Investigating cases of sudden and unexpected death in small animal patients

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INTRODUCTION

This article is the second in a two-part series on sudden unexpected death (SUD) in small animal patients. The first discussed some of the more common causes of SUD, and this article will now detail how the general practitioner should proceed with the investigation of such cases in practice.

CIRCUMSTANCES OF SUDDEN UNEXPECTED DEATH

In general there are two types of circumstance in which you may become involved in cases of SUD:

1. **A client may present you with a pet that died suddenly/unexpectedly at home or at an outside facility.** Some common situations involve deaths associated with:
   - **Feeding:** A well-known example here is gastric dilatation/volvulus in large/giant breed and deep-chested dogs. Few conditions will produce death in an otherwise healthy dog as quickly as this syndrome.
   - **Exercise:** Although better known as a sudden occurrence in athletic animals at exercise, death can also occur in pets during their normal daily exercise routine. In either situation, underlying cardiovascular disease should be strongly suspected as causative.
   - **Boarding/groomer visits:** It is not infrequent for kennel/cattery/groomer personnel to discover that a pet has died in their care. These situations are often very difficult, as you will be placed in a position of conflict between the pet owner and the facility owner.

2. **Alternatively, you may be directly involved if a patient dies suddenly or unexpectedly whilst at your practice:**
   - **Anaesthetic-related or post-surgical deaths** represent the more common situations surrounding SUD in which you may be directly involved, and are a relatively common reason for submission of small animal cases to diagnostic pathology laboratories for investigation.

     Although post-surgical death may be a consequence of a surgery-related problem such as uncontrolled haemorrhage or a slipped ligature (Fig. 1), there may alternatively have been pre-existing disease that was not detected during the pre-anaesthetic health screen but which may have been exacerbated by anaesthetic and surgical stress.

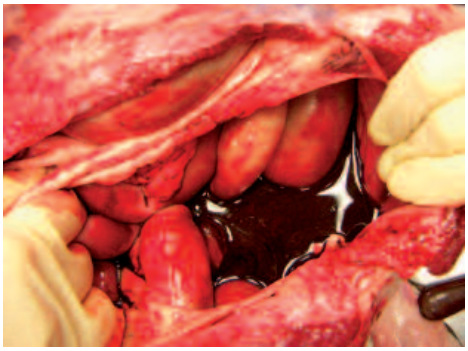

Fig. 1: *Haemo-abdomen in a dog due to a post-surgical slipped ligature.*

In the event of an anaesthetic-related or post-surgical death, the client should be informed of the availability of a post-mortem examination (PME) either through a trained pathologist or at least a veterinarian independent of the attending veterinarian (ideally at a different practice). Inevitably the client may choose to allow you as the attending veterinarian or an associate at your practice to perform the examination, but an independent source should be offered initially.

One of the major goals of PME in these cases is to determine whether underlying but previously undetected disease contributed to death. Where concurrent disease does turn out to be a major factor contributing to death during anaesthesia, it most often involves the cardiovascular or respiratory systems (Figs. 2 and 3). In one Canadian study conducted among Ontario veterinary practices, respiratory complications (including apnoea and respiratory depression) were the most commonly reported problems associated with anaesthesia, and cardiac arrhythmias were also common. Another not uncommon example of this is undetected chronic renal disease (Fig. 4) in which the animal previously compensated adequately, but for reasons that remain poorly understood, anaesthesia and surgery can precipitate acute renal failure.

CPD

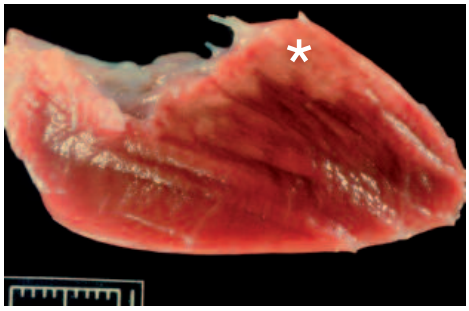

Fig. 2: *Myocardial infarcts in a dog represented by peripheral areas of pallor (*).*

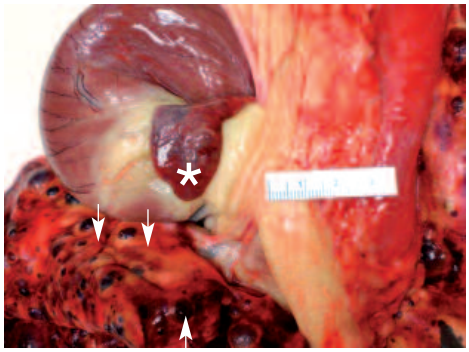

Fig. 3: *Right atrial (*) and pulmonary (white arrows) haemangiosarcoma in a dog.*

