VN 'How to': administer intensive care following traumatic diaphragmatic rupture

In this, the final of three 'How to' articles, VN Aoife Joyce Dip AVN, describes the intensive care required for a cat following traumatic diaphragmatic rupture. Anaesthetic and surgery protocols for the same case were described in previous articles published in April and August 2009. These articles are aimed at qualified VNs and self-test questions are provided at the end of each article

PREVIOUS RELEVANT HISTORY

The patient, a one-year-old male neutered cat, was presented having been involved in a road traffic accident five days previously. A cranial midline coeliotomy was performed and a right-sided radial and circumferential diaphragmatic rupture was identified and repaired. An eight french chest drain was placed during the procedure and 60 mls of air were removed following closure of the diaphragm.

THE GENERAL AIMS OF INTENSIVE CARE FOR THIS CASE WERE:

- Provide oxygen (O_2) to stabilise the patient prior to corrective surgery;
- To provide analgesia;
- To correct dehydration and provide ongoing fluid maintenance;
- To manage chest drain post-operatively; and,
- To correct post-operative hypothermia.

OXYGEN THERAPY

Supplemental O_2 increases the O_2 content of the blood, increases the partial pressure of O_2 in the capillary system and improves tissue perfusion. There are many modes by which to deliver O_2 to a patient, for example by face mask, flow-by, O_2 hood/chamber or intra-nasal catheters. The route chosen should deliver the highest fraction of inspired O_2 ($Fi\ O_2$) as possible. Consideration must also be given to what the individual will tolerate, as increasing stress and, therefore, O_2 demand is counter productive. In this case the cat resented being handled, so O_2 was delivered into a chamber that was constructed of clear perspex. This allowed the patient to be visually monitored while a pulse oximeter probe was used to check the O_2 saturation periodically. Once the saturated O_2 (SpO_2) was above 97%, the patient was sedated for surgery.

During surgery, mechanical ventilation of the lungs was initiated using a Hallowell ventilator at a tidal volume rate of 40 ml/min and a respiration rate (RR) of 18 breaths per minute. During recovery, nasal insufflation of 0.5 L/min O_2 using a bubble through humidifier was supplied via a 4 french nasal catheter placed in the right nasal meatus. The catheter was placed while the patient was anaesthetised. The use of a nasal catheter is a satisfactory method of administering supportive oxygen to a compromised patient. A silicone nasal catheter was used as it is considered less irritant to the nasal mucosa and dried mucous does not adhere.

Monitoring equipment was used to evaluate the animal's response to the treatment and careful observation was important in determining how well the patient was tolerating the therapy. SpO_2 was monitored while the patient was on room air only, using pulse oximetry, and O_2 supplementation was ceased when the patient could maintain a SpO_2 above 97%. The patient was continuously monitored for signs of dyspnoea and the chest drain was assessed every two hours for the first eight hours.

ANALGESIA

Assessment of pain is based on expectations, physiologic parameters and behavioural responses. As cats rely mainly on the diaphragm for breathing, any manipulation of the costal arch or diaphragm during the repair results in extreme post-operative pain. The resultant hypoventilation causes respiratory acidosis and hypoxaemia, which, in turn, delays recovery. Respiratory acidosis occurs as a consequence of hypoventilation when carbon dioxide (CO_2) accumulates in the body as carbonic acid. It can be treated by improving ventilation to remove excess CO_2. Patients suffering from respiratory acidosis should be monitored post-operatively for arterial blood gas values, to tailor their management during the recovery period.

The use of good analgesia allows spontaneous respiration, deep breathing and coughing, which, in turn, prevents retention of secretions, airway closure and atelectasis. Having a chest drain *in situ* is a good opportunity to provide additional analgesia as suitable local anaesthetic can be instilled post-operatively intrapleurally.

Most physiologic changes involve sympathetic nervous system activation, but they should not be used exclusively for assessing pain because other variables for example, drug administration may alter them. Behavioural characteristics of pain may be used in conjunction with physiologic responses to evaluate patients. The best time to prevent pain is before it begins i.e., pre-emptively 0.6 mg morphine (Morphine Sulphate; Antigen Pharmaceuticals) was administered intravenously (IV) and 0.9 mg meloxicam (Metacam; Boeghringer Ingelheim Ltd.) subcutaneously (SC), both at induction. Post-operative analgesia consisted of 0.6 mg morphine intra-muscularly (IM), which was administered six hours post-operatively.

