Treating systemic shock in adult equine patients

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Veronica completed a Bachelor Degree in Veterinary Nursing in 2004. On qualifying, she worked in a small animal practice in South Wales before moving to an equine practice in 2009. After a years' experience in a first-opinion practice she moved to Newmarket and is currently working at Rossdales Equine Hospital, where she is enjoying the challenges of referral nursing. Veronica qualified as an equine nurse in 2013 and has a special interest in intensive care and wound management.

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Introduction

Systemic shock is a condition of acute circulatory failure, which if not controlled or prevented, can disturb a system enough to drive it out of equilibrium. This is when organ systems start to shut down and multi-organ failure progresses to death.

Shock is usually a consequence of other systemic responses such as sepsis, endotoxaemia and/or Systemic Inflammatory Response Syndrome (SIRS). Sepsis is one of the most common causes of shock in the horse, leading to a high morbidity and mortality rate in critically ill patients. It presents with multifactorial aetiology with variable signs, and is gradually becoming better understood.

Since 1991 when the American College of Chest Physicians (ACCP) and the Society of Critical Care Medicine (SCCM) published a consensus defining sepsis (known as Sepsis-1), veterinary specialists adopted it to provide consistency among practitioners (Taylor, 2015). In 2017 the definition was reviewed and a new proposal from the SCCM and European Society of Intensive Care Medicine (ESICM) was recommended. Sepsis-3 is now defined as a "life-threatening organ dysfunction caused by a dysregulated host response to infection" (Marik & Taeb, 2017). SIRS and bacteraemia are still the main hallmarks for sepsis, but septicaemia is no longer thought to be a consistent factor, as it depends on the pathogen type, the location and duration of exposure (Gul, Arslantas, Cinel, & Kumar, 2017). In horses this is believed to be true as patients with gastrointestinal disturbances usually show signs of endotoxaemia, caused by translocation of bacteria due to ischaemia–reperfusion injuries (Moore & Barton, 1998).

Endotoxins (lipopolysaccharide molecules from Gram-negative bacterial cell walls) activate the immune response by binding to the acute-phase protein of leukocytes, neutrophils, macrophages and endothelial cells, as well as stimulating cytokine release, which is part of the inflammatory cascade. Horses seem extremely sensitive to these effects, triggering an excessive and unbalanced stimulus causing hypotension and metabolic acidosis (Werners, Bull, & Fink-Gremmels, 2005). Whether it is an infection-triggered inflammation or a sterile inflammation, these complex haematological, immune and inflammatory mediators, if left untreated, may result in systemic shock, multi-organ failure and, with time, death.

Clinical signs for disorders causing systemic shock

Due to the variable presentation of the disorders causing shock it is important to recognise clinical signs prior to systemic shock developing.

Early recognition and understanding the multifactorial aetiology is fundamental for generating appropriate and effective treatment. In human patients exhibiting signs of SIRS it has been shown that early recognition will substantially improve survival by about 50% and subsequently reduce the number of patients developing systemic shock (Andaluz & Ferrer, 2017; Gray, 2017). There are as of yet no defined criteria in equine veterinary medicine for SIRS; however, in people the physiological parameters include body temperature, respiratory rate, heart rate and an abnormal leukocyte count (Taylor, 2015). Due to the lack of data for equine patients, the human parameters are generally adapted. In the 2017 review, further parameters were added including blood pressure, coagulation factors, and mentation (**Table 1** – Marik & Taeb, 2017). More research is needed to evaluate if these clinical signs can be of significance to equine veterinary medicine.

General clinical signs such as reddened mucous membrane colour and prolonged capillary refill time is a sign of compromised peripheral perfusion either due to

