When an animal’s death is suspected to be the result of a criminal act, the practicing veterinarian may be asked to perform a post mortem examination. In this situation, the practitioner falls into the role of medical examiner, or forensic investigator.

A medical examiner is an individual who, through the use of his or her medical education and practical experience, investigates facts surrounding a human death; then determines the cause, mechanism, and manner of death.1,2 Veterinarians who specialize in forensics need to be familiar with the legal process of collecting, maintaining, and presenting medicolegal evidence in a court of law.

The goal of this series of articles is to help practitioners understand this process in the event they need to fulfill the role of a forensic veterinarian, whether as a crime scene investigator, medical examiner, and/or expert witness.

THE FORENSIC REPORT
A pathology report, as we learned to write in veterinary medical school, is not the same as the medicolegal document known as the forensic report.3,4

The goal of the forensic report is to, within a reasonable degree of scientific certainty, determine the cause, manner, and mechanism of death.

Any circumstances surrounding the death of the animal, including medical, pathologic, or toxicologic issues, should be addressed in the report.

The report should include pictures, supporting documents, and necropsy findings from which facts, inferences, and conclusions can be drawn.

All conclusions in the forensic report are formed with consideration of associated police, witness, and crime scene/investigation reports. To draw valid conclusions, alternative scenarios should be considered.

Finally, one should be aware that the forensic report and all evidence is subject to “discovery,” meaning all legal parties will have access to the report, evidence, photographs, medical histories, and investigator notes.

FORENSIC REPORT TERMS

Cause of death is defined as the disease, injury, or traumatic process that initiates a sequence of events, which lead to death. In criminal investigation, cause of death is sometimes referred to as the proximate cause of death that, but for this event, death would not have occurred.6

Mechanism of death refers to the physiologic action that resulted in death (eg, asphyxiation, hemorrhage, cardiac thrombus, renal failure).

Manner of death is the final determination made by the forensic investigator. The legal terms used by physicians and medical examiners for manners of death, such as suicide or homicide, are not applicable in veterinary forensics. In veterinary medicine, the medicolegal terms for manner of death include:7

- Natural
- Accidental
- Nonaccidental/malicious
- Undetermined.

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This is the second article in the Veterinary Forensics Series, which is examining important roles that may embrace veterinarians who are faced with crimes related to animals. The first article in the series—The Veterinarian as Crime Scene Investigator—was published in the January/February 2013 issue of Today’s Veterinary Practice and is available at todaysveterinarypractice.com.
If an animal is euthanized, the cause of death is listed as euthanasia, along with the reason for euthanasia. The manner of death is determined based on the reason for euthanasia.

**CHAIN OF CUSTODY**

Before any forensic examination begins, everything related to the animal and case must be handled according to chain of custody protocol. This includes any reports, samples collected, photographs, imaging, and the body. Secure chain of custody is critical for admissibility of evidence.

Chain of custody refers to the written paper trail that follows the identification, storage, alteration or testing, and transport of any evidence or samples from collection to their final disposition. 

- All forensic samples should be maintained in a secure location, sealed in a tamperproof container under appropriate storage conditions, and readily identifiable.
- Any tissue or biological evidence that may be submitted to a forensic or veterinary laboratory should be prepared in accordance with laboratory protocol and appropriate forensic principles. Most of these laboratories will provide a submission manual or written guidelines.
- Use of commercially available evidence collection and packaging equipment and tamper-proof tape can significantly reduce the risk of legal challenges or objections regarding improper evidence collection and handling.

**NECROPSY EXAMINATION**

Postmortem examination (necropsy) is one of the most important aspects in the forensic investigation. Consultation with a pathologist, toxicologist, forensic veterinarian, or other forensic professionals may be beneficial during necropsy, evidence collection, and/or interpretation of findings.

It is reasonable to review all antemortem information before initiation of the necropsy, including, but not limited to:

- Medical history (to identify pre-existing conditions that may be implicated in an animal's death)
- Witness statements of antemortem signs and clinical signs
- Police reports of the events surrounding the suspected crime.

1. **Microchip Identification**: Initially, the body is unwrapped and scanned for a microchip.
2. **Photography**: Close-up photographs of any unusual characteristics should be made. Lesions, wounds, or other material of potential evidentiary value should be photographed and recorded with and without a measuring scale. The measuring scale is best placed on the same plane relative to the item of interest. Photographs should be identified both within the image itself and in a written log, with anticipation of the need to answer questions about them at a later date.

**POSTMORTEM DECOMPOSITION: WHAT IT TELLS US**

Postmortem changes include livor mortis, algor mortis, and rigor mortis.

