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Nursing the critical patient: Part 1

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Critical-care nursing is defined by the Academy of Veterinary Emergency and Critical Care Technicians (2014) as the care taken or required in a response to a crisis. This includes the treatment of a patient with a life-threatening, or potentially life-threatening, illness or injury, whose condition is likely to change on a moment-to-moment or hour-to-hour basis. Such patients present a challenge to the veterinary team as they require intense and often constant monitoring, reassessment and treatment.

Critical cases will be presented at many clinics and it is important that the veterinary nurse is familiar with how to deliver effective care to these patients. They can be demanding and frustrating cases which require a great team effort. Types of patient that may require critical care include: recovery from anaesthetic complication cases, post-surgical patients (such as those recovering from thoracotomies and portosystemic shunt ligations) (**Figure 1**), critical medical patients (such as those with diabetic ketoacidosis, septic peritonitis, pneumonia) and seizuring patients.

Ideally, such patients will be hospitalised in facilities that have 24-hour nursing care, such as an intensive care unit, as these patients are at risk of decompensating or deteriorating. In some situations (maybe where finances are a concern and so referral is not an option, or the patient is too unstable to transfer), the patient will be managed in the clinic to which it is presented. In such situations a rota of staff may need to be put in place to ensure that adequate care can be delivered out of hours.

The nursing process

When we come to think about how we care for these critical patients it is

Figure 1. A critical care patient following thoracotomy recovering from anaesthesia. Monitoring equipment includes ECG, non-invasive blood pressure measurement, pulse oximetry and active warming. The patient is receiving fluid therapy and oxygen therapy.

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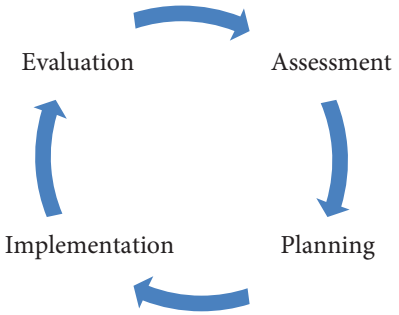

Figure 2. The nursing process.

important that we remember the concept of the nursing process (**Figure 2**).

The nursing care of critical patients is a cyclical process that moves continuously through these four stages in order to move nearer to an end point. The level of observation will depend upon many individual patient factors, such as reassessment of pain, managing a hypotensive crisis or maintain homeostasis. This nursing protocol may be repeated up to every 15 minutes for a patient who is deteriorating or not responding to therapy. For individuals that are more stable, the process may be repeated one to four hourly.

Communication

Given the nature of these cases, there can be an extensive amount of information to record and pass between members of the team. Hospital sheets should have information about the patient's problem(s), personal details, weight, nutritional information, resuscitation instructions, prescribed drugs and treatments. There should be space to write a daily Subjective, Objective, Assessment Plan (SOAP) and record clinical notes throughout the day.

There should be some form of verbal handover between shifts. There is no reason why this cannot take the form of nurse-led cage rounds, at which point each patient is briefly presented to the team by the person who has provided their primary care that shift. They should highlight the patient's problems and consequently their nursing concerns. Details about improvements/deteriorations, changes to the treatment plan and further diagnostics can be discussed. This can be a great learning tool for less-experienced members of the team and it gives the person taking over responsibility for the patient's care the opportunity to ask questions that have not already been addressed.

Critical care nursing frameworks

When a critical care patient is hospitalised it can be difficult to ensure that all the patient's individual requirements are addressed, as often these are so complex that it can be difficult to see 'the wood for the trees.' Nursing frameworks can be useful to guide treatment and monitoring to ensure that things are not overlooked and forgotten.

Below are 15 parameters which can be monitored in critically ill patients, taken from Kirby's Rule of 20 (Hopper & Silverstein, 2009a).

