General anesthesia consists of four main periods, the peri-operative period, the induction phase, maintenance of the anesthetized patient and the recovery period. Although seemingly less critical the peri-operative and recovery period have become more closely studied as they can lead to adverse effects during the maintenance and the more critical recovery period where still more deaths occur.

**Peri-Operative period:** This period consists of multiple parts. Starting with a good and clear patient history is crucial, either form the owner using a history form or the attending clinician. As the anesthetist, you play a vital role in alerting the surgeon to a potential problem or issue that needs further investigation prior to anesthesia. If an underlying condition or problem exists the veterinarian may wish to postpone the procedure until a further diagnostic workup can be performed. You should also conduct your own physical exam as a baseline for the patients overall demeanor, vital signs (preferably when not stressed or excited) and assessing ASA status. What factors must be considered when assessing a patient's signalment and history?

- **Signalment:** species, age, breed, sex
- **Body weight**
- **Presenting complaint. duration and severity**
- **Symptoms of organ system disease:** diarrhea, vomiting, polyuria/polydypsia, seizures, behavior change, exercise intolerance, coughing, dyspnea, weight loss, poor body condition
- **Concurrent medications:** organophosphates, H, -blockers, antibiotics (e.g., aminoglycosides), cardiac glycosides, phenobarbital, nonsteroidal anti-inflammatories, calcium channel blockers, 13-blockers, catecholamine-depleting drugs
- **Previous anesthesia**
- **Allergies**
Classifications of ASA Status

<table>
<thead>
<tr>
<th>Category</th>
<th>Physical Status</th>
<th>Working Definition</th>
<th>Possible Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Normal, healthy adult patient (minimal risk)</td>
<td>“Young, healthy patient for elective procedure”</td>
<td>No obvious disease</td>
</tr>
<tr>
<td>II</td>
<td>Patient with mild systemic disease; pediatric (&lt;3 months of age) and geriatric patients (slight risk)</td>
<td>“Healthy patient that needs a procedure”</td>
<td>Skin tumor, fracture without shock, obesity, uncomplicated hernia, localized infection, cryptorchid, compensated cardiac disease</td>
</tr>
<tr>
<td>III</td>
<td>Patient with significant systemic disease (moderate risk)</td>
<td>“Systemic disease complicates anesthesia”</td>
<td>Fever, anemia, dehydration, cachexia, moderate hypovolemia</td>
</tr>
<tr>
<td>IV</td>
<td>Patient with severe systemic disease that is a constant threat to life (high risk)</td>
<td>“Systemic disease jeopardizes anesthesia”</td>
<td>Uremia, toxemia, severe dehydration, severe hypovolemia, cardiac decompensation, emaciation, high fever, significant anemia, diabetes</td>
</tr>
<tr>
<td>V</td>
<td>Moribund patient not expected to survive 24 hours with or without surgery (extreme risk)</td>
<td>“Patient will likely die with or without the procedure”</td>
<td>Extreme shock and dehydration, terminal malignancy or infection, advanced systemic disease (renal failure, hepatic failure, etc), severe trauma</td>
</tr>
<tr>
<td>E</td>
<td>Emergency</td>
<td>“Procedure is so emergent it cannot be scheduled”</td>
<td>Can be assigned to any of the above categories that require immediate intervention or surgery</td>
</tr>
</tbody>
</table>

- ASA status is **NOT** based on the type of procedure that is being done. Performing an advanced procedure such as a thoracotomy on a healthy patient would NOT make the anesthetic risk any higher than ASA I or II.

*Credit to Darci Palmer LVT, VTS (A&A) for the chart

Whenever possible baseline pre-anesthetic blood work is favorable. Depending on the ASA status of the animal the following can be used in determining the minimum diagnostics that should be evaluated.

<table>
<thead>
<tr>
<th>ASA Status</th>
<th>Less than 5 yrs old</th>
<th>5-10 years old</th>
<th>10 + years old</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>PCV, TP</td>
<td>PCV, TP</td>
<td>CBC, BUN, UA</td>
</tr>
<tr>
<td>II</td>
<td>PCV, TP</td>
<td>PCV, TP, BUN</td>
<td>CBC, BUN, UA</td>
</tr>
<tr>
<td>III</td>
<td>CBC, BUN, UA</td>
<td>CBC/Chem, UA</td>
<td>CBC/Chem, UA</td>
</tr>
<tr>
<td>IV</td>
<td>CBC/Chem, UA</td>
<td>CBC/Chem, UA</td>
<td>CBC/Chem, UA</td>
</tr>
<tr>
<td>V</td>
<td>CBC/Chem, UA</td>
<td>CBC/Chem, UA</td>
<td>CBC/Chem, UA</td>
</tr>
</tbody>
</table>

*Credit to Darci Palmer LVT, VTS (A&A) for the chart

Fasting periods have also been under review and in general the recommendations have become shorter.
Adult dogs and cats should be fasted from food for 6-8 hours prior to general anesthesia. This shortened time decrease the body's production of bile and stomach acid which can creep up the esophagus during lateral recumbency with general anesthesia as the esophageal sphincters are relaxed. Esophagitis is a common and often underdiagnosed condition that can prolong hospitalization and delay normal eating behavior.