**LIVOR MORTIS** (lividity, dependent hypostasis) is the red–blue–purple discoloration of the body that results from postmortem gravitational settling of blood within capillaries.
- Lividity changes can manifest both internally and externally. Examples include discoloration of the dependent aspect of skin, oral mucosa (Figure), and lungs.
- Contact points with the ground or other objects will exert pressure on the body and prevent blood from settling at these points, resulting in blanching that may provide information about the contact surface.

**ALGOR MORTIS** is the decrease of body temperature in the direction of the current environmental temperature. After death, the body cools unless the ambient temperature is greater than the body's temperature. Algor mortis is affected by several factors, including ambient temperature, antemortem activity levels, body insulation (hair/adipose tissue), immersion in water, infliction of significant tissue trauma/destruction, local movement of air, or underground burial.

**RIGOR MORTIS** is the muscular stiffening that follows the immediate and total muscular relaxation, which takes place upon death. Rigor mortis is then followed by a secondary muscular relaxation (flaccidity). All muscles in the body are affected by rigor mortis; however, there may be differences in the timing of onset based on muscle group.

Several factors influence the extent and duration of rigor mortis, including environmental temperature, infection, electrocution, fever, seizures, and degree of muscular activity immediately before death.
- In humans and animals with decreased glycogen levels (eg, starvation, exhaustion), onset of rigor is faster and of shorter duration.
- High environmental temperatures can result in accelerated onset of rigor and shortened duration.
- Decreased muscle mass or under developed musculature, excessive glycogen stores, or obesity can retard or even prevent development of rigor.
3. **External Examination:** During the external examination, signs of traumatic injury (ie, puncture wounds, lacerations), nutritional condition (emaciation versus obesity), and natural disease are recorded. An anatomic body chart is helpful to annotate significant information.

In some cases, a fine tooth comb can help collect evidence that may be loosely attached to the body, such as botanical, entomological, or trace evidence, which may provide valuable information about the case. Collection and packaging of evidence should follow recommended guidelines based on the evidence type.

4. **Radiography:** Generally, full body radiographs should be taken and examined prior to necropsy to evaluate abnormalities of the skeletal system, identify projectiles, and locate any microchips. Radiographic interpretation often helps identify sites on the skeleton where gross examination of specific bones is warranted to identify the nature of injury or traumatic fractures.

Each radiograph should include the case number and animal’s identification information, labeled with correct left and right markers. Failure to adequately identify and label radiographs may result in their inadmissibility in a court of law.

5. **Internal Examination:** Relative organ position within the body cavity, free blood, body fluids, and evidence of blunt trauma (eg, bruising, ruptured organs) should be recorded. Examination of individual organs (including the brain), major vessels, lymph nodes, muscle masses, and joint fluid may reveal additional lesions of diagnostic or evidentiary significance. In cases of paired organs, samples of both organs (left and right) should be examined, collected, and labeled. With medicolegal cases, duplicate or even triplicate samples should be collected for potential additional testing if sufficient tissue is available.

6. **Additional Diagnostics:** Beyond basic necropsy, additional diagnostics may be required for the investigation. Any advanced tests or analysis should be selected with great care to ensure that the maximum relevant information is obtained to draw valid conclusions, such as to:

- Refute or support witness, suspect, or police reports
- Establish the relationship of the animal victim to the crime scene or suspect
- Establish the cause, mechanism, and manner of death and rule out other causes.

Additional diagnostic tests and analysis include histopathology, microbiology, toxicology, dental analysis, entomology, DNA typing and analysis, and genetic testing. Other significant testing may include the evaluation of plant and insect material found on the remains for toxicology evaluation or to determine time of death.

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### SPECIAL CIRCUMSTANCES

#### Sexual Abuse in Animals

Sexual abuse is defined as actions that involve the sexual/reproductive organs, anus, rectum, and cloaca or vent in birds. Studies have suggested that the incidence of sexual abuse in animals is 1% of all abuse cases.

#### Malnutrition & Starvation

Severe malnutrition must be evaluated within the context of overall health. In dogs and cats, body condition scoring (5- or 9-point scales) provides an indication of nutrition status. However, a body condition score is designed to assess live animals in the standing position, not a cadaver.

It is important to obtain the animal's body weight prior to examination as well as examine musculature and fat deposits.

- In general, the typical carnivore will pass food through the gastrointestinal system in 5 to 40 hours, depending on health, food composition, and hydration status.
- In carnivores, atrophy of muscle mass begins within 24 hours of starvation.
- Antemortem fat deposits are first depleted from subcutaneous fat, then the omentum, and finally deep organ fat (renal and heart). Assessment of bone marrow adipose tissue (depleted last) may be consistent with malnutrition and other wasting diseases.
- Serous atrophy of fat is commonly observed in starved animals.

