Forensic Necropsy: Considerations for Examination of the Deceased Victim
Melinda Merck, DVM
Veterinary Forensics Consulting, LLC, Austin, Texas

There are many different types of non-accidental injuries. They include penetrating injuries, non-penetrating injuries, burns, gunshot wounds, asphyxiation, drowning, poisoning, ritualistic crime, sexual assault, and animal fighting injuries. There are several considerations to first determine if the injury is a result of accidental versus non-accidental causes. The veterinarian must draw on their own experience with known accidental injuries and compare those findings to the evaluation. Another source of information is emergency veterinarians who have a wealth of knowledge and experience with trauma though some of their cases may have been undetected abuse. The information provided by the caregiver and/or the investigator is critical to properly evaluate a possible case of cruelty, whether the animal is alive or deceased. A necropsy should never be performed without investigation findings and crime scene information including photographs of the scene. The environment and husbandry for the animal directly affects the health of the animal and must be analyzed along with physical exam findings. Animal cruelty should be suspected in every case where the history, crime scene findings, and environmental conditions do not support the exam findings. Aberrant findings should not be disregarded for they are often the key piece of evidence that the injuries sustained are non-accidental.

Forensic Necropsy Procedure Considerations

The necropsy procedure involves a process of documentation and examination of the external and internal body. Photography starts with the body still in the package or bag. Photos with and without a photo scale should be taken of any evidence where the size is important. The external body should be examined for trace evidence, foreign material, bodily fluids, and obvious area of trauma. External wounds or evidence of injury such as contusions should be shaved and measured. The necropsy may be performed in lateral or dorsal recumbency. The skin should be reflected to identify underlying injuries. The dissection, and opening of body cavities should be done based on the apparent injuries avoiding major blood vessels which can contaminate the field and distortion or alteration of wounds. Flap dissection should be used to analyze and follow wound tracks through tissue such as gunshot wounds or sharp force penetrating injuries. It is important to consider skin tension lines and avoid manipulation of skin or wound tracks which can distort the weapon characteristics. It is best to examine the skin and soft tissue wound characteristics first without manipulation and then with gentle manipulation to restore skin tension. Scotch tape may be used to re-appose the wound edges to discern blade characteristics such as serration. The use of a necropsy exam form and diagrams are recommended to ensure complete examination and documentation. The form also corresponds to the forensic report form making report writing easier. The deceased animal intake form is used to document case information when receiving the body. The evidence-chain of custody log and photo log are also forms that should be used.

Non-Accidental Injuries

With every animal cruelty case, one must consider the animal suffered blunt force trauma in addition to any other injuries. Contusions are very hard to see on the skin surface of animals unless there is light colored skin and the fur is parted all over the body to inspect for discoloration. It can take hours for bruising to show up on a live animal so re-inspection of the body should be done every few hours. In deceased animals, the skin should be reflected all over the body to reveal subcutaneous hemorrhage. Sometimes the hemorrhage is in the deeper muscle next to the bone, such as the rib cage, and does not extend to the subcutaneous layers especially if the survival period was very short after the injury. Careful dissection of the muscle layers can reveal the deeper evidence of trauma. The size and shape of the contusions can help determine what was used to cause the injury. There may be a denser area of hemorrhage with seepage into the surrounding tissues. It is the denser area that provides the clues to the cause. Petechiae may be seen on the pinnae and horizontal ear canal with blunt force trauma to the head. The petechia in the ear canal is a unique finding in dogs and cats due to the shape of their ear canal. Frank hemorrhage may be seen inside the ear due to a ruptured tympanic membrane. The common rule-out for any hemorrhage is clotting disorders which have a wide variety of causes so a full work-up should be conducted.

Proving Sequence of Events

It is important to try and determine the sequence of injuries which re-creates the crime scene events. The veterinarian’s knowledge of animal behavior, clinical experience, and common sense must be used to evaluate injuries. There are several considerations to make this determination depending on the type of injury. In deceased victims, the first thing to determine is the fatal injury and then back track from there. For contusions and areas of hemorrhage, one
must remember that hemorrhage requires a beating heart. In multiple stab wounds, there may be little to no hemorrhage around an injury that was made when or after the heart stopped beating. But, if there is minimal blood supply to the area then it could account for the minimal amount of hemorrhage. With multiple fractures or injuries, a diagram can help in the evaluation of the number of blows and determining sequence of events. With multiple fractures of the skull, one blow may cause concentric or radiating fractures. Evaluation of where these lines stop and start can help determine the number and type of impacts. Consideration must be given to the impact each injury would have had to the animal. This includes how the injury would have compromised the animal such as severe pain, the ability to move, vocalize, or fight back. In addition, the veterinarian must consider what the animal’s response would have been to each injury. This is critical in courtroom where the veterinarian must testify about the expected reaction and vocalization to each event/injury as part of their expert witness testimony.

