Lesions Of Forensic Importance
Gunshot Wounds
Trauma Wounds
Poisonings

Gunshot Wounds
The Science of "Ballistics" is the study of the factors affecting the travel of a projectile to a target
The Science of "Wound Ballistics" is the study of the pathological effects of a projectile passing through a body
Objectives: Gunshot Wound Exam

Can you answer the following questions?

Type of weapon used
Number and type of projectiles (bullets/pellets)
Position of shooter relative to victim (trajectory)
Lethality or incapacitation caused by wound
Duration of wound
Recovery of projectile

Type of gun

- Rifle
  - High velocity centerfire
  - Low velocity rimfire
  - Low velocity black powder
- Pistol
- Air Guns

Type of Gun

- Shotgun
  - bird shot
  - buckshot
  - rifle slug
**Type of Ammunition**

- Semi jacketed bullets
- Fully jacketed bullets (military)
- Barnes type solid copper bullets
- Solid lead bullets and shotgun slugs
- Lead, copper plate, steel, tungsten and bismuth shot

**Wounding Dynamics**

High Velocity Rifle Bullet
Based on wound dynamics, the pathologist may infer some information on the type of projectile.
**Projectile Wound Paths**

- Low Velocity
- High Velocity

**High Velocity Rifle Wounds**

- "Snowstorm" effect of high velocity bullet

**Shotgun Wounds**
Buckshot

Trajectory

- The direction of the projectile relative to the shooter and the victim
- Important in many "self defense" cases
- May be key to finding bullet and/or casing in environment

Number and Trajectory of Bullets

Apparent gunshot wound extending from anterior right shoulder (entrance) to left posterior thorax (exit).
X-rays tell a different story – can you determine the true number and trajectory of bullets?

Defining Bullet Direction

“Self Defense”
“Self Defense”

Radiographic Examination

• Projectile Path (Trajectory)
• High Velocity vs Low Velocity
  - Rifle Bullet vs Shotgun Slug vs .22 Rimfire
• Projectile Location - DV and Lateral
• Projectile Type - Lead vs Steel Shot
• Bones Fractured

Lethality of Wound

• Wolf traveled long distance before bleeding out from wound in spleen from .22 cal bullet
Bullet Wounds Without Fragments

Which shot kills or disables the bird - lead or steel?

- Document particles in tissue with x-ray
- Confirm lead presence with chemical or XRF analysis

Lead vs Steel Shot

Lethal Lead Pellet Wounds
Recovery of Bullets

- Do not handle with metal forceps
- Clean and dry before storage
- Never use airtight container

Arrow Wounds

- Cut hair pattern
- Evidence of hemorrhage
- Bone fracture characteristics

Some “arrow wounds” contain lead particles

Salted Antelope Cape
Some “arrow wounds” contain lead particles

Entrance wound Exit wound

Samples for lead analysis

Trauma

Trauma Wounds Of Forensic Importance

- Patterned Injuries
  
  Does the pattern of lesions tell or confirm a story?

- Blunt Trauma Injury
- Sharp Trauma Injury
- Predator Injury
- Post Mortem Scavenger Injury
Patterned Injury

Characteristic lesion pattern indicates instrument of death

Attack Pattern – Bite Wound Analysis

Attack Pattern – Bite Wound Analysis
Blunt Force Injury
Vehicular Injury

Sharp Force Injury
• Knife Wounds
• Axe Wounds
• Arrow Wounds

“Sturgeon Axe Murders”
Lesions inconsistent with suspected axe blade pattern
Human psychopath or dog?

Multiple cat kills in area may cause panic and be falsely attributed to illegal human activity

Canine tooth puncture wounds in cat carcass

Sharp Force Injury?
Livestock Predation

- Deep muscle hemorrhage
- Premortem subcutaneous hemorrhage

- Killer or scavenger?
- Hemorrhage?
- Mechanism of death?

Electrical Contact Lesions
Electrocution

Hemopericardium common in electrocuted eagles

Forensic Poisoning Cases

Field Investigation

- Species affected (single or multiple)
- Food habits of species involved
- Distribution of carcasses, death stance
- Post mortem condition of carcasses
- Evidence of scavengers
- Presence of potential baits, pest control activity, previous suspected poisoning events
**Objectives: Poisoning Examination**

- Detect lethal poisons in illegally killed animals
- Identify source of poison
  - Ingestion
  - Contact
- Determine if primary or secondary target
  - Primary consumer of poison bait
  - Consumed another animal which was primary target of poison

**Detecting Poisons in Carcasses**

- Crop contents (absorption directly through crop lining from recently ingested bait)
- Stomach contents or stomach lining when stomach is empty (consider water source)
- Skin contamination (pesticide residue detectable in skin of feet for 28 days with about 65% degradation in experimental studies)
- Organ tissue analysis (liver, kidney, brain)

