THE NECROPSY IN VETERINARY MEDICINE: PART 1

REASONS AND PRINCIPLES

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"The cursory autopsy, with lack of attention to detail and without an understanding before the dissection begins of what one might seek, of what one must consider, and how tissues should be sought and prepared, can only yield missed opportunities." (1)

ABSTRACT

Over the past two decades there has been pressure placed on veterinary clinicians to perform more of their own postmortem examinations. Many are reluctant to do so due to the time that has elapsed from their formal training, unfamiliarity with technique and unsure knowledge of the appearance and typical variation of normal vs abnormal tissues. This article is the first in a series that will cover the necropsy in veterinary medicine from the basic principles, through detailed technique to preparation and submission of samples from necropsies to referral laboratories. In this particular article, the reasons for and principles behind a necropsy as well as some aspects of euthanasia and postmortem degeneration of carcasses are discussed.
INTRODUCTION

This paper is the first in a series that will cover the place, procedure, and ancillary tests for postmortem examination in veterinary medicine. This first paper discusses the role and the principles of necropsy examination.

Veterinary clinicians, while trained in postmortem techniques as part of their education, are by nature of their interest more oriented towards treating and managing live animals, and are often uncertain in working with postmortem material. This series of articles is an attempt to provide clinicians with reference material to allow them to feel more comfortable in extending their practices to include regular postmortem examinations.

A necropsy, also known as a postmortem examination, is the examination of the body of an animal after its death. The goal of necropsy examination in veterinary medicine is to provide an analysis of dysfunction at the level of the entire animal or even the herd. Analysis of dysfunction only at the cell, organ or system level is inadequate (2).

Disease control requires information, and information is obtained by surveillance. Surveillance has two arms, commonly referred to as active and passive. Passive surveillance consists of examination of clinically affected cases of diseases in a population. Necropsy examination is one of the two main tools of passive surveillance in veterinary medicine¹. The term “passive surveillance” is misleading and unfortunate because it implies a less robust approach than its counterpart. Passive surveillance is actually “finger on the pulse” surveillance.
The second is clinical examination of unhealthy animals
REASONS FOR CONDUCTING A NECROPSY

The information obtained from a complete necropsy is used primarily by veterinary clinicians and animal owners but in some instances more generally in society. There are many reasons to conduct a necropsy in veterinary medicine:

1. to determine the cause of death of an animal including the provision of a source of primary or corroborative information in cases of sudden, suspicious, or unexplained death, and to establish an etiology of disease.

2. to confirm, clarify or correct a clinical diagnosis and to rule out other disease processes. In this way the necropsy can serve as quality control for the clinician, monitoring the accuracy of interpretation of clinical signs and antemortem diagnostic tests. Clarification of clinical signs, especially those that were unexpected or atypical of the disease condition and correlation of clinical signs and pathologic findings is thereby provided.

3. to increase the accuracy of diagnosis in any of a number of conditions which are very difficult to accurately diagnose clinically.

4. to search for and to assess concurrent disease and management problems in order to establish causes of production loss.

5. as an information gathering device in research to assess the effectiveness of medical or surgical therapy, new medical and surgical techniques, and to determine the efficacy and toxicity of therapeutic agents.

6. to provide accurate information which can be used to compile provincial or national records of animal disease, to identify disease trends, to recognize, document and investigate diseases that are new to an area, emerging diseases, or
novel disease processes. This is particularly important in veterinary medicine, because changing animal management systems may create entirely new diseases, or new opportunities for existing pathogens.

7. as a method for education of veterinary students, animal health technicians and those who may need to deal with animal disease such as wildlife officers.

8. to obtain forensic or legal information.

9. to identify emerging diseases.

10. to monitor the influence of environmental factors on physiologic processes.

11. to serve as an indicator of the presence of zoonotic diseases.

Very similar reasons are given for conducting autopsies in human medicine (3)
There are several principles that underlie necropsy technique:

1. to proceed every time with a standard, consistent, repeatable approach.
2. to expose the internal organs with minimal disturbance and contamination.
3. to open and examine organs in such a way that they may be reasonably reassembled into the shape and position that they occupied before they were cut.
4. to yield the best specimens possible for ancillary tests.