Gastrointestinal foreign bodies may be evidence of starvation, pica, attempted intoxication, or behavioral issues and should be preserved.

#### Penetrating Wounds

Wounds may be inflicted by a variety of items, tools, or weapons. The more common sources include gunshot wounds, knives, and arrows. Other weapons may include screw drivers, box cutters, and hammers.

Photographic, histopathologic, and topical chemical analysis can help substantiate conclusions regarding the nature of the wound and method used to inflict the wound. Generally, gunshot leaves a tell-tale residue around the entrance wound if the firearm is discharged in relatively close proximity to the body. This residue may be chemically analyzed for gunpowder either in the laboratory or by a field gunshot residue kit.

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### BULLET WOUNDS

**Bullet entrance wounds** are often associated with subcutaneous bruising and, depending on the ammunition and angle of impact, may be circular in nature. **Exit wounds** are variable in nature and may be larger than the associated entrance wound. Hemorrhage and wound tissue dehiscence may also be associated with entrance and exit wounds.
Projectile Wounds
- Projectile wounds—arrows, bullets, pellets, and shot—may be perforating, having both entrance and exit lesions. These “through and through” wounds should be carefully examined to differentiate the entrance from the exit wounds.
- Radiographs may help locate projectiles within the remains if there is no demonstrable exit wound.
- Black powder stippling (tattooing) and bruising of the skin around an entrance wound may indicate a firearm discharged at close range.29
- Any projectiles or casings (bullet coverings) should be recovered with plastic or soft-tipped forceps to avoid interfering with the rifling pattern. The rifling pattern is essential evidence that matches projectiles to the same firearm.29

Stabbings
- Careful consideration and examination of the external wound and wound track characteristics can provide information about the type of weapon used.
- Various techniques exist for following a wound track.
  » The more common method is to gently probe the tract with a pliable object than dissect tissues
  » A second method is to dissect surrounding tissues (flap method).
- Probing and attempts to follow penetration tracks must be done carefully to avoid destroying or creating false evidence.
- Consideration of the depth and breadth of the wound may allow scientific elimination of some weapons.

Toxicology
Toxins are chemical agents derived from a biological source (eg, botulinum, anthrax). Poison is a more general term that includes toxins and chemically derived poisons (eg, ethylene glycol, potassium cyanide, rodenticides).

Some common poisons seen in malicious crimes against animals include strychnine, cyanide, ethylene glycol, corrosives, human pharmaceutical agents, carbon monoxide, illicit and illegal drugs (eg, amphetamines, heroin, cocaine), and rat poisons (eg, difacinone, bromodialone, bromethalin, cholecalciferol, carbamate).17,30,31

Toxicology testing should be considered in all cases where it cannot be definitively ruled out.32,33 Analytical test results may yield sufficient information for a search warrant or even a conviction in some courts.

Any request submitted to the toxicology analytic laboratory should include all antemortem signs, medical records, postmortem information, and the suspected class of poison. As mentioned earlier, evidence should be prepared in accordance with laboratory protocol and appropriate forensic principles.

THE NEGATIVE NECROPSY
The negative necropsy is one where, after both gross examination and histopathologic examination, no conclusive cause of death is found.34,35 Reasons for a negative necropsy include:
- Failure to obtain a thorough and complete medical history and/or investigation findings
- Failure to complete a detailed external or internal examination
- Failure to complete appropriate histopathologic tissue collection
- Improper storage of remains.

The negative necropsy doesn’t indicate “defeat” since a thorough necropsy, with appropriate testing, may corroborate or contradict evidence contained in police, witness, or crime scene reports. The negative necropsy may present a significant challenge to the veterinarian’s credibility as an expert witness, and therefore, must be directly addressed in any forensic report.

There are now trends in the field of human necropsy for negative findings to be followed by genetic testing to identify precursor risk factors that may explain the death.36 For this reason, it is prudent to maintain duplicate tissue samples, appropriately stored for follow-up testing.

IN SUMMARY
The goal of this article is to educate the general practitioner about the significant issues related to the forensic, medicolegal necropsy. This information does not replace...
additional education or experience in the areas of forensic pathology, toxicology, criminal investigation, criminal procedure, and rules of evidence. Consultation with forensic pathologists, toxicologists, and other forensic professionals is encouraged.

Key skills to becoming an effective and successful forensic veterinarian include:

- Attention to detail
- Meticulous photography
- Impeccable record keeping
- Ability to think critically, avoiding distraction by issues that may preclude understanding of the scientific truth.

References

17. ASPCA. Dog Fighting FAQ. Published in 2012 and available at aspca.org/mydocuments/aspca_crueley_dogfighting_vet_faq.pdf.