**Document Exposure Route**

- Sequence of Ingestion
- Identification of Food Items
- Analysis of Individual Items
- Consideration of Water or Cutaneous Route
- Consider Time Delay and Travel From Potential Source of Poison
Identify Source of Poison

Cyanide capsule

Split Sample of Evidence

Pesticides Found In Wildlife Poisonings

<table>
<thead>
<tr>
<th>Pesticide</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avitrol</td>
<td>5%</td>
</tr>
<tr>
<td>Strychnine</td>
<td>5%</td>
</tr>
<tr>
<td>Diazinon</td>
<td>6%</td>
</tr>
<tr>
<td>Other Op/Carb</td>
<td>7%</td>
</tr>
<tr>
<td>Aldicarb</td>
<td>9%</td>
</tr>
<tr>
<td>Fenthion</td>
<td>10%</td>
</tr>
<tr>
<td>Famphur</td>
<td>14%</td>
</tr>
</tbody>
</table>

Misc. 8%
Carbofuran 31%
82% Involve OP or Carbamate Pesticides
Carbofuran (Furadan)

- 31% of all wildlife poisonings
- 37% of eagle poisonings

Aldicarb (Temik)

- 9% of all cases
- 20% of eagles

Strychnine

- Blue-Green Stained Grain
- Clear Liquid
- “Sawhorse Stance” if rigor not broken
M-44 (Coyote Getter)

UV light activated fluorescent dye added to cyanide explosive device

Pentobarbital

• Veterinary Sources
• Illegal or Inappropriate Disposal of Euthanized Carcass

Oil Contamination
Cause of Death in Oil Cases

- Hypo or Hyperthermia
- Exhaustion
- Inhalation (volatile and non volatile)
- Ingestion (short term or long term toxic effects)
- Combination of all the above

Eliminate other causes?

COD Documentation in Oil Contamination Cases

- Inhaled
- Ingested

External Contamination

Peanut Oiled Grebes
Forensic Pathologists Get Involved In Their Work

Add a little challenge to your practice – forensics!
Part 2: Lesions of Forensic Importance

1. Gunshot wounds, trauma wounds and acute poisonings are the most commonly encountered forensic cases requiring pathological evaluation encountered. The pathologist should recognize and interrupt these conditions in the forensic context and be able to document and collect appropriate supporting evidence.

2. **GUNSHOT WOUNDS:** Objectives of a gunshot wound pathological evaluation -
Based on the wound characteristics, what can the pathologist determine that will assist in the investigation or prosecution of an illegal shooting? What observations can be made that would support or discount the defendant’s version of events? Pathological examination of wounds can be very critical in determining facts around a shooting incident. An enforcement officer would like to know the following: type of weapon used, number of shots and type of projectiles, position of shooter relative to victim (trajectory), lethality or incapacitation caused by wound, duration of wound, and recovery of projectile for evidence.

3. Basic knowledge of the types of firearms and ammunition used in hunting is essential for the evaluation of gunshot injury in wildlife. **Ballistics** is the study of the flight of a projectile from the barrel of the gun to the target and must not be confused with the term “wound ballistics” which concerns the pathology of projectile impact in the tissues of the animal.

4. The basic types of guns used to kill animals include rifles (low velocity and high velocity), pistols, air guns, and shot guns. Significant differences exist in the wounds caused by high velocity center fire rifle bullets and low velocity bullet wounds from the common .22 rimfire bullets, black powder rifle bullets, most pistols bullets and shotgun slugs. Shotgun pellets may be multiple but are generally also of a relatively low velocity.

5. The velocity of the projectile (bullet) is extremely important in the wound characteristics. The energy available for tissue disruption and penetration increases exponentially with velocity. The mass and the construction of the projectile may also influence the wound characteristics but to a lesser extent than the velocity.
6. Gunshot wounds in tissue consist of the primary projectile path (permanent cavity) surrounded by “satellite” paths from bullet and bone fragments and tissue expansion and tearing trauma. High velocity projectiles increase significantly the amount of tissue damage compared to low velocity projectiles.

7. The lead “snowstorm” effect of a high velocity rifle bullet may be demonstrated on a radiograph. The visible tissue damage to the carcass is directly correlated with the snowstorm of radio dense particles except where particles of the bullet are washed by free blood around the internal body cavities.

8. Shotgun pellet wounds are often multiple. The number and concentration of pellets is dependant on the size of the pellets and the distance from the shooter. Shotgun wounds containing very high concentrations of pellets indicate very short range gunshot and should be examined for the presence of plastic or fiber wad material which are not radio dense and do not show up on x-rays. These wads are important evidence items as they indicate the gauge of shotgun used.

