Australian and New Zealand College of Veterinary Scientists

Fellowship Examination

June 2014

Veterinary Emergency Medicine and Critical Care

Paper 1

Perusal time: **Twenty (20)** minutes

Time allowed: **Four (4)** hours after perusal

Section A: Answer **ONE (1)** question

Section B: Answer **ALL FIVE (5)** questions

Section C: Answer **ALL TEN (10)** questions

Section A: Answer **ONE** essay-style question worth 60 marks .....total 60 marks

Section B: Answer **FIVE** short-answer questions each worth 24 marks.....total 120 marks

Section C: Answer **TEN** short-answer questions each worth 6 marks.....total 60 marks

Paper 1: Veterinary Emergency Medicine and Critical Care

Section A: Answer ONE (1) essay-style question

1. **Regarding lactate metabolism**

Answer **all** parts of this question:

a) Describe the production of adenosine triphosphate (ATP) under aerobic and anaerobic conditions. Include in your answer the cellular mechanisms by which lactate and pyruvate are produced and consumed. *(20 marks)*

b) Describe, using appropriate examples, the classification of hyperlactataemia (lactic acidosis) in the body. *(10 marks)*

c) Using examples of specific disease conditions briefly discuss the prognostic value of elevated plasma lactate concentrations in dogs. *(10 marks)*

d) Describe the relationship between oxygen delivery (DO_2) and oxygen utilisation (VO_2) in health and sepsis. Include in your answer a definition of the anaerobic threshold. You may use a diagram as part of the answer to this question. *(10 marks)*

e) A septic patient has normal cardiac output and haematocrit. Briefly describe **two (2)** mechanisms that could explain increased lactate levels in this patient. *(10 marks)*

Section B starts over page

Section B: Answer ALL five (5) short-answer questions

1. Answer **all** parts of this question:

a) Write the equation that defines pH. Using this equation, explain why normal pH is 7.4. Define and give normal values (including units of measurement where applicable) for elements of the equation. *(6 marks)*

b) The Henderson-Hasselbalch approach to acid-base analysis relies upon the balance between carbonic acid, bicarbonate, and carbon dioxide.

Write the equation that describes this balance (commonly known as the Henderson-Hasselbalch equation). Outline and briefly explain **four (4)** weaknesses of the Henderson-Hasselbalch approach. *(6 marks)*

c) Stewart and Constable developed the strong ion difference (SID) approach to acid-base analysis:

i. List the **three (3)** categories of variables that impact plasma pH. Give examples of the key parameters in **each** category. *(3 marks)*

ii. Explain the impact of a low SID on the pH of a patient. *(2 marks)*

iii. Give an example of a crystalloid fluid that has a low SID. *(1 mark)*

d) Hopper and Haskins developed the quantitative approach to acid-base analysis:

i. List the **five (5)** laboratory parameters required to use this method. *(1 mark)*

ii. Indicate what effect an **increase** in **each** of the parameters listed in d) i, has on pH. *(1 mark)*

iii. Briefly explain the impact that body water has on acid-base status using this approach. *(3 marks)*

iv. Is the quantitative approach of most relevance for respiratory or metabolic acid base disturbances? *(1 mark)*

Continued over page

2. Answer **all** parts of this question:

a) Briefly describe the defence mechanisms that prevent bacterial translocation from the gut to surrounding tissues in healthy animals. *(4 marks)*

b) Discuss strategies that are employed to prevent bacterial translocation in critically ill animal patients. *(10 marks)*

c) Preventing bacterial translocation is given as a reason for the prophylactic use of antibiotics in all critically ill patients. State whether you agree with this and justify your position. *(10 marks)*

3. Secondary brain injury is caused by a combination of intracranial and systemic insults after head trauma.

Answer **all** parts of this question:

a) Describe the mechanisms by which secondary brain injury occurs. *(14 marks)*

b) Explain how systemic hypotension contributes to secondary brain injury. *(7 marks)*

c) Briefly list mechanisms by which hyperglycaemia potentiates neurologic injury. *(3 marks)*

4. Answer **both** parts of this question:

a) Describe the formation and physiological role of the natriuretic peptides BNP and ANP. *(4 marks)*

b) Discuss the potential clinical applications of measuring natriuretic peptides and cardiac troponin(s) in dogs and cats. Include references to current veterinary literature to support your assertions. *(20 marks)*