Similar to rabbit anesthesia, prokinetic medications are also being recommended (when appropriate), especially for already debilitated or geriatric animals as GI stasis can occur with these patients. Volatile anesthetics do cause a decrease in GI peristalsis in all creatures. A single SQ dose of metoclopramide can be used pre-operatively as its best action is stomach clearing, also alleviating concern doctors may have with the shortened fasting times.

Finding out what other medication the patient has been on will be vital in the next part of the perioperative period, individualized anesthetic plan and drug protocols.

Emergency drug dosages should be calculated before every anesthetic event or easy access to the RECOVER emergency drug chart should be available.

A fluid pan should also be discussed as the once taught 10ml/kg/hr has fallen out of current recommendations. AAHA/AAFP published new fluid therapy guidelines for dogs and cats in early 2013 that can be found at (https://www.aahanet.org/PublicDocuments/Fluid_Therapy_Guidelines.pdf). Any time general anesthesia with inhalants is given to a patient, an IV catheter and IV fluid therapy should be administered as well. IV fluids help compensate for the vasodilation caused by the inhalants or premedication/induction agents and therefore can help minimize or prevent hypotension during anesthesia. Fluids also counteract fluid losses that occur during the procedure. Abnormal blood parameters and hypovolemia should be corrected prior to an anesthetic even whenever possible. Traditional parameters are used to estimate dehydration which include, blood work, skin turgor, mucus membranes and lethargy can be used as with the glossy appearance of the eye. The rate and amount of balanced replacement fluid (typically crystalloids) administration depends on the estimated rate of fluid losses and clinical status of the patient. Based on human and now more and more veterinary research it has become clearer that we have grossly overestimated insensible fluid losses. Demonstrations show that fluid lost through skin and airway added up to approximately 0.5 mL/kg/hr. Fluid loss increases to 2 mL/kg/hr with an open abdominal cavity. This increases to 8 mL/kg/hr when the abdominal cavity was open with organs and intestines exteriorized.

Pre-anesthetic medications as indicated in nearly every patient no matter which ASA status they fall under. Remember pre-anesthetic medications now include a prokinetic and when appropriate an antiemetic/nausea and potentially a proton pump inhibitor or H2 blocker if working with patients are susceptible to regurgitation by either condition, surgical manipulation or anatomy (brachycephalic breeds). Pre-anesthetic medications without a doubt provide a smoother, anxiety relieving induction while reducing the amount of general anesthesia required. The other added benefit is analgesia some of the agents can provide.

Opioids are the authors preferred drug choice for premedication and gas inhalation reduction (MAC sparing). Even the most critical patient can tolerate appropriate dosing of opioids. Relieving pain can also relieve stress.
Anxiolytics, such as midazolam, are also a preferred medication of choice by reducing the amount of opioids, anesthetic gas and systemic release of catecholamines stressed animals produce.

Dexmedetomidine has great clinical relevance with its sedative, anxiolytic and analgesic properties. This medication also has the added benefit of allowing opioids to better attach to receptor sites making the opioid essentially more effective. Micro doses have also been described to increase blood pressure by 10% effects, peripheral vasoconstriction and MAC reduction.

**Induction/Airway:**

It feels like every year we are bombarded with new products that will “revolutionize” the way we practice medicine. A product called the V-gel® caught my eye as an exotics and anesthesia guy back in 2014. The V-gel is a veterinary specific supraglottic airway device, also known as a laryngeal mask airway (LMA).

The company that makes the V-gel, Docsinovent®, currently has products for two species on the market, one for rabbits (Fig. 1) and one for cats. The company has made soft announcements of a canine, guinea pig and equine specific model in the near future. Before I continue, it is imperative that, as rational, intelligent and ethical practitioners, we evaluate each product we use very carefully, especially since one of our negative outcomes can be death of a patient. It is also imperative to overcome the hypnosis of sales representatives who are paid to market and sell a product with little to no experience after they catch us in a post-prandial state while walking through the conference exhibit floor.

Let’s start with the familiar. Traditional endotracheal intubation offers several benefits when it comes to anesthetic and resuscitative measures.
* A direct airway and reasonable protection from gastric or other fluid aspiration
* Effective ventilation and oxygenation
* Ability to suction the airway
* Delivery of anesthetic and other drugs through the endotracheal tube in emergencies

Some of the more lasting negative outcomes include:
* Inner tracheal lumen mucosal damage
* Respiratory resistance while intubated
* Increased dead space
* Focal ischemia and necrosis, tracheal tearing, tracheitis from traumatic placement and possibly secondary tracheal strictures

Appropriate technique, proper laryngoscopy placement, and management of staff performing the procedure can mitigate most of these risk factors.

