



DEATH INVESTIGATION

Presented at the Washington State
Criminal Justice Training Commission
Basic Law Enforcement Academy

Curriculum Design and Lecture by
Officer Daniel V. Christman
Bothell Police Department
Bothell, Washington
(425) 486-1254

Medicolegal Death Investigation Systems

The History of the Medicolegal Death Investigation System:

Coroner (1194 AD) Medical Examiner's Office (1877 AD)

Coroner / Funeral Director
Coroner / Sheriff

Coroner / Prosecutor
Coroner / Medical Examiner

Differences Between a Medical Examiner and a Coroner

Coroner

Elected
Resident of the County

Medical Examiner

Appointed
Residency does not matter

Educational Requirements:

At least a High School Education

Graduate of Medical School
Successful residency
Pass the Forensic Boards

Office Structure: Investigators:

Deputy Coroners

Often Lay Investigators

Medical Investigators

Retired Cops
Nurses / Physician Asst.'s

Role of the Coroner / Medical Examiner:

1 Determine the Cause and Manner of Death

Cause of Death: is a simple statement of the primary disease process or injury that results in the individual's death

Manner or Death: is the medical examiner's opinion how the cause of death came about, and will be one of the five; listed below.

- 1 Natural,
- 2 Homicide,
- 3 Suicide,
- 4 Accident, or
- 5 Undetermined.

2 Identify the Decedent

3 Determine the Time of Death and Injury

4 Collect Evidence from the Body

5 Document Injuries of Lack of Injuries and Deduce how they Occurred

6 Document any Natural Disease Present

7 Determine or Exclude other Contributory Factors to the Death, and

8 Provide Expert Testimony.

DEATHS THAT NEED TO BE INVESTIGATED

1. Persons who die suddenly when in apparent good health and without medical attendance within 36 hours prior to death.
2. Circumstances indicate death resulted entirely or in part by unnatural or unlawful means like: Drowning, Suffocation, Asphyxia, Burns, Electrocution, Starvation.
 - ◆ Therapeutic Deaths
 - ◆ Addiction to Narcotics and other illicit drugs, including alcohol and other toxic agents.
 - ◆ Occupational Deaths
 - ◆ Deaths occurring from apparent natural causes during the course of a criminal act.
 - ◆ Those deaths following an accident even if the accident is not thought to have contributed to the cause of death.
 - ◆ Death following all injury producing accidents.
3. Suspicious Deaths
 - ◆ Deaths resulting from apparent homicide or suicide, Hanging, gunshot wounds, stabs, cuts, strangulation
 - ◆ Alleged rape
 - ◆ Death caused by or precipitated by a criminal act
 - ◆ Deaths that occur while in jail, prison, in custody of law enforcement, or other non-medical public institution.
4. Unknown or Obscure Causes
 - ◆ Bodies found dead.
 - ◆ Deaths following an unexplained coma.
5. Deaths caused by any violence whatsoever.
 - ◆ Falls, Fractures, etc.

Time of Death

I. EARLY POSTMORTEM PERIOD

A. LIVOR MORTIS

Lividity is a postmortem change produced by blood, being acted upon by gravity, settling to the dependent regions of the body.

Blood remains within the vascular system and does not “leak” from the capillaries until later in the decomposition process. The body’s position determines the pattern of lividity.

Lividity will settle in dependent, pressure-free areas of the skin. In areas where skin is restricted by clothing (a tight brassiere, elastic waistband, or tight socks, etc.) or bodily areas contacting a surface the result is an area that appears white and is described as “blanched.” In those areas, the superficial capillaries are compressed, and don’t allow the blood to settle. These areas of pressure give useful information about the body’s position, its relation to changes in position, surfaces of contact, or the presence or absence of constricting clothing.

LIVIDITY FIXATION TIME FRAME

Start phase	Minutes, to 4 hours
Well developed	4 – 6 hours
Fixed Phase	6 - 12 hours
Permanent Phase	3 - 5 days

COLOR OF LIVIDITY

Red-purple	Normal
Cherry red	Carbon Monoxide
Pink	Cyanide

- B. RIGOR MORTIS: Is the postmortem stiffening of the body**
The onset of rigor mortis begins in the smaller muscles and progresses to stiffen major muscle groups in approximately 4-8 hours. The entire body and trunk will generally stiffen in about 8-12 hours. Rigor endures from 24 - 48 hours, after which muscle groups again become flaccid.

“SOME RULES WORTH REMEMBERING”

Rule #1

Heat, internal or external, speeds the onset of rigor, particularly in thin persons whose muscles are small. The muscles of a febrile pneumonia victim, stiffen quickly.

Rule #2

Bodies with poorly developed muscles, such as infants or emaciated elderly people, become rigid quickly and likewise will lose their rigidity quicker.

Rule #3

Rapid rigidity may result if there is intense muscle activity immediately prior to death. The death of an Individual following a rigorous exercise routine, will produce a rapid onset of rigidity, sometimes in less than an hour after death.

Rule #4

Individuals with powerful muscles generally develop rigor mortis slower and retain rigor longer. This occurs because rigor is proportional to the amount of glycogen originally present in the muscles, and we know larger muscles take longer to stiffen.

Rule #5

Rigor disappears more rapidly in high temperatures since the disappearance of rigidity results from the decomposition process. Cold retards its dissolution so stiffness may be retained for days in wintry environments.