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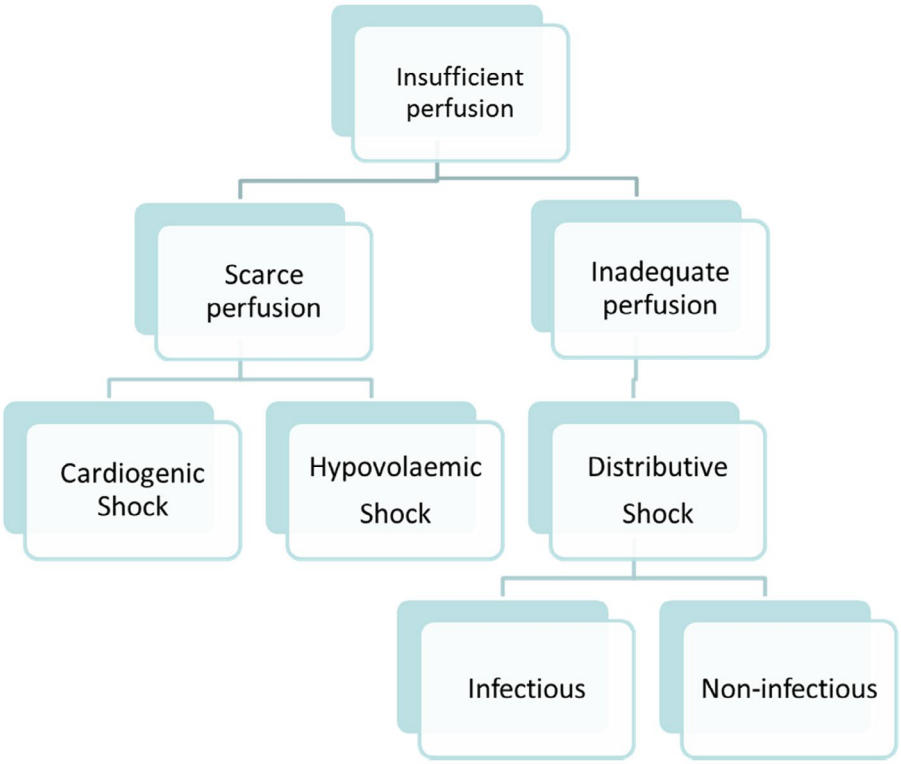

Figure 1. An illustration of the different types of shock.

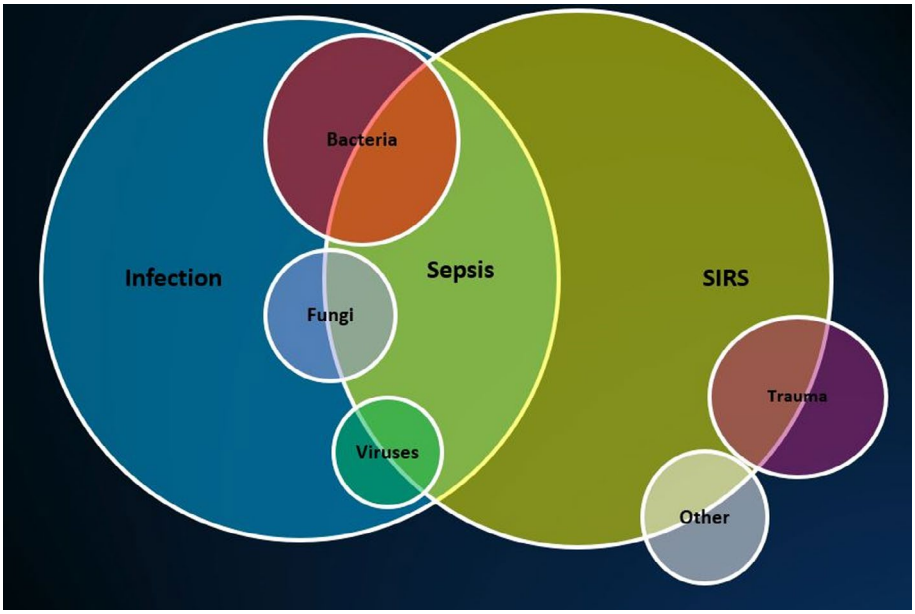

Figure 2. The multifactorial aspect of disease processes leading to shock.

hypotension, hypovolaemia, acid-base and electrolyte disorders or endotoxaemia. These signs should be treated promptly with intravenous fluid therapy to prevent the patient developing systemic shock.

Laminitis is a secondary condition commonly developed in patients suffering from SIRS and multi-organ failure, due to the hydrodynamic effects that involve the lamellar structures during hypotension and poor tissue perfusion. Decreased digital blood flow and intravascular microthrombosis have been implicated as a cause for sepsis-related laminitis (Belknap & Black, 2012).

