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Nursing the sepsis patient - part 1

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ABSTRACT: This two-part article aims to provide the knowledge and understanding for nurses to gain the confidence necessary to provide care for patients with sepsis in a critical care environment. It includes a critical care framework which can be utilised to implement the nursing interventions and assessments which are necessary to provide holistic nursing care to these patients.

KEYWORDS: sepsis; critical care; ECC; ICU; nursing care

Glossary of terms

Coagulopathy: a disorder of blood coagulation
Colloid osmotic pressure: a form of osmotic or oncotic pressure induced by proteins which helps to maintain intravascular volume
Distributive shock: Shock due to vasodilation which can lead to poor blood flow to vital organs
Extravasated: The escape of fluid from the blood vessels
Hypermetabolic: an increase in the normal metabolic rate and energy requirement
Hypoperfusion: inadequate delivery of blood and oxygen to body tissues
Hypovolaemic shock: Shock due to reduced blood volume
Hypoxaemia: deficient oxygenation of the blood
Normotension: Blood pressure within the normal limits
Pathophysiology: The study of the physical and biological abnormalities as a result of the disease
Polycythaemic: a high concentration of erythrocytes
Splanchnic circulation: blood flow to the gastrointestinal organs
Vasopressors: drugs to cause vasoconstriction to increase blood pressure

Introduction

Systemic inflammatory response syndrome is a life-threatening response to an overwhelming systemic inflammation and is termed sepsis when in response to infection and has a high mortality rate (Devey, 2019). The most common source of infection being from septic peritonitis, but it can be due to any infection (Figure 1).

It is important that a knowledge of the pathophysiology and the potential effect on each body system is understood and as with any condition, it is important to provide holistic nursing care. The challenge with that is sepsis is such a complicated disease process, it is therefore recommended to use a framework designed for critically ill patients. Kirby's rule of 20 (Kirby, 2013; Figure 2) includes 20 parameters which must be evaluated in critical patients, to aid effective monitoring and support of the sepsis patients (Waxman, 2020). The nursing considerations of number 1–10 are outlined in this article and number 11–20 will be outlined in part two.

Systemic inflammatory response syndrome

Sepsis occurs due to an overwhelming inflammatory response triggered by infection which dysregulates the inflammatory system, immune system and haemostasis, including the coagulation system which can lead to multi-organ dysfunction syndrome and disseminated intravascular coagulation (Chan & Li, 2014; DeClue, 2015). Detailed, extensive hospital records are necessary for sepsis patients as well as a specific critical care hospital chart to enable all nursing interventions and vital signs to be recorded, along with all drugs given. Each intervention must be noted on the record to allow all staff involved in the case to have an accurate illustration of the patient's status at any time. Due to the complicated nature

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- Septic peritonitis
- Pyothorax
- Pyometra
- Aspiration pneumonia
- Gastro-intestinal disease
- Parvovirus
- Infected burns

Figure 1. Causes of sepsis.

of sepsis, it is likely that the plan will continually evolve throughout each day and this must be reflected in the hospital record, as shown in the Veterinary Hospital in the University of Pennsylvania ICU record.

1. Fluid balance

As with any patient, it is important that fluid "ins and outs match" so these should be calculated to maintain homeostasis. Urine output should be calculated every four hours in ml/kg/hr, this is simple if an indwelling urinary catheter is in place. If not, it is possible to collect samples in a dish, or weigh incontinence sheets assuming that 1 g = 1 ml of urine. It is important to include fluid from drains when calculating fluid output (Haskey, 2015). The fluid output should be 1–2 ml/kg/hr and intravenous fluid therapy (IVFT) should be adjusted to maintain this.

Sepsis patients often present with both hypovolaemic and distributive shock as well as dehydration. It is important to correct the dehydration and improve the hypovolaemia; however, the distributive shock and blood pressure (BP) will not improve with fluid resuscitation alone due to vasodilation and capillary leakage of fluids into tissues. Synthetic colloids may help to increase colloid osmotic pressure (COP) by increasing intravascular volume; however, there is an increased risk of coagulopathy; so consideration must be given to decide whether the risks are appropriate to warrant their use. Continual unsuccessful attempts of fluid resuscitation can increase extravasated fluid and contribute to tissue oedema which can compromise organ function (Haskey, 2015).

Hypertonic 7.2–7.5% saline can be used to increase intravascular volume, as it has a large osmotic gradient which works by drawing interstitial and intracellular fluid into the vasculature.