Rigidity Fixation Time Frame	
Onset	1-3 hours
Complete	9-12 hours
Receding	18-36 hours
Gone	+48 hours

C. ALGOR MORTIS: Is the postmortem loss of body heat.

The body cools until it reached the ambient (surrounding) temperature. Essentially, cooling will occur at a rate of 1.5 degrees per hour for the first 12 hours, and .5 to 1 degree for the following 12 hours.

Conditions to be considered

1. Environmental Issues

1. Room temperature.
2. Amount of covering or clothing.
3. Age of decedent.
4. Corpulence (Obese subjects retain heat longer.)
5. A body cools more quickly in water than in air.

2. Types of Death to Consider:

An infectious type of death (meningitis, tuberculosis, or pneumonia) can causes a post mortem rise in body temperature. Conversely, the hypothermic alcoholic can die with a lowered body temperature and have an inappropriate postmortem core temperature measurement.

3. Time Frames: (In a controlled environment.)

- **During the first 1-3 hours after death**, there is a marginal decrease in the deep core body temperature. Eventually, body heat begins to flow through the surface insulating layers (subcutaneous fat, clothing, etc.) and
- **For the next 6-9 hours**, the body temperature falls steadily.
- **After about 12 hours**, skin temperature is approaching that of the surrounding “ambient temperature.”

**BODY TEMPERATURE CALCULATION FORMULA
(In a controlled environment)**

$$\frac{99.6^{\circ} \text{ F.} - \text{Core Temperature F.}}{1.5^{\circ} \text{ F.}} = \text{Hours after death}$$

II. LATE POSTMORTEM PERIOD (Postmortem Decomposition)

A. Internal Forces

1. **Autolysis:** The softening and liquefaction of tissues due to the digestive action of enzymes released from the cells themselves.
2. **Putrefaction:** Bacteria, mainly from the large bowel, invade the body, spreading via the blood. The soft tissues of the body are largely converted to liquid and gases.

a. Time Frames:

With a body lying in a room at about 60 degrees F.:

- **2 - 3 days:** greenish discoloration over the lower abdomen / upper groin, which then spreads up and over the belly and chest.
- **1 week:** most of the trunk is discolored greenish-purple. Veins may show as a purple/brown “network” also called “marbling.” Outer layers of the skin loosen and rub off this is often referred to as “skin slippage.”
- **2nd Week:** Gas bubbles form in the skin. Intestines fill with gasses and the abdomen distends. Blood tinged fluid is forced from the body orifices. All the body tissues become distended with gas, especially where the tissue is loose (scrotum, breasts.) There is a generalized swelling of the body, the tongue protrudes from the mouth, and the features become unrecognizable.
- **3 - 4 weeks:** hair and nails are loosened. The face is greenish-purple and bloated, the body “balloons,” and appears much larger than in reality it was.

Decomposition is accelerated with the introduction of heat which acts as a catalyst in the putrefaction process.

B. External Forces

1. Animals and Rodents:

2. **Flies** - eggs may be deposited within a few hours, especially on the eyes, nostrils and lips. These eggs will hatch within 24 hours into maggots, which are full-grown in about 4 days. They feed for a week and then pupate.

3. **Temperature:** increases in temperature raises the rate of autolysis and bacterial activity.

4. **Obesity:** Body fat acts as an insulant and reduces the rate of body cooling. When heat is “trapped” in the body, the rate of decomposition is accelerated.

5. **Air and Moisture** - when air is severely restricted, e.g. burial in clay, soil, putrefaction is slow. When moisture is removed, e.g. when the body is lying in hot dry air, the outer tissues become dry before decomposition has become established, and remain preserved for many years.

6. Environmental Conditions:

After Normal Burial - rate of decomposition is affected by the depth of the grave, warmth of the soil, permeability of the coffin, efficiency of drainage of the soil, and whether or not the body is embalmed, and how well. Roughly, one week in air equals two weeks in water, and eight weeks in the ground. Skeletonization in well-drained soil usually takes about ten years.

Decomposition in Water – The upper body, including the lungs and intestines, distended with gas, which causes the trunk to rise to the surface. The head, arms, and legs, hang down, and because they are dependant to the rest of the body, they have more lividity. The body will surface in this way after a few days to three weeks according to the temperature of the water.

□

DROWNING ARTIFACTS

- Skin Hydration (washer-woman skin)**
- Mutilation by scavengers**
- Drift abrasions**
- Gas formation**

C. MUMMIFICATION

For this process to occur, environmental conditions must have caused drying of the tissues quick enough to halt decomposition before this has become well-established. This may occur in warm indoor surroundings. Air-movement will aid drying. Part or all of the body may become mummified. the tissues become hardened, darker and resist decomposition for many years.

D. ADIPOCERE FORMATION

This unusual chemical change requires warmth, a certain degree of moisture, and some invasion of the affected tissues by endogenous bacteria. The process affects the body fat, mainly subcutaneous fat, converting them to long-chain fatty acids (waxes). The process helps preserve the form and even features of the body or evidence of injuries. The material is soft, crumbly and greasy, and being acid prevents further bacterial decomposition. Easily recognized adipocere takes three or more months to form, even under suitable conditions, then probably affecting only certain parts of the body.