The necropsy is conducted in a routine manner every time. This is necessary to avoid chasing lesions as they are encountered and thereby being distracted from conducting a thorough examination. An orderly approach also has the benefit of making the prosector observe normal structures, and more importantly, variations of normal. This builds a basis of experience that will allow the abnormal to be recognized when it is encountered. To achieve this, the necropsy proceeds in a strict routine, progressing through a standard series of steps each time it is performed.

Necropsy procedure is designed to reveal organs as close to possible as they were in the animal at the point of death. This implies that there should be the minimum possible amount of handling of the carcass as it is moved into position for examination. This is relatively straightforward when the animal is to be examined in the field, but rather more difficult when it is to be transported to a clinic or laboratory. However, animals can be loaded and unloaded with relatively little disturbance of internal organs if care is taken. Rolling and twisting movements are particularly to be avoided as they potentially affect the relationship of abdominal organs, and may reduce torsions and volvulae prior to opening the carcass. In addition, there should be an economy of cutting: the most information
should be revealed about the carcass and organ systems with the fewest incisions. This is one way of reducing the amount of damage. Contamination of the carcass and each individual organ by organisms and toxic compounds must be avoided so that when microbiologic or toxicologic techniques are required, there is no difficulty interpreting the significance of findings.

The necropsy procedure is designed to cause a minimal degree of damage to tissues, organs or organ systems and allow their reconstruction by reassembly if necessary following the necropsy. This capability is required as it may be necessary to verify the relationships of organs one to another or the presence or absence of an anatomic structure based upon some finding that has been made after the removal of that particular organ or part. This is true most commonly of the relationships between the great vessels and the heart and lungs which very often need to be reconstructed based upon finding anomalies or vascular pathology. The technique should proceed in such a manner that the organs can be reasonably reconstructed and identified as to location (left or right) if necessary. Aimless cutting and hacking has no place in proper necropsy technique.

The basic necropsy examination is organized in such a manner that all organ systems are first evaluated grossly. Once this basic examination has been completed, the pathologist may then proceed to focus on the specific abnormal organs or tissues, but this should only occur after a thorough stepwise initial examination. A truism of veterinary practice is that you are more often wrong because you didn't look than because you didn't know. A standard procedure properly conducted requires the prosector to continuously search, look and be aware of what is seen.
Necropsy technique should also be designed to yield the best specimens possible for any ancillary tests that may be necessary following gross examination. The same principles apply: specimens should represent cell morphology and function as closely as possible to that which was present at the time of death. The necropsy must be conducted to avoid any exposure to water, contamination with foreign compounds, organisms or other material that could affect the findings and interpretations of further tests.
EUTHANASIA

Euthanasia is defined as "the deliberate ending of life of an animal suffering from an incurable disease" (4). Words that are used synonymously include euthenics and sacrifice. The verb for euthanasia is euthanatize, not euthanize. For a lively discussion of the correct English form, see references 5-7.

The various acceptable methods of euthanasia are reviewed and detailed elsewhere. For this discussion a few comments related to the circumstances and actions around euthanasia are relevant. The greatest paradox of veterinary medicine is that the first concern of the veterinarian should be the best possible care in the interest of the animal, yet often circumstances dictate that the best care of the herd is euthanasia of selected individuals. On the surface, this paradox appears to have its root in the greatest bane of the profession, economics. In fact, the situation is more complex. Usually there are several conflicting circumstances affecting the unwell animal or herd. The importance of each circumstance carries different weight according to the situation. The economic and sentinel value of the animal, economic situation of both owner and veterinarian, degree of suffering of the animal, emotional makeup and outlook of both owner and veterinarian, attachment of owner or some family member to the animal, quality of service offered by the practice, emotional symbolism of the animal, and many other factors bear upon the decision to euthanatize an animal. Veterinarians must be aware of these factors when assisting a client in this decision. This is more difficult than it appears, because the individuals involved may not be aware of all the relevant factors, or may turn a psychological blind eye to them. The relative demand and importance of each factor must be judged carefully when advising an owner in order to render the best advice.
The word euthanasia is commonly used to sanitize the taking of animal life for the owner and the owner's family as well as for the veterinarian and his or her staff. The verb "to kill" is very often closer to the truth. This is very much the case in diagnostic veterinary practice when the disease problems encountered are often curable. Often the need for a high quality sample of a tissue or organ, or an untreated animal showing typical signs of a disease is a major factor in the decision to euthanatize a specific animal. In such situations, euthanasia is seldom in the interest of the animal, but is very often in the interest of the surviving members of the herd or flock.