1.	Fluid balance	11.	GI motility and integrity
2.	Oxygenation and ventilation	12.	Nutrition
3.	Blood Pressure	13.	Renal function
4.	Heart rate, contractility, rhythm	14.	Coagulation
5.	Glucose	15.	Immune status, antibiotics
6.	Body temperature	16.	Drug dosage and metabolism
7.	Albumin	17.	Wound care and bandages
8.	Electrolytes	18.	Pain control
9.	Mentation	19.	Nursing care
10.	RBCs and haemoglobin	20.	Tender loving care

Figure 2. The rule of 20 (Kirby, 2013).

2. Oxygenation and ventilation

The patient's respiratory rate (RR), effort and pattern should be observed without disturbing the patient to enable an accurate assessment and avoid alterations due to stress. An increase in RR may be due to increased oxygen demand (Devey, 2019). There is a risk of pulmonary oedema with crystalloid use due to the decreased COP and increased capillary leakage.

The oxygen status of the patient should be monitored frequently to ensure that the patient is oxygenating efficiently. The gold standard method of performing this is arterial blood gas analysis, which requires the placement of a cannula into an artery, usually the dorsal pedal artery. This can be technically challenging and may be more commonly utilised at referral and emergency hospitals. Pulse oximetry is readily available and can be used to monitor the oxygen bound to haemoglobin in arterial blood, (SaO_2) as a percentage. Partial pressure of oxygen (PaO_2) < 80 mmHg or SaO_2 < 95% indicate hypoxaemia, PaO_2 < 60 mmHg or SaO_2 < 90% indicating this as severe (Savino & Sierra, 2018).

If respiratory distress or hypoxaemia is evident then oxygen should be supplemented to the patient utilising the least stressful method possible, either by flow-by, an oxygen kennel or tent, nasal prongs or cannula (Savino & Sierra, 2018). Auscultation of the entire lung field is necessary to localise abnormal sounds and it is important to remember that aspiration pneumonia and pyothorax can be the sources of infection contributing to sepsis (Haskey, 2015). Ultrasound and/or radiography should be performed to confirm the cause if either of these are suspected (Devey, 2019). If the patient is becoming distressed due to dyspnoea, then light sedation may be required to enable them to settle and avoid exacerbation of the condition (Haskey, 2015).

3. Blood pressure

Normotension is difficult to maintain in the sepsis patient due to multiple factors. The decrease in COP is difficult to improve due to the increased capillary leakage and inappropriate vasodilation involved in distributive shock. Once hypovolaemia and dehydration have been addressed, the arterial BP fails to respond to crystalloid boluses. Vasopressors are usually necessary to maintain the BP which should be initiated early alongside IVFT treatment of hypovolaemia. Noradrenaline is a catecholamine which has profound vasoconstrictive effects and helps to redirect the blood flow from the peripheral to the central circulation. It is the recommended first choice of vasopressor to be delivered as a constant rate infusion (CRI), starting at the lowest end of the dose range and titrating the dose to effect to maintain the mean arterial pressure > 65–70 mmHg. The lowest effective dose is important as noradrenaline causes vasoconstriction of the splanchnic circulation which may lead to gastro-intestinal ischaemia (Brown, 2012).

BP must be closely monitored, observing trends in relation to IVFT and drug administration. The gold standard method of monitoring BP is directly or invasively, by placing a cannula into an artery. This is attached to a heparinised line to a transducer which displays the BP readings in real-time on a multi-parameter monitor. If this is not available, then BP can be measured indirectly or non-invasively by the oscillometric or doppler method at regular intervals (Haskey, 2015).

4. Heart rate, contractility and rhythm

Heart rate (HR) alone is a non-specific indicator, and changes must be considered whilst observing all other parameters and performing a clinical examination to assist in determining the cause of any alterations (Haskey, 2015). Auscultation of the heart, whilst palpating a pulse is important to compare the rate and rhythm and check for pulse deficits and arrhythmias. In recumbent patients, an ECG can be attached to allow for continuous monitoring of HR and rhythm without needing to disturb the patient as frequently. Any noted abnormalities can be recorded to show to the veterinary surgeon (VS) if not directly witnessed (Savino & Sierra, 2018).

It is also important to note pulse quality, the absence of peripheral pulses may indicate that the systolic BP is <80 mmHg and the mean <50 mmHg and that hypoperfusion is present. A bounding pulse indicates a hyperdynamic state; which is a compensatory mechanism with an increase in cardiac output (CO), HR and tachycardia which can be associated with sepsis among other conditions. There is a large difference between systolic and diastolic BP as a result of hypovolaemia and vasoconstriction (Savino & Sierra, 2018).

