Candidates are required to attempt ALL TEN questions on this paper.

Allow 12 minutes per question.

Illegible handwriting or failure to answer the question in the form requested may result in examiners being unable to award marks for information which candidates intended to convey.

1. **Briefly** describe the actions of, and indications for the following drugs in veterinary cardiology:
   a. Amiodarone
   b. Spironolactone
   c. Digoxin.

2. What are the typical radiographic features associated with the following:
   a. Peritoneo-pericardial diaphragmatic hernia in the cat?
   b. Reverse shunting patent ductus arteriosus in the dog?
   c. Ventricular septal defect in the cat?

3. Write **short notes** on the following blood tests used in veterinary cardiology:
   a. Pro-ANP in the dog.
   b. Troponin I in the dog.
   c. Lactate dehydrogenase iso-enzymes in the horse.

4. **List THREE** different techniques for measuring blood pressure in cats and briefly discuss the limitations of each technique.

5. Write **short notes** on the uses and limitations of the following echocardiographic derived measurements:
   a. Fractional shortening
   b. The ratio of pre-ejection period to ejection time
   c. The ratio of the diameter of aorta to diameter of left atrium.

P.T.O for Questions, 6, 7, 8, 9 and 10
6. Using a **simple diagram** draw the following equine cardiac rhythms, indicating whether they are a normal or abnormal finding. Describe the lead configuration used to record your ECG.

   a. 1st degree AV block  
   b. 2nd degree AV block  
   c. atrial fibrillation.

7. **List** the indications for the use of permanent implantable cardiac pacemakers and the complications that might arise from their use.

8. **Briefly** describe how diastolic function may be assessed echocardiographically.

9. **List** the broad mechanisms by which cardiac arrhythmias may arise in domestic animals (“arrhythmogenesis”). Illustrate **ONE** of these diagrammatically.

10. For **each** of the following abnormal heart sounds illustrate the timing of the sound in the cardiac cycle diagrammatically and **list** the possible causes.

   a. Gallop sound  
   b. Systolic click  
   c. Split second sound.
Candidates are required to answer THREE of the following four questions on this paper.

Allow 40 minutes per question.

Illegible handwriting or failure to answer the question in the form requested may result in examiners being unable to award marks for information which candidates intended to convey.

If insufficient time is available to answer a question fully, it will be acceptable to complete in note form.

1. What are the indications for the use of beta adrenoreceptor blockers in veterinary cardiology? Discuss the rationale for their use in these situations and any adverse effects that may be encountered.

2. Compare and contrast the causes, diagnosis and management of pericardial disease in dogs and cattle.

3. You are presented with a 6 year-old domestic shorthaired cat with a systolic murmur over the mitral valve area. What are the possible causes? Discuss your approach to the investigation of this case and how you might reach a definitive diagnosis.

4. There is controversy concerning the initial treatment of chronic valvular disease (endocardiosis) in dogs, specifically as to whether an angiotensin converting enzyme inhibitor or pimobendan should be used (with a diuretic when appropriate) at the onset of congestive heart failure. Discuss the pros and cons of each approach.
1. Using a simple labelled diagram, draw the following abnormal cardiac rhythms. **List** the drugs which could be used treat atrial flutter.
   
   a. Isolated ventricular premature complex in a dog.
   b. Atrial flutter in a dog.
   c. 3rd degree atrioventricular block in a horse.

2. What are the typical echocardiographic features associated with the following conditions:
   
   a. A moderately large ventricular septal defect in a calf?
   b. Restrictive cardiomyopathy in the cat?

3. **List** the clinical features and presenting signs that you might expect to find with cardiac tamponade in a dog.

4. **List** **TWO** nutritional supplements that may be used in the treatment of cardiac disease in the dog or cat. **Briefly** describe the circumstances where **ONE** of them might be used.

5. **Briefly** describe the actions of and indications for the following drugs in veterinary cardiology.
   
   a. Procainamide.
   b. Calcium channel blocking agents.
   c. Thiazide drugs (e.g. hydrochlorothiazide).

6. **Briefly** describe how systolic function may be assessed by echocardiography.

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P.T.O. for Questions 7, 8, 9 and 10
7. By means of annotated diagrams, show the origin and timing of the 3rd and 4th heart sounds. What is the significance of hearing these sounds in:
   a. A horse?
   b. A cat?