There are many indications for killing or euthanatizing animals. Discussion here will be restricted to those most commonly encountered in diagnostic practice. These are:

1. As the best alternative to needless pain or other suffering.
2. When there is incurable illness or injury.
3. To obtain a particular type of sample.
   a. a fresh tissue from a specific organ that cannot be obtained by other means.
   b. an animal or bird showing typical signs of the disease process.

Once the decision to kill an animal has been made, the most important factor should be to minimize the discomfort and stress to which the animal will be subjected during the procedure. The methods of killing animals that cause the most rapid loss of consciousness with the least discomfort are considered the most humane. Safety of personnel involved in killing the animal is an important factor, especially if the animal is large, deranged, or vicious, if the area where the animal is to be killed has solid barriers to movement, an irregular floor surface or other dangerous features, or if there is some inherent danger in the method of euthanasia selected. The emotional effect of the procedure on the owner and
other observers is an important, but secondary consideration to the two already mentioned, but must always be kept in mind. As a general policy, the author is of the opinion that owners should not be present when an animal is killed. If they wish assurance that the animal has been killed, they should be asked to sit in a waiting room during the procedure, and then invited to view the body when the animal is dead. This allows the veterinarian and staff to concentrate on the task, removes unnecessary pressure should the procedure not proceed smoothly, and allows time for the animal to be placed in a natural position following death prior to the owner viewing the body.

Agonal reflex respiratory movements made by large animals following barbiturate injection are often misinterpreted by owners. If an owner does wish to witness the euthanasia of an animal, a brief explanation of what is going to occur and the reactions to be expected from the animal will help to reassure the owner and pre-empt any misinterpretation of events. Equally important is that new staff or students that are assisting or observing have the steps and events they see explained to them, especially if death of the animal is not as smooth and painless as anticipated. The veterinarian should never assume that paraveterinary staff know everything that is occurring, nor that they know how to respond in every situation. For new staff members, explanation can be given as the procedure is being carried out. This has a reassuring effect and involves them more deeply in their role. At all times, the veterinarian has to work in a calm and methodical manner, and the worse the situation becomes the calmer and more methodical he/she has to be.

Massive trauma to the central nervous system is an acceptable method of euthanasia, but carries some caveats. Captive bolt pistols produce instant unconsciousness,
but can be both inhumane and dangerous in the hands of an inexperienced operator. They are of no use in older swine and bulls, both classes of animals having large frontal sinuses which prevent penetration of the brain by the bolt. These pistols cannot be used if it is necessary to properly examine the brain. A prerequisite for their use is complete physical restraint of the animal. Captive bolt pistols can be noisy when used inside concrete or steel structures. There is a role for firearms in killing animals in certain field or emergency situations. A single, well aimed shot into the brain administered by an experienced individual to a well restrained animal causes sudden death and is humane. Alternatively, a shotgun blast from short range laterally to the neck aimed such that the carotid arteries, trachea, cervical nerves and other structures are simultaneously destroyed can be an effective, humane, and safe method of killing a restrained large animal or wildlife under field or emergency conditions. However, use of firearms can become both dangerous and a nightmare of cruelty if the operator does not know the landmarks used to target the brain, misses the shot, or if the animal moves prior to discharge of the firearm. As with captive bolt pistols and for the same reasons, firearms should not be used on animals with heavy frontal bones or large frontal sinuses. Firearm use is precluded inside enclosed structures because of the possibility of ricochets.
POSTMORTEM CHANGES

Prior to examining a carcass, it is important to be familiar with the changes that may occur in the body of an animal in the periods immediately prior to, during, and following death. Such changes may give clues to the nature of the underlying disease process, but just as often may result in alterations that potentially confuse the diagnosis and interpretation of postmortem findings and must be understood in order to properly interpret observations.