Dogs presenting with hypovolaemia often have a HR of >140 beats per minute (bpm), which is an appropriate response to maintain sufficient CO when there is a decrease in stroke volume (Brown, 2012). If they are normotensive then it is considered compensatory shock, but if hypotensive, then it is decompensatory. Cats rarely show this sign and usually have a HR of 175–200 bpm. If bradycardia of <170 bpm is identified, the cat is considered unstable and <140 bpm can signify septic shock (Brown, 2012; Devey, 2019).

Arrythmias commonly occur in surgical patients both during and after surgery, commonly gastric dilation volvulus and splenectomy patients may have ventricular premature contractions, although this may be due to myocardial hypoxia (Devey, 2019). The VS will decide a treatment option depending on the severity of the arrhythmia.

5. Glucose

Hypoglycaemia is common in critical patients, especially sepsis patients due to the combination of a hypermetabolic state and a decrease in hepatic production of glucose. The patient's blood glucose should be monitored closely, and a CRI of glucose initiated if necessary and titrated to maintain the blood glucose at a normal value (Devey, 2019; Haskey, 2015). Other causes of hypoglycaemia such as insulinoma must also be ruled out (Brown, 2012).

6. Body temperature

It is important to monitor the patient's body temperature regularly. Cats with sepsis often present with hypothermia, whereas dogs are often hyperthermic (Brown, 2012). Active cooling is discouraged unless the temperature is deemed dangerously raised as hyperthermia is an appropriate response to infection (Brown, 2012). Paracetamol, which can be given as intra-venous analgesia, may help to lower the body temperature in dogs; but must be avoided in cats due to toxicity. Hypothermia may indicate that the patient is decompensating due to severely altered perfusion (Devey, 2019).

7. Albumin

Albumin is important to maintain COP, it also helps to transport drugs and supports growth and healing (Haskey, 2015). The main source of albumin is from nutrition; therefore, it is important that this is provided (see section 12 in part two of the article).

Patients with sepsis have an increased capillary permeability and proteins, especially albumin can be lost via this route which leads to a decreased COP leading to hypovolaemia, decreased CO, hypotension, tissue hypoperfusion and hypoxia (Haskey, 2015).

If hypoalbuminemia of <22 g/dL and decreased COP is evident, then human serum albumin may be transfused as a CRI over six hours. Close monitoring as with any blood product transfusion should be implemented to observe for reactions. If any change in parameters is noted, the transfusion should be discontinued, and the VS informed. Due to the risks involved, it is recommended that human serum albumin should not be given if artificial colloids may be appropriate as these have fewer side-effects (Humm & Adamantos, 2012).

8. Electrolytes and acid-base balance

A minimum database (Figure 3) should be performed multiple times daily, as frequently as every few hours in critical cases, to monitor the parameters. This enables the veterinary surgery to intervene with drugs or adjust the IVFT to try and correct any abnormalities and to monitor the patient's response from these interventions (Haskey, 2015).

Due to the effects of sepsis on oxygenation, anaerobic metabolism occurs which produces lactate, this leads to lactic acidosis. The provision of supplemental oxygen and increasing intracellular volume may reduce this (Humm & Adamantos, 2012).

Hypokalaemia is the most common electrolyte imbalance and is seen due to anorexia, increased gastro-intestinal losses or IVFT with insufficient potassium supplementation. The VS may decide to supplement the IVFT with potassium depending on the patient's serum potassium concentration (Humm & Adamantos, 2012).

Minimum Database
Packed Cell Volume (PCV)
Refractometric total solids (TS)
Blood Glucose (BG)
Blood Urea Nitrogen (BUN)
Blood smear evaluation
Acid-base and electrolytes

Figure 3. Minimum database parameters (Brown, 2012).

Hypocalcaemia is common in critical patients, although rarely requires supplementation. Ionised calcium is a better indicator than total calcium, supplementation is necessary if ionised calcium is <0.7 mmol/l (Humm & Adamantos, 2012).

It is vital to label all supplements clearly and note the maximum dose to be given. Supplemented fluids must never be used to provide boluses to avoid overdoses. If boluses are necessary then a separate, unsupplemented crystalloid bag should be provided to keep the supplemental dose constant.

Sepsis patients can have various alterations to their acid-base balance (Figure 4), both respiratory and metabolic acidosis and alkalosis are common. Venous samples are adequate to measure acid-base balance, but arterial samples are necessary for blood gas analysis.