DEATH DUE TO NATURAL CAUSES IN ADULTS

I. **Unexplained deaths fall into two categories:**

- A. Those that occur in patients who have been studied extensively during prolonged, complex illness without a satisfactory diagnosis having been established.
- B. Those that follow an illness of such brief duration that there has been little or no opportunity for medical observation or studies to provide a reasonable explanation for what occurred. The more **unexpected** the death, the more likely it is to be **unexplained**.

“The more **unexpected** the death,
the more likely it is to be **unexplained**.”

II. **Obtaining a medical history**

A. **Purpose**

- 1. Aids in evaluating the cause and manner of death.
- 2. Assists in deciding whether an autopsy is warranted.

B. **Through an informant (Anyone who knew the decedent.)**

- 1. Family history is important i.e. cardiac disease
- 2. Find out who the regular attending physician is or where the decedent has been previously treated.
- 3. Symptoms manifested prior to death can lead you to a conclusion about the cause of death.

C. **Medical Records/Hospital Charts**

History and Physical - peruse with discretion, this record is often here say and misconstrued.

Physician progress notes/consultations - Pertinent only to immediate hospitalization, can be hard to read.

Lab/X-ray results - Obtain with charting from the hospital.

Admission record/"face sheet." These will contain most of the statistical and factual data needed.

Discharge summaries - give the basic information of the current hospitalization.

Operative notes or other major procedures

Pathology reports

D. **Other Agencies**

- 1. Detox, Alcohol Rehab. Centers, Jail, Senior Centers, etc. take medical histories and next-of-kin information for emergency contacts.

III. Physical and History

A. Cardiovascular disease - Signs and Post Symptoms

1. **Arcus Senilis** - Light gray or yellowish ring around outer iris associated with familial hypercholesterolemia or coronary disease.
2. **Peripheral edema** - Swelling of the extremities due to the heart's inability to adequately pump excess fluid through the peripheral capillaries and back into the blood stream.
3. **Oblique creases** - Deep groove-like channels of the ear lobes significant to those with coronary disease.
4. **Scars** - that signify surgical correction cardiovascular problems. A sternotomy is a linear scar that extends from the base of the neck, to the upper abdomen and is indicative of a coronary artery bypass graft surgery (CABG "Cabbage") An endarterectomy scar is located on the neck, either one or both sides. During this procedure the artery is cleansed of obstructions that diminish blood flow to the brain.

B. Respiratory Disease

1. **Hemoptysis** - traces of blood in sputum secondary to a number of conditions including cancer and pulmonary emboli (blood clots in the lung.)
2. **Barrel chest** - the chest appears rounded, as if during inspiration (there is generally no movement during respiration).

C. Central Nervous System

Seizures - look for bite marks on the tongue or in the mouth. Dilantin is one of the very popular medications for control of seizures.

Carotid Endarterectomy scars - surgery to increase blood flow to the brain. The scars usually extend from the region of the ear(s) to the to the clavicle(s).

D. Hepatic (Liver) Disease

1. **Jaundice** - yellowish cast of the skin secondary to hepatitis, hepatic necrosis or other liver disease.
2. **Ascities** - the accumulation of fluid in the abdominal cavity. Appears as a very distended belly. The most common cause is cirrhosis but there are a number of other disorders that result in ascities such as ovarian cancer.
3. **Spider nevi** - are spider-like vessels in the nose, face and other areas of the skin.

E. Renal (Kidney) Disease

1. Dialysis fistula - tube that is usually located in the forearm. It appears as a large, raised scar with evidence of needle marks.

F. Diabetes Mellitus (DM)

1. Disease that involves the pancreas' ability to produce or secrete sufficient insulin to metabolize dietary glucose. Foot lesions are a common manifestation and are caused by a combination of peripheral neuropathy and peripheral vascular disease. Smoking and alcohol use can exacerbate DM. Infections, ulcerations and sometimes gangrene is present in these individuals.

2. There are two primary forms of DM.

Type I: Insulin dependant DM accounts for about 5% to 10% of all cases. These people require injection of insulin. Type I DM used to be called juvenile onset DM. Look for insulin vials in the refrigerator.

Type II: Non-insulin dependant DM occurs in the remaining 90% – 95 % of the cases. These people do not inject insulin and Type II DM tends to occur later in life.

III. Markers and Associated Evidence

A. Medications

1. Special attention should be made with respect to medications. A cursory inspection of pill counts may turn the investigation of a natural death into a suicide or accidental death investigation. Psychiatric prescriptions warrant even closer examination. Compare the date the prescription was filled and the frequency taken to the number of pills remaining. Make note of where each medication is found.

B. Places to look

1. Bathrooms
 - a. Medicine cabinets and other cupboards
 - b. Drawers
 - c. Counters and the back of the toilet tank
2. Bedroom
 - a. Nightstand, including drawers
 - b. Headboard and compartments there
 - c. Windowsills
 - d. Dressers
3. Kitchens
 - a. Counters

- b. Cabinets, even lower level ones
- c. Refrigerator/freezer
- 4. Miscellaneous
 - a. Purses, backpacks and other totes
 - b. Trash cans

C. Evidence of medical care

- 1. This can be in the form of doctor/hospital bills, appointment cards and insurance papers.
 - a. Next to the phone (address books, lists)
 - b. File cabinets
 - c. Desk, kitchen or bedroom drawers
 - d. Kitchen cabinets, Purses, wallets, etc.

SUDDEN INFANT DEATH SYNDROME

I. Definition

Sudden Infant Death Syndrome (SIDS), more commonly known as "crib death" is a medical mystery, which affects up to 7,000 infants each year in the United States alone.