Continued over page

5. Regarding carbon monoxide toxicity in the dog:

a) Describe the mechanisms of acute toxicity of carbon monoxide. *(8 marks)*

b) Draw with a solid line a normal oxygen-haemoglobin dissociation curve for a dog and label the axes. Mark on your line the following points: *(5 marks)*

i. Venous point

ii. Arterial point

iii. P_{50}

c) Superimposed over the normal curve drawn in 5 b), draw with dashed lines the curve for a dog with carbon monoxide intoxication and a carboxyhaemoglobin content of 40%. *(3 marks)*

d) Explain why pulse oximetry is inaccurate in animals with carbon monoxide poisoning. *(6 marks)*

e) Explain the rationale for using oxygen to treat animals that have carbon monoxide intoxication. *(2 marks)*

Section C starts over page

Section C: Answer ALL ten (10) short-answer questions

1. Canine *Babesia* spp. occur in Australia:

   a) List the clinical signs that may be seen in Australian dogs infected with *Babesia* spp. *(2 marks)*

   b) Describe the likely methods of transmission of *Babesia* spp. between dogs in Australia. *(2 marks)*

   c) Name the specific test available to confirm a suspected diagnosis of *Babesia* infection and identify what this test detects. *(1 mark)*

   d) Name **one (1)** anti-babesial drug that may be successfully used to treat *Babesia* spp. infections in Australia. *(1 mark)*

2. Regarding the measurement of cardiac output:

   a) Briefly describe the Fick method of determining cardiac output. *(3 marks)*

   b) Briefly describe the lithium dilution method of determining cardiac output. *(3 marks)*

3. A cat has a corona virus titre of 1:1600. Discuss the significance of this result. Justify any other clinicopathological tests that may be indicated to support or rule out a diagnosis of feline infectious peritonitis (FIP). *(6 marks)*

Continued over page

4. You are treating a four-month-old puppy with parvo viral enteritis. The dog is well perfused and has an albumin concentration of 24 g/L (reference range adult dog 25–37 g/L). His activated partial thromboplastin time (APTT) is within normal limits. There are no other haematological abnormalities.

   The following have been advocated as adjunctive treatments:

   - fresh frozen plasma
   - oseltamivir (Tamiflu®)
   - antibiotics

   For **each** of these treatments, state with brief justification, whether you would recommend their use in this dog. *(6 marks)*

5. Answer **both** parts of this question:

   a) List **six (6)** factors that affect oxygen delivery (DO_2). *(3 marks)*

   b) Outline the main mechanism by which paracetamol toxicity affects oxygen delivery. *(3 marks)*

6. Answer **both** parts of this question:

   a) Differentiate physiological oliguria from pathological oliguria. *(3 marks)*

   b) Outline the mechanism by which blood loss may lead to physiologic oliguria. *(3 marks)*

7. Regarding non-depolarising neuromuscular blocking agents:

   a) Describe the mechanism of action of the non-depolarising neuromuscular blocking agents and list **two (2)** types of non-depolarising neuromuscular blocking agent. *(3 marks)*

   b) List **three (3)** advantages to using non-depolarising neuromuscular blocking agents over depolarising neuromuscular blocking agents. *(3 marks)*

Continued over page

8. Describe the mechanism of action of the drug pimobendan on the cardiac myocyte. *(6 marks)*

9. Answer **both** parts of this question:

   a) Dogs who have blood type DEA 1.1 negative have been described as 'universal canine blood donors'. Explain why this is so. *(2 marks)*

   b) Briefly describe the pathophysiology of acute haemolytic transfusion reactions. *(4marks)*

10. Regarding the REassessment Campaign On VEterinary Resuscitation (RECOVER) guidelines for cardiopulmonary resuscitation (CPR):

   a) State the published return of spontaneous circulation (ROSC) and survival-to-discharge rates after CPR in dogs and cats. *(1 mark)*

   b) List factors associated with post-cardiac arrest (PCA) syndrome. *(2 marks)*

   c) List key post-cardiac arrest care recommendations. *(3 marks)*

End of paper

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Veterinary Emergency Medicine and Critical Care

Paper 2

Perusal time: **Twenty (20)** minutes

Time allowed: **Four (4)** hours after perusal

Answer **ALL <u>FIVE (5)</u>** questions

All five questions are of equal value.

Answer **FIVE** questions each worth 48 marks.....total 240 marks

Paper 2: Veterinary Emergency Medicine and Critical Care

Answer all five (5) questions

1. A four-year-old male neutered domestic shorthair cat weighing 4.5 kg is presented to your clinic for examination. The cat had several episodes of salivation and vomiting yesterday but this resolved. He did not pass any faeces overnight but has urinated this morning. Today he is lethargic and not interested in eating. He is an indoor only cat and is not on any medications. A bouquet of flowers containing lilies was delivered to the house two days ago.