8. Briefly outline the actions, side-effects and indications for the use of digitalis glycosides in veterinary cardiology.

9. Briefly define each of the following terms:
   a. Preload
   b. Afterload
   c. Contractility.

10. What are the typical radiographic features associated with the following conditions? You may answer using short note form or annotated diagrams.
    a. Mitral dysplasia (dog)
    b. (Sub-)aortic stenosis (dog)
    c. Hypertrophic cardiomyopathy (cat).
CANDIDATES ARE REQUIRED TO ANSWER THREE OF THE FOLLOWING FOUR QUESTIONS ON THIS PAPER.

ALLOW 40 MINUTES PER QUESTION.

ILLEGIBLE HANDWRITING OR FAILURE TO ANSWER THE QUESTION IN THE FORM Requested MAY RESULT IN EXAMINERS BEING UNABLE TO AWARD MARKS FOR INFORMATION WHICH CANDIDATES INTENDED TO CONVEY.

1. Compare and contrast the causes, diagnosis and management of atrial fibrillation in the dog and the horse.

2. There has been considerable interest recently in the concept of ventricular remodelling and its role in heart failure. Define the term ‘ventricular remodelling’, and discuss the actions and pharmacology of three families of drugs, that may be used in veterinary medicine and are believed to affect this process.

3. What is meant by the term ‘interventional cardiology’? List the procedures which might be included under this heading, giving indications for each. Describe ONE such procedure in detail, including complications that might arise.

4. In the United Kingdom there are a number of breed-specific schemes to identify congenital and acquired cardiac disease, with the aim of identifying a disease-free stock for breeding purposes. Which breeds and which diseases are currently covered in the United Kingdom? Describe in detail the protocol followed in one of these breeds. What are the potential pitfalls in such schemes?
THE ROYAL COLLEGE OF VETERINARY SURGEONS

CERTIFICATE EXAMINATION IN VETERINARY CARDIOLOGY

TUESDAY 27 JULY 2004

PAPER I
(2 hours)

Candidates are required to attempt ALL TEN questions on this paper.

Allow 12 minutes per question.

Illegible handwriting or failure to answer the question in the form requested may result in examiners being unable to award marks for information which candidates intended to convey.

1. Briefly describe the typical radiographic features of:
   a. Pericardial effusion in the dog.
   b. Pulmonic stenosis in the dog.
   c. Patent ductus arteriosus in the dog.

2. a. Using a simple annotated diagram/s, draw the normal cardiac rhythms that you might encounter in a horse.
   b. Describe the position of the electrodes used to record a base-apex ECG trace from a resting horse.

3. Implantable Pacemakers are described in a 3 - 5 letter code (e.g. VVI100). List the common codes and briefly indicate how these codes are interpreted.

4. a. With the aid of a diagram, describe the echocardiographic features of mitral valve prolapse in a dog OR a horse.
   b. Briefly discuss the significance of this finding in a 6 year-old small-breed dog OR a four year-old racehorse?

5. Write short notes on the following:
   a. Cardiac troponin I.
   b. Atrial natriuretic peptide.

P.T.O. for Questions 6, 7, 8, 9 and 10
6. **List** the echocardiographic findings that you might expect to find in **EACH** of the following conditions:
   
a. Severe aortic valve regurgitation in a horse.
   
b. A moderate sized ventricular septal defect in a cat.

7. **List** the similarities and differences between atrial fibrillation in large and small animals:

8. a. **List** the **FOUR** classes of drugs most commonly used to treat systemic hypertension in cats and dogs, giving an example of **ONE** drug in **EACH** class.
   
b. **Briefly** describe the mode(s) of action of **ONE** of these drug classes

9. a. **List** the possible clinical signs associated with infective endocarditis in dogs.
   
b. Name **THREE** species of bacteria commonly recovered from dogs with this condition.
   
c. Which cardiac valve(s) are most commonly affected in:
   
   i) Dogs?
   
   ii) Cattle?

10. Write short notes on **EACH** of the following:
   
a. Amiloride
   
b. Amiodarone
   
c. Amlodipine.
1. Discuss the ways in which systemic diseases may affect the heart.