Although there are several theories of cause, none have yet to withstand the careful scrutiny of medical investigation. SIDS is defined as the sudden death of an infant, which is unexpected by history and following a thorough autopsy, there is no satisfactory explanation of a cause of death.

II. Basic Facts About SIDS

- A. SIDS is the number one cause of death in infants who are more than one week old. 90% of all SIDS cases occur before six months of life with a peak from 2 to 4 months.
- B. SIDS most commonly occurs in infants between ages one week to one year of life. Occasionally an older or younger baby may die of SIDS
- C. SIDS is not a rare disease. Approximately 6,000 to 7,000 babies die as a result of SIDS every year in the US - about two to three for every 1,000 live births.
- D. SIDS victims do not suffer; death comes quickly, within seconds, usually during sleep.
- E. SIDS is at least as old as the Old Testament and seems to have been at least as common in the 18th and 19th centuries as it is now. The term Sudden Infant Death Syndrome (SIDS) came into general medical use after 1969.

- F. SIDS is not suffocation, aspiration or regurgitation, although sometimes death certificates erroneously bear such terms. SIDS became an acceptable term for general use on death certificates after 1973. Periodically other terms may still be used.
- G. A minor illness such as a common cold may precede the death, but many victims display no observable symptoms. The majority have appeared entirely healthy.
- H. SIDS is not contagious.
- I. SIDS is not considered heredity.
- J. SIDS occurs among families of all socio-economic strata.
- K. Researchers believe SIDS probably has more than one cause, although the final process of death may be similar in most cases.
- L. Due to the nature of SIDS, no single test has been discovered to identify which infants will succumb to it. There is, therefore, no means of prevention.

III What Causes SIDS?

Countless theories exist about the possible causes of SIDS. Today, in spite of extensive research, no single theory has yet been proven, but many have been disproved. It seems likely that SIDS, like many other disorders, will eventually have more than one final explanation.

Current studies include those involving the nervous system, the heart, breathing and sleep patterns, body chemical balances, autopsy findings and environmental factors. Researchers claim that no single area of study will provide the final solution, but each area may ultimately contribute to its understanding. Scientists generally agree that while SIDS victims may appear normal, they most likely have subtle functional defects which are not discernible at this time. The National SIDS Foundation makes available results of the most current research.

Articles and reports about SIDS often appear in the news media, often claiming "the cause" has been discovered. It is important to re-state that SIDS continues to be an unsolved problem. Even with current scientific knowledge, SIDS victims cannot be identified beforehand.

WOUNDS DUE TO BLUNT TRAUMA

I. Wounds

A. Abrasions (Scrapes)

1. **Defined:** Abrasion is the name given to an injury to the skin in which there is removal of the superficial epithelial layer of the skin (the epidermis) due to friction against a rough surface with resultant scraping away of the superficial portions of the epidermis, or destruction of the superficial layers by compression.
2. **Characteristics**
 - a. Abrasions heal without scarring.
 - b. Antemortem abrasions have a reddish-brown appearance, while
 - c. Postmortem abrasions are yellow and translucent with a parchment-like appearance.
3. **Types**
 - a. Scrape or brush abrasions (graze or sliding abrasions) The blunt object scrapes off the superficial layers of skin.
 - b. Impact abrasions (pressure abrasions) The blunt force is directly over perpendicular to the skin, crushing it.
 - d. Patterned abrasions (A variation of an impact abrasion) The imprint of either the offending object or the intermediary material is imprinted on the skin by crushing effect of the blunt object.
4. **Stages of Healing**
 - a. Stage One (scab formation) earliest onset is 2 hours up to 30 hours.
 - b. Stage Two (regeneration) beginning at 30 hours through 72 hours.
 - c. Stage Three 5 through 8 days.
 - d. Stage Four (Regression) Begins around 12 days.

B. Contusions (Bruises)

1. **A contusion (bruise) is an area of hemorrhage into soft tissue due to the rupture of blood vessels caused by blunt trauma.**
 - a. May be present on the surface of the skin or in internal organs (lungs, heart, brain and muscle.)
 - b. When a large collection of blood gathers in the area of a contusion, this is called a **hematoma**.

2. Aging the Contusion; aging is difficult and dangerous to one's reputation.

- a. A fresh bruise usually appears reddish-purple.
- b. After 24 hours the margin begins to lighten.
- c. After a few days the bruise changes to green/yellow.
- e. The contusion may last for weeks or months.

3. Characteristics

- a. May not develop at site of impact.
- b. Hemorrhage may not be immediately visible but delayed in appearance.
- c. Bleeding may remain deep in tissues and not develop on the surface.
- d. The number of contusions generally reflect the minimum number of impact, but coalescence creates difficulty in interpretation.
- e. Size need not necessarily correlate with the impacting surface.
- f. Commonly are located over prominent bony structures such as the head and extremities.
- g. May be the only indication of the cause of death in strangulation.
- h. May show a pattern matching impacting surface particularly if the surface is narrow or intricate.

C. Lacerations

1. A laceration is a tear in tissue caused by either a shearing or by a crushing force.

- a. Like a contusion, a laceration can be found on the surface of the skin or on the surface of an internal organ.
- b. They are caused by blows from blunt objects, falls, or impact from vehicles.

