Review of Fluid Therapy in Acute Blood Loss

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Permissive hypotension and increased use of plasma and fresh, warm, whole blood instead of crystalloid fluids may benefit equine patients with acute blood loss. Author’s address: Hagyard Equine Medical Institute, 4250 Iron Works Pike, Lexington, KY 40511; e-mail: mfrazer@hagyard.com. © 2013 AAEP.

1. Introduction

Acute blood loss in the veterinary patient is an emergency that many practitioners must manage in the field or hospital setting. Diagnosis may be obvious in cases of external blood loss, whereas internal blood loss may be more difficult to determine. Acute hemorrhage can occur into the peritoneal, pleural, or pericardial cavities; reproductive tract; gastrointestinal tract; guttural pouches; joints; and muscle tissue. In the equine patient, common causes include trauma, rupture of a vessel in the reproductive tract in pre- or post-foaling mares, fractured ribs in foals, and inadequate hemostasis during surgery. History, physical examination, ultrasound examination, and blood work aid in diagnosing acute hemorrhage as well as assessing the severity and determining the cause.

In hemorrhage, the number of circulating red blood cells decreases, and the oxygen-carrying capacity of the blood is compromised. Initially, physiological responses are able to compensate and maintain blood pressure with transcapillary refill, tachycardia, tachypnea, and systemic vasoconstriction. When significant volume is lost, the body can no longer compensate for the blood loss, and hemorrhagic shock occurs. In this situation, adequate tissue perfusion and oxygenation cannot be maintained. This eventually leads to organ dysfunction and cardiovascular collapse.

Patients with blood loss can be placed into one of four categories as defined by the American College of Surgeons. Category 1 is loss of \( \leq 15\% \) of blood volume. Transcapillary refill typically compensates for this loss and maintains blood volume and blood pressure. Category 2 is loss of 15\% to 30\% of blood volume. Compensatory mechanisms such as tachycardia and tachypnea occur, and sympathetic vasoconstriction can typically maintain blood pressure. Category 3 is loss of 30\% to 40\% of blood volume. Compensatory mechanisms can no longer maintain blood pressure, and decompensated hypovolemic shock occurs. Organ dysfunction, such as acute renal failure, may occur from decreased tissue oxygenation. Decreased urine production and hypotension occur. Category 4 is loss of >40\% of blood volume. Patients in this category require immediate emergency treatment, and changes in blood pressure and perfusion may not be reversible.

The goal of treatment in patients with acute blood loss is preventing hemorrhagic shock while also preventing further loss of blood. Two areas of controversy have occurred as to how best to accomplish this goal: fluid type and volume to be administered.

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2. Materials and Methods

A review of literature from the past 10 years describing fluid resuscitation for acute blood loss in human medicine was undertaken. Current trends in fluid choice and volume of fluid administered were reviewed.

3. Results

In human medicine, a strategy has been developed called Damage Control Resuscitation (DCR) to resuscitate patients with acute hemorrhage. The goal of DCR is early prevention and/or treatment of the lethal triad. The lethal triad consists of coagulopathies, hypothermia, and acidosis. Metabolic acidosis occurs from hypoperfusion leading to organ/tissue damage from decreased oxygenation and a switch to anaerobic metabolism. Hypothermia results from hypoperfusion and, if used in treatment, the use of cold resuscitation fluids. Coagulopathies primarily occur from hypoperfusion and tissue trauma. Other factors including loss of procoagulant proteases, dilution of blood from fluid resuscitation, and organ dysfunction from acidosis and hypothermia also potentiate coagulopathies.

One of the key points in the DCR resuscitation plan is permissive hypotension. A minimum volume of intravascular fluid replacement is administered at a rate to maintain mean arterial blood pressure at 50 mm Hg and systolic blood pressure at 80 mm Hg. These pressures are considered sufficient to maintain organ perfusion without potentiating hemorrhage. Proponents of DCR cited a 40% survival rate in DCR-resuscitated patients versus a 16% survival rate in patients not undergoing DCR resuscitation strategies.

DCR protocol recommends minimal administration of crystalloid fluids to maintain blood pressure in a range closer to normal to preserve organ perfusion and prevent hypovolemic shock. The risk of limiting fluid therapy is hypovolemic shock and subsequent cardiovascular collapse. Without appropriate fluid volume, organs do not receive adequate perfusion and oxygenation. In opposition, some clinicians advocate more liberal use of crystalloid and colloid fluids to maintain blood pressure in a range closer to normal to preserve organ perfusion and prevent hypovolemic shock. The risk with this method is that further hemorrhage may occur.