   On physical examination the cat is very quiet, and has pain over the lumbar area. His mucous membranes are dry and slightly pale. He is mildly tachycardic (HR 170) and his rectal temperature is 37.6C. He is estimated to be 7% dehydrated by slightly increased skin turgor. There are no other physical abnormalities.

   A blood chemistry panel and urinalysis have the following results:

Parameter	Patient	Normal Ranges
PCV	48%	32–48 %
Total Protein	94 g/L	60–86 g/L
Urea	48 mmol/L	5.7–12.8 mmol/L
Creatinine	748 µmol/L	70–211 µmol/L
Na^+	162 mmol/L	145.8–158.7 mmol/L
K^+	2.7 mmol/L	3.5–5.8 mmol/L
ALT	58 IU/L	12–130 IU/L

   Other analytes were within laboratory reference ranges.

   Urinalysis: Urine SG 1.010, 1+ glucose, 2+ protein, some epithelial casts seen on sediment examination.

   Answer **all** parts of this question:

   a) Describe and justify your initial plan (first six hours) for this cat. *(10 marks)*

Question 1 continued over page

b) After 24 hours in hospital, the cat is adequately hydrated and has a mean arterial pressure (MAP) of 90 mmHg. Its urine output is measured at 0.1 ml/kg/hour. Describe what medications you could use to increase urine output. You have optimised fluid therapy using isotonic and hypertonic crytalloids and colloids. Discuss the advantages and disadvantages of using the following medications in an attempt to increase urine output. Indicate the dose rate that you would use for **each** agent:

i. Frusemide *(3 marks)*

ii. Mannitol *(3 marks)*

iii. Dopamine *(6 marks)*

iv. Fenoldopam *(4 marks)*

c) After 30 hours in hospital, urine output has decreased to 0.05 ml/kg/hour and the cat now weighs 5.2 kg. The following blood results are obtained:

Parameter	**Patient**	**Normal Ranges**
PCV	43%	32–48 %
Total Protein	96 g/L	60–86 g/L
Urea	65 mmol/L	5.7–12.8 mmol/L
Creatinine	826 µmol/L	70–211 µmol/L
Na^+	155 mmol/L	145.8–158.7 mmol/L
K^+	5.8 mmol/L	3.5–5.8 mmol/L

You elect to perform peritoneal dialysis on the cat. Describe your technique for this. Include in your answer potential adverse events that may occur.

(22 marks)

Continued over page

2. A four-year-old female neutered Australian cattle dog weighing 22 kg is presented to your clinic for examination at 10 a.m. The dog has been anorexic for three days but was still drinking water until last night. She did not pass any faeces overnight but has urinated this morning. This morning she is very lethargic and depressed. She lives in a well-fenced back garden in a suburban environment with no other pets in the household. She is not on any medications. Her vaccinations and worming program are current.

   On physical examination the dog is very depressed, but still able to stand and walk. Her mucous membranes are dry and slightly pale. Her heart rate is 170 bpm, respiratory rate is 30 breaths per minute and her rectal temperature is 38.6C. She is estimated to be at least 10% dehydrated by significantly increased skin turgor. The remainder of her physical examination is normal.

   A blood chemistry panel and urinalysis have the following results:

Parameter	**Patient**	**Normal Ranges**
PCV	58%	37–55 %
Total Protein	94 g/L	55–75 g/L
Urea	25 mmol/L	3.1–9.2 mmol/L
Creatinine	180 µmol/L	44–130 µmol/L
Glucose	28 mmol/L	3.4–6.0 mmol/L
Na	132 mmol/L	140–154 mmol/L
K	4.5 mmol/L	3.8–5.6 mmol/L
Cl	128 mmolL	102–117 mmol/L
Mg	0.35 mmol/L	0.7–1.1 mmol/L
iCa	0.8 mmol/L	1.1–1.3 mmol/L
pH (venous)	7.153	7.350–7.410
$PvCO_2$	28 mmHg	33–41 mmHg
PvO_2	65 mmHg	40–60 mmHg
SBE	- 13 mmol/L	- 0.3–2.2 mmol/L
PO_4	1.1 mol/L	0.9–2 mmol/L
Lactate	3.1 mmol/L	0.2–1.9 mmol/L

   A urinalysis performed with UA dipsticks and refractometer showed the following results:

   Urine SG 1.040,

   3+ glucose,

   3+ ketones,

   1+ protein,

   Sediment examination : some epithelial casts seen.