1. Fluid balance

Ins should match outs. Patients need to have their maintenance fluid requirement calculated, and to this total should be added any underlying deficits. Hypovolaemia should be addressed with incremental fluid boluses until the patient's cardiovascular status has improved. Dehydration should be estimated and addressed over 12–24 hours. Hydration status and weight should be checked twice daily to ensure that supportive therapies are meeting the patient's requirements.

Crystalloids are inexpensive and readily available, and they provide the mainstay of fluid balance. Electrolyte disturbances may mean that a specific crystalloid is chosen or an additional electrolyte, such as potassium chloride, can be administered. It can be useful to assess where you are in terms of 'ins and outs' by calculating the total amount of fluid that the patient has received versus the total that they have produced (urine and fluid collections from drains) every 4–8 hours. By re-evaluating frequently, adjustments can be made to avoid the patient become over- or under-hydrated.

2. Cardiovascular system

Heart rate is a non-specific parameter – it must be taken in context with the other findings from the clinical examination. We can assess the heart by auscultation, pulse or ECG measurements. Heart rate and rhythm should always be compared to pulse rate and rhythm. By doing this we may pick up on pulse deficits which could indicate an arrhythmia. Examples of cardiac arrhythmias seen in critical patients include premature atrial contraction, atrial fibrillation, premature ventricular contraction and ventricular tachycardia. All pulse abnormalities should be confirmed by an ECG.

Mucous membranes (MM) and capillary refill time (CRT) can aid in assessment of the cardiovascular system (**Figure 3**). In normal, healthy patients the mucous membranes should be salmon pink and moist, with a capillary refill time of 1–2 seconds. In diseased states they may be:

- yellow – liver disease, haemolysis
- pale/white – anaemia, shock, blood loss
- brick red – sepsis, polycythaemia, hyperthermia, carbon monoxide toxicity
- blue – hypoxia

Capillary refill time is an indication of peripheral perfusion and should not be thought of as an indicator of blood pressure. Prolonged CRT is due to peripheral vasoconstriction, and a shortened CRT is due to peripheral vasodilation.

Central venous pressure (CVP) is the hydrostatic or luminal pressure in the vena cava. CVP is affected by circulatory mean systemic pressure and venous return. Its measurement provides information on the heart's ability to function as a pump, blood volume in relation to volume capacity and vasomotor tone. It can be a useful monitoring tool in patients with acute renal failure, heart failure and shock.

Blood pressure is the measurement of the pressure exerted on the vessel

Figure 3. Icteric mucous membranes in a patient with immune-mediated haemolytic anaemia.

walls by the circulating blood. Blood pressure can be measured by placing an arterial catheter (most commonly in the dorso-pedal artery) and attaching a transducer. This procedure is invasive, can be technically challenging and expensive, however it is the gold standard in terms of reliability. Caution should be taken with patients with coagulation abnormalities. Non-invasive blood pressure can be measured either with an oscillometric machine or manually with a Doppler. Trends should be recorded and action should be taken in the face of hypo- or hypertension.

3. Respiratory system

When we come to monitor respiration it is also important that we consider oxygenation and ventilation. Respiratory rate, effort and pattern should all be assessed before we engage with the patient, e.g. from outside the kennel. As soon as we handle the patient, its breathing is likely to become altered. Critical patients tend to fall into either end of the spectrum: they may be breathing very slowly, due to respiratory centre dysfunction, intracranial space-occupying lesions, drug induced bradypnoea or abnormally low CO_2 levels. Alternatively they may be in respiratory distress because they are hypoxic, in pain, have altered CO_2 levels or for metabolic reasons.

The entire lung field should be auscultated and all abnormal lung sounds should be localised and characterised. Crackles are indicative of bronchopulmonary disease, such as pulmonary oedema. Aspiration pneumonia is common in the critically ill; expiratory wheezes are likely to be due to asthma; muffled lung sounds ventrally may indicate a pleural effusion and dorsally a pneumothorax.