Respiratory alkalosis can be seen in patients with inflammation, pain, anxiety, fear and as a compensatory mechanism for metabolic acidosis to "blow off" excess carbon dioxide. An increased RR is often noted (Humm & Adamantos, 2012). Supplemental oxygen is required if hypoxia is evident.

Respiratory acidosis is seen in sepsis patients with pneumonia and conditions which prevent normal respiration and the ability to take a deep breath, often due to muscle fatigue.

Metabolic alkalosis can be due to hypoxaemia, hypercapnia (PCO_2 > 50 mmHg) and severe leucocytosis (Devey, 2019).

Metabolic acidosis occurs with increased diarrhoea and lactic acidosis. It is possible

for the patient to have a combination of respiratory and metabolic acidosis and alkalosis. A mixed variant is common in sepsis patients due to hypovolaemia and hyperlactataemia (Humm & Adamantos, 2012; Figure 4).

9. Mentation

The brain is the last organ to undergo compromise in blood flow, therefore any alterations in the patient's mentation should be taken seriously as they may signify significant hypoperfusion of tissues; however, this is reversible with correction of perfusion (Brown, 2012).

It is important to rule out other causes of altered mentation, such as electrolyte imbalance or hypoglycaemia. The Glasgow Coma Scale is a useful tool to use to measure changes in mentation with a score out of 18 (Figure 5). The greater the score the better the prognosis with a score < 9 being poor (Haskey, 2015).

The patient's level of consciousness and awareness of its surroundings and manipulation should be assessed at every interaction as this can indicate multiple factors, such as pain and discomfort (Brown, 2012). It may be expected to see some degree of altered mentation due to the severity of the disease and drugs which have been administered (Savino & Sierra, 2018).

10. Red blood cells and haemoglobin

Anaemia is common in sepsis patients, this can be a result of blood loss, haemolysis and frequent blood sampling (particularly in small patients).

Packed cell volume requires a small sample and is instrumental in detecting whether a patient is anaemic or polycythemic. Total solids should be measured at the same time as it gives an indication on serum proteins and COP.

Complete blood count is useful to diagnose haemolysis, and non-regeneration which are contributing factors to anaemia with non-regeneration being more common in cats (Brown, 2012).

Anaemic patients have a decreased oxygen carrying capacity due to reduced red blood cell numbers and haemoglobin and, with the occurrence of anaerobic metabolism in sepsis patients, it is therefore important to address anaemia, supplement oxygen and consider blood transfusions depending on the status of the patient (Waxman, 2020).

Summary

The nursing considerations and observations for patients with sepsis have been outlined using the Kirby's Rule of 20 (2013) points 1–10. This will continue in part two of this article from points 11–20 to complete the analysis of how this critical care framework can be utilised to nurse the sepsis patient.

Disclosure statement

No potential conflict of interest was reported by the author.

Acid-base disorder	pH	HCO3- (mmol/l)	Base excess (mmol/l)	pCO2 (mmHg)
Metabolic acidosis	↓	↓	↓	↓
Metabolic alkalosis	↑	↑	↑	↑
Respiratory acidosis	↓	↑	↑	↑
Respiratory alkalosis	↑	↓	↓	↓

Figure 4. Interpretation of acid-base disorders (Humm & Adamantos, 2012).

Motor Activity	Score
Normal gait, normal spinal reflexes	6
Hemiparesis, tetraparesis or decerebrate rigidity	5
Recumbent, intermittent extensor rigidity	4
Recumbent, constant extensor rigidity	3
Recumbent, constant extensor rigidity with opisthotonus	2
Recumbent, hypotonia of muscles, depressed or absent spinal reflexes	1
Brainstem Reflexes	
Normal pupillary light reflexes and oculocephalic reflexes	6
Slow pupillary light reflexes and normal to reduced oculocephalic reflexes	5
Bilateral unresponsive miosis with normal to reduced oculocephalic reflexes	4
Pinpoint pupils with reduced to absent oculocephalic reflexes	3
Unilateral, unresponsive mydriasis with reduced to absent oculocephalic reflexes	2
Bilateral, unresponsive mydriasis with reduced to absent oculocephalic reflexes	1
Level of Consciousness	
Occasional periods of alertness and responsive to environment	6
Depression or delirium, capable of responding but response may be inappropriate	5
Semi-comatose, responsive to visual stimuli	4
Semi-comatose, responsive to auditory stimuli	3
Semi-comatose, responsive only to repeated noxious stimuli	2
Comatose, unresponsive to repeated noxious stimuli	1

Figure 5. Modified Glasgow Coma Scale (Doyle, 2014).

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