2. Characteristics:

- a. Unequal splitting of tissue planes leading to **bridging** with intact vessels, nerves, or fascia in the wound.
- b. Lacerations of the skin look irregular with abraded contused margins.
- c. The degree of bleeding may vary depending on crush injury to the vessels.
- d. There may be trace evidence found in the base of the wound which was shirred off or flaked from the impacting surface.

3. **How lacerations occur:**
 - a. Surface is impacted by an area of the body, the body surface impacts a stationary object; these lacerations are commonly produced in falls and automobile impacts.
 - b. Objects used as weapons which impact the body surface such as a bottle, pipe, tree limb. An instrument becomes a weapon when it is used to inflict injury. Some weapons like bottles can have a cutting and/or tearing component.
 - c. Because of the associative bruising, some lacerations may bear the imprint of the weapon of injury. The more irregular and intricate the impacting surface, the more likely an imprint will occur.

D. Defense Wounds due to Blunt Force

1. Just like defense wounds in knife attacks one may find defense wound from an attack involving a blunt instrument.
 - a. Abrasions and contusions of the back of the hands, wrists, forearms and arms.
 - b. Lacerations are rare.
 - c. Fractures can be seen in defense wound areas.

BLUNT TRAUMA INJURIES OF THE TRUNK AND EXTREMITIES

I. Blunt Force Injuries to the Thorax (Chest)

- A. The chest is a bony, cartilaginous cage containing and protecting the heart, the lungs, and their major blood vessels.
 1. **Landmarks**
 - a. The sternum (breastbone) and the ribs make up the front of the chest.
 - b. The diaphragm forms the floor of the chest and divides the thoracic and abdominal cavities.
 - c. The heart lies between the two lungs, in the middle of the chest. It projects farther into the left chest cavity than the right.
 2. **Injuries**
 - a. Non penetrating blunt force injuries of the chest organs may occur with or without external evidence of injury to the chest wall. This may be attributed to the victim's clothing.

B. Injury to the Ribs

1. Four general types of injury

- a. Spontaneous or Pathologic Rib Fractures
- b. Iatrogenic (Therapeutic) Rib Fractures
- c. Rib Fractures Caused by Direct Localized Violence
- d. Rib Fractures Caused by Indirect Violence

2. Complication of Fractured Ribs

- a. Flail chest (collapse of the chest, making breathing impossible),
- b. Lacerations of the intercostal blood vessels with hemothorax,
- c. Laceration of the lung with pneumothorax
- d. Laceration of the lung with hemopneumothorax
- e. Pleurisy, pneumonia, and
- f. Impaling wounds of the heart.

C. Injury to the Pericardium and Heart

1. Any massive crushing force applied to the anterior chest may cause lacerations of the pericardium and heart.
2. Similar force applied to the anterior chest may also produce contusions to the heart tissue.
3. Lacerations of the heart occur primarily when a very severe crushing force is applied to the anterior chest
4. If the heart is lacerated and the pericardial sac remains intact the result is rapid death. Blood is pumped into the pericardium causing a cardiac tamponade.
5. If the pericardial sac is lacerated, blood will move into the pleural cavities.

D. Injury to the Aorta

1. Aortic lacerations are most commonly seen in automobile accidents, less common in falls. Usually seen in the driver who sustains impact injuries with the steering column or when the passenger strikes the dash board.

E. Injuries to the Diaphragm

1. Traumatic rupture of the diaphragm is most often caused by severe blunt trauma to the lower anterior chest. Often times it's associated with fractured ribs and thoracoabdominal injuries.
2. With traumatic rupture of the diaphragm, abdominal viscera invades the thoracic cavity.

F. Injuries to the Lungs

1. **Pneumothorax** (air in the chest cavity) may be due to natural disease, medical procedures, or trauma.
2. **Hemothorax** (blood in the chest cavity) caused by trauma to the lung(s).
3. **Pneumohemothorax** (air and blood in the chest cavity).

G. Blunt Force Injuries of the Abdominal Viscera

1. The type of injury is dependent on the organ involved.

H. Injury to the Liver

I. Injury to the Spleen

J. Injury to the Gastrointestinal Tract

K. Injury to the Kidney

II. Blunt Force Injury of the Extremities

These injuries may be limited to the skin and subcutaneous tissues or extend to muscles, blood vessels, nerves, bones, and joints.

A. The lower Extremities

1. Usually seen in automobile - pedestrian accidents.
2. Complications of Blunt Force Injuries to the lower extremities
 - a. Shock
 - b. Hemorrhage
 - c. Venous Thrombosis with fatal Pulmonary Embolism
 - d. Fat Embolism
 - e. Infection
 - f. Crush Syndrome
 - g. Effects of Injury on Preexisting Natural Disease

B. Upper Extremities

1. Usually seen in motorvehicle accidents, falls and assaults.

TRAUMA TO THE SKULL AND BRAIN: (CRANIOCEREBRAL INJURIES)

I. Categories

A. Impact injuries

1. Defined as injuries caused when an object strikes or is struck by the head.
 - a. Lacerations, abrasions, and contusions of the scalp
 - b. Fracture of the skull
 - c. Contusions of the brain
 - d. Epidural hematomas
 - e. Intracerebral hemorrhages

B. Acceleration/Deceleration injuries.

1. Defined as injuries that are due to sudden movement of the head the instant after injury resultant production of intracranial pressure, subjecting the brain to both shearing and tensile forces. Two types of injuries are incurred:
 - a. Subdural hematomas
 - b. Diffuse axonal injury

GUNSHOT WOUNDS (GSW)

Upon discharge of a firearm, the following materials leave the barrel:

1. The bullet.
2. Gases.
3. Powder (burning and unburned.)
4. Soot.
5. Bullet and jacket fragments.
6. Primer compounds (lead, antimony and barium.)
7. Copper, brass and nickel from the cartridge case.