We can use pulse oximeters to provide non-invasive and continuous information about the percentage of oxygen bound to haemoglobin by clipping the probe on a lip or ear in a conscious animal. Gold standard assessment of oxygenation and ventilation is to take an arterial blood sample, most commonly from the dorso-pedal artery, and to measure the arterial blood gases. $PaCO_2$ (partial pressure of carbon dioxide in the blood) will provide information on how well the patient is ventilating and PaO_2 (partial pressure of oxygen in the blood) will provide information on oxygenation.

Figure 4. A patient receiving oxygen therapy via nasal oxygen catheters.

If you have a concern that a patient is in respiratory distress or unable to oxygenate, oxygen should be administered. Short-term, non-invasive methods include flow-by with a circuit/mask or nasal prongs. Longer-term options for oxygen delivery include oxygen kennels, nasal catheters (**Figure 4**) or intubation for the delivery of 100% oxygen. Ideally, oxygen should be delivered in the least stressful way, as causing the animal to move around and avoid your attempts to supplement its supply will only increase oxygen demand, making the situation worse. Light sedation can sometimes be beneficial in calming distressed patients, thus aiding in the delivery of oxygen.

Capnography can be used in intubated patients to give more information about ventilation. We can measure end tidal CO_2 ($ETCO_2$) in conscious patients by placing a nasal catheter and attaching the capnography line directly to it. This can be useful if you have a patient who is at risk of developing respiratory failure, as CO_2 will change before O_2 does. Normal $ETCO_2$ is approximately 1-4 mmHg less than the $PaCO_2$. We are able to gain information about the way that the patient is ventilating from the $ETCO_2$ trace.

4. Neurological status

Mentation should be assessed every time we interact with the patient. There are four categories used to describe mentation (**Table 1**). It is important when thinking about our patient's mentation that we ask 'Why is the mentation altered?' Have we ruled out reasons other than a neurological one that could be contributing towards the change in mentation (e.g. electrolyte imbalance)?

If we have a concern about a patient's level of consciousness altering, we can use the modified Glasgow Coma Scale (Hopper & Silverstein, 2009b) to help us decide subjectively whether there is a deterioration or improvement in consciousness. The scale assesses level of consciousness, posture and cranial nerves to provide a score out of 18. A score lower than eight indicates a guarded prognosis; the higher the score the better chance of a positive outcome. Such scoring systems can be very useful in the detection of subtle changes in a patient, which may lead to specific treatment being given sooner.

5. Glucose and electrolytes

Glucose is often altered in the critical patient. It may be necessary to keep a close eye on results or to administer a constant rate dextrose infusion to avoid hypoglycaemia in septic patients. Unstable diabetics may require frequent sampling if they are administered a constant rate infusion of insulin. Hyperglycaemia is associated with an increased risk of mortality as it increases inflammation, has negative effects on the heart and can alter coagulation. In human medicine there is evidence that normoglycaemia decreases mortality

Table 1. Categories of mentation (Ettinger & Feldman, 2010)

Normal	Reacts normally to surrounding environment Is responsive and alert
Obtunded	Lethargic and withdrawn from the surrounding environment unless stimulated
Stuporous	Patient responds only to a noxious stimulus and the response may not be appropriate
Comatose	The patient does not respond to a noxious stimulus

and the incidence of transfusion, acute kidney injury, infection and ventilation, (Knieriem *et al* 2007).

A minimum data base will often consist of measurement of the above parameters (including glucose and lactate) and further tests may be run at intervals of up to every several hours if we need to monitor a parameter, such as high sodium, closely. Electrolytes should ideally be kept within their normal range by selecting appropriate fluid therapy and additional supplementation where necessary. The latter should be monitored closely to avoid over-supplementation.