Other biomarkers such as L-lactate, bilirubin and creatinine have been noted as useful parameters, but these are usually used to further evaluate the patient for the presence of infection and/or organ dysfunction after the present criteria have been identified (Andaluz & Ferrer, 2017; Gray, 2017; Marik & Taeb, 2017).

Treatment

Because of the diverse presentation of the disorder, many clinical signs will be more specific to associated conditions.

Patients may benefit from intravenous fluid therapy to restore or maintain adequate perfusion. Colloids and crystalloid fluids are both advantageous for the resuscitation of patients in shock (Tavanaeimanesh et al., 2015). The choice of fluid will be determined by the patient's need to reach normovolaemia. Isotonic crystalloids (such as Hartmann's or Lactated Ringers Solution) should be administered at a replacement rate of 20 ml/kg, bolused over 30 min (Taylor, 2015).

For more severe hypovolaemic patients, colloids may also be indicated, as a smaller volume of fluid is required to achieve the same resuscitative effect. Both natural and synthetic colloids are available for use in veterinary medicine; however, due to the increased cost of plasma, synthetic colloids may be the only affordable option. The use of hetastarch should be used with caution as its use has been associated with acute renal injury in human patients (Tavanaeimanesh et al., 2015; Taylor, 2015). Alternatively, 7.2% hypertonic saline can be used in the short term, to avoid the potential problems of synthetic colloid use, but must be accompanied with a maintenance rate (2.5 ml/kg/h) of isotonic crystalloids (Tavanaeimanesh et al., 2015). RVNs should monitor patients continuously for any signs of fluid overload (oedema, urine output and blood pressure) or other fluid-related complications such as electrolyte imbalances (Borer & Corley, 2006).

Although the clinical signs for laminitis are only detectable later in the disease process, maintaining adequate perfusion as well as anticoagulant and anti-inflammatory therapy has been shown as beneficial. Cryotherapy is also an effective prophylactic strategy that is believed to diminish histological changes in early laminar inflammation (Kullmann et al., 2014). Applying ice-boots to the patient's feet have been shown as a good strategy for obtaining sufficient cold therapy.

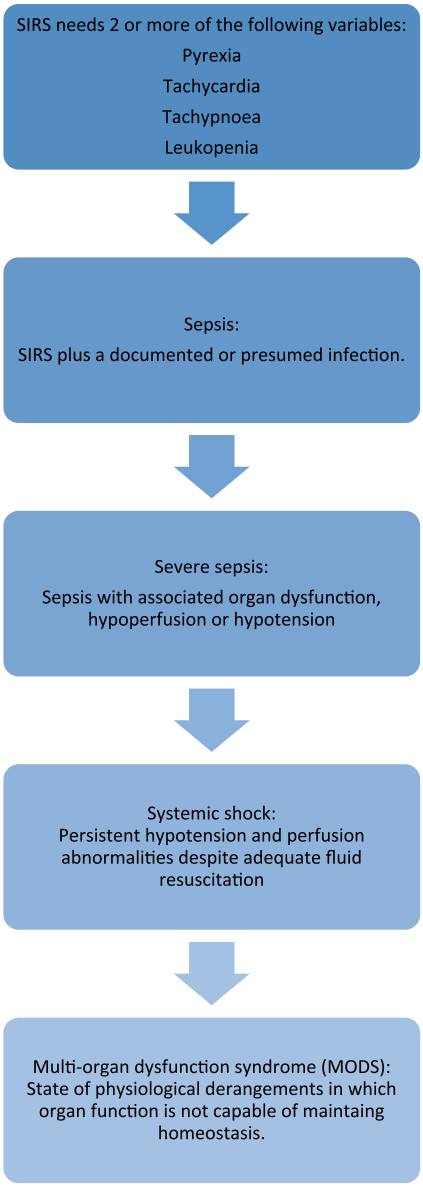

Figure 3. Clinical cascade to systemic shock.

Figure 4. Red and congested mucous membranes of a horse with endotoxaemia.