I. GSW's are generally divided into four categories, by range:

A. Contact

1. The muzzle is in contact with the body.
2. In all contact wounds there are:
 - a. Scorching of the wound margin.
 - b. soot (powder blackening) deposited on the inner wound margin.
 - c. Soot and powder particles driven into the wound tract.
3. In all contact wounds there may be:
 - a. A muzzle impression, due to blow back of the skin.
 - b. Soot on the skin adjacent to the wound.
4. In contact wounds over bone, as in the head:
 - a. Soot is usually deposited on the outer table of the skull, around the entrance, in the bone
 - b. A stellate wound of entrance is often produced by subcutaneous expansion of the powder gases between the skin and bone.
 - c. Soot may also be deposited on the inner table of the skull and on the dura.
 - c. Discontinuous skull fractures may be present.

B. Near-Contact Wounds

1. Differ from hard contact wounds in that:
 - a. They occur one-eighth to one-quarter inch from the target.
 - b. There is an area of powder blackening (soot) around the entrance wound not confined to the edges of the wound.
 - c. Stellate tears usually do not occur.
2. In contact / near-contact wounds over clothing, the clothing may absorb all the external soot and powder. However, those powder grains and soot particles will still be inside the wound track.

C. Intermediate Gunshot Wounds

1. The range is greater than that for contact wounds, but close enough to cause “powder tattooing” of the skin.
2. Maximum range of powder tattooing for handguns is around:
 - 24” for flake powder
 - 36” for flattened ball powder
 - 48”for ball powder
3. Powder tattooing occurs as a result of unburned and burning grains of powder the impacting the skin.
4. The diameter and density of the powder tattoo pattern can be used to determine the range. The same weapon and ammunition should be used, as powder patterns are varied from firearm to firearm and ammunition to ammunition.
5. Soot (powder blackening) is also present on close-up gunshot wounds 6” to 10” away from the target.
6. Soot can be wiped off, while powder tattooing cannot be wiped away.
7. Hair and clothing may interfere with powder tattooing to some degree. All clothing should be retained and examined.

D. Distant Gunshot Wounds

1. The range is greater than intermediate wounds. No soot or powder tattooing is present.
2. The exact range cannot be determined.
3. An entrance wound can be differentiated from an exit wound.

II. Entrance Wounds

1. Every entrance wound has an abraded margin, often referred to as an abrasion ring. This is due to the bullet’s scraping the margin of the bullet hole as it enters the skin.
2. The abrasion ring is present in contact, close-to-contact, intermediate and distant gunshot wounds.
3. Entrance wounds, with the exception of contact wounds over bone, tend to be small, circular and regular.
4. Symmetrical abrasion rings suggest a head-on shot and oval rings suggest an angular shot. This is not necessarily always the case. The course of a bullet can only be determined by careful internal examination of the body.
5. Gunshot wounds to palms of hand or the soles of the feet have no abrasion ring. Rather, they demonstrate a ragged wound (looks like an exit.) The reason for this phenomena is unknown.

III. Exit Wounds

1. These wounds are usually larger and more irregular than entrance wounds because of
 - Lack of support (reinforcement) for the skin.
 - Bullet tumbling.
 - Bullet deformation.
2. There is usually no abrasion ring.
3. It is rare to locate an abrasion ring on an exit wound. This can occur when the exit wound is “shored-up” by a firm surface or object such as a wall, floor or stiff belt.

IV. Other Considerations in Gunshot Wounds

A. Graze Wounds

1. May show the angle and direction the bullet traveled. Deeper wounds under the skin cause tearing of the skin.

B. Bullet Wounds to Bone

1. The entrance wound is a punched out, circular or oval hole with sharp edges. The opposite surface is beveled. In skulls for example, the entrance bullet hole is beveled on the internal table.
2. The exit wound is beveled or “cratered.” In skulls the exit hole is beveled on the outer table.

C. Bullet Wipe

1. The bullet wipe is a gray ring around the entrance hole in skin or clothing. It appears when bullet grime is wiped off on the skin or clothing as the bullet enters.
2. It is more common with revolvers.
3. It must not be mistaken for soot on the wound margin.

V. Miscellaneous Points

1. It is impossible to tell the caliber of a bullet by x-ray examination due to x-ray distortion.
2. The caliber of a bullet cannot be determined from examination of the entrance wound in the skin.
3. The trajectory of a bullet through the body is dependent on:
 - The position of the victim.
 - The position of the shooter.
 - The angle at which the weapon is held.

VI. Comments on Suicides with Firearms

1. Right-handed individuals occasionally fire the weapon with their left hand, steadying the barrel with their right hand.
2. Multiple bullet wounds do not rule out a suicide. One woman shot herself nine times in the chest, while another man shot himself five times in the head.
3. A fatal “accidental” shooting of an individual while “cleaning” his / her firearm is almost always a suicide. Most one man hunting accidents turn out to be suicides.

