Monitoring and treatment of hypovolemic shock in small mammals

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BLOOD PRESSURE MONITORING

Although there are several indirect or noninvasive methods (i.e., oscillometric and Doppler) available, it is sometimes impossible to obtain a reading on exotic patients. The Doppler method is more versatile than the oscillometric method, and is the method used by the author for all exotic patients. The ultrasonic Doppler flow detector (Parks Medical Electronics Inc., Aloha, OR) uses ultrasonic waves to detect and make audible blood flow in an artery distal to the blood pressure cuff. The ferret, rabbit or small mammal are placed in lateral recumbency. A pneumatic cuff is placed above the carpus, tarsus or on the tail base in a ferret. Hair is shaved between the carpal/tarsal pad and pads of the feet. The transducer probe crystal is placed on the shaved area (digital branch of the radial artery) in a bed of ultrasonic gel and taped or held in place. The cuff bladder is inflated to a suprasystemic pressure with cut-off of the Doppler signal. The cuff is deflated with the first sound heard and marked as the systolic pressure.

FLUID THERAPY-FERRETS, RABBITS, AND SMALL MAMMALS

The blood volume in the ferret and rabbit is 50-60 ml/kg in contrast to 90 ml/kg in the dog. When intravascular volume deficits result in poor perfusion, it has been recommended in the past that crystalloids be administered fast in volumes equivalent to the animals’ blood volume. However, resuscitation with crystalloids alone can result in significant pulmonary and pleural fluid accumulation. The resultant hypoxemia contributes to the shock pathophysiology.

Rabbits, ferrets and small mammals are difficult to resuscitate from hypotensive episodes. In the rabbit, when baroreceptors have detected inadequate arterial stretch, it has been found that vagal fibers are stimulated simultaneously with sympathetic fibers. As a result, the heart rate may be normal or slow, instead of the typical tachycardia demonstrated by the dog. This baroreceptor response may be similar in the ferret and other small mammals. In the authors experience, normal ferrets and rabbits have heart rates between 180-240 beats per minute (bpm), systolic blood pressure between 90-120mmHg, and temperatures between 100-102° F (37.7-38.8° C). Most ferrets, rabbits and small mammals presented for hypovolemic shock demonstrate heart rates less than 200 BPM, hypotension (systolic blood pressure less than 90 mmHg), and hypothermia (temperature < 98° F [36.6°C]).

Because cardiac output is a function of contractility and rate, the compensatory response to shock normally seen in dogs and birds is most likely blunted in ferrets, rabbits and small mammals. The hyperdynamic signs of shock seen in the dog and birds are not typically seen in the cat, ferret, rabbit and small mammals. Shock in the cat, rabbit, ferret and small mammal is most commonly decompensatory, manifested by normal or slow heart rate, severe hypothermia (<98 degrees F or 36.6°C), weak or non palpable pulses, and profound mental depression. The mucous membranes are gray or white and capillary refill is not evident. The bradycardia and low cardiac output contribute to hypothermia, and hypothermia accentuates the bradycardia.

HYPOTHERMIA

The hypothermia most likely plays a significant role in the poor compensatory response and to the difficulty in providing adequate fluid resuscitation without causing pulmonary edema. The theory is that as the rectal temperature falls, the adrenergic receptors become refractory to catecholamines. This leads to the normal or slow heart rate and most likely impaired compensatory vasoconstriction, in spite of the presence of norepinephrine and epinephrine. Part of the resuscitation plan in the rabbit, ferret and small mammal must include re-warming. Once the rectal temperature approaches 100 degrees F, it appears that the adrenergic receptors begin to respond to catecholamines. Temperatures during this rewarming phase must be checked frequently in all exotic species to prevent hyperthermia.

Resuscitation from hypovolemic shock can be safely accomplished with a combination of crystalloids and colloids and rewarming procedures. This animal must be handled as little as possible. Placement of an IV or IO catheter will facilitate fluid administration. Initial blood work is done to determine the packed cell volume (PCV), total protein (TP), glucose and azostick. In the hypovolemic ferret, rabbit, and small mammal, a rapid infusion of isotonic crystalloids is administered at 10-15 ml/kg. Hetastarch is administered at 5 ml/kg over 5-10 minutes. The blood pressure is checked and once it is above 40 mmHg systolic, then only maintenance crystalloids are given while the patient is aggressively warmed. The warming procedures should be done within the next 30 minutes to 1 hour with warm water bottles and warm-
ing the IV fluids. Active re-warming is required for patients with moderate to severe hypothermia and core temperatures below 95 degrees F. Active external re-warming can be accomplished by hot water bottles, heated blankets or a forced warm air blanket. Active external re-warming can be accomplished by hot water bottles, heated blankets or a warmed incubator for small animals. Forced air enclosed around the patient has proved effective in core re-warming in humans. Temperatures increased from 92 degrees F to 99 degrees F in 1 hour at the Animal Emergency Center using the forced air system (Thermacare®, Gaymar Industries Inc., Oakland Park, NY), which is a system of disposable plastic and paper covers and a heat source that directs warm air across the skin. This system simultaneously provides convective heat transfer and shielding against radiant heat loss.

**REFRACTORY SHOCK**

If cardiac function is normal, and glucose, acid-base and electrolytes abnormalities have been corrected, treatment for nonresponsive shock is continued. Oxyglobin® has not been approved for use in the cat, ferret, rabbit or small mammal, but has been used successfully at our hospital when given in small volume boluses. Cats, ferrets, rabbits and small mammals do not tolerate rapid, large volume boluses as given in the dog and birds. Cats and ferrets appear to be more predisposed to rapid onset of pulmonary edema when large volume boluses are given (this is assumed to occur in the other small mammals). At the Animal Emergency Center we titrate 2 ml/kg boluses given over 10-15 minutes until normal heart rate and blood pressure (systolic blood pressure greater than 90 mmHg) are obtained. This is followed by a continuous rate infusion of oxyglobin® at 0.2-0.4 ml/kg/h. The author has used 7.5% hypertonic saline for resuscitation of refractory shock when Oxyglobin® is not available. Use 3 ml/kg of 7.6% hypertonic saline and 3 ml/kg of hetastarch. Give as a slow bolus over 3 to 5 minutes. This may be repeated as a second bolus until systolic blood pressure is greater than 90 mmHg. If the blood pressure is below 90 mmHg systolic, then consider using a continuous rate infusion (CRI) of dopamine (5 mcg/kg/min CRI).