2. You are presented with a 7 year-old male Doberman, for evaluation of a recent onset soft cough, lethargy and laboured breathing. On physical examination you detect a low grade left sided systolic heart murmur, an arrhythmia and pulmonary crackles. Discuss your approach to this case in terms of the diagnostic tests you would carry out and the therapeutic options you would consider.

3. ANSWER EITHER

   You are presented with a 5 year-old domestic shorthaired cat with a left sided systolic murmur. What are the possible causes of the murmur? Discuss your approach to the investigation of this case and describe how you would reach a definitive diagnosis.

   OR

   You are presented with a four year-old warmblood gelding with a grade 3/6 left sided systolic murmur and asked to assess it for insurance purposes. What are the possible causes of the murmur? Describe how you would approach this case and how you might proceed.

4. Compare and contrast the positive inotropic drugs used to treat congestive heart failure in the dog available in the United Kingdom and Europe.
Candidates are required to attempt ALL TEN questions on this paper.

Allow 12 minutes per question.

Illegible handwriting or failure to answer the question in the form requested may result in examiners being unable to award marks for information which candidates intended to convey.

1. Write short notes on *Dirofilaria Immitis* infection in dogs.

2. Define the following:
   a) Starling’s Law.
   b) LaPlace’s Law.
   c) Preload.

3. Write short notes on each of the following drugs:
   a) Amlodipine.
   b) Hydrochlorothiazide.
   c) Carvedilol.

4. List the typical presenting signs of heart failure in dogs AND horses.

5. Using an annotated diagram, describe the action potential in a typical myocyte and list the principal ionic movements involved.

6. Write brief notes on the echocardiographic assessment of diastolic dysfunction.

P.T.O. for Questions 7 – 10
7. Write short notes on each of the following:
   
   a) Paradoxical septal motion.
   b) Pulsus paradoxus.

8. With the aid of a diagram(s) describe the ECGs that you might record from each of the following patients:
   
   a) A cat with left anterior fascicular block.
   b) A dog with right bundle branch block.
   c) A horse with first degree atrioventricular block.

9. What are the typical echocardiographic findings associated with:
   
   a) Pulmonic stenosis in the dog.
   b) An endocardial cushion defect in a cat.
   c) A large ventricular septal defect in a foal.

10. Describe the main radiographic features of the common pulmonary patterns in dogs.
    
    List the conditions that are most often associated with each.
Candidates are required to answer THREE of the following four questions on this paper.

Allow 40 minutes per question.

Illegible handwriting or failure to answer the question in the form requested may result in examiners being unable to award marks for information which candidates intended to convey.

ANSWER EITHER

1a. **Discuss** Systolic Anterior Motion (SAM) of the Mitral Valve. Include in your discussion the pathophysiology, proposed mechanisms and treatment options for this condition.

**OR**

1b. **Discuss** mitral valve regurgitation in horses: Include in your discussion, the pathophysiology, prognosis and management options for this condition.

2.  
   a) **Discuss** the pathophysiology of pericardial effusion in domestic animals.
   b) **Briefly** describe its typical clinical manifestations and treatment in ONE of the domestic or companion animal species.

3. Compare and contrast cardiomyopathy in the dog and the cat.

4. **Discuss** the use of inplantable pacemakers in one of the veterinary species. Include in your discussion; the indications for pacemaker therapy; the types of device available and how they are selected; the possible complications and contra-indications for pacemaker therapy in the species you have selected.
Candidates are required to attempt ALL TEN questions on this paper.

Allow 12 minutes per question.

Illegible handwriting or failure to answer the question in the form requested may result in examiners being unable to award marks for information which candidates intended to convey.

1. Write short notes on the causes, presentation, diagnosis and treatment of pulmonary hypertension in dogs.

2. Write short notes, with diagrams, on the different types of atrial septal defects, their presentation and diagnosis.

3. By means of short notes and/or a diagram, explain what is involved with persistent right aortic arch (PRAA) anomaly. List the clinical signs you might expect in such a case. Write short notes on how the diagnosis might be confirmed.

4. List three arrhythmias that can be encountered in aging cats with hypertrophic cardiomyopathy (HCM). Briefly describe how the pathological changes associated with HCM might result in these rhythm disturbances.

5. Write short notes on the mechanism of action of the various classes of drugs commonly used to treat supraventricular tachycardias in dogs (give an example of each class of drug).