The boots need to be topped up with ice regularly and the feet monitored carefully for signs of deterioration. Assessing heat around the hoof capsule and monitoring digital pulses should be a standard check performed regularly by the RVN.

The use of non-steroidal anti-inflammatory drugs (NSAIDs) is the conventional approach to addressing the inflammation associated with SIRS and other associated conditions. Flunixin meglumine (0.25 mg/kg IV QID) is known to be the most effective NSAID in controlling inflammation associated with SIRS. Studies have shown that using a combination of flunixin meglumine and pentoxifylline has a profound effect (Werners et al., 2005). Using steroids in septic patients is controversial, but glucocorticosteroids have been used to inhibit inflammatory mediators and at a

Figure 5. A mare wearing ice boots made out of the legs of jeans. © Bonny Millar

Table 1. Parameters for SIRS.

Hypothermia or hyperthermia
Tachycardia
Tachypnoea or hyperventilation
Leukopenia, leucocytosis or > 10% band neutrophils
Hypotension
Coagulopathy
Change in mental status

Breton (2012); Mark and Taeb (2017); Taylor (2015)

low dose this may prove beneficial (Taylor, 2015; Werners et al., 2005). Polymixin B (a peptide antimicrobial drug) has exhibited anti-endotoxin effects and there are many studies supporting its use in septic patients (Barton, Parviainen, & Norton, 2004; Wong et al., 2013). However, caution should be taken with patients showing signs of hypovolaemia or kidney disease, as at the recommended dose (1000–6000 U/kg QID), there have been reports of nephrotoxicity (Taylor, 2015). Although antimicrobial resistance should always be a concern, it may be appropriate to use a broad-spectrum bactericidal approach (Taylor, 2015). Subsequently, targeted therapy can then be implemented after sensitivity results are returned.

Coagulation abnormalities also commonly occur due to the inflammatory processes of the disorder. Initially, the patient advances to a hypercoagulable state developing microthrombi, leading to ischaemia and multi-organ dysfunction. Once the coagulation factors have been consumed, the patient enters a hypocoagulable state characterised by petechiation or ecchymosis of the mucosa, spontaneous epistaxis or prolonged haemorrhage after nasogastric intubation (Gray, 2017; Taylor, 2015). Low molecular weight heparin has been used (50 iu/kg, SC q. 24hrs) in an attempt to reduce the risk of microthrombi when the patient is at a hypercoagulable state and studies have shown that it can reduce the incidence of laminitis (Taylor, 2015). However, there is a risk of worsening the symptoms of hypocoagulation when the patient develops this state.

Assessment

Microthrombi and decreased blood flow to the brain are believed to have adverse effects to mentation in human sepsis patients. The Glasgow Coma Scale is commonly used to determine mental state in human intensive care units and is currently a parameter used to assess patients at risk of developing sepsis (Marik & Taeb, 2017). Several studies have been done on assessment of mentation in dogs after head trauma, but not as an indicator of sepsis (Gray, 2017). No equine studies have been found on the assessment of mentation. However, behavioural pain scoring is frequently used and could therefore be adapted when nursing a septic patient (Gleerup, Forkman, Lindegaard, & Andersen, 2014).

Due to the variable presentation of the disorder general patient needs should never be discounted, and the patient should always be treated holistically. Anorexic patients should be encouraged to eat, blood glucose monitored, and dextrose supplementation considered if necessary (Taylor, 2015). Patients should be monitored very carefully on a regularly basis and signs of deterioration noted. A good understanding of the pathophysiological processes will allow rapid and appropriate treatment to optimise chances of recovery.

Prognosis and conclusion

The ideal treatment for systemic shock is prevention. Survival rates in adult horses vary considerably depending on the progression of the primary disease and the amount of perfusion compromise that occurs.

Recognition and close monitoring of risk patients requires a proactive approach, reversing the effect before the inflammatory response has developed a dynamic of its own. The main goals in successfully treating sepsis are: restoring organ perfusion, correcting systemic blood pressure and normovolaemia, blocking production of inflammatory mediators, treating underlying inciting factors, and attempting to rebalance the clotting system. Ultimately, rather than a "one size fits all" approach, a more tailored treatment plan for each patient is preferred.

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