Question 2 continued over page

Answer **all** parts of this question:

a) Assuming that all patients with diabetic ketoacidosis (DKA) have a relative deficiency of insulin, use words or diagrams to explain the pathophysiology of this condition. In your answer include reasons why diabetic patients commonly develop the following metabolic abnormalities:

   i. ketonuria *(6 marks)*

   ii. hyponatraemia *(6 marks)*

   iii. hypokalaemia *(6 marks)*

   iv. dehydration *(6 marks)*

   v. acidaemia *(6 marks)*

b) Calculate this patient's approximate strong ion difference and explain its relevance to the patients pH. You do not need to correct the chloride concentration. *(5 marks)*

c) Your patient requires potassium supplementation and you elect to use potassium phosphate, in anticipation of possible hypophosphataemia. You would like the nurse to prepare a 1000 ml bag of lactated Ringers solution so that it contains 60 mEq/L of potassium. The potassium phosphate (K_2PO_4) on the shelf contains 1.7 g of potassium per 10 mL. The molecular weight (molar mass) of potassium is 39 grams.

   Calculate the volume of the K_2PO_4 solution which should be added to the fluids. *(5 marks)*

d) Describe the pathophysiology of paradoxical cerebrospinal fluid acidosis. *(8 marks)*

Continued over page

3. A five-year-old female neutered Labrador has been referred to your hospital for continued care after being attacked by another dog three days ago. The initial injuries consisted of multiple bite wounds on both sides of the ventral thorax, neck and forelimbs, as shown in the image below.

At the time of presentation, the dog has hyperaemic mucous membranes with a capillary refill time of < 1 second. The dog's temperature is 40.1C. The heart rate is 170 bpm, with bounding femoral pulses. The respiratory rate is 40 bpm. The dog's respiratory effort and thoracic excursion is normal. The dog is depressed but responds aggressively to any attempt at handling or treatment.

Answer **all** parts of this question:

a) Describe the pathophysiology of systemic inflammatory response syndrome (SIRS) and its progression to septic shock. Include criteria that are used to define it in its various stages. *(24 marks)*

b) Define and explain the terms transduction, transmission, modulation, and perception as they relate to pain pathways. Where do these processes occur? *(12 marks)*

c) Describe your approach to managing this patient's wounds and justify your approach. *(12 marks)*

Continued over page

4. Answer **both** parts of this question:

a) Describe the physiologic significance of the following equation: *(12 marks)*

$VA = (VCO_2 / PCO_2) \times K$

b) **Three (3)** mechanisms of hypoxaemia are hypoventilation, impaired diffusion and shunt.

Answer **both** of the following:

i. Characterise the changes that would be seen in **each** of these hypoxaemic mechanisms with respect to: alveolar ventilation (V_A), alveolar oxygen pressure (P_AO_2), arterial pressure of oxygen (PaO2), arterial pressure of carbon dioxide ($PaCO_2$), and end-tidal carbon dioxide pressure ($ETCO_2$). *(30 marks)*

ii. Give a case-based example of **each** of the **three (3)** mechanisms, such as a 'cat with _____ condition'. *(6 marks)*

Continued over page

5. Answer **both** parts of this question:

a) Regarding lower motor neuron disorders in the dog:

i. Describe the abnormality at the neuromuscular junction of a dog with acquired myasthenia gravis. *(6 marks)*

ii. Explain how the edrophonium (Tensilon®) test aids in the diagnosis of myasthenia gravis. Include in your answer the mechanism of action of edrophonium, and any adverse reactions that may occur. *(4 marks)*

iii. Briefly describe pathophysiology of botulism. Include in your answer the clinical symptoms of botulism and how they can lead to death. *(4 marks)*

b) A seven-year-old male desexed dog weighing 35 kg with suspected myasthenia gravis has the following arterial blood gas results on room air: PaO_2 51mmHg, $PaCO_2$ 65 mmHg, haemoglobin 150 g/L, PvO_2 31mmHg, saturation O_2 (arterial) 82%, saturation O_2 (venous) 54%.

The venous blood samples were collected from a central line, the distal portion of which is just proximal to the right atrium.

Cardiac index in this dog is 4.2 L/min/m^2, which is within the normal range.

i. Calculate this dog's alveolar oxygen: arterial oxygen gradient. List any assumptions you have made in this calculation. What information does this figure give you about the dog? *(8 marks)*

ii. Calculate the shunt fraction in this dog. What information does this figure give you about the dog? *(12 marks)*

iii. Given the blood gas results and based on the calculations in b) i and ii above, what is your assessment of the dog's respiratory function? *(8 marks)*

iv. Continuous positive airway pressure (CPAP) is selected as the initial ventilation mode for this dog. Discuss whether this is appropriate for this dog. *(6 marks)*

End of paper