Now the new school approach. When it comes to LMAs, we also have risk factors. Some of the more concerning are:
* Pharyngeal or laryngeal trauma
* Focal ischemia and necrosis
* Aerophagia
* Aspiration
* Anesthetic gas leakage
* Complete airway obstruction
* Lingual swelling with prolonged use

As with traditional endotracheal intubation, most of these complications are associated with incorrect placement and sizing of the device. Because LMAs are still new to the veterinary world, we are met with
a new learning curve regarding appropriate size and fit. Luckily, the V-gel have a sizing chart that can give a guideline for choosing the right tube based on patient weight. However, this sizing chart also has associated drawbacks, especially with obese or gravid patients. Choosing the right LMA should be based on the patient’s ideal weight. Other concerns associated with LMAs are the wide range of anatomical differences among breeds of rabbits and cats, in particular, brachycephalic breeds.

Human patients also complain of a sore throat and the feeling of pressure in the oropharyngeal space up to 72 hours after removal of the LMA, but this is also common with traditional endotracheal intubation. Human LMAs (Fig. 2), although used by some veterinary practitioners, are not designed for veterinary species and cannot be ethically advocated. Laryngeal mask airways do have a place in our ever-growing toolkit. They are perfect for non-invasive procedures like CT or MRI scans, patients undergoing radiation or animals that need to be anesthetized semi-regularly, such as in the research setting. The V-gels are excellent for the initiation of CPR. I personally find them particularly helpful in intubating rabbits, which are historically difficult to intubate. A stylet can be passed through the V-gel, then the V-gel is removed and an endotracheal tube is passed over the stylet, which is then removed once the patient is intubated. The devices are also useful in practices that rarely see rabbit patients or there is no staff appropriately trained in rabbit intubation. However, I would argue that these are the opportunities to learn.

Certain risk factors or procedures should exclude the use of LMAs, some of which include dental procedures, patients expected to have reflux, patients with laryngeal spasm, and procedures where the head will be manipulated or neck bent. Considerations need to be made if a mechanical ventilator is expected to be used as an excellent seal in imperative.

Monitoring

A holistic approach to the patient and watching trends rather than focusing on specific numbers is still standard. Keeping in mind certain numbers (MAP, SpO2) should use a goal directed approach, we do have some newer technologies making their way into our OR’s.

Cardiovascular perfusion and balanced fluid therapy is yet another fundamental part of traditional patient monitoring using subjective opinion or complicated machinery, until now. Advanced techniques to monitor such parameters can involve placing a central line for central venous pressure measurement or even placing and maintaining an arterial catheter. As we all know this may be difficult and not practical for the duration of a case or feasible in a certain species. Not to mention financially burdensome to the client or out of the scope of your practice’s needs and abilities. This, in turn, can lead to less effective treatment and response in our patients. The Masimo Radical-7 includes the features of Perfusion Index (PI) and Pleth-Variability Index (PVI). These are two newer monitoring parameters and can be very telling when obtained correctly. The perfusion index is the ratio of the pulsatile blood flow to the non-pulsatile or static blood in peripheral tissues. What this means is now we can monitor peripheral tissue perfusion in our patients non-invasively giving better insight into our fluid therapy management, cardiac/renal output, and efficacy of medications. A defined reference variable is not yet established in the canine or feline patient or any other species for that matter, other than humans, which tends to be quite broad. However, the PI parameter, as well as all of the other non-conventional parameters, is great for trending and monitoring. The PI is also a great tool for assessing the efficacy of opioids and epidurals. When full onset of the opioid or epidural occurs, we see a spike in the PI showing via vasodilation.
The Pleth Variability Index (PVI) is a new technology even in human medicine. It is a measurement of the change of perfusion index with a complete respiratory cycle. With this in mind, PVI is most reliable with patients undergoing mechanical ventilation. In a scientific abstract presented at the American College of Veterinary Anesthesiologists conference, one research group found that the PVI had a good correlation in detecting hypovolemia and return to normovolemia in dogs, but could not be used in definitively stating hypervolemia. Several more recent veterinary papers on PVI have come out with positive conclusions as to the reliability of predicting fluid responsiveness using this non-invasive tool.

**Recovery**
The recovery period, unfortunately, does not mean one is out of the woods with intensive monitoring. In fact a study showed that a majority of small animal anesthetic deaths occurred during recovery within three hours following extubation. Pulling a tube too soon may inhibit proper gas exchange, or the animal may be at risk for aspiration. Keeping the animal warm is one of the other bigger challenges. A common mistake seen in many practices is having the animal exposed. People understandably want to see the animal and assess breathing. Unfortunately leaving an animal exposed and uncovered increases their chance of becoming hypothermic, unless in a temperature controlled incubator. Patients after longer anesthetic events may have become hypoglycemic as well and may require glucose supplementation IV or orally. Restarting caloric intake is vital to a successful recovery and prognosis in many small animals. Tube feeding may be indicated in some critical animals, especially if a history of poor appetite or anorexia was present prior to the anesthetic event. Preferably IV access and fluids will be able to be maintained post anesthetic event and routine catheter care should be implemented. Appropriate analgesia is crucial in accommodating the patient’s comfort and ability to heal and should never be overlooked.

*References available upon request*