Proving Time of Death

Proving time of death is usually an estimate at best. It requires taking into account several exam findings in addition to eye witness statements. Rigor mortis, algor mortis, and gastric emptying time are all variable depending on the events prior to death and the environmental conditions. The most accurate time of death can be provided using insect evidence. Maggots can aid in determining TOD, location of death and provide DNA and toxicology evidence. Maggots can help determine the time of death by providing the post mortem interval. Flies lay eggs during certain environmental conditions, at certain times of day after an animal has died depending on the species of fly. These eggs then hatch into maggots based on environmental conditions. The larvae develop at a certain rate, depending on the species and environmental conditions, and can be aged by a forensic entomologist. Blow flies are attracted to the body postmortem so by dating the time of colonization (laying of eggs), the time of death can be estimated. It is important to note that in some cases, maggots may be found on live animals, known as myasis. This is usually due to fecal soiling or wound necrosis present on the animal that attracted the flies. In this case, the time estimate will be for the time of trauma. Other insects are forensically important such as beetles which feed at different times post mortem.

A sample of all insects, pupae and pupa casings on the body should be collected noting the location on the body they were found. If there is a mass of maggots, then a temperature of the mass must be taken by inserting a thermometer in the center. The mass of maggots generates heat affecting their rate of development and affecting the entomologist’s analysis. In some cases there may be pupae casings present indicating the fly has gone through at least one life cycle and these should be collected. If maggots are present then it is important to get a sample of the adult flies to assist maggot species identification. One should also get a sample of any beetles if present which appear on deceased bodies at certain time intervals after death. Maggot samples should be collected and shipped for testing, taking care to get the largest larvae.

Forensic entomology analysis is dependent on the ambient temperature readings. Weather data for the past 2-3 wks as well as temperature of where the body had been held prior to examination is needed for accurate analysis. When the body is moved from the scene temperature of the transport vehicle and the time of transport must be recorded. If the body is held in a cooler prior to maggot sample collection, the temperature and time in the cooler must also be recorded. The entomologist needs certain information in addition to the weather data. They need photographs of the animal and the environment it was found in. They need to know if there were any unhatched eggs on the body and the location. They need to know the position of the body when found at the scene – sternal, lateral, curled, anything covering the body, any if the body was in direct sunlight or under shade taking special note of the head and perineal area. It is also helpful to provide them with any information regarding the crime scene and the presumptive cause of death.

Every effort should be made to get a sample of live flies at the scene where maggots or maggot eggs are present for species identification. Blow fly egg masses should first be photographed and their location documented. Using forceps, break a small piece of egg mass off approximately the size of a dime, taking care to collect from the center as the eggs at the edge may be desiccated and no longer viable. Each egg mass collected from each location on the body should be kept separate. The mass collected should be broken in half and one half placed in 75% ethyl alcohol. The other half should be placed in a larval-rearing pouch. These pouches are made taking a piece of aluminum foil and folding it to create a three-dimensional rectangular pouch, crimping the corners together. A small piece of beef or pork liver should be placed inside as a feeding substrate should the larvae hatch. The top should be crimped together sealing the sample. This pouch should then be placed inside a plastic container for shipment with approximately one inch of soil or vermiculite in the bottom and small air-holes punched into the plastic top. This substrate absorbs any fluids that leak from the pouch and, for late stage larval samples, provides a burrowing substrate. Two labels should be created for the larval feeding pouch with the date and time, case number, location of the sample collected, and the sample number. These should be filled out in pencil to avoid any destruction of the writing. There should always be a double labeling system used where
by the time it reaches the forensic entomologist. As time goes on, there is sequential colonization of the area by development of vesicles on the skin, skin and hair slippage, and the color of the body is pale green to greenish-black. Marbling occurs in these areas due to hemolysis of the blood within the vessels and the hemoglobin reacting to putrefaction. The tissues affected, medications, and the fluid, will drain from the mouth and nose and may be found in the body cavities. This may be mistaken as secondary to the cause of death or the type of injury, hemorrhage, neutrophils, and/or edema fluid may be present with hours of the injury. The inflammatory responses may be affected by the age of the animal, the tissues affected, medications, and the health of the animal. An injury without an inflammatory response is indicative it occurred in close proximity to death. The nature of any inflammatory response may also determine a time interval such as in the case of peritonitis that resulted from intestinal rupture caused by blunt force trauma. The microscopic examination may have evidence of chronic inflammation including fibroblasts and hemosiderin. Putrefaction involves bacteria and fermentation and is often used interchangeably with the term decomposition. After death, the bacteria from the gastrointestinal tract spread throughout the body. Putrefaction is accelerated in animals that are septic prior to death and this process may continue even with refrigeration of the body. In addition to the body, the development of putrefaction is dependent on the environment. In high temperatures the rate of decomposition is accelerated and the body can reach an advanced state of putrefaction within 24 hours. In cold temperatures the rate slows down and may even stop in extreme cold. Even under refrigeration, a non-septic body may still continue to decompose. If the body is constricted in any way decomposition may be delayed. If the animal is overweight, has a heavy fur coat, or is wrapped in something to retain heat, putrefaction may be accelerated. Decomposition may be asymmetric occurring more rapidly in areas of injury. Decomposition may progress to skeletonization in only one part of the body due to insect feeding in areas of injury.