FLUID THERAPY

The aims of fluid therapy are initially to restore the volume and composition of body fluids. Once this is achieved, it is important to maintain external fluid and electrolyte balance so that input matches output. Fluid status must be assessed prior to any treatment and a physical examination can be used to determine the degree of dehydration. Clinical signs that may indicate water depletion include: a raised temperature; weak rapid pulse; increased capillary refill time (CRT) due to low blood volume; poor skin elasticity as a result of loss of water from the interstitial space; cool distal extremities due to decreased perfusion; sunken eyes; and, a decreased urine output. The patient was considered approximately 7% dehydrated as there was some loss of skin elasticity and the mucous membrane (MM) were dry. To calculate the total fluid requirement the fluid deficit, the maintenance requirements and the ongoing losses were added together (**Table 1**).

Table 1: Ongoing fluid losses and fluid therapy calculations

Normal intake	**40-60 ml/kg/day**
Insensible losses	**20 ml/kg/day**
Urine losses	**20 ml/kg/day**
Vomiting	**5 ml/kg/vomit**

Fluid deficit (L) = body weight (kg) x % dehydration (decimal)
Total fluid requirement = fluid deficit + maintenance requirement + ongoing losses

A balanced crystalloid, which has a composition similar to the extracellular fluid, was chosen as these solutions can be given rapidly without inducing changes in electrolyte concentration. Compound sodium lactate (CSL) is a very versatile solution as it can be administered IV, SC, intraperitoneally (IP) and intraosseously (IO). A 22 g, 32 mm polyurethane IV cannula was placed aseptically into the right cephalic vein on day one and fluid therapy was initiated with warmed CSL (Vetivex No. 11 Hartmann's; Dechra) at a rate of 10 ml/kg/hr. This was continued post-operatively at a reduced rate of 5 ml/kg/hr. An infusion pump was used to deliver the fluids at the desired rate. The catheter was flushed regularly with heparinised saline (2 units per ml) to help maintain patency and the contact dressing was checked twice daily and changed if wet or soiled. Fluid therapy was discontinued on day two and the IV cannula was removed.

CHEST DRAIN

After any thoracic surgery, a chest drain is required in the pleural cavity. It is necessary to keep a drain in place for intermittent suction until normal negative pleural pressure is re-established. There are many potential problems associated with the management of a chest drain, including patient interference, accidental dislodgement of the three-way tap and fluid reaction within the thorax.

A Chinese finger-trap suture was used to secure the chest drain and all connectors and the three-way tap was glued with cyanoacrylate (Superglue; Bostik). In all cases, the chest drain must be carefully bandaged to prevent damage or displacement by the animal, which could lead to a potentially fatal pneumothorax. An Elizabethan collar was fitted to prevent patient interference and a stockinette vest was applied. In addition, a gate-clamp was attached to the patient end of the tube when not in use.

Although it has been recommended that drains should be left in place for 24 hours after surgery, it is common practice to remove the drain when the drainage decreases to a volume that is consistent with that caused by the presence of the tube itself, i.e., less then 2.2ml/kg/day. The chest drain was checked every two hours and a total of 22 mls of air was removed in the first six hours.

MONITORING

Continuous monitoring and documenting findings is imperative to providing good intensive care. Regular information about the animal's condition and its response to treatment is essential in order to continue care and adjust treatment. A written record was kept and measurements were made at regular intervals. Trends, as well as isolated measurements, could then be seen. Post-operative monitoring of animals following diaphragmatic rupture repair is especially critical in the first few hours after surgery. During this period, careful assessment of various parameters is needed to determine whether the patient is able to maintain an adequate SpO_2.

1. Temperature: This is discussed in hypothermia correction measures below.
2. Pulse: Blood pumped into the aorta during ventricular contraction creates a fluid wave that travels from the heart to the peripheral arteries. This wave is referred to as a pulse and its rate and quality provide information about the cardiovascular system. The pulse strength, pulse quality and heart rate of the patient were assessed simultaneously by auscultating the heart while palpating a peripheral pulse.
3. Respiration: An increased rate may indicate pain, hypoxia, sepsis or deteriorating pulmonary function and must be assessed in light of other findings. It was essential, especially when administering fluids, that the RR rate and character were assessed regularly. Auscultation of the lungs can detect harsh lung sounds, which may indicate pulmonary oedema caused by fluid overbalance.
4. MM colour and CRT: The normal pink colour of non-pigmented membranes depends on appropriate blood haemoglobin concentration, and peripheral capillary blood flow. An increased CRT (> two seconds) suggests poor peripheral perfusion.

HYPOTHERMIA

During the surgery the temperature of the patient was monitored continually via a thermocouple probe placed in the oesophagus. Patients undergoing diaphragmatic rupture repair are prone to hypothermia (temperature less then 36.6 °C/98 °F), as both the thorax and the abdomen are exposed for long periods, allowing ongoing heat losses. Several measures were taken to prevent hypothermia, including wrapping the limbs in cotton wool and bubble wrap, placing warm water gloves around the body and placing the animal on a circulating warm water blanket for the duration of the surgery. Core body temperature was monitored continually, and a minimum recorded temperature of 33.0 °C was reached during surgery.