WOUNDS DUE TO POINTED AND SHARP EDGED WEAPONS

General Comments

Death from stabbing or cutting is seldom due to an accident, rather it's almost always a;

- Homicide, or
- Suicidal (Self-inflicted) injury.

I. STAB WOUNDS

A. Stab Wounds are a result of a pointed weapon being thrust through the body's surface.

1. The length of the wound tract into the body exceeds its width in the skin.
2. The majority of stab wounds are homicidal.
3. Stab wounds are produced by pointed instruments and weapons.
4. The wound edges in the skin are typically sharp, without abrasions or contusions.
5. The most commonly used weapon in stabbings is a knife which by virtue of its design can also produce incised wounds.
6. The typical weapon is a flat bladed, single edged, kitchen, pocket or folding knife with a four to five inch blade.
7. Other commonly used sharp edged weapons include ice picks, scissors, screwdrivers, glass, forks, pens, and pencils.
8. In describing stab wounds one should never use the term *laceration*. **Lacerations** are defined as mechanical tearing caused by varying amounts of crushing, shearing, tearing or even stretching of the tissue. Lacerations are not caused by sharp edged instruments / weapons

II. INCISED WOUNDS

A. **Incised Wounds:** result from a sharp-edged instrument or weapon contacting the body surface in a "stroke-like" fashion.

1. The length of the wound is greater than the depth of the wound.
2. The sharp edge of the weapon is pressed into and drawn along the surface of the skin, producing the wound.
3. A knife is the typical weapon used to inflict an incised wound.
4. The margins are clean cut, straight edges, if the skin is taut the wound will be free of abrasion and contusions.
5. Incised wounds are usually not fatal. When they are fatal, the wound is more likely to be on the neck and/or arms.
6. Incised wounds are usually seen on exposed portions of the body.
7. The wound tends to gape and bleed freely.

B. Homicidal

1. Homicidal incised wounds are generally found on the neck and are not accompanied by “hesitation marks.”
2. The mechanism of death in incised wounds is usually either:
 - exsanguination (blood loss), or
 - air embolism
3. Clothing **will** be cut.
4. If the victim had an opportunity to initiate maneuvers, blood spatter evidence will be found in and or around the death scene.

C. Self Inflicted Injury

1. Suicidal incised wounds are usually accompanied by superficial “hesitation marks.”
2. Incised wounds found on the wrists and neck accompanied by “hesitation marks” usually indicate a suicide.
3. Wounds tend to be multiple and parallel and usually in one place (wrist, neck or ankles).
4. Usually commences from the left to right in right handed victims and right to left in left handed victims.
5. Clothing is usually not cut because the victim will remove it prior to producing the wound.
6. Blood spatter evidence will usually be confined to the area around the body except where the victim survived for a period of time and moved about the scene.

D. Defense Wounds

1. Defense wounds are incised or stab wounds, usually of the upper extremities, obtained when the individual attempts to ward off a sharp, edged weapon attack.
2. They are most commonly found on the palms of the hands, due to attempts to grasp or “block” the knife. Also they can be found on the back of the forearms and upper arms and on the back of the forearms. It is rare to find defense wounds on the lower legs and/or feet.

E. Chop Wounds

1. **Chop Wounds** are often deep gaping wounds involving major structures and resulting from the use of heavy, relatively sharp weapons.
2. Produced by heavy weapons with a blade.
3. Most commonly used weapons are axes, hatchets, machetes and meat cleavers.
4. They demonstrate mixed characteristics because the skin is incised while the subcutaneous bony structures are fractured.

ASPHYXIA

I. Suffocation

- A. **Entrapment** occurs when an individual is trapped in an air tight or near air tight enclosure.
1. Initially there is adequate oxygen to sustain life.
 2. As oxygen is consumed there the gas is not replenished.
 3. When the oxygen is consumed, the individual asphyxiates.
 - a. Most often seen when people become trapped in old refrigerators.
- B. **Environmental Suffocation** occurs when an individual unknowingly enters an environment where oxygen is not sufficient to sustain life.
1. Oxygen is displaced by other gases.
 - a. Underground chambers often lack enough oxygen for sustaining life.
 2. An oxygen concentration of 16% or less is immediately dangerous to life. Further reduction to less than 5% causes rapid loss of consciousness and eventual death.
 3. The cause of death is not determined by autopsy, rather by a thorough scene investigation.
- C. **Smothering** occurs when the external respiratory orifices (nose and mouth) are obstructed.
1. Obstruction of the nose and mouth can be occluded by an object such as a pillow or by particulate matter like sand, soil or grain.
 2. **Manner of death** is either Homicide, Suicide or Accident.
 - a. **Homicide:** A pillow or another device is placed over the victim's nose and mouth, occluding the external airways.
 - b. **Suicide:** A plastic bag is placed over the head, can be secured around the neck with string or tape.
 - b. **Accident:** A child's might become trapped between the crib side rails and the mattress causing complete occlusion of the external airways.
- D. **Choking** involves the internal obstruction of air passages.
1. The manner of death can be Natural, Accidental or Homicidal.
 - a. **Natural:** Most commonly occurs when the epiglottis becomes swollen and closes off the airway (epiglottis).

- G. Suffocating Gases** cause death by robbing life sustaining oxygen from the atmosphere.
- 1. Common gases** include; Carbon monoxide, carbon dioxide, and methane.
 - a. Reduction of oxygen to a concentration of 50% of the normal value causes noticeable symptoms.
 - b. When reduced to 25% or less, unconsciousness can occur in seconds and death in a matter of minutes.
 - c. Autopsies in such cases reveal no significant anatomical findings.