The sequence of decomposition in humans begins with a greenish discoloration of the abdomen. This discoloration then develops on the head, neck and shoulders along with bacterial gas formation causing bloating of the face. Marbling occurs in these areas due to hemolysis of the blood within the vessels and the hemoglobin reacting to hydrogen sulfide, developing a greenish-black discoloration along the blood vessels at the surface of the skin. The then body develops generalized bloating where the eyes may bulge and the tongue protrudes from the mouth. This is followed by development of vesicles on the skin, skin and hair slippage, and the color of the body is pale green to green-black. The weight of the internal organs actually decreases with decomposition. A red-colored decomposition fluid, known as purge fluid, will drain from the mouth and nose and may be found in the body cavities. This may be mistaken as secondary to

When collecting maggots for analysis, you are looking for the oldest (largest) larvae because they are the ones that first hatched and in turn were the first eggs laid. At first, the body and the surrounding area should be examined for prepupal maggots (post-feeding). These will most likely be found off the body but may be found in the fur, carpet, the first 3-5 cm of soil, or up to 50 meters from the body. If none are found then samples of the largest instar larvae should be collected, noting their location on the body. Temperature recordings and time of collection should be documented as described above. A sample of the collected maggots should be preserved at the scene. Place a sample of the largest maggots and some of the next size down into hot or boiling water for five minutes to kill and blanch them documenting the time of blanching. They should then be transferred to a vial of 70-85% isopropyl alcohol. They may be placed in 70-85% isopropyl alcohol at the scene if hot water is not available for blanching. The vial should be double-labeled as described with egg masses, with one label in the liquid and another affixed to the outside. Another live sample of the maggots should be preserved for examination using the larval-rearing pouches. Do not put too many maggots in the pouch because they need air and too many could cause the majority or all of them to die. The migratory larvae and puparia may be found usually within 20-30 feet of the body, depending on the species. They may be found under surface debris, in the top few inches of soft soil, vegetation, under rocks, or on tree trunks. The presence of the empty pupa cases indicates that a complete blow fly life cycle has taken place on the body and indicates a minimum elapsed time since death. These casings are often mistaken for rat droppings. They may be found in the same areas as the prepupal maggots and the pupae. Newly emerged adult flies should be collected in dry vials and a description of their appearance noted, as it will change by the time it reaches the forensic entomologist. As time goes on, there is sequential colonization of the remains by other insects. Analyses of these later appearing insects can help with the estimate of the postmortem interval.