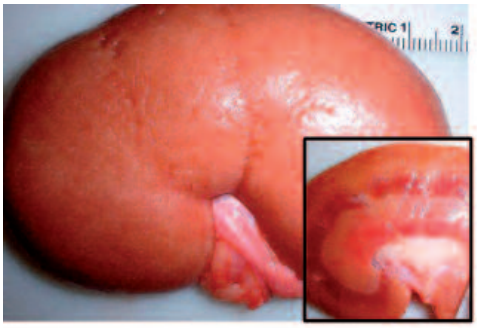

Fig. 4: *Renal swelling and pallor in a dog (normal canine kidney colour is dark brown) consistent with glomerulonephritis (inset shows kidney in cut section).*

Unfortunately, however, although occasionally we find unsuspected organic disease that may have precipitated death under anaesthesia, in most cases we find no lesions to account for death; however, since biochemical, electrical conduction, or idiosyncratic drug-induced disturbances usually do not produce detectable or pathognomonic lesions at PME, these aetiologies must at least be considered where no other identifiable cause is found.

- **Death post-vaccination** is another not uncommon scenario in which you may be directly involved, and usually involves kittens or puppies that were healthy at a pre-vaccination examination, but die unexpectedly within minutes to hours of vaccination. Typically no lesions are found at PME to suggest the presence of any underlying disease to explain death, and we can only speculate about vaccine-associated idiosyncratic or allergic-type reactions. The vaccine manufacturers should be informed of the patient's death as soon as possible as they are usually keen to cover the costs of post-mortem examination in these circumstances.

INVESTIGATING CASES OF SUDDEN UNEXPECTED DEATH

Whatever the circumstances, an organized and systematic approach is essential when investigating cases of SUD, especially in our current and increasingly litigious society.

From the pathologist's perspective, submission of the entire animal to the diagnostic laboratory is preferred, and this is also advised if you are involved in a medico-legal case. If for some reason this is not possible and the PME is conducted at a veterinary practice, you should at least contact a veterinary pathologist prior to the PME to discuss the case - they will be able to outline any particularly important points of the procedure, as well as to advise you best on tissue collection.

Overall, the key to any PME is to be organized and systematic with your procedure: everything should be examined. An external examination should be performed initially, in much the same way as you would undertake a physical examination (Fig. 5) in a live patient. This enables you to look for such things as evidence of trauma. With regard to the internal examination once inside the body cavities, everything should be examined: all solid organs should be cut into, and all tubular organs should be opened; the heart and liver should be weighed and expressed as a percentage of the patient's bodyweight (these are the main organs for which known reference ranges are documented for cats and dogs). Written or dictated notes should be made throughout the procedure, detailing all findings, no matter how seemingly insignificant at the time. Wherever possible, photographic images should be taken to support your findings, whether positive or negative – these are invaluable, especially if litigation is a possibility, and also are easy to forward to a pathologist for interpretive help.

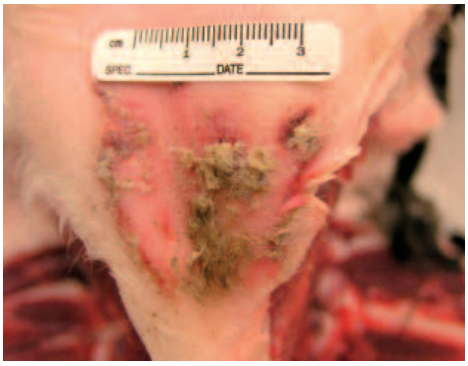

Fig. 5: *Document all external lesions, no matter how seemingly insignificant (location, size, colour, texture etc).*

Sometimes a definitive cause of death can be identified by PME alone, for example, gastric dilatation and volvulus syndrome in a dog, or organ rupture (Fig. 6), and further investigation may not be necessary. In many cases though, gross examination alone will not suffice to make a clinical diagnosis, and further diagnostic tests will be necessary. Histopathology is the next crucial step in these cases, so it is important to retain tissue samples at the time of PME in case this should be required. The minimal tissues required for histological examination are sections of: lung, liver, kidney, whole heart, and brain. Ideally, however, a section of all tissues examined should be taken at PME – a pathologist can be consulted later about the case to decide which need to be examined. Specimens should be placed in 10% neutral buffered formalin as soon as possible (for optimum fixation, the volume of formalin used should be at least 10 times the bulk of the tissues) - also avoid the 'jar-shaped heart' phenomenon and do not force tissues into a container with a narrow neck.

