Determining the degree of hepatic dysfunction is of prime importance when developing the anesthesia plan for each individual patient. Congenital shunts are commonly diagnosed within the first year of life. This is important in that we must now also consider the age of the patient as well as recognize that most of them are “poor doers” being smaller in size with a decreased body reserve. The liver is responsible for lipid, carbohydrate and protein metabolism as well as storage and metabolism of many vitamins. It is also the storage organ for minerals, glycogen and triglycerides. It plays a major role in extramedullary hematopoiesis and coagulation. Metabolism and detoxification of compounds, endogenous and exogenous, is another role the liver plays that must be considered prior to sedation and or anesthesia.

It would not be unusual to see a concurrent anemia in these patients due to altered serum iron concentrations coupled with defects in iron transport. Hypoproteinemia and hypoalbuminemia are the rule vs. the exception. Hepatic enzymes are of course, increased indicating hepatocellular injury. We expect to potentially see decreased glucose levels as well as decreased blood urea nitrogen (BUN) and cholesterol levels.

Coagulation panels may indicate decreased ability to clot as the liver is a major player in the coagulation cascade. The liver is the site of all coagulation factor synthesis except factor VIII, von Willebrand factor, calcium and tissue thromboplastin. The liver is responsible for the activation of factor II, VII, IX and X. Would this patient be one that I would like to perform a buccal mucosal bleeding time on? Absolutely, as it gives me one more piece of information that can be of help during a surgical event.

Now, having said all of that, what options do I have when it comes to selection of analgesic and anesthetic agents? Let’s look at the pharmacology of some various agents.

Opioids – remember that the majority of our opioids are roughly 85-90% protein bound. With hypoproteinemia this means that more of our drugs are free to do the job they were hired to do so a decrease in dosage should always be considered. They are metabolized by the liver, so again, consider a decreased dose. Are opioids reversible? You may reverse them totally with the administration of naloxone. Remember that to reverse them totally not only takes away the sedation but also the analgesia effects.

The exception to the rule – remifentanyl is a rapid onset, noncumulative pure mu opioid that is metabolized by nonspecific tissue and plasma esterases.

Mixed agonists/antagonists – excellent agents for mild to moderate pain but they are difficult to reverse. They are metabolized by the liver.

Disassociative agents – Ketamine is metabolized by the liver but has no direct effect on hepatic function. Ketamine cannot be reversed.

Hypnotics – Propofol does have some hepatic metabolism, is short acting and possesses no analgesic properties. Etomidate, another hypnotic that is typically used in conjunction with a
sedative or opioid, as a single dose induction agent is rapidly hydrolyzed. Note that it is typically used in conjunction with another agent that might not be as “hepatic” friendly.

Inhalant agents – Isoflurane is reported to reduce hepatic portal vein flow while increasing hepatic arterial blood flow. The same may be said of sevoflurane.

Benzodiazepines – Midazolam, as a water soluble agent, would perhaps be considered the benzodiazepine of choice if it is available. It is typically short acting and may be reversed by the administration of flumazenil. Interesting fact about diazepam, resedation 6 to 8 hours post administration has been documented and is attributed to enterohepatic recycling of the metabolites of diazepam. It may also be reversed by the administration of flumazenil.

Phenothiazines – the most commonly used phenothiazine in companion animals is acepromazine. This agent is metabolized by the liver and exaggerated or prolonged duration is seen in those patients with impaired hepatic function. It cannot be reversed. Their use is not recommended in patients with hepatic insufficiency.

Alpha2 agonists – These agents undergo hepatic metabolism and while they may be reversed, their use is typically recommended for young healthy animals and is contraindicated in patients with hepatic insufficiency.

With this information in hand, we might consider the following protocols:

Premedication with – +/- Anticholinergic, heart rate dependent but please always have a dose calculated in case of urgent/emergent need.

Pure mu opioid of choice – hydromorphone 0.05mg/kg (very modest dose for normal patient)

Oxymorphone 0.05mg/kg. The typical dose for both of these agents is 0.1 – 0.2mg/kg. Remember that we can always start low and go higher if needed.

Induction – if there is no cardiovascular compromise, propofol IV titrated to effect. With the decreased dosage of the premedicant, calculate propofol at 4-6 mg/kg. Be aware that based on the effect of the premedicant, your induction dose may be even lower so remember to titrate to effect. Remember that it is not atypical for these patients to have decreased blood glucose due to their disease. Checking blood glucose post-induction will give you an indication of how to best provide supplementation of dextrose during the surgical procedure based on this reading.

Maintenance – If your facility has the availability of remifentanyl, this patient is an ideal candidate for CRI. It is expensive and does require familiarity of its use to maintain a nice, even surgical plane of anesthesia

Inhalant choice is typically dictated by the agent available in the practice. I do have a tendency to reach for sevoflurane myself as I am better able to more rapidly effect a change in plane of anesthesia with sevoflurane vs. isoflurane.

Patient monitoring should include the Academy of Veterinary Anesthesiologist (ACVA) patient monitoring recommendations as updated in 2009.

- Circulation - The objective of monitoring circulation is to ensure that adequate circulatory function is maintained and this may be achieved by the following methods.
- Palpation of peripheral pulses would include monitoring rate, rhythm and pulse quality. Additionally the evaluation of mucous membrane color and capillary refill time should be assessed.
• Auscultation of the heart beat by utilizing a stethoscope, esophageal stethoscope or other audible cardiac monitor. This may be achieved by either a continuous monitor or intermittent monitoring.
• Pulse oximetery should be utilized to determine the % of hemoglobin saturation.
• A continuous display of an ECG would detect any arrhythmias.
• Blood pressure may be monitored either by indirect or direct arterial pressures. Bearing in mind that these patients are typically hypoproteinemic and hypoalbuminemic, the use of a colloid in addition to a decreased rate administration of crystalloid IV fluid therapy should be considered to maintain blood pressure without causing further dilution of the patient’s proteins.
• Oxygenation - Pulse oximetery, this is more widely available, less invasive and ultimately more affordable. Blood gas analysis, this provides the oxygen partial pressure and requires advanced skills, and specialize monitoring equipment and lab equipment.
• Ventilation - Visualization of chest wall movement when possible to evaluate excursion, or movement of the rebreathing bag should the chest wall not be visible to the individual dedicated to patient monitoring. Utilization of a stethoscope to auscultate breath sounds, utilization of an esophageal stethoscope, or the use of an audible respiratory monitor. Capnography may be employed to assess the level of end tidal carbon dioxide being expelled. Arterial blood gases may be utilized in critical cases to appreciate carbon dioxide partial pressures. Depending on the machine you have in your facility, you may also be able to assess electrolyte values as well as blood glucose values.
• Temperature - should be monitored and recorded regularly in an attempt to maintain as closely as possible a normal body temperature and may be achieved by: Use of a rectal thermometer to obtain frequent intermittent readings. Temperature probe that is used either rectally or placed esophageal for continuous monitoring. It is further suggested that the patient’s body temperature continued to be monitored during the first several hours post general anesthesia. These patients are typically thin with little or no body fat and active heat support should be provided as soon as possible to maintain their body temperature.