Decomposition

Decomposition involves the two processes of putrefaction and autolysis. Autolysis is a chemical process by the intracellular enzymes that causes the breakdown of tissue and organs. Heat accelerates autolysis while cold slows it down. Freezing can stop the process and in some cases significant heat can inactivate the intracellular enzymes. Organs that have higher enzymes will undergo autolysis faster, such as the liver and pancreas. Decomposition usually occurs in from 6 to 36 hours depending upon the condition of the animal and the environmental conditions of the exposed body. Microscopic exam may reveal autolysis of the tissues with no immune or inflammatory reaction. However, the presence or absence of an inflammatory reaction to an area of injury can help determine a time interval between injury and death. Depending on the cause of death or the type of injury, hemorrhage, neutrophils, and/or edema fluid may be present with hours of the injury. The inflammatory responses may be affected by the age of the animal, the tissues affected, medications, and the health of the animal. An injury without an inflammatory response is indicative it occurred in close proximity to death. The nature of any inflammatory response may also determine a time interval such as in the case of peritonitis that resulted from intestinal rupture caused by blunt force trauma. The microscopic examination may have evidence of chronic inflammation including fibroblasts and hemosiderin. Putrefaction involves bacteria and fermentation and is often used interchangeably with the term decomposition. After death, the bacteria from the gastrointestinal tract spread throughout the body. Putrefaction is accelerated in animals that are septic prior to death and this process may continue even with refrigeration of the body. In addition to the body, the development of putrefaction is dependent on the environment. In high temperatures the rate of decomposition is accelerated and the body can reach an advanced state of putrefaction within 24 hours. In cold temperatures the rate slows down and may even stop in extreme cold. Even under refrigeration, a non-septic body may still continue to decompose. If the body is constricted in any way decomposition may be delayed. If the animal is overweight, has a heavy fur coat, or is wrapped in something to retain heat, putrefaction may be accelerated. Decomposition may be asymmetric occurring more rapidly in areas of injury. Decomposition may progress to skeletonization in only one part of the body due to insect feeding in areas of injury.
an injury but the amount of fluid is usually small in the body cavities in contrast to the amount expected with injury. Decomposition also causes hemolyzed blood to leak out of the broken down blood vessels into the surrounding tissue (imbibition) usually within 12 to 24 hours after death. This can be mistaken for ante mortem bruising so careful examination of lividity and concurrent injuries must be done to differentiate the two. Microscopically this is represented by hemolysis of erythrocytes in the blood vessels whereas the hemorrhage from ante mortem bruising is represented by erythrocytes outside the vessels in the surrounding tissues.

Changes in the eyes are difficult to interpret and depend on whether the eyes are open or closed. With closed eyes, a white scummy deposit develops on the cornea making it cloudy by 24 hours postmortem. If the eye is open and exposed to the air, occasionally a brown to black band may form on the sclera or cornea due to drying called tache noire. Following the wet decomposition, the surface tissues begin to dry, collapse, and darken developing a leathery texture. The organs and tissues will become desiccated and shrink. The body may become mummiﬁed or skeletonized. The time frame for skeletonization of the body depends on environmental conditions, insect activity, and scavengers. Mummiﬁcation can occur in hot, dry conditions when the body rapidly dehydrates. The skin will appear brown or black and leathery. Decomposition continues with the internal organs turning them blackish brown with a putty-like consistency. Adipocere is a grayish-white to brown, firm, wax-like material made up of the fatty acids oleic, palmitic, and stearic acids. It is found primarily in the subcutaneous tissue and other fatty deposit areas. When a body is found immersed in water or in a damp, warm environment, adipocere formation may occur. It may also be seen in bodies that have been placed in bags. In these warm moist environments, fat undergoes hydrolysis by endogenous lipases and bacterial enzymes to free fatty acids. These are then converted to hydroxyl fatty acids by bacterial enzymes, primarily *Clostridium perfringens*. Adipocere formation can take weeks to several months to develop and is resistant to chemical bacterial destruction. For the severely decomposed/skeletonized or burnt body the fragile body should be handled very carefully and samples taken for possible testing. The body should be photographed, measured, weighed, and radiographed. Radiographs may reveal gunshot or broken bones. Depending on the decomposition, samples of kidney may reveal ethylene glycol poisoning. Stomach contents may still test positive for poisons. Examination of bones may reveal evidence of trauma.

Livor mortis, also referred to as hypostasis or lividity, is the pooling of blood due to gravity in dependent body sites after the heart stops beating. Lividity is most useful in determining the body position at time of death and if the body was moved. It is usually visible in light-colored skin, the buccal mucosa, and the sclera. It is also found on the internal body surfaces and internal organs where it is most noticeable on the surface of the lungs. Lividity on internal organs can be mistaken for congestion. At first appearance, contusions may be grossly difﬁcult to differentiate from postmortem lividity. When pressure is applied to the area there will not be any blanching. To differentiate between bruising and lividity, incise the area in question. A bruised area will have diffuse hemorrhage into the soft tissues whereas lividity is characterized by blood conﬁned to within the blood vessels. A contusion involves hemorrhage into the soft tissue and when incised the blood cannot be wiped or squeezed out. This is not the case in areas of lividity. Another factor to consider is the pattern and location of the discoloration – if it is more consistent with lividity based on location and other discolorations in the body or isolated which is more characteristic of injury. Over time, decomposition can make it very difﬁcult to differentiate ante mortem bruising and lividity. Hemolysis of the red blood cells creates diffuse discoloration of the soft tissue. The blood within the vessels and the erythrocyte leakage due to the breakdown of the blood vessels from decomposition will hemolyze. The erythrocytes in the soft tissue from ante mortem bruising will also hemolyze making it impossible to distinguish from an area of livor mortis.

References:
3. www.veterinaryforensics.com – Forensic Forms