Symptoms from percent of hemoglobin saturated with carbon monoxide.

Percent	Symptoms
0 - 10	Usually none
10 - 20	Possibly slight headache
20 - 30	Headache, throbbing in temples
30 - 40	Severe headache, weakness and dizziness, dim vision, nausea, vomiting, possibly collapse
40 - 50	Even greater possibility for collapse increased pulse and respiration.
50 - 60	Unconsciousness, coma with intermittent convulsions, periodic respirations.
60 - 70	Depressed heart action and respiration, possible death.
70 - 80	Weak pulse, respiratory failure, death.

II. Strangulation

A. Hanging is an asphyxial death secondary to the compression or constriction of the neck structures by a noose or other constricting band tightened by the weight of the body.

Judicial hanging produces death by fracture-dislocation of the upper cervical vertebrae with transection of the spinal cord.

1. Characteristics

- a. Complete suspension denotes the body is not in contact with a solid surface.
- b. Incomplete suspension indicates that the body is supported by other means than just the ligature (Feet on the ground, kneeling, seated, prone, supine).
- c. Death is due to compression of the blood vessels of the neck such that there is an insufficient amount of oxygenated blood reaching the brain. Obstruction of the airway can also occur but is not necessary to cause death.
- d. Pressures needed to compress neck structures
 - Jugular veins - 4.4 lb;
 - Carotid arteries - 11 lb;
 - Vertebral arteries - 66 lb;
 - Trachea - 33 lb.
- e. In asphyxia by hanging unconsciousness is usually very rapid (a matter of seconds). Death may take five to twenty minutes depending on severity of obstruction and preexisting disease.
- f. Almost all hanging deaths are suicidal (2nd or 3rd most common method of suicide).

2. Ligatures

- a. The ligature (noose) is fashioned from whatever is handy.
- b. A simple slip knot type of noose is normally used.
- c. The noose usually slips above the larynx, catching under the jaw and creates a furrow in the skin. The furrow does not completely encircle the neck but slants upward, toward the knot, fading out at the point of suspension - the knot.
- d. Ligatures should be studied, documented and preserved.

3. General appearance

- a. Petechial hemorrhages present on the conjunctivae-sclera as well as the mucosal lining of the face.
- b. Congestion of the head superior to the ligature.
- c. Protrusion, swelling and drying of the tongue.
- d. Lividity of the dependent portions of the body.
 - Tardue spots

B Autoerotic deaths are asphyxial deaths due to hanging, whereas the asphyxia is intentionally induced to enhance sexual arousal, during masturbation.

1. Euphoria: Thought that anoxia timed with the ejaculation will intensify the sexual gratification.

2. Scene

- a. Private area (wooded area, garage, attic, closet).
- b. Body is nude or semi-nude.
- c. Cross dressing might be evident.
- d. Usually found suspended by the neck with padding under the noose to protect the skin from abrasion injury (padding is the key to this diagnosis).
- e. This pattern of behavior is repetitive.
- f. May be evidence of self-bondage.
- g. Body is not usually fully suspended.
- h. Erotic literature, female clothing, mirror(s) to observe self, or none of these items may be found at the scene.

C. Ligature Strangulation is the application of pressure by use of a constricting band that is tightened by a force other than the body's weight. Virtually always homicides, victims are usually female, suicides and accidents are rare.

The mechanism of death is the same as in hanging, occlusion of the vessels supplying blood and oxygen to the brain. Loss of consciousness occurs in 10 - 15 seconds.

1. Ligatures

- a. Any common article, such as a tie, belt, electrical cord, stocking, or scarf may be used.
- b. A soft ligature (towel, sheet) may result in an unremarkable furrow.
- c. The thinner and harder the ligature the more obvious the injury produced.

2. General appearance

- a. The furrow caused by a ligature tends to be horizontal, overlying or falling below the thyroid cartilage, and usually encircles the neck.
- d. In adults, because of struggle, there may be bruising and abrasions of the neck as a result of the victims attempting to free themselves from the ligature.

D. Manual Strangulation occurs when pressure is applied to the neck and air passages by the hand(s) or forearm(s). Virtually all cases are homicides, victims include but are not limited to, infants, children, women, or impaired men, and them unable to defend themselves. Suicide by manual strangulation is impossible.

1. General appearances

- a. Cyanosis of the face with petechiae of the scalp, conjunctiva, sclera, eyelid, and periorbital skin.
- b. External marks on the skin are usually present.
- e. Fingernail marks, abrasions and bruises of the skin are common.

E. Law Enforcement Neck Holds

1. Carotid Sleeper

- a. This hold is taught to law enforcement and correction personnel as a means to incapacitate an individual quickly. Originated from the martial art of Kung Fu.
- b. Intended to impede blood flow in the carotid arteries by pressure exerted on both sides of the neck.
- d. Pressure is applied by the pincer effect of the arm and the forearm of the person applying the hold.

2. Bar Arm Control or "Choke Hold"

- a. Law enforcement acknowledge the hazards of the choke hold but defend its proper application.
- b. This hold is designed to occlude the airway by forearm compression of the upper airway.
- c. When a struggling combative person tries to free himself, the constricting neck hold does additional damage.