Hypothermia results in reduced metabolic rate. There is a decrease in oxygen consumption and in the ability of haemoglobin to release oxygen to tissue. Hypothermia affects the cardiovascular system by causing peripheral vasoconstriction, decreased heart rate, and hypotension.

Once the patient was recovering in the intensive care unit, efforts made to increase the body temperature included:

- Placing the patient in a pre-warmed kennel with a circulating warm water blanket placed underneath a vetbed.Circulating warm water blankets are better then heating blankets and lamps because there is less chance of accidental thermal burns; and,
- Using a hairdryer to blow warm air onto the patient.

Once the temperature began to rise the patient was left to recover wrapped in bubble wrap with warm water gloves packed around it and a second vet-bed placed over the patient. Another method to increase hypothermia is a forced hot air warmer (Bair Hugger; Gaymer), but unfortunately this is not available at the time. Temperatures are ideally monitored from the same site and rectal temperature of 37.6°C was achieved within two hours, which rose to 38.8°C two hours post-operatively.

Antibiotic therapy was discussed in part two of this series in the August edition of the IVJ (www.irishveterinaryjournal.com).

BEDDING, HYGIENE AND GENERAL NURSING CONSIDERATIONS

The use of a vet-bed was ideal, as fluids soak down to the base and the patient remains dry. The patient was allowed to lie in whichever position it found comfortable. Hygiene considerations included providing a litter tray and preventing any staining from urine or faeces. It was essential to keep the chest drain site clean and it was covered with a stockinette vest while the drain was in place.

Finally, cats are fastidious cleaners who, under normal conditions, spend 70% of their time grooming. They can become very depressed if they cannot groom for whatever reason but many will tolerate being combed or brushed and are usually very appreciative of the attention.

In conclusion, most intensive care cases require a mutli-modal approach and can be both interesting and challenging. It is important however, not to treat symptoms in isolation but to consider the patient as a whole and not to forget to address the basic requirements of all animals in our care, that of simple love and affection.

Material used in these articles has been adapted from case studies submitted for the Royal College of Veterinary Surgeons Diploma in Advanced Surgical Nursing.

RECOMMENDED READING

Battaglia AM (2007) Small Animal Emergency and Critical Care for veterinary technicians. (2nd Ed). WB Saunders Company

Hines DA (2001) Critical steps for optimising intensive care. In: Veterinary Technician 22, (7). Pp. 378-383

CONTINUING EDUCATION: QUESTIONS AND ANSWERS

Q1. SIGNS OF RESPIRATORY DISTRESS INCLUDE: ABDOMINAL EFFORT

A. Open-mouth breathing
B. Abducted elbows
C. All of the above

Q2. DYSPNOEA DESCRIBES:

A. Difficultly swallowing
B. Difficultly defecating
C. Difficulty breathing
D. None of the above

Q3. RESPIRATORY ACIDOSIS OCCURS AS A CONSEQUENCE OF:

A. Hypoventilation
B. Hyperventilation
C. Hypoxaemia
D. None of the above

Q4. RESPIRATORY ACIDOSIS IS TREATED BY:

A. Administering bicarbonate
B. Improving ventilation
C. Administering IV fluids
D. Discontinuing mechanical ventilation

Q5. COMPOUND SODIUM LACTATE IS AN EXAMPLE OF:

A. An artificial colloid
B. A balanced crystalloid
C. A hypertonic solution
D. A plasma expander

Q6. HYPOTHERMIA AFFECTS THE CARDIOVASCULAR SYSTEM BY:

A. Causing peripheral vasoconstriction
B. Decreased heart rate
C. Hypotension
D. All of the above

Q7. SINUS ARRHYTHMIA…

A. Occurs in relation to the respiratory pattern of the animal and is a normal finding
B. Occurs when the animal uses its abdominal muscles to try and improve respiration
C. Is found in hypovolaemic shock
D. Is a noise generated from the nasal passages

MORE THEN ONE ANSWER MAY BE CORRECT FOR THE FOLLOWING QUESTIONS:

Q8. IN A CRITICAL CARE PATIENT PYREXIA MAY INDICATE:

A. Infection
B. Shock
C. Hypovolaemia
D. Sepsis

Q9. IN A CRITICAL CARE PATIENT, A SLOW PULSE RATE MAY INDICATE:

A. Hypothermia
B. Pain
C. Pyrexia
D. Circulatory failure

10. IN A CRITICAL CARE PATIENT A RAPID PULSE RATE MAY INDICATE:

A. Pain
B. Hyperkalaemia
C. Sepsis
D. Convulsion activity

Answers: 1:D 3:C 3:A 4:B 5:B 6:D 7:A 8:A and D 9: A and D 10: A and C.