6a. Write short notes to compare and contrast the different mechanisms of action of the following THREE drugs:
   
   i. Furosemide
   
   ii. Hydrochlorothiazide
   
   iii. Spironolactone.

6b. What is meant by sequential nephron blockade?

P.T.O. for Questions 7 - 10
7. Briefly explain by means of short notes and/or a diagram why the presence of a bounding arterial pulse in a horse with aortic regurgitation is likely to be associated with a poor prognosis.

8. Write short notes on the current treatment options, and their indications, for a dog with recurrent pericardial effusion.

9. Write short notes on the potential cardiac effects of:
   a. hypoadrenocorticism
   b. gastric dilation and volvulus
   c. Lyme disease.

10. With the aid of diagrams, describe the following:
    a. Tetralogy of Fallot
    b. Ebstein’s anomaly
    c. Eisenmenger’s syndrome.
Candidates are required to answer **THREE** of the following **four** questions on this paper.

Allow 40 minutes per question.

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1. **Discuss** the key evidence from clinical trials for the use of angiotensin converting enzyme inhibitors and inodilators (Pimobendan) in dogs with congestive heart failure secondary to dilated cardiomyopathy and degenerative mitral valve disease.

2. **Compare and contrast** sub-aortic stenosis with pulmonic stenosis in dogs, in terms of the typical signalment, presenting signs, clinical and diagnostic findings, treatment options and prognosis.

3. **Describe** some common clinical, radiographic, echocardiographic and laboratory findings in dogs with congestive heart failure.

   If you were only able to select one of these **FOUR** methods to help you reach a diagnosis, which would you choose and why?

4. **Describe and discuss** the options for treatment of:

   **EITHER**

   a. patent ductus arteriosus in the dog

   **OR**

   b. atrial fibrillation in the horse.
THE ROYAL COLLEGE OF VETERINARY SURGEONS

CERTIFICATE EXAMINATION IN VETERINARY CARDIOLOGY

TUESDAY 24 JULY 2007

PAPER I
(2 hours)

Candidates are required to attempt ALL TEN questions on this paper.

Allow 12 minutes per question.

Illegible handwriting or failure to answer the question in the form requested may result in examiners being unable to award marks for information which candidates intended to convey.

1. Write short notes on:
   a. Sodium nitroprusside.
   b. Bosentan.
   c. Nesiritide.

2. With the aid of diagrams, describe the ECG features of:
   a. Left anterior fascicular block.
   b. Atrial flutter.
   c. Ashman’s phenomenon.

3. Discuss with diagrams the echocardiographic similarities and differences between constrictive pericardial disease and restrictive cardiomyopathy.

4. What is the “apex beat” and how is it generated? Write notes on its significance in clinical examination.

5. How may respiratory disease be distinguished from cardiac disease in the small dog with a cough and a heart murmur?

P.T.O. FOR QUESTIONS 6 - 10
6. **With the aid of diagrams, LIST** the standard routine views performed in the echocardiographic examination of small animals, with reference to subjective and objective analysis.

7. Write **brief notes** on heart sounds and murmurs in horses.

8. Describe in **short note form** with the aid of a diagram of the foetal heart and aortic arches, the development of:

   a. persistent truncus arteriosus.
   b. persistent ductus arteriosus.

9. A five-letter system exists to describe implantable cardiac pacemaker function – what does **each** letter indicate?

   A VVIRO system has been used in veterinary medicine – what do these letters represent?

10. What do you understand by the term – high output heart failure?
   Give some examples of this condition.

   ______________
1. **LIST** the ACE inhibitors licensed in the United Kingdom. Discuss their actions, indications and contraindications. What trial evidence is there regarding their use?

2. What is meant by the terms “systemic hypertension” and “pulmonic hypertension”? Compare and contrast for each condition:
   a. Aetiology.
   b. Clinical signs.
   c. Diagnosis.
   d. Treatment.

3. A four year-old male boxer dog is presented to you with signs of relatively sudden onset severe dyspnoea, cough and haemoptysis [frothy/blood expectoration]. Over the preceding week, the dog had been examined on two occasions with signs of malaise, inappetance and “hind limb stiffness”; a pyrexia had been detected, a three day course of broad-spectrum antibiotic tablets prescribed but no diagnosis made. Two years ago, a systolic murmur had been identified and “mild aortic stenosis” diagnosed on the basis of Doppler echocardiography when a good prognosis had been given. In the intervening period the dog had remained well with an excellent exercise tolerance.

