a problem is developing should be discussed with the client. It is very important that the owners understand how to care for their pet and the bandage. Bandages, splints and casts that should be changed immediately are those where the toes are swollen, a foul odor is present, wetness is present, there is a drastic change in shape, and/or the patient begins to show signs of discomfort such as chewing. If the patient develops a sore, the bandage should be changed more frequently. Helpful tips for the owners, such as using a plastic bag to cover the foot when taking their pet outside will keep the bandage dry and an Elizabethan collar to deter the pet from chewing or licking the bandage can help decrease the amount of unnecessary visits. The slings must be watched for partial limb swelling or sores. If an Ehmer is causing swelling around the stifle, relief incisions in the elastic tape should help. Sores can sometimes be protected with a non-adherent dressing. A handout and check up calls can be beneficial to the pets' care and to ensure that simple complications do not lead to unfortunate circumstances.

2019 Veterinary Technicians Conference

Abstract Submission and Case Report Competition Entry Form

Save this document as an Adobe file before you fill it in and save it. The completed competition application packet must be sent no later than 8 p.m. CST, May 24, 2019 to: Tamuvettechseminar@gmail.com. This address will only be monitored until the application deadline of May 24, 2019. After that time, any questions about the competition or the conference should be directed to mchodorow@cvm.tamu.edu or call 979-845-9102.

1. Full name, (first name, middle initial, last name)

Cherie R. Murphy

2. Degrees and credentials, (A VTS specialty should be identified)

Associates of Applied Science, LVT, VTS (surgery)

3. Your employer

Gulf Coast Veterinary Specialist

4. School and year graduated

Lonestar Tomball College 2000

5. Category of abstract/poster

A unique or successful clinical treatment approach

Biography (150 word limit to include where and when degrees obtained, years of experience, additional relevant professional information.)

Cherie graduated from Lonestar Tomball College with an Associates of Applied Science in Veterinary Technology in May of 2000 and began her career working for Gulf Coast Veterinary Specialists Surgery Department. Cherie has worked on the clinical floor, assisted with clinical study trials, and worked in the operating rooms assisting on a variety of specialty surgeries. She received her VTS in 2017 and remains an active member examination committee and the recertification committee. Cherie is a Member at Large on the VTS Board of Directors. Cherie actively works on the externship program for new technician students at GCVS. Her passions are to continually advance her knowledge of surgery and to support technicians to pursue individual goals in veterinary technology, bringing excellence to our profession.

Abstract: Cranial Mediastinal Mass in a Geriatric Feline

By Cherie Murphy, LVT, VTS-Surgery

A 17 year-old female spayed indoor only cat presented for evaluation of lethargy and dyspnea. On initial physical examination heart rate was 160 beats/min, respiratory rate was 32 breaths/min, mucous membranes were pale pink, CRT was <2, and temperature was 98.8 degrees F. An increased expiratory effort was observed. Pulses were strong and synchronous.

Blood analysis showed a PCV of 16% with a total protein of 8 g/dl. Thoracic radiographs revealed marked pleural effusion. The patient was sedated with 1.5 mg Torbugesic IV and thoracocentesis was performed. Two hundred mls of serosanguinous fluid was removed from the thoracic cavity. The fluid had a PCV of 12%, consistent with a hemorrhagic effusion. A whole blood transfusion was administered to treat the immediate symptoms of anemia (tachypnea), and post-transfusion the patient's PCV increased to 30%. Thoracic radiographs post-thoracentesis revealed a possible cranial mediastinal mass. The primary differential for the patient's anemia at this point was blood loss, likely secondary to a bleeding thoracic mass.

A thoracic CT scan revealed a 1.5 x 2.5 x 3.5 cm cranial mediastinal mass. An ultrasound-guided fine needle aspirate was performed. The cytology results from the fine-needle aspirate suggested possible sarcoma, but the diagnosis was not conclusive.

Thoracoscopy was selected to maximize mass visualization and to minimize iatrogenic damage to surrounding structures as compared to ultrasound-guided Tru-cut biopsy.

Thoroscopy was performed with the patient in dorsal recumbency. The cranial mediastinal mass was located and biopsied using a tru-cut biopsy device and a clamshell forceps. Hemorrhage was controlled with electrocautery and a vessel sealing device. Gelfoam was placed in the biopsy site to aid hemostasis. A thoracostomy tube was placed under thoracoscopic guidance. Portal incisions were closed routinely and blocked with liposome encapsulated bupivacaine. Intradermal skin closure was performed.

Histopathology revealed that the mediastinal mass was a poorly differentiated malignant neoplasia. The biopsied fragments contained primarily spindle to polygonal cells. Immunohistochemistry testing provided a definitive diagnosis of hemangiosarcoma. Options considered for treatment included: Median sternotomy with surgical mass excision, chemotherapy, radiation therapy, or some combination of these treatments. Life expectancy even with aggressive treatment was estimated to be 0-4 months. The owner felt that given the patient's age and short life expectancy, a conservative management approach was more appropriate than surgery. The patient survived 2 months before passing away at home.

2019 Veterinary Technicians Conference

Abstract Submission and Case Report Competition Entry Form

Save this document as an Adobe file before you fill it in and save it. The completed competition application packet must be sent no later than 8 p.m. CST, May 24, 2019 to: Tamuvettechseminar@gmail.com. This address will only be monitored until the application deadline of May 24, 2019. After that time, any questions about the competition or the conference should be directed to mchodorow@cvm.tamu.edu or call 979-845-9102.

1. Full name, (first name, middle initial, last name)
   Ashley K. Reeder

2. Degrees and credentials, (A VTS specialty should be identified)
   CVA II

3. Your employer:
   Mabank Animal Hospital, Inc.

4. School and year graduated Mabank High School 2012

5. Category of abstract/poster
   A unique or successful clinical treatment approach

Biography (150 word limit to include where and when degrees obtained, years of experience, additional relevant professional information.)

My name is Ashley Reeder and I am a CVA Level II. I have worked with large animals since childhood. I have worked as a CVA since 2016 under Dr. Darrell Kinnard at Mabank Animal Hospital, Inc. He has helped me obtain my CVA certifications. At our clin very mixed practice. The species we treat are widely varied; everything from rabbits, cats, dogs, bovine, equine, to bison and llamas. We have even treated some camels and black bears. My journey being a CVA has been an amazing journey thus far. My passion for this profession has only intensified as I learn and grow in my chosen field.

Ashley & Reeder
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CERIOUSLY RING THE BELL MAKE IT VERD
As we all know finding a cat with heartworms is rare, but did you know that there is something that is even rarer? This defect is not only an eyesore, but is tricky to repair. The procedure to fix the issue is both messy & tiring, but present an excellent teaching/learning moment. The end result gives one a rewarding feeling knowing that the eyesore has been eliminated without any lasting effects on the animal.