6. Red blood cells and coagulation

Frequent sampling in the smaller critical patient can lead to anaemia, potentially severe enough to require blood transfusion. This will depend upon a number of factors including frequency of sampling, size of the samples required and whether the patient is predisposed to anaemia at the outset. Packed cell volume (PCV - also known as haematocrit) and Total Solids (TS) or Total Protein (TP), should be monitored during treatment and taken into consideration with cardiovascular parameters. There is no 'cut-off' for when a transfusion becomes necessary: a decision is made based on the individual and how well they are compensating with their disease. Blood typing should be carried out in any anaemic patient so that provision can be made to administer blood products if necessary. If the patient has already received blood, they will need to be cross-matched. The patient may require several transfusions during their recovery period, especially if they have suffered considerable trauma and they require multiple surgical procedures.

Platelet and clotting parameters (aPTT and PT) should be measured in critical patients that are at risk of developing disseminated intravascular coagulation (DIC). Any septic patients should have these parameters checked so that fresh-frozen plasma can be administered to help stabilise them prior to surgery. If there is a concern with coagulation, the team should avoid sampling from major vessels and handle the patient carefully to avoid bleeding and bruising. As with blood transfusions, it may be necessary to administer several plasma transfusions during the recovery period.

All transfusions should be monitored closely for signs of a transfusion reaction. Heart rate, respiratory rate and temperature should be recorded on a chart so that any trends can be observed. Signs of a reaction include: increases in heart rate, respiratory rate and temperature, a swollen face and/or urticaria. If a reaction is suspected the transfusion should be stopped immediately and the case veterinary surgeon alerted.

7. Immune system, antibiotics and infection control

Critical patients will have a supressed immune system due to the severity of their condition and they will also have invasive devices (such as IV lines, urinary catheters, drains) in place, which will increase the risk of developing an infection. Haematology samples can be assessed to look for white blood cell changes such as neutropenia in severely ill patients.

In recent years there has been a shift away from the administration of broad-spectrum prophylactic antibiotics. If there are concerns with regard to an infection or septic focus, bacteriological samples should be taken and cultured so that the correct antibiotic(s) can be prescribed and administered.

Strict infection control measures are ***vital*** in the critical patient. Hand hygiene measures should be of a gold standard. We must handle these patients in a hygienic manner, and adhere to local rules and encourage our colleagues to do so too. If a patient becomes wet or soiled, it can develop skin sores/scalding and so patients should be kept clean and dry at all times. Ancillary equipment will be cleaned between patients as a routine but barrier nursing should be adopted if there are concerns that the susceptible patient may contract an infection or if there is a risk to personnel or other patients.

8. Renal system

There are many factors in the critically ill patient that can contribute to renal dysfunction, including shock, hypotension, hypoxia and nephrotoxic drugs. We can use blood urea nitrogen (BUN) and creatinine measurements to tell us if azotaemia is a problem. Measurement of urine output and urine specific gravity (USG) can help us decide if the azotaemia is pre renal, renal or post renal. Further urinalysis can help to determine if there has been renal damage, whether there are crystals or an infection present.

In order to manage impaired renal function we need to ensure that the patient is adequately hydrated and that blood pressure is within the normal range. If the patient is oliguric or anuric, there should be concerns about an acute kidney injury (AKI). The inability to concentrate urine causes loss of electrolytes (such as potassium) and dehydration.

Urinary catheters should be placed in patients at risk of developing an AKI (**Figure 5**) so that fluid 'ins and outs'

Figure 5. A critical septic peritonitis patient - a urinary catheter has been placed to monitor urine output as this patient is at risk of acute kidney injury. There are two active Jackson Pratt abdominal drains *in situ* - these need to be emptied and reactivated when full. The total volume of abdominal effusion can be calculated in ml/kg/hr. © Eleanor Haskey 2014. All Rights Reserved

can be monitored carefully. Urine output (UOP) should be measured and recorded at set intervals in terms of ml/kg/hour. At this time USG can be measured to aid in monitoring the kidneys' ability to concentrate urine.