A number of changes occur with the process of dying. These include hypoxia/anoxia, responses to metabolic changes and aspiration of blood/rumen content into the lungs. Hypoxia is a common antemortem condition that is reflected in the blood of an animal postmortem. While all blood can be thought of as hypoxic when the carcass of a dead animal is opened, close observation and experience will reveal differences in degree that allow differentiation of significant antemortem hypoxia occurring as a cause of death from hypoxia due to the endstage of other more important processes. Characteristically, when an animal is hypoxic for any length of time prior to death, the blood is dark and unclotted, even in the major vessels and heart. Blood that is adequately oxygenated at the time of death will be well clotted, especially in the heart and major vessels. In addition, in the left ventricle and aorta, it will be a distinctly brighter red than elsewhere.

Animals that have died slowly with gradually failing circulatory or respiratory systems will have associated metabolic changes that are grossly visible as varying degrees of paleness and swelling of the liver. The microscopic correlate of this change is parenchymatous degeneration of hepatocytes, a change that may be mentioned in histopathology reports received from reference laboratories.
The actual event of death is often accompanied by either aspiration or passive flow of gastric/rumen content into the larynx, trachea, or lung. Postmortem shifting of a carcass such as occurs when positioning it prior to examination, may also result in gastric/rumen content being introduced into the respiratory tract. It is important, and fairly easy, to differentiate between material entering the respiratory tract at this time from material entering the respiratory tract that is responsible for pneumonia and ultimately death. There is no tissue reaction to gastric/rumen contents entering the respiratory tract immediately at or following death. Material that enters shortly prior to death will elicit some hyperemia and fibrin exudation from mucous membranes. A much more severe inflammatory response is seen if true, active aspiration has occurred as part of the disease process that led to death, either due to accidental inhalation of ingesta, or more commonly, due to inhalation occurring as a consequence of some other process affecting laryngeal reflexes such as nervous disease or toxicosis. This is an important differentiation to make, because appreciation of gastric/rumen contents cannot occur in the presence of normal laryngeal reflexes. Aspiration is therefore an indication of either nervous disease affecting reflexes, or some systemic condition that has altered nerve function.

The process of decomposition begins at the ultrastructural level immediately following death. As circulation stops, active arterial bleeding ceases. The blood that flows from cuts made at postmortem examination is due to passive collapse of the walls of veins and arteries as their walls are incised. Blood gravitates to dependent parts of the carcass. Postmortem decomposition occurs at all times of the year in animals that die outdoors, but the rate varies with the environmental temperature and is generally more rapid during the summer and fall. Decomposition is influenced by various factors that modify the
accumulation and dissipation of heat such as thickness and type of haircoat, physiological condition of the animal at the time of death, rates of rumen fermentation and amount of body fat. The rate at which various animals decompose varies from species to species under the same environmental conditions. Insects will invade the carcasses of animals that die outdoors, and sequential changes in the populations of these occur. Such changes can be used to determine when the animal died in forensic cases (8). Some specific aspects of the post-mortem decomposition of ruminants are presented elsewhere (9).

Rigor mortis, or stiffening of the muscles after death is the postmortem change that is most familiar to the veterinarian. Rigor is usually gone by 36 hours, but its speed of onset, progression and termination depend on a variety of conditions. These include physiological condition of the animal at death, amount and distribution of body fat, type and thickness of the haircoat and ambient temperature, among many others. Livor mortis is a second alteration that follows death. This is a purplish discolouration of the skin. In veterinary medicine, livor mortis is seen most commonly in thin haired animals such as pigs, and will be present but not visible in animals with heavy haircoats. Dessication is a much longer term postmortem change which leads to mummification: drying and shrinking of non-durable parts.

At the cellular level, death does not necessarily occur at one defined point in time as it does with the organism as a whole. Cell death is a process which progresses through a series of stages. Different cell types commence and progress through these stages at different rates. The absolute requirement of a particular cell type for oxygen and other nutrients largely determines when the processes that ultimately lead to cell death commence, and how fast each cell will progress through these various stages. The various
stages of cell death have been correlated with various microscopically observable anatomic changes. The stages and processes of cell death are excellently reviewed elsewhere (10).
CONCLUSION

Prior to actually conducting a necropsy, the prosector needs to have a clear idea of the purpose of any particular postmortem examination and the type of information that is expected to be obtained at the conclusion of the procedure. There are a number of principles that need to be observed while conducting the procedure, the two most important being to employ a standard, consistent approach, and to proceed in a manner that yields the least disruption to the carcass and organs while yielding the most information possible.
REFERENCES