9. Trajectory is the direction of the projectile relative to the shooter and victim. Establishing the trajectory is very important in so called “self defense” cases. It may also be important in locating a bullet which has passed through and animal and is lost into the environment. Bullets, if found, are important evidence items which may be individually matched back to a suspect’s firearm. Bullet entrance wounds have different characteristics than bullet exit wounds and the pathologist must differentiate entrance from exit wounds.

10. The lethality or the incapacitation ability of the wound is important for the pathologist to document based on the damage to vital organs or structures because the animal’s ability to move after it has been shot may be critical in presenting the facts of the case.

11. Radiographs (x-rays) are essential in documenting gunshot wounds. The type of projectile and the direction of travel through the body can be observed. Finding the projectile or major fragments, if present, is enhanced by the x-ray. The bullet jacket, important in the matching of the bullet back to an individual gun, may be differentiated from the bullet’s lead core which has little use in comparison analysis. Bone fractures caused by the projectile can also be assessed. Not all bullets leave fragments in the wound (example: all copper Barnes bullets, military full metal jacket bullets).

12. Toxic shot (lead shot) must be differentiated from non toxic shot in waterfowl legal cases. It is essential to document with pathological observation and shot recovery and analysis if toxic shot caused death or incapacitation of the waterfowl.

13. Projectiles recovered from wounds are valuable forensic evidence. Bullets may be matched to an individual gun by a firearms examiner. Preservation of the detail on the bullets exterior surface is essential for matching. Therefore, the bullet must be handled in a manner which does not scratch or mar the surface and must be carefully cleaned, dried
and stored in a manner which prevents corrosion of the metallic surface. Use of porous paper envelopes instead of plastic bags or sealed bottles will reduce the possibility for oxidation and corrosion. Wrapping the bullet fragment in gauze will protect it from possible physical damage. Remember that projectiles from the carcass are important additional evidence and that a “chain of custody” must be established for the new item.

14. Differentiation of arrow wounds from gunshot wounds into which an arrow has been placed is a common law enforcement request. Pathological examination, radiographic documentation and finally lead analysis may be required to prove that a bullet has made the original wound. In a whole carcass examination, it is also important to document that the wound is incapacitating and/or lethal.

15. **Trauma** lesions are generally classified as sharp force (ex. hook or knife wound) and blunt force (tower or vehicle collision). Trauma lesions may be patterned or singular. Predation and/or scavenger damage to a carcass must also be identified and differentiated from other trauma.

16. Trauma lesions told a story different from the defendant in a cause involving the illegal killing of a cougar in Utah. Patterned rope abrasions to the mouth, strangulation lesions to the larynx and abraded claws were documented by the pathological evaluation of the carcass see case #2 presentation).

17. Snares leave patterned lesions around the neck of trapped animals.

18. Bone fracture patterns in the skulls of sturgeon determined that sturgeon were going over a dam and were not caught and clubbed to death by an irate fisherman as suspected.

19. Vehicular or radio tower collisions are frequent occurrences in wildlife. Birds or animals may travel some distance from the point of impact before internal hemorrhage from ruptured organs results in death.

20. Sharp force trauma, such as a knife wound, may be differentiated from hook trauma in illegally taken fish.

21. Several major cases of “animal abuse” or “satan worship” have involved deaths of multiple cats in an area. These have been very disturbing to the local inhabitants. Predators or feral dogs have been responsible for these cases. Documentation of bite fatal bite wounds must include skinning of the carcass because much of the damage is done without skin puncture. Tearing of skin must be differentiated from “cutting of the skin” which implies human intervention. Examination of the carcass of domestic animals allegedly killed by predators should carefully document lesions which indicate premortum hemorrhage. Scavenger damage must be differentiated from actual predator attack by assessing the pattern of attack, the presence of a lethal wound caused by the suspect predator, and the demonstration of hemorrhage associated with the wounds indicating the animal was alive when attacked.
22. Electrocution of raptors is very common. Birds found in association with power lines may or may not die from direct electrical insult resulting in thermo electrical burns. On the other hand, some raptors may travel some distance after having been electrocuted. Burns, when present, may be as small as 1 to 2 mm in diameter or may envelope the entire carcass. Feathers around the primary lesion of contact are characteristically brunt and curled. Additionally, tissues along the tendons may appear “cooked”. Subcutaneous tissues may be “pocketed” around seared fatty tissue. Hemopericardium is a common finding in electrocuted eagles.

23. Poisoning of protected wildlife is common and is a major wildlife forensics issue. Restricted use cholinesterase inhibitory pesticides (carbamate and organophosphate classes) are by far the most commonly used toxins found in intentional poisoning cases. These chemicals are widely available for legal use by registered pesticide applicators. However, an underground market also exists and is a source for illegal use by those who often attempt to control livestock “predators” such as eagles, coyotes, bears, wolves and cougars.