9. Gastrointestinal (GI) system

Critical illness is often complicated by ileus or gastric ulceration as a result of stress, hypotension or medications. Patients should be observed for signs of nausea, including hypersalivation, lip-smacking and inappetence. Anti-emetics should be administered if there is a concern that the patient is nauseated or vomiting.

If patients are suffering with ileus and reflux, a nasogastric tube can be placed to remove fluid from the stomach, thus reducing the reflux and aiding with comfort. Care must be taken, however, to measure acid/base ratio closely, as changes to pH and electrolytes can occur when stomach acid is removed.

Drugs such as steroids and NSAIDs should be avoided in patients at risk of gastric ulceration. Gastrointestinal drugs such as omeprazole can be administered and the patient should be monitored closely for signs of GI perforation or peritonitis developing. Diarrhoea should be noted and the presence of blood (either fresh or digested) should be reported to the case veterinary surgeon.

10. Nutrition and albumin

The provision of adequate nutrition is always difficult in the critical patient. It is beyond the scope of this article to discuss it in depth, however the nurse should aim to meet the patient's Resting Energy Requirement (RER). If it has not been met it for three days, or you suspect that you are unlikely to meet it, assisted feeding measures should be taken. This can range from hand-feeding to total parenteral nutrition. Feeding-tube selection will depend upon the patient's disease process and whether they are stable enough to undergo anaesthesia to facilitate placement. If a decision to give parenteral nutrition is made, the patient will require a central venous catheter.

Albumin is a very important protein in the body; it maintains colloid oncotic pressure, binds and transports drugs and supports growth and healing. Critically ill animals often have low albumin if they have GI disease, renal disease or an exudative focus (e.g. open wound). The main source of albumin is food so nutrition is important and should be addressed promptly, especially in trauma cases and other patients, which have long recovery and healing phases.

11. Drugs and drug metabolism

When administering any drug it is essential that the patient has been accurately weighed and that the proper dose, route of administration and dosing interval have been confirmed. Errors in calculation can lead to devastating complications and it is considered best practice to ensure that drugs are double-checked by a second staff member prior to administration.

The liver and kidneys play an important role in the metabolism and excretion of many drugs. Toxic levels of drugs or metabolites can accumulate in patients with liver or kidney disease, therefore the veterinary surgeon may wish to select alternative options in the face of hepatic or renal damage. The veterinary nurse should have an understanding of the mode of action of the drug they are administering, why it is being given and what potential side effects/complications may be seen.

In the majority of critical patients, drugs will be given via the IV route to facilitate more rapid onset of action. However, not all drugs are compatible for administration with one another (e.g. calcium and phosphate) so it may be necessary to place an additional i/v line for administration. Subcutaneous injections take longer to be absorbed in dehydrated and hypotensive animals. Oral medications may have altered absorption if there is GI disease. It can often be beneficial to give short-acting drugs and to give the lower end of the dose range, as ill patients respond differently to drugs than healthy animals.

12. Analgesia and stress

It is very important not to confuse pain and stress. This can sometimes be extremely difficult in a sick patient. Severe pain can have detrimental effects, including a neuroendocrine response (excessive release of hormones), cardiovascular compromise, respiratory compromise, the development of coagulopathies, reduced nutritional intake and problems associated with recumbency (Battaglia, 2007).

Pain-score systems, such as the Glasgow composite pain scale for dogs (Murrell *et al.*, 2008) and the Colorado cat pain scale should be implemented to assess and manage pain effectively and adequately. Ideally, a multimodal approach will be taken so that we can provide holistic analgesia. Opioids, constant-rate infusions and regional analgesia are all useful in critically ill patients. Paracetamol can be a useful adjunct in canine patients. NSAIDS are often avoided in the critical patient until a time when cardiovascular parameters are stable and the patient is well into the recovery period due to the risk of renal and GI damage. If there is any concern that a patient is in pain then analgesia should be implemented.