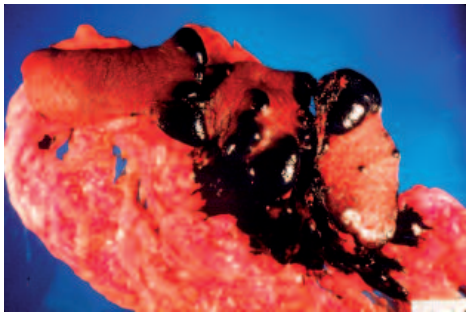

Fig. 6: *Splenic rupture and haemorrhage in a dog following a road traffic accident.*

Discussion of the case with a pathologist will also be helpful to determine if additional specimens should be collected for bacteriology or virology testing, or toxicological analysis. If in doubt, collect specimens at the time of PME and speak to a pathologist as soon as possible thereafter for advice. Specimens for toxicology should be retained frozen and unfixed - do not place them in formalin. Ideal specimens for toxicological evaluation are: liver, kidney, stomach contents, urine and blood from the heart (additional very useful specimens include aqueous humour, cerebrospinal fluid, adipose tissue and brain). Solid tissues can be retained in a zip lock bag and body fluids can be collected into a plastic container – all should be able to be tightly sealed and should be appropriately labelled (patient identification and contents) (Fig. 7). It is advisable to first wait for the histopathology report before considering toxicological testing, as this will be the best guide as to whether there is any suggestion of intoxication as a cause of death. The pathologist should then be able to advise you further as to whether toxicological testing is worthwhile.

Fig. 7: *Appropriately labelled zip lock bags and plastic containers can be used for collection of tissue/fluid samples for potential toxicological analysis.*

THE POST-MORTEM EXAMINATION

There are numerous protocols for performing a post-mortem examination, and these often differ between pathologists. As mentioned earlier, however, the key is to be systematic in your approach.

This brief outline details one method of approach:

External examination and exposure of the body cavities

1. Ensure that you have the correct body (Fig. 8). Weigh the body and perform an external examination (note the animal's sex, breed, coat colour, lesions and information such as surgical incisions, catheters, bandage material, identification tattoos etc). If trauma is suspected as a cause of death, radiography can be a useful adjunct at this stage. Remove eyes (do not dissect them, merely place them in 10% formalin).

Fig. 8: *Always ensure that you have the correct patient's body before you begin the post-mortem examination, and take care to note its external identifying features at the start of the report (type of animal, breed, sex, age, coat colour etc).*

2. Stabilise the body in dorsal recumbency. Transect the skin and skeletal muscles between the scapula and thoracic wall. Transect the inguinal regions and disarticulate the coxofemoral joints.
3. Make a continuous, midline ventral skin incision from the mandibular symphysis to pubis: (in males, extend the incision bilaterally parapreputially and reflect the penis and prepuce caudally). Carefully reflect the skin from the abdomen, thorax and cervical region.

3. Open the abdominal cavity by a midline incision that extends alongside the caudal ribs. Puncture the diaphragm and expose the thoracic cavity by cutting bilaterally through the ribs (pruning shears are adequate for this – their size will depend on the size of the animal; in a very young animal, a scalpel can even be used to transect the costochondral junctions). Remove the thoracic wall along with the ventral cervical musculature attached to the cranial sternum – this will expose the cervical portion of the trachea.
4. At this stage when the body cavities are open (Fig. 9), it is wise to examine the tissues *in situ* to identify and describe any gross lesions before removing the tissues for further dissection. Assess the pleural and abdominal cavities for excessive fluid or exudates (measure volumes if present).

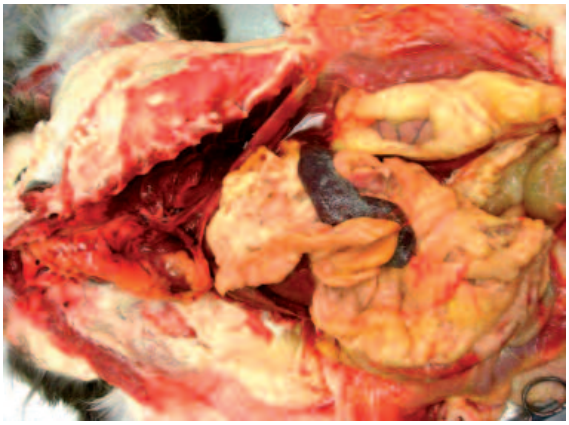

Fig. 9: *Once the body cavities have been opened, all tissues/organ systems should be systematically examined for lesions in situ before removal.*

Examination of the abdominal cavity

5. Remove and examine the spleen and greater omentum.
6. Separate and uncoil the small and large intestine by cutting it from its mesenteric attachment.
7. Sever the oesophagus at the gastro-oesophageal junction; retract the colon cranially and sever it at the pelvic inlet. Open the entire gastrointestinal tract with a continuous, longitudinal incision (cut the stomach along the greater curvature). Examine all mucosal surfaces and lumina.
8. Remove and examine the liver, and weigh it after removing the gall bladder. In general, the liver should not normally exceed 3-4% of bodyweight in a dog or cat (Table 1).
9. Remove and examine both adrenal glands and both thyroid glands.
10. Remove the kidneys, ureter and urinary bladder as a single unit. In males, sever the urethra distal to the prostate gland and remove the gland with the urinary bladder. In females, examine and remove the reproductive tract (ovaries, uterus, cervix, vagina and vulva).