   Your physical examination reveals extensive bilateral soft inspiratory pulmonary crackles on auscultation, a grade III/VI systolic murmur with a distinct diastolic murmur over a confined area of the left heart base and pyrexia. The murmur was not audible over the mitral area.

   **Outline** your chronological approach to investigation and treatment of this case. Arrive at a likely diagnosis accounting for the past and present history by means of pathophysiology.

   **P.T.O. FOR QUESTION 4**
4. You are asked by a colleague to examine a 17 year-old retired racehorse in which he has found a left sided grade V/VI diastolic decrescendo murmur and grade III/VI systolic murmur. Explain the diagnostic tests that should be performed in order to give a prognosis and allow recommendations for the continued use of this horse as a teenager’s hack.
THE ROYAL COLLEGE OF VETERINARY SURGEONS

CERTIFICATE EXAMINATION IN VETERINARY CARDIOLOGY

WEDNESDAY 23 JULY 2008

PAPER 1
(2 hours)

Candidates are required to attempt ALL TEN questions on this paper.

Allow 12 minutes per question.

Illegible handwriting or failure to answer the question in the form requested may result in examiners being unable to award marks for information which candidates intended to convey.

1. A 35kg four year-old, male entire Doberman Pincher presented with a history of syncope and recent onset coughing and dyspnoea. On physical examination his cardiac rhythm was found to be chaotic (240 bpm) and a holter ECG recording showed the complex of arrhythmias seen below (paper speed: 25mm/sec i.e. five squares per second).

In note form, discuss your management of these arrhythmias describing the mechanisms of action and potential side effects of the drugs that you would select.

2. a. List the clinical signs associated with right sided heart failure.

b. Name the conditions which can cause right sided congestive heart failure.

3. List the commonest cardiovascular causes of syncopy in horses. Briefly discuss the methods you would use to confirm your diagnosis and describe the treatment options available.

P.T.O for Questions 4 - 10
4. **Describe with the aid of diagrams**, the embryological development of the cardiac septa and the atrio-ventricular valves. **On a separate diagram**, identify the location of the common congenital septal defects.

5. Why is biochemical and haematological analysis important in the diagnosis and monitoring of heart failure in cats and dogs?

6. **With the use of diagrams**, describe the following: 2nd degree atrio-ventricular block, accelerated idio-ventricular rhythm, Torsades de Points.

7. Write **brief notes** on:
   a. NT proBNP
   b. Troponin I.

8. A horse presents in biventricular failure.
   a. State the most likely cause and describe the pathophysiological mechanisms involved.
   b. **List** the clinical signs most likely presented; relate these to the pathophysiological mechanisms involved and **briefly discuss** any differences in presentation you would notice in a cat, dog and cow with a similar condition.

9. **Briefly describe** the role of aldosterone in the pathophysiology of congestive heart failure and the risks and benefits of aldosterone blockade when used in addition to other standard therapies for managing heart failure.

10. **List** the canine and feline endocrinopathies that are associated with or directly cause cardiac disease. **Briefly describe** the pathophysiology for each condition.
Candidate are required to answer **THREE** of the following **four** questions on this paper.

Allow 40 minutes per question.

*Illegible handwriting or failure to answer the question in the form requested may result in examiners being unable to award marks for information which candidates intended to convey.*

1. What are the methods available for the diagnosis of dilated cardiomyopathy in dogs? How can these be used to determine the treatment protocol?

2. During a routine cardiac examination prior to flu/tetanus vaccination of a nine year-old show jumper you identify a grade 4/6 holodiasystolic murmur over the left hemithorax.

   What advice would you give to the client as to the likely cause, clinical significance and potential implications of this murmur in this case?

3. You have been approached by a breeder of Maine Coons who has recently had a number of kittens returned to her because they had developed evidence of heart disease. What information could you give her in order for her to be able to investigate and hopefully eliminate the problem from her population?

   What are the echocardiographical changes seen in cats affected by hypertrophic cardiomyopathy?

4. An eight year-old spayed female Rottweiler is presented to you with a history of a gradual reduction of exercise tolerance over two to three months and a very recent abdominal distension. There was no other relevant history. Your physical examination reveals a fluid thrill on abdominal ballottement, indistinct heart sounds bilaterally and respiratory-linked variation in pulse quality. There was no audible heart murmur present.