24. Field investigation is essential for the proper documentation of suspected poisoning cases. Questions related to species affected, food habits of the species, clinical signs or death stance, post mortem condition of most of victims, scavenger evidence, legal pesticide use history in area are all important to establish in order to narrow the list of possible toxic substances and the sources of such substances. Because of the expense of analysis, the various approaches to extraction for analysis and often the limited amount of suspect material to test, chemical analysis should be used to confirm the presence of a suspect pesticide, not screen for a multitude of possible poisons.

25. Most acute poisons leave little or no visible pathological changes. Therefore the objectives of the pathological evaluation is to collect appropriate samples for chemical analysis and identification of the toxin, document and identify the possible source of the poison, and determine if the victim is a primary or secondary target (intent of suspect).

26. Crop and/or stomach content is the most frequently tested material for ingested poisons. Carbamate and organophosphate pesticides are often absorbed directly through the crop lining in birds. When the crop and stomach are empty of food items, the tissues lining the crop or stomach may be analyzed for the presence of pesticides. If pesticides are present in the lining, a water source might be considered along with the possibility of vomiting of the original content. Likewise, skin of the feet of birds may be tested for absorbed pesticide residue (cutaneous absorption). The cutaneous tissues of the feet of raptors may be the only tissues that retain traces of organophosphate and carbamate pesticides in decomposed or scavenged carcasses. Tissue levels or organic pesticides may vary significantly post mortem due to decomposition of the molecular structure of the chemical. Brain tissue may be collected for cholinesterase determination.

27. Identification of items such as hair, tissue, feathers, seeds, etc. and their location within a victim’s digestive track is an important forensic consideration. These items, as well as the suspect material for chemical analysis, become additional evidence items.
which may be passed on to other analysts. Therefore, documentation of presence, collection, position in the digestive track, etc. and proper establishment of a chain of custody are important. Remember that the defense also has a right to evaluate the evidence if they choose and that duplicate samples of material which is consumed in analysis should be collected on a routine basis.

28. Carbofuran and aldicarb are the most commonly detected pesticides detected in cases of intentional wildlife poisonings. Famphur, an unrestricted organophosphate pesticide used widely in the cattle industry, is also used to illegally poison pest birds which often results in secondary poisoning of predatory or scavenger birds. Strychnine, avitrol and anticoagulant rodenticides are pesticides that tend to be seen in secondary poisoning cases of protected wildlife where they are used legally to control pest rodents or birds. Accidental poisoning of wildlife occurs associated with legal agricultural use of pesticides.

29. Carbofuran is available in both granular and liquid forms. It is often poured on carcasses or incorporated into baits to kill scavengers such as coyotes, foxes, raccoons, eagles, vultures, etc. Aldicarb, most often seen as small black granules, is often also frequently observed in baits. The granular form is resistant to biological degradation and may remain in the environment for extended periods, especially in arid climates. Both of these compounds may kill birds within minutes of ingestion leading to the “circle of death” surrounding a baited carcass.

30. Strychnine is frequently observed in victims as green or blue green round grain seeds which are commercial preparations intended for rodent control. Nuisance waterfowl often are intentionally poisoned with strychnine impregnated grain were as raptors feeding on rodents which have fed on the seeds are victims of secondary poisoning.

31. UV light is used to examine for fluorescent particles incorporated into explosive cyanide devices called “M-44 coyote getters”.

32. Eagles and other scavengers are particularly susceptible to pentobarbital poisoning. Veterinarians, the primary source of this material, have been found liable for eagle kills due to improper directions to clients to dispose of large animal carcasses after euthanasia.

33. Oil contamination of birds after oil spills and due to entrapment in oil tanks, separation ponds or other facilities associated with petroleum production is a major need of forensic documentation because of the well established system of oil fund remediation for injured resources. Proper documentation of cause or causes of death in such cases must consider the possibility of death from other causes and secondary contamination of the carcass post mortem. Numerous forms of oil or petroleum products may be spilled into the environment with variable toxicities or physical effects.
USEFUL REFERENCES

Court Room Testimony


Firearms and Bullet Wounds


General Forensic Pathology


Time of Death


**Wildlife or Veterinary Forensic Pathology**


Walker, Danny N. and William J. Adrian (Editors), 2003. Wildlife Forensic Field Manual, Third Edition. (Multiple authors), Published by Association of Midwest Fish and Game Law Enforcement Officers, c/o David W. Oates, Nebraska Game and Parks commission, 2200 N. 33rd St., Lincoln, NE 68503 USA


**Wildlife Toxicology**