Examination of the thoracic cavity

11. Make deep stab incisions parallel to the mandibular rami and reflect the tongue ventrally. Disarticulate the hyoid bones and remove the tongue, larynx, trachea, heart and lungs *en bloc*. Examine the tonsils. Longitudinally open the entire length of the oesophagus and trachea.
12. Leave the heart attached to the lungs and dissect open the cardiac chambers. Locate the pulmonary artery and open its major branches into the caudal regions of all lung lobes (to check for thrombi [Fig. 10]). Remove and weigh the heart - it should not normally exceed 1% of bodyweight in a dog, and should not exceed 18-20 grams in a cat (Table 1).

Table 1: Normal weight ranges for canine and feline heart and liver

	HEART	LIVER
DOG	<1% of total bodyweight	3-4 % of total bodyweight
CAT	≤ 18-20 grams	3-4 % bodyweight

The brain

13. Without the correct tools brain removal is difficult. It is therefore advisable to merely remove the head and forward it to a pathologist as soon as possible for this procedure to be performed (or at least telephone one for advice on removing the brain): From a ventral approach, disarticulate the head at the atlanto-occipital junction. If it is absolutely necessary to remove the spinal cord, a pathologist should be consulted.

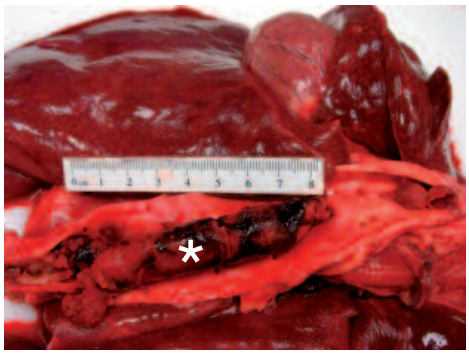

Fig. 10: *A pulmonary artery in a dog is dissected open to reveal a large thromboembolus in the lumen (*).*

REPORTING YOUR FINDINGS

As soon as possible following the procedure, a formal report should be written to detail the post-mortem findings. Most pathologists favour use of the present tense for report writing as this enhances credibility. Be as concise as possible and avoid embellishments – findings should be reported in as few words as possible. Importantly too, be aware of unintended readers – owners and lawyers often get access to reports, so consider the implications of everything that you write, and avoid abbreviations.

The report should be paragraphed to maintain organization. Begin with some basic demographic

data in the first paragraph: a description of the animal (age, sex, colour, weight, identifying features such as tattoos, surgical incisions etc) and its condition (nutritional condition as well as post-mortem condition). The date, time and location of the procedure and length of time between death and post-mortem examination, as well as all findings from the external examination should follow. Findings from each body cavity in turn should be systematically described in subsequent paragraphs – state the most significant findings in each cavity first. Lesions and abnormal findings may be described in lay terms (be as direct and specific as possible) and should ideally at least detail their location, three-dimensional size, colour, and texture. Where possible quantify the lesions (measure the volume of effusions, measure the length of any incisions).

The report should finally be signed and dated by the veterinarian who performed the procedure.

CONCLUSION

The unexpected death of a pet is a devastating experience for owners, and the level of sensitivity used in dealing with these cases is crucial to allow the owner to come to terms with the situation in the long term. True sudden death, however, is a fairly rare event in dogs and cats. In cases that are likely to become medico-legal issues where malpractice is a consideration by the owner, it is strongly advised to forward the body to a trained pathologist for PME. If this is impossible for some reason, PME should be undertaken by an independent veterinarian – preferably from a different practice, but at the very least by a veterinarian who was not involved in the case. In any event, it is recommended to at least speak to a pathologist for advice about the case.

FURTHER READING

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CPD CONTINUING PROFESSIONAL DEVELOPMENT SPONSORED BY CEVA ANIMAL HEALTH

These multiple choice questions are based on the above text. Answers appear on page 99.

1. **The upper limit of acceptable heart weight for a normal cat is:**
   a. 15 g
   b. 20 g
   c. 25 g
   d. 30 g

2. **In dogs, the heart should not represent more than what percentage of bodyweight:**
   a. 1%
   b. 2%
   c. 3%
   d. 4%

3. **In small animals, the liver should not represent more than what percentage of bodyweight:**
   a. 2%
   b. 4%
   c. 8%
   d. 10%