Veterinarians also vary in what fluid should be used in resuscitation. Crystalloid fluids are typically inexpensive, easy to administer, and readily available to most practitioners. However, the majority of the fluid rapidly leaves the vascular compartment and moves to the interstitial space. Colloid fluids are more expensive and require specialized equipment to administer. Fresh, whole blood requires the presence of a donor and ideally, a laboratory to perform a cross-match. Plasma requires refrigeration for storage. Both require specialized IV lines with a filter designed for administration of blood products. Anaphylactic reactions may occur with either. Hydroxyethyl starch, a synthetic colloid, does not require refrigeration or specialized equipment to administer, but it has been associated with coagulopathies. Also, colloids may increase the blood pressure more than desired and may potentiate further bleeding.

Extrapolating data and strategies from human medicine and applying it to veterinary medicine may assist the veterinarian in establishing a treatment plan for resuscitative fluids in acute hemorrhage cases. Application of DCR strategy to veterinary medicine will guide the practitioner in choice of resuscitative fluid in hemorrhagic shock. Plasma and potentially warm whole blood should be the initial resuscitation fluid. Plasma provides additional clotting factors. Warm blood is used to prevent hypothermia because the coagulation cascade is less effective at lower body temperatures. Fresh, whole blood is preferred over packed red blood cells. Interestingly, this practice is already routinely performed in equine medicine because a blood bank with packed red cells from equids is not available.

DCR protocol recommends minimal administration of crystalloid fluids because they dilute coagulation factors and may increase coagulopathies. However, in the equine patient, financial constraints and availability of colloids may prevent administering the volume of plasma and whole blood needed to maintain mean arterial blood pressure at 50 mm Hg. Crystalloid fluids, therefore, are required in these cases.
Historically, hemoglobin and hematocrit levels have been utilized to determine when blood transfusions should be administered. However, these clinical parameters are not reliable transfusion triggers because they are unreliable indicators of blood loss severity. In acute blood loss, red blood cells and plasma are both lost; therefore, hematocrit and hemoglobin do not change until transcapillary refill and other compensatory mechanisms occur. In addition, treatment with intravenous fluids will dilute but not alter the total number of circulating red blood cells. Therefore, the hematocrit decreases even if the number of red blood cells remains unchanged. In species that have a large reservoir of red blood cells in the spleen (such as the horse), the hematocrit alters rapidly with splenic contraction and may initially increase even in patients with severe blood loss.

Application of DCR strategy will also aid in determining the volume of fluid to administer in hemorrhagic shock. The goal of DCR is permissive hypotension. A volume of fluid is administered that maintains the mean arterial blood pressure at 50 mm Hg or the systolic blood pressure at 80 mm Hg. Measuring blood pressure in the equine patient to obtain the ideal pressure readings is difficult. Many field or hospital practitioners will not have equipment to accurately measure blood pressure. If a practitioner rarely encounters a case of hemorrhagic shock, justifying the cost of the equipment may be challenging. Even when equipment is available, obtaining frequent, reliable blood pressure readings may be impossible and potentially dangerous to the veterinarian or technician. Horses with blood loss may exhibit colic signs, ataxia, or change in mentation. Therefore, the blood pressure cuff may not be maintained in the correct position, and readings may be unreliable. Even if blood pressure readings are not obtained, other parameters may be utilized to determine if fluid resuscitation is adequate to maintain organ perfusion. DCR strategy advocates fluid therapy until the radial pulse can be palpated. In the equine patient, lack of peripheral pulses and cold extremities suggest hypoperfusion. Abnormalities in creatinine, blood urea nitrogen, and electrolytes are indicators of potential renal dysfunction. When these parameters are altered from the reference range, renal damage from hypoperfusion should be considered and fluid therapy must be adjusted.

Applying the DCR strategy of permissive hypotension and administration of plasma and fresh, warm blood to equine patients with acute hemorrhage may assist the veterinary practitioner in successful treatment of these cases. Limiting factors with this strategy are having the appropriate equipment to monitor blood pressure and having access to plasma or whole blood. However, physical examination and blood work parameters may compensate for lack of equipment. The DCR strategy needs further evaluation in equine medicine, but it may become the standard of care in resuscitation of equine patients with hemorrhagic shock.

References