Stress should be minimised by handling patients carefully and considerately. Cats should have boxes to hide in and ideally be housed in an area separate from dogs.

13. Mobilisation and physiotherapy

Recumbent patients need to be managed by turning them frequently (every 2–4 hours) and ideally propping them in sternal recumbency so that both lungs can expand. Foam wedges, pillows and duvets are useful as aids. Massage, passive and active range of movement routines can be adopted to keep patients supple and to promote blood/lymph flow and reduce muscle wasting. Once patients are ambulatory, physiotherapy sessions can be extended to include sling walks, balancing exercises and even hydrotherapy. Nebulisation should be included in the chest-care regime for patients who have aspiration pneumonia.

We should aim to keep all patients normothermic. We only tend to cool hyperthermic patients actively if they have temperatures approaching 41°C - in cases of true hyperthermia (not pyrexia). Patients should be cooled to 39.5°C and then efforts should be stopped, as the patient's temperature is likely to continue to decrease that last degree by itself. Hypothermic patients should be warmed slowly to about 37°C. During this process there can be a change in perfusion and therefore blood pressure, so be conservative with warming if your patient is hypotensive.

14. Wound care, tubes, lines and drains

All wounds should be handled with gloves to avoid the risk of infecting the wound and/or personnel, and should be

assessed daily for signs of improvement. Flushing should be carried out with an isotonic solution, skin disinfectants should be avoided as they can cause tissue damage and cell death. Dressings should be kept clean and dry, any strike-through should be reported to the case veterinary surgeon so that the wound can be reassessed sooner if required.

All tubes, lines and drains should be checked at least daily (ideally twice daily) for signs of complications. If there is any redness, heat or swelling at the skin insertion site the invasive device should be removed. If there is any discharge present, a swab should be taken and sent for culture and sensitivity. Urinary catheters should be wiped from proximal to distal with an alcohol-soaked swab to decontaminate the line, and collection bags should be kept off the floor (below the level of the patient) and ideally double bagged. Central lines should be handled with strict asepsis. Multi-lumen lines should be checked for flushing and drawing blood back when the skin site is observed. Any collections (**Figure 5**), e.g. urine, air from a chest drain or transudate from a wound, should be measured and recorded in ml/kg/hour at appropriate time intervals. Invasive devices should be removed as soon as they are no longer required.

15. TLC

Nurses should work at creating a patient bond by providing periods of TLC and grooming. The area of the hospital where critical patients are housed should be quiet, with minimal traffic. There should be the facility to dim lights to mimic day/night and allow periods of quiet time and rest. Sleep is an important therapy, which is often forgotten in the veterinary hospital (**Figure 6**). Treatments should be appropriately grouped, again to allow periods of rest and avoid disturbing the patient unnecessarily.

Measures should be taken to help settle noisy/stressed animals and prevent them from upsetting others - quiet music can sometimes help. It is amazing what can be achieved with anxious patients if you just take things slowly and talk to them. Imagine what it would be like if it were your pet in the hospital!

Figure 6. A pacemaker patient who was extremely anxious in a kennel was very happy to hide under the nurse's station and sleep peacefully. This meant that the patient didn't have to be sedated due to the risk of lead displacement following pacemaker placement.

Conclusion

The critical-care environment can often be a busy and stressful place. Staff can feel tired and stretched and it is important that there is a system in place for recognising this. Encourage colleagues to speak up if they are struggling with the caseload or feeling overwhelmed by a case, and offer support. We can all get emotional from time-to-time when we feel that we are 'giving it our all' and the outcome is not what we hoped for. I think this makes us human, compassionate and empathetic towards our patients and their owners. When we get a success story, a 'little critter' that is pulled back from the brink and nursed through its recovery, pat your colleagues on the back and congratulate them. Effective nursing of the critically ill patient requires teamwork - without a team it is simply not possible.

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