   **Outline** your approach to investigating this case with your differential diagnosis.

   Offer a likely diagnosis with a cardiac cause, indicate the relevance of the history and clinical signs, detail the pathophysiology involved and **describe** your approach to treatment.
Candidates are required to attempt **ALL TEN** questions on this paper.

Allow 12 minutes per question.

_Illegible handwriting or failure to answer the question in the form requested may result in examiners being unable to award marks for information which candidates intended to convey._

1. **Describe with the aid of diagrams**, the progressive changes expected to a lead II ECG from hyperkalaemia. Give a **brief** explanation of the physiology behind these changes.

   **List** any conditions in the dog and cat where hyperkalaemia might occur with a **brief** explanation of the cause.

2. What are the typical radiographic features associated with the following conditions? You may answer using **short notes** or **annotated diagrams**.

   - Left to right shunting patent ductus arteriosus in the dog.
   - Pulmonary thromboembolism in the dog.
   - Tetralogy of Fallot in the dog.

3. **Briefly compare** the use of quinidine sulphate and cardiac electroconversion for the treatment of atrial fibrillation in horses.

4. **List** problems, side-effects or drug interactions you might expect from the concurrent use of:

   - Digoxin and thiazide diuretics
   - Digoxin and atenolol
   - Loop diuretics and lidocaine
   - Digoxin and diltiazem
   - Diltiazem and atenolol
   - Furosemide and NSAIDs (e.g. meloxicam)
   - Prednisolone and high dose furosemide
   - Atenolol and cimetidine

**P.T.O. for Questions 5 – 10**
5. Write **short notes** on the echocardiographic assessment of diastolic dysfunction in feline hypertrophic cardiomyopathy.

6. **With the aid of diagrams, illustrate and describe** anomalies of the coronary circulation that can occur in the English bulldog breed associated with pulmonic stenosis. How might this influence your choice of treatment of this condition?

7. (a) **List** the cardiovascular responses to pregnancy.

   (b) How may these changes affect a mare with compensated mitral valve disease due to foal in one month’s time?

8. **List** **THREE** different types of ambulatory electrocardiography recorder that can be used to assess if a collapsing episode is caused by a cardiac dysrhythmia. **Briefly describe** the **advantages and disadvantages** of each type of recorder.

9. **Describe** the possible causes, dynamic effects, diagnosis and treatment of systolic anterior motion (SAM) of the mitral valve.

10. Write **brief notes** on:

    (a) The technical problems using a syringe and needle method to achieve an accurate result when taking an arterial blood sample for blood gas analysis.

    (b) What is the relationship of arterial PCO2 to total ventilation?

    (c) What happens to the blood acid-base balance when using a high dose of a loop diuretics, e.g. furosemide?
Candidates are required to answer THREE of the following four questions on this paper.

Allow 40 minutes per question.

Illegible handwriting or failure to answer the question in the form requested may result in examiners being unable to award marks for information which candidates intended to convey.

1. List any significant congenital cardiac defects of the dog and cat that you would expect to produce NO murmur on auscultation.

Select ONE such defect and describe a likely history and clinical signs, the pathophysiology and your approach to investigation and treatment.

2. A nine year-old Thoroughbred cross riding horse presents with a harsh, grade 4/6 pansystolic murmur over the right hemithorax.

   • What information derived from your clinical examination could help you to diagnose the likely cause of this murmur?

   • What further tests would you recommend to confirm the diagnosis in this case and how could these be used to help you inform your client of the likely significance of this murmur?

3. Write short notes on:

   • Virchow’s triad and how it might apply to a cat with a restrictive cardiomyopathy.

   • (Vena) Caval syndrome.

   • Vagal manoeuvres.

   • Vestigial/persistent left cranial vena cava.

   P.T.O. for Question 4
4. An eleven year-old male miniature daschund has been treated for heart failure for 6 months, he was diagnosed as having myxomatous degeneration (endocardiosis) of the mitral valve and was in stage 2 ISAAC heart failure on the basis of clinical signs and chest X-rays. He had been treated with furosemide and an ACE-inhibitor. He now presents as an emergency following a sudden deterioration in his heart condition.

Describe how you would investigate this case outlining the